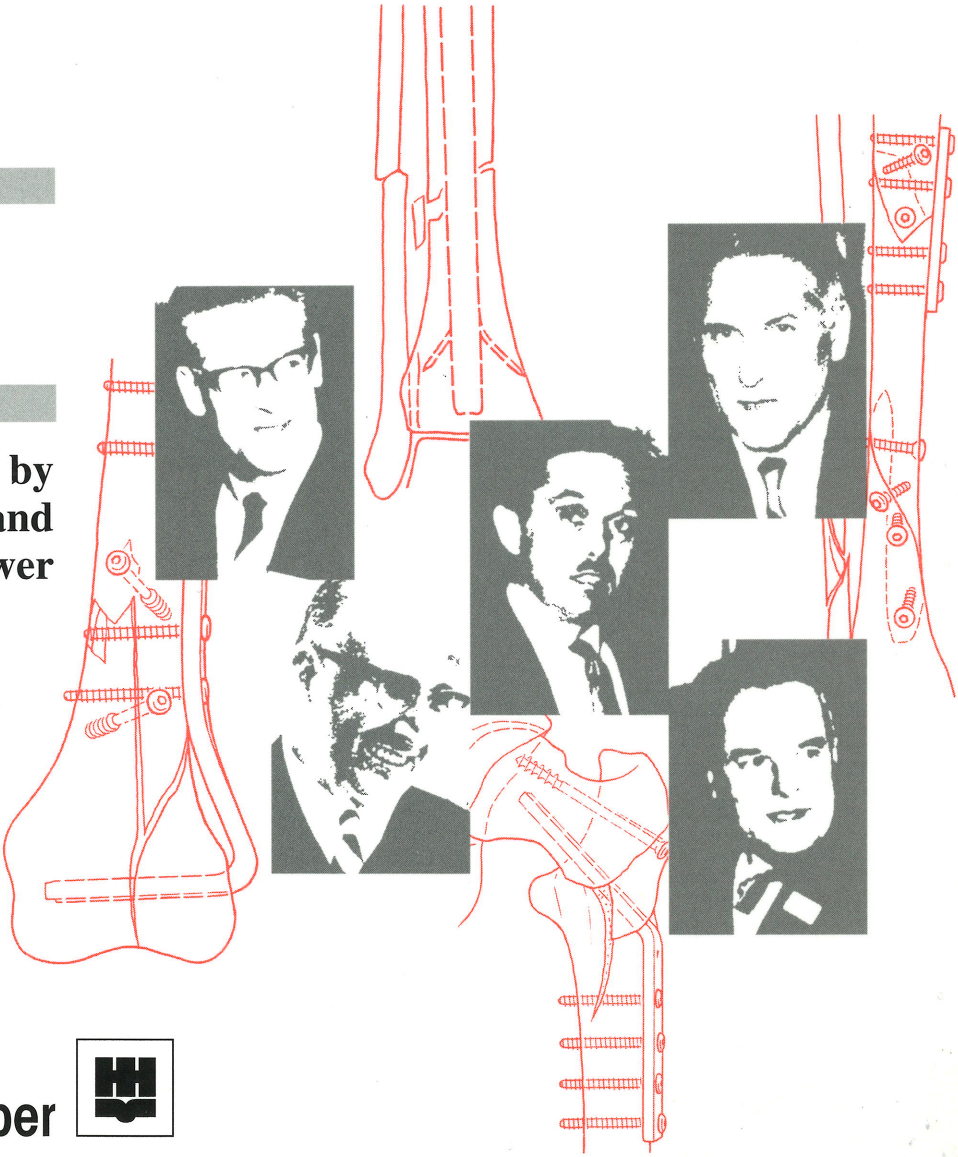
Urs F. A. Heim

The AO Phenomenon

Foundation and early years of the Association for the Study of Internal Fixation (ASIF)



Foreword by
M. E. Müller and
M. Allgöwer

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Foreword

Towards the end of the year 1960, there appeared on the horizon a new light shining on surgery, as it was applied to the locomotor system. This was a phenomenon by a group of relatively young orthopaedic and general surgeons who had become disappointed by the poor results, world wide, of the then prevalent fracture treatment methods.

In the following decades this group became gratified by the general impact of their "AO ideas". AO stands for the Arbeitsgemeinschaft für Osteosynthesefragen and is called ASIF, the Association for the Study of Internal Fixation, in English speaking countries.

We in the AO, impressed by Robert Danis' ingenious concept of rigid operative fixation of fractures which was followed by immediate, pain free mobilization of the injured limb, were anxious to prevent this idea from falling into oblivion. Thus, we set up a new instructional course concept – hands-on practical exercises in groups of two – and lectures on the scientific background of bone biomechanics.

Already the first course impressed the participants greatly. The newly developed, easily handled surgical armamentarium of screws, plates, nails and wires were put freely at their disposal and they were allowed to carry out themselves, in pairs, the four advocated methods of internal fixation on human bones.

A series of some 500 consecutively operated fractures with their postoperative healing pattern proved, more than any words, the validity of the concept. Particularly impressive was the attainment of early, active mobilization of the injured limbs and the positive radiological results at 12 and 52 weeks. The courses were repeated on a yearly basis and really changed the lives of orthopaedic and general trauma surgeons.

The AO phenomenon might have been only a temporary outburst of enthusiasm if it would not have been paralleled by the creation of Synthes AG Chur. This body had to draft royalty agreements with the producers of implants and instruments. Maurice Müller let the Synthes Chur have, free of charge, all the newly developed implants and instruments. All of the four initial shareholders, during the first 25 pioneer years, renounced any personal share of the increasing royalties, preferring support to be given to teaching and research. This financially provided the AO members and their institutions complete independence from any support by governmental or political bodies. It gave them complete freedom to go about research, documentation, conferences and courses. Merle d'Aubigné, one of the pioneers of modern orthopaedics in Europe, considered this complete independence the most important accomplishment of the AO.

Forty years after its beginninng, in the late fifties of the twentieth century, the history of the AO seems to have become mythical where facts and fiction tend to get mixed. It is very fortunate therefore that Urs Heim, a witness of the early years, decided to dig into the origins of AO. Over a number of years he was able to document vast numbers of historical facts and realistic oral reports. He could also lean heavily on two summarizing reports of our long-time chairman Robert Schneider, which are no longer available. Schneider has been a very puristic representative and a missionary of the AO philosophy. For his benevolent, critically documented look at the early AO years we owe Urs Heim a great debt of gratitude, which extends also to his commitment to his book as well as to the cause of the AO as a whole. We are also grateful to the many unselfish helpers who made the AO phenomenon come true. In the long run we are respectfully obliged to those "heirs" willing to carry the AO philosophy into the future.

Maurice E. Müller
Martin Allgöwer

Postscript by Martin Allgöwer

As an orthopaedic trauma surgeon, with immensely admired technical skill, Maurice had, over many years, created a solid group of friends. These friends, who later proved to be the main supporters of the AO, were grateful to Maurice for sharing with them his enlightening experience with Robert Danis, a pioneer of extremely meticulous fracture surgery, which permitted immediate pain free postoperative mobilization without plaster fixation.

Maurice brought this message to us. But he did this not before having succesfully tested the Danis concept on a sizeable number of tibia fractures, and after having created an innovative and very practical surgical armamentarium. His input and that of the whole AO group, had first a national and shortly thereafter a worldwide impact, changing and humanizing the treatment of fractures and non unions.

Preface

The present document has not been written to order or on the suggestion of anyone else.

The AO as an idea and its realization is a phenomenon, i.e. an unexpected occurrence, which awakens surprise, it is unique in its time and, therefore, demands special consideration.

The secret of the uniqueness and significance of the AO is that a whole group of equal, experienced young surgeons met together to develop a new treatment concept making use of equipment they designed themselves, to test it and, in collaboration with technical designers, engineers, scientists and economists, to promote and publicize it.

I recognized the necessity of writing a new script about the foundation phase and the early years of the AO when preparing for the Annual Meeting of the Foundation in 1989. This took place in the early summer in Switzerland up on the Bürgenstock. At that time, I was responsible for international relations.

At this meeting, a great number of newly elected members from distant continents were expected, members who were not familiar with the origins, basic ideas, and achievements of the early years. I had prepared an introductory lecture entitled "Why Switzerland" with which to open the meeting, however, the information once imparted quickly disappeared into thin air.

From various meetings at this conference it became apparent that the knowledge of many younger members – even those from a similar background – had only a biased or incomplete knowledge of the history and ideas of the pioneers. Legends were already developing.

This despite the fact that Robert Schneider – an outstanding, long-serving AO founder and leader – had written his second book "25 Jahre AO-Schweiz" *[25 years AO Switzerland]* only a few years before. But his chronicle was written in German, not registered with any publisher, not commercially available, and thus, not to be found in the libraries. The print-run was unknown. It had been sent to the members at the time and some friends. The purpose of providing information to a wider readership could not be achieved with this volume.

The original plan was to write a shorter sort of paperback in English as an introduction to the thinking and activities of the young AO. Humorous anecdotes were to be included to lighten the reading and make the book more accessible.

The project was delayed by numerous, more pressing obligations until the mid 1990s. Long before that, informative discussions with the pioneers had already taken place. Robert Schneider and Fritz Straumann were no longer alive then, but Walter Bandi, Hans Willenegger and Robert Mathys were. Maurice Müller and Martin Allgöwer with their intact memories have both been a great help right up to the present time.

Additional material about the early years came to light during two brief meetings of the pioneers and collaborators in the late summer of 1997 and early 1998. I also received several letters at that time, but co-authors were not to be found amongst the 'pensioners'. Thus, the project became a one-man undertaking.

The difficult task of reading and processing the documentation began in 1997 and, the end of 1998, had culminated in a richly illustrated text, which I was informed was unpublishable.

These preliminaries had however already shown clearly that a small booklet with a humoristic slant would never do justice to the subject matter. The sheer volume of relevant facts required more profound and comprehensive study. Thus, the originally intended and repeatedly proposed target group of predominantly younger readers disappeared from the horizon.

Work was continued regardless of the readership or economic dictates with the primary aim of highlighting the original ideas, relationships and motivations of the AO and thus facilitating an understanding of the "AO Phenomenon".

At this time, PD Dr. Th. Schlich of the Institute of the History of Medicine at the University of Freiburg i.Br. was also commissioned through the Board of Directors of the Foundation to write a manuscript on the scientific significance of the AO. His task of focusing on the international divergence of the movement would have a different objective and be published primarily in English. A friendly exchange of thoughts, records, and texts developed between us[1].

I derived much encouragement from the very remarkable *"Geschichte der Unfallchirurgie" [History of Traumatology]* by my friend Fritz Povacz, published early in the year 2000 and also the work of an emeritus. I will be referring to it here and there[2].

I took up my task again intensively at the start of the year 2000 and was able to complete it early in 2001.

Actually – it could be argued – that the AO, which is still developing at a great pace, is not yet history. What then is history?

The famous French historian, Jules Michelet, wrote in the mid 19th century when he was working on his *"Histoire de la révolution française"* [History of the French Revolution] that *"L'histoire c'est le temps" [History takes time]*[3]and with that he meant an optimal period of 40 to 50 years. For any shorter period, the level of emotional involvement is too great. Later on, the psychologically indispensable eyewitness is no longer alive: the 'oral tradition' has dried up.

The AO was founded in 1958 but its origins reach back much further. We have passed Michelet's deadline; we are writing history.

History has taught us that all ideologically motivated movements continue to adhere in name to their objectives, but that their original character does not outlast a generation. Centrifugal forces or material considerations, disguised as necessities, gain the upper hand.

Schneider recognized this. In 1969 he wrote (Schn I/16): *"Mit zunehmender Anerkennung entfällt die einigende Kraft" [As recognition increases, so the unifying forces ebb away]* and again later on in the text (Schn II/5) *"Aus diesen Gründen scheint eine Rückbesinnung auf die Ursprünge, die Wurzeln des sichtbaren, erwünscht, also auf den Geist der damaligen Zeit" [For these reasons, a recollection of the origins, the roots of the visible, indeed of the spirit of those times, is desirable]*. This also explains why we wish to restrict this work exclusively to the early years of the Association.

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Introduction

This report is based primarily on two fundamental books by the founder and AO spokesman Robert Schneider: *"10 Jahre AO" [10 years AO]*, published in 1969 and printed by AO Documentation in Berne[4] and *"25 Jahre AO-Schweiz" [25 years AO Switzerland]*[5] printed in 1983 by W. Gassmann Inc. in Biel (**Fig. 1**). It is our particular concern that these two reports with their valuable content and personal statements should not fall into oblivion. We will follow after them, refer to them constantly, and often quote from them word for word.

Fig. 1: The title pages of the books by Robert Schneider from 1969 and 1983.

Most references are taken from the second book, abbreviated as **Schn II** plus the page numbers. Almost all the texts from the 1969 book were reproduced in the second book. If this is not the case, then we refer to the 1969 book, abbreviated as **Schn I**.

Schneider's first book had 85 pages. It is made up for the most part of annual reports, agendas and lectures from the meetings, lists of courses, etc. The members at that time were introduced by inclusion of a passport photo and a brief curriculum vitae.

The 1983 book covered 280 pages. The annual reports were included up to 1982. The number of members had risen by that time to 110 (of these, 8 were scientific and 13 were corresponding members). The movement had become an international force (AO International had been in existence since 1972). There were separate chapters for the development of the instrumentation, the technical commission, documentation, AO International, and Synthes. These chapters had been written by M. E. Müller, H. Willenegger, W. Bandi, and P. von Rechenberg. Schneider had added his personal thoughts here and there and had had some older documents reproduced.

The chronological part of this report is taken completely from Schneider's work. His statements have been repeated and, if need be, commented on and/or supplemented. This book can therefore be understood, so to speak, as the *"expanded Schneider III"*.

The two versions of Guidelines [Merkblätter] from 1961 proved to be valuable documents. These are referred to by the abbreviations "**Me I**" and "**Me II**"[6,7].

In 1963 the first AO book entitled *"Technik der operativen Frakturenbehandlung" [Technique of operative fracture treatment]* was published by Springer Publ. Inc.[8]. It was soon sold out and is hardly known today. It reports clearly the theories valid at the time, principles of treatment, and techniques. We refer to this book with the abbreviation "Te" plus the page numbers.

Other publications at that time are also referred to and are presented in the reference list.

The following literature was also available for reference: the Annual Reports of the Laboratory for Experimental Surgery in Davos[9], the Annual Reports of the Cantonal Hospital in Chur[10] and the protocols of the meetings of the Technical Commission (from May 1962)[11]. These are referred to by the abbreviation "TK" and the date of the meeting. Statutes and contracts were also available for perusal (Appendix p. 226ff).

Additional valuable information originated – as already mentioned – from interviews and discussions with members, collaborators or their relatives, and from letters. I wish to express my deepest gratitude to all of them. The source of these statements and excerpts is marked with the initials of the originator. A list is given on p. 16.

To understand the idea and realization of the AO, it is necessary to refer to earlier pioneers, in particular, the actual forerunners Lambotte, Danis, Küntscher and Böhler. Their short biographies are given in Chapter 1. Details of their specific equipment and techniques are described in Chapters 6 and 7 and compared with those of the AO.

How the founders met and initiated their collaboration is reported in Chapter 2.

The personalities and their professional careers are summarized in the form of short biographies in Chapter 3.

Chapters 4 and 5 portray the course of events in the period 1959–1963 with reference to Schneider.

The first five chapters are therefore a chronicle.

In contrast, chapters 6, 7 and 8, are entirely my own compilation.

The special structures existing in virtual reality as the four columns of the AO (instrumentation, documentation, teaching, and research), together with the Cooperation are presented as a synthesis in Chapter 6.

In Chapter 7 principles and technique, which exist in close relation to each other, are both summarized under particular consideration of the Guidelines of 1961 and the book *"Technik" [Technique]*.

In Chapter 8 selected examples from the documentation illustrate how the principles of the AO were applied to the individual practice of osteosynthesis. The connoisseur will find an interesting variety there and be able to follow the manifest technical development from 1958 to 1963. The unavoidable slip ups are also reported.

The report ends in 1963. At that time, Müller was appointed to Berne, Allgöwer was awarded an associate professorship, there was an equilibrium between the courses and the book, the essential results of histological and biomechanical research had been obtained. The final contract between the producers and Synthes had been signed. The expansion of the ideas, instrumentation, and techniques of the AO could begin.

The rather brief Chapter 9 (Epicrisis) sketches the immediate period of development which followed.

After the concluding remarks, a number of documents are reproduced in the appendices. These are considered necessary for a proper understanding of the period described in this book.

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8 Müller ME, Allgöwer M, Willenegger H. Technik der operativen Frakturenbehandlung. Springer Berlin, Göttingen Heidelberg
9 Annual Reports of the Laboratory for Experimental Surgery (Research Institute, Davos) 1960–1970
10 Annual Reports of the Kantonsspital Chur 1956–1963
11 Protocols of the AO Technical Commission from May 1962–1970

Thanks

For the creation of this book, I was obliged to rely on active assistance from many quarters:

- for the organization and transcript of the text, I received great assistance from my secretary Mrs Sandra Schoch-Lehnherr, who, for family and professional reasons, could only access her computer in the evenings.
- the *"old guard"* have also participated: Klaus Oberli as graphics artist responsible for the drawings, Urs Keller and Lotti Schwendener for the photographs.
- much good advice and assistance with organizational, stylistic and grammatical problems was received from within the close family.
- Thankfully, Dr. med. Max Landolt took on the responsibility of critically appraising the manuscripts and their content.
- My thanks also go to Mr Jürg Flury, Mr Kurt Thönnes and the Hans Huber publishing house for acceptance and design of the book, the fate of which is still subject to uncertainty.
- Finally, I owe my special thanks to Joy S. Buchanan, Member of the Institute of Linguists and the Society of Authors, London, UK, and citizen of Hombrechtikon (ZH). She placed her outstanding specialist knowledge of both subject and language fully at the disposal of this task. The translation was completed in less than two months, so quickly that the English and German versions went to print simultaneously.

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Stratec Medical Oberdorf
Synthes Inc. Paoli/PA USA

List of frequently used abbreviations

Schn I	Schneider Robert 1969
Schn II	Schneider Robert 1983
Me I	Guidelines from July 1, 1961
Me II	Guidelines from December 15, 1961
Te	Book entitled "Technik der operativen Frakturenbehandlung" [Techniques of operative fracture treatment], 1963.
TK	Protocols of the meetings of the Technical Commission

List of contributors

The following have made special contributions to this publications by personal communication, suggestions and/or lending me publications and illustrations:

AM	Allgöwer Martin
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HU	Heim Urs
KE	Kuner Eugen
KM	Klebl Manfred
LM	Landolt Max
MP	Matter Peter
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MG	Moser Godi
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NM	Nicolet Margrith
PO	Pohler Ortrun
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SR	Schenk Robert
ST	Schlich Thomas
SG	Segmüller Gottfried
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StS	Steinemann Samuel
VH	Vasey Harold
WaH	Wagner Heinz
WB	Weber Bernhard
WS	Weller Siegfried
WiH	Willenegger Hans

Chapter 1 The surgical treatment of pseudarthroses and fractures before 1958

Early pioneer work (before antisepsis)

Before the second half of the 19th century when virtually every wound was followed by inflammation and purulence, conserving operations on the skeleton could only rarely be successful, that is to say, only under extremely favourable conditions.

The few interventions for pseudarthrosis of which we can be sure have been summarized in two works:

In 1841 Edward Hartshorne of Philadelphia compiled all previously published cases of pseudarthrosis in a monograph[1]. He includes 28 resections. Only in five of these were the fragment ends more or less approximated or successfully united after surgery.

- In 1828 and 1830 John Kearny Rodgers (1793–1851) of New York had achieved successful union of fragments after pseudarthrosis of the humerus and radius by fixation with silver wire.
- Valentin Mott (1785–1865) of New York also performed silver wire suture in 1830 to treat pseudarthrosis of the humerus.
- Achille Cléophas Flaubert (1784–1845), father of the writer Gustave Flaubert and Head Surgeon at the Hôtel Dieu in Rouen, achieved union of fragments after resection of a pseudarthrosis of the humerus by a thread suture technique in 1838.
- In 1839 Cheesman in New York placed a wire loop (cerclage) around the femur after resection.

Ernst Julius Gurlt (1825–1899) of Berlin presented a detailed list of 455 pseudarthroses in his *"Handbuch von der Lehre von den Knochenbrüchen" [Handbook of the principles of fractures]* in 1862–1865[2]. By this time a further 14 successful bone sutures had been added.

The following techniques and successful interventions for the treatment of fractures are still known today:

- The first operation goes back to Achille Cléophas Flaubert in Rouen in 1838: two months after the above-mentioned operation on a pseudarthrosis he sutured a wide open humeral fracture after oblique drilling of the somewhat shortened fragment tips[3]
- The date of the first application by Joseph François Malgaigne (1806–65) of the patellar claw – the precursor to the external fixator – is usually given as 1830–1840[4]. The technique was modified over time.
- Laurent Jean Baptiste Béranger-Féraud (1832–1900) identified Malgaigne as the first to perform cerclage of a tibial fracture before 1850. It is certain that two interventions of this kind were performed on sailors by the surgeon Long in the hospital (Hôtel Dieu) at Toulon in 1851[5].

In 1870 the book entitled *"Traité de l'immobilisation directe des fragments osseux dans les fractures" [Treatment of direct immobilization of bone fracture fragments]* by Béranger-Féraud was published[6]. He records all fracture interventions known at that time: 92 bone sutures, 10 cerclage procedures, 91 applications of Malgaigne's "point" or patellar claw, and numerous fixations of mandibular fractures by dental cerclage.

1870–1939 (antisepsis and asepsis)

In 1867 Joseph Lister (1827–1912) in Edinburgh – starting in isolation – then encouraged by the experiments of Pasteur (1822–1895) – introduced the chemical germ inhibition known as *antisepsis* for the operative field, the instruments, and the surgeon's hands[7]. After two decades, this antiseptic method had been further developed and constantly improved to become *asepsis*. Thus, the conditions for successful intervention to treat the locomotor system had been achieved.

Lister himself had performed wire fixations on closed fractures of the olecranon since 1873 and on the patella since 1877. The first successful screw fixation for a proximal femoral fracture close to the joint has been attributed to Franz König (1832–1902) in Göttingen in 1875 after a similar intervention in 1857 in the Langenbeck's clinic in Berlin had culminated in a fatal infection[8].

Metal plates fixed to the bone by screws were first reported by Carl Hansmann (1853–1917) in Hamburg in 1886[9]. He had gained experience with 21 fractures. Some time around 1890 the brothers, Elie and Albin Lambotte in Brussels commenced their successful fracture treatments and in 1892 Arbuthnot Lane (1856–1943) in London also enjoyed success[10]. The only conscientious advocate of operative fracture treatment for *"subcutaneous"* fractures in the German speaking world since 1905 was Fritz König (1866–1952), son of Franz König. He maintained close contact with Albin Lambotte. His book entitled *"Operative Chirurgie der Knochenbrüche" [Operative treatment of fractures]* was published in 1931[11].

Similar opinions were held in England by E.W. Hey-Groves (1872–1944)[12], whereas in the United States of America these ideas were propagated at first by Charles L. Scudder (1860–1947)[13] and subsequently taken up by William O'Neill Sherman (1880–1979) who developed the technology further. The latter also carried out first metallurgical investigations[14]. Alessandro Codivilla (1861–1912) in Bologna in 1903 had reported transosseous extension of the calcaneus[15], which was then further developed by Fritz Steinmann (1872–1932) in 1907 in Bern and Martin Kirschner (1879–1942) in 1927 (probably in Tübingen)[16] and which soon became a standard technique in the conservative treatment of numerous fractures.

The four most important forerunners of the AO

Albin Lambotte, Robert Danis, Gerhard Küntscher and Lorenz Böhler are considered the most important forerunners of the ideas and techniques of the AO (**Fig. 1-1**).

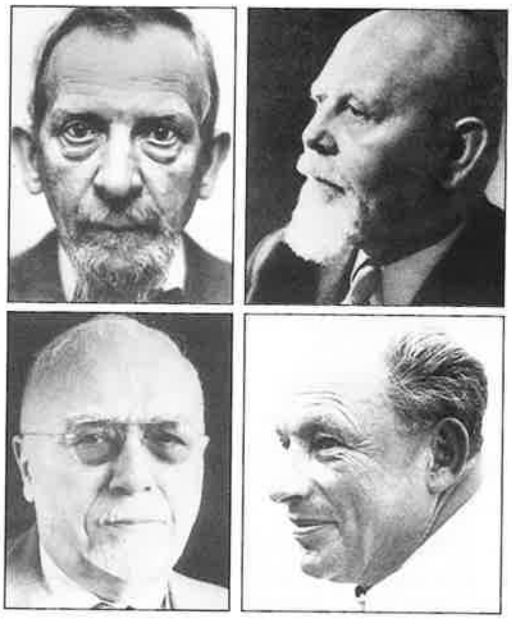

Fig. 1-1: The immediate forerunners of the AO: top left Albin Lambotte (1866–1955), bottom left Robert Danis (1880–1962), top right Lorenz Böhler (1885–1973), bottom right Gerhard Küntscher (1900–1972).

Albin Lambotte (1866–1955)
Of the four great figures setting an example to the young AO Group, Albin Lambotte was the most important, not only because he was the eldest.

Born into an academic family in Brussels, he also studied and in 1888 became an intern at the Schaerbeek Hospital in the Brussels suburbs assisting his genius of a brother, Elie, who unfortunately died aged 32 years.

Here, the brothers performed operative fixation of closed fractures.

In 1890 Albin Lambotte moved to Antwerp and worked at the Hospital of Stuyvenberg where he spent the following decades. In 1893 he became head of surgery. Lambotte was exceptionally talented and versatile, for example, performing gastric resections, transduodenal choledochotomies, laminectomies, craniotomies, and gynaecological operations, all of which were reported in numerous publications.

Around 1900 he started to concern himself increasingly with the operative treatment of fractures and their consequences. He promoted radiography so that the surgeon could check his own work.

For every operation, Lambotte made drawings of the radiographic findings and the implants he had used for stabilization. These reproductions of the radiographs together with photographs of the patients showing functional outcome formed an unusually rich archive which he documented in his two books: 1907 *"L'intervention Opératoire dans les fractures récentes et anciennes" [Operative intervention for fresh and old fractures]*[17] and 1913 *"Chirurgie opératoire des fractures" [Operative treatment of fractures]*[18]. In these books, he describes his instrument sets, his techniques and his own patient samples.

Lambotte applied cerclage wires, steel screws, nails, staples, and gutter-shaped plates narrowing at the end: originally these were made of aluminium and later from special hardened steel. His screws (even for the fixator) originally had self-tapping, lancet shaped tips above which was a self-cutting thread. These screws for plate fixation were short and monocortical. After 1907 only self-tapping screws without lancet tips were inserted. Pre-drilling was performed using a manually driven drill. Only in cases of pseudarthrosis or osteotomy were bicortical screws inserted. He called the plate the *"Prothèse interne"* or *"Prothèse perdue"*. His unbelievably short consolidation times (Povacz makes special mention of them[19]) can only be explained by these technical details.

As a condition for plate and screw fixation (close to the joint) a strictly anatomical reduction was required *"... la réduction absolue, mathématique"*. During insertion of the implant, the fracture gap was compressed by the powerful reduction forceps. The stability of the construction had to be maintained until consolidation *"... assez solide pour maintenir les fragments jusqu'à la consolidation"*. This meant that any form of outer bandage was superfluous *"... rendre inutile toute éspèce de bandage immobilisateur"*. The technique permitted immediate movement thus circumventing muscle atrophy and joint stiffness *"... permettant par la mobilisation immédiate d'éviter les atrophies musculaires et les raideurs articulaires"*[20]. He called this operative fixation of fragments *"Ostéo-synthèse"*. It was he who coined the term.

Initially, he made the instruments and implants himself in his own workshop; later he had them made in the surgical workshops of the time.

In 1902 Lambotte constructed his own *"Fixateur externe"* which he applied to the majority of shaft fractures. He also coined that term. By 1913 his model had been considerably improved.

Asepsis was rigorous: he only operated once the skin at the fracture site had recovered fully and the swelling had gone down (after 8–15 days or later). Fragments were only minimally exposed. He used exclusively instruments to achieve indirect reduction. His sketches anticipate the most modern methods. He practised an absolute "no-touch" technique, a slogan devised by his friend Lane[21]: his white yarn gloves had to be immaculate at the end of the operation.

Of the 187 patients documented in his first book only two had died: one female undisciplined alcoholic died from a secondary infection; one patient died of a generalized haemolysis. For the time, this was an absolutely extraordinary result. The second book contains reports on more than 550 syntheses.

Lambotte was also a great music appreciator. In his workshop he produced over 180 violins, much prized by the experts, also ultra-light reels for fishing rods (he was an enthusiastic fisherman), and other precise mechanical apparatus. His hobbies included painting and woodcarving.

In 1920 he founded the Belgian Orthopaedic Society and was their first president. Many prominent figures of the time visited him in his hospital and he cultivated these friendships: for example, Arbuthnot Lane, Albert Hoffa, Fritz König, the Mayo brothers from Rochester and Kocher from Bern (Schn II/5). René Leriche[22] described him as *"a great inventor"*.

However, the opposition to which the few like-minded were exposed prevented the international dissemination of his work. He did not have the necessary academic connections. He was admired as an exceptionally gifted surgeon, but his wisdom was not followed. Only Jean Verbrugge (1896–1964) – later to become professor of orthopaedics in Gent – is a well known pupil of his. Of the founders of the AO, it is probable that only Willenegger knew his work. He had 18 of Lambotte's sketches reproduced in the book *"Technik"*[23] published in 1963 (Te 3-5).

Robert Danis (1880–1962)

The second forerunner of the AO with his theory and his refined instrumentation had a direct scientific and technical influence on the young AO.

Danis was a general surgeon and had worked, even scientifically, in the fields of thoracic and vascular surgery (doctoral thesis 1912 on vascular anastomoses and ligatures).

In 1921 he was elected as professor of theoretical and practical operative surgery at the University Hospital of St. Pierre in Brussels and simultaneously became director of the gynaecological clinic. First, he developed his own technique for radical operation of breast cancer.

Then he turned his attention more and more to operative fracture treatment and made demands on reduction and stability which went far beyond those of Lambotte:

- He fundamentally rejected immobilization with a cast because this often led to permanent trophic disorders. In fact, it was just adding an ailment to an accident: "... *et ajoute, en somme, une maladie à un accident*"[24]. This led to the term "fracture disease"[25].
- For functional reasons, every fracture was an indication for osteosynthesis (under certain circumstances, even non dislocated fractures). The operation should be performed as soon as possible. Preparatory reduction and immobilization was not to be attempted. The anatomical reduction was to be absolutely exact and verified by sight: he worked with an angled mirror, as used by dentists, to observe the rear aspect of the fracture. A single radiograph might be misleading, the procedure had to be repeated, if necessary, several times during the operation.
- Optimal reduction was imperative if the implants were to exert long-lasting, interfragmentary compression adequate to tolerate the postoperative movement of muscles and joints. Moderate compression was osteogenetic; excessive compression might lead to necrosis. Regular observation of the healing of pseudarthroses subject only to axial compression, i.e. without removal of the fibrous callus, reinforced his opinion.
- Under continuous interfragmentary compression, consolidation without visible callus would occur. He called this *"per primam"* healing (he also used the term *"soudure autogène"* = welding), as occurs in the healing of soft tissue wounds. He regarded this process as economic and considered traditional healing processes with callus formation to be an unnecessary deviation. Achieving his objectives was not always easy, he writes.

For fixations in cortical bone he initially applied double or crossed transosseously tensioned metal wires. He implanted screws with a wide thread in cancellous bone (*"vis hélicoidale"*) as well as working with special hip screws, threaded bolts, cerclage wires, transosseous hemicerclage wires, and short nails with V profile. These implants dominate in his first book published in 1932: "*Technique de l'ostéosynthèse*" [*The technique of osteosynthesis*][26].

In his search for better implants he began, having been disappointed by the contemporary producers, to make them in his own workshop as Lambotte had done before him.

First, a precise cortical screw fixation technique with pre-tapping of the thread was developed. In 1938 he constructed a plate with which axial compression could be exerted (known as a "*Coapteur*"). Its screws were anchored in both cortices.

In his second book published in 1949 and entitled "*Théorie et pratique de l'ostéosynthèse*" [*Theory and practice of osteosynthesis*][27] he described his implants and his new techniques and reported the results of more than 1500 fractures.

His classification and operative techniques for malleolar fractures were highly significant[28]. He brought fibular fractures to the fore. These were classified according to height and concomitant ligament rupture. Today this classification is referred to as the "*Danis-Weber*" classification.

Danis was a very talented teacher; he could draw on the board with both hands at a time and showed films of operations. He became president of the International Society of Surgery and was awarded several honorary doctorates.

In his free time, he also enjoyed drawing and painting just like Lambotte, he was a lover of music, played several instruments himself, a good shot, enthusiastic amateur cook, and smoked a pipe.

Müller was the only one of the AO founders who had known him and his work.

Gerhard Küntscher (1900–1972)

Küntscher was born in Zwickau (Saxony) the son of a factory director. He studied in Würzburg, Hamburg and Jena, where he was awarded a "*summa cum laude*" doctorate in 1926. He was highly skilled in technology and physics and could draw splendidly. First, he became an intern in Freiberg and Jena, then at the University Clinic for Surgery in Kiel where he advanced to senior registrar and qualified as a university lecturer in 1938. After performing physical pilot studies on bones and implants, he began development of the intramedullary nailing technique.

Various metal intramedullary pins for the fixation of reduced shaft fractures had already been used before, for example, in 1915 by Schöne in Greifswald and in 1936 by the brothers L. V. and H. R. Rush in Mississippi USA, on forearm bones. In 1912 Hey-Groves in Bristol had nailed a femoral shaft fracture[29].

By carrying out experiments Küntscher established that a lack of motion at the fracture site was indispensable for uneventful healing and that an intramedullary foreign body did not interfere with the healing process. He postulated the elastic jamming of a steel load carrier into the medullary cavity and tried it out first on dogs and then on humans.

At the end of 1939 he presented his first report of results with the V profile nail in closed technique to the Kiel Medical Society. He gained even more experience in the Russian-Finnish war in the winter of 1939–1940. He operated as head surgeon of a German army surgical unit at the front. One of his patients was Swiss and we will meet him again in Chapter 3 on p. 43.

At the Congress on Surgery in Berlin in 1940 he was able to report more than 12 successful medullary nailing procedures in humans. For the most part, he met with the bitterest resentment. Lorenz Böhler alone adopted his method immediately.

The senior registrar G. Neff had been delegated by the hospital in Winterthur, Switzerland (Director: Dr. O. Schürch), to attend this congress. He was able to get hold of a V nail and smuggle it back to Switzerland. Sulzer Inc. then produced nails during the war based on this model and the clinic in Winterthur used them successfully in humans and animals.

At the next German congress in 1941 in Dresden the situation had already turned in Küntscher's favour. The German army had adopted his method as confirmed by a 200 page *paperback* book by C. Häbler[30] published in 1944. Intramedullary nailing became known in the German occupied territories of Europe.

When working on his new designs, Küntscher had the advantage of constant support from the highly qualified company owned by the engineer Ernest Pohl. In the meantime, the cloverleaf profile had been produced and manual reaming (from 1960 power-driven) of the medullary cavity permitted the insertion of larger diameter nails.

In 1942 Küntscher was appointed extraordinary professor and, together with his collaborator, Maatz (who was also an engineer), wrote the book entitled *"Technik der Marknagelung" [Technique of intramedullary nailing]*[31], which could not be published until 1945 because of the war.

In the USA and England medullary nailing was only heard of after the end of the war, but very rapidly gained acceptance and became a standard technique worldwide. It is possible that Danis had not heard of it in 1949.

From 1941–1945 Küntscher worked as a surgeon on the Eastern front, after that he directed a municipal hospital, and from 1957–1965 he acted as medical director of the Hamburg Hafen Hospital. As an emeritus he continued to operate in Flensburg.

He constantly expanded the indications for his technique and modified the implants accordingly; he thought up the *"Detensionsnagel"* (a distraction device and precursor of locked nailing) and the *"internal saw"* for osteotomies.

In 1962 his monograph entitled "The practice of intramedullary nailing" *"Praxis der Marknagelung"*[32] was published and presented the diversity of possible applications.

Küntscher received numerous international awards and was a well known personality everywhere. In the clinic he was rather reserved and reticent, his office filled to overflowing with files and radiographs. Since he had no family, he lived very simply.

The instrument sets and working procedures in his clinic were regarded as robust. From countless clinics abroad guest surgeons came. The senior registrar, G. Moser, delegated by Willenegger reported: *"For two weeks I have seen only osteosynthesis performed by intramedullary nailing, whereby reaming of the medullary cavity is taken to extremes (sometimes even subperiosteally) in order to insert the thickest possible nails (the thickest was a 40 mm nail in a Paget femur!). No bone was safe from the intramedullary nail .... a Mall. Ext. Fracture was treated with an i.m. fibular nail whereby the ankle was destroyed. In its place a shining nail protruded from the fibula. A senior registrar explained it to me: "Here we have very broad indications" (MG).*

Lorenz Böhler (1885–1973)

A very lively and succinct portrayal of the exceptionally rich life and work of Lorenz Böhler can be found in the *"Geschichte der Unfallchirurgie" [History of Traumatology]* by Povacz[33]. Here we must be brief.

Lorenz was born in the small village of Wolfurt near Bregenz in the Vorarlberg and grew up in modest circumstances as the son of a carpenter. The young family lived at first with the grandparents. When his parents moved away, Lorenz stayed with his grandmother and later on lived with various relatives.

Very early on he demonstrated manual dexterity, an unusual degree of self-confidence, and a great thirst for knowledge.

Having moved from place to place and changed schools repeatedly, he was finally able to study in Vienna thanks to money he had earned and a scholarship. He was soon assisting in the surgical departments of hospitals.

After receiving his doctorate in 1911 he worked his passage to South America as ship's doctor. In 1912 he became assistant medical director in Bozen. He learned English. In the summer of 1914 he was on a tour of America to attend congresses and visit the hospitals (e.g. the Mayo Clinic in Rochester) when war broke out and he was summoned to return and join up as army medical officer.

After serving as a surgeon at various places at the front and being commander of a unit and young regimental doctor he became seriously ill. In 1916 he was put in charge of a *"Reserve military hospital for the slightly wounded"* in

Bozen, not far from the front. This was billeted in a former monastery which had served as a school for trade and commerce before that. It had 240 beds but no equipment. In the workshops, his henchmen made extension splints and other aids from wood and Böhler, at first secretly, had patients with gunshot fractures abducted from the trains transporting the wounded when they stopped at the local station.

He treated these patients according to his principles: fix up the patient as painlessly as possible, uninterrupted immobilization of the fracture fragments until osseous consolidation was achieved, and intensive active movement of all unhindered joints.

His successes were so convincing that the military hospital was converted into a *"Special department for fractures and gunshot wounds of the joint"*. From then on numerous surgeons came to visit. By the end of the war in November 1918 more than 600 gunshot fractures and 176 gunshot wounds to the joint had been treated. When the hospital closed, Böhler was unemployed.

He had, however, got his hands on the statistics for industrial accidents from 1906–1911. From these he noted that the Austrian State Insurance Company, which at that time had no legal influence on treatment, were paying very high lifetime pensions after fracture (60–90%). He calculated that a specialized hospital, like the traumatology hospitals of the German trade association could be financed if improved treatment would lead to a dramatic decrease in pensions. He succeeded, after overcoming endless hurdles, in convincing the authorities and directors of the Austrian State Insurance Company (AUVA) to set up a traumatology department. This went into operation in 1925 in a partially unused administrative building in Webergasse, Vienna. The original 50 beds in the clinic soon had to be increased to 100. An outpatient department was integrated.

Böhler lived – as his convictions demanded – with his family in a staff flat on the upper storey of the building and directed and supervised activities down to the smallest detail from there. His style of leadership was very authoritarian. Official regulations were drawn up, of which one extract contained 132 articles (LM). From the very beginning he ensured complete documentation right up to final healing and the patient's return to work and regularly produced statistics. Apart from numerous publications, these formed the basis for the book entitled *"Technik der Knochenbruchbehandlung" [Technique of fracture treatment]*[34], published in 1929 and repeatedly revised, updated, and expanded up to 1954 and translated into many languages.

While Böhler was being ignored by the universities, surgeons came to him from all over the world to study and adopt his principles and techniques. During a visit to Vienna, Müller apparently said to Böhler: *"Professor, your success is based 50% on psychology"* and Böhler answered: *"No, 90%."*

Böhler's treatment was essentially conservative. He had experienced so many failures with osteosynthesis that he was very sceptical towards it, although he did not reject it outright. He also operated on dislocated articular fractures: he introduced the operative treatment of femoral neck fractures in the 1930s and also improved the three lamellar nail of Smith Petersen. Dislocated posterior wedge fragments in malleolar fractures were also fixed by screws. In 1940 he adopted Küntscher's intramedullary nailing technique for shaft fractures (later restricted to the femur). He reported his experiences in a third volume of his textbook in the year 1945[35].

In 1936 Böhler had finally been appointed extraordinary professor and in 1954 full professor. In 1951 he achieved the creation of a title for specialists in traumatology. On his initiative the AUVA established their own traumatology hospitals even in larger cities in Austria.

In 1964 Böhler was guest of honour at the AO Course in Davos. Beforehand he undertook extensive and highly systematic ward rounds (taking in all the patients in the hospitals) in St. Gallen, Zürich-Waid and Chur. In 1965 he founded and became president of the Austrian Society for Traumatology.

Several internationally renowned traumatologists came from Böhler's eminent school and later on worked closely with the AO (e.g. Spath, Russe, Jörg Böhler (son of Lorenz), Trojan, Beck etc.).

Böhler and his school are regarded by the AO as exemplary figures because of their systematic approach to diagnosis and treatment:

- the call for painless treatment and
- the active mobilization of all unhindered joints prevents the occurrence of functional and trophic disorders, even at the fracture site
- thorough records and documentation up to return to work. This was unique.

Fracture treatment before 1958

After the end of the war in 1945 there was a rapid development at all university centres in extensive surgery of the gastroenteric and biliary tracts and the lungs. This went hand in hand with new discoveries in pathophysiology. Anaesthesia became a separate specialist discipline. The clinic directors and their immediate subordinates were so absorbed in these areas that their interest in fractures waned. Fractures at that time were rarely life-threatening (the polytraumatized generally died before reaching the hospital) and therefore without dramatic impact. Non operative treatment was left to younger assistants, who were supposed to perform according to Böhler's guidelines, which they however had not mastered.

Patients whose fractures could not be reduced or who were suffering from open fractures of the lower leg, femoral fractures of any kind, cranio-cerebral injuries, and certain fractures of the upper limb were admitted to hospital. Monotrauma after industrial accident dominated, sports injuries started to increase, road traffic accidents did not yet play a significant role. Thus, pelvic fractures, severe vertebral fractures, and polytrauma were rare. Injuries to the hand with their social consequences were badly neglected. The invalidity which frequently resulted did not count for much with the insurance companies.

The fixation with cerclage wires of non reducible torque fractures of the tibia had become established. It required the additional support of a plaster cast. The high compression cerclage (Falzcerclage) reported by Leemann[36] in 1952 was initially stable. Medullary nails were considered suitable for secondary open reduction.

The hospital treatment for patients with femoral shaft fractures consisted of several weeks wire traction to which the femoral and pelvic plaster casts were attached.

Here are a few passages from letters written about that time:

- *"In L. femoral shaft fractures were extended, possibly operated on (plates, nails), later maltreated with a pelvic cast, and often ended in malalignment (rotation) + shortening, not to mention knee + hip ankylosis. Hospital stay: months"* (BH).
- One report from a world famous clinic states: *"... of course, sensible osteosynthesis was hardly ever performed there. For example, I had a young patient with a femoral shaft fracture on my ward who was to lie in a pelvic-femoral cast for 120 days. That was the 'minimal time'. However, after this period the fracture had not yet consolidated and so, with much effort, a (much too thin) intramedullary nail was inserted. I don't know how the saga ended."* (MC).
- *"Whole rooms were filled with patients in traction"* (MA) (**Figs 1-2**).

If possible, long-term patients were shunted off to the outside wards. Here a report:

"At the university clinics in Basel (1951–1954) and Zürich (1956–1958) I was delegated for 6 months in each clinic to the outside wards where such patients – mainly younger men with delayed fracture healing after industrial injury, pelvic cast etc. – were hospitalized. The Hilfsspital ("auxiliary hospital"), a leftover barracks from the war years situated on the Burgfelderstrasse, and the Hospital Hegibach (former neurosurgical clinic) were, so to speak, structurally and operationally

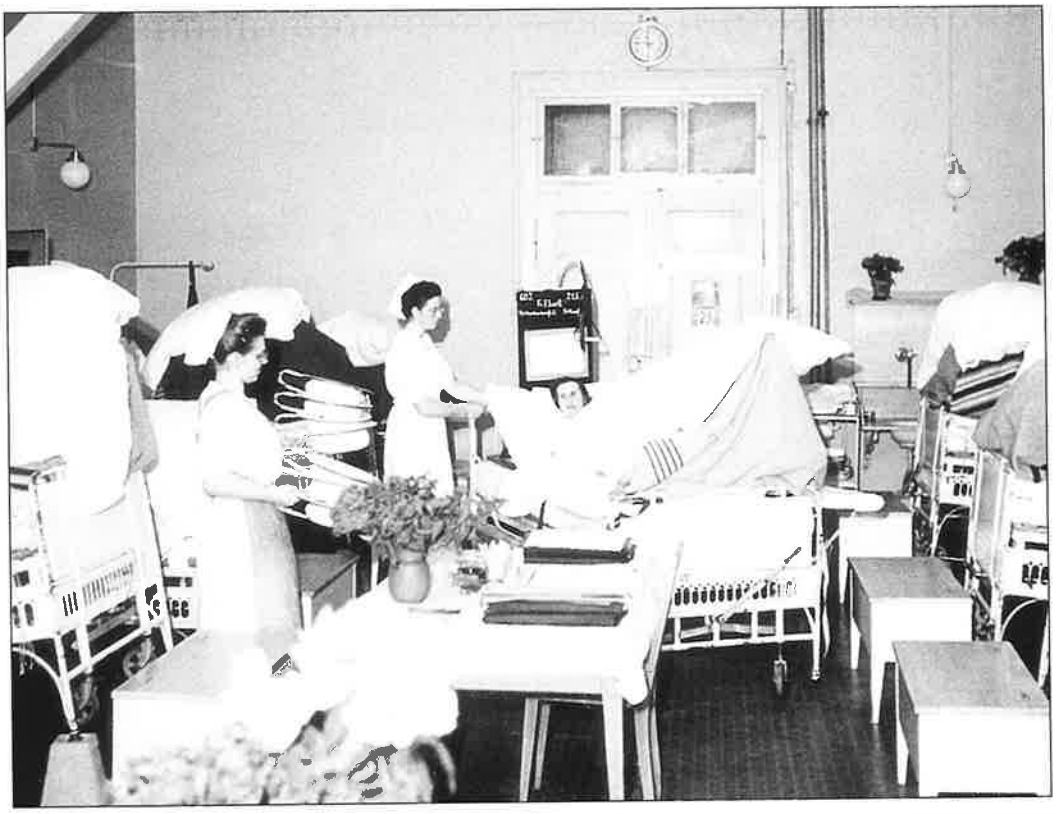

Fig. 1-2: *"Traction room"* on the women's ward of the Universitätsklinik Zürich in about 1945: The foot end of the bed is raised and rests on a support. Nurses in the uniform of the Swiss Red Cross School in Zürich: one is busy wheeling a patient in her bed out of the crowded room; another is carrying seven empty chamber pots ready for use. Photos courtesy of Professor O. Trentz, Zürich.

identical: a younger, still relatively inexperienced house officer visited the wards twice a week, if he had time. Once a month the senior registrar came by, the medical director was never seen there.

In the dormitories with up to 14 beds, the patients either lay or hobbled about on crutches in their heavy plaster casts. They generally stayed in hospital for many months. It was difficult to maintain discipline and there was an ill wind amongst the care staff. It was hard to know whether alcohol problems had existed before or developed at the hospital. I initiated animal experiments to study the effect of alcohol on fracture healing." (HU).

The reduction and retention of supracondylar fractures proved the most difficult task of all.

Femoral neck fractures were operated on and stabilized with Böhler's three lamellar nail. Various dual component, but unreliable implants with adjustable angle were available for the treatment of pertrochanteric fractures. The threaded bolts were the implant of choice for articular fractures of the distal femur and proximal tibia. The technical difficulties of these operations were considerable. The procedure generally lasted several hours. Complications occurred frequently.

Having been discharged from the hospital, the patient was more or less left to his own devices in terms of aftercare, joint stiffness was almost inevitable, permanent muscle atrophy and postthrombotic oedema were not infrequent. In

1945 the Swiss Accident Insurance (SUVA) was still paying lifetime invalidity pensions to 40% of all patients who had suffered a tibial fracture and to 70% after femoral fracture[37].

There was a consensus that the prognosis for articular fractures could only be improved by open reduction and fixation, but this was rarely attempted due to lack of technical experience and fear of infection or the operation was only performed after many weeks of procrastination. Poor results were attributed to the method.

The greatest uncertainties were related to the treatment of delayed consolidation, usually associated with osteoporosis, and the still frequent cases of pseudarthrosis, the nature of which was only vaguely understood. The recommended operative techniques were numerous and failure frequent.

"In 1953 I was sent by the Professor to convey a thick, heavy package of radiographs to the practice of a surgeon in another area in order to obtain his opinion on the situation and his proposals for further treatment of that particular patient. The young man had been under treatment for an unconsolidated osteoporotic tibial fracture, had been admitted to hospital repeatedly and had been operated on. In the clinic, a promising plan for recovery could not be devised. The expert – previously active and interested in the field of traumatology (he later became a professor) – dismissed me having studied the files without proffering any constructive suggestion. I no longer remember what happened to that patient" (HU).

The orthopaedic hospitals and departments did not admit patients suffering from fractures or their immediate sequelae. The most frequent interventions on the skeleton were arthrodeses, osteotomies, especially of the foot, hip grafts, and epiphysiodeses. Postoperative cast fixation was the rule. In contrast, aftercare was – thanks to well trained staff and suitable installations (mechanotherapy, gym, hydrotherapy, etc.) – well organized and thorough, though time-consuming.

Stagnation in traumatology was depressing for the surgical assistants in the larger clinics. Most of the injured were strong, young workers condemned to months in hospital or of inactivity because of their fracture and who suffered psychologically. The results of treatment were unsatisfactory. It was felt that an amelioration must be possible if early operative treatment could be performed. Since the medical directors did not dedicate themselves to this task the same old routines were maintained.

The psychological terrain was ready for a fundamental change in thinking and there was a desire for technical innovation.

In summary, three conditions were still lacking for the development of reliable osteosynthesis:

- reliable instrument sets
- improved asepsis appropriate to the implantation of metal foreign bodies
- specially trained and actively interested surgeons to take up the task

The realization of these postulates was then primarily the work of younger medical directors in the regional hospitals. How they met and commenced their collaboration will be the subject of the next chapter.

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Chapter 2
Background to the foundation of the AO or "From friendship to joint venture"

Preamble

An understanding of the birth and early development of the Association (AO) must be preceded by an awareness of some of the typical and relevant structures and peculiarities of Switzerland. They derive from the past and live on to some extent today as customs.

- The national language and dialectical style may change over a very short distance, sometimes from one village to the next.
- The mentality of the population may differ – starting with the language – within a very small geographical area (e.g. in two adjacent valleys). The greatest differences are found between the Cantons, which also form the borders of religious denominations.
- Winter sports developed early because the winters were colder then and there was often snow at the front door of the house. By the end of the 1920s skiing had already become a sport for everybody.

Domicile and place of birth have a different significance for the Swiss than for the neighbouring states. In many ways, the Bürgerort (place of citizenship) is of overriding importance. Every Swiss inherits citizenship of the place of his ancestors. It is entered in the official documents and each Swiss is aware of it. Sometimes there are still connections or a sort of family tradition. Rights or practical advantages, previously important because of Corporations, are now rare.

Robert Schneider in his two books: "*10 Jahre AO*" and "*25 Jahre AO Schweiz*"[1, 2] noted the town of citizenship of each AO member. We will do this too.

The Swiss citizen is generally also a soldier and, consequently, responsible for his personal equipment and firearm, which are maintained at home.

The militia – arising from a century old tradition – is deeply rooted in the common consciousness. Among other objectives, it plays an essential social role: collaboration and camaraderie – and the various periods or service, exercises and courses at different locations – inevitable bring together all sorts of people from all over the country. But, it is often the case that there is a discrepancy between the professional and social standing of a citizen in civilian life and his rank or function in the army.

After a long process of promotion, doctors would serve their time at the annual, compulsory refresher courses of 3½ weeks as army medical officers or in the medical corps of the military units. Several AO members rose to high rank and positions of command (e.g. Bandi, Willenegger, Landolt etc.). The chief surgeons of the hospitals could request temporary dispensation from military service.

In a small country where people are often personally acquainted or at least well informed about each other, verbal agreements may be equivalent to a formal contract – sealed by a handshake. A written version is not necessary. We will meet such agreements within the AO.

With respect to the hospital system and surgery, the following peculiarities deserve mention:

Throughout the country small and medium-sized public hospitals, irregularly distributed and sometimes very close together, had been founded by town and local communities even before the turn of the century and up to approximately 1920.

Poor transportation and sometimes geographical obstacles encouraged this dissemination. However, the primary justification was the affection felt by the local people for their region.

In smaller hospitals, the surgeons worked as freelancers. In the medium-sized hospitals, the system of chief surgeons dominated, for the most part without written contracts and without a salary (payment was according to the tariffs of the health insurance companies). The election committee was generally a commission comprised of members of the regional authorities. Indigenous applicants were preferred.

The chief surgeons were normally the incumbents for obstetrics and gynaecology. Sometimes they were in charge of internal medicine and performed all radiographic diagnoses. They were responsible for anaesthesia, which was done by the nursing staff.

In these hospitals there was generally only one lone live-in medical house officer. The replacement of the chief surgeon during periods of absence (military service, further training, vacation) was a problem solved in many ways, but a problem. Only the larger hospitals, e.g. Liestal, Chur, Langenthal, Fribourg, Winterthur, had a senior registrar. All the others operated on an ad hoc basis.

The chief surgeons were usually versatile and experienced physicians, respected, independent, and proud autocrats in their areas. They knew each other – often from their student days – and were mostly friends – especially in the Canton Bern – where the student corporations (*Studentenverbindungen*) were active even in the grammar schools. The professors at the university clinics usually kept their distance.

In the regional hospitals, trauma patients played an important role, partly because of lack of transportation.

There were only two geographically and organizationally independent orthopaedic university clinics in Switzerland, both Foundations: the *Balgrist* on the south-eastern border of the city of Zürich and the *Hospice* (later hospital) *Orthopédique de la Suisse Romande* in Lausanne. Neither of these institutions took trauma patients. In Bern, there was a *"non clinical department"* – integrated into the university clinic for surgery, concentrating primarily on orthopaedics. Basel had a professor for orthopaedics, but no ward.

The Swiss Society for Surgery was the parent organization for the entire management of the universities. For the advanced training of physicians at the smaller hospitals, two less elitist societies were popular:

- the *Swiss Society for Trauma and Occupational Diseases* (Schweizerische Gesellschaft für Unfallmedizin und Berufskrankheiten: SGUB), founded in 1912, with its own journal (ZUB). This included an annual meeting of doctors from the insurance companies, private practice, and the hospitals.
- the Swiss Section of the *Collège International de Chirurgiens*, founded in 1954 and presided over until 1960 by the active and traumatologically interested Dr. André Nicolet, chief surgeon at the Stadtspital Tiefenau in Bern.

Many chief surgeons participated at those practically oriented annual meetings. The advanced training excursions to clinics in other countries led personally by Nicolet were something quite special and stimulating and led to many new contacts. He and his wife, Margrit, also offered the most admirable hospitality (*"the Hotel Nicolet"* NM). Although Nicolet (because of his close relationship to Küntscher (NM)) did not join the AO Group when it formed, a close friendship always remained between many AO members, the Collège and its founding couple.

1952–1957: From friendship to concept

Robert Schneider, a tall grammar school student, first met Maurice Müller, who was six years younger and small, when the latter was coxswain in a "foursome" at the Maritime Club in Biel and shouting the rhythm to the oarsmen. Apart from a brief episode in the student corporation Zähringia in Bern they did not meet again until 1952, more than 20 years later, in military service.

Captain Müller – in civilian life, senior registrar at the university clinic for orthopaedics 'Balgrist' – was commander of the surgical company IV/2, a specialized medical unit. Its task was to set up and operate a field hospital. For this purpose, eight army medical officers were assigned as subordinates to the commander to act as specialists (amongst them many surgeons). From 1952, one of these was Captain Robert Schneider (**Fig. 2-1**). Since the lack of army medical officers had become acute (BW), he had been required to decline an imminent promotion to an elite troop of the infantry, the situation being made worse by the fact that he was no longer a freelance surgeon, but had become chief of surgery at the hospital in Grosshöchstetten. This meant changing over to the unarmed branch of military service, which was equivalent to a form of degradation.

Despite the intensive and continuously innovative service run by the commander, the two prominent, but very different personalities, soon made contact and found opportunities to test their skill: in pistol shooting the two were ex aequo, at the card table in the evening Müller clearly had the upper hand.

Thus, opportunities arose for stimulating discussions about surgery of the locomotor system, in which both were interested. Müller reported on his visit to Danis and subsequent os-

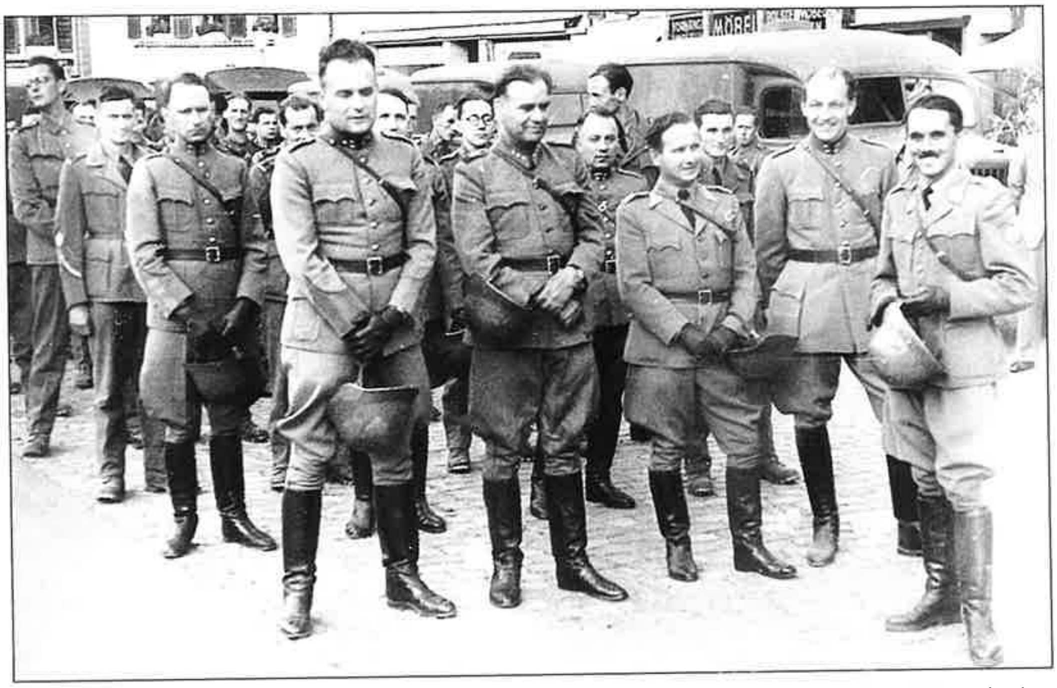

Fig. 2-1: The leaders of the surgical company IV/2 with their commander on the occasion of the refresher course of September 1952. On the right: Captain Müller (looking tall because he is standing in the foreground). In the front row on the left Captain Schneider, chief surgeon.

teosynthesis procedures in Fribourg. Schneider described the case of a patient who had been admitted to his hospital for personal reasons and who had suffered intolerable pain after a subcapital humeral dislocated fracture. Since the patient was of short stature and weighed 130 kg, all surgeons had refused to operate. Müller rose to the challenge and operated on this patient, together with Schneider, on a free Saturday and after thorough preparation (MM: *"a type of tension band arthrodesis with outer tensioning devices, cerclage and Kirschner wires"*). The immediate success of the intervention was the beginning of a long-lasting, trusting cooperation and friendship. During subsequent meetings in the course of their annual military service (MM: *"up to 1956 more than 100 days"*) more ambitious plans began to mature.

As early as 1952 Schneider had already introduced Müller to the three closely acquainted Bernese chief surgeons: Bandi in Interlaken, Schär in Langnau and Stähli in St. Imier (the *"3 Walters"*). From then on, Müller came over for special orthopaedic and occasionally trauma operations on Saturdays as guest surgeon and always brought with him not only his own instruments and implants – but also his ideas.

Through Schneider Müller also met Willenegger (another Bernese). They had already met briefly in 1945 in Winterthur. Willenegger, a highly experienced traumatologist, had been chief surgeon in Liestal since May 1953, and was a medical lecturer in Basel. Müller was familiar with the hospital since he had been a senior registrar there in 1946–1949. On his first visit, he operated on three cases of epiphyseal loosening at the femoral head; on his second visit he performed an osteotomy for coxarthrosis (MM). Willenegger was impressed by Müller's preoperative planning procedures with his precise drawings and the way they matched up with the postoperative radiograph.

During his second visit, Müller also spoke of his experience with stable osteosynthesis and functional aftercare according to Danis and of his osteosynthesis statistics from Fribourg. Everyone was very sceptical. Willenegger had more experience than anyone else in Switzerland with intramedullary nailing and, for the stabilization of fractures close to the joint (above all, pertrochanteric and malleolar fractures), it was usual to work with multiple K-wires. Surprisingly, he nevertheless immediately adopted the Danis coapteur for the fixation of forearm fractures (GA).

In October 1956, having obtained the approval of his superior, Francillon, Müller held a sort of three day course in operative technique at the Balgrist for his five friends. Schneider had been complaining about the inactivity of the Faculties since he wanted to learn more about orthopaedic operative techniques. Willenegger was also in favour of the course. Müller wanted to bring his friends together. The main emphasis of this course was on osteotomies and arthrodeses without plaster casts, ligament reconstructions, etc. Müller had only just returned from a visit to Böhler in Vienna.

Wouldn't it be possible to establish a similar sort of "school" for operative technique?

In 1957 Müller had obtained his postdoctoral lecturing qualification in orthopaedics and left the Balgrist Clinic on September 29. At the end of his first lecture on December 6, 1957, he invited everyone to an aperitif at the Hotel Storchen in Zürich. His friends stayed late and decided to found a school for operative technique. Müller suggested a French name for it: *"Association pour l'Ostéosynthèse"* abbreviated to *"AO"*.

Having left the Balgrist Clinic he was (until October 1960) a much sought after guest surgeon for orthopaedics in the clinics and hospitals of Switzerland (in all more than 70). Thus, his circle of acquaintances grew and his reputation, too. If anyone wanted to watch him operate, he could visit Liestal on a Monday and attend the orthopaedic operation programme, followed by lectures and discussions. He also operated in Geneva with Patry and with Baumann in Langenthal. The latter was the Nestor (chief and counsellor) of the Swiss Traumatologists, titular professor in Bern and President of the Swiss Society for Trauma and Occupational Diseases (SGUB) from 1955–1960. This widespread operative activity was the basis for many of the close relationships between AO members joining later during the founding years, for example, the Bernese Stähli in Thun, Barraud in Aarberg, and also Molo in Bellinzona, Keller in Walenstadt, Ott in Rorschach and Bloch in Glarus. Müller met Kaiser in the City Hospital Zürich-Waid on the recommendation of Willenegger, who was well acquainted with him because of their common interest in visceral surgery.

At the end of September 1957 Allgöwer, chief surgeon in Chur since the spring of 1956 and university lecturer in Basel, had rung up his friend Willenegger to ask advice on a patient with an orthopaedic disorder of the hip. Willenegger recommended that he read the new book *"Die hüftnahen Femurosteotomien" [Femoral osteotomies around the hip]*[3] or to call upon the author of the book, Müller, now no longer working at the Balgrist, to help with the operation. A few days after leaving the clinic, Müller received the phone call from Allgöwer. He was very interested in Chur, which even at that time was a well known centre for the treatment of winter sports injuries.

Their very first meeting in Chur gave rise to lively discussions about traumatology. Although they were quite different characters they were equally impressed by each other. Allgöwer had a great deal of experience in animal experimentation, was working on shock and burn injuries, and wanted to carry on with experimental research. He was well versed and active in visceral surgery and practised an exceptionally careful soft tissue technique. He was fascinated by the possibility of stable osteosynthesis with plaster-free aftercare. In the following winter of 1957/58, he changed his operative treatment technique for the frequent torsion fractures of the tibial shaft from cerclage to the systematic application of screw fixation as recommended by Müller. He also adopted Müller's technique of reaming the medullary cavity so that thicker, more stable nails could be inserted. And, he took on board the new ideas. Müller later said of him: *"Allgöwer was the only one who consistently enforced early postoperative mobilization in his hospital"* (MM).

Müller now came to Chur every month. He always brought his own instruments and implants with him in a thick, bulbous leather case (called "vache"). The evening before the operation he would unpack his bag before the eyes of the OR nurses, who looked on timorously, and say to them (in his Bernese dialect): *"What sister! You haven't seen this before? Then you must be right out of date!"* (HU). Having operated, always assisted by Allgöwer and to the exclusion of spectators, the ward rounds followed, then discussions and sometimes demonstrations. Soon a lasting and close, but competitive friendship had developed between them.

Müller introduced Allgöwer to his Bernese friends. The idea of a study group for modern osteosynthesis began to take on a more tangible form.

To what extent the idea of stable osteosynthesis and biological and functional concepts had already been accepted by the small group at that time is elucidated by the following excerpt from a lecture delivered by Willenegger at the Annual Meeting of the SGUB in Schaffhausen on January 2, 1957. He was speaking about the results of intramedullary nailing using the Herzog technique. By way of introduction the speaker said: *"If we allowed ourselves to be guided by purely biological considerations, then the ideal treatment of fractures would consist of restoring the shape and strength of the bone by application of appropriate load carriers as quickly and completely as possible. If the broken bone can be adequately stabilized in this way, then the uninterrupted immobilization of the fracture, offering the best conditions for undisturbed healing, is guaranteed. Furthermore, the adjacent joints can be mobilized early so that the functional approach to fracture treatment as devised by Böhler can be brought closer to its ultimate goal. This is central to any operative treatment of fractures.*

Only within the context of a school of thought based on functional considerations can operative fracture treatment find serious justification" (Schn II/11).

1958: The founding year

Müller and Allgöwer sent out a circular letter on February 19, 1958 to invite their circle of friends to a three day conference in mid March at the Cantonal Hospital in Chur.

The following interested persons were also invited:

- Baumann in Langenthal
- Eckmann in Basel, who was much esteemed by Allgöwer and who had just completed his postdoctoral thesis on tetanus
- Guggenbühl, since 1957 chief surgeon in Grenchen (previously senior registrar under Willenegger)
- Hunziker in Belp (who had been friends with Allgöwer since their student days)
- Molo in Bellinzona, where Müller had performed operations
- Nicole, a paediatrician interested in trauma and professor in Basel (a friend of Allgöwer's)
- Ott in Rorschach
- Patry in Geneva

Molo, Nicole and Patry were unable to attend, Eckmann (later specialist in visceral surgery at the Tiefenauspital Bern) only attended briefly.

Details of the conference from March 15–17 have been reported in detail by Schneider in his two books (Schn II 13f). His text is reproduced here literally with only minor additions and alterations.

On Saturday morning Müller, who had drawn up the programme, gave an introduction on *"Grundprinzipien der funktionellen Anatomie und der Osteosynthese"* [Basic principles of functional anatomy and osteosynthesis] and commented on various instruments on display. The typed outline of his lecture can be found in the appendix p. 216/217. Allgöwer and his collaborator Ganzoni presented their experience with plaster substitutes and synthetic materials.

The afternoon was reserved for lower leg fractures, at that time the most prevalent type of injury. Allgöwer spoke about *"Minimale Osteosynthesen"* (experience with about 70 screw fixations on tibial fractures performed during the preceding winter). Willenegger reported on the Herzog nail[4]: he had introduced this implant in Liestal in 1956 and had it demonstrated by his senior registrar Moser in other hospitals (MG). Bandi spoke on Leemann's technique of high compression cerclage *(Falzcerclage)*[5]. This seemed very promising and was discussed.

Afterwards, the participants were able to practise the application of all the instruments and implants available and currently in use at that time, which had been brought along for the purpose, on cadaveric bones in the workshop of the chief mechanic Wiesendanger in the cellar of the hospital. In his text Schneider lists (Schn II/14):

- Femoral neck – three-lamellar nail of Smith-Petersen and Böhler
- Femoral neck nails made of vitallium
- McLaughlin plate (2-part implant with adjustable angle for pertrochanteric fractures)
- Cerclage wires
- Küntscher and Herzog's intramedullary nails. The medullary cavity was reamed at that time by means of a hand drill with T-handle.
- Plates according to Eggers and Lane
- Compression plates (Coapteur) of Danis
- External tensioning device according to Charnley
- Lag screws according to Baumann

The last three implants were only known to a few of the participants.

Müller had also introduced and applied the osteotomy plates of Blount, Bosworth and Moore (blade plates with fixed angle) into several hospitals.

The technique of pre-tapping the screw thread in the cortical bone as introduced by Danis was only known to Müller. Schneider writes that some experts had seen it before in Lyon under Creyssel, but had not recognized its significance (Schn II/14) (on the occasion of the first trip abroad of the Collège with Nicolet to Lyon in 1955 (NM)).

Schneider does not refer to the elastically flexible rods developed by the Rush brothers, namely, the *"Rush Pins"* (published in 1937) or the external fixator of Hoffmann, that is, the *"Osteotaxis"* (first published in 1938) – which were being used at that time in many hospitals at home and abroad[6,7].

On balance, the result of the practical part was that the participants concluded that the instruments were inadequate or useless. They were mechanically and metallurgically questionable, incompatible, and had not been adequately tested. In the case of the Coapteur, screw breakages and corrosion problems were not unusual (MM). It was generally agreed that Müller had been right all along and new instruments and implants would have to be constructed. These would have to be complete, simple in form and handling, and all implants would have to be made from the same, biocompatible metal.

According to Schneider (Schn II/14), informative films from the USA and France were then shown, but we have no detailed information on this. In the evening, everyone was enraptured by the stunning performance of Müller, the magician (BW).

On Sunday morning the participants were driven to Flims where the ski lifts had been extended as far as the Cassonsgrat ready for the coming season. Müller and Allgöwer were able to demonstrate their almost equal performance in sport.

After lunch, the group gathered again at the hospital in Chur for the continuation of the scientific programme. Willenegger, Müller and Schneider spoke on proximal and diaphyseal femoral fractures. Then, supper and discussions.

On Monday morning the first rounds together took place on the surgical wards, then more lectures on fractures of the upper limb (humerus and forearm) and on treatment of pseudarthrosis and arthrodesis by means of a compression device (the relevant publication by Müller and Allgöwer *"Zur Behandlung der Pseudarthrose"* [On the treatment of pseudarthrosis][8] appeared in the same year. In the afternoon, Willenegger spoke on bi- and trimalleolar fractures. There were final discussions prior to departure whereby Müller was put in charge of developing the instrumentation.

During this conference (on Saturday or Sunday), baroness X from Germany was brought into casualty after a skiing accident having sustained a torsion fracture of the lower leg. Allgöwer operated on her immediately (screw fixation). The spectators in the operating theatre included the patient's daughter (degree in physics) and all the participants at the conference.

The almost unavoidable postoperative infection became manifest on the 5th day. When Allgöwer cast a dubious glance at the redness, he was asked: *"Is it serious?"* and when he said yes, the answer was: *"Then I will stay here until it has healed".* Relations remained excellent and this self-confident lady left the hospital after 11 weeks. Consolidation of the fracture was uneventful (AM).

This conference in Chur has to be regarded as the first extended AO conference because of its structure and content. In these three working days, the whole known spectrum of traumatology and related problems had been discussed. Schneider writes: *"at that time we did not have the instrumentation, but instead we had plenty of time to discuss and to contemplate. Without these unhurried hours, the development of the AO would not have been possible"* (Schn II/14).

The most pressing concern was now the creation of new instruments and implants.

Three weeks later, on April 8, Müller appeared for the first time in Robert Mathys' workshop in Bettlach (**Fig. 2-2**). This man had founded his own company in 1946 and then specialized in processing stainless steels. The steel company Notz in Biel had recommended

Fig. 2-2: Workshop and home of Robert Mathys in Bettlach. The new building of 1955.

him to Müller. Schneider writes: "*A fruitful co-operation soon developed and in 1958 the brilliantly designed, principal component of the instrumentation had already been developed, the AO cortex screw. The technical drawing for it bears the date October 6, 1958. The cancellous bone screw was produced at the same time and in August the drawings for the "radius", "humerus", and "femur" plates had been drawn. The first sketch for a drill sleeve originated on November 20, 1958*" (Schn II/14f).

In summary, Schneider writes: "*I have recorded these dates as a reminder of how much concentrated and valuable work was done in the first 7 months of the development of our instruments and implants by Maurice Müller and Robert Mathys*" (Schn II/15). Müller had entered into a contract with Mathys (by handshake) on his third visit. In the coming years ("*at least three years*" (MM)), Mathys would not work with any other surgeon and would not sell either instruments or implants outside the AO production site in Biel until everything had been tested and the quality guaranteed.

A further difficulty, that of finding rooms to carry out basic research, had already been addressed by Allgöwer. In February 1958 he went on reconnaissance to the former Institute of Pathological Anatomy in Davos because he had heard that it had been abandoned. On this particular day, Basset from the University of Columbia was a guest in Chur and Heim had come from Zürich to apply for a post as senior registrar under Allgöwer, whom he knew from Basel. Allgöwer simply took both of them with him to Davos.

The Institute, under the leadership of the pathologist Berblinger, had been dedicated exclusively to research into tuberculosis. In the pre-antibiotic era, several hundred autopsies were performed in Davos each year. Now, the interminable cures and, particularly, deaths as a result of this disease had become a rarity. The sanatoriums were already being converted into hotels. "*In the Institute of Pathology we found a caretaker whose job was to maintain the temperature of the building above freezing. Apart from that, there was nothing but abundant emptiness,*

Fig. 2-3: The building of the Swiss Research Institute for High Mountain Medicine in Davos in which the Laboratory for Experimental Surgery was housed in 1959.

except for the marble dissection table still standing idle in the former autopsy room. It later became the operating table for the experimental animals" (HU).

This rather old and seemingly impractical building (**Fig. 2-3**) appeared adequate for the purpose of animal experimentation and the installation of laboratories. In a newer extension there was a lecture hall to seat approximately 60 people.

The building was owned by the Foundation *Swiss Research Institute for High Mountain Medicine*. Its director, Dr. med. Felix Suter, medical director at the Thurgauisch-Schaffhausische Heilstätte (sanatorium) in Davos, was prepared to make the greater part of the building available to the AO, provided it was maintained in good order. No rent was demanded (AM). Allgöwer founded the *"Laboratorium für experimentelle Chirurgie, Forschungsinstitut Davos"* [Laboratory for Experimental Surgery, Research Institute, Davos] as a personal Foundation with a capital sum of CHF 10'000. Members of the Foundation Committee were Willenegger and Müller who each contributed an identical sum. The founding certificate is still in existence and is dated June 18, 1959 (Appendix p. 218–222).

In the *"Laboratory"* in Davos another concern of the group, the demand coming mainly from Müller and Willenegger, was to be dealt with, namely, the central documentation of all osteosyntheses performed and the results thereof.

The group met again on Friday October 6, 1958 in the Hotel Elite (*nomen est omen*) in Biel. It was on the eve of the annual Trauma Convention (SGUB), the president of which was Baumann. The agendas have been listed by Schneider. Numbering and text are reproduced literally with relevant additions and comments.

1.»*Official Foundation of the SAO (Schweizerische Arbeitsgemeinschaft für Osteosynthese)"* [Swiss Association for the Study of Internal Fixation] (Schn II/15). The term *"Arbeits-Gemeinschaft"* (collaboration in friendship?), so important for an understanding of the later collaboration of the group, appears here for the first time. Allgöwer claims to have chosen this word from the German language (AM). Translation into "Association" in English or an equivalent in French tone down the meaning. Gemeinschaft means a privileged level of working and collaborating together towards a definite objective. It manifests the voluntary stand of independent men together, without subordination and in keeping with ancient Swiss tradition, that is, without a hierarchical structure of leadership.

Schneider omits to publicize the important amendment to the title, namely: Arbeitsgemeinschaft *"für Osteosynthesefragen" [for questions of osteosynthesis]*, which is a shortened form of the wording in the statutes: *"Schweizerische Arbeitsgemeinschaft für* ***das Studium*** *der Osteosynthese" [Swiss Association for* ***the Study*** *of Internal Fixation]*. Willenegger always emphasized this specific point. There was never any intention to decry non operative fracture treatment or to substitute it, but rather to offer operative treatment in such cases as would benefit from it. The only definite indications at first were pseudarthrosis and posttraumatic malalignment.

2. *"Presentation of the osteosynthesis products for the winter season"* (Schn II/15).
During autumn 1958, screws and prototypes had been delivered to various hospitals. The members were informed of the current status and of further developments of instruments and implants.

3. *"Production site"* (Schn II/15) (from 1962 *"Sales outlet"*)
As production went underway, storage, ordering, and distribution of the new instrumentation had to be organized. Müller's sister, Mrs Violette Moraz-Müller, took on the responsibility. She had recently lost her husband under tragic circumstances and now she dedicated herself for many years to this fulfilling task. She established the *"Production site"* in her small house in Biel.

4. *"Brief address on operative technique and discussion of the results of the last winter; Discussion of the Guidelines"* (Schn II/15)

These three items on the agenda form a sort of unit. Presumably, experience was reported and conclusions drawn. The phrase *"Results of the last winter"* must be an error of some kind and refer to the period after the March 15.

The term *"Guidelines" ("Merkblätter")* appears here for the first time. Müller had already drawn up initial texts in Fribourg in 1951 and amended them in 1956. Two texts are still in existence from the year 1961.

5. *"Scientific plans, experimental opportunities at the Research Institute Davos. Assigning responsibilities"* (Schn II/15).

The inauguration of the Laboratory for Experimental Surgery in Davos was planned for the summer of 1959. The building had to be structurally modified inside to suit the new purpose, it had to be equipped and qualified personnel appointed. Allgöwer had taken on this task. Initial funding was requested from the members. The unanimous feeling of enthusiasm was manifest in *"the willingness of those present to contribute CHF 500 towards the planned laboratory in Davos"* (Schn II/15).

Schneider writes *"With this, the AO had been founded de facto. More detail was required for de jure validity.... however, far more important than regulations was the common enthusiasm for a clear objective"* (Schn II/15). *"The following were present in Biel: Allgöwer, Bandi, Baumann, Brussatis, Guggenbühl, Hunziker, Müller, Ott, Patry, Schär, Schneider, Stähli and Willenegger"*. These are the **13 Founding Members of the AO 1958**. Of these, only Brussatis and Patry had not attended the conference on March 15–17, 1958 in Chur.

These 13 founders will be introduced in the next chapter by presentation of short biographies. How their paths crossed, their relationships to each other developed, and how the subsequent members came to the AO is shown as a sort of 'family tree' (**Fig. 2-4**).

It has to be assumed that a meeting at which so many topics were discussed and so many decisions made on one single evening ended late. The following morning Willenegger, Müller and Allgöwer had lectures to deliver at the Congress[9].

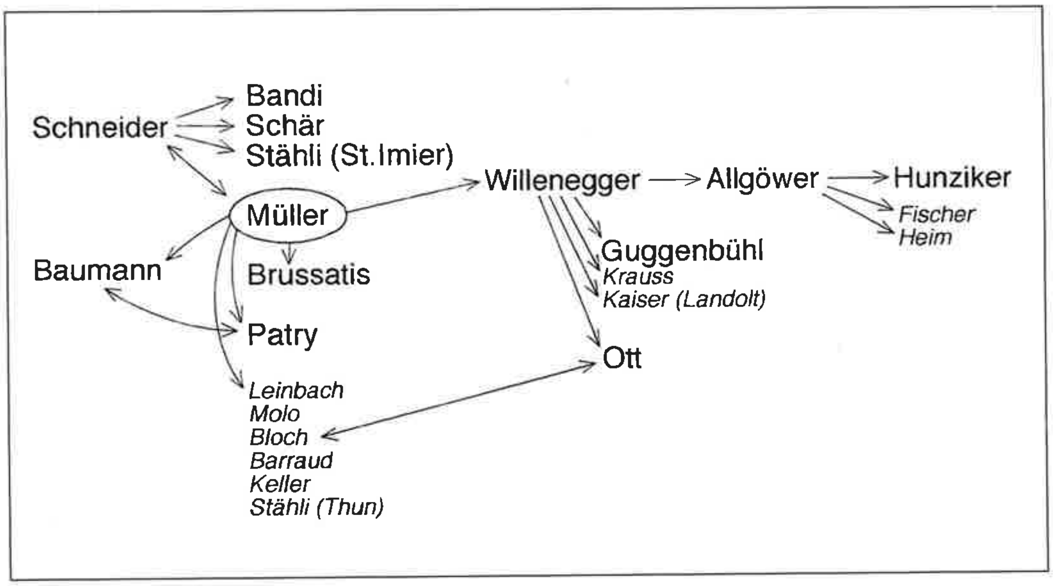

Fig. 2-4: *"Family tree".* The 13 Founding Members (in large roman type) and their relationships to each other and to the new members joining in the period up to 1962 (italic).

AO Goals

Finally, the **objectives** of the newly founded Gemeinschaft must be set down. They have been recorded as part of the lecture on principles delivered by Müller at the meeting on March 15 in Chur. A two page summary is still in existence and has been reproduced in Schneider (Schn II/6ff) in extenso (Appendix p. 216/217). On the first page, there are some hand-written notes made by Müller under the title *"Objectives"* which we will quote here:

"1. *Maximal restoration of anatomical form and function of the injured limb. Therefore, osteosynthesis that permits immediate mobilization.*"

"2. *Shortest socially and economically justifiable hospital stay, rapid return to work. Disability pension dependent upon achieving the first objective.*"

In the typed script, the objectives are expressed more comprehensively under items 1, 2 and 3. Below, another hand-written note: "*4. Preservation of the soft tissues, especially the vessels!*"

These were the corporate ideas of a group of young doctors. The active founders were all young men (with the exceptions of Baumann and Patry, both 68 years old). Their ages at the time of founding were: Allgöwer 41, Bandi 46, Brussatis 41, Guggenbühl 40, Hunziker 43, Müller 40, Ott 43, Schär 52, Schneider 46, Stähli 49, Willenegger 48.

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Chapter 3
Personalities at the time of founding

Introduction

Before we go into the further development of the "Association", we will introduce the personalities who came together to work collectively towards a clearly defined goal – namely, the active treatment of those suffering fractures and their consequences. Chronologically, the group of Bernese friends comes first. For practical reasons, we will however first introduce the five members of the *"core group"*: the three qualified lecturers and scientifically active men, Müller, Willenegger and Allgöwer, and two other early members, Schneider and Bandi (**Fig. 3-1**). The biographies concentrate on the years before 1958 and form the basis for a better understanding of these persons.

Their activities during the early years of the Association are presented in the context of later events, that is to say, in Chapters 4 and 5. Their careers after 1963 are largely known and are only outlined here.

The senior registrars are also given. They assisted the chief surgeons who were struggling with the formation process of the AO by managing the hospital departments, teaching, and supporting scientific projects with enthusiasm. Many of the osteosyntheses, documented in Chapter 8 under the initials of the clinic, were performed by the registrars. Later, when they had taken on independent functions, they too became members of the AO.

In a second group, those founders are presented who, after completing their doctorates, were no longer active scientifically but became competent and experienced surgeons and chiefs. Their task, after long years of acquaintance and collaboration, was to work within a system agreed by a consensus and to contribute their experience at the meetings, thus co-determining the further development of the techniques. In a way, they were swept along in the wake of the movement. Many stimulating suggestions came from these members. Almost all of them participated in AO teaching activities. All of them documented their osteosynthesis procedures, with the exception of Patry and Baumann. Several of them collaborated on joint publications.

Fig. 3-1: The core group of the AO. From left: Allgöwer, Willenegger, Müller, Bandi, Schneider. The photos were taken at the first course in Davos in December 1960 (name tags).

We have added two additional personalities to these 13 doctors:

- Robert Mathys: He had been working intensively on the new instruments and implants for many months even before the official foundation of the AO. Therefore, he must be listed alongside the founding doctors. Schneider calls him the *"mainspring of AO development"* (Schn II/103).
- Violette Moraz-Müller, Maurice Müller's sister: She took on the administration and distribution of the instrument sets.

The medical core group

Maurice Edmond Müller (born March 28, 1918) citizen of Volketswil (ZH)

Maurice was born in the bilingual city of Biel as the eldest of five siblings. His grandfather had moved there from the countryside of Zürich.

His father, born 1890, left his parental home when he was 15 years old and emigrated to the United States, studied medicine, practised in St. Louis, and simultaneously commenced training as a surgeon. On his father's request, he returned in 1916 to do military service in his homeland. Since he could not pursue his profession without the higher school certificate and Swiss qualifications, he took over his parent's business which involved wholesale, trade, and transport to and from the railway station. In 1927 he expanded into packaging, but his business suffered greatly during the economic recession after 1929.

Maurice always felt more at home speaking French because his mother (née Huguenin) could not and did not wish to speak German with the children. She came from a family of clockmakers in Neuchâtel, was a qualified violinist, and had spent some of her childhood in Italy. His mother's piety and concern with bible teaching, and the Sunday school, where the mission to Africa and especially to the Copts in southern Egypt were a main topic, had a lasting influence on the boy. His mind was on Africa and surgery.

He and his friend played in the big garden and attempted forbidden pyrotechnical experiments in the hidden shed; then he moved on to breeding rabbits which had to be stopped abruptly because it soon became utterly disorderly. But, it had all been worth it. Maurice was head of a suburban gang. The adventurer was also drawn to the nearby lake, to swimming and an interest in ships. He liked to be the helmsman, a much sought after post amongst the boys, and had a preference for the larger rowing boats. As an adolescent he bought old, broken bicycles, took them apart, put them back together again, and sold the ones he had repaired (FR).

At 17 he taught himself to do magic and managed to get his skill in tricks of all kinds up to a professional level. On rare occasions, particular during military service, he would give a performance.

After his higher school certificate in 1936 he studied medicine, first in neighbouring Neuchâtel, then in Lausanne, and for a short while in Bern. Under the code name of "Fakir", he took an active interest in the goings on of the "*Valdesia*" student corporation, soon becoming the treasurer and prefect for the freshmen. In the psychotechnical exams to which some students were ordered, Müller drew attention to himself because of his grasp of the three-dimensional. It was recommended that he pursue an education in surgery of the locomotor system or as an architect in city planning. At the joint party of the fraternities in Bern he again met his rowing companion and former team mate, Robert Schneider of Zähringia (nicknamed: "Spitz" 'peak') who came from the same part of Biel, and became acquainted with the latter's inseparable pal Walter Bandi ("Fix").

Together with an older cousin, who was a lawyer, Müller had established a company in Lausanne with himself as junior partner, in order to commercialize his patented inventions, one being a tie rack. At first, the business developed well until war broke out in 1939. The whole venture collapsed after general mobilization for war. He pursued the rest of his studies under the burden of long periods of military service. He passed the state exams in 1944. When acting as a locum for doctors on leave from the army, two patients had a particular impact on him:

- One of these had quit service in the French foreign legion to fight as a Swiss on the Finnish-Russian front in the winter of 1939/1940. His fracture of the femur had been nailed by Küntscher himself. To walk without a plaster cast immediately after the operation had been a military command. He now came – with a fully functional limb – to request implant removal.
- The other came hobbling along on crutches, one leg shorter than the other, but not suffering any pain. He had received an interpositional arthrograft of the hip joint according to *Leveuf* to treat necrosis of the femoral head; he had lain for months in traction receiving physiotherapy, and now came for a follow-up examination. Was it not possible to achieve good function without sequelae for this hip just as for the femoral fracture?

In the autumn of 1944 Müller was employed as an assistant at the University Orthopaedic Clinic Balgrist in Zürich.

In the summer of 1945 surgeons were being sought by advertisement for a medical mission in Ethiopia. The entrepreneur Wittlin from Bern wanted to open a hotel there. A member of the Swiss Parliament, Dr. med. E. Bircher (up until 1934 chief of surgery in Aarau, then commander of a field division until 1942), was of the opinion that Swiss doctors should take on the responsibilities of the Italian doctors who had left the country. In 1941 Negus had returned from exile to his homeland and experts from neutral Switzerland were being given preference (WiH). Müller applied as an assistant because, as he wrote in his letter, a hierarchically structured team would work more smoothly and the French language would be more useful there after the many years of Italian occupation than German.

The task of choosing amongst the numerous applicants (after the end of the war jobs in hospitals had become rare) and the detailed organization had been passed to the Clinic for Surgery in Winterthur (Chief surgeon: PD Schürch), but was carried out de facto by the locum senior registrar, Willenegger. His friend, senior registrar Knoll, was in charge of the team. Willenegger wanted to take a closer look at the candidates and the accompanying women, including Müller's fiancée. The future couple were accepted and Müller became assistant to Knoll. The preparations took five months.

In order to be accepted abroad, it was absolutely necessary to be *"Doctor of Medicine"*. Müller therefore set aside an already advanced, but arduous thesis at the Balgrist and, in a great rush and based on material from the clinic archives, wrote up his dissertation on *"Contribution à l'étude de la maladie de Calvé-Legg-Perthes-Waldenström ou Coxa-Plana"*[1], which was accepted just before departure. The author had inspected the 150 documented cases (1913–1945) and looked particularly at 15 patients followed up over more than 20 years and which he was then able to assess personally. Radiographs at that time were photographed on glass plates; films did not yet exist.

In May 1946 six hotel experts, five doctors, an OR nurse, and a lab technician left for Ethiopia and arrived there in June. Müller was assigned management of a hospital in Jimma (about 200 km to the south-west of Adis Abeba) with 200 beds. His superior, the Africa expert, Rutishauser (formerly in Lambarene), was in charge of the out-patients department 3 km away. Sometimes there were week long expeditions into uncertain, rough areas accompanied by a military escort. In October, Madame Martha arrived and always went with them, quite regardless of the dangers.

Müller returned in the following summer for family reasons. He had acquired great surgical skill and experienced the unbelievable. He has said: *"My time in Ethiopia had a lasting influence on my life"* (MM).

On his return, despite his short and atypical background, he immediately obtained a position as a senior registrar for two years (in order to obtain the specialist title in surgery [FMH: Foederatio Medicorum Helveticorum, Swiss Medical Association]) in Liestal (Chief surgeon: Dr. Berger), but he had to live in with his wife and child.

The position he was hoping for at the Balgrist would only have become vacant in April 1950. He used the time to visit the leading orthopaedic clinics in Europe, for example, Max Lange and his senior registrar Witt in Bad-Tölz, Hohmann in München, Pauwels in Aachen, Merle d'Aubigné and Judet in Paris.

He then went to Leyden for four months to the clinic of the orthopaedics expert Van Nes (Cornelis Pieter Van Nes 1897–1965), who was revered as an outstandingly skilled surgeon at that time. There he learned to perform surgery of the hip and spine and wrote two scientific papers. Van Nes sent him to his friend Robert Danis (1880–1962) in Brussels at the Hôpital St. Pierre.

The memorable visit to Danis (March 1, 1950), so important for the history of the AO, only lasted one day. Danis had time for him because a patient had failed to show up for an operation. He had just published his second book *"Théorie et Pratique de l'Ostéosynthèse"*[2], in which he reported his latest experience with osteosynthesis techniques. Müller was given an autographed copy. Danis showed his guest the results of stable osteosynthesis with a compression plate, called the *"Coapteur"*, whereby the consolidation of the fracture was achieved without visible callus. He also showed him his instruments and implants, especially the tap for the cortex screws. Müller was also impressed by the radiographic documentation. In the evening, he had to survive a tasting session based on Danis' large whisky collection with the result that he had some trouble finding his hotel later in the dark.

Müller spent one month in Winterthur learning the latest methods of anaesthesia from a particularly renowned colleague (at that time there were no professional anaesthetists in the country). While he was there he reported on his visit to Danis, whereupon the senior registrars set off for Brussels themselves. As a result, Leemann developed the high compression cerclage (*"Falz-Cerclage"*)[3].

This was followed by several months of military service to earn the rank of captain from March to June 1950.

Since the job he had been promised at the Balgrist failed to become vacant due to a change in chief surgeon, Müller applied for and obtained the post of senior registrar at the *Hôpital des Bourgeois* in Fribourg. Here he was allowed, with the approval of the chief surgeon, to treat patients with fractures and pseudarthroses in accordance with the ideas and techniques of Danis. He documented the 72 osteosyntheses performed during this time thoroughly, whereby he also recorded the type of accident and the return to professional activity and normal life. The first *Guidelines* ostensibly originated during this period.

In October 1951 the position at the Balgrist became vacant and in the spring of 1952 he was senior registrar there. In this year, he was also awarded the title of specialist FMH for surgery. He now worked largely independently towards the goal of dedicating himself exclusively to orthopaedics. He introduced himself to the doctors in Zürich and Winterthur by delivering a lecture on stable fixation and plaster-free aftercare. Many colleagues came to the Balgrist to watch him operate. Among them, and especially interested, was the senior registrar H.U. Buff of the university clinic for surgery.

In the military, Müller had taken command as captain of the Surgical Company IV/2 in 1951. His predecessor had been W. Bandi. In September 1952 during a refresher course for his unit he met Schneider again and subsequently became acquainted with Schneider's Bernese friends.

Müller was an innovative troop leader. The image of the medical corps needed to be improved at that time. He organized exercises that were as realistic as possible (operations on animals, blood transfusions, etc.). On one occasion, a *"radiation-proof"* field hospital was set up. Officers from increasingly higher ranks of the combatant arm of the service were invited. In 1952 Müller was already a member of the

Army Commission for Field Surgery. In 1954 he was commissioned – pursuing one of his own ideas – to develop a mobile operating room so that aseptic operations could be performed close to the front line, this not being possible in a tent. A publication appeared in 1955[4].

From 1951 Müller began to construct instruments and implants that he had designed himself. He collaborated with various companies, e.g. Zulauf in Langenthal and Ulrich in Ulm and St. Gallen. Casparis in Zürich was his sales outlet. He had everything patented as he went along.

Quite early on he had effected the transfer of F. Brussatis from the Neurosurgical Clinic to the Balgrist. An interdisciplinary approach seemed imperative for the operative treatment of the vertebral column, the spinal medulla, and nerve root problems, e.g. numerous herniated discs.

How relations to the later AO members developed from 1952–1957 has already been reported. He later said: *"Working together with these friends renewed my interest in traumatology"* (MM).

In 1956 Müller had attained the additional title of specialist in orthopaedics. He completed his postdoctoral thesis the following year in the form of the book: *"Die hüftnahen Femurosteotomien"* [Osteotomy of the femur around the hip joint][5]. During this project he travelled to Aachen several times to visit Pauwels and make sure that he had made proper application of the theories of this leading authority. The book was an immediate success. It received the renowned Heine Prize (reprinted 1971).

Now, the burden of low wages and the impossibility of maintaining a family in this way had become intolerable. Müller had hoped that with his lecturing qualification he would receive one or two private beds from his chief surgeon. His request having been refused, he quit, and left the clinic in September 1957. As a well known and extraordinarily skilled surgeon, he very soon became a much sought after guest surgeon. He gained not only contacts to later AO members, but also to the university clinics (Basel, Geneva, Zürich), hospitals, and private clinics. This extensive operative activity was condemned by the orthopaedic surgeons (with the exception of Debrunner in Basel). At the Zürich faculty, the proposition was put forward to deny him the *venia legendi* (without success).

Müller's activities in the years 1958–1963 have been set down in subsequent chapters. The following complementary remarks must still be made:

- In Aachen he had met Blount who was preparing a publication together with Pauwels. Blount invited him to the United States and organized a two month tour for him in 1959 during which he would visit all the important clinics – whereby he *"delivered 27 lectures"* (MM). He was a guest at the SICOT Congress in New York in September 1960, gave lectures, and presented a scientific exhibition. Schneider writes: *"the focus was compression osteosynthesis for pseudarthrosis without graft and without excision of the pseudarthrotic tissue"* (Schn II/18).
- In St. Gallen a new building was being erected to accommodate the surgical clinic of the Cantonal Hospital. As early as April 1958 the search had started for a chief surgeon to head the independent orthopaedic department which was expected to open in the autumn of 1960. Müller had applied for the post and was preferred initially. He was the only applicant with a postdoctoral lecturing qualification and two specialist titles, general and orthopaedic surgeon. But then disapproving and bilious murmerings were heard from the faculty in Zürich and from St. Gallen. Müller announced the withdrawal of his application. However, negotiations with other applicants had already petered out. In the summer of 1960 the cantonal minister of health, who had just been elected, stumbled over the pending file for the appointment of the chief orthopaedic surgeon: Without a moment's delay he rang up Müller and asked him whether, despite everything, *"he wouldn't after all ..."* (MM). This set of circumstances suddenly gave him the unforeseen opportunity to realize his concept of a large orthopaedic-traumatology clinic mod-

elled on the American, English, and more recently, French hospital setups – a novelty for Switzerland.

- He was officially elected by the legislature on August 16, 1960. The new building was ready for occupancy in November. The 200 bed clinic in St. Gallen was extremely busy and contrary to all expectation, also attended by patients from other parts of the country and abroad. It was also considerably larger than the traumatological sections in the other AO hospitals, e.g. Chur, Zürich-Waid, Liestal and Interlaken. Accordingly, qualified and motivated younger professionals developed their skills here. Only a few weeks after taking over the clinic, the new team already had important tasks to fulfil at the first AO Course in Davos.

- The model clinic was soon visited by numerous surgeons and groups of doctors from all over the world. The witty orthopaedic surgeon, Louis Descamps of Nice, invented the bon mot of the 5th gospel *"L'évangile selon St. Gall" [The gospel according to St. Gallen]* (HU).
  In the early years, Müller supervised the clinic personally and with great dedication. *"The boss had to be called in the night if an emergency fracture came in which was atypical and could not be operated on, but he also had to be called if the non operative treatment of a child was unsuccessful. He usually came in person."* (BH).

- In 1963 Müller was offered a post as professor and director of the university orthopaedic clinic in Bern. Since it was an invitation, he was able to put his concepts of structure and organization into practice here as well, and started off by only attending Bern one day a week until the new buildings were finished (MM). He continued to work primarily in St. Gallen until 1967. Senior registrars from St. Gallen were delegated to manage the clinic in Bern on a yearly rota.

Müller was exceptionally full of ideas and, so to speak, ahead of the times and of reality. His impatience was often difficult to endure. For example, he could not wait to show implants, which only existed as prototypes, in public and to comment on them, thus awakening false expectations.

In 1963 the book by the authors M. E. Müller, M. Allgöwer and H . Willenegger entitled *"Technik der operativen Frakturenbehandlung"*, which will be discussed separately in Chapter 7, was published[6]; in 1969 the *"Manual der Osteosynthese"* by the same authors[7], which was translated into six languages, enjoyed several editions, and became a standard textbook worldwide.

In 1965 Müller established the Foundation and in 1967 the Protek company for the development and distribution of his total hip prostheses. There was a very great future before them.

He remained professor in Bern until 1980 and then dedicated himself entirely to the further development of his Foundation for advanced training and documentation in orthopaedic surgery, including its many international branches. This took place under the motto of the three interlinked rings: *"Evaluation, Learning, Teaching"*. Since 1998 he has dedicated himself more to cultural projects.

In 1968 he was President of the Swiss Society for Orthopaedics, the International Society for Hip Surgery; in 1981 President of SICOT. He was also awarded 12 honorary doctor titles. In 1987 another standard textbook was compiled, his *"Classification AO des fractures"*[8], which was translated into all sorts of languages. His classification – the groundwork for which can be traced back to 1975 – has since been accepted by the SICOT and distributed throughout the world.

The team in St. Gallen. Three dedicated senior registrars had been working in the large clinic in St. Gallen since November 1960. Three more arrived in the following years:

Bernhard G. Weber, born 1927, who had studied in Basel in 1953 and completed his doctorate in 1956. At first he was assistant in various surgical departments and then at the Balgrist, where he had worked with Müller who had called him to St. Gallen when the clinic opened there. As first senior registrar, he had to represent his chief when the latter was absent. He was scientifically very active and also co-author of two chapters in the first AO book in 1963. In 1966 he obtained his postdoctoral lecturing qualification in Bern for his book *"Die Verletzungen des oberen Sprungelenks"* [Injuries to the ankle] published in 1967 (2. Ed. 1971)[9]; it obtained international recognition. In 1967 he became Müller's successor as the chief of the clinic in St. Gallen and in 1974 titular professor. He published other important scientific works.

Andrea Mumenthaler (1927–2000) completed his studies in Basel in 1951 and received his doctorate in 1953. After working as an assistant in surgical and non surgical clinics and undertaking various periods of training around Europe and in the USA, he became senior registrar at the surgical clinic in St. Gallen and part of Müller's team in November 1960. He was co-author of a chapter in the first AO book in 1963. From 1966 to 1982 he was chief of the orthopaedic traumatology department of the Hospital in Langenthal and later scientific collaborator at Protek Inc. and the M. E. Müller Foundation in Bern.

Hans Christoph Meuli, born in 1929, studied in Bern and Vienna, graduated in Bern in 1956, doctorate in 1957. He worked at the university surgical clinic in Basel and temporarily at *"Bergmannsheil"* in Bochum under Bürkle de la Camp. Müller had met him in Basel where he was working for Heusser and called him to St. Gallen when the clinic opened; he soon became senior registrar. In 1967 he moved permanently to Bern with Müller. He had his own practice in Bern, but remained a consultant for the clinics. He was awarded his postdoctoral qualification as lecturer in 1967 and became a titular professor in 1982.

Alexandre-J. Boitzy, born 1930, studied in Lausanne, qualified in 1955, doctorate 1958. He was surgical assistant in Lausanne and Geneva, also at the Hôpital Cochin in Paris under Merle d'Aubigné, and at the Orthopaedic Hospital in London. He moved to St. Gallen in March 1961, started off as an assistant and then became senior registrar. His native language was French and since he had a profound knowledge of the anatomical and technical terms, he was given the task of translating German texts and specialist terminology. It was especially difficult to find neologisms for the new instruments and implants. He also transferred to Bern with Müller and obtained his postdoctoral lecturing qualification in 1970. After that, he took charge of different orthopaedic departments and worked as a freelance orthopaedic surgeon at various hospitals in the French speaking part of Switzerland.

Harold Vasey, born 1930, studied in Neuchâtel, Geneva and Vienna, graduated in 1955 in Geneva, doctorate 1956. He worked as an assistant in various clinics of the Cantonal Hospital, Geneva and came to St. Gallen on the proposition of his uncle, Robert Schneider, in October 1961. In 1962 he was co-author with Müller on his work on open shaft fractures[10] and with Weber on his work on fractures of the olecranon[11]. He returned to Geneva in 1963 as senior registrar at the newly established clinic for surgery of the locomotor system and was assistant chief surgeon from 1971. He obtained his postdoctoral lecturing qualification in 1972, became professor in 1977, and director of the clinic in 1987. Professor emeritus since 1995.

Eric Courvoisier, born 1928, studied in Geneva where he graduated in 1954. He worked as an assistant in various clinics and in the pathological anatomy department in Basel, where he obtained his doctorate in 1959. He was one of R. Patry's nephews and came to St. Gallen in 1962 as an assistant, soon became senior registrar, and returned as such to Geneva to the clinic for surgery of the locomotor system. He had his own practice in the city of Geneva from 1968, but remained as *"Médécin adjoint consultant"* at the clinic and was awarded his postdoctoral lecturing qualification in 1973.

Robert Schneider (1912–1990)
citizen of Reigoldswil (BL)

Robert was the son of an electrical and mechanical engineer, born in Biel, where he spent his early childhood with his younger brother. Thanks to school attendance in Biel and Delémont, he had grown up bilingual. His favourite game was playing with the *"Meccano"* metal building kits with which he put together the most complicated constructions. He went through grammar school as an ambitious star pupil. He was tall, strong, and very athletic. He passionately loved rowing, especially in the larger boats of the maritime club in Biel and was always the leader, which is why he was later given the nickname "Spitz" ["peak"] at the student corporation, a name which characterized him well. He also loved nature, art, and music. Robert had an excellent command of his German mother tongue: *"He helped me later with the linguistic preparation and polishing of publications in German"* (MM). He was well versed in French, and especially Italian, but the English language and the culture of the English speaking world were foreign to him.

He commenced his studies in medicine in 1931 in Bern, together with W. Bandi. Their great examples were the surgeons Theodor Kocher (1841–1917) and F. De Quervain (1868–1940). The two friends also spent a semester in Paris together. State exams, 1937. Later they both got married in the same month and both to professional musicians.

In the army, Robert joined the infantry, he was soon promoted, and became commander of the elitist company I/3 of the Bernese rifle battalion during the war.

He worked as a medical assistant first at the Tiefenauspital in Bern, then in various specialist departments of the university hospital, at the Zieglerspital in Bern, and finally at the university clinic for surgery, together with Walter Bandi. The two commenced their training under Professor Matti, successor to De Quervain, but could not really get on with Lenggenhager, elected in 1941. In 1944 Schneider became senior registrar, but left the clinic in 1945 to open a practice in Grosshöchstetten. There he was initially a freelance surgeon; from 1951 he was chief of surgery. In this small hospital, the problem of finding a locum for the chief was a difficult one to solve. Of the surgeons who were found to take on this responsibility, some later became delegates from AO clinics, especially, E. Kuner (at that time in Chur) and K. H. Schweikert in Freiburg and Mainz. Thus, friendships formed that were to stand the test of time.

On the subject of his acquaintance with Müller in 1952 as a result of his military orders to transfer to the medical corps and their subsequent collaboration, he writes (Schn II/81): *"In 1952 Maurice Müller came to me in Grosshöchstetten. He was loaded down with ideas and instruments. Although I had performed my first intramedullary nailing procedure nine years before in Bern, I was astonished by a thing calling itself a "tensioning device", by taps and pins to fit it and by a strange retractor named after Hohmann. I experienced for the first time the pneumatic motor which sometimes had to be run on oxygen! In 1953 I succeeded in healing ulnar, tibial and femoral pseudarthroses with only compression and plaster. My teacher, Hermann Matti, as would Lexer, had excised the pseudarthrosis interstice as for a tumour. A new world opened up. In 1955 tapping for the first time for the Danis coapteur and subsequent disappointment at refracture of the forearm, although the radiological evidence of "healing" had been so overwhelming. In 1957 first nailing procedure with reaming."* Müller often came to Grosshöchstetten from the Balgrist on a Saturday as a guest surgeon and later said: *"I learned a lot from Schneider. He was an outstanding, technically highly skilled general surgeon"* (MM). His daughter writes: *"I remember so well how Marty Müller kept us children busy making things while Maurice and father were operating. Once we found them the next morning, wrapped in blankets, sleeping on the couch…"* (MSR).

"He was a practical man, that made him special, a very exact surgeon. The results interested

him, even the bad ones, which he not only collected systematically, but also incorporated into his lectures, which shocked many. Bad results, he thought, showed best what had to be avoided and what should have been done" (MSR).

Schneider was a tall, domineering, cultivated personage, a typical Bernese personality. In the AO Group in its formation phase, he combined natural authority with generosity. It was, so to speak, obvious that he should become their "spokesman", which he remained until 1978. He dedicated himself to his task both within the AO and abroad. "*For many years he travelled like a missionary for the AO to operations, for example, in Freiburg, München, Mainz, Bochum, Hamburg and Halle*" (MSR). Müller emphasizes: "*Without Robert Schneider the AO would not have come into being*" (MM).

He participated actively in the scientific work, but because of ever increasing professional obligations could not be a main author on the first AO book in 1963 or on the first manual of 1969.

In the field of traumatology he was, above all, an expert in intramedullary nailing. In the first AO book, he wrote the chapter on complications (Te 166–169). Together with P. Gisin in Waldenburg, he invented and constructed the conical thread in 1962, which essentially improved insertion and removal of the nail.

In German and also in Austria, Italy, and Spain, he participated in all activities and foundations. For the Germans, he was a father figure.

In 1970 Schneider returned to Biel and devoted himself from then on exclusively to hip surgery in close collaboration with Müller. In 1976 he wrote the monograph "*Die Arthrodese des Hüftgelenks mit Kreuzplatte und Beckenosteotomie*" [Arthrodesis of the hip joint with cruciform plate and pelvic osteotomy][12]. He had already developed the implant in 1964. In 1977, nominated by his friends Brussatis and Schweikert, he became honorary professor at the university of Mainz. In 1982 his essential book "*Die Totalprothese der Hüfte*" [Total prosthesis of the hip][13] was published (2. Ed. 1987, English translation 1989). During these years, he dedicated himself primarily to reoperation after hip prosthesis, something nobody else really wanted to do. He died of a heart attack, having just completed an operation.

Walter Bandi (1912–1997)
citizen of Oberwil near Büren an der Aare (BE)

Walter was born in Zollikofen (BE) the second of three children. His father, Dr. phil., taught as an agronomist at the agricultural school Rütti. The family moved temporarily to Zürich-Oerlikon (Swiss Research Institute for Agronomy) and returned to Münsingen in 1920 where his father was a teacher at the cantonal school of agriculture "Schwand". Walter continued his schooling there. He was an active boy scout. He went to the grammar school in Bern, higher school certificate 1931. His ability was clearly on the side of mathematics and physics so at first he considered taking up technical studies, but then decided to do medicine. In the same semester and in the same student corporation *Zähringer* (where he was given the nickname "*Fix*"), he met Robert Schneider, "*Spitz*" from Biel, with whom he had a lot in common and with whom he remained close friends for the rest of his life. They spent a semester together in Paris. After the state exams in 1937, Bandi was a medical assistant in Biel, then in the district hospital in Niederbipp under the reputable chief, Dr. Rudolf Ramser, as H. Willenegger had been one year before. Afterwards, he worked together with Robert Schneider at the university clinic for surgery in Bern under professors Matti and, after 1941, Lenggenhager. Having attained the title of specialist for surgery, he left the clinic in 1945. Initially, he was a freelance surgeon in the small country hospital in Wattenwyl (BE) at the far end of Gürbetal. In 1951 he became chief surgeon at the district hospital in Interlaken. There he had two assistants but no senior registrar. He was replaced in his absence by Dr. Rieben, chief of obstetrics and gynaecology.

Even then, the hospital had a large number of traumatology patients from the winter health resorts of Mürren, Wengen and Grindelwald.

In 1952 he was introduced to Müller by Robert Schneider and made an active contribution throughout the formative period of the Association. He concerned himself initially with the method of high compression cerclage according to Leemann[14], but gained recognition within the AO primarily for his screw fixation technique and in 1961 he developed the first contoured plates for pseudarthrosis of the proximal humerus and fractures of the distal tibia. He was a very good lecturer and – thanks to his interested, but calm manner – he was also a very good leader of discussions. Scientifically, he had concerned himself very early on with the pathology of the femoropatellar joint, where physical problems played a considerable role. In 1959 he wrote *"Zur Therapie der Osteochondritis dissecans"* [On the treatment of osteochondritis dissecans][15], together with M. Allgöwer. His monograph *"Die retropatellaren Kniegelenkschäden"* [Retropatellar knee joint disorders][16] published in 1977 enjoyed international recognition.

In the army, Bandi rose to colonel and commander of a rear army hospital structured like a regiment.

As chief surgeon he was extremely focused on his patients, spent the whole day in the hospital, and was never home before 10 p.m. *"His private life was a mystery"* (NB).

On the one hand, Bandi had a good sense of humour and liked mischief, but on the other hand, he could be very authoritarian. Just two episodes to illustrate the point: Once when Bandi was operating, the only access to that wing of the building was being besieged by a man (probably a journalist) who was calling for Bandi and would not move from the spot. Bandi did not want to meet him at all. He abruptly had himself laid out on a "banana cart" (a sort of concave transportation trolley), was covered with a sheet, and thus, disguised as "fresh from the operation" was wheeled out of that wing by the most anxious looking assistants (NB).

One Sunday morning – as Bandi tells it (HU) – he noticed a journalist from the 'rainbow press', which he much disliked, trying to force his way into the hospital in order to *"dig about a bit"*. Bandi stood in front of the entrance in so threatening a manner that the man called out: *"Do you want a fight?"* When Bandi replied with a vigorous *'yes'*, the trouble-maker took to his heels.

In 1974 Bandi became titular professor at the university in Bern. After a serious accident, he resigned in 1978 but remained as a scientific collaborator of AO International together with H. Willenegger and M. Allgöwer.

Hans Robert Willenegger (1910–1998)
citizen of Mühleberg (BE)

Hans was born on January 6, 1910 in Zürich. Little is known of his early childhood and adolescence. His father was a tradesman. The family moved to Interlaken, then to Thun. Hans attended primary and secondary school in Interlaken where he was given private lessons in Latin. This meant he could attend the humanistic grammar school in Bern which he completed in 1929. He was drawn to theology, but then decided to read medicine. As a working student, he lived with his aunts in the town and gave extra lessons for grammar school and younger students (mathematics, grammar), for which he earned CHF 4. On one occasion an affluent father, whose son he had helped to succeed in his second attempt at a pre-clinical exam, gave him CHF 1'000, a lot of money at that time. He always said with pride: *"All my protégés passed their exams"*. He prepared documents and tables as teaching aids and was also active in the haematological laboratories and wrote a paper on the blood type substance A, which served as a basis for his doctoral thesis in 1937: *"Über den Gruppenstoff A des Schweins, mit Schweinemagen hergestelltem Peptons, von Pepsin-Präparaten und Impfstoffen"* [On the group substance A of pigs, with peptons derived from the pig stomach, pepsin preparations, and vaccines].

He passed the state exams in 1935 and, in the same year, took up the much sought after post of assistant to chief surgeon, Dr. Rudolf Ramser, in Niederbipp. Willenegger really wanted to become a general practitioner. But Ramser told him that he had a gift for surgery. At that time, a background in pathological anatomy was considered an advantage. In 1937 he found a job in

Zürich. Since he started off as a trainee doctor, he kept his head above water by providing written expert opinions which he could charge for.

In March 1938, he was given a job as assistant at the surgical clinic of the Cantonal Hospital in Winterthur (Chief surgeon: Dr. O. Schürch, univ. lecturer: 1944). Here he produced his first publications on the problems of blood transfusion initially culminated in the book "*Blutkonservierung und Transfusion von konserviertem Blut*" [Blood conservation and the transfusion of conserved blood][17]. This book – to which he had contributed by far the greater part – was published by the authors Schürch, Willenegger and Knoll in 1942, in the middle of the war by Springer in Vienna. It was immediately distributed widely and remained in demand for a long time after the war since scientific research and publication in Germany and Austria were still disabled. At that time, it was largely the surgeons who were interested in the field of transfusions. From 1938–1950 Willenegger had dedicated 13 publications to these problems, including his postdoctoral thesis in 1947 "*Der Blutspender*" [The blood donor][18] (by 1962 a further 12 had followed). He also participated in setting up the blood donor service of the Swiss Red Cross and in 1954 became co-founder and twice President of the German Society for Blood Transfusions (later renamed as the "*German Society for Blood Transfusions and Immunohaematology*"). Willenegger was nonetheless also interested in traumatology. He had heard an impressive lecture by Böhler in 1938 (WiH).

A report of his experience with the intramedullary nail starting in 1940 at the clinic in Winterthur has already been presented in Chapter 1.

In 1943, the team Knoll, Willenegger and Jacques Jenny (vet.) had also performed the first nailing procedure on a femoral shaft fracture in a dog, for which the documentation still exists. Jenny then emigrated to the USA and is regarded there as the founder of the "*Veterinarian Orthopaedic Association*".

After the end of the war, Willenegger demonstrated the new technology, still rather controversial in France, to Blanguernon, who was visiting at the time. The latter wrote a paper on it[19] and Willenegger operated as a guest surgeon in 1947 in Paris.

As already mentioned, Willenegger, had participated in 1945 in the selection and preparation of the surgical team for Ethiopia. On the flight back, Knoll had a fatal accident. Willenegger became senior registrar and in 1948 transferred to Basel with Schürch, elected professor of surgery. At the university surgical clinic, the lecturer Willenegger represented the chief surgeon in his absence. He was provisionally in charge of the clinic after Schürch's death for $1^1/_2$ years until the beginning of 1952.

Willenegger was a born schoolmaster: "*I met him in 1952 in Basel as an assistant in the parallel department of the large clinic. The operating theatres were managed together and we occasionally met during the rite of preoperative scrubbing in the morning (30 minutes). Willenegger looked at me for a while, then he said "Look, you are doing it wrong. You have to wash your hands like this." and he then explained the 'correct' procedure to me in detail. At the time, I was rather cross about this interference. In retrospect, it was actually very meritorious and useful.*" (HU).

In May 1953 Willenegger became chief of surgery (including gynaecology and obstetrics) at the Cantonal Hospital in Liestal and was given the task of transforming it into a modern central hospital. He kept senior registrar Guggenbühl and brought Dr. Lieselotte Witschy with him from Basel, creating a second post as senior registrar for her. Planning for a new building was begun and it was ready for occupancy in 1962.

In the old building conditions of work and hygiene had been rather dubious and postoperative infection was frequent. This unhappy state of affairs explains Willenegger's early and, in fact, lifelong dedication to the problems of chronic infection of bones and joints, starting with his revolutionary "*antibiotic local drainage*"[20]. His cases were meticulously documented and followed up over very many years. He was an almost fanatical improver of asepsis. There are many, sometimes rather borderline, anecdotes in circulation on this subject. Later, he turned his attention to local atoxic disinfection and worked from 1962 with the thorax surgeon Good (former senior registrar in Basel), who had, in this sense, set up a model clinic in Germany.

In his list of publications with over 240 titles the early works are about blood transfusion, followed by papers on visceral surgery, which occupied him throughout his active career, then from 1951 works on traumatology became more frequent. The topic of operative fracture treatment would soon dominate. He worked systematically on fractures of the proximal femur, the distal radius, and the ankle. Stabilization was generally performed with multiple, fanned out K-wires. His second focus was intramedullary nailing. At that time, pseudarthrosis after non operative treatment and malalignments were frequent. Closed nailing was preferred for shaft fractures, but was usually supplemented by a single cerclage via a small incision.

In 1956 Willenegger travelled to Krefeld in order to study Herzog's stable tubular slotted nail[21]. He introduced this technique in Liestal and in hospitals receptive to it. By the time the AO was founded, most of these hospitals were familiar with the technique.

Willenegger also had a special way with animals and, consequently, a privileged acquaintance with veterinary medicine. The vets brought their four-legged patients with dislocated fractures and pseudarthroses to the hospital where these were reduced and nailed by the chief surgeon or senior registrar. Much to the consternation of the hospital administrator, this took place in the old hospital building in the operating theatre itself; later in the new building it was done in the pathology department. Willenegger participated actively in founding the AO Veterinary Group and for this he received several, even international, academic honours (MG).

As a boss Willenegger was an exemplary figure for his collaborators. He was an indefatigable assistant to them with endless patience, but always penetrating didactics.

If there was a serious condition, he would remain by the patient and watch over him all night with the senior registrar and the senior house officer. When there were complications, he would ask the surgeon: "*What did you do wrong? If you don't know what you did wrong, you'll never get on*". His own errors or those occurring in his clinic weighed heavily on his mind (MG).

From his study days Willenegger knew the somewhat younger colleagues, Schneider and Bandi, who brought him into contact with Müller in 1954. Müller was by this time senior registrar for orthopaedics at the Balgrist in Zürich. For a time he was an occasional guest surgeon in Liestal, from 1957 he went there regularly.

In 1960 collaboration on animal experimentation began, together with the anatomist, Schenk, in order to investigate the histological aspects of callus free direct healing of fractures and pseudarthroses.

Willenegger was co-author of the book "*Technik der operativen Frakturenbehandlung*" [Technique of operative fracture treatment][22] published in 1963 and of the "*Manual der Osteosynthese*" [Manual of Osteosynthesis][23], published in 1969.

In 1968 he became extraordinary professor and later full professor ad personam in Basel.

In 1972 he founded AO-International and, from 1975 when he had become professor emeritus, invested an enormous amount of energy in it:

- The foremost objectives were the worldwide organization and coordination of AO Courses. In this he was a pioneer and missionary, travelling sometimes under precarious circumstances with the representatives of the relevant producers to distant countries.
- Also of great importance was his introduction of the system of Fellowships: in order to facilitate the practical introduction of AO techniques, young surgeons and orthopaedic surgeons from countries with limited training opportunities were hosted by an AO hospital for 1–3 months and integrated into all

activities. This system of training had a more profound effect than the participation at AO courses. Many lasting professional contacts and personal friendships developed from it.

Through these activities, Willenegger acquired for himself an uncommon level of prestige, not only in neighbouring countries but worldwide. His manner was always conciliatory, even with those who did not share his opinions. To these he would say: *"Of course, you are right, but …"*. As soon as you heard this phrase you could be sure that sound and detailed arguments to the contrary would follow (HU).

Officially, he handed over the management of AO-International to M. Allgöwer in 1984, but remained active and indispensable for another decade. He died in December 1998.

The team in Liestal

August Guggenbühl was senior registrar in Liestal from 1949–1957 and then chief surgeon in Grenchen. He was a founding member of the AO.

Liselotte Witschy studied in Basel; state exams in 1949. She was an assistant at the university surgical clinic, a tall and very robust colleague, who was difficult to miss (HU). Willenegger brought her to Liestal as a senior registrar, especially for additional support in gynaecology and obstetrics. She was exceptionally efficient and cooperative. She later left the hospital and dedicated herself to cantonal health politics, and then we lose track of her.

Gottfried Moser, born 1922: studied medicine in Basel. In 1948, state exams and doctorate, assistant at various institutions, finally at the university surgical clinic in Basel, work in other countries in orthopaedics in London, urology in München and at the university women's hospital in Basel. In 1957 senior registrar of the surgical department at the Cantonal Hospital in Liestal, from 1965 chief of surgery at the Zieglerspital Bern. Member of the AO from 1965.

Martin Allgöwer (born May 5, 1917)
citizen of St. Gallen and Basel

Martin was born in St. Gallen, the youngest of three brothers. His father, co-proprietor of a textile company, became a victim of the depression in 1929. The young man attended schools in his home town, then completed his entire preclinical studies in Geneva and thus learnt perfect French. He started his clinical semester in Zürich, but then moved to Basel, where he felt the approach was more open. He passed the state exams there in 1942. Since he wanted to be self-sufficient, he worked for two years in the tissue culture lab at CIBA, a large pharmaceutical company in Basel.

His doctoral thesis in 1944 was entitled *"Vorkommen, Natur und Bedeutung von Sulfonamid-Antagonisten (Inhibitoren) in Körpermedien"* [Occurrence, nature and relevance of sulfonamid antagonists (inhibitors) in the body][24]. He also worked on antimitotica with reference to cancer treatment and discovered that connective tissue could sometimes be observed in leukocyte cultures. During animal experimentation on rabbits, he became friends with the lab technician, Ernst Frei.

In 1945, at the end of the war, Allgöwer wanted to specialize in internal medicine, but he was only offered a trainee post in Basel. He tried his luck with Professor Henschen in the surgical department, who immediately offered him paid work as a regular assistant and – as a special attraction – his own laboratory which he operated in the evenings. He practised his operative technique on animals since he considered himself lacking in skill. In 1947 Henschen became professor emeritus. His successor, O. Schürch from Winterthur, who brought with him his own senior registrar, H. Willenegger, despised the team of his predecessor and was rather unrefined in his behaviour towards them. Serious animosity developed between him and Allgöwer, who was representing the assistant doctors. Moser, the administrative director, intervened on his behalf, but Allgöwer organized a working stay for himself in the Research Department of the Medical School in Galvestone in Texas under Blocker and Pomerat, who were, at that time, running a renowned centre for plastic and reconstructive surgery. This project was financed by three Foundations in Basel. Willenegger supported this stay abroad. Three publications were produced in these 10 months. Allgöwer concerned himself there with research into burn injuries. At that time, only shock treatment was known. Cortisone had been a disappointment. Hopes were set on antibiotics. Then, he had the idea of burn toxins and started investigations in mice on homogenized burned skin. Before returning to Basel, he visited various centres and clinics on the eastern side of the USA. In the meantime, Schürch had died. Willenegger was the interim head of the clinic. R. Nissen, from the school of Sauerbruch, became the new professor, having returned to Europe early in 1952 from professorships in Turkey and New York. Allgöwer became first assistant and was soon senior registrar.

In 1952 he sustained a torsion fracture of the lower leg after a skiing accident during military service. Cerclage fixation was performed by Willenegger. Plaster removal was followed by a dangerous lung embolism.

In 1953 he produced his postdoctoral thesis on *"The cellular basis of wound repair"*[25]: Single nucleus monocytes, which form homogenous granulation tissue through the body via diapedesis, were the main subject: *"Apparently the precursors of the stem cells"* (AM).

After Willenegger's election to Liestal, Allgöwer became first senior registrar at the clinic and in 1956 chief surgeon at the Cantonal Hospital in Chur, as successor to Becker, who had died young. This hospital – after years of stagnation – now took a significant turn for the better with its new chief surgeon and his dynamic management of surgery. This is also apparent from the figures in the Annual Reports of 1956–1963[26]. Initially, traumatology was not a priority for Allgöwer. He says: *"At that time, apart from cerclage, I didn't know a thing about osteosynthesis"* (AM). But, the increasing number of ski accidents in the Grisons called for a new system of both indication and technique.

The meeting with Müller has already been reported. Allgöwer: *"I could sense that he was 'better' and I wanted to learn from him"* (AM). On the first visit, he had shown Müller his tissue-preserving *"Eindraht-Cerclage"* ["single wire cerclage"] (the rotationally stable hemi-cerclage). Müller expressed the opinion that application of a plaster cast after the operation was superfluous if the fracture could be stabilized by screw fixation. The only usable screws were those by Baumann (with self-tapping thread and a thread free shaft, much like the later AO malleolar screws). In the winter of 1957/58, screw fixation was performed on all torsion fractures of the tibia treated in Chur.

Allgöwer was the only one of the founders who had profound experience of animal experimentation. He established the *"Laboratorium für experimentelle Chirurgie"* in Davos and managed it personally from Chur, together with Ernst Frei, whom he had recruited from Basel as chief laboratory assistant.

Allgöwer was one of the last to join the circle of AO founders and was initially nearly the only one who was not from Bern. He soon became one of the leading personalities in the group. This is owed mainly to his dynamic versatility, his distinctive sense of teamwork (presumably enhanced by his stay in the USA), and his quick-witted, sometimes sarcastic sense of humour, with which he often succeed in defusing a critical situation. His care of soft tissues was exemplary as demonstrated by the figure showing his *"single intracutaneous skin suture"* in the 1963 AO book[27]. He was also very much occupied by pathophysiology and throughout his career introduced innovations to the traumatological and visceral sectors of general surgery. In Chur, thanks to his persuasive ability, he could count on the very extensive and willing cooperation of his team members. One visitor in early 1960 writes of the mood and team as he found it: *"I was astonished by the free, somewhat provocative – scientific – fun-loving and quasi American approach. I immediately felt that this was an atmosphere in which great advances would take place in future"* (FR).

At the end of 1959 he had introduced his accountant and friend, the economist, Dr. P. von

Rechenberg, to the problems of the AO in order to regulate the organization of production and sales (1960 Synthes).

In 1963 Allgöwer became extraordinary professor and from 1967 to 1983 he was ordinary professor of surgery in Basel. By combining the specialties into the so-called *"Surgical Department"*, a flexible structure was created for the operative clinics, which guaranteed their independent development without fragmentation. A section for surgical research was also integrated.

The introduction of a pool from the honoraria of the private patients was also new to Switzerland. This was used to even out the perks for the staff and to finance advanced training events and study abroad.

Until he became professor emeritus, Allgöwer continued to operate in general surgery (visceral and traumatological) and took his turn once a week to be on call for emergencies.

From 1976–1978 he was President of the Swiss Society for Surgery and as such founded, in collaboration with the surgeon, Deucher, and the orthopaedic surgeon, Fredenhagen, the *"Union der Schweizerischen Chirurgischen Fachgesellschaften"* [Union of Swiss Surgical Societies]. From 1979–1981 he was President of the *"Société Internationale de Chirurgie"* (SIC/ISS) and subsequently their secretary general.

Allgöwer was co-author of the books *"Technik der operativen Frakturenbehandlung"* 1963[28], the *"Manual der Ostesynthese"* 1969[29] and all following editions, together with Müller and Willenegger.

Within the AO, he was, as treasurer, a board member until 1972, spokesman from 1978–1982 and 1983–1988 President of AO-International. He was the promotor and first President of the AO Foundation established in 1984. The new building to house the AO Center, promoted by Allgöwer, was inaugurated in Davos in 1992.

During his professorship and as professor emeritus, he was awarded numerous honours worldwide: Honorary Professor and Fellowships at universities in the USA, Europe and Australia, numerous honorary memberships and honorary doctorates.

Allgöwer has continued to pursue his scientific work since 1992 and is still very much engaged to the present day in research in his former specialist field – burn injuries.

The team in Chur. In 1956 in Chur Allgöwer had kept on senior registrar **Hermann Lüdi,** with whom he had already collaborated in Basel. The latter moved to a private clinic in St. Gallen in 1958 and later became chief surgeon at the hospital in Langenthal. He was a member of the AO for a short time, but left in 1966 because he was working exclusively in the field of visceral surgery.

His successor as senior registrar (there was only one official post) was **Emilio Bisaz**, who moved to Fribourg in early 1959 to work as a freelance surgeon at the private hospital Daler.

In the spring of 1959 **Urs Heim** officially became senior registrar (representative since October 1958). As chief surgeon of the nearby Kreuzspital (1961–1981) he became a member of the AO in 1962. His successor for a while was **Robert Egli** who decided to return to his work in the developing countries and with the Red Cross. **Ernst Hochuli** (1928–1999) came after him: He had started his training in Interlaken under Bandi and came to Chur in 1960. In 1963 he was elected chief surgeon at the hospital in Thusis. He became a member of the AO in 1966.

In retrospect, it seems that the energy of the chief surgeon had not altogether infected the senior registrars in the early years. From 1963 onwards, the younger colleagues, who had only started their training in surgery in Chur under the new boss, came forward. They identified better with his scientific and operative/technical aspirations. Not in strict chronological order, these included: Gottfried Segmüller (1926–2000), Caius Burri, H. U. Gruber, Peter Matter, Stephan Perren, Thomas Rüedi. Most of them moved to Basel in 1967 with their chief surgeon. Details of their later careers are easily accessible.

The other founding members

Walter Schär (1906–1982)
citizen of Wyssachen (BE)

He studied in Zürich; state exams 1931. First, he was an assistant in pathology and internal medicine, then at the university surgical clinic in Bern (Professor De Quervain). He became senior registrar in 1940. Bandi and Schneider worked for him as house officers.

1944–1968 Chief surgeon at the district hospital in Langnau i. Emmental.

Schär belonged to the initial group of Bernese friends, who were introduced to Müller by Robert Schneider. The former came to Langnau fairly frequently as a guest surgeon. Schär was a born example of the strong, assertive, but rather quiet Bernese character. He was totally reliable in technical matters and as a person.

Walter Stähli (born October 20, 1911)
citizen of Schüpfen (BE)

He studied in Bern and Lausanne and graduated in 1936. He trained in surgery at the Bürgerspital Solothurn.

From 1945–1981 he was chief surgeon at the district hospital in St.-Imier in the French speaking Bernese Jura valley. He was also a good example, like his friends Schär and Bandi, of the quiet manner of the Bernese, but interspersed and lightened by a great sense of humour.

On the subject of AO implants and instruments, which he originally received as an AO member for purposes of testing, he wrote: *"The quality of both the instruments and implants was very good. The village locksmith only had to be called in once"* (in order to remove an intramedullary nail) (SW).

Fritz Brussatis (1919–1989)

Brussatis came from Göttingen and studied in Berlin and Vienna. After the war, he came to the university clinic in Zürich to train in neurosurgery and transferred to the Balgrist in 1952. This was the beginning of a fertile cooperation with Müller. In 1954 they published the case of an occipitocervical arthrodesis[30] treated according to an idea from Van Nes. Müller introduced Brussatis to the AO in its preparatory phase as the only non Swiss member. But, by 1958 he had already returned to Germany (neurology in Hamburg, orthopaedics in Münster). He completed his postdoctoral training in Münster in 1961 and in 1969 became Director of the Orthopaedic University Clinic in Mainz.

His scientific interest was directed primarily towards those areas bordering on orthopaedics and neurology.

August Guggenbühl (called Urs) (born November 17, 1918) citizen of Meilen and Zürich

He studied in Geneva, Freiburg and Basel, state exams 1945, doctorate 1946. He acquired his surgical training at the hospitals Neumünster in Zürich, Aarau and Interlaken. He was senior registrar from 1949 in Liestal as successor to Müller and in 1953 was kept on by Willenegger.

From 1957–1983 he was chief surgeon at the hospital in Grenchen. There he permitted Robert Mathys to be present at a hip osteotomy performed by Müller in 1958. In 1959 Guggenbühl and Willenegger published the first series of operatively treated distal radius fractures[31].

He was a great friend of animals and always worked together with the veterinary surgeons. He was a founding member of AO VET in 1968.

In 1984, after his retirement he moved to Dubai on the appointment of Willenegger to act as AO delegate and he managed a large state trauma clinic there until 1995. He trained the native doctors and organized their advanced training in AO hospitals so that they were able to take over modern management of the clinic themselves in 1995. During this period, he also participated actively at various AO courses in the Middle East and Emirates of the Persian Gulf.

Ernst Baumann (1890–1978)
citizen of Attelwil (AG)

Baumann studied in Basel and Kiel, initially had his own practice in the country, then trained as a surgeon at the Cantonal Hospital in Aarau (including obstetrics and gynaecology).

From 1928–1960 he was chief surgeon at the district hospital in Langenthal.

1942 postdoctoral qualification in Bern, 1957 titular professor.

Baumann was Nestor of the Swiss Traumatologists, whereby his best known works are those on elbow fractures (in children with vertical extension)[32] and on pseudarthrosis of the internal malleolus[33]. He developed a self-drilling and self-tapping lag screw with which the early AO screw fixations were performed. He was President of the Swiss Society for Trauma and Occupational Diseases (SGUB) from 1955–1960.

René Patry (1890–1983) citizen of Geneva

Patry came from a family of doctors in Geneva, was very well educated and cultured, having a very broad medical background: Geneva, Strasbourg, St. Gallen, Aarau and Lucerne. From 1931–1938 he was SUVA-Kreisarzt (district medical advisor to the state insurance company) working in Geneva, then active in various posts at the Cantonal Hospital in Geneva, the largest public hospital in Switzerland. Postdoctoral qualification in 1938, professor in 1947, and Director of the University Policlinic for Surgery from 1948–1968. He had met Müller at the Balgrist. From 1957 Müller regularly operated in Geneva and brought Patry into the AO. Patry admired Müller very much, but he despised the instrumentation as *"Quincaillerie"* (ironmongery) and hardly ever operated with it (VH).

Patry was President of the SGUB from 1948–1955 and of the Swiss Society for Surgery in 1959 and in the first half of 1960, therefore, he was chairing the Congress where the AO appeared in public for the first time.

Walter Ott (born 1915)
citizen of Aarburg (AG) and Zürich

He was born in 1915 in Zürich, grew up and started his medical studies there. Then he went to München (because of his interest in painting and drawing) to continue his studies and graduated in 1939. He was an assistant in pathology, internal medicine, and surgery in Winterthur from 1942–1945, then in urology in Bern. In 1947 he became senior registrar in Männedorf and later in Winterthur.

From 1954–1977 chief surgeon at the Hospital in Rorschach, where Müller sometimes operated after 1957. He was introduced to the AO primarily by Willenegger. He became particularly good friends with H. Bloch.

His special interest was directed towards the treatment of open fractures, about which he wrote an extensive work in the form of a postdoctoral thesis when he was in Winterthur[34]. He lectured on the subject at the AO meeting in July 1960 in Davos and had hoped to write the chapter on that subject in the AO book.

He could not come to terms with the wider implications of AO membership. Robert Schneider mediated but could not prevent him from leaving at the end of 1962. He later developed friendly relations again with many AO members.

Willy Hunziker (1915–1987)
citizen of Kirchleerau (BE)

He studied medicine in Geneva and Basel, state exams in 1942. He worked in the surgical department in Aarau and became senior registrar in Langenthal (under Baumann).

From 1948–1977 chief surgeon at the district hospital in Belp (BE).

He was introduced to the AO by M. Allgöwer with whom he had been friends since his student days but did not attract much attention within the group.

Other significant personalities at the time of founding

Robert Mathys (1921–2000)
citizen of Willadingen (BE), honorary citizen of Bettlach (SO)

Robert was born in Willadingen on January 31, 1921 as the second of three children. His father managed a building company which suffered badly during the depression after 1929.

The family moved to Jegenstorf where the boy went to school. Since there were no apprenticeships available, he then worked for one year as delivery boy for a baker in Neuchâtel. Then he had the opportunity to become an apprentice mechanic and technical draughtsman at the Haenny company in Jegenstorf. He was mainly employed in the construction office. Here he already showed his ability as an inventor, was always trying out new ideas and constructed all sorts of machines, including a small diesel motor for model aeroplanes. In the village, he was known as *"Motörli-Röbu"* [little motor Robby].

He also learned to fly and in 1940 obtained his pilot's licence. He had started attending courses at the Technical College in Burgdorf, but the doors closed during the war years. During the many months of military service, and also while working, he and two of his service comrades continued their education in the form of correspondence courses at the Institute Onken in Kreuzlingen (TG).

In 1942 and 1943 he worked at Siemens and Haske in Bern and then transferred to the aeroplane construction company Farner in Grenchen, where he was also predominantly engaged in the construction office.

He wanted to become a professional military pilot after the war but received the longed for offer of training too late. Two months before, he had decided to become self-employed and had already ordered equipment for his machine shop in Bettlach, near Grenchen. He founded him firm *Robert Mathys & Co. (RoMa) für Decolletage und Apparate* on June 6, 1946. He was 25 years old. At first, Robert worked alone, then he took on two assistants and made small components for clocks, machines, and aeroplanes. Then, he specialized in processing stainless steel and supplied various companies in the chemical industry. The raw material was obtained for the most part from Notz Co. Ltd in Biel. He also executed individual commissions for the instruments factory Ulrich in St. Gallen (threaded bolts). This awakened his interest in bone surgery. The company was doing well. In 1956, it moved into a new building. In early 1958, Mathys had 14–16 workers and employees and reliable customers.

On April 8, 1958 university lecturer Müller appeared in his machine shop in Bettlach on behalf of the group of surgeons who had met in Chur on March 15–17. He was looking for a qualified manufacturer for his own AO instrumentation now being planned. A close knit collaboration developed quickly and Müller came along with his ideas every 8–10 days. The other founders met Mathys later on.

For Mathys the turning point was a hip osteotomy performed by Müller at the hospital in Grenchen in October 1958: chief surgeon Dr. A. Guggenbühl had given his permission for Mathys to attend as a spectator: "I immediately noticed a whole number of possible improvements to the instruments *(e.g. a solution for screws, a no wrench chuck, etc.)*" (MR). The modifications to the existing commercially available instruments for use in bone surgery were intensified. New implants were being designed continuously: *"Within a few weeks I had thought up 16 innovations, e.g. the new screw head with hexagonal recess"* (MR). Consequently, the entire first AO instrumentation was created very quickly (**Abb. 3-2**). It was introduced into the hospitals step by step from the end of 1958 to the beginning of 1960. In December 1958 Mathys showed Müller the prototypes for the flexible shaft for reaming of the medullary cavity: Müller was full of enthusiasm and, from the machine shop, immediately rang up Allgöwer in Chur. He was saying: *"Listen, its unbelievable, he's shown me a shaft that is so flexible you could tie a knot in it" "This was the first time I heard the name Allgöwer"* (MR)

Mathys was so completely occupied with the development of prototypes and the manufacture of instruments and implants that he neglected his former clients or left the jobs to his foreman. From the *"sales outlet"* in Biel, managed by Mrs Moraz-Müller, he received payment *"in accordance with the invoices for his deliveries"* (MM). This clearly did not cover his costs since he had to finance the deliveries in advance. In addition, he needed to invest in the purchase of machinery. Thus, by 1959 Mathys had incurred increasing debts. The difficulty was recognized by the AO and Müller interceded for him at the bank.

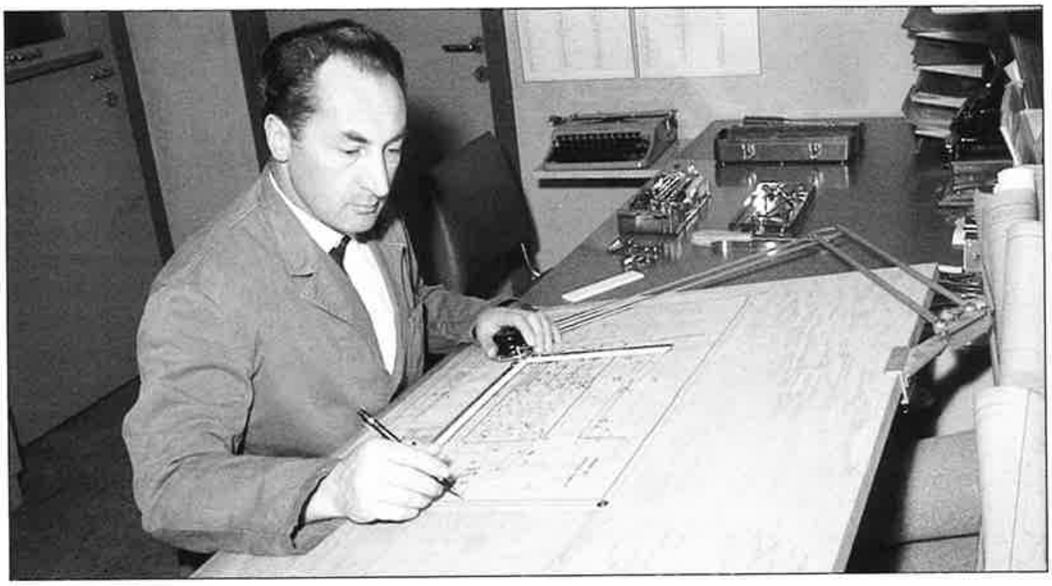

Fig. 3-2: Robert Mathys at the drawing board in his workshop in Bettlach in 1958

In 1960 Dr. P. von Rechenberg from Chur visited Mathys for the first time to offer advice. In December, the commercial company Synthes AG Chur was founded, of which von Rechenberg was the manager.

At much the same time, Willenegger had made contact with Prof. Reinhard Straumann and his internationally renowned company in Waldenburg (BL), making components for the clock industry. At first, it was a question of metallurgical problems (corrosion) arising in relation to AO implants. Straumann would also have been able to resolve the financial difficulties Mathys was having, but this would only have been possible on a profit-sharing basis. It was already apparent that the AO instrumentation would achieve international distribution. With much misgiving, young Mathys set off to speak to the famous Professor R. Straumann and finally agreed to a collaboration.

Mathys often attended operations, especially when prototypes were being used. Requests for modifications could be judged with the device *in situ* and discussed with the surgeon. He was also sometimes called in if an incident occurred intra-operatively since he was the developer of the various special instruments. In 1960 he was once called to Grabs where Müller and Allgöwer were stranded in the middle of a femoral nailing procedure due to a disorder of the angular drive: *"I flew in my private plane from Grenchen to Bad Ragaz and was met at the aerodrome by a young doctor in a Porsche* (probably A. Mumenthaler) – *and was driven to the scene of the incident."* (MR). Chief surgeon Allgöwer on his return to Chur many hours later made a frustrated impression. His expletives cannot be reported here (HU), but Mathys had saved the day.

In September 1962 the long awaited AO instrumentation became commercially available for the first time. To organize sales, Mathys suggested dividing the world markets between the two companies. The strange division of continents and countries between the two producers, still in existence today, goes back to the drawing of lots at that time. Straumann took over the stock. At the end of 1963, a definitive contract regulated the collaboration of the two producers.

In 1963 Mathys already had 31 employers and workmen. In the following year, he introduced profit-sharing for the entire staff. He founded his first sales companies abroad: Bochum in the Federal Republic of Germany, Montbéliard in France, Brussels, somewhat later Salzburg, Australia etc. In order to publicize the instrumentation, he undertook a tour of Africa in 1966 in his heavily loaded private plane and visited more than 30 hospitals. He retained a special affection for the black continent for the rest of his life.

Robert Mathys participated actively in the development of subsequent AO instruments and implants, from 1961 onwards in collaboration with the technical commission.

In 1969 he became a corresponding member of the AO. In 1974 he received the title of Doctor of Medicine *honoris causa* from the university in Bern and in 1990 he became an honorary member of the AO Foundation.

In 1990 he handed over the management of the enormously expanded company to his sons, but remained active in certain areas.

Violette Moraz-Müller

(later Bangerter-Müller) (born 1921)

The AO would not have been able to function efficiently without the untiring cooperation of Müller's sister, Violette. We met her already briefly on the day the AO was founded (Schn II/15).

Violette Müller was unusually active even as a child, she cared for the garden at her parent's home and helped her big brother with numerous projects. She played the piano well and would have liked to study, but became a social worker instead. After the death of her husband, she was left alone with a young daughter, and did not know what to do next. Her brother suggested that she should take over the task of dealing with the AO instruments which were now being developed.

She agreed and on October 6, 1958, when the members met to found the AO, he took her to a dark attic room in the Hotel Elite and showed her the *"Küntscher nails"* stored there and his new screws. He introduced her to his friends Schneider, Allgöwer, Willenegger and Bandi.

Mrs Moraz modified her small house in Biel (*"9 by 9 metres"* BV), thus making two rooms available to the AO while she and her daughter confined themselves to the third. This is the way it remained for the following years.

The instrumentation developed rapidly. Mathys, completely absorbed in his construction work, brought new products from Bettlach almost every evening. She had to sort and pack them as ordered by the hospitals and arrange the quickest possible delivery: her daughter took the packages in a trolley to the post office just before closing. She herself took the rest of the packages to the station late at night to put them in the mail car of the last evening train. Thus, the ordered goods were ready for use the next day in the hospitals.

This meant an uninterrupted service day in day out, including Sundays, and until late into the night. Not only was the instrumentation expanding, but the number and requirements of the hospitals increased constantly.

Mathys enclosed his invoices with the deliveries and she passed these on with a 10% surcharge (later 15% MM) to the hospitals. How payment to Mathys was regulated cannot be reconstructed today. Certainly, there must have been latencies which would explain his financial difficulties to some extent.

Mrs Moraz had to check the quality and function of the instruments and that all packages were complete before they were sent out because the doctor's complaints also came to her.

She acquired a profound knowledge of the instrumentation, took part at the courses in Davos, especially as an instructor at the courses for OR nurses (*"They thought I was a doctor, otherwise they would never have accepted me"* BV), and also attended the meetings of the technical commission. She drew up the first catalogue. In 1963, before her second marriage to Dr. med. Bangerter, she handed over the entire stock to Waldenburg where several staff were now engaged to take care of it. After five years she was finally able to take a holiday.

Several years later, she helped her brother again, this time to establish his new company, Protek Inc.

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Chapter 4
The AO 1959 and 1960: Setup and organizational expansion

The development of the young AO in the years 1959 and 1960 can be summarized in one chapter as was done by Schneider (Schn II/15–19, 105f, 114f). For the most part, we will follow his lead:

The main events were:

- the AO conferences and meetings:
  1959 in March and November in Zürich-Waid
  1960 in March in Interlaken
  in July in Davos
  in November in Bern
- Statutes and elections
- Inauguration and operation of the Laboratory for Experimental Surgery in Davos
- Experimental research in Boston (Bassett), Münster (Wagner) and Basel (Schenk)
- Experience with the instrumentation and its further development
- Two presentations of the AO at the Swiss Society of Surgery 1960
- The foundation of Synthes AG Chur in December 1960
- The first AO Course in Davos in December 1960
- Widening the circle of friends by
  Admitting new members:
  1959 Bloch, Kaiser, Molo
  1960 Leinbach, Fischer, Keller and Stähli/Thun
- Contacts beyond the borders of Switzerland:
  Ch. A. Basset, J. Böhler, H. Rosen

The year 1959

The first meeting of the members took place on March 5 and 6, 1959 on the invitation of Kaiser at the Stadtspital Zürich-Waid.

The following new members were admitted: Hans Bloch, Glarus; Ernst Kaiser, Zürich; Clemente Molo, Bellinzona.

The instrumentation:

- Reports of screw fixations during the preceding winter came from Interlaken and Grenchen. The first cortex and cancellous bone screws had been available to the hospitals since late autumn 1958. The first sawtooth thread was not entirely satisfactory. Schneider does not mention this first model, but rather the modified hollow ground screw thread (drawing from October 6, 1958), which remained unchanged in the following years. Several months elapsed before serial production started and the new screws could be delivered to the hospitals.
- Müller presented the AO compression plates (prototypes?) and explained their application. They were intended to replace the complicated and delicate Danis' coapteur. The new plates were delivered during the year to the hospitals. In the documentation they appear in May, having been applied to forearm and humerus.
- Willenegger reported on his experience with the Herzog nail for the tibia. It is still to be found in the documentation in 1960. The drawings by Robert Mathys for the new, more flexible AO nail are dated November 1959. It appears in July 1960 in the documentation.

- A lecture on malleolar fractures (Willenegger?) is also mentioned in the agenda of this meeting.
- Under administrative items, we have: *"Invoicing according to the records of the sales outlet"* and *"Research Institute"* (Schn II/105,113). Details are missing.

The **Guidelines (Merkblätter)** were discussed and revised. Standardization of indications and techniques for the new implants was imperative in the interests of collective evaluation. The texts from 1959 have been lost. *"Aims and principles"* (in accordance with the principles of Danis) – Guidelines No. 1 – had been drafted by Müller as early as 1951 in Fribourg. In 1956 they were revised together with Schneider (MM). They added No. 2: Screw fixation of lower leg fractures and No. 3: Intramedullary nailing of the tibia (Schn II/113).

The second meeting again took place at Stadtspital Zürich-Waid. Different dates have been given: November 21 (Schn II/16) or December 3 and 4 (Schn II/105,113).

The first item on the agenda was discussion of the proposals for the Statutes and Elections: *"Willenegger had done the groundwork together with a lawyer. The AO had to be organized as a society according to § 60 of Swiss Civil Law ... unplanned elections took place. Unanimous election of: spokesman Schneider, secretary Müller, treasurer Allgöwer"* (Schn II/16).

Guidelines Nos. 1–3 were discussed again. No. 4, compression plates was new and so was No. 5 on malleolar fractures.

One lecture was on the treatment of pseudarthrosis, another on malleolar fractures.

The new intramedullary nail was demonstrated as well as the angled blade plate with U-profile, first documented in December 1959.

Then the preparations of lectures for the Surgeon's Congress in May 1960 in Geneva were discussed (Schn II/16,105).

The laboratory for experimental surgery in Davos. It had been open since June. Allgöwer reported its activities at the meeting.

The scientific and experimental investigations were directed towards *"Wound healing, biomechanics and shock"*.

At the laboratory central documentation of osteosyntheses had started (chief lab technician Frei). This task was especially important with a view to the first official public appearance of the members and to the AO course the following year.

Funding was difficult initially. Each member had contributed CHF 500, the members of the Foundation-Müller, Allgöwer and Willenegger-CHF 10'000 each. Willenegger succeeded in obtaining contributions from insurance companies. Two of his begging letters from May 1960 have been reproduced by Schneider (Schn II/40f). The Canton Graubünden and the SUVA also contributed. After 1960 noteworthy contributions came from the Rockefeller Institute, the National Institute of Health in America and the Swiss National Fund[1].

The team in Davos. At first, $6^1/_2$ persons were employed in Davos (Schn II/17).

Ernst Frei was chief lab technician – known as *"Baschi"* – whom Allgöwer had invited from Basel. He stayed until about 1965 and then transferred to a special laboratory in the Tessin. In the 1960–1961 Annual Report of the Laboratory[1], the following are also named:

- Dr. med. Lotte Hulliger, head of the tissue culture laboratory with lab assistant Ms A. Arcon, and later Ms S. Schick as lab assistant for histology (from 1963 Ms V. Geret)
- Working in documentation and the AO main office were Mrs Frei (from 1963 Mrs H. Klebl), Ms B. Rütsche as a secretary (later Ms V. Jörg), Ms H. Weber as photographer (later Ms M. Sciarmella) and Ms G. Wiessner as librarian.
- To take care of the animal facilities and general work there was K. Jäggi, the caretaker, and Mr Ch. Pally and Mrs Jenny (cleaning).
- In early 1962 M. Klebl joined as a mechanic. He had previously worked in the bioclimatic

laboratory in the same building and was trained in Chur as a *"scrub nurse"* for operations on sheep (KM).

The Statutes

In order to be recognized and to obtain the legal capacity to act freely, the **AO** had to be constituted as **a Society**. The 1959 (undated) proposal written by Willenegger still exists. This version must have been available for discussion at the meeting in autumn 1959 in Zürich. It led to the 1960 approved and printed version from Interlaken, dated March 19, 1960.

From these texts (Appendix p. 226–232) – presented here somewhat out of chronological sequence – the following clauses are particularly important:

The purpose of the Society (paragraph 1) is given as: *"The study of matters pertaining to fracture healing and the practical and scientific exchange of experience"*. In the preliminary draft, it had also said *"experimental research in this field exclusively with the Laboratory for Experimental Surgery in Davos"*. In a subsequent version, the monopoly on research for Davos was not included, presumably because work was already being done elsewhere.

New members (§ 3) must be nominated by existing members, be professionally independent, and have participated as guests at two meetings. Acceptance of a member must be unanimous (so-called right of veto) (§ 5 in the preliminary version). These restrictive regulations indicate that the AO considered itself a small compact group and only wanted to expand gradually and very carefully, placing particular emphasis on collaboration. The right of veto was only exercised once in the history of the AO.

Guests (§ 8): close collaborators and interested persons are invited on the proposal of the members to the scientific meetings by the spokesman. This regulation was not included in the preliminary version.

Rights and duties of the members (§ 12). For example:

under a) *"The members are to be present if possible at the meetings"*. This was de facto an obligation which was considered of particular importance in the early years. Repeated failure to attend did not occur.

under b) *"They are to process the statistics on their own patients with fractures in accordance with the published communal guidelines and have the right to mutual access to these statistical analyses."*

under c) *"... Advances ... are to be made accessible to all members of the AO"*.

The regulations under b) and c) emphasize the duty to work together to build up the documentation and its general accessibility for advanced training and scientific study. *"Only 1 member was against this regulation, arguing that his operations were his intellectual property"* (MM).

under d) it says, among other things, *"with regard to indications every member is free ... to respect whenever possible the treatment principles formulated by the AO."*

In the preliminary version, the text in paragraph 11d read *"... is obliged to use the instruments developed by the AO whenever possible and to obtain them from the AO."* Surprisingly, the regulations in the preliminary version were regarded as too restrictive. The reason for this is unclear.

The Obmann (translated as "spokesman")

This unusual term needs more detailed explanation. In the dictionary – Dictionary of Origin, it is defined as *"principal, intermediary"*. The term is derived from the Middle High German *"Obeman"*. It used to exist in courts with a jury, in certain societies, and also in specialist medical groups (in Basel). In Zürich after the Reformation, it was the Obmann who administered the property of the dissolved monasteries

(LM). "Obmann" points, above all, to Bern where all the guilds (today still a small majority) and the Societies of the Bernese citizens used to be headed by an Obmann.

The term emphasizes social, economic or cultural responsibilities in the sense of *"primus inter pares"*.

The idea of calling the coordinator of the AO an Obmann can certainly be attributed to the Bernese members. The term remained for as long as founding members were part of the committee. A hierarchical structure with *"Presidents"* – an office that predominates in politics – was not wanted. *"Obmann"* emphasizes the horizontal structure of the Society and the equality of its members.

It is also conspicuous that the responsibilities of the Obmann were more or less obvious: preparation and management of the meetings, public representation. Only his exclusive right to invite guests is defined (§ 8).

Obmann Robert Schneider managed the meetings with aplomb and stood to read his Annual Reports to the members. Their content has been covered in his two books.

Structures, areas of authority, and executive procedures

The committee (§ 9): *"Consists of three members, elected for two years (spokesman, secretary, a third member or treasurer) ... who work in a voluntary capacity."*

The tasks and areas of authority of the committee are not really defined. According to § 10, it mainly concerns cashier duties (which can be delegated), budgeting, taking down the decisions *"day-to-day management"* and preparation of the general meetings.

The way the AO committee worked was also quite relaxed: there were no meetings. Everything was either dealt with verbally by telephone or personal contact or presented directly to the plenum. *"When I was elected in 1972 as a 'younger' treasurer, my predecessor Martin Allgöwer explained: 'Nothing much will change, we have never had any meetings yet'. And that's how it remained from 1972–1982"* (HU).

The treasurer's report was presented as for the Annual Report whereby from 1960 onwards it was possible to refer to a detailed report prepared by Dr. P. von Rechenberg's office and distributed to all members.

The secretary always lectured extensively on experiences, new developments, activities, and plans.

Neither was there – as was customary in other societies – a table for the committee in front of the attendees (sometimes a little higher to keep an eye on things and be seen?). The committee members sat amongst the attendees somewhere in the room.

The concluding discussions were very open. Any differences of opinion within the core group were not discussed at the meetings; tension was not felt.

A vote was never held at the general assemblies. After discussing an issue, a consensus was soon found and an appropriate decision taken.

The great potential for action of the AO in the early years can probably be explained in part by this entirely unconventional and flexible working method of the committee and members.

The new members of 1959

Hans Rudolf Bloch (born February 4, 1913) citizen of Balsthal and Solothurn

Bloch grew up in Solothurn, studied in Geneva, Bern and Vienna. State exams 1938 in Bern, doctorate 1940. Assistant at the hospital in Olten.

In 1941 he participated as a medical officer in the first Swiss Red Cross mission to the German eastern front.

In 1943 senior registrar at the Neumünster Hospital in Zürich, and in 1945 at the Cantonal Hospital in Chur.

1947–1951 Urological specialization in Paris and in the USA

1952–1973 Chief of Surgery at the Cantonal Hospital in Glarus, later private medical practice in Solothurn.

H. Bloch was introduced to the AO by Müller, who had been operating in Glarus since 1957. He was particularly close friends with Ott.

Within the AO he was concerned principally with shaft fractures of the forearm on which he lectured frequently, including a lecture at the Congress of the Swiss Society for Surgery in 1962[2]. He wrote the chapter on this subject in the first AO book in 1963[3].

He had close family ties with Spain and was active from 1974 onwards at the courses in Pamplona and in South America.

Ernst Kaiser (1903–1967)
citizen of Horgen (ZH)

Schooling and medical training in Zürich. State exams in 1928, then assistant at the Ospedale Internazionale in Naples and at the hospital in Männedorf, Switzerland. In 1933 he became senior registrar at the Neumünster Hospital in Zürich.

1935–1953 Chief surgeon at the hospital in Wädenswil (ZH).

1953–1967 Chief of Surgery and Director of the newly founded city hospital Zürich-Waid.

Kaiser was almost exclusively concerned with visceral surgery (biliary ducts, stomach and strumectomy) and acquired for himself a national reputation. His interest in the AO was awakened through collaboration with Willenegger. He sensed the importance of this dynamic group and joined early without applying the operative techniques himself. He made his hospital available for conferences and meetings.

Max Landolt (born June 21, 1925)
citizen of Zürich

He grew up in Zürich, went to school and studied there. State exams 1950. Assistant at the hospital in Wädenswil under Kaiser, who took him with him to the Stadtspital Zürich-Waid, where he became senior registrar in 1956.

Since the inauguration of the new hospital was delayed, he was able to spend six months as a guest surgeon at the Böhler Clinic in Vienna.

The transition from the familiar, conservative methods of fracture treatment according to Böhler's principles – and in which great confidence was placed – to thinking and working predominantly according to the AO has been described by him as *"associated with considerable effort"* (LM). Virtually all the osteosyntheses marked in the documentation as KZ (Kaiser Zürich) were performed by Landolt.

In 1967 he became an AO member.

On the death of Kaiser, he became chief surgeon at the Zürich-Waid Hospital and then in 1969 of the newly founded Stadtspital Triemli.

After retirement in 1990, he became a collaborator of AO International.

Clemente Molo (1909–1998)
citizen of Bellinzona (TI)

He grew up in Bellinzona and Lugano. He studied in Zürich and Vienna; state exams in Zürich in 1935; doctorate 1941.

Assistant in pathology in Vienna, then at the university surgical clinic in Zürich. Advanced training in Berlin and Boston (USA).

He participated twice (in 1941 and 1942) in Swiss Red Cross missions to the German eastern front.

In 1945 he became chief surgeon of the Italian military hospital in Merano.

1946–1975 Chief of Surgery in Bellinzona.

Molo was introduced to the AO by Müller, who had been operating in Bellinzona since 1957. He took an active part in making and maintaining contacts to the Italian orthopaedic surgeons and traumatologists.

After retirement he continued in practice with his son in Bellinzona.

The first six months of 1960

In the early months of this year, events began to accumulate:

In the foreground were the preparations for presentations at the Congress of the Swiss Society for Surgery in May: Titles and content of the lectures and the necessary documents had to be prepared and the lecturers chosen. In particular, the documentation had to be *"à jour"*. This would be the only way to meet the expected criticisms.

A circular letter concerning this matter was sent out on January 26 by Müller to all the members. Emphasis was placed on recording all screw fixations of the tibia, all intramedullary nailing procedures and treatments of pseudarthrosis without graft, and on completion of all follow-up assessments and the corresponding documentation (Schn II 26).

In February Müller organized and guided a tour for French orthopaedic surgeons around Switzerland. The hospitals in Liestal, Grenchen, Langnau, Grosshöchstetten, Hirslanden Zürich and Chur were visited and operations demonstrated. The tour ended with a visit to the Laboratory for Experimental Surgery in Davos. The participants in this intensive programme included: M. Postel from Paris (Hôpital Cochin) and L. Descamps (Nice).

On March 5 and 6 the **Trauma Convention** of the Professional Insurance of Southwest Germany (südwestdeutsche Berufsgenossenschaften) was held in Freiburg i.Br., chaired by Prof. Hermann Krauss, professor of surgery.

Willenegger had been friends with the professor for internal medicine and haematologist Heilmeyer (Ludwig Heilmeyer 1899–1969) in Freiburg for many years because of their mutual interest in blood transfusion.

As president of the German Society for Blood Transfusion, Willenegger regularly went from Liestal to take part in the "Complications Conferences" of the Freiburg clinics. Kuner writes[4] that Willenegger and Krauss had met on these occasions. It is certain that Heilmeyer had drawn the attention of Krauss to Willenegger's activities in the field of trauma and, thus, obtained invitations for both Willenegger and Müller, who then spoke on the *"Fundamental questions of operative fracture treatment"* (Schn II/28), emphasizing the goal of complete functional restoration. Willenegger brought seven patients from Liestal. Some of these had just been operated on, that is to say, 4–12 days previously (malleolar fractures, intramedullary nailing, plate osteosynthesis), the wounds showed no signs of irritation and the articulations were freely mobile. Two patients had infected pseudarthrosis with ongoing local drainage.

Krauss showed interest and said in the discussion that the arguments presented were *"undoubtedly impressive"* (Schn II/32). He delegated his senior registrar to go to the AO Meeting in Interlaken.

Jörg Böhler well remembers this event, which must have been quite spectacular. During the other lectures, Müller had spread out the AO instrumentation on a table in the cloakroom. Böhler and his wife took a look as did Primarius Schalle from the Trauma Department in Rankweil (Vorarlberg, Austria). Müller was there on his own and explained it all to them (BJ). Böhler and Schalle registered themselves as guests at the forthcoming AO Meeting on March 18–19 in Interlaken.

The Spring Meeting of March 18 and 19 took place in Interlaken.

The guests from abroad included: Koslowski Freiburg, Böhler Linz, Schalle Rankweil (Schn II/16). I.S. Leinbach, Florida, was given membership.

The first item on the agenda was the adjustment and approval of the Statutes. Then followed reports from Davos, the sales outlet in Biel, and production at Mathys.

In the scientific sessions, the lectures planned for the Surgeons' Congress in May were delivered to the assembly by way of preparation: screw fixation (Allgöwer and Müller), the technique of intramedullary nailing (Schneider), malleolar fractures (Willenegger) and the principles (Müller) *"with lively discussion by all members"* (Schn II/113).

Müller had expressly reminded the members in his letter of January 26 (Schn II/26) that: *"all Guidelines produced until now are to be studied in detail because your opinion and your observations are not only very valuable, but indispensable for the future development of the AO…"*. It seems that the members were more active on this occasion and introduced new ideas for the guidelines.

On May 16 and 17, the **Congress of the Swiss Society of Surgery** was held in Geneva. Patry was still President (later replaced by Fehr, Winterthur). The AO lecturers had been allotted four slots of 10 minutes each at the end of the congress (published in 1961 in Helvetica Chirurgica Acta[5]): *"Müller spoke on the 'Principles of osteosynthesis', Allgöwer on screw fixation of tibial fractures, Willenegger on the treatment of dislocated fractures of the ankle from a biomechanical point of view, and Schneider on intramedullary nailing of the tibia. There was no time for discussion. Our lectures had raised so much dust that a separate 'extraordinary' meeting had to be convened in November for the discussion"* (Schn II/16f).

In June the first Annual Report of the Laboratory of Experimental Surgery in Davos was produced (Schn II/17). It was reported that approximately 1000 osteosyntheses had been documented (with almost 10'000 copies of radiographs).

The scientific activities had been carried out according to plan. They included wound and bone healing, shock, and tissue culture.

The laboratory had been visited by 31 guests from all over the world, including (Schn II/28): E. Baur, SUVA Lucerne; W. Blocker, Texas; J. Böhler, Linz; R. Mc Elvenny, Chicago; Prof. H. Krauss and L. Koslowski, Freiburg i.Br.; O. Russe, Vienna; I.S. Leinbach, Florida; R. Pomerat, New York; Schalle, Rankweil; Prof. W. Schega, Mainz; R. E. Stevenson, Washington.

The year-end balance almost broke even: Members and insurances had contributed *"the pioneering time of the AO was a time of personal financial donation and of begging letters"* (Schn II/39). Salaries for the first year amounted to CHF 42'820.

During 1960 various scientific activities based on animal experiments had begun outside Davos: The first to be mentioned (possibly already involved in 1958) is Bassett in New York, the second was H. Wagner in Münster (Westphalen) and then Robert Schenk in Basel.

Heinz Wagner (born December 7, 1929) from Kronstadt in Transylvania (Ru)

He studied in Erlangen, graduation from medical school 1954, doctorate 1955.

Scientific assistant in pathology in Erlangen, in the Orthopaedic Clinics Eisenberg in Heidelberg and from 1958 in Münster. There he began experimental and histological investigations into fracture healing.

Müller had heard of these experiments from Brussatis, who was also working at that time in Münster, and he encouraged Wagner to investigate *"screw anchorage in bone and callus-free fracture healing"*. Work very probably began in the spring of 1960. The results were of enormous value to the young AO. We will come back to this later. In 1962 Wagner received the first AO Prize.

In 1967 he became a scientific member of the Swiss AO and in 1970 a founding member of the German AO.

He obtained his postdoctoral lecturing qualification in 1966 in Münster and, in the same year, became chief surgeon of the Orthopaedic Clinic in Altdorf, near Nürnberg. He later transferred to the Rummelsberg Clinic near Schwarzenbruck which had been newly built according to his concept.

In 1969 professor in Erlangen, in 1983 President of the German Society of Orthopaedics, and in 1987 President of the SICOT.

The second half-year of 1960

On the July 8 and 9, a **second AO Meeting** took place in Davos. The aim was to present the structure and function of the *"Laboratory"* to the members. A larger circle of guests was invited, among them Prof. Krauss from Freiburg i.Br., who brought his scientific assistant, S. Weller, with him.

"On the first evening Allgöwer and Müller held a lecture on basic research: new experimental investigations of biomechanical factors of osteogenesis and nerve regeneration: Results of the collaboration with Basset at the Columbia University New York" (Schn II/17).

The next day experience with the compression plates and the hip and condylar plates was exchanged for the first time (Willenegger, Bandi, Bloch) and the new AO angled blade plate for the femoral neck was discussed. Willenegger spoke on the intramedullary nailing of pseudarthroses, Müller and Schneider on the AO plate for the femoral neck.

By this time the AO instrumentation was already fully developed and in *"practical testing"* (Schn II/17). It was decided – though not without opposition (the session apparently proceeded rather *"tempestuously"*[6]) – to hand the instruments over to the participants at the forthcoming course in December.

The administrative items on the agenda were: laboratory report (Allgöwer), documentation system (Müller), report on activities (Müller), budget (Allgöwer), expansion of the AO, courses, collaboration with Swiss universities (Schn II/105).

On August 17 Müller was elected chief surgeon of the newly built orthopaedic and traumatology clinic in St. Gallen. He still had $2^1/_2$ months to dedicate himself to its organization and to finding staff before the clinic went into operation at the beginning of November.

In September he had held lectures at the SICOT (Société Internationale de Chirurgie Orthopédique et de Traumatologie), together with Basset in New York, and had shown exhibits (*"50 pseudarthroses healed by compression with plates and external tensioning devices"* MM). Basset presented his experimental Millipore sheath for cortical defects.

The November 23 must be regarded as the **Autumn Meeting**. The members gathered in Bern to finalize the lectures planned for the following day – the extraordinary meeting of the Surgeons' Society – and to prepare themselves for the ensuing discussion.

The instrumentation was also *"discussed and in part replaced"* (Schn II/18, 105, 113). Was the *"old"* replaced by the *"new"* or had deficiencies already become apparent? Details are not known.

The following were admitted to membership: Reinhard Fischer, Otto Keller, Willy Stähli.

On November 24 the **extraordinary meeting of the Surgeons' Society**, or so-called *"Symposium"* was held in the lecture hall of the surgical clinic in Bern to discuss fractures and their treatment.

The programme had been proposed by the new President, Fehr, and finalized by correspondence with the AO spokesman (letters of July and the invitation of September have been reproduced (Schn II/33ff).

It was intended that in the morning there should be discussions of *"general questions of fracture treatment and osteosynthesis"*, in the afternoon the focus was to be on *"fractures of the lower leg"*, and enough time was to be reserved for *"extensive discussions"*. Lower leg fractures were foremost at that time both numerically and as a paradigm.

Schneider reports the course of the meeting in detail (Schn II/18, 37ff):

In the morning, Müller had 30 minutes to speak. He spoke on the fundamentals and basic principles of osteosynthesis. Schneider recorded the *"remarkable excerpts"* from this lecture in his book *"25 Jahre AO-Schweiz"* (Schn II/37ff). It can be assumed that he had been involved in the linguistic refinement of the manuscript and therefore still had a copy in 1983.

As regards content, it dealt with direct consolidation of fractures without visible callus. At that time, results of animal experiments with Millipore (a filter impermeable to cells), as applied by Bassett in New York (and possibly also in Davos?) were already available.

Then clinical experience with stable osteosynthesis was reported and it was stated that *"for certain fracture types in long series"* no disturbance to healing had been observed and that *"for incipient pseudarthrosis the ossification of the interposed tissue"* could be induced. Müller also spoke on intramedullary nailing of femoral and tibial shaft fractures and especially on reaming of the medullary cavity having determined in advance the optimal nail diameter. Finally, he came to speak of the risks and insufficiencies of osteosynthesis *"as have been remarked all too often in our group"*.

Afterwards, H. U. Buff (at that time university lecturer, chief surgeon in Solothurn and Secretary of the Swiss Society of Surgery) spoke for 25 minutes on *"General considerations with reference to fracture of the lower leg"*. Buff had meanwhile become an opponent of the AO.

The lectures of the AO followed: Instead of Allgöwer, who had fallen ill, W. Bandi spoke on technique and results of screw fixation on the tibia. Schneider spoke on nailing technique in the tibia and Willenegger reported the results.

Debates: It is not clear from the records whether the original programme for the meeting was adhered to at all. Schneider writes (Schn II/18f): *"A real spirit of conflict prevailed. The main opponents were Buff, Lenggenhager* (professor of surgery in Bern since 1941) *and Geiser* (at that time senior registrar in the orthopaedic department in Bern, later titular professor) *who had drawn swords against us. On our side of the discussion, Walter Bandi had stepped boldly into the arena. They simply did not want to believe that bone healing without traditional callus was possible"*.

Peter Matter was present at this meeting as a delegate from Chur. He later reported: *"The lecture hall of the Inselspital was full to bursting with more than 300 interested surgeons from all over Switzerland, there were some foreigners there ... The only results of animal experiments were presented by the Bernese orthopaedic surgeon, Geiser"*(MP).

Obviously, the debate was centred on *"non operative versus operative"* (MP). It was *"extremely lively and emotionally infused... lasting several hours"*. *"Walter Bandi and Robert Schneider ... tried repeatedly to mediate"* but the session ended *"without any actual conclusions"* (MP) *"in the uproar of many private discussions"* (Schn II/18f).

"The lecture by Dr. Baur from the SUVA, Lucerne (Schweizerische Unfall-Versicherungs-anstalt – Swiss Accident Insurance Company), *much in our favour, on the results of lower leg fractures operated on at the AO hospitals remained unheard"* (Schn II/19). The members had, on the request of Allgöwer (letter of September 13, 1959), reported the SUVA numbers of the patients they operated on to Dr. Baur. The evaluation had shown that the AO results were better than other treatments from the point of view of the insurance company (duration of disability and permanent invalidity and/or invalidity pension payments).

This meeting was the second public appearance of the AO in Switzerland. Extensive discussions took place for the first time at a large assembly in Bern, whereby Schneider and Bandi excelled as lecturers in terms of organization, tactics, and science.

In the course of 1960 **manufacturing problems** had increasingly been encountered: the precision of serial production left much to be desired. Implant failures became more frequent. More and more local inflammations, not always distinguishable from subacute infections, were being observed as a result of corrosion and patients and surgeons were worried by it. Mathys himself had become alerted to it and contacted the physicist, Dr. W. Müller, in Grenchen, to whom Schneider wrote in support on September 9 (Schn II/31).

At about the same time, Willenegger and his friend Prof. Dr. ing. Reinhard Straumann

(1892–1967) were in contact discussing this issue at the meeting of the Rotary Club at the well known Hotel Engel in Liestal (Schn II/19).

Straumann owned the company of the same name in Waldenburg, which produced special precision components for the watch-and-clock-making industry and owned two international patents: the thermo-compensated hair spring Nivarox, built into millions of clocks and watches, and later the cobalt alloy, Nivaflex. As a flight officer and ski-jumper, Straumann was also a pioneer in sports medicine (construction of a special profile for the jump ramp and studies of the aerodynamics of the ski-jumper).

In 1927, after a long hospital stay in Basel after a ski-jump accident, he started to work with Prof. Henschen, at that time professor of surgery, on the organic structure of bone. They produced a fairly extensive publication in 1932 on *"The results of radiospectrographic investigations of bone"*[7].

Straumann owned several companies and had founded his own research institute in Waldenburg where work was done mainly on micromechanics and metallurgy. He became an honorary professor and honorary doctor of the Technical University in Stuttgart.

He was interested in the metallurgical problems of the AO. The institute started to investigate the explanted, broken implants. A close collaboration and research activities developed rapidly.

They were also interested in participating in production – which was very promising – and were able to free Mathys from his financial distress. Mathys consented to a provisional solution which also included production rights for Waldenburg. Dr. P. von Rechenberg from Chur mediated in these negotiations. In Waldenburg, Fritz, son of Reinhard Straumann, continued collaboration with the AO and with Mathys.

Fritz Straumann (1921–1988)
citizen of Bretzwil and Waldenburg (BL)

Son of R. Straumann, who grew up in Waldenburg.

In 1947 diploma as Ing. HTL at the Technical College Le Locle. First of all, he was technical director of the company Tschudin and Heid in Waldenburg, then collaborator at his father's private laboratory. In 1955 he was the representative of the Administrative Committee.

In 1960 contacts to the AO and Synthes began. Participation at the first AO course. In 1961 member of the technical commission.

In Waldenburg Fritz was in charge of metallurgical and micromechanical research and implant testing. He rapidly expanded into enormous research activity because he was interested in scientific issues. He became a co-author on various publications of the AO group and on the first AO book in 1963[8].

Fritz Straumann also made an important contribution to the animal experimentation performed by Schenk, for which he designed special equipment for the experimental model. He played an active role in the research of his co-workers and facilitated their projects by acquiring or manufacturing equipment. *"He was a pioneer, always wanted something new, so much so that he was even accused of neglecting the production activities of his own company"* (SR).

Many years after his death, people still say: *"Right now, I still miss him very much"* (PS).

Fritz Straumann managed his rapidly expanding company with a great deal of human sympathy. *"His generosity was often exploited"* (PO). After his father's death, he continued the technical activities and work in the field of sports medicine. He was a great lover of animals, co-founder and sponsor of the AO veterinary group.

In 1967 he became a scientific member of the AO.

In 1974 doctor *honoris causa* of the University of Geneva.

The team in Waldenburg. Since this was a specialist company for metallurgical research in the service of the watch-and-clock-making industry, several qualified specialists were already employed in Waldenburg in 1960. These collaborators were working on the metallurgical problems of the AO and were active in the technical commissions. These were:

Ortrun E. M. Pohler, born 1936 in Gera (D)
Schooling in Weimar. Diploma in metallography at the Max Planck Institute of the University of Stuttgart. X-ray diffraction studies.

She was offered a post in Waldenburg by R. Straumann in 1957. Ms Pohler worked on clock spring materials, quality control testing, and measuring instruments at the laboratory of Tschudin and Heid.

In 1960/61 Fritz Straumann involved her in work for the AO: corrosion and fatigue testing. She participated in the other metallurgical studies of the company.

1968 Head of the department for metallography.

1973 Scientific member of the AO

In the same year she began university study in metallurgy at the Ohio State University (USA). 1979 M.Sc., 1983 Ph.D. Ms Pohler nonetheless continued to work now and again in Waldenburg.

She was until recently a collaborator of the Stratec company.

Samuel Steinemann (born December 5, 1923)
citizen of Zürich

1951 diploma in physics at the Confederate Technical University (Eidgenössische Technische Hochschule (ETH)) in Zürich. 1958 doctorate. In 1972, Steinemann came from Neuchâtel to Waldenburg where he was director until 1970. He was particularly active in corrosion research, together with F. Straumann and O. Pohler. He wrote the chapter on metallurgical issues in the first AO book in 1963 together with F. Straumann[9].

In 1968 he became a professor in Lausanne, in 1975 ordinary professor, but remained a consultant for the Straumann Institute.

In 1978 scientific member of the AO.

Fridolin Séquin (1921–1989)
citizen of Thun and Lichtensteig (SG)

Séquin had gone to the Cantonal grammar school Trogen with Fritz Straumann. He studied in Zürich and obtained his diploma as a mechanical engineer at the ETH.

He worked first in Thun at a company for precision mechanics and then came to Waldenburg in 1962 as the commercial director. Member of the AO technical commission since 1963.

Séquin had a profound knowledge of the AO instrumentation. He put together the catalogues (initially together with Mrs V. Moraz-Müller) and administered the archive of all technical drawings of the producers. Later, together with R. Mathys jun. and P. Gisin, he saw to it that the International Standards Organization (ISO) took the AO implants as its basis (especially the screws).

In 1973 he became a collaborator of AO-International and in 1980 he and Ms R. Texhammar (head of courses for OR staff) wrote the book *"Das AO-Instrumentarium"* [The AO instrumentation][10].

Paul Gisin (1925–1995)
citizen of Lauwil (BL)

Gisin was an unusually gifted and inventive, kind and helpful technician. He was employed at first by the clock makers Tschudin and Heid, then by Straumann in Waldenburg, where in 1962, together with R. Schneider, he developed the conical thread for insertion and withdrawal of the intramedullary nail. In 1963 he made an essential contribution to the development of the small AO drilling machine (Schn II/258).

1963 member of the technical commission.

He was especially committed to the activities of the AO courses.

On December 10, 1960 the company **Synthes AG** was founded in Chur (Schn II/19). This event has a lengthy prehistory on which subject a stray document has only recently come to light.

In 1959 Mathys had already experienced a financial bottleneck. The reasons can no longer be reconstructed in detail. The delayed payments for his deliveries to the *"sales outlet"* in Biel certainly played a role. Here his deliveries could only be paid for once the hospitals had settled their bills from Biel. Mathys was convinced of the potential of the instrumentation but did not want to be left alone with it. He asked to meet the other surgeons (MM), probably to safeguard himself. He wanted to have his situation as sole producer guaranteed.

Thus, on January 6, 1960 in Chur a four page contract was signed by Mathys and the surgeons (*"as representatives of the AO for the one or more societies to be established"*). Mathys was to acquire a 50% interest once the society was established with the obligation when turnover increased *"to transform it into a public company"* in which the AO could acquire *"up to a 50% share"*.

The text was obviously written by Dr. P. von Rechenberg because his *"Curia Inc."* is mentioned in it. This is his first active appearance in the history of the AO.

It was signed by Allgöwer and Mathys, then Müller, Willenegger and Schneider.

This document should not be overestimated. It belongs as an episode in the larger context of difficult financial circumstances for all those concerned and for which a solution had to be sought. The contract was never applied. Therefore, it need not be discussed further here.

It subsequently became apparent to the signatories that the AO as a medical society *"for the study"* of fractures and *"experimental research"* (paragraph 1 of the Statutes) could not acquire shares in a commercial company. This difficulty was finally resolved by founding Synthes AG Chur at the end of the year.

This society and the ideas and realizations it was based on were so unique, so unusual, and of such great importance for the future of the AO that the matter will be dealt with in some detail here.

The instrumentation lived up to the surgeons' highest expectations. Everywhere that it was demonstrated, demands for it were made. However, until now it had only been handed out to the members (and later a part of the course participants).

Through the collaboration of Mathys with Straumann, who had now joined in, an increase in production was anticipated. It was necessary to find practical solutions early enough in preparation for market introduction (September 1962).

The AO was not supposed to profit from a commercial company for professional and ethical reasons. But, it did not seem right that the producers alone should benefit from the ideas and inventions of the surgeons. There was also a great need to finance research and teaching.

For these reasons, Müller had the idea of establishing an independent joint-stock company to coordinate production, to represent it publicly, and to regulate profit distribution.

All medical patents and inventions would in future pass gratuitously to Synthes and be administered by it. Manufacturing and marketing was left to the producers who returned a percentage of their sales earnings. The basis of the proposed solution was the known fact that in the USA, for example, doctors received 18–20% of the net profit of the companies involved in the production of instruments they had developed – and which then also carried their name. The latter had to be prevented. The name Synthes was neutral.

Müller handed over all his existing patent rights free of charge to Synthes. All subsequent inventions by the surgeons were treated likewise. They were taken over by Synthes AG, patented, and commercialized in collaboration with the producers.

The surgeons were not permitted to derive private earnings from their shares and could only pass them on at their nominal value. This arrangement was a *Gentleman's Agreement* among the surgeons (in another version referred to as a *"shareholders fixed-rate contract"*). Once again this was obviously a verbal contract. No written text is available. There is only an agreement signed by the shareholders on January 27, 1968 in Bern, which confirms the preceding agreement (Appendix p. 234–236):

- Paragraph 1 states that the primary goal of Synthes AG was not to earn profits for the shareholders but to provide the necessary financing for research purposes to be determined by the shareholders.

- Paragraphs 2 and 3 obliged the shareholders (max. 6) and their assignees to transfer their shares at the nominal value.

Synthes AG Chur was founded by the shareholders Müller, Allgöwer, Willenegger, Schneider and P. von Rechenberg. P. von Rechenberg was the sole administrator and manager. Foundation certificate (Appendix p. 233) and Statutes are still in existence. The latter are only informative for those with an advanced knowledge of economics.

The 50 shares with a nominal value of CHF 1000 were distributed as follows: Müller 14, Willenegger and Schneider 12 each, Allgöwer 11, Rechenberg 1. Together with one medical shareholder Müller was assured a majority for difficult decisions *"but actually in a democratic manner he never made use of it"* (AM).

The producers were not shareholders but contracting parties. Mathys and Straumann consented to this agreement. They obviously derived advantages from it, too.

The agreement proved itself to be practicable and valid for the future. Increasing profits from production were expected, thus providing the means for research, especially the Laboratory for Experimental Surgery, documentation, and the courses. These areas were expected to require one-third of the income each.

This innovative symbiosis, which separated the ideas and technical inventions of the surgeons from the profits from production, but used them rather for research and teaching, seemed implausible to many. It had to be explained and defended continuously.

Peter von Rechenberg (1920–1992)
citizen of Haldenstein (GR)

Peter was born in Wernigerode, in the Harz (D) the youngest of four. His father, originally an army officer, had been retrained as a theologian after being wounded in the first World War. In 1928 the family moved to Davos because his mother had tuberculosis; his father became minister to the German congregation. As a Nazi opponent, he had to leave Davos in 1933. He found employment as a minister in Trimmis (where they lived), Haldenstein and Says – three small impoverished villages in the Rhine valley in the Grisons, that is, on its south bank. Peter attended the cantonal school in Chur. The whole family became citizens of Haldenstein in 1936. Peter entered military service in the Swiss army and became an officer. He studied national economics (as a working student) and received his doctorate in 1950 for his work on *"Die Staatssteuern des Kantons Graubünden seit 1913"* [State taxes in the Canton of the Grisons since 1913]. This topic was the beginning of his professional career as a tax specialist. In 1956 he and a partner founded the Curia Treuhand Inc. in Chur. He was often consulted by non-profit-making companies.

He was introduced to the AO in 1959 as a friend of Allgöwer's who esteemed his disciplined thinking and his open-minded philosophy.

The AO as a medical group and its connection with the industrial producers fascinated Rechenberg. He placed his distinct sense of balance and his organizational talent at the disposal of this unusual symbiosis of producers and surgeons, Synthes AG. He was their only administrator.

He soon took charge of the administrative meetings of the technical commission and played a leading role in the negotiations and the definitive regulation of the contracts with the producers in 1963. With his quiet objectivity, he was able to master many tricky situations and commanded the respect of all those involved.

One good example for this was his action at the Synthes meeting of June 22, 1961: Irregularities in production and financial demands by Mathys (absent) had caused a crisis – for the surgeons as well. The representatives from Straumann (also absent) were trying to provoke a basic alteration in favour of their company. Müller then moderated his statements. V. Rechenberg (chairman) abruptly closed the discussion and proposed *"that today's meeting be regarded as an informative meeting and no deci-*

sions should be made", instead it would be better to *"look for a solution together"* and to include Mathys in these future discussions.

This was always his approach to conflicts. He always worked to mediate. He compared his role amidst the tumultuous doctors to that of a sheepdog.

In 1975 he became a corresponding member of the AO.

His contribution to the preparation and organization of the AO Foundation in 1984 was invaluable. He died suddenly during the inauguration ceremony for the new AO Center in Davos on June 13, 1992.

The first course. The first AO Course was held in Davos from December 11–15, 1960. Schneider (Schn II/24) writes: *"We tried to emphasize from the very beginning that osteosynthesis is a difficult operation requiring special training. We designed the courses on the basis of this realization. Thus, we were better able to bear the responsibility for the distribution of our instrumentation. For we know why we are in the red: many poor operations, bone necrosis, material failure, and even infections can be explained in terms of incorrect indication and technique."*

The idea was to initiate a limited number of interested surgeons, beyond the circle of members, in the ideas and techniques of the AO, to train them, gain from their experience, and enter into discussions with them.

Handling of the instrumentation was to be learnt in practical exercises on cadaveric bones. The aim was to eliminate poor performance which had brought the entire method of osteosynthesis into discredit.

At this time there was absolutely no intention of releasing the instruments and implants for distribution. Production could hardly keep up with the demands coming from the AO hospitals anyway. With mixed feelings, it was seen to become the property of non members. Its proper application was no longer guaranteed.

It is not clear from the documentation when the idea of holding a course was decided. Allgöwer (AM) thinks it must have been during the meeting in March 1960 in Interlaken because of the time needed to prepare. An indication is given by the participation of Müller at the Hand Surgery Course run by Marc Iselin in Nanterre in June 1960. He was obviously interested in the course organization. Fischer and Heim were there because of their commitment to hand surgery. This was the only course at which practical exercises on cadaveric bones were performed and where lectures were interspersed with patient demonstrations and operations (shown on black and white TV at a magnification of 4:1 by live transmission from a separate room).

The list of administrative items on the agenda of the meeting in Davos from July 8–9 includes: *"Expansion of the AO introductory courses, possibly in association with an extra meeting of the Swiss Society for Surgery, the Collège and separately for foreign surgeons"* (Schn II/105). At this time it was only a question of organizational details and, in particular, the practical involvement of the Laboratory for Experimental Surgery in the planned courses.

At the beginning of November Müller had taken on management of the clinic in St. Gallen and obliged his new collaborators (Weber, Meuli) to participate actively at the course. But representatives of the other larger AO clinics were also on the spot with their colleagues as instructors and helpers (from Liestal Moser and Gasser, from Zürich Landolt, from Chur Gruber, Matter and Segmüller), and all the employees in Davos.

Guest of Honour was Professor Krauss from Freiburg in Breisgau. The chief of orthopaedics in Lausanne, Dr. Nicod, had turned down the invitation (MM). He participated at the second course in 1961 (BH).

The course participants. Twenty-five were originally intended, but an enormous demand arose and had to be met.

Willenegger registered *"passive participants"*, representatives from private insurance companies who had contributed to funding the laboratory and from SUVA, the anatomist Schenk from Basel, and Fritz Straumann from Waldenburg. The press and local politicians also had to be admitted.

The list of participants has been retained: there are 102 persons named on it. It includes 14 AO members and the team of instructors (Appendix p. 237f).

46 professionally active Swiss surgeons, mostly chief surgeons, participated.

Attendees from other countries were – in alphabetical order:

- Dr. A. Abel, chief surgeon of the Hütten-Krankenhaus in Dillingen/Saar (FRG)
- Dr. habil. H. Brandt from Detmold (FRG), Head of an Armed Forces Hospital in the process of expansion
- Prof. K. Chiari, Director of the Orthopaedic Clinic in Vienna, one of the most renowned orthopaedic surgeons of his time
- Dr. Ferret from Santa Fe (New Mexico USA)
- Prof. O. Hepp, ordinary professor for orthopaedics in Münster (FRG) in whose clinic Brussatis and Wagner were working at that time
- Dr. J. Kerner from Nice (F)
- Prof. H. Krauss from Freiburg i.Br., guest of honour (AO member from 1961)
- Dr. W. Pfleiderer from Stuttgart (FRG)
- Dr. H. Rosen, orthopaedic surgeon in New York (the spokesman had delegated his nephew, H. Vasey from Geneva, to be his private translator)
- Primarius Dr. O. Russe, Trauma Clinic Meidling, Vienna
- Dr. B. Sandick from Pittsfield (Mass. USA) (friend of Rosen)
- Prof. W. Schega from Mainz, ordinary professor of surgery
- Dr. S. Weller, scientific assistant in Freiburg i.Br.

Course Model. The course programme can no longer be found. Schneider writes *"the course model devised by Maurice Müller in his capacity as organizer was good and has basically been retained until today. The distribution of topics among the AO members has changed little. There were no lectures on scientific findings; tibial fractures were stabilized either by screw fixation or by intramedullary nailing. Even if the course participants could not cope very well with all the new ideas, they all acknowledged our will to do honest work and to collaborate"* (Schn II/19).

Photographs still exist of the lecture hall, of the entire course (participants and staff) (**Figs 4-1, 4-2**), and a picture of Müller doing the practical exercises (**Fig. 4-3**).

The famous group photo of AO members present at the course as lecturers and instructors (**Fig. 4-4**) is generally mistaken for a picture of the 13 founders of 1958.

At the end of the course and to celebrate its success an impromptu ski race took place which was later to become a tradition.

A promise was made to the course participants to remain at their disposal for further discussions. A well attended Meeting of *"former participants"* took place on November 23, 1961 at the Stadtspital Waid in Zürich. Later on, similar *"refresher courses"* were not possible.

Histology. In 1960 the collaboration of Willenegger and the anatomist, Schenk, (then in Basel) on experimentation began. Existing knowledge of callus-free fracture healing was based on the observations of Danis and personal experience in clinical practice and from observation of radiographs. To clarify these phenomena, experiments and histology were to be called upon. The arrangement and progression of these investigations is reported in Chapter 6.

Robert Schenk (born March 3, 1923)
citizen of Zürich and Winterthur

Schenk studied in Zürich, state exams in 1948. He was an anatomy assistant and worked at the hospital in Herisau. In 1951 prosector for anatomy in Zürich, 1953 postdoctoral qualification.

In 1956 he moved as an extraordinary professor from Zürich to Basel where there was already an electron microscope.

In 1957 he met Willenegger at a lecture on *"surgical anatomy"*. Willenegger drew his attention to the unsolved question of *"primary"* callus-free fracture healing and encouraged him to collaborate on research projects.

Basic histological work done in 1960–1962 on the rigidly stabilized osteotomy of the canine radius led to several publications, some of them with the AO founders[11,12].

1965 advanced training at the Columbia University in New York, later connections to the State University in Columbus Ohio.

Schenk soon started work with Fleisch. Their joint lecture at the AO Courses was – Schneider says – *"indispensable as a biological basis"* (SR).

1967 scientific member of the AO.

1971–1988 ordinary professor of anatomy in Bern.

Schenk has remained scientifically active to the present day.

The new members in the year 1960

Irwin S. Leinbach (1890– approx. 1985) from Reading (Pennsylvania USA)

Leinbach was the first non European AO member. His professional career with its numerous changes of location and function is typical for many surgeons in the USA. Leinbach studied in Philadelphia and was then assistant in Reading (PA), New York and Philadelphia.

1942 orthopaedic chief resident at the American Hospital in Oxford, England, later returning to New York.

Leinbach was also a lawyer and spoke German. He had been stationed for a long time in Germany after the end of the war as part of the occupying forces. During this time he travelled widely and met Müller at the Balgrist. He became an ardent follower and visited him several times later on in St. Gallen.

From 1945 he worked in private hospitals as an orthopaedic surgeon, finally in St. Petersburg

Fig. 4-1: The participants at the first course in Davos in December 1960 in the lecture hall at the Laboratory.

Fig. 4-2: Group photo of participants, lecturers, instructors, and helpers at the first course. In the first row from left to right we see Bandi, Schneider, Mrs Moraz, Müller. Photo courtesy of Dr. Reinhard Fischer, Wattwil.

Fig. 4-3: Practical exercises in 1960: Müller applying the last few hammer blows to insert a femoral nail. There were not yet separate instruments for insertion and removal.

Fig. 4-4: Group photo of the AO lecturers and instructors taken at the end of the first course (often mistaken for a group photo of the founding members). From left to right: Fischer, Keller, Schneider, Ott, Willenegger, Schär, Müller (sitting in a basket), Bandi, Stähli, Allgöwer (holding up his walking caliper in his outstretched hand), and on the far right Bloch. Baumann and Brussatis had already left.

Florida. He was on the orthopaedic staff of several hospitals, was a consultant and visiting professor, finally in St. Petersburg Florida and Miami.

Reinhard Fischer (born July 29, 1920)
citizen of Meisterschwanden (BE)

Fischer grew up in Biel where he knew Müller, who was somewhat his elder. He studied in Basel and Geneva, state exams in Basel in 1945, doctorate in 1946.

Training in pathology in Utrecht, gynaecology and obstetrics in Biel and surgery in St. Gallen. Senior registrar at the hospital in Walenstadt.

1954–1955 longish study period at the Mayo Clinic in Rochester (USA).

1955 Senior registrar of surgery St. Gallen.

1959–1985 Chief surgeon at the hospital in Wattwil (SG).

Fischer had grown up with non operative fracture treatment in St. Gallen. He was introduced to the AO by Allgöwer whom he visited early in 1960 in Chur and whose spontaneity and uncomplicated manner with his team and guests had impressed him very much.

He was a very active AO member. He participated at the first AO Course as a lecturer and was later repeatedly active in teaching at AO Courses at home and abroad.

In 1965 he was called in rapid succession to the treatment of two lower jaw fractures in pregnant breeding cattle. Osteosynthesis is a vital indication in ungulates. Together with the vet and a dentist skilled in AO techniques, he stabilized the fractures successfully with femoral compression plates. He produced a film of it which he showed at an AO meeting, thus publicizing his two patients[13].

Having retired in 1985, he remained active in a private practice for phlebology in St. Gallen.

Otto Keller (1911–1971)
citizen of Oberendingen (AG)

Studied in Geneva and Montpellier. 1936 state exams and doctorate in Zürich, assistant at the hospitals in Walenstadt, St. Gallen and Davos.

Senior registrar at the Surgical Clinic in St. Gallen.

Study periods in London and Basel. He was also a specialist in urology.

1951 chief surgeon at the hospital in Walenstadt.

Keller was introduced to the AO by Müller who had also operated in Walenstadt after 1957. He was also friendly with Fischer and was with him as part of the staff at the first AO Course in 1960.

Willy Stähli (1915–1995)
citizen of Thun and Schüpfen (BE)

Stähli grew up in Biel, studied in Bern and Vienna, state exams in 1939 in Bern, doctorate in 1942.

He was an assistant in pathology at the ENT Clinic in Bern, in Davos Clavadel, then at the surgical clinic and in urology in Bern. Senior registrar at the Cantonal Hospital Winterthur.

1949–1980 Stähli was chief of surgery in Thun.

He was introduced to the AO by the Bernese chief surgeons some of whom he had been friends with in his student days. He did however also know Müller who had operated in Thun after 1957.

Friends of the Swiss AO in other countries in 1960

As a result of meetings before 1961 scientific contacts and friendships with the representatives of university clinics in Germany and also personalities from the USA and Austria were consolidated. We have met them already or will find them in Chapter 5: in Freiburg i.Br. Krauss, Koslowski, Weller; in Münster Brussatis and Wagner; in the USA Leinbach, Rosen and Bassett; in Austria Jörg Böhler. The last three are introduced here:

Charles A. L. Bassett (born August 4, 1924)
in Crisfield Maryland (USA)

Bassett completed his studies in 1948 at the Columbia University in New York and was awarded his Sc.D. in 1955. In 1960 he became director of the orthopaedic research laboratories of the Columbia University.

He was one of the first to contend scientifically with the theories of the AO and to demonstrate by animal experimentation that cortical osteogenesis can be independent of the endosteum and periosteum[14]. The founders of the AO have repeatedly referred to his investigations (Schn II/37). They were mentioned in the book "Technik" published in 1963 and illustrated there (Te 13f).

In Schneider's first book (Schn I/71) he is listed as a scientific member of the AO. His research changed direction later.

Jörg Böhler (born December 15, 1917 in Gries near Bozen).

He studied medicine in Vienna, doctorate in 1941. Specialist training in traumatology by his father Lorenz, qualification as a specialist 1948.

1948–1950 study periods in Paris, Zürich, Graz and San Francisco (Sterling Bunnell).

In 1951 he was elected as Primarius of the newly opened Trauma Hospital in Linz.

1957 Lecturer in Vienna.

His early contacts with the AO in Freiburg i.Br. in March 1960 have already been reported. He attended the Spring Meeting of the AO in Interlaken and the second AO Course in Davos in 1961. His father, Lorenz, occasionally transferred patients requiring difficult osteosynthesis procedures to him from Vienna.

1964 appointment as professor.

1969 founding member of the AO in Austria.

1971 Primarius at the newly opened Lorenz-Böhler Hospital in Vienna.

In German speaking countries, Böhler

earned a reputation for his translation and enlargement of the standard work by St. Bunnell: *"Die Chirurgie der Hand"* [Surgery of the hand][15].

Jörg Böhler is still active and takes charge of several hand surgery courses each year in Vienna.

Howard Rosen (1925–2000), New York

He studied in his home town and became an orthopaedic surgeon in 1949. Private practice and lecturer at the Columbia University College 1952.

Rosen's acquaintance with the AO is reported by Schlich as originating from an interview in 1997[16]: Rosen met Müller at the SICOT Congress in New York in September 1960. Müller was exhibiting the results of his pseudarthrosis operations and the AO instrumentation. Rosen showed him the radiographs of his friend's uncle, Herbert Sandick from Pittsfield, who was suffering from a pseudarthrosis of the humerus which had been operated on twice without success. The elderly gentleman travelled to Switzerland and was operated on by Müller. Six weeks later he was playing tennis again. As a result Rosen and Sandick registered for the first AO Course and returned home laden with instrumentation. However, having got back they were completely at a loss. They had no contacts. Sandick gave up. Rosen, on the other hand, travelled several times to St. Gallen and practised on cadavers before daring to operate on patients. He soon became the *"pseudarthrosis specialist"* of the region. His immense and constantly increasing collection of data was unique.

In 1967 Rosen became Professor of Orthopaedics at the Mount Sinai School of Medicine and, in the same year, corresponding member of the AO. He was a very witty and cultivated friend.

His lecture on the treatment of pseudarthrosis enriched the English language courses in Davos and America until recently.

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Chapter 5
The AO in 1961–1963
Stabilization and early expansion

The events of these three years will be summarized in one chapter.

Schneider writes in 1969: *"by 1961 the early pioneering phase was over ..."* (Schn II/20). Retrospectively, this statement has to be modified. The limit has certainly been set too early: the equipment was only just complete and it soon diversified. The instrumentation had not yet proven its worth beyond the ranks of the AO. New structures had only recently come into existence or were in the preparatory stages. Metallurgical research and animal experimentation had only just begun. Of course, many problems seemed to have been solved, but others were emerging. There was to be quite a long wait until the AO and its techniques met with wider acceptance. Three examples can be given:

- In 1962 the famous German orthopaedic surgeon, Max Lange, wrote in his textbook of operations[1]: *"It is utopian to believe that the simple bone screw can really provide lasting stability ... after a while, the screw itself, which sits loosely in the bone, can be plucked out with a pair of tweezers"*.
- At the annual spring meeting of the French Society for Orthopaedics (SOFCOT) in Toulouse, Louis Descamps of Nice, an orthopaedic surgeon influenced by the ideas of the AO, spoke about osteosynthesis of the fibula in malleolar fractures, whereupon the famous Merle d'Aubigné shouted his protest into the room: *"Ne suivez pas ces bergers Suisses"* [Do not follow these Swiss shepherds][2]
- Schneider himself mentions the hail of catcalls at the German congresses in the mid 1960s whenever the AO lecturers showed *"plates or screws on the radiographs"* (Schn II/52).

In this chapter the following events will be reported in greater detail:

- The conferences and meetings
  - 1961 April in Waldenburg, November in St. Gallen
  - 1962 June "Private meeting" in Davos, December in Zürich
  - 1963 May in Liestal, November in Zürich
- The technical developments
  - Plate osteosynthesis on the tibia
  - New implants
- Founding of the technical commission November 1961
- Continuation of experimental research in Davos, Münster and Basel
- Written documents on teaching and technique (Guidelines 1961, book "Technik" 1963)
- Market introduction of the instrumentation Sept. 1962
- Müller called to Bern and nomination of Allgöwer to professor 1963
- Lecturing activities of the members in 1962 and 1963
- H. Fleisch, head of the laboratory in Davos 1963
- The AO Courses 1961 and 1963
- Courses for OR personnel from 1961
- New members
  - 1961 Krauss and the team in Freiburg
  - 1962 Barraud and Heim
- The contract between Synthes and the producers of November 1963

The year 1961

In the early months of this year, simultaneously in St. Gallen and Chur, the combination of screws and plates for the osteosynthesis of tibial fractures was discovered and consequently became a dominant technology.

Bandi's T-plate for the proximal humerus was introduced.

The following modifications were made to the straight plates:

- enlargement of the end holes for the insertion of cancellous bone screws
- alternating arrangement of the holes in the broad plates
- cambering of the cross section to accommodate the shape of the bone

From April 27–29 the **Annual Spring Meeting** in Waldenburg took place (Schn 21, II/105, 113f).

It commenced with a tour of the Mathys facility in Bettlach: Factory and offices were still quite basic, the number of employees and workers was easy to cope with. *"Only one very skilled man was able to bend the angled plates without breaking them. You could watch him as he heated them up in the gas burner and then, at a temperature recognized by him alone, he would bend them elegantly in one go and thus shape them one after another to the desired form"* (HU).

Later came the move to Waldenburg where metallurgical and mechanical testing of the straight plates was first demonstrated at the Institute (HU). Then, the first part of the meeting itself took place.

Prof. H. Krauss from Freiburg i.Br. was admitted as a new member. He affiliated himself to the young movement as the first ordinary professor of surgery. His commitment and the collaboration of his team were very important for the AO.

The administrative items on the agenda included the minutes, annual report, financial report, cash report, reports on the laboratory in Davos, Synthes, documentation, and instrumentation with subsequent discussion. Schneider calls these items *"Standard"* (Schn II/105). They were discussed at all following meetings and will be summarized hereafter under this heading.

- the financial statements for the first AO Courses were approved, followed by the decision to run a second one in December.
- new films for the courses are mentioned (produced by the team in St. Gallen, HU), publications (in preparation?), and a plan for the year 1962.

The hosts were very attentive in hospitality and accommodation (HU).

The main topics for the scientific items on the following morning were:

- femoral neck fractures, especially the early recognition of head necrosis by means of isotopes on the subject of which the radiologist, Bessler, from Winterthur, lectured. It had been hoped that more favourable results would be achieved with the angled blade plates than with the former three-lamellar nails.
- F. Straumann reported on his mechanical and metallurgical investigations, his collaborators spoke on strength properties of metals and alloys, metallographical investigations of implants and on corrosion of stainless steel.

Among the difficulties of this year Schneider mentions production worries, which weighed especially heavily on the lady in charge of the sales outlet in Biel, Mrs Violette Moraz-Müller. She mastered her task *"with uttermost dedication, skill, and charm"* (Schn II/20). On the one hand, production at Mathys was lagging behind the orders and demands, on the other hand, there had been complaints about quality.

The second meeting took place on November 24 and 25 in St. Gallen. Müller wanted to present his clinic and its organization.

The main clinical topics were:

- femoral neck fractures (Müller). Early experience with head prostheses was now available (first documented April 1961 in Interlaken).
- fractures of the humeral head (Bandi). The first reports of the T-plate were presented. They had actually been designed for pseudarthroses and appear in the documentation in January 1961. The new design was intended to improve the fixation of fractures in cancellous bone – that is, close to the joints.
- Tibial plateau fractures (Allgöwer). Here the threaded bolts had not proven successful. The first combinations of straight (contoured) plates and threaded bolts were documented in January 1961. Previously, the 90∞ angled blade plates had been used. T-plates were not a topic until mid 1962.

For the first time, reports on experimental work on sheep were presented from Davos (Willenegger and Schenk). These dealt with the first pressure measurements in vivo after osteotomy and application of ferromagnetic plates; published 1962 [3].

In November the **"technical commission"** was established together with Mathys by verbal contract (Schn II/20). This was a leadership structure of extreme importance for the future. Mathys had collaborated until now exclusively with Müller on the development of instruments and implants. The only exception had been the T-plate with Bandi. Now Straumann was a producer as well.

But the problems had also become more diverse: raw materials, prototypes, serial production, manufacturing procedures, etc.

Suggestions were also being received from the medical side and needed to be evaluated.

In the Commission surgeons were to be in the majority because production had to meet the demands of operative technique and/or clinical experience and not be dependent upon possible advantages or simplifications in production. The needs and capacity of the producers was however also taken into account because their economic success was in the general interest.

When authorizing prototypes a decision had to be taken on whether these should be available as *"standard"* (i.e. as part of the basic instrumentation) or only as *"available on request"*.

But also the series manufactured on the basis of prototypes had to be checked for their precision and quality. Up to this time prototypes had not been available or production had sometimes deviated from them.

From now on the producers were only to manufacture instruments and implants in series which had been tested and approved by the Technical Commission as a Synthes product.

Müller writes of the new structure (abbreviated to TK) (Schn II/256): *"At the beginning it was a fairly informal structure and consisted at the first meeting on December 16 of the surgeons Allgöwer, Müller, Schneider and the producers Mathys and Straumann and their collaborators Vogt, Karpf and Mrs Moraz"*. The small versatile committee promoted the swift development of the instrumentation.

Müller retained chairmanship of the TK and played a dominant role. A vote was never held. In unclear situations he was in the habit of providing clarification by saying: *"We had all agreed ... hadn't we ..."* (AM).

In this year the two versions of the **Guidelines** still in existence today (July and December) were written. We will come back to them later.

In December (presumably from 11–15 of the month) the **second AO Course** was held in Davos. Details of the programme can no longer be ascertained. The number of participants is given as 136. In addition to 96 Swiss (including the Faculty), there were 14 participants from Germany, 16 from France, 4 from Austria, 6 from Great Britain, and one each from Italy and Belgium (Schn I/81) (**Fig. 5-1, 5-2**).

This list already shows a certain level of international activity. The guests of honour were:

Fig. 5-1: John Charnley with Allgöwer during the practical exercises at the 1961 AO Course in Davos.

Fig. 5-2: Bandi working on the practical exercises (angled blade plate on the proximal femur). It is difficult to date the photo exactly, probably the 1961 course.

- John Charnley from Wrightington (GB). This was one of the best known and most innovative English orthopaedic surgeons of the time. He had developed the compression arthrodesis and a total hip prosthesis. He and Müller were friends.
- Michel Postel from Paris, who had worked alongside Merle d'Aubigné in the Hôpital Cochin and become his successor. He had already participated in the *"Swiss Tour"* for French orthopaedic surgeons with Müller in February 1960. However, a long-term collaboration did not develop.

Immediately after the surgeons' course, the first **Course for OR Personnel** was held on December 15 and 16. Whose idea it was, is not known. The nurses came into contact with the instrumentation because they generally managed the implant stocks in the hospitals and ordered their completion. The instruments were assessed in terms of handling (dismantling, cleaning, number of parts, sterilization) and durability.

The course focused on teaching OR personnel how to handle and maintain the relatively complicated instrumentation, raising their confidence in it, and also explaining the technical procedures of the surgeons. It was very important to alert them to the imperative optimization of asepsis and its constant maintenance. Without doubt, these courses strengthened the self-confidence of the OR nurses, improving their image as specialized assistants to the surgeon.

The invitation was written by Allgöwer, who also took care of the programme, together with Schneider (Schn II/42):

- on Friday after arrival, allocation of rooms, and supper at the Hotel Post, a welcome was offered (presumably with guided tour) at the research institute. Those interested were offered the opportunity to try out the instruments themselves on bones.
- The next day there were demonstrations of operative procedures and instruction in the cleaning and maintenance of the instruments.

Photos exist of the participants in the lecture hall and doing the practical exercises (**Fig. 5-3, 5-4**).

Subsequently, these courses became an institution. At first, they took place immediately after the courses for surgeons; later they were decentralized and organized independently.

For the winter season 1961/62 Allgöwer had had an **Information Brochure** on winter sportsmen in hospital printed and illustrated with amusing drawings by a talented co-worker. In it, it said: *"You are an accident victim and not a patient"* (Schn II/20). The need for detailed information had become urgent since follow-up treatment was being carried out by unknown doctors and there was a risk of the patients losing control. In a much read women's magazine an article by an enthusiastic skier was published with the title *"Break your leg in the Grisons"*. Allgöwer was immediately reproached for politically incorrect propaganda (HU).

Hermann Krauss (1897–1971)

He was born in Württenberg, studied in Tübingen and München. In 1924 he was an assistant in Mainz and in 1927 senior registrar at the regional hospital, Kreiskrankenhaus Göppingen.

In 1930 he transferred to the University Clinic Charité in Berlin, headed by Sauerbruch, where he became a senior registrar in 1935.

In 1941 he was director of the Surgical Department of the City Hospital St. Urban in Berlin and, during the war, consultant surgeon for the medical inspectorate of the army responsible for the organization of treatment of the wounded. After the end of the war, he was an internee of the occupying forces, later to be appointed chief of the surgical department in Göppingen in 1948.

In 1952 he was given a chair for surgery in Freiburg i.Br. He was – as was his mentor Sauerbruch – mainly a thorax surgeon (tuberculosis of the lung, heart surgery, oesophagus) and helped anaesthesia to become an independent discipline. From 1964–1965 he was president of the German Society for Surgery.

Fig. 5-3: First course for OR personnel held in 1961 in Davos: Female and male participants in the lecture hall at the Institute.

Fig. 5-4: Nurses working on the practical exercises in 1961at the first course.

His team participated actively in the Swiss Group and became a *"germ cell"* in the formation of the German AO.

The team in Freiburg i.Br.

Fritz Kümmerle (born February 14, 1917) had been at the Freiburg Clinic since 1954. Specializations: gastroenterology and pancreas surgery. He took turns with Koslowski to hold the lectures on fractures and dislocations. Professor in 1959, in 1963 ordinary professor for surgery in Mainz. He took the lecturer, Carl-Heinz Schweikert (1929–1979), with him to be head of traumatology. The latter founded the Trauma Symposia held there after 1965 and promoted the nomination of Robert Schneider to honorary professor which he then became in 1977.

Jörg Rehn (born 1918)
The descendant of a dynasty of surgeons, Rehn obtained his postdoctoral qualification in 1956 in Freiburg. In 1961 he became professor and chief surgeon (successor to Bürkle de la Camp) of the Berufsgenossenschaftliche Klinik *"Bergmannsheil"* in Bochum (the first and famous hospital of the German Accident Insurance Company founded in 1894). Although at first hesitant, he then introduced the AO methods and in 1970 became a founding member of the German AO chapter. Professor emeritus in 1983.

Leo Koslowski (born 1921)
He came to Freiburg in 1956 and obtained his postdoctorate in 1958. Professor in 1963. Taking turns with Kümmerle he held the lectures on fractures and dislocations.

As a delegate of the chief surgeon, Krauss, he was a guest at the AO Meeting on March 18–19, 1960 in Interlaken and had a skiing accident immediately afterwards. He was operated on by Bandi for an avulsion fracture of the great tubercle with dislocation of the right shoulder. He appears in the AO documentation as BJ 3/5. In 1968 Koslowski became ordinary professor of surgery in Tübingen. He initiated the foundation of the German AO in 1970 (KE).

Siegfried Weller (born July 28, 1928)
He studied in Würzburg, Innsbruck and Heidelberg where he received his doctorate in 1954. Assistant at the Paterson General Hospital (NY/USA), then in the American hospital in Stuttgart/Bad Cannstadt and the private clinic of Dr. Bertele in Ulm.

In 1959 scientific assistant at the clinic for surgery in Freiburg. Together with Professor Krauss, he participated at the first AO Course in Davos in 1960 and took on responsibility for liaison between the AO and Freiburg. In this capacity he had the tricky task of transporting instruments, implants, and radiographs across the border. He attended all the AO meetings in Switzerland. He invested particular efforts in intramedullary nailing. Together with Koslowski he organized the first AO Course outside Switzerland in 1965 in Freiburg i.B. He became a member of the TK and, in 1967, a member of AO Switzerland.

In 1963 postdoctorate. In 1968 professor and head of Trauma Surgery in Freiburg. In 1969 Medical Director of the Berufsgenossenschaftliche Unfallklinik in Tübingen. In 1970 he became spokesman for the German AO. In 1979 ordinary professor for trauma surgery. He dedicated himself above all to the teaching activities of the AO and organized the courses in East Asia. 1994–1996 President of the AO Foundation.

The year 1962

Schneider writes: *"The year 1962 was characterized by our efforts to produce the AO book"* (Schn II/20). The book was most certainly the central preoccupation.

The courses had been proven to have a powerful immediate effect on the dissemination of principles and techniques, but the effect was not lasting. The instrumentation was now available in many places but in inexperienced hands. A book which could be consulted at any time would make up for this and provide some protection. It was the appropriate medium to record the concerns of the AO and represent them to a wider public.

Early in 1962 the **medical department** of the research institute for High Mountain Medicine **in Davos** was reactivated. It had previously been under the management of the bacteriologist, Vischer, and had remained unstaffed for several years – as had pathological anatomy.

Under the leadership of PD Dr. Ernst Sorkin from Basel the main focus was on questions relating to allergy and bronchial asthma. The facilities were divided up between the two departments. A collaboration developed between shock research and tissue culture[4].

A letter from Allgöwer to the members dated March 24, 1962 warned: *"against the dangerous extraversion of our Society. Eminent AO members are speaking ex cathedra at cross purposes"* (Schn II/20).

What had probably happened can be assumed: increasing public appearances of prominent members meant an increasing risk of uncoordinated statements. More detailed information is not available.

The problem that had arisen does however explain why in this year a decision was taken to hold a mutual **week of contemplation in Davos** instead of the usual spring meeting (Schn II/20). This took place from June 21–25 as a sort of closed meeting in a small hotel in Davos-Wolfgang. The entire spectrum of AO doctrine, instrumentation, and techniques was discussed and coordinated in terms of presentation in the planned book. The Guidelines formed the basis (Schn II/20, 106, 114).

The titles and lecturers corresponded to the chapters and authors of the AO book of 1963[5].

- Introduction, Guidelines and generalities – Müller
- Tibial fractures – Allgöwer
- Humerus – Bandi: not only the T-plate for proximal application, but the whole of humerus traumatology was to be presented. Mumenthaler from St. Gallen became co-author in the book.
- Elbows – Weber: Weber had further developed the tension band principle of Pauwels[6], especially for osteosynthesis of patellar and olecranon fractures.
- Forearm – Bloch
- Navicular bones – Willenegger
- *"AO Instrumentation"* – Straumann: with reference to the section on metallurgical questions of the AO book[7] (corrosion, metallosis, metal analysis, and manufacture of implants).

The committee was confirmed in its functions by re-election..

The following new members were admitted: Bernhard Barraud from Aarberg and Urs Heim from Chur.

It was decided to award an AO Prize annually for outstanding experimental or clinical work in the field of osteosynthesis. The first prize winner was H. Wagner. He held a lecture on this occasion (WaH).

An impressive AO delegation participated at the *Congress of the Mid-Rhine Society for Surgery* (Kongress der Mittelrheinischen Gesellschaft für Chirurgie) in September in Schaffhausen: the lecturers were Müller, Willenegger, Allgöwer, Weber and Straumann.

Here the **instrumentation** was exhibited to public view for the first time. It was now being sold on the **open market.** Having completed several years of development and testing of quality and suitability, it was time to give in to the pressure of numerous interested parties.

In anticipation, Mrs Moraz (in collaboration with Séquin and Boitzy) had compiled **catalogues** in German and French. Schneider had them reproduced (Schn II/43–46, Appendix p. 239ff). The basic instrumentation for screw fixation (incl. implants) cost CHF 1'110, a set of plates and cancellous bone screws cost CHF 1'778 Additional instruments and implants were available *"on request"*. Custom-made pieces, for which there was a 20% surcharge, had a delivery time of 8–10 days. Catalogues are short-lived. They had to be revised the following year (TK July 10, 1963).

Sale on the open market however also increased the risk of incorrect application. The technical rules which had been set down in the revised guidelines for internal use now had to be replaced by a publication for wider distribution.

Funding for the Laboratory in Davos was still precarious: in Allgöwer's letter of March 24, 1962, as already mentioned, the members had been invited to pay CHF 480 each, of which CHF 280 was to employ a librarian (Schn II/49).

To the sponsors who had donated in 1960 more had been added (among others, the Foundations of the pharmaceutical companies Hoffmann LaRoche and Sandoz), and the first contribution from Synthes AG Chur. The annual expenditure had however reached CHF 250'000[4].

Herbert Fleisch was appointed head of the Laboratory. He had introduced himself by way of a lecture at the *"week of contemplation"*.

In June Müller, then in St. Gallen, had taken over responsibility for the central documentation in Davos.

New implants had been introduced:

- the longer T-plate for the distal tibia by Bandi (later called the *"spoon plate"*). It appears in the documentation in April 1962.
- The semi-tubular plate which appears in the documentation in December.
- The outer dimensions of the thread for the small cancellous bone screws had been increased to 3.5 to 4.0 mm.

With reference to difficulties with the producers, Schneider writes *"in the second year of its existence Synthes was much troubled because it was not easy to achieve a satisfactory equilib-*

Fig. 5-5: Straumann and Mathys being indoctrinated by Willenegger over a meal. No exact date, but probably 1962 or 1963.

rium between Mathys/Straumann" (Schn II/20) (**Fig. 5-5**).

The Straumann Institute had soon come to grips with testing implants and dealing with metallurgical difficulties. Fritz Straumann had advanced to become a regular speaker on these matters.

Mathys, the inventive designer of the instrumentation, who had been bound over to Müller as sole producer for nearly four years, necessarily felt he had been outstripped. Negotiations were constantly taken place under the management of Dr. P. von Rechenberg.

The members met for the **Autumn Meeting** on December 13 in Zürich. Schneider notes the agenda items: *"Standard, AO book and discussion of difficult cases"* (Schn II/106, 114).

Walter Ott had withdrawn from membership. Schneider writes: *"Because the Society had become too big and too inflated"* (Schn II/22). Apparently authoritarianism had become perceptible.

It was decided that no new members were to be admitted for the next few years (de facto until 1965).

The new members in 1962

Bernhard Barraud (1916–1998)
citizen of Bussigny and Villars-Tiercelin VD

Schooling in Aarberg and Bern, he studied medicine in Bern, state exams and doctorate in 1943.

He was an assistant in Liestal and at the University Medical Clinic, later in the surgical and orthopaedic departments of the Inselspital in Bern.

In 1950 he was chief of surgery and orthopaedics at the district hospital in Aarberg. He retired in 1982.

Although he was somewhat younger than the *"3 Walters"*, Barraud belonged to the Bernese group which Willi Stähli, who was much the same age had joined two years earlier. He was also active in local politics (town mayor).

Urs Heim (born April 4, 1924)
citizen of St. Gallen and Zürich

Due to frequent change of domicile and attendance at high altitude health cures, schooling at various Swiss locations and in Paris. He studied medicine in Zürich, state exams 1949, doctorate 1951.

Assistant in pathology, internal medicine, obstetrics and gynaecology, surgery and urology in Basel, St. Gallen and Zürich.

October 1958 first assistant to M. Allgöwer in Chur, from spring 1959 senior registrar and deputy chief surgeon.

1961–1981 chief surgeon at the Kreuzspital Chur.

From 1964 work on development of the small fragment instrumentation.

1972 member of the committee (treasurer) and of the Technical Commission.

1973 postdoctoral qualification in Basel (1984 in Bern).

From 1981 private practice for hand surgery in Gümligen BE and collaborator of AO-International.

1988–1993 President of AO-International

1992 Doctor *honoris causa* from the University in Jena

The year 1963

An AO Course was not held in 1962 because of the preparations for the book. It had been assumed that once the book was published the demand for courses would diminish and perhaps even disappear altogether. Müller had already said as much at a meeting in 1962 (HU). The surgeons had complained about the extra workload of preparing for the courses and absence from their usual functions during the courses (TK August 20, 1963). Only P. von Rechenberg was of a different opinion and he was to be proven right.

The demand for continuation of the courses was based on several factors: the desire to meet the promoters in person, the lively teaching methods, the opportunity to discuss, and the now indispensable practical exercises for applying the instrumentation on bones. A book was useful to get started and to commit to memory what had been heard and attempted at the courses, and as a reference work. These arguments have remained valid.

Having finished the manuscripts and handed them over to the publisher (early 1963), the teams were again ready to take up teaching duties. In December (TK December 19, 1962) it had already been decided that two courses would be organized.

The third AO Course took place from March 24–27. It brought together in Davos 113 participants; 85 from Switzerland, 23 from Germany, 2 from Yugoslavia and one each from Holland, Austria and Belgium (Schn I/81).

The guest of honour was Prof. H. Bürkle de la Camp, director emeritus of the first Berufsgenossenschaftliche Unfallklinik in Germany, *"Bergmannsheil"* in Bochum.

In 1960 he had said disparagingly to his visiting surgeon, Meuli (at that time delegated from Basel to Bochum), on the subject of the AO: *"They just nail everything"* (MC 1998). He changed his mind after participation at the third AO course; this was a very significant change for the AO. His speech at the closing banquet – which he held in German tradition as a 'toast to the ladies' – was not to be forgotten (BH).

At the congress of the German Society for Surgery held in April in München he then said: *"... if the screws and plates were radiolucent so that they could not be seen on the radiograph, then there would be immediate enthusiasm and no misgivings about the magnificent success of this method; it is simply the sight of metal shadows on the radiograph which awakens opposition"* (Schn II/21).

After the course for surgeons, a second course for OR personnel was held. Details are not available.

Herbert André Fleisch (born July 22, 1933) citizen of Romanshorn (TG)

He grew up and studied in Lausanne and then in Oxford and Zürich. State exams in 1957, doctorate in 1959. Assistant at the Institute of Physiology in Lausanne, at the Biology Department of the University of Rochester NY (USA) and at the surgery clinic in Lausanne.

Actually Fleisch wanted to become an orthopaedic surgeon and went to see Müller twice about the matter, first in Zumikon before he was elected, and a second time in St. Gallen. By the time he returned from the USA he had already published more than 12 scientific works. Müller however rejected his proposal to work half clinically and half scientifically. By chance, at the second interview Allgöwer was also present, was interested in him and proposed that he should come and visit Davos. After further preliminaries, he was elected as head of the Laboratory for Experimental Surgery. He took over in May 1963. His main areas of activity were calcium metabolism and the biochemistry of bone formation. By 1967 over 60 scientific articles had been published. In this year, he also became a scientific member of the AO. He lectured regularly at the AO Courses.

Fleisch obtained his postdoctorate in 1966 in Basel and in 1967 he became Director of the Institute for Pathophysiology in Bern, 1969 ordinary professor.

Professor emeritus 1997. He is still scientifically active today.

The **Spring Meeting** took place on May 3 and 4 in the new building of the hospital in Liestal hosted by Willenegger.

- the main scientific topics were fractures in children (Willenegger, summary by Müller)
- Information on animal experimentation on *"primary bone healing"* by Schenk, Willenegger and Riniker (Pathologist in the Tessin). Some of this fundamental research was as yet unpublished[8]. It is referred to in the book entitled "Technik" of 1963 pp. 13–15 and illustrated.

Appointments. On June 21 Müller accepted appointment as professor of orthopaedics in Bern. From then on, he was active in both St. Gallen (which he only left definitively in 1967) and Bern. Allgöwer became extraordinary professor.

In this year several members held **lectures outside Switzerland**, for example, at the Congress of the German Society for Surgery in April: Müller, Allgöwer and Willenegger delivered a lecture about the AO entitled *"Gemeinschaftserhebung der Arbeitsgemeinschaft für Osteosynthese" ["Common achievements and records of the Association for Osteosynthesis"]*[9]. It focused mainly on the documentation. Five closed series with a total of more than 850 osteosyntheses performed in Liestal and Chur were presented (tibial and malleolar fractures) whereby a complete record of late results came into being based on a labour intensive procedure. This objective had not been achieved by the general AO documentation.

From October 3 to 5 the *Annual Meeting of the Swiss Society for Trauma and Occupational Diseases* (SGUB) took place in St. Gallen, presided over by Cl. Verdan (Lausanne).

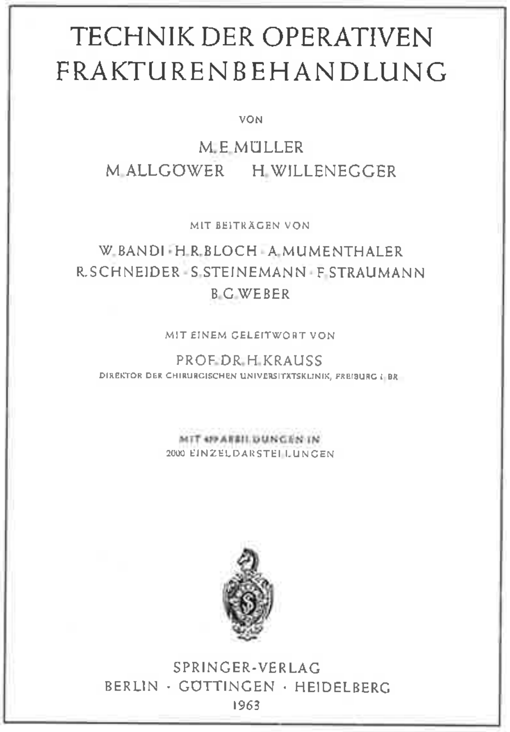
For the first time Eidophor technique (colour TV projected onto a large film screen) was used to transmit live operations and short lectures from the St. Gallen clinic into a large auditorium.

Lectures on various topics were held by: Vasey, Mumenthaler, Ledermann, Meuli, Boitzy, Keller, Schenk, Fleisch, Müller, Lehner. Some of them were published in 1964 in the Journal of Trauma and Occupational Disorders [Zeitschrift für Unfallmedizin und Berufskrankheiten (ZUB)][10].

In October **the first AO book** entitled *"Technik der operativen Frakturenbehandlung"* [*"Technique of operative fracture treatment"*] was published by Springer Berlin, Göttingen, Heidelberg[11] (**Fig. 5-6**).

The authors were Müller, Allgöwer and Willenegger. The book contained contributions from W. Bandi, H. R. Bloch, A. Mumenthaler, R. Schneider, S. Steinemann, F. Straumann, BG. Weber. This edition was soon out of print. We will come back to it later.

The title of the book could be perceived as an allusion to Böhler's world famous *"Technik der Knochenbruchbehandlung"* [Technique of fracture treatment][12].


TECHNIK DER OPERATIVEN
FRAKTURENBEHANDLUNG

VON

M. E. MÜLLER
M. ALLGÖWER H. WILLENEGGER

MIT BEITRÄGEN VON

W. BANDI · H. R. BLOCH · A. MUMENTHALER
R. SCHNEIDER · S. STEINEMANN · F. STRAUMANN
B. G. WEBER

MIT EINEM GELEITWORT VON

PROF. DR. H. KRAUSS
DIREKTOR DER CHIRURGISCHEN UNIVERSITÄTSKLINIK, FREIBURG I. BR.

MIT [illegible] ABBILDUNGEN IN
2000 EINZELDARSTELLUNGEN

SPRINGER-VERLAG
BERLIN · GÖTTINGEN · HEIDELBERG
1963

Fig. 5-6: Title page of the first AO book published in 1963

The **Contract between Synthes and the producers.** On November 21 the final contract between the equal partners Synthes, Straumann and Mathys was signed (Schn II/21).

The purpose was declared as: *"Collaboration in the manufacture and distribution of instruments and implants for bone surgery".*

Paragraph III/1 states: *"Synthes as the sole owner of all rights to the instrumentation and the principles of the Association for Osteosynthesis assigns to the producers the sole right to manufacture and distribute the aforementioned ..."*

Synthes determines the contents of the instruments and implants, has extensive rights of control, and safeguards new inventions (patents, protection of the registered trademark, etc). Instruments and implants carry its trademark.

The producers pay to Synthes a *"Research contribution of 15% of the sales price"* (which is determined by agreement), and a fixed annual "*Documentation contribution*".

These provisions seem to be primarily in favour of Synthes. Essentially, they only codify the status quo and specify many details.

The authority of the Technical Commission was extended. It became the central organ for coordination and further development. The decisions recorded in the minutes are final. Synthes (chairmanship) and the producers have the right to vote. The surgeons only have an advisory function. They commit themselves to collaboration with the TK, continue to work on "*scientific propaganda and instructive material*" and hold courses of instruction.

The paper was signed by: the AO surgeons Müller, Allgöwer, Schneider (Willenegger was unable to attend but signed later), also F. Straumann, R. Mathys, P. von Rechenberg (as the representative and chairman of Synthes).

This event had been preceded by a division of the world markets for the sale of instruments and for the sales forces of the two producers. This had taken place at a meeting held on "*neutral ground*", namely in the Bahnhofbuffet SBB (railwaystation café) in Olten. Mathys had proposed determining allocation by drawing lots. The staff at Straumann had written the relevant names on slips of paper – in accordance with economic potential at that time – continents, geographical regions or countries. Mathys, being the eldest, was the first to dip into the ominous bucket: he drew "Africa".

Then Straumann drew "Switzerland", and so it went on (MR). Africa, Asia, northern Germany, the Middle East, France, Austria, Italy, Yugoslavia, and Greece went to Mathys. Southern Germany, Great Britain, Spain, Scandinavia, Latin America and, at that time, North America (later independent) went to Straumann. The two producers soon established Synthes agencies abroad in their most important market areas.

The organization of the **sales outlet** in Biel had to be altered because of the forthcoming remarriage of Mrs Moraz-Müller. The stock went from Biel to Waldenburg, which had drawn the market in Switzerland.

In the autumn of 1963 two former employees from the producers, namely Vogt and Karpf – who had been part of the Technical Commission, also taking the minutes and who had extensive insider knowledge – set up a **rival company.** They began under the name of VOKA (later OSTEO) to manufacture and sell minimally altered instruments and implants in Selzach, a village adjacent to Bettlach, headquarters of Mathys. Since they had practically no research and development costs to cover, they could sell more cheaply.

The Autumn Meeting was held on November 28 in Zürich. It focused on the problem of infection. Dr. med. H. Good had been invited as lecturer; he had already worked for some time with Willenegger. Good was head of the department for thorax surgery in Basel from 1943–1948, then from 1949 chief surgeon of the clinic for thorax surgery Wehrawald in Todtmoos in the Black Forest and had succeeded in freeing this hospital from an extremely high infection rate by undertaking rigorous structural and organization measures. He subsequently became the AO expert in these questions. In 1973 he became a scientific member.

Allgöwer, Willenegger and Müller spoke on the subject of infection after osteosynthesis.

The second AO course of the year (the fourth overall) took place in December. For the first time it was held in English and French. The number of foreign participants was correspondingly greater: total 98, of these 51 from Switzerland (French-speakers from the whole of Switzerland), 28 from France, 10 from Britain and America, 3 from Italy, 2 from Belgium, and 1 each from Holland and India (Schn I/81) (**Fig. 5-7, 5-8**).

The guest of honour was the medical historian E. van der Elst from Brussels. On the evening before the course – when the Faculty was traditionally invited to Allgöwer's house in Davos-Wolfgang – he delivered an unforget-

Fig. 5-7: Müller demonstrating the AO instrumentation in the new graphic cases. 1963 course.

table laudatio to Lambotte whose life and work he had particularly studied (HU).

At the end of the year 1963 those chapters close which have dealt with the chronology of events and their narration. The founders themselves perceived this as a milestone by stating: "*5 years after foundation*" and with the "*publication of the first book by our Society ... the first phase of the AO came to a close*"[9].

Fig. 5-8: Practical exercises with a group of French surgeons at the course in December 1963.

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Chapter 6
The four pillars of the AO

The Association owes its stability to a concept built on four pillars and to cooperation based on trust.

The ideal building to represent these structures was the imitation of a classical temple in miniature as proposed by Heim and drawn many years ago by the graphics artist, Klaus Oberli (who illustrated the AO manuals) (**Fig. 6-1**).

Each pillar represents a particular area of activity: Instrumentation, Research, Documentation and Teaching.

A platform rests on the pillars and on the platform the letters "A" and "O" stand upright. They are held together by the broad band of Cooperation. Without this the "A" might easily tip forward or back and the "O" would inevitably roll away to the side.

Depending on how the figure is viewed, it always looks as if one pillar is at the front and the others in the background. In fact, every observer has his own preferred standpoint. He assesses the structures from his own point of view. But, this is deceptive. There is no hierarchy among the pillars. They are all closely linked to each other and they can only carry the platform together. Damage or neglect of one pillar would endanger the stability of the whole structure. If one pillar was taken away, it would all collapse.

We will also address the issue of whether the forerunners of the AO had similar structures and whether the pillars of the AO were raised independently or on top of the others.

Presentation of the pillars as independent structures does mean that the content of this chapter will sometimes unavoidably overlap with that of the surrounding chapters.

A separate section is dedicated to "Cooperation", the friendly collaboration and openness as set down in the Statutes, paragraph 12. Cooperation is a prerequisite for cohesion and strength in any group. Economic considerations also belong in this section since they determined the interaction with technicians and manufacturers.

In this analysis, we take in the whole period from 1958–1963. Although construction started in 1958, building did not advance in synchrony but varied for the individual pillars. The building was only fully erected after several years.

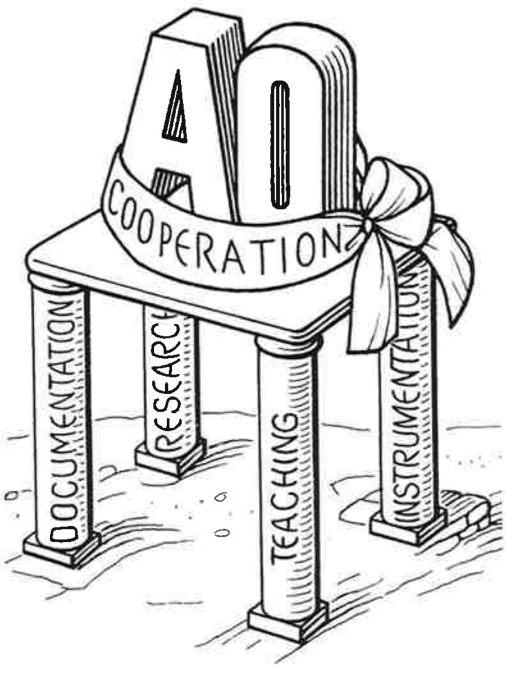


Fig. 6-1: The four pillars of the AO and the Cooperation. Drawing by Klaus Oberli.

The sequence of presentation is a matter of practicality; a chronological approach would not have been appropriate.

The Instrumentation, one pillar

The surgeon is an individualist. He wishes to work with instruments that sit well *"in the hand"*. He is never quite satisfied with what already exists. He has his own ideas and wants to implement them.

In museums the instruments of earlier surgeons are on display. They were unique handcrafted tools but were not used by their successors. The latter wanted their own up-to-date equipment.

Van Nes once said to young Müller in Leyden that a surgeon must have his own tools. Danis said the same to him in Brussels (MM). From 1951 Müller had instruments made for his own personal use at orthopaedic operations. He later introduced them to the AO.

Implants for bone surgery are something quite different. They are intended for certain indications and localizations and for application by many surgeons.

Exact descriptions, instructions and scientific papers are required to explain their construction and the associated techniques. These alone will not, however, prevent incorrect application and the inventor has no influence on what happens beyond his own four walls.

The important creations of Lambotte and Danis matched their own personal use or the application in their own clinics. This is probably one reason why they did not achieve wide distribution.

A totally new and revolutionary concept was devised for the instrumentation of the AO. From the very beginning, it was to be applied in standard technique by a group of independent surgeons. With this broad base, a larger number of products could be tested for their applicability and reliability quickly and at a variety of locations and later analysed centrally by all. This provided ideal feedback. Corrections and modifications were possible before commercialization loomed large on the horizon. Thus, one essential reason for the failure of earlier instruments had been excluded.

To achieve an overall reform of operative fracture treatment, the instrumentation had to be complete. This had not been accomplished before.

At the meeting in Chur on March 15–17, 1958, the participants had convinced themselves by practical testing of existing implants that there was a need to construct new instrumentation. It was to have the following properties: simple handling, compatible components, and be constructed from *"one and the same"* metal (Schn II/14).

The sequence in which the instruments and implants appeared has been listed by Müller in Schneider's second book (Schn II/257f). We add just some practical details:

- From 1951 to 1957 Müller had developed: the external threaded tensioning device, various bone retractors, periosteal elevators, chisels, and the triangular drill bit. The commercially available ARO compressed air drill was acquired and modified.
- In 1958 the cortex and cancellous bone screws were developed, and the plates for radius, humerus, and femur along with the plate tensioning device.
- In 1959 the AO intramedullary nail arrived together with the flexible reaming shaft and the angled blade plate with U-profile.
- In 1960 the first inserters and extractors for i.m. nailing were created.
- In 1961 the plates were cambered and the screw holes at the ends enlarged.
- The first contoured plates were created as proposed by Bandi.
- In 1962 the semi-tubular plate arrived and the small cancellous bone screws were modified.
- In 1963 a conical thread was machined into the upper end of the nail to accommodate the new insertion and extraction instruments.

- An AO *"small"* drill was made.
- Instruments and implants were stored in aluminium cases moulded to accept the instruments and suitable for sterilization in the autoclave.

The screws and their instruments

Initially Lambotte only inserted self-drilling and self-tapping screws with a lanceolated tip, but abandoned them sometime before 1913 in favour of a self-tapping screw which required pre-drilling of a hole the size of the core diameter using a manually operated device (**Fig. 6-2**)[1]. He preferred to use screws as isolated implants in cancellous bone and hardly ever inserted them into cortical bone.

The Danis cortex screw was almost identical to that of the AO screw with regard to dimension and pitch, but it did not have hollow grinding. Therefore, the bone/metal ratio was 6/1 (**Fig. 6-3**).

The Danis screwhead was dome-shaped with a cruciform recess, the undersurface was flat (**Fig. 6-4**). The drill bit was shaped so that it could not slip. Both cortices were drilled with a high-revolution electric drill. Finally, the near cortex was enlarged by hand using a graduated reamer to create a gliding hole (**Fig. 6-5**). Danis was the first to tap in cortical bone, but his

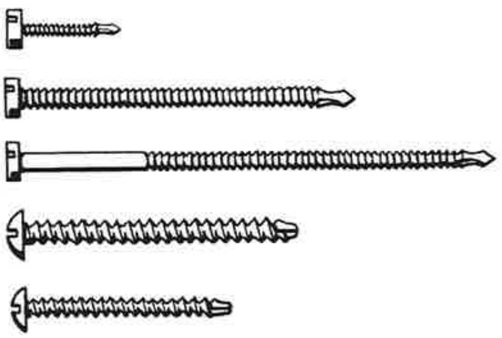


Fig. 6-2: Lambotte screws: top: self-cutting (based on the drawing from 1907), bottom: the self-tapping screws which required predrilling (1913). Outer diameter 2–4 mm.

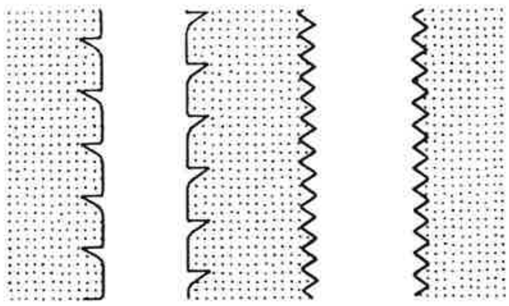


Fig. 6-3: Left: thread design of the Danis cortex screw. Right: for comparison, the thread for metal screws (from 1949 p. 76).

depth gauge had to be screwed into the tapped thread.

In 1932 Danis also constructed[2] the first screw for cancellous bone *"vis hélicoidale"*. It was self-tapping. By 1949 it had been simplified[3] and could accommodate a washer (**Fig. 6-3**). Its thread was coarse, the shaft was slim.

The **AO cortex screw** was *"the brilliant nucleus of the instrumentation"* (Schn II/14). The hexagonal recess was a completely new concept (3.5 mm) and together with the round head of the screw provided a better bite for the screwdriver ensuring good control of implant insertion. At the same time, the conical undersurface fitted exactly into the countersunk space for the screwhead, or centrally into the plate hole. The first screws were made with the *"sawtooth thread"* (ratio bone/metal approx. 1/1, **Fig. 6-6**). Cutting the screw thread was still tough going and screw anchorage unsatisfactory (LM, HU). The drawing from October 6,1958 – to which Schneider refers – already shows a thread with hollow grinding, for which the compressed flank of the thread is almost perpendicular to the screw axis and the ratio of bone/metal is 4/1 (Te 45). **Fig. 6-7** provides an overview of the AO screws. One of these is a self-tapping screw with a short thread and a wide shaft (nowadays called the *"shaft screws"*) which was not further developed but was nevertheless mentioned in "Technik" in 1963 (Te 45) (**Fig. 6-7b**). An aim-

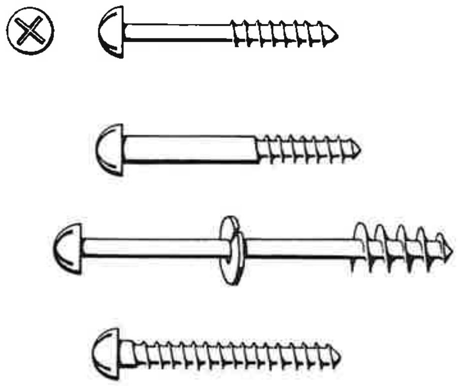


Fig. 6-4: Danis screws (redrawn from 1949 p. 77): top: cortex screw with slim shaft (pre-drilling 3.0 mm). Beneath it, a cortex shaft screw (after drilling of 3.0 mm. sliding hole created manually). Cancellous bone screw ("Vis hélicoidale") with slim shaft and washer. Finally, the plate screw with full thread. Outer diameter 4.5 mm, inner diameter 3.0 mm, pitch 1.8 mm. The short nails (V-profile) were not drawn, nor were the threaded bolts.

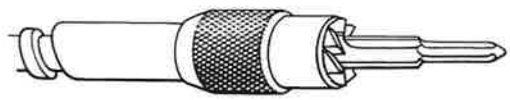


Fig. 6-5: Double reamer (handle) by Danis to create the sliding hole and possible space for the screw-head for oblique screw insertion (from 1949 p. 78).

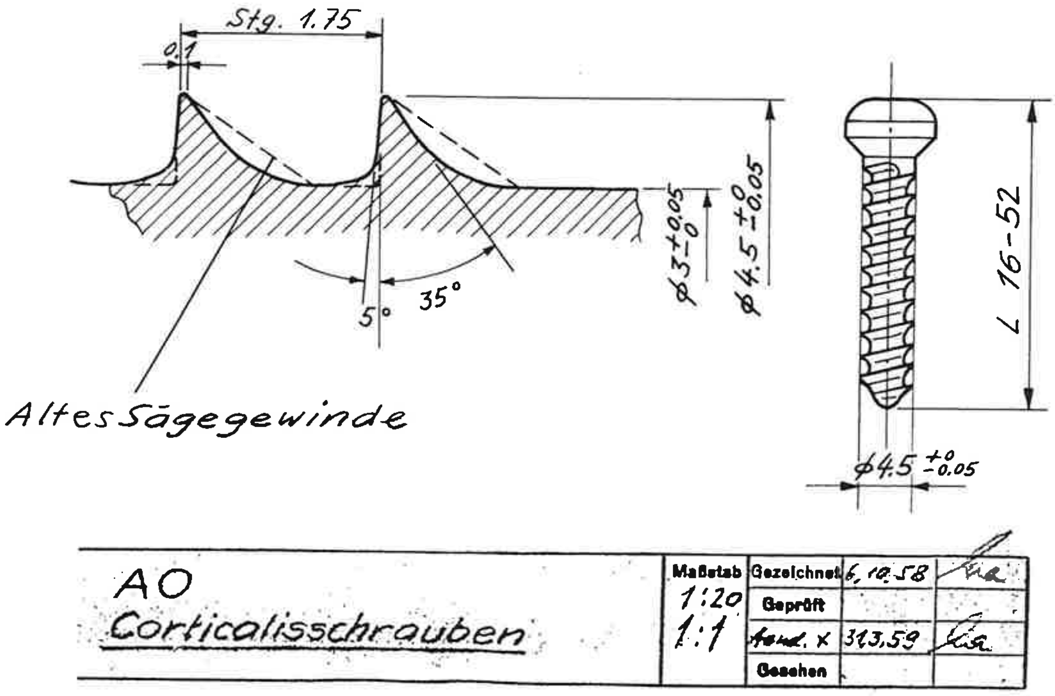


Fig. 6-6: The AO cortex screw. Construction drawing by Mathys, dated October 6, 1958. The dotted lines were for the "sawtooth thread" produced in the first series and then abandoned. Solid lines: the final thread design with a bone-metal ratio of 4:1. Drawings courtesy of Mathys Inc.

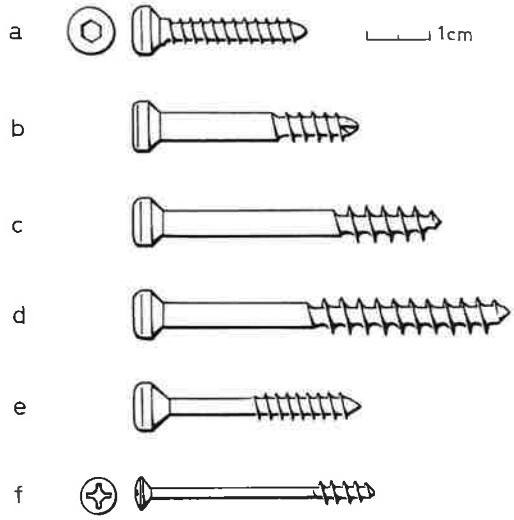


Fig. 6-7: Overview of the AO screws in AO 1959: (a) Cortex screw. Head with hexagonal recess. Outer diameter of 4.5 mm, inner diameter of 3.0 mm. (b) The self-cutting shaft screw – only produced for a short period. (We thank Mathys Inc. for supplying an example of one.) (c) Cancellous bone screw with short and (d) long thread (outer diameter of the thread 6.5 mm and of the shaft 4.5 mm) (e) The "malleolar screw" with hexagonal recess and sharp tip. Outer diameter of thread: 4.5 mm. (f) The "small cancellous bone screw": Philips recess, thread outer diameter 3.5 mm, shaft 2.0 mm.

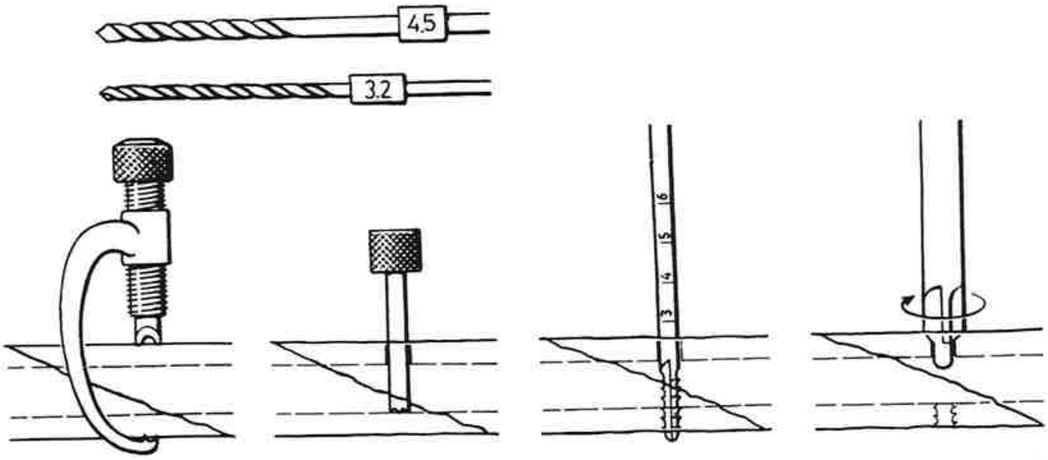


Fig. 6-8: Instruments for screw fixation: drill sleeve for sliding hole and 4.5 mm drill bit with stop. Insert drill sleeve. 3.2 mm drill bit with stop. The drill bit is a little wider than the core diameter of the cortex screw in order to reduce friction and improve compression. Graduated tap, countersink.

ing device was screwed firmly in place and guided the first wide drill bit with stop. The insert drill sleeve fitted exactly into the pre-drilled gliding hole and guided the second, slimmer drill bit used to create the threaded hole. The tap, graduated for the purpose of screw length measurement, and the countersink completed the instrumentation (**Fig. 6-8**). The compressed air power drill worked on a sliding scale and could be set to revolve slowly.

The AO **cancellous screw** (**Fig. 6-7c, d**) had two different thread lengths. The unthreaded part of the shaft was wide and could withstand high torsional loads.
From the start, the AO had developed two smaller screws:

The **malleolar screw** (with hexagonal recess) (**Fig. 6-7e**) – intended for insertion into cancellous bone – was self-drilling with sharp tip, short thread and an unthreaded, slim neck. It was similar to some screws by Lambotte and those of Baumann.

The **small cancellous screws** (**Fig. 6-7f**) had a flatter head with a conical hexagonal recess like the Philips and a short thread. They were used predominantly by Willenegger for navicular fractures of the hand and were soon adopted by the clinic in St. Gallen for a great variety of anatomical sites.

Plates

After 1907 Lambotte utilized two types of concave steel plates (**Fig. 6-9**): the one – narrowing at the ends – was for the diaphysis of femur and tibia, the other for the metaphysis. The end part was spoon-shaped and equipped with numerous holes. Only short screws were inserted to fix the plate in hard bone[4]. The Lambotte plates were bio-logical, but not very precise. Neither model was continued.

In 1938 Danis constructed the straight plate, called the *"coapteur"* and illustrated in his book of 1949[5] (**Fig. 6-10a**). The screws always engaged in both cortices. Drilling was performed through a drill sleeve with a spherical front (uncertain verticality). The complicated compression mechanism had a limited range of displacement (**Fig. 6-10b**).

The AO **straight plates** (**Fig. 6-11**) were originally named after their intended region of application "for radius" (later called the "narrow plate"): "for humerus" or "for femur" (later known as the "broad plate"):

- The screw holes in the plate were conical and countersunk. The undersurface of the screw head fitted exactly into these holes, providing drilling was central and perpendicular.
- Drilling was performed using a drill without stop, guided through a thick drill sleeve with wide contact zone sitting exactly in the hole.
- The plate tensioning device was attached next to the plate in a separate drill hole in the bone and fixed into a notch in the last plate hole. Due to its wide span it could also be

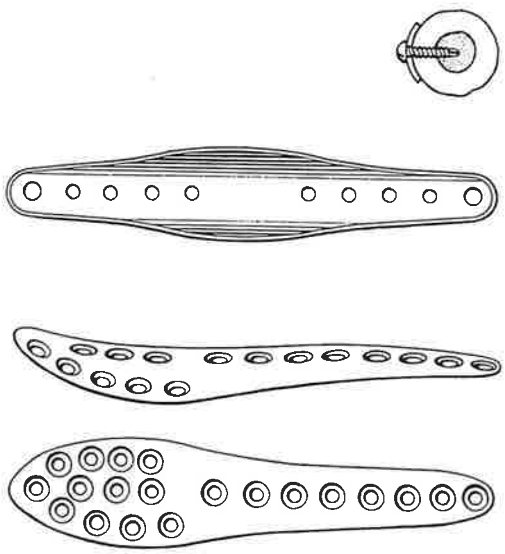


Fig. 6-9: The steel plates of Lambotte. Top: Plate for the diaphysis, concave in the centre, narrowing at the ends. On the right: cross section of a monocortically fixed plate. Centre and bottom: the plate for the metaphysis. Drawings from 1913 p. 61.

Fig. 6-10: (a) The Danis coapteur: the shorter, narrower plate is 7 mm wide and 3 mm thick, the longer one is 10 mm wide and 8 mm thick. (b) Detail: Compression system by means of a small axial screw which exerted a compression force on the plate screw in the oval hole at the end of the plate thus displacing the plate. Maximum distance: 5 mm.

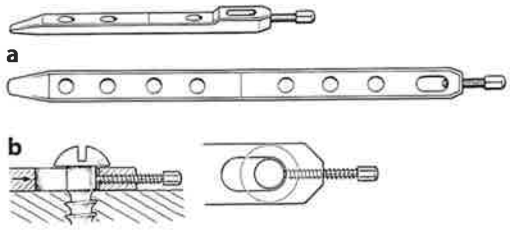
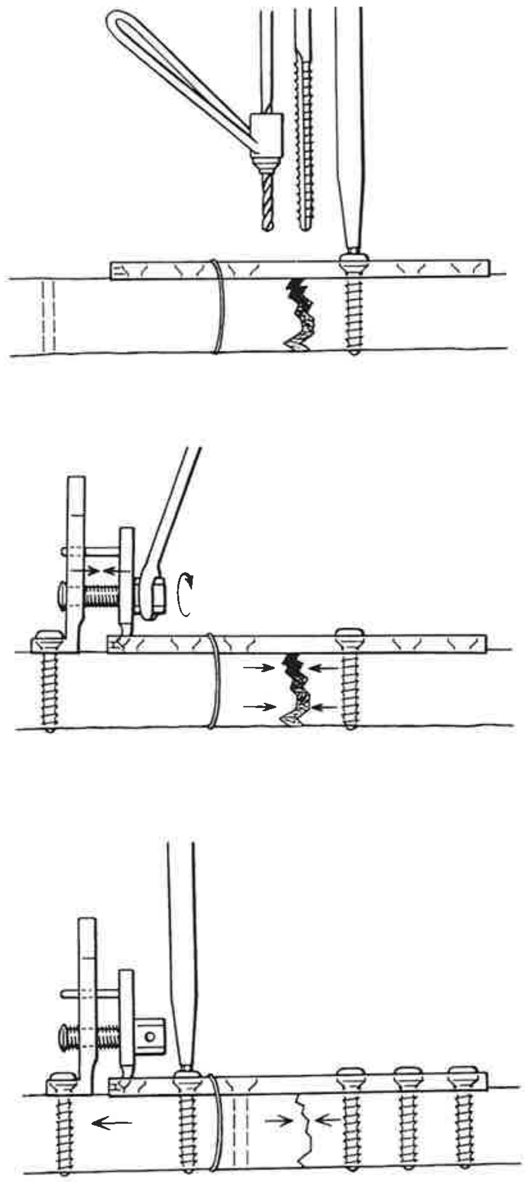


Fig. 6-11: The AO straight compression plate with instruments. Top: 3.2 mm drill bit introduced in the plate drill sleeve, tap, screw driver. Centre: plate tensioning device anchored to the plate. Bottom: Compressed fracture. Not in the drawing: removed tensioning device, final screws. The narrow plate is 3,5 mm thick and 11 mm wide. The broad plate is 7 mm thick and 16 mm wide.



used for fine reduction. After successful compression, it was removed and the end screws inserted into the plate.

The **contoured plates**: in 1961 a thin T-shaped plate was produced for the metaphysis (**Fig. 6-12**). Its wide end was designed to accept cancellous bone screws. The central shaft hole was wide. Before tightening the screws, compression could be achieved by shifting the plate (Te 259). The T-plate was followed by other similarly designed implants for the metaphysis.

The **semi-tubular plates** (**Fig. 6-13**) were cut from tubes which were intended for the manufacture of i.m. nails but which had been delivered with an irregular inner surface. The implant was thin and flexible and had oval

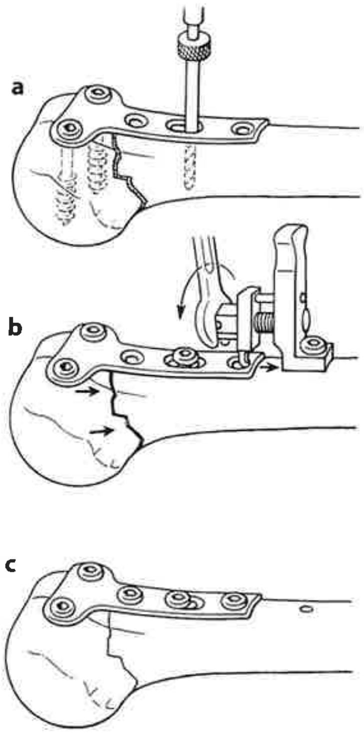


Fig. 6-12: The T-plate from 1961 modified from Te 259: slim implant, cancellous bone screw near the head. In the central, oval hole, a screw is inserted eccentrically but not tightened (a). The plate tensioning device displaces the plate and compresses the pseudarthrosis (b). After tightening the central screw in its new position, removal of the tensioning device and application of the most distal screw (c).

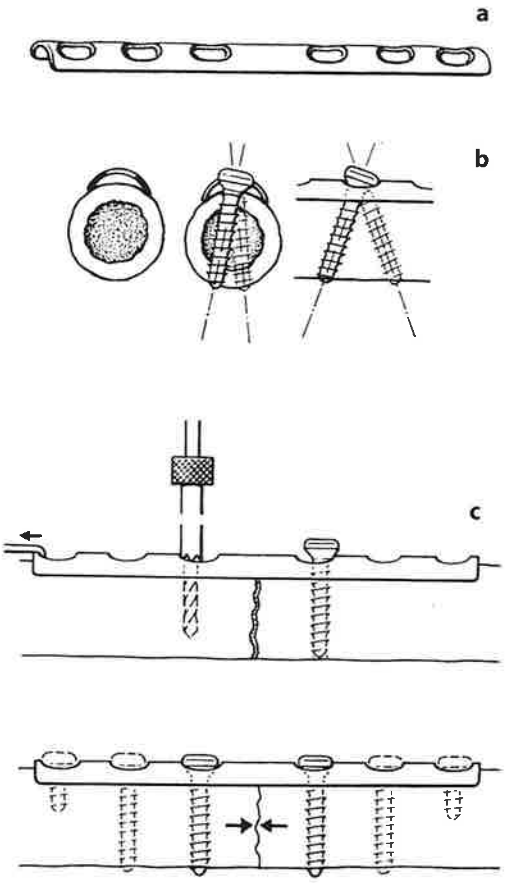


Fig. 6-13: The semi-tubular plate of 1962, initially called the *"tin plate"*. It is thin and easily bent with wide, oval holes (a). It rests on its edge on the bone and acts as a splint. The screws have a range of freedom (b). If the screw is inserted eccentrically into the plate, tightening the screw will effect a certain amount of interfragmentary compression (c).

holes which permitted tilting of the screw. Later, it was noticed that by drilling at the edge of the plate hole a compression effect could be achieved when tightening the screw (Figure Manual 1969 p. 38). Originally intended for the *"anterior tibial ridge"* (Te 53), this implant was soon applied at a wide range of anatomical sites.

The intramedullary nail

In the case of this implant, it was not a matter of creating a new principle or new equipment, but just a matter of modification. The disadvantages of previous nails were: the stiffness of the tubes (Küntscher and Herzog), the elongated linear construction (Küntscher) and the sharp tips.

The AO nail was manufactured from a thin tube which was slit dorsally (and left closed proximally). It had thin walls and was flexible; the cross section was heart-shaped (Te 58). For the femur, the nail was slightly bent to match the physiological curvature of the bone. For the tibia, the Herzog curvature proximally and the two distal lateral slits (for insertion of the so-called antirotational wires) was retained. The nail narrowed at the distal end (**Fig. 6-14**). It was chemically and electrically polished inside and out (corrosion had occurred with earlier models).

Reaming was performed over a guide wire with the new flexible shaft designed by Mathys (illustrated in "Technik" 1963 (Te 60)). It was mounted using the angular drive with the compressed air drill and replaced the manual reamer and the Pohl's rigid *"Lentodrill"* to advantage.

For insertion and removal a device was constructed in 1960 with an expandable tip which could be placed on the nail head and locked (Schn II716) (**Fig. 6-15a**). This was replaced after 1962 by the threaded conical screw (**Fig. 6-15b**).

The angled blade plates

Previously, only single component steep angle blade plates had existed for orthopaedic surgery of the pelvis (Moore, Blount, Bosworth). For pertrochanteric femoral fractures, dual component implants were commercially available (McLoughlin type implants). Metallurgical

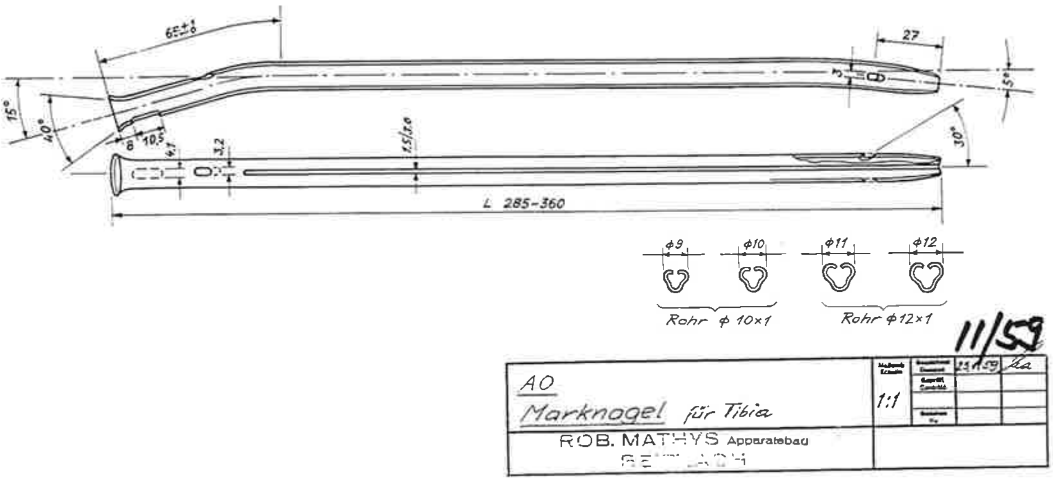


Fig. 6-14: AO tibial nail. Construction drawing by Mathys dated November 25, 1959. The nail is produced from one tube, slit dorsally, thin and elastic. It narrows at the tip and the lateral slits permit insertion of antirotational wires. The tube is closed proximally and retains the Herzog curvature. The cross section looks like a cloverleaf. Our thanks go to Mathys Inc. for the drawings.

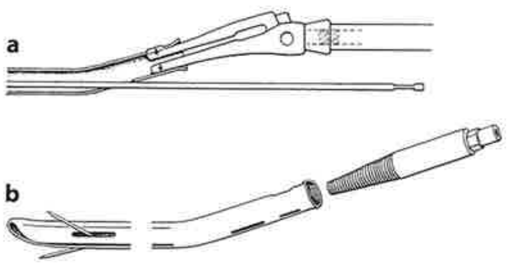


Fig. 6-15: AO insertion and extraction systems for the intramedullary nail. (a) The system in 1960 with locking clamps that would expand and lock in the head of the nail. (b) The system in 1962/63: conical threaded screw which could be screwed into the thread in the head of the nail.

problems had been observed with these implants and the connecting screws were not strong enough.

The angled blade plates designed by Müller were an important innovation in orthopaedic surgery and traumatology. The blades only displaced a small amount of bone tissue and were rotationally stable. The shaft was similar in shape and dimension to the broad plates. The angles were originally 130° or 95°. An important aid was the seating chisel, a precursor of the plate blade and also a reduction aid. There were other instruments available for use as aiming devices and to guide the plate.

Initially, angled blade plates (sometimes straight plates as well) with a sliding inset in the shaft were manufactured to permit a certain amount of impaction. This design (**Fig. 6-16c**) is illustrated in the 1961 Guidelines, but only described in the book by Schneider (Schn II/15). There are several examples in the documentation.

The external tensioning device

Müller had his threaded rods constructed very early on (also useful for distraction) (**Fig. 6-17**). They were applied in interventions for osteotomy, arthrodesis, and pseudarthrosis. He writes (Te 72) *"They combined the advantages of Charnley's and Hoffmann's methods"*. In the latter case, he is referring to the external fixator which was being applied in many hospitals in traumatology[6].

The basic instrumentation of the AO was still in clinical testing at the beginning of 1960. There were constant complaints and suggestions for improvements. Schneider (Schn II/27) quoted, for example, excerpts from a letter from

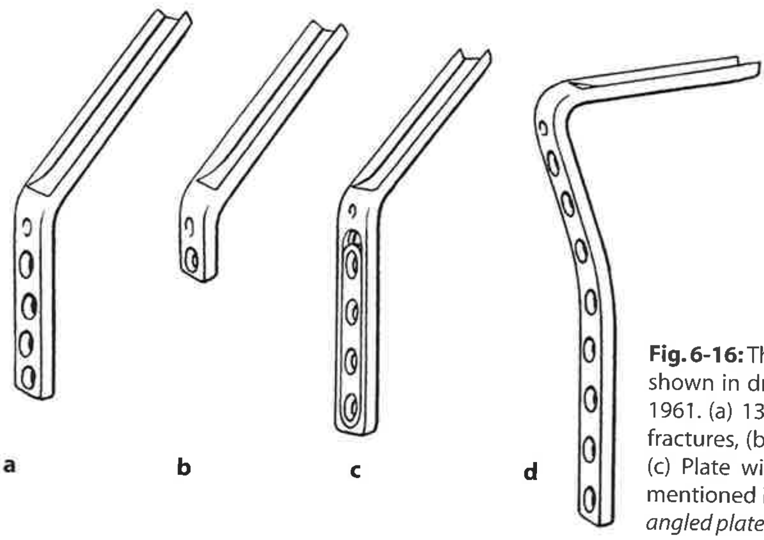


Fig. 6-16: The AO angled blade plates as shown in drawings in the Guidelines of 1961. (a) 130° plate for pertrochanteric fractures, (b) for femoral neck fractures (c) Plate with gliding inset (no longer mentioned in "Technik" 1963). (d) *"right-angled plate"* for the distal femur.

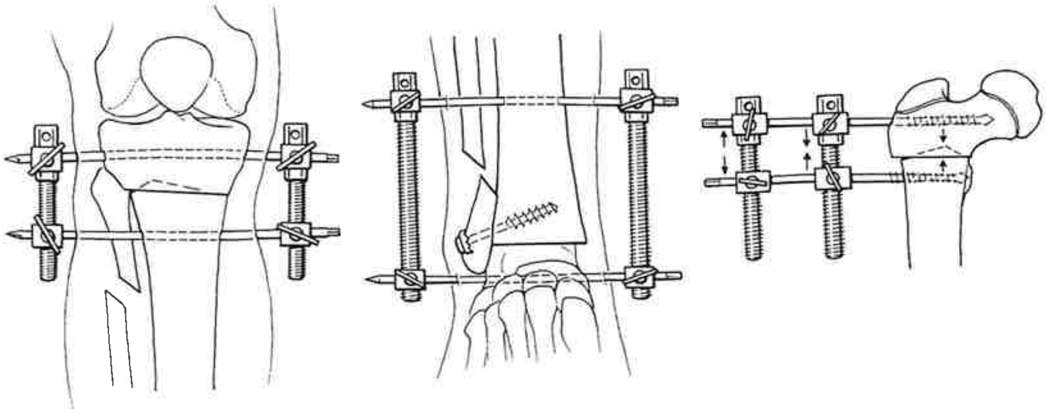


Fig. 6-17: Threaded rods for the external locking sleeve, developed by Müller 1952–1957. Compression by assembling Steinmann nails as a frame construction (left) or with Schanz screws as a clamp system for children (distraction by the outer rods).

Müller to Mathys of February 22, 1960 in which various problems were addressed (e.g. screws and taps) and in which modifications were proposed.

The AO instrumentation was a much heeded innovation. By 1960 Müller had already demonstrated it in one place or another.

Even before the first public appearance of the AO, the news had got out. It was a topic of conversation among experts and seemed to meet undeclared needs. The opportunity to obtain the instrumentation, not yet for sale, was an important one and for some clinic managers the primary motive for participation at the first AO course in Davos (HU). A certain degree of covetousness and pressure to make it generally available was felt. This has already been reported.

Documentation, an other pillar

Documentation is closely related to instrumentation since it was also a very early idea and the two developed in parallel.

The result of a treatment can only be evaluated by *follow-up* which is a commandment of medical ethics. It leads to critical assessment of the success of treatment.

The result will either confirm the actions of the surgeon or force him to act differently.

An uninformed patient may not always understand the purpose of the follow-up assessment. He may think: *"Nice of him to think of me, but go there specially?"* or *"Was I just a guinea-pig?"* or *"I'm alright, what should I go there for?"* or *"He made a right pig's ear of it. I'm not going to him again"*. General practitioners are often of the opinion that their aftercare is more than adequate. They may regard the concerns of the surgeon as interference. For these reasons, it is almost impossible to obtain all late results for any patient sample. Incomplete statistics are the rule.

Documentation is the next step in follow-up. It increases the scientific credibility of a treatment method and is well suited to promoting confidence in it. The objective is to record a fact or a condition as proof, to store it and to make it visible and accessible to others. Today this is called *"transparency"*. Thus, methods, techniques, and results can be compared and made available for teaching and research purposes.

The assessment of fracture healing requires a great deal more time than other pathologies. An even longer period of time is required for the functional adaptation of the patient after an orthopaedic operation. Some complications (e.g. necrosis of the femur or humeral head) may only become manifest very late. This explains why orthopaedic surgeons attach great value to long-term documentation. The radiograph is the ideal basis for documentation. Although it is a good indicator, it is not sufficient. A record of functional outcome is more important.

Lambotte, Danis and Böhler followed up their patients

Lambotte, working on his own, had a complete overview of his patient sample. In his second book published in 1913 he presents more than 1'000 figures in his report of the results of treatment of over 500 patients. The available documents include drawings (1907) and reproductions of radiographs (1913), the majority of which only record fracture and operative technique. The late results were only partially documented, but the course of healing is generally given in the legends. In many cases, photographs showing functional outcome are available. Lambotte's record of late results may be described as practically complete.

Danis as the chief surgeon of a university clinic had to admit that only those patients could be assessed who accepted the invitation to attend a follow-up examination[7]. Exact figures are given for malleolar fractures[8]. After 132 operations, late results were obtained for 79 fractures. The record was the radiograph.

Only Böhler's clinic was able to record the course of healing up until the conclusion of treatment continuously and completely for its gigantic patient sample. This is owed mainly to the fact that all patients were insured, i.e. completely dependent on the institution, and to the paramilitary organization and discipline of the clinic.

Each patient in Böhler's clinic had a file sorted according to diagnosis stored in the "Journal books". These contained all details of the accident, the treatment and a drawing of the fracture. To cope with a greater volume of statistics, these data were transferred onto *"Hollerith punch cards"* (introduced at the end of the 19th century in the USA, a forerunner of IBM) which could be sorted mechanically (LM).

AO Documentation

In 1951–1952 Müller recorded his osteosyntheses in Fribourg with clinical controls and radiographs. He had slides made for his lectures. For the reproductions in his doctoral thesis in 1957 he photographed the radiographs with a Leica camera. In the following year, he had the idea of recording his operations using miniature copies of negatives (1:1).

In Davos the radiographs of the accident and the osteosynthesis were photographed with the Leica camera and **miniature copies** of these stuck onto the back of cards which had the patient's personal details and data on the front. After 4 and 12 months the miniature pictures of the follow-up assessments were added. Thus, for a completely documented fracture there were 8 pictures on the card after one year (**Fig. 6-18**). If complications occurred, additional cards were required for the record.

By standardized **notches** around the borders of the cards, details of the accident, the findings, and the operation could be marked. Certain features could be *"extracted"* from a series of cards by sticking a needle through them. This method was time-consuming and not entirely reliable. The members did not work much with this system.

In Davos **two documentation cards** were produced each time. One was returned to the surgeon (with the original radiographs), the other remained, as for the negatives, in the central archive. The surgeon thus retained an overview of his own results and could also access the techniques and results of other members of the group from the central archive for purposes of checking and/or evaluation. Slides could be made from the negatives (most of which are still available today).

The quality of the radiographs varied. It was

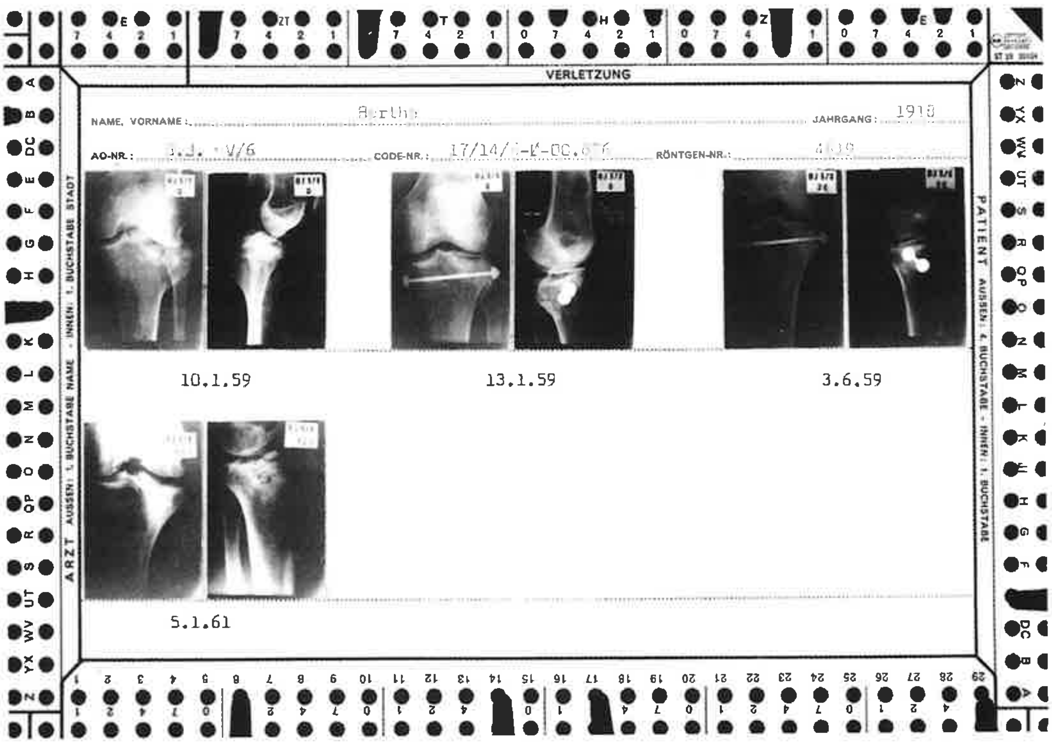


Fig. 6-18: The back of a punch card from AO Documentation with miniature copies of radiographs stuck on. Photograph of the original index card for the patient in **Fig. 8-28**. The corresponding code sheets have been reproduced in appendix p. 223–225

greatly improved by the introduction in 1963 of the so-called Log-Etronic-Machine. This system had been used by the allies in the second World War to optimize aerial views of the German Atlantic Wall. The new device partly automated the process but, above all, it enhanced the contrast of the pictures. From then on AO slides and reproductions of radiographs were of the highest quality (first shown in "Technik" in 1963).

To create uniform records of clinical findings a **standard data carrier** also had to be developed which corresponded in content to a summary of the case history. In this way, it was possible to make comparisons and later to evaluate large numbers.

For this purpose the so-called *"Code sheets"* were introduced: the surgeon could enter the data into the appropriate spaces on a printed form. These were then continuously evaluated at the documentation centre. Three code sheets were drawn up: the first for the fracture and primary treatment. A second was to record the patient's condition at four months. After this time fracture healing is either assured or complications requiring treatment have occurred. The third sheet was to be filled out after one year. By this time, the definitive functional and radiographic result is known, the implants have usually been removed and social reintegration has been achieved.

A few code sheets from 1959 still exist. An example for the patient shown in **Fig. 8-28** has been reproduced in the appendix p. 223ff.

This was the technical side of the very time-consuming AO documentation system. In 1963 experts were employed for the computerized evaluation of the standard questions on the code sheets.

The essentially new aspect of AO Documentation was that it was a collection of material from a whole group of independent surgeons. The files of each member were open to all the other members. Criticism and central evaluation led to optimization of indications and techniques. In this way, large numbers of cases were soon available for statistical evaluation, for lectures and for publications. The producers were also interested in it.

The **contribution of all members** to documentation was obligatory – as stated in paragraph 12 of the Statutes. Only Patry and Baumann as senior members were exempted. Participation was based on a very strong feeling of community and trust that had grown up over the years. It required experience, hard work, and personal commitment. It was financed by the members themselves; they paid 18 CHF to Davos for each documented case (Schn II/51).

Each member had to organize himself so that he could perform correct documentation which involved a preparatory period. To the merit of the system, a large number of cases with complications were extensively recorded. Schneider writes (Schn II/15) *"The urge of the AO to document was so great that on August 1, 1959* (two months after the Laboratory had opened) – *Frei (chief lab technician) announced in a letter that so many radiographs had been received that, as a result, only a limited production of slides was now possible".*

At the end of the first year of operation (June 1960) about 1000 osteosyntheses had been recorded. By 1964 about 5000 more had been added. Examples can be found in Chapter 8.

AO documentation was certainly never without omissions, but these can only be assumed. It is highly probable that all patients operated at that time in Chur, Zürich-Waid, Liestal, Grenchen, Grosshöchstetten and Interlaken were recorded and from November 1960 all those in St. Gallen as well where the osteosyntheses were given consecutive numbers – as seen from the examples in Chapter 8.

Records of the further course of healing based on the **follow-ups** at 4 and 12 months remained **patchy**. For patients living a long way from the hospital, the late assessment was associated with an enormous investment of time and effort. A further hindrance was that the doctor responsible for aftercare was unknown to the surgeon and was either unfamiliar with operative fracture treatment or opposed to it. The majority of patients coming from abroad were put back in plaster once they got home. It was not unknown for the metal simply to be taken out (HU). These experiences prompted Allgöwer to write his information booklet for fracture patients in the autumn of 1961.

To obtain **statistics** which included all the late results of a complete series, it was necessary to take into account the patient samples from all the various clinics. At the Congress of the German Society for Surgery in 1963[9] Müller, Allgöwer and Willenegger presented five such series with data from over 850 fracture patients (lower limb and malleolar fractures), complete with follow-up. The 188 tibial osteosyntheses shown in "Technik" (Te 125–165 and 328–336) were part of this sample.

Follow-up in the documentation was regarded by the promoters themselves[9] as the weakest link in the teamwork of the AO. Therefore, it was planned that from 1963 general documentation would be taken to its conclusion only for certain fracture sites.

Of eminent importance for the AO was the **record of complications** and failures from which a great deal was learnt. Schneider cites (Schn II/26) the letter from Müller of January 26, 1960 in which he says to the members: "*... you should therefore classify all such cases so that the total number, including all failures, is available at the next AO meeting.*"

In June 1962 Müller, still in St. Gallen, took over direct management of the documentation centre and transferred it in 1967 to Bern.

Beyond the AO the importance of documentation for clinical practice and teaching was not always understood. Latterly, interest has also been dwindling within the organization.

There is an important relationship between documentation and the classification of fractures. This only became fully apparent later on with Müller's "AO Classification of Fractures"[10]

Teaching, an other pillar

The content of this section can be defined as: establishing and transmitting a common treatment concept subject to constant improvement on all levels of communication.

From 1952 **person to person training** was typical for the slowly expanding group of surgeons. The situation was one of mutual teaching and learning, i.e. no conventional teacher-student or master-subordinate relationship. Although Müller introduced most of the ideas and the instrumentation and was foremost in operative technique for the locomotor system an attitude of equality with his experienced and more senior friends was always maintained. Teaching was never a monologue, but always reciprocal give and take. If Müller states that he *"learnt a lot"* from Schneider, it is not a matter of politeness. The work of the guest surgeon Müller with the AO members to be, through which he gained insight into their everyday problems, re-awakened his interest in traumatology, as he says himself. He was, so to speak, called away from pure orthopaedics by these friends.

Opinions were influenced before 1958 by convincing demonstrations in clinical practice and not by authoritarian behaviour, also by gaining practical experience and keeping each other informed. Only this open communication and discussions in small groups can explain the later cohesion under the difficult circumstances of the early years. The typically Bernese steadfastness must have been behind it. When in 1959 operative interventions could commence in the clinics with the specially developed instrumentation, a uniformity of thought and action was already present amongst the members.

In the following years, the Guidelines became fundamental to the standardization of methods and technology. This will be referred to again in Chapter 7.

Lectures

At first lectures were only held for *small groups*:

- Very early on Müller had already spoken repeatedly in various places about the treatment principles of Danis and his experience. This topic was occasionally presented by other members speaking to small groups.
- At the AO meetings, introductory lectures were held on the main current topics. On the basis of the subsequent discussions, the Guidelines were revised. For these lectures to small groups the principle of *"docendo discimus"* was valid: the lecturer educates himself in content and form. At the AO meeting in Interlaken in March 1960 the lectures were held as a dress rehearsal for the main presentation at the upcoming surgeon's congress in Geneva and were *"exposed to the criticisms of the plenum"* (Schn II/27). Prominent guests from foreign countries were in attendance.
- The lectures at the AO meetings and courses also served to support the next generation: younger coworkers who had concentrated especially on topics of interest had to present them. They were however not left to their own devices but didactics, form and content were checked and criticized in advance. With Allgöwer a dress rehearsal of a different kind (called the *"test gallop"*) was held to make sure the lecturer kept to time (HU). Willenegger indoctrinated the younger lecturers down to the last detail. Later – when travelling to courses on distant continents he cor-

rected the logical coherence of the lecture, the choice and sequence of the slides, etc., during the flight.

Public lectures – based on experience with the instrumentation were given by the AO from 1960:

- at the trauma convention of the Berufsgenossenschaften in Freiburg i.Br. in March
- at the congress of the Swiss Society for Surgery in May 1960 in Geneva and at the extraordinary meeting on November 24 in Bern. In addition to the many objections evoked by these lectures, they also awakened a general interest in the presentation topics.
- in 1962 a select group of AO lecturers spoke at the Mid-Rhine Surgeon's Congress in Schaffhausen and Müller and Bloch also lectured in the same year at the Congress of the Swiss Society of Surgery.
- after 1963 the AO members often held lectures at such events; the doors had been opened.
- The content of the lectures was often presented to a wider circle by means of subsequent publications, e.g. the summary of information in the *"Gemeinschaftserhebung"* [Common achievements and records][9].

The experience and confidence of the coworkers meant that at public appearances the lecture topics were not the sole domain of one person. For example, on November 24, 1960 in Bern Bandi lectured at short notice on screw fixation of the tibia instead of Allgöwer who had fallen ill. In 1962 Schenk unexpectedly had to deliver Willenegger's lecture at the German Surgeon's Congress in Munich (Schn II/49). Later on, for example at the courses, the request for a lecture was often received at very short notice (HU). The basic principles were general knowledge; each member had his own experience to report and additional material was obtainable from the documentation centre.

The AO Courses

Schneider writes in 1969 in summary that *"....osteosynthesis is a difficult operation requiring special training. We initiated the courses in recognition of this fact ... and in order to ease responsibility for the widespread use of the instrumentation ... since many incidences of poor performance, bone necrosis, material failures, and even infections can be explained by incorrect indication and technique."* (Schn II/24f).

The courses served the purpose of improving theoretical knowledge and practical handling of the instrumentation.

Such courses to introduce a new concept of fracture treatment and for practical training with the instrumentation were something completely new. How attractive they were is apparent from the list of participants at the first course (Appendix p. 237/238). The courses set new standards for education in trauma surgery in general and for the introduction of new techniques.

The **course structure** was developed by Müller. It consisted of alternating lectures on basic principles and techniques with subsequent discussions. The introduction to the instrumentation was followed by exercises to practise its application.

The titles and content of the **course lectures** corresponded more or less to those given at the meetings. Innovations in the instrumentation and theoretical lectures on metallurgy and animal experimentation were continuously integrated.

The **practical exercises** on cadaveric bones were a new idea. The participants were able to gain basic experience with the instrumentation before operating on patients. This was important in preventing technical errors. Here some more detail:

Procuring cadaveric bones was very difficult and expensive. It was the business of a few insiders – sometimes by way of illegal shortcuts (e.g.

the pathology attendants). It was best not to ask. Transportation of the bones to Davos was also a confidential matter. Once a colleague from St. Gallen travelling in his Volkswagen with his bag of bones collided with a delivery van. Our man "failed to stop" (DA), but left us an entertaining caricature of his mishap (**Fig. 6-19**).

Fig. 6-19: Caricature of a collision during transportation of the cadaver bones to the courses in Davos.

Work on porotic bones was generally poor and also to some extent unrealistic. Drilling was too easy and screw anchorage was often insufficient. It was necessary to wear protective clothing and rubber gloves. The floor had to be covered over because fat would drip out of the bones. This situation did not change until much later when artificial bones were made available. The first discussions on this topic (initiated by P. von Rechenberg) took place in 1970 (TK May 8). Many years passed before they were introduced.

Disposal of the used bones after the courses was sometimes an even bigger problem requiring initiative and imagination. A veil of silence was drawn over the various *"atypical"* solutions.

In the afternoon, there was a **break from work** lasting several hours. The participants and accompanying persons could enjoy the fresh air or winter sports.

Up until 1965 all courses were held in Davos. Even for the first course with 66 participants and a total of 92 people actively involved the premises at the research institute were cramped. As the number of participants rose in the following years, temporary solutions had to be found: lectures were held in the local cinemas, practical exercises in empty rooms of sanatoria or hotels. In 1968 the practical exercises were held for the first time on the well-suited premises of the subterranean emergency hospital beneath what later became the new congress centre.

Guests of honour were also invited to the courses. These were persons of international reputation who did not belong to the AO or were even opposed to it. They held a lecture on their own experience. It was especially important to hear their critical appraisal of the courses.

The **collaborators** from the AO hospitals participated enthusiastically in the learning experience. Foremost was the team from St. Gallen which produced models and films and cut and stuck them together until late into the night (tension band technique, plate fixation of forearm fractures, etc.). *"When a foreign guest asked Müller how long his assistants worked, he answered: "8 hours". The guest worked out that that could not be right because they came at 8 a.m. and were still there in the evening. The answer from Müller was: "They are in employment for 8 hours, the rest of the time they are working to advance their education"* (BH).

The situation was similar in Chur and Liestal, although perhaps a little less hectic.

Here we must also mention the supervision and information for **guests** visiting the hospitals and attending the operations as spectators.

- The orthopaedic operating schedule of Müller working with various constructions in Liestal from 1957–1960 is an example.
- The tour to AO hospitals organized by Müller in February 1960 for a group of French orthopaedic surgeons has already been reported.
- Following inauguration of the clinic in the autumn of 1960 a stream of visitors from all over the world poured into St. Gallen. To

avoid complete obstruction of work, special visiting days were reserved. A short, translated report by a coworker (BA) says:

- *They were generally groups of two to three or even six to fifteen participants, not beginners but mostly experienced surgeons from various countries which also made demands on our language skills. We took refuge in standard phrases we had heard from the boss such as: "crazy case" "nearly perfect" "what would you do in such a case?" etc. It was constantly necessary to integrate praise and criticism, questioning, transparency. All in all, a very stimulating situation".*
- These visits often led to valuable personal and professional relationships: away from the role play and back to the natural order of professional reality.
- Much the same was taking place at the institute in Davos. The list of guests for 1960 has been duplicated in Schneider (Schn II/27f). Many of this visitors had also been to the AO hospitals because they were on *"tours of Switzerland"*.
- There were also frequent visitors to the other AO hospitals. All of them were received in the *"spirit of the open door"* (Schn I/5).

Research, an other pillar

Schneider writes in 1983: *"May the AO remain a scientific vanguard"* (Schn II/101).

The declared goal of the AO is the STUDY of osteosynthesis (paragraph 1 of the Statutes). Study means primarily the processing and analysis of your own actions with reference to an evaluation of the literature: this is clinical research.

Then, the search for fundamentals and for the relevant biological and physical laws and application of them in clinical practice: this is experimental, biomechanical and metallurgical research.

Clinical Research

Any work done in the field of surgery must be based on clinical research, that is, on observations made in the operating theatre, at the bedside, and in the course of healing and its evaluation.

Leriche[11] says on this subject "... *it is our daily responsibility. It has always been the great work of the doctors. It is not second rate research. For the inquiring mind every illness is an experiment which must be correctly understood .. a great deal of pathology has only emerged from anatomical and clinical observations."*

For bone tissue, which only grows and heals slowly, a particularly long observation period is necessary in order to assess the results.

On the basis of the principles of Danis, Müller had already published his own results for various pathologies before 1958[12,13]. In 1958 he produced a work on the treatment of pseudarthrosis together with Allgöwer[14].

The young AO adopted the theories of Danis and – applying the new instrumentation – produced publications and numerous lectures reporting their cases. At first, these were based on patient samples from the larger hospitals, then – for less common injuries – also on the central documentation. The most important were:

1961	Allgöwer on screw fixation of the tibia
	Schneider on intramedullary nailing of the tibia
	Willenegger on dislocation fractures of the ankle
1962	Weber and Vasey on osteosynthesis of olecranon fractures
	Müller and Vasey on open diaphyseal fractures
1963	Bloch on plate osteosynthesis of forearm fractures
	Müller on operative treatment of malleolar fractures
	Müller, Allgöwer and Willenegger: Common achievements and records (Gemeinschaftserhebung)

These publications are given in the References of the book entitled *"Technik der operativen Frakturenbehandlung"* (Te 237–357)[15] of 1963. The book itself is a review publication of the clinical work of the AO group.

Experimental research

Leriche says that with this addition clinical observation becomes *"an essential science"* [16].

At the time of founding in 1958 the members were aware that callus-free fracture consolidation assisted by stable osteosynthesis was only based on clinical observations and that there was an urgent need for experimental substantiation.

Danis had expressed this in 1949 as[17] *"Les notions que nous possédons sur les pressions et les tractions ostéogènes sont purement qualitatives ... ou empiriques. Aussi leur étude expérimentale s'impose-t-elle sans contredit".* Which means in English *"Our knowledge of osteogenesis under compression and traction is purely qualitative ... or empirical. Experimental investigation of the same is imperative".*

The lack of animal experimentation and histological analysis was probably the main reason for the vehement refusal of impartial clinicians and scientists to accept the AO. Schneider writes (Schn II/19): *"They simply did not want to believe us when we said that bone healing was possible without the usual callus".*

Two issues were paramount:

- is resorption at the fragment ends (as postulated by Böhler) indispensable? If so, then lasting stable osteosynthesis would be impossible.
- what is the histological course of this type of cortical bridging of the fracture?

The Hungarian anatomist *Krompecher in Debrecen* stated in 1937 in his book "Die Knochenbildung" [Bone formation][18] that he had simulated *"primary angiogenic bone formation"* in animals, tested it under various conditions of mechanical loading, and obtained proof of it in humans. But, due to the political unrest at that time his manuscript remained unheeded. Within the AO, his work was only known to Willenegger (SR).

The question of osteolysis at the fragment ends was tested early on by Bassett of the Columbia University in New York in his own experimental model. He created an oblong defect in the canine radius and sheathed the defect – after removal of the endosteum and periosteum – in a Millipore membrane impermeable to cells. As hypothesized, new bone formed in the defect.

Thus, it appeared to be proven that bridging of smaller defects did not require the periosteum or the endosteum and that the repair could be generated directly from the Haversian system. The experimental model and the histology are illustrated in "Technik" (Te 14); the relevant publication appeared in 1961[19]. Bassett also spent various periods of time in Davos working on compression and tension measurements on tissue cultures (PS).

Wagner was scientific assistant at the orthopaedic clinic in Münster at the time. This clinic was very well equipped for animal experimentation. His boss, Professor Hepp, was very active and interested (participant at the first AO course in Davos in 1960). Wagner started with investigations of screw anchorage in bone and callus-free fracture healing. The AO screw was superior to other available implants in design and surface quality. Wagner writes: *"I took on this task with great scepticism since I was well acquainted with the accepted opinions of the day. I have to admit that even after the first experiment 'Saul' had become 'Paul'. The most challenging part of these investigations was to demonstrate the interrelations between mechanical forces and bone structure. In principle, we were familiar with Wolff's law of transformation and Pauwel's observations, but these gentlemen had drawn their conclusions from observing natural phenomena, whereas in an experiment various mechanical forces can be artificially introduced and their consequences directly evaluated from radiographs or histological specimens. This was an extremely fascinating undertaking in the light of contemporary knowledge".*

First, Wagner turned his attention to the AO cortex screw. Osteolysis did not occur. In fact, living osteocytes were observed at the bone-to-metal interface. The implant had to be inserted according to the instructions (pre-drilling, tapping). For commercially available screws, extensive fibrosis of the screw track developed (**Fig. 6-20**).

Findings were similar for the cancellous bone screw. He implanted it at an oblique angle in the tibial plateau of a young dog and left it there for five months. Thus, it was continuously subjected to the pressure of growth from the epiphyseal cartilage. It did not loosen. On the part of the screw thread exposed to pressure there was increased density of the cancellous bone (**Fig. 6-21**).

These investigations have been described and the original figures reproduced in "Technik" (Te 8–12). The work continued for several years and was published from 1961–1964[20].

Thus, it seemed proven that under stable conditions pressure had an osteogenetic effect.

Somewhat later the anatomist Schenk in Basel, encouraged by Willenegger and working constantly in collaboration with him towards

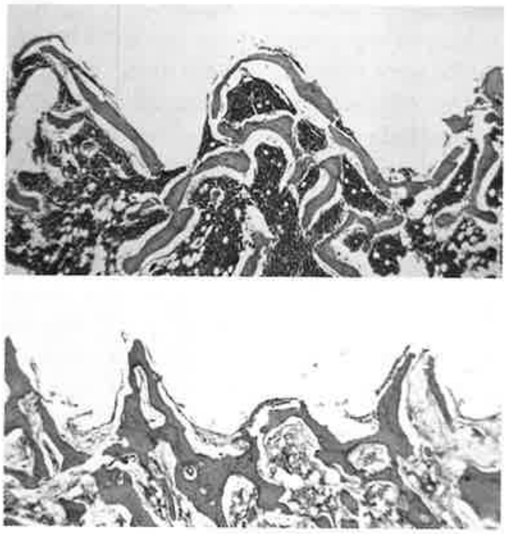


Fig. 6-20: From Wagner's experiments: Top: Screw holes in the cancellous bone of the greater trochanter of a dog. Thin bone lamellae have formed in a regular pattern on the rounded thread of the AO cortex screw. Between the lamellae and the screw, a fine layer of connective tissue has sometimes formed. Bottom: In the fine thread of a screw from another system, the sharp edged thread has been irregularly filled with bony tissue (Figures from the AO course 1961).

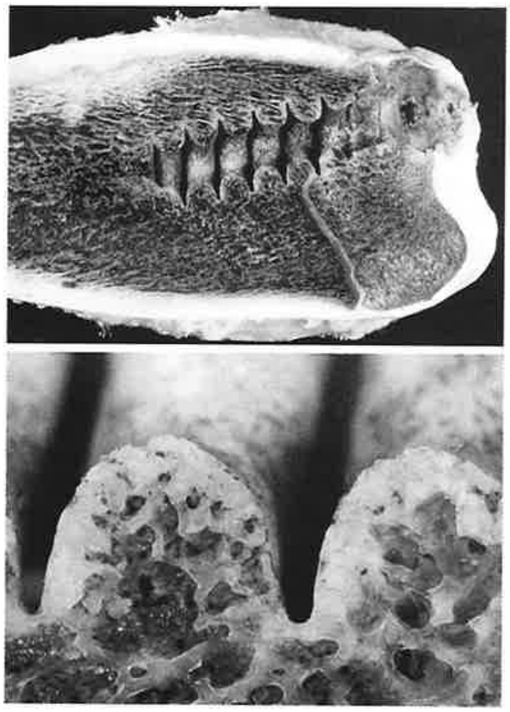


Fig. 6-21: From Wagner's experiments: A cancellous bone screw bridging the epiphyseal plate at the distal end of the canine femur was exposed for three months continuously to the effects of growth. On the compression side of the bone thread (left), an increase in the density of the cancellous bone has occurred as an expression of functional adaptation to continuous mechanical pressure (scientific meeting of the AO in July 1962 in Davos). We thank Professor Wagner himself for Figures 6-20 and 6-21.

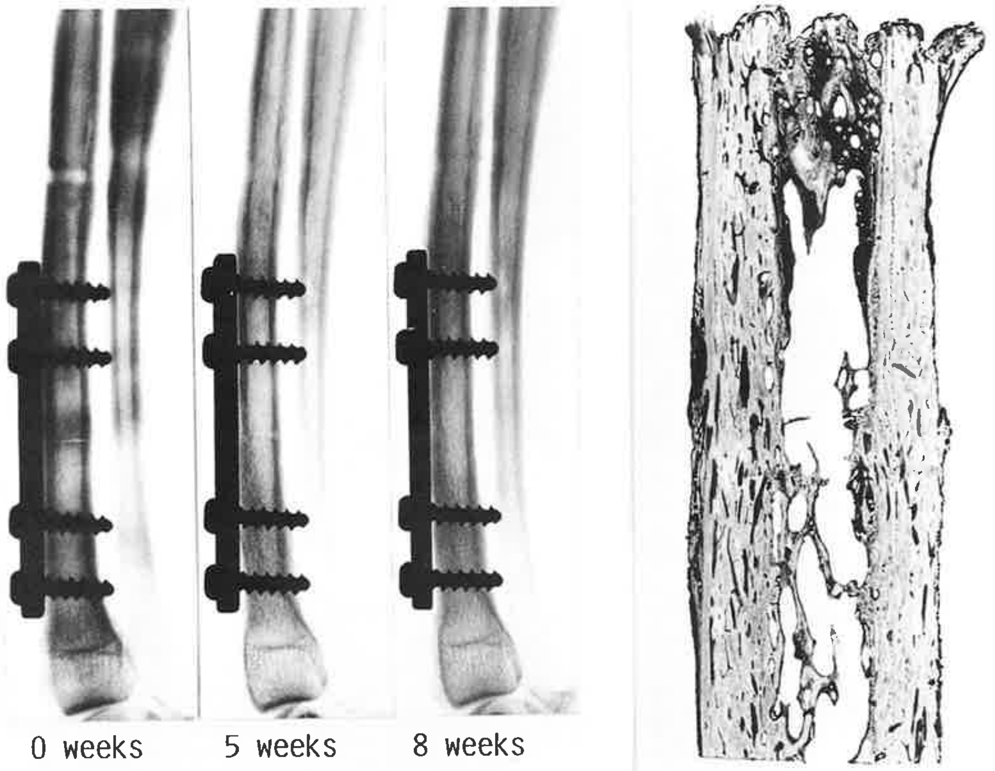


Fig. 6-22: Experiments by Schenk: Direct bone healing of a transverse osteotomy of the canine radius. Disappearance of the osteotomy line on the radiograph after eight weeks. Right: enlarged view of the longitudinal section after 10 weeks: the osteotomy site has been largely bridged by Haversian remodelling. At the upper margin, bone deposition on the screw thread.

the same objectives, started animal experimentation to investigate the AO compression plates. He regarded the canine radius as the ideal bone in terms of biological structure. The leading pharmaceutical company in Basel, Hoffmann-La-Roche, gave the two men access to their *"dog compound"*.

Fritz Straumann also helped with experimental design. He had a circular saw made by one of his vacuum cleaner companies which could cut 0.2 mm thick sections. Thus, the freshly fixed, non embedded, undecalcified bone could be cut, stained, and examined microradiologically.

A grinding technique originating in 1913 and described by Krompecher was adopted to process the freshly fixed, non embedded bone. The sections were then stained by hand with fuchsin.

First, the healing processes of an artificially created defect pseudarthrosis under pressure from the plate were investigated. Consolidation was achieved *"without surplus callus formation"*, whereby the screw had not loosened *"despite maximal loading"*. In "Technik" (Te 15) the radiographs from this experimental series are presented (**Fig. 6-22**). The corresponding publications appeared from 1961–1964[21] and were very important for the AO.

Then, the callus-free consolidation of an osteotomy under alternating compression loads was investigated histologically. It turned out that a very thin devitalized layer occurred initially at the near cortex where the fragments

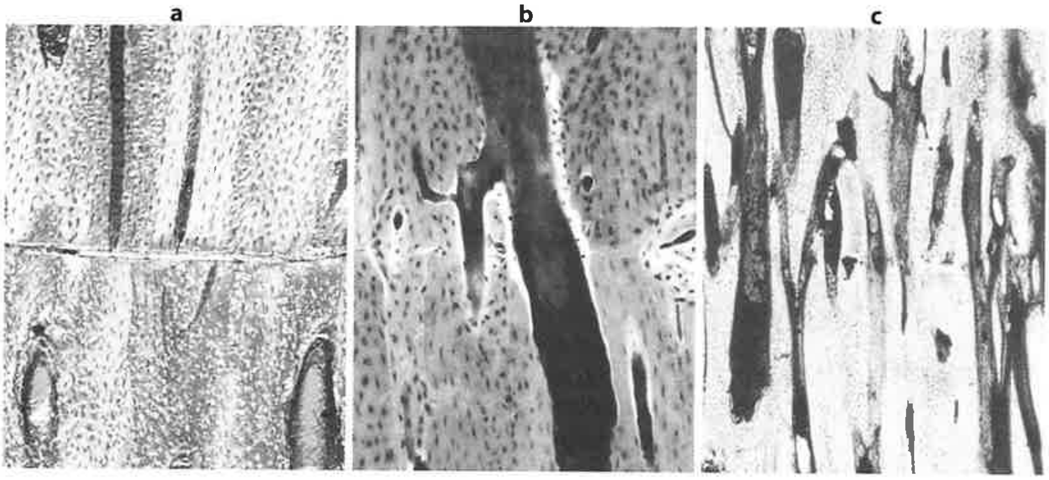


Fig. 6-23: Experiments by Schenk: Histology of direct contact healing of the near cortex where pressure is fully exerted at the osteotomy site. (a) Fresh osteotomy. (b) Migration of osteons into the osteotomy gap. (c) After six weeks numerous osteons have migrated across the contact zone. The osteotomy site is still visible.

were in close contact. This layer was soon replaced and bridged by the ingrowth of Haversian canals. New osteons had advanced across the gap and a sort of *"mortise and tenon"* effect had been created (**Fig. 6-23**).

At the far cortex where there had initially been a slight widening of the gap due to asymmetrical loading, cells migrated from the periosteum and endosteum and then direct filling of the gap with non lamellar bone occurred. Periosteal callus formation was not seen. After a delay, this gap was also bridged from the Haversian system. Later, the terms *"contact healing"* and *"gap healing"* were used to describe this process[22] (**Fig. 6-24**).

Thus, a further scientific basis had been established for direct fracture healing. It had also been proven that *"the effect of pressure was not so much bone degenerating as bone regenerating"* (Te11) and that *"pressure led to important additional stabilization of the bone fragments"*.

These results, obtained by several researchers working independently of each other in different places now confirmed the AO theory as derived from clinical observations.

Research at the **Laboratory for Experimental Surgery** is summarized in the Annual Reports of 1960–63[23]. Here experiments of a different sort had started: under the leadership of Allgöwer, who spent two days in Davos almost every week, experiments were being done on small animals (mice, rabbits) to investigate burn toxins, wound healing, and haemorrhagic shock. The surgeons at the clinic in Chur were delegated to take turns: Burri, Gruber, Segmüller, and Matter. Burri's work on central venous pressure, that is, the circulatory parameters for shock diagnosis (*"shock index"*) went into immediate clinical application[24]. Likewise, the work of Gruber and Siegrist et al. on blood volume measurement[25].

Early on, tissue culture and later organ culture (chicken femora) were used in various experimental designs under the leadership of Dr. Lotte Hulliger: for example, toxicity testing of various substances and metal alloys in collaboration with Ms O. Pohler in Waldenburg.

In Davos in 1961, under the leadership of Willenegger, Schenk and Straumann, experimentation was done on sheep to investigate the interfragmentary pressure exerted at the os-

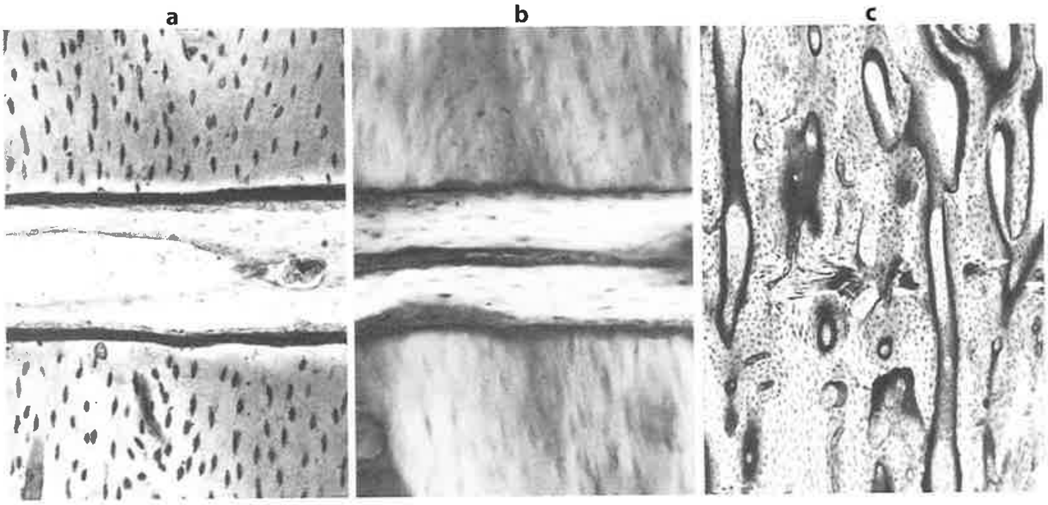


Fig. 6-24: Histology of gap healing at the far cortex (where slight gaping occurs due to pressure at the opposite cortex). (a) Gap of 0.2 mm one week after osteotomy. (b) After four weeks the gap has been temporarily filled with lamellar bone. (c) After 10 weeks the osteotomy site has been extensively bridged by regenerated cortical bone. Our thanks go to Professor Schenk himself for providing Figures 6-22, 23 and 24.

teotomy site over time and to compare it with histological results. For this purpose, ferromagnetic plates (incandescent nickel) were implanted and continuous measurements taken in an induction coil. The lab journals for the experiments still exist. After the lecture on this subject in 1962, the relevant manuscript was published[26]. The method was, however, too complicated.

In 1962 Perren (together with the orthopaedic surgeon Huggler) started his biomechanical testing. He was based in Chur and went to Davos for two days a week. He was the first to make use of strain gauges for pressure measurements after osteotomy in the sheep. With these it was possible to show that after an initial reduction of approximately 20% due to the viscoelasticity of the bone, pressure values in vivo only diminished slowly and after two months, that is, after initial bone healing, about half the compression force remained active. Thus, Perren proved that pressure necrosis, generally understood as pressure related resorption at the fracture surface, did not occur after compression osteotomy and that the stabilizing effect of compression could be applied without biological disadvantages. In the same period of research, he discovered the reason for the resorption processes observed by Böhler at the fracture site and in relation to unwanted implant loosening as a result of micromotion which occurred under functional load in the absence of preload[27].

After Herbert Fleisch took over management of the laboratory on May 1, 1963, biochemical investigation of bone tissue commenced. His collaborator was the chemical scientist, Ms Silvia Bisaz.

Research in physics and metallurgy

That metal implants could cause pathological, physical-chemical reactions in the living organism had been largely negated by the forerunners of the AO:

- Lambotte fixed his plate (originally made of aluminium, later steel) with steel screws. He was of the opinion that so-called incompatibilities were symptoms of creeping infections, the consequence of inadequate asepsis[28].

- Danis[29] essentially agreed with him, but emphasized that the steel had to be completely rustproof (*"vraiment inoxydable"*). Then the question of chemical compatibility (*"tolérabilité"*) no longer arises. At that time, he had access to V2A steel (containing 18% chromium, 8% nickel). On the basis of his own observations he rejected the application of implants and drill bits made of different metals or different steel alloys.

The contacts originating in 1960 between the AO and the Dr. R. Straumann Institute in Waldenburg have already been reported.

For a physicist who concerns himself only with lifeless matter, the questions arising in relation to biology and surgery came *"as if from another world"* (PO). Both sides were challenged to recast their logical and conceptual thought processes.

A typical example of this was a verbal exchange which apparently really took place: Müller announced: *"The AO has the best steel in the world; it comes from Sweden"* to which he received the equally provocative reply: *"The AO has the worst steel in the world; it comes from Sweden"* (StS). The explanation is that iron ore from Sweden has a high sulphur content and in steel this reacts with manganese to form manganese sulphide. In order to make *"stainless steel"* stainless, the manganese sulphide inclusions must be eliminated by resmelting.

Clinically relevant **corrosion** and **fatigue failures** of implants had become more frequent with more widespread use of the AO instrumentation. The latter was mostly due to biomechanical mistakes made by the surgeon, but with steel it was possible for pitting, contact and frictional corrosion to occur. The extremely thin, so-called *"superficial passive layer"* on the implant played an important role and was not to be damaged during manipulations. This explains the initial instruction within the AO that plates should not be bent.

Pitting corrosion could also lead to local metallosis (migration of metal particles into the adjacent tissue).

The only way to tackle the problem of corrosion was to improve the quality of the raw material. Therefore, the Straumann Institute drew up specifications for austhenitic implant steel which later formed the basis for international standards (ISO, ASTM etc.)[30].

Mechanical strength and susceptibility to corrosion was investigated in Waldenburg in cyclical loading tests. Every single broken implant was analysed and all explanted implants and all newly designed implants were subjected to these tests performed by Ms Pohler.

Some typical **material deficiencies** were identified. The AO osteosynthesis material was refined to very high precision and quality by means of various mechanical process (including electrolytic polishing). The Straumann Institute took on responsibility for buying in the raw material for both producers.

It had become apparent that improved **surface treatment** of the implants would lead to improved tissue compatibility. Wagner had demonstrated this in his experiments (Te 41). Lambotte had already stated in 1913[31] that implanted foreign bodies with a smooth surface were more readily *"s'enkystent"*, that is, encapsulated and that therefore cerclage wires might under certain circumstances be tolerated even after infection. He had observed a decline in the number of disturbing tissue reactions for the screws of his fixator after the screw surfaces had been polished better by the manufacturers[32].

There was also constant testing of new *alloys* intended for implantation in humans. These were to have the following qualities: mechanical strength, tissue compatibility, machinability, and cost efficiency.

Compatibility was tested in Davos in tissue and organ cultures and by implantation in animals. There were many disappointments. For example, a lot of time was spent on the promising alloy *"Syntacoben"*, but, in the end, there was a return to steel alloy.

In summary, it can be said that at the AO the questions addressed to the histologists and physicists invariably came from the three scientifically active surgeons Müller, Willenegger and Allgöwer who were, as a rule, personally involved in creating the experimental designs and carrying out the experiments, thus ensuring direct clinical application.

Research at the AO was always stimulated and guided by clinical needs whereas previously the findings from independent scientific research often only entered into clinical practice by a convoluted route and after much delay.

Cooperation

The wide ribbon of Cooperation should really be multi-coloured. It encircles the letters A and O and holds them upright (**Fig. 6-1**).

The English word *"Cooperation"* has – in German and French – many meanings in addition to simply "working together":

- *"joint effort"* (this may be social, political or professional)
- *"to contribute to something"* (this indicates assisting in a certain matter).
- *"involvement"* and, above all, *"co-operative involvement"* emphasizes social and economic thinking.

The various nuances seem to have been tailored to the AO. Reference will be made to them later.

A great deal has been said in previous chapters about the common endeavour of the surgeons.

In order to improve their techniques and to research into them, contacts to experts in a wide variety of fields had been established even before the founding year: inventive engineers and designers, biomechanics, histologists and physicists. To remain viable, economics had to have its place in the organization. Schneider called this *"the spirit of cooperation"* (Schn II/26), but it has been understood more generally as *"the spirit of the AO"*. Everybody was motivated. This new form of Cooperation engendered enthusiasm and led to unforeseeable activity.

Gemeinschaft [Association]

The meaning of the German word *"Gemeinschaft"* cannot be translated into other languages – see Chapter 2. The English word *"association"* for the A is much too weak, *"community or communauté"* is much too strong to describe this ideology (affiliation).

The Gemeinschaft emerged from many years of partnership, characterized by give and take. This created a basis of trust and a strong sense of cohesion. Of greatest importance were: exchange of experience (paragraph 1 of the Statutes) and reciprocal access to documents and records (paragraph 12 of the Statutes). Also, joint participation in documentation and scientific publications, joint ward rounds, and reciprocal assistance at operations. The collaboration of all involved on drawing up the Guidelines (paragraph 12 of the Statutes) promoted integration. The homogeneity of the operative procedures led to a sense of security within the group of friends. If difficulties or complications arose, there was always someone with more experience to offer advice. Qualified assistance was always on hand for a tricky secondary intervention. In the case of failure, *"there was understanding and suggestions on how to cope with the difficulties"*[9].

The group of Bernese chief surgeons which formed around Müller was the most close-knit. He had the knack of making his ideas the centre of attention without being domineering. Within this core group there reigned a sort of *"complicité"* in a positive sense on which neither rivalry nor animosity could impinge.

Friendship in its narrowest sense was not necessarily an integral part. The common goals and special professional interests dictated the relationships. I once heard said: *"It was not really close friendship but rather very good relations ... the maintenance of a psychologically positive atmosphere.... you didn't stab each other in the back. There was civilized respect amongst the* *members. The occasional referral of a patient from one to the other was not taken resentfully. Everyone was interesting in establishing the method"* (AM).

Close friendships between people who meet at the middle of life and career are not very frequent. It would be necessary to curb natural attention seeking behaviours in the interests of the common good. The members were all interesting, often stimulating, and highly active persons. Collaboration in the group was extremely motivating. Mutual respect, even towards the younger members, was always clearly apparent.

Propriety and tolerance always dominated or returned after emotional outbreaks despite the sometimes quite different characters or difficult personality traits.

- Müller could sometimes be rather gruff at conferences and especially at meetings where he might unintentionally be offensive. However, common sense and his natural generosity of thought soon got the upper hand.
- Allgöwer had a more sophisticated manner and was more factual. His quick-witted jokes might be somewhat uncalled for on occasion, but they often saved an intractable situation.
- Willenegger was always restrained, rational, and calm, but school-masterly and not always easy to enthuse.
- Schneider, with his towering stature and acting the *"Grand Seigneur"* [lord of the manor], was sometimes a little theatrical, but he was the ideal ambassador to meet VIPs from Switzerland and abroad as is clearly apparent from the early correspondence.

It must however not be forgotten that leading personalities have to be disquieting in order to bring about changes.

The **AO Meetings** were always an opportunity to enhance contact between friends. One member was always host to the participants and took care of their physical well-being in an exemplary manner.

The **financial contributions** which the members had to make in the interests of the whole and for purposes of research and documentation also worked in favour of integration. The sums of money in the early years were quite considerable. Schneider writes (Schn II/49): *"The personal financial obligations in addition to the scientific associations created the special atmosphere of a common destiny".*

Funding from Synthes took the place of the contributions by the members to finance documentation, teaching, and research. Only the four shareholders had a direct relationship with Synthes.

At the meetings financial issues were no longer discussed – apart from questions of annual membership fee and internal invoicing as in every society. To the relief of the first members and to the astonishment to later members *"money was never spoken about at the AO"* (MM). However, this meant that one of the factors contributing to a sense of common destiny had gone.

Sporting events played an important role. Müller and Allgöwer were impassioned skiers. At the end of the first course in 1960 a spontaneous ski race took place to celebrate its success. This became an annual tradition, first of all in Davos and later organized independently of the courses.

Thus, the teams had a chance to compete whereby it was almost always a race between Chur and St. Gallen. The competition was fierce: A younger collaborator who happened to miss the barely visible finishing line and was therefore *"responsible for the defeat of his team"* was *"deleted from the operating schedule for several weeks"* (not that his boss noticed) (BH). Ambitious youth could then let off steam at the evening event amongst much chatter and laughter.

The *teams* in the larger hospitals were like-minded and worked enthusiastically together, especially in St. Gallen. Innovative ideas from the younger generation were however generally not appreciated by the chief surgeons who felt they had a monopoly on the like.

An air of superiority was sensed by the outside world which sometimes stood in the way of close contacts to the colleagues in other hospitals. The chief surgeons, who communicated with each other on a level of equality probably did not realize.

Hospitality

Cooperation included hosting guests who came to visit the hospitals and the Laboratory for Experimental Surgery. Guest surgeons often visited and they were received and informed openly everywhere they went by the chief surgeons and the collaborators. As already mentioned, these visits often led to valuable relationships.

Cooperation and engineering

The *"sash on the AO signet"* was not only wound around the surgeons, but also around all those who contributed to the further development of the Association. These were primarily the technicians, the engineers, and their manufacturing companies.

In first place, we find Robert Mathys alone in his workshop. Long before the official foundation he had been working intensively with Müller. He dedicated all his creativity and technical talent as a designer to this task with a level of commitment that went far beyond that of an employee. It was *"co-operation"*. It is often impossible to find out from the documents or from interviews from whom the first idea or first construction came for many of the implants and instruments. Retrospectively, the question seems largely irrelevant.

The situation was quite different for Fritz Straumann who joined $2^1/_2$ years after the foundation. He already had a qualified staff. He then dedicated himself totally to research. In contrast, his company had to alter its direction of expertise and its goals away from its original tradition in order to accommodate the AO.

Both proprietors took a considerable economic risk by associating themselves with a small, almost unknown group of surgeons, who were generally opposed by the Establishment. For both men, ideology took priority over financial gain.

Cooperation and economics

While instrumentation, documentation and early research was developing, the economics of the AO relied totally on repeated contributions from the medical members and financing of the laboratory in Davos by individual sponsors. This could only be a temporary arrangement – a sort of launch capital.

A solid financial basis could only be envisaged in terms of proceeds from the commercialization of the instrumentation. It was an ingenious idea to define this as a percentage of sales income to be submitted by the producers of the instrumentation. That this idea took the form of a contract with Synthes AG Chur at the end of 1960 when the economic future already looked promising is still astonishing. Consequently, both contracting parties could develop largely unhindered.

This was a quite uncommon form of Cooperation – a symbiosis (*"perhaps the beginning of medical technology"* (MM)) – based on mutual consideration and respect, a sort of *"co-operative involvement"*. P. von Rechenberg – the sheepdog – played an important part in these events.

This solution was only possible in a small country and viable in the long-term given that everyone knew and respected each other and class differences were insignificant.

Concluding remarks

This section on cooperation closes with a quotation from Schneider (Schn II/83): In 1978 on the occasion of the 20th jubilee of the foundation he asked: " .. *what would have become of us all without the AO? What have we to thank the AO for? In what ways were our lives changed by the AO? Each individual will have his own personal answer to these questions. For myself, I am convinced that the scientific benefit, the obvious improvement in treatment modalities and, last* *but not least, the valuable and far-reaching personal contacts and friendships make up a very positive balance. General and orthopaedic surgeons, researchers, technicians, and producers are links in a chain, dependent on one another and certain that with these partners they have entered into a promising alliance. Today we must give thanks that we have all been given the opportunity to contribute to such a satisfying endeavour."*

- Without the new and complete instrumentation, it would have been impossible to perform the AO techniques.
- Without the documentation the indispensable data for teaching and clinical research would have been lacking.
- Without the courses and the book, the application of the instrumentation would have become chaotic and poor performance would, as had happened to earlier attempts, sooner or later have brought it into disrepute.
- Without animal experimentation and histological investigation, the AO would not have been accepted by the scientific community.
- Without metallurgical research the implants would have corroded and broken.
- Without the new form of Cooperation set up by the AO and into which all the players were integrated, the impetus and motivation would have been lost.

The order of these statements is as arbitrary as the order of the pillars. Once again, they all exist in the context of each other and cannot stand alone. You must have four pillars. Don't try taking one away!

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Chapter 7
Theory and Techniques

The line between teaching and technology is a bit hazy. In the writings of the AO, the two are always presented in close relation to each other. Consequently, they are also combined here in a single chapter.

Before the actual doctrines of the AO can be expounded, the theories of fracture healing must be presented.

Fracture healing

A succinct overview, for which we have Muhr[1] to thank, is reproduced here.

Indirect healing

"By far the greater majority of fractures heal in an indirect way by periosteal callus formation. In the fracture zone, there is at first a haematoma – the fracture haematoma – which is subsequently infiltrated by connective tissue cells. Since bone necrosis a few millimetres deep occurs at the fracture ends because the blood supply has been impaired as a result of the accident, slight primary shortening is necessary to achieve the indispensable fragment contact required for healing. This stage can be observed on the radiograph within the first two weeks as a widening of the fracture gap. The connective tissue cells which have migrated into the fracture zone differentiate under conditions of relative mechanical inactivity to cartilaginous cells and then to bone cells. Special growth factors form a new substrata in the fracture gap and on the outer surface of the bone. This is expressed by the gradual disappearance of pain arising from motion at the bone ends and is visible on the radiograph as ever-increasing bone regeneration around the fracture. This initially unstructured woven bone increases in density. Under loading due to the activity of the musculature or functional use of the limb, the bony tissue becomes harder and more dense. The callus, often spherical at first, becomes flatter so that in the end after months or years only an insignificant thickening of the cortex remains as an indication that the bone was once broken. The majority of fractures of the shaft heal in this manner."

Direct healing

"If the fracture ends can be successfully and ideally aligned and completely immobilized (compression osteosynthesis), then a different form of fracture healing occurs without visible callus.

After revascularization of the traumatically avitalized fracture ends, cells emerge from the fracture surface itself and criss-cross the fracture gap forming new bony tissue. Thus, a network of regenerated bone is built up in the fracture gap. This cannot be identified on the radiograph as callus formation, but the previously sharp contours of the fracture gap become gradually more blurred and finally vanish. This so-called callus-free fracture healing only occurs under conditions of absolute mechanical stability as is achieved by some operative procedures based on technology."

The AO dedicated itself to this new form of fracture healing. The following texts will describe what this meant in terms of doctrine and practical application.

The texts of the forerunners

In 1949 Danis wrote the following: "... *après une ostéosynthèse de précision, idéalement solide et aseptique, ce cal se réduit à si peu de chose qu'il ne devient plus apparent* ...". that is, "... after precision osteosynthesis, which should be absolutely stable and aseptic, callus is reduced to such a small amount that it is no longer visible..." and later he writes: *"cette ,soudure autogène', qui se fait aussi discrètement que dans le cas d'une fêlure incomplète ..."* or: "... this type of 'welding' occurs as inconspicuously as for an incomplete fracture" and on the next page we read: *"L'ostéosynthèse doit transformer le foyer fracturaire en un bloc dont la rigidité doit être de se maintenir absolue pendant tout le temps que dure la consolidation naturelle de l'os".* "Osteosynthesis must transform the fracture into a solid block which can be retained for the whole period of natural fracture healing". Danis is quoting statements made by Lambotte in 1890 and by Lane in 1893 in manuscripts which are no longer obtainable. He goes on to say: *"L'ostéosynthèse doit réaliser et maintenir une pression suffisante entre les fragments osseux principalement dirigée suivant leur axe"* "Osteosynthesis must continuously exert sufficient interfragmentary pressure, primarily along the main axis."[2]. He refers to his own publication of 1931 which, however, has now disappeared.

In 1932[3] he had repeated that when the periosteum was intact, extensive callus formation was generally not to be expected.

For Danis callus is a pathological structure ("*une formation pathologique*"). Osteosynthesis can (and should) prevent its occurrence *"dont l'ostéosynthèse permet souvent déjà d'éviter l'apparition"*[4].

We owe the following statements to Schlich[5]:

In 1917 Bardenheuer[6] had already interpreted excessive callus as *"an expression of inadequate contact of the fracture surfaces just as a soft tissue scar is an expression of deficient union of the wound surfaces or of a secondary wound infection with spreading of the wound margins".* He even spoke of a *"prima intentio"* in fracture healing. His objective was *"To achieve healing of interrupted bone continuity by primary healing as for skin wounds with a minimal scar, i.e. callus. Just as the healing of a wound per primam intentionem is the quickest, so it should be for the healing of bone fragments"*. This doctrinal opinion of an expert in conservative fracture treatment is very much in agreement with the postulates of Danis.

Lambotte was very pragmatic. He writes nothing about pressure or callus. For him, fracture healing without these was more or less a natural process. It was the result of anatomical reduction, i.e. of his *"réduction absolue, mathématique"*[7], described as the *"engrènement des surfaces"*[8] (interdigitation of the surfaces) and a stable construction which fixed the fragments in place until union. Then, technically perfect osteosynthesis accelerated consolidation by putting the fragments in the situation of a torus fracture: *"L'ostéosynthèse rationellement exécutée hâte la consolidation en plaçant la fracture dans les conditions d'une fracture sous-périostée sans déplaçement"*[9].

There are not many examples in his books because he concentrated mainly on keeping records of fracture morphology and osteosynthesis technique. In his first book his records were mostly drawings and in the second undated radiographs.

Assumptions that Lane made very similar statements have not been confirmed. The second edition of his book which appeared in 1914 is untraceable. In 1912 he fails to express his opinion but recommends the plate he himself had introduced in 1907 instead[10].

Compression osteosynthesis in orthopaedic surgery

In 1948 Charnley presented the example of a knee arthrodesis to show that compression at cancellous bone contact surfaces led to rapid consolidation; in 1953 in his monograph *"Compression Arthrodesis"*[11] he demonstrated his technique for other anatomical sites.

The observation that the majority of pseudarthroses could be healed just by compression was comparable to a revolution. The callus tissue had always been resected before reduction of the fragments and application of an (external or internal) immobilizing device. Even Lambotte resected the callus before osteosynthesis[12]. Charnley considered compression to be osteogenetically ineffective in cortical bone because of the slow rate of remodelling[13]. Danis seems to have been the first to show that pseudarthroses could be united by purely axially compression (without callus resection). His most impressive examples show treatment of the diaphysis of the forearm[14]. This conceptually new technique had a direct influence on the founding members of the AO, especially Müller, and led to his first publication together with Allgöwer in 1958[15].

Pseudarthroses and malalignments are definite indications for stable osteosynthesis, which cannot be said for all fractures. Willenegger used this argument later when establishing the AO in the developing countries. He stressed that stable osteosynthesis was intended primarily for the treatment of those conditions arising after a fracture has not responded well to non operative treatment (HU).

Biomechanics

Biomechanics refers to the interaction of the calculable forces of *"basic physics"* which the living organism is obliged to activate.

If implants are used to stabilize the locomotor system, their qualities and positioning must be adapted to the known or predicted muscle forces and the probable load.

Pauwels introduced the concept *"Biomechanics"* in 1940[16]. He investigated the relevance of mechanical forces in the treatment of pseudarthroses and fractures with reference to clinical examples. In the vocabulary of the AO, the rather impressive sounding adjective *"biomechanical"* appeared occasionally in the Guidelines (Me I/5.1, I/8 and II/IVII, Te 178), later more frequently in lectures and publications where it was used extensively, if not always correctly.

Pauwels defined the principle of tension band technique in 1946[17]. This refers to the transformation of asymmetrical bending or tension forces into symmetrical compression forces by the optimal application of implants. Tension band technique first found a place in orthopaedic surgery but rapidly became popular for application in traumatology (fractures of the patella, olecranon, etc.).

That the forerunners of the AO had integrated the unwritten laws of biomechanics into their work is demonstrated by the astonishing drawing by Lambotte on p. 66 of his book published in 1913 (**Fig. 7-1**).

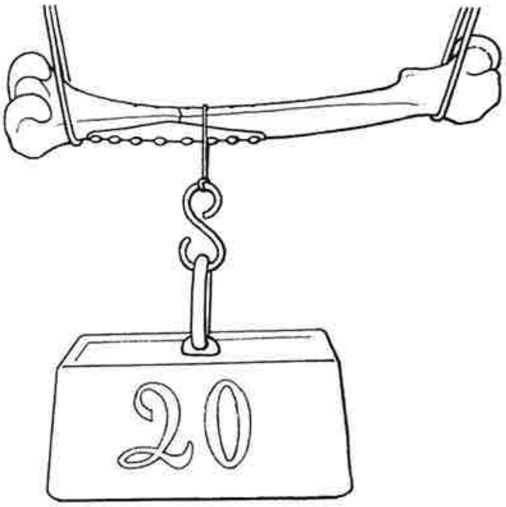

Fig. 7-1: The biomechanically correct position of the plate for an anatomically reduced diaphyseal fracture according to Lambotte. Taken from Lambotte 1913 p.66.

The writings of the AO

Three manuscripts have been preserved one of which contains the theory, the other two contain both the theory and the technology: the lecture by Müller in March 1958 in Chur, the Guidelines[18] of 1961, and the book "Technik"[19] of 1963.

Guidelines: Structure and content

These are the first detailed transcripts of the principles and technology of the AO. They are based on earlier discourses by Müller. The texts of 1961 were compiled in collaboration with the members and served to standardize indication and technique.

The first preserved Guidelines date from July 1, 1961. They are entitled: *"Operative Frakturbehandlung, Merkblätter der Arbeitsgemeinschaft für Osteosynthesefragen, zusammengestellt von Maurice Edmond Müller, orthopädisch traumatologische Abteilung des Kantonsspitals St. Gallen"* ["Operative Fracture Treatment, Guidelines of the Association for the Study of Internal Fixation, compiled by Maurice Edmond Müller, orthopaedics and traumatology department of the Cantonal Hospital St. Gallen"]. This is a booklet of more than 90 pages of A4 typescript, photocopied and stapled together.

In addition, the Introduction, Guidelines 1–10, and an appendix include technical drawings, presumably the designs for the first catalogue of Mrs Moraz-Müller (Schn II/43).

The content of these texts will be referenced from now on by the abbreviation Me I; sheet and page numbers will be given in Arabic letters, e.g. Me I/4,7.

A second version is also available, dated December 15, 1961. In the following texts, it will be referred to by the abbreviation Me II and the relevant page numbers.

The latter contains some modifications compared with the July version.

The Guidelines were an important reference work for the first AO book. The chapter by Müller is partly a word for word reproduction of the texts in the 1961 Guidelines.

"Technique of operative fracture treatment"

In October 1963 the first AO book with the above-mentioned title was published by Springer Publ. Inc. (Berlin, Göttigen, Heidelberg). The surgeons had worked on it intensively since early summer 1962. It was soon sold out and a second-hand copy can now only be obtained with difficulty. Therefore, an overview of the contents is provided here and the original referenced with the abbreviation (Te ...) plus relevant page numbers.

A short historical overview by Willenegger (Te 1–6) is followed by the section by Müller about the goals and risks of osteosynthesis, about the theoretical, scientific and practical principles of functionally stable osteosynthesis (Te 6–18), and about operative technique and aftercare (Te 21–27). In the section entitled *"Instrumentation and handling"* the topics corrosion and metallosis and suitable metals for osteosynthesis are elaborated by F. Straumann and S. Steinemann (Te 32–39). This is followed by a presentation of the instrumentation and its functions by Müller (Te 41–82).

In the special section, tibial fractures (written by Allgöwer) take up the most space (Te 84–168). Schneider wrote a section on complications associated with intramedullary nailing (Te 166–169). The chapter on malleolar fractures was compiled by Willenegger and Weber (Te 169–208), the one on femoral fractures by Allgöwer (Te 209–217) and Müller wrote about patellar fractures (Te 218–222).

Fractures of the upper limb were described by different authors: Bloch (forearm shaft fractures – Te 223–231), Weber (proximal ulna and distal radius, Te 332–342), Willenegger (the navicular bone of the hand, Te 242–253) and Bandi and Mumenthaler (humerus, Te 254–279). Fractures of the hip (Te 280–301) were described by Müller.

In the appendix (Te 302–327) the topics open fractures, infection, and shock were presented.

In 1965 Springer published an English language version, as prepared by Segmüller in

Chur; only very few copies still exist. The sections on osteosynthesis of the tibia had to be deleted because of the prevailing opinions in North America.

The AO doctrine

A record still exists of the lecture held by Müller at the meeting of the group in Chur on March 15, 1958 on the *goals and basic principles* of modern osteosynthesis in the adult. The content was much the same as that of earlier lectures, but this is the first written record.

In the text (Schn II/6–8), Appendix p. 216, three goals are presented:

1. The immediate active mobilization of muscles and joints adjacent to the fracture to avoid muscle atrophy and joint stiffness. Mobilization had to be started immediately after the operation, not early loading. The pension payments (invalidity) depended on achieving this first goal.
2. Restoration of the anatomical shape of the bone.
3. The *"per primam" healing of the fracture without visible 'callus formation'. Any surplus callus is a sign of inferiority ...*".

There is a hand-written note that says "4": *"Conservation of the soft tissues"*.

The following are stated as basic principles for good osteosynthesis:

1. Thorough asepsis
2. Transformation of the fracture site into a stable block, the strength of which does not diminish during fracture healing. Only then can a *"per primam"* course of healing be expected. Fragments should never be excised.
3. The implanted metal must be biocompatible and not cause any chemical, mechanical, or electrical irritation.
4. *"Axial pressure between the fragments (Danis 1931). Pseudarthroses generally heal by axial pressure alone. The mechanical/biological problem must however be discovered in order to remove it operatively."*
5. Operation as early as possible, within 8 hours (maximum 12 hours).

In the *Guidelines of 1961* (approximately 3½ years later) the texts are more detailed, but the content is little changed.

In *"Technik" in 1963* (Te 8–20) – written about one year later again – the structure and formulations have been somewhat modified. The results of scientific and experimental work (Bassett, Wagner, Willenegger and Schenk) were now available and had been integrated. The demand for *"primary callus-free consolidation"* is unchanged (Te 10–15).

Regulations relating to osteosynthesis

On the subject of general indication, the Guidelines state: *"if osteosynthesis were a procedure that only permitted the more or less safe union of fracture fragments, it would have to be rejected every time that fracture union could be expected from non operative treatment. Stable osteosynthesis has set its sights much higher"* (Me I,1).

The preoperative phase

- Clinical examinations and operability are only discussed in the context of open fracture (Te 302ff) and shock (Te 318ff).
- With respect to *planning* for elective osteosyntheses it only says, the surgeon must prepare himself for possible surprises (Te 23): *"If during the operation the planned procedure proves inappropriate, the surgeon must be capable of changing over to a more favourable method immediately"*.
- In general, emergency procedures are addressed (*"immediate operation"* Te 22) within 8–10 hours of the accident (Me I/13, Me II/17). The contraindication is the condition of the soft tissues (especially for the lower leg and malleolar fractures (Te 111, 180, 184).
- In both the Guidelines (Me I/1,11, Me II/15f) and in the book "Technik" (Te 21–24)

very precise instructions are given for asepsis and local preparation of the operative site.

The intraoperative phase

"Tissue conserving operative technique" is described in "Technik" (Te 22f) as: long, straight incisions, excision of necrotic tissue, avoidance of pressure by retractors, frequent irrigation of the wound (Ringer solution), and minimal vessel coagulation.

On the subject of *preservation of vascularity* at the fragment ends, the Guidelines of 1961 (Me II/5) only say: *"the nutritive supply to the bone fragments must be ensured"*.

In "Technik" (Te 18f) this issue is dealt with more comprehensively: fragment devitalization as a result of periosteal stripping or heat is to be avoided (*"deficient operative technique"*) and, if necessary, adjuvant *"autogeneous cancellous bone grafting"* should be performed to promote *"secondary revascularization"*.

With regard to *reduction* it is only stated that this must be: *"anatomical"* (Me II/5), *"in anatomical position"* (Te 7). The demands of the forerunners were identical, namely, *"réduction absolue, mathématique"*[20] and *"réduction vraiment exacte"* according to Danis[21].

How to achieve this reduction, i.e. which devices and manoeuvres were required, was communicated in a variety of ways:

- In the general section of "Technik" (Te 22) it only says: there has been a move away from the *"no-touch technique"*... *"pressure of the finger at the right place..."*
- In the fracture-specific chapters, just a few more precise details are given (Te 227, 241, 258, 288).

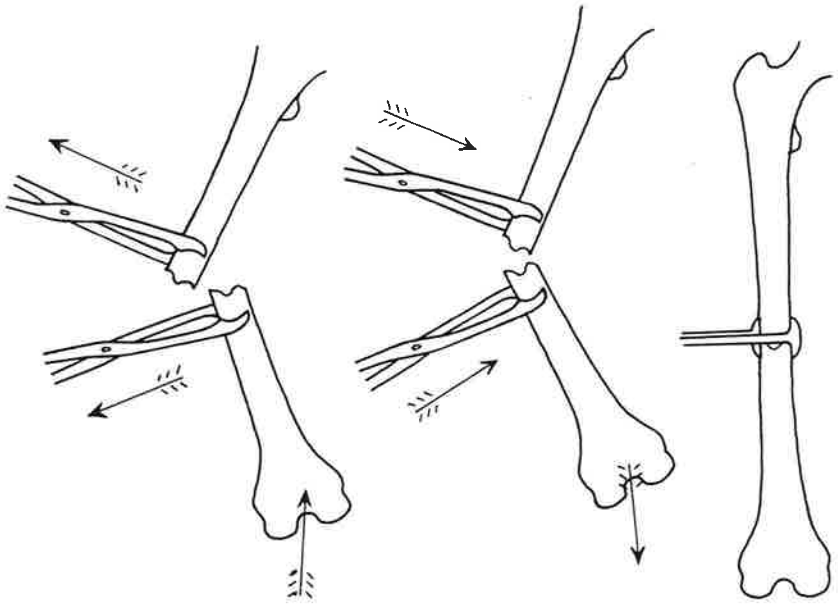

Fig. 7-2: Indirect reduction and temporary fixation of a femoral fracture (before mounting the external fixator). Taken from Lambotte 1913 p 30.

- Lambotte and Danis always performed indirect reduction. They practised the *"no touch technique"*, that is, they never touched the fracture site. Lambotte described numerous *"instrumental manoeuvres"* to achieve this[22, 23], which are remarkable (**Fig. 7-2, 7-3, 7-4**) and which are now being *"re-discovered"*. Danis constructed an adjustable traction table for approximate reduction of fractures at various anatomical locations[24]. In 1932 he presents a temporary, firmly mounted fixator for fine reduction – a sort of precursor to the distractor[25] (**Fig. 7-5**).

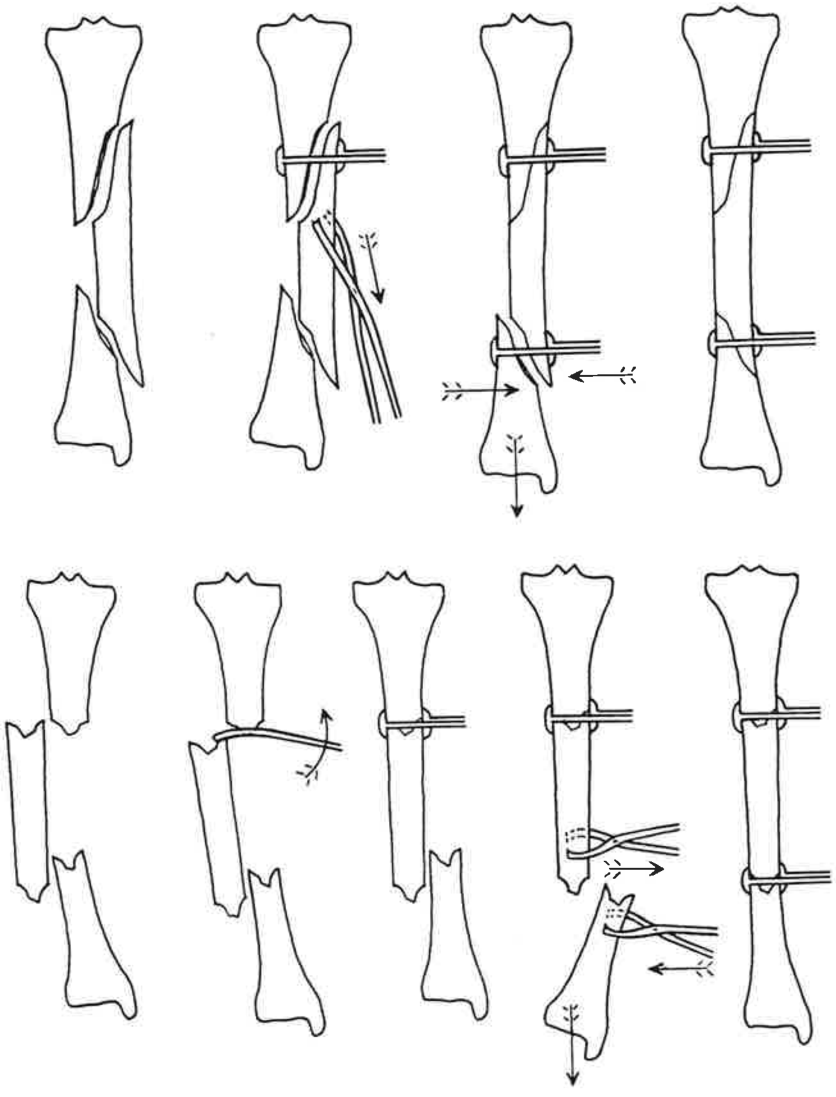

Fig. 7-3: Indirect reduction and temporary fixation of a segmental fracture of the tibia. For torsional and for transverse fracture lines. Taken from Lambotte 1913 p. 39.

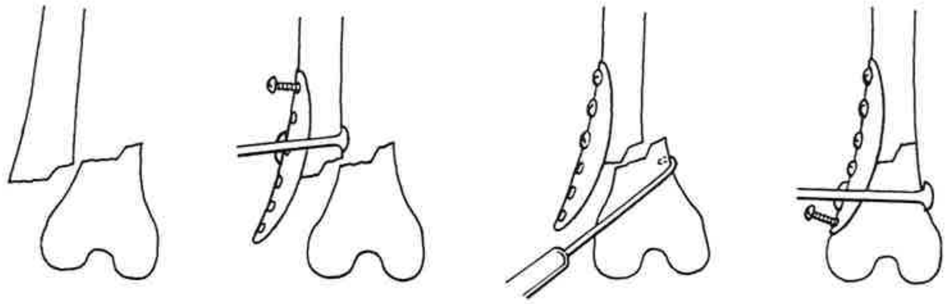

Fig. 7-4: Application of the plate as a reduction aid for distal shaft fractures. Taken from Lambotte 1913 p.41.

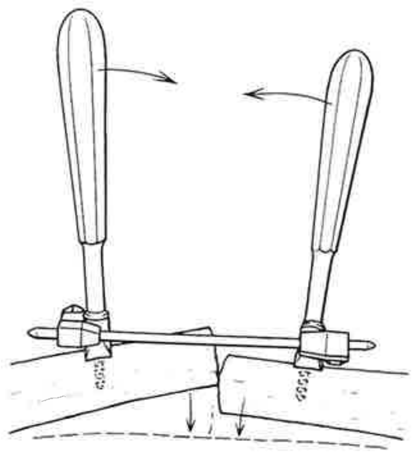

Fig. 7-5: Auxiliary instrument by Danis for indirect reduction. A precursor of the distractor. Taken from Danis 1932 p.22–24.

On the subjects of *wound closure* and *skin suture* comments are only found in *"Technik"* in the chapter on fractures of the lower limb (Te 111–114). The author is Allgöwer, who worked in reconstructive surgery: no suture of the periosteum in adults, bone contact with well vascularized tissue. Sutures of the fasciae were critical.

- Special care was required for the skin suture: for the first time his unilateral intracutaneous variation of the Donati suture is recommended and illustrated (Te 114).
- Suction drainage with Redon drains is generally recommended. They are to be removed after 24–28 hours (Te 24).
- The wound should only be covered with a thin protective bandage (with the exception of the hip region where there is friction) (Te 24, 117).

Postoperative treatment in hospital

- For fractures of the lower limb and foot, a right-angled U-type plaster splint with sole is mounted over the wound dressing to relieve pain (Te 24).
- The lower limb (Me I/1, Me II/24, Te 24f) is elevated with the knee slightly bent and protected in a foam splint (to prevent pressure-induced paralysis).
- After removal of the drains, the wound is left open.
- Postoperative early mobilization of the joints and muscles is emphasized in all written communications. This is not new:
  - Lambotte advocated the early active mobilization of the joints for stable synthesis in 1907 to avoid muscle atrophy and joint stiffness: *"éviter par la mobilisation précoce les raideurs articulaires et les atrophies mus-*

culaires"[26]. He starts with the "*mouvements actifs*" after removal of the first bandage, that is, on the third to fourth day.
- For Danis active mobilization was the primary objective of osteosynthesis[27]. This was his justification for regarding slight dislocations as an indication for operative intervention.

A detailed description of the aftercare is given in Te 117–121, the chapter on lower limb fractures. The importance of the first voluntary movements without pain is mentioned for the first time here.

- All the joints of the injured limb are moved actively under instruction until full function has been regained.
- After swelling has subsided and wound healing is certain, the patient learns to walk on crutches without bearing weight on the injured leg. The skin sutures are removed after approximately 10 days.
- On discharge from hospital, the question of further procedure arises: circular plaster for 8–12 weeks (as protection), walking calipers or rehabilitation without an external fixator (for "*solid constructions*"). The personality of the patient plays a crucial role.

With reference to early local complications, it only says (Te 24) "*a late haematoma* (after removal of drains) *is punctured under sterile conditions*".

Treatment after discharge from hospital

The instructions for assessment of the postoperative care of tibial fractures are exemplary (Te 121f). Partial weight-bearing commences between the third and tenth weeks and is gradually increased. A table is included.

The clinical picture dictates the course of treatment. Pain indicates remodelling processes (turbulence in the bone). Overheating and redness are alarm signals, but oedema will often react positively to elevation of the limb.

Radiographs must be made – provided there are no signs of irritation – at intervals of 6, 10 and 14 weeks postoperatively. After this time, the fracture line should have disappeared (primary fracture healing) without callus becoming visible. Now, the limb can be loaded without hesitation and no further assessments are necessary until implant removal.

Under the heading "*Follow-up assessments*" (Me II/18, Te 25f) the Guidelines and the general section of "Technik" speak of the follow-up examinations at 4 and 12 months because these can have "*consequences for treatment*" (e.g. diagnosis of an impending pseudarthrosis). The code sheets together with the corresponding radiographs form the basis of the documentation.

Postoperative callus

If after 14 weeks the fracture lines are still clearly visible, this indicates osteolysis. Callus is also seen. This is either:

- "*Cal excité*"[28], in English "*irritation callus*". This is nebulous, blurred, and "*can be regarded as a reaction to excessive instability*" (Te 123), thus requiring immediate immobilization of the limb.
- During the further course of healing, the clinical symptoms frequently subside and the radiographic findings return to the expected pattern. Less often – but particularly if loading is continued – a pseudarthrosis may develop.
- Or, a second form of callus which is periosteal, localized, sharply delineated, and usually causes no clinical symptoms. It has been called a "*fixation callus*" and indicate a slight irritable reaction which has already healed. The term originated from the team in Chur. Manuscripts on this subject were published by the radiologist Wieser[29].

Implant removal

On this matter, the opinions of the forerunners differ from those of the AO whereby it should be remembered that Lambotte and Danis did not perform intramedullary nailing.

- Lambotte[30] writes that the deeply situated implants were so inert that he only removed them in exceptional cases, e.g. in cases of unclear neuralgic symptoms, fine serous fistulae or if plates near the joints were causing mechanical hindrance.
- Danis was of the same opinion[31]. He only removed implants if the patients especially requested it, with the exception of percutaneous plates, but even these were well tolerated in the forearm[32].

In all the writings of the AO, implant removal after definitive consolidation is recommended. The instrumentation takes this into account: hexagonal recess of the screwhead, no implantation of shaft screws, wide shaft for cancellous bone screws, special extraction systems for the intramedullary nails. In the Guidelines, it says that, in principle, plates and screws should be removed after 9–12 months because the implants *"exert unphysiological tensile and compressive forces"* (Me I/Introduction, 10, Me II/17). The bone needs to readjust its inner structure (*"recover its elasticity"*). After fractures of cancellous bone and especially after malleolar fractures (syndesmoses), fixation for two months should generally be sufficient. Intramedullary nails should be removed after one year at the earliest.

Identical statements are to be found in "Technik" (Te 27–31); the time for plate and screw removal is set at 12 months and at 3 months for fractures of cancellous bone. In older patients without any local complaints, the material can be left in situ.

Before removing the implants, it should *"be ascertained that the fracture has completely consolidated, which might not always be easy to determine. It may be the case, especially after synthesis with two plates for multi-fragmentary fractures, that the blood supply was so severely impaired that one of the fragments is still in the process of remodelling"* (Te 31). Vascularity can be tested during the operation by chipping into the fragments and possibly a plate will be left in situ or cancellous bone grafting performed.

The word *"refracture"* only appears once (Te 229) as a warning against removing implants too soon after diaphyseal fracture of the forearm.

Techniques of implant removal are detailed in the chapter on lower limb fracture in "Technik" (Te 124ff): the cosmetic result should not be jeopardized by a removal operation. Screws should be extracted through small incisions at an out-patient appointment; plates are removed by partial re-incision of the existing scar. The hospital stay may last 4–5 days.

Following plate and nail removal *"for two months exceptional demands"* (sport) were prohibited (Te 125).

The AO techniques

Three types of osteosynthesis are given as approved In the Guidelines (Me I, 1,6): the intramedullary load carrier, compression between fragments, and the angled blade plates. Details of operative technique were defined in relation to the instrumentation.

Once again, in the Guidelines, theories, techniques and instrumentation are described in relation to their typical sites of application, e.g. *"screw fixation of tibial shaft fractures"* (Me II/26–31).

In the book "Technik" published in 1963 basic techniques and instrumentation are dealt with together – the detailed presentation of which was of prime importance to the contemporary reader. The topic appears in the general section (Te 41–82), separate from discussion of local applications. The latter are discussed in their own special sections.

The basic AO techniques have become common knowledge (e.g. lag screw fixation, reamed intramedullary nailing). Here these topics will only be discussed if they relate to developments by the forerunners or the AO in the period up to 1963.

Screw fixation in cortical bone

This is reserved for long diaphyseal torsional or oblique fractures for which there is a large area of interfragmentary contact after anatomical reduction and which are not exposed to large forces postoperatively, that is to say, primarily fractures of the tibia.

For screw fixation of the diaphysis, Lambotte compressed the reduced fragments with his powerful reduction forceps and drilled through them both with his mechanical drill. The implant itself does not exert a compression force (**Fig. 7-6**)[33]. He used cerclage wires for wedge fractures and an additional fixator.

Danis achieved interfragmentary compression as follows: With his high-revolution machine he drilled through both cortices[34] and then enlarged the hole in the near cortex using a reamer to make a gliding hole (**Fig. 6-8**)[35].

AO technique was much more precise: for the instrumentation, the reader is referred to Chapter 6-1 and the corresponding illustrations.

A power drill at low rpm was used for all holes. The drill bits were always inserted and centred through protective sleeves. Screw length measurement is atraumatic. Compression is felt when tightening the screw because of a small amount of friction (difference in the diameter of the drill bit and the core diameter of the screw).

The definitions of optimal position of the screws (there must be at least two) vary: for simple fractures Lambotte and Danis place their screws perpendicular to the diaphysis[36,37]. For wedge fractures Danis inserts his screws perpendicular to the fracture lines (**Fig. 7-7**)[38]. At the AO Bandi defined the optimal position according to his mechanical experiments (Me II/27,29, Te 52): one screw should be inserted perpendicular to the shaft axis, the remaining screws should be inserted on the bisecting line between the shaft axis and the perpendicular to the fracture gap. This somewhat abstract and seemingly complicated technique is clarified by

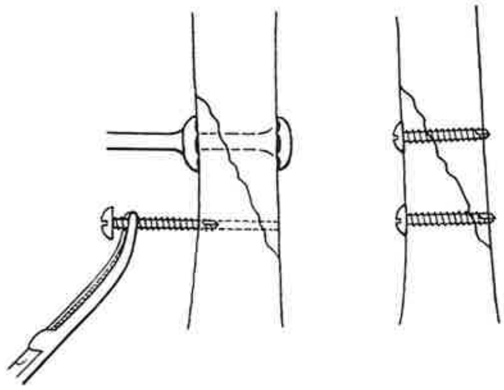

Fig. 7-6: Cortical screw fixation as performed by Lambotte. After reduction, compression using powerful pliers. Pre-drilling and insertion of the self-tapping screws. No interfragmentary compression by the screws. Taken from Lambotte 1913 p.59.

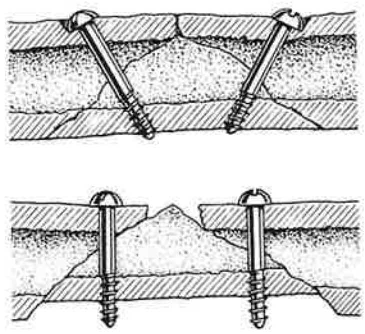

Fig. 7-7: Screw position in a wedge fragment according to Danis: perpendicular to the fracture lines. Taken from Danis 1949 p.82.

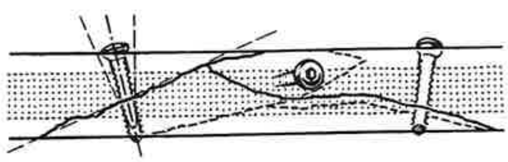

Fig. 7-8: The correct screw position for a wedge fracture according to AO doctrine: a screw joins the main fragments together, the other screws are positioned to bisect the angle between the fracture plane and the bone axis. According to Te 51.

a diagram (Te 51, **Fig. 7-8**). For a butterfly fragment, one screw should be anchored in both main fragments.

Early enthusiasm for screw fixation alone waned after a time. The demands on operative precision were high and direct consolidation was not always achieved, partly because postoperative loading was often underestimated.

Screws combined with plates

In 1961 the combination of screws and plates was introduced increasingly for long shaft fractures (in various planes). In the Guidelines (Me I/4,7, Me II/47) it says that *"there is still a need to gather experience"* because late results were not yet available.

In "Technik" (Te 53f) it is stated that *"for oblique fractures and butterfly fractures of the tibia a (narrow) plate combined with screws inserted perpendicular to it is sufficient to ensure stability".* This rather tentative remark in the general section of the book had already been outstripped by clinical practice as can be deduced from one of the chapters in the special section (Te 84–166).

The statistics of all osteosyntheses performed in the winter of 1961–62 in Chur (Te 126–160, 328–336) demonstrated the results of these interventions in a dedicated clinic very well. This is a complete series of cases documented radiographically and clinically up to the final follow-up assessment. It comprises 83 screw fixations, 76 combined plate and screw fixations, 12 intramedullary nailing procedures (for short fractures), 15 deep intraarticular and two proximal fractures. For the plate and screw syntheses a superficial late infection only occurred once (and healed after implant removal), there was one tibialis anterior syndrome, and two refractures. In one case, secondary nailing was performed to avert possible pseudarthrosis. Postoperatively, all joints were mobilized. After wound healing, the majority of patients were equipped with an individually custom-made walking caliper, providing support at the tibial condyles and the patella. In only four cases was it necessary to apply a plaster cast enclosing the knee joint. Nine patients required no external fixation at all. At that time, great caution was exercised regarding full weight-bearing (walking without sticks): It was achieved on average after 14.6 weeks (6–36 weeks). At the one year follow-up, a slight restriction of movement at the ankle joint was diagnosed for seven patients. All case files, except one, could be closed by the insurance companies with no record of permanent disability.

This and two other studies, also with a complete record of the late results of subsequent series of operatively treated tibial fractures, could be successfully performed and documented thanks to the untiring efforts of Mrs Eva Segmüller, wife of senior registrar G. Segmüller in Chur.

Axial compression with the plate subsequently became mandatory. All plate fixations of the tibia as recorded in the documentation and in the illustrations in "Technik" (Te 90,91) are tensioned. Retrospectively, the question arises of whether axial compression made sense for long oblique and torsional fractures. Connecting the main fragments without compression, that is to say, splinting (later in the *Manual* of 1969[39] described as *"neutralization"* of forces or *"protection"* for a screw fixation) was foreign to the thinking of the day.

The compression plate

For plates Lambotte only required perfect reduction: "*... coaptation ... mathématique*[40]". The postulate of interfragmentary axial compression with the plate goes back to Danis[41]. His *"coapteur"* was intended to create "*... une immobilisation puissante, une pression vraiment axiale*". The construction was however rather delicate, complicated to handle, and its displacement distance (thus, the possible compression force) too short.

The AO plate was designed for osteosynthesis of transverse and short oblique fractures and pseudarthroses of the forearm, humeral, and femoral shaft. With the external tensioning device, considerable pressure could be exerted on the fragments (30–60 kg, Te 55).

For *forearm bones* the technical details are described in the Guidelines (Me I/4,3–6, MeII/43–46):

- Reference is made to a special sheet (untraceable) describing the approach. A more exact description of difficult approaches for the shaft of the radius is also missing in "Technik" (Te 225–227).
- A distinction is made between application for simple transverse fractures (4-hole plate) and multi-fragmentary fractures (5–6-hole plate).
- For pseudarthroses, axial and rotational alignment has to be restored by osteotomy and the pseudarthrotic gap subjected to pressure. For pseudarthroses after nailing and for defects, autogenous cancellous bone graft should be inserted into the medullary cavity and adjacent to the bone. For atrophic bones, cortical bone graft on the opposite side is recommended (no example in the documentation). There is a description of shortening of the ulna after a distal radius fracture.

The optimal position of the plate on the radius is not defined in the Guidelines. In the relevant chapter in "Technik" (Te 223–231) it says that the radius plate may be applied to the distal or mid-third radially or dorsoradially, and to the proximal shaft dorsally. Some new advice here is that the plate may be bent slightly (Te 227). This had been recommended by Danis in 1949[42].

Application of the narrow plate for tibial fractures has already been reported.

Humeral fractures

In the Guidelines there are only a few brief remarks in the section on compression plating techniques (Me I/4,6, MeII/46).

In "Technik" the relevant chapter (Te 254–267) was written by Bandi and Mumenthaler. Pseudarthroses are not mentioned. Primary osteosynthesis with six and eight hole plates is particularly recommended for transverse and short oblique fractures since *"good results have been … consistently achieved"* (Te 260). The approaches are described. Indications are limited for oblique and fragmentary fractures. Double plating or *"graft from the iliac crest opposite the plate"* is recommended (no documented cases). Six radiographs of successful treatments are included. One of these shows a prototype of a T-plate applied to an oblique fracture of the distal humerus via a dorsal approach.

Opinions regarding the adjacent radial nerve changed: In the first version of the Guidelines, it said: *"… is generally not exposed at all"* (Me I/4,6). In the second version of the Guidelines (Me II/46) it must be exposed in the *"distal third"*, whereas in "Technik" (Te 264) general identification of the nerve is required. Its position in relation to the implant must be noted.

In the section on distal fractures (Te 268–279) paediatric injuries dominate (treated with K-wires or single screws). Supracondylar, predominantly cortical fractures in adults are stabilized by one or two narrow plates *"without compression"* (Te 272).

Femoral fractures

Two plates are necessary for compression osteosynthesis; their fixation screws are at right angles to each other and they must be tensioned simultaneously (Te 213).

Double plating

In 1916 Hey-Groves had already applied two plates opposite each other on the diaphysis[43]. The *"coapteur jumelé"* by Danis is similar[44] (**Fig. 7-9**): He used an aiming device to drill through both plates and fixed them with threaded rods and nuts. On pp. 234–237 he records three pseudarthroses treated successfully with this technique. The two AO plates fixed at right angles to each other by screws caused less devitalization.

In the Guidelines the double plating technique is justified *"to achieve absolute stability"* (Me I/4,6, ME II/46). Pseudarthrosis is named as the most appropriate indication *"if for some reason a nail cannot be inserted"*. Double plating was also recommended (and applied) for fractures of the femur (Te 213) and of the tibia. Although many results were good, some were catastrophic.

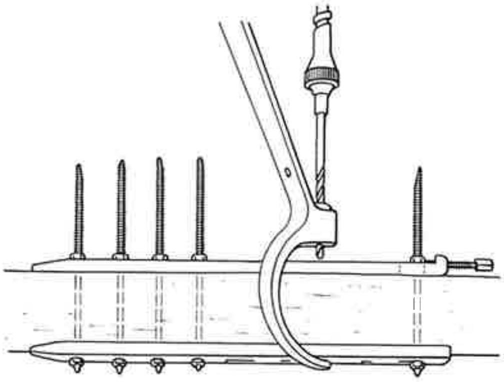

Fig. 7-9: Application of a double plate by Danis ("coapteur jumelé") on the femur after drilling with a C-shaped aiming device. The small axial screw compresses the first place screw and displaces the plate (interfragmentary compression – here asymmetrical). From Danis 1949 p. 104.

Implant removal in such cases had to be carefully performed in two stages because *"the blood supply was severely impaired"* (or might be) (Te 31).

Double plating is diametrically opposed to our current thinking. The mechanical justification for it was that tensioning a unilateral plate unavoidably led to gaping of the fracture at the opposite cortex. The objective was to achieve *"the elimination of the slightest movement at the fracture gap"* and simultaneously ensure that *"the limb was capable of weight-bearing"* (Te 57). Apparently, some were in favour of this at the time.

Osteosynthesis techniques in cancellous bone

Fractures in cancellous bone were an indication for operative intervention very early on, especially in cases of intraarticular dislocation. The stabilization devices available were K-wires, nails, flexible cerclage wires, and individual screws and threaded bolts. Additional external fixation was the rule. By inventive configurations and combinations of these implants, solid constructions were successfully assembled at various locations. In principle, even the three-lamellar nail for femoral neck fractures created a stable environment.

As the figures by Lambotte show[45] he compressed the reduced fragments with forceps (**Fig. 7-10**). The threads of his screws engage both fragments. The implants here are not compressive (**Fig. 7-11**). In 1932 Danis[46] introduced systematic interfragmentary compression in cancellous bone for the first time with his special *"vis hélicoidale"*.

The Guidelines hardly mention these fractures. Therefore, reference must be made to the relevant sections in "Technik". These are: distal and proximal tibial fractures, malleolar fractures, fractures of the patella, of the proximal humerus and of the navicular bone of the hand.

The distal intraarticular tibial fracture (Pilon). The special character of this injury, which was rare at that time, was only recognized gradually. It is not mentioned in the Guidelines. The operative procedure had to be developed.

In "Technik" in 1963 (Te 90–95) Allgöwer had defined the Guidelines for these syntheses for the first time. They have remained valid for the most part ever since. It is a procedure in four stages: primary synthesis of the fibular fracture (at that time performed by intramedullary, distally contoured splint, and possibly an additional cerclage wire); anatomical reconstruction of the articular surface of the tibia; filling of the frequently observed cancellous bone defect with autogenous graft and, as a fourth step, definitive stabilization of the tibia. If possible, this

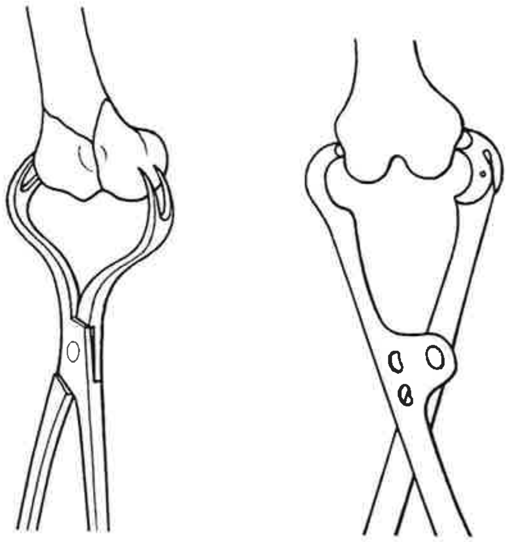

Fig. 7-10: Temporary fixation and compression of joint fractures with powerful pliers (left taken from Lambotte 1907 p. 37, right from Lambotte 1913 p.20).

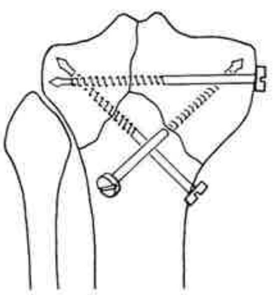

Fig. 7-11: Screw fixation in cancellous bone as performed by Lambotte: the screw threads engage in both fragments, that is, they do *not* exert compression. From Lambotte 1913 p.279.

was achieved by insertion of screws. However, even in a series of 15 cases recorded in 1961–62 in Chur (Te 160–65) the plate was beginning to dominate, mainly applied to the medial aspect as a *"buttress"*. This term for plate function was first used by Allgöwer in "Technik" (Te 102, 110f).

Fractures of the proximal tibia. These fractures of cancellous bone were infrequent then. Before the AO implants came into being, they were managed with threaded bolts. In "Technik" four pages are given over to this topic (Te 107–111) and there are four radiographic examples. The series in Chur includes only two cases (Te 165). Individual screws or the highly stable, but bulky right-angled plates were preferred initially as buttress and compression fixation devices applied via a medial approach. Malalignments were corrected in a similar manner. Lateral plates only appear towards the end of 1962.

Malleolar fractures. It was recognized early on that non operative treatment would not permit exact reduction nor retention of the reduction and it was hoped that the late results could be improved by operative treatment. The pioneers were Lambotte and, above all, Danis. Whereas previously reduction of the inner ankle had been the main objective (in 1955 Baumann published an article on prevention of pseudarthrosis of the inner ankle)[47]), Danis in 1949[48] placed fractures of the external malleolus and the fibula at the forefront of his classification. Its anatomical reconstruction became the primary focus of the synthesis.

Of the founding members of the AO it was Willenegger in Liestal who had concerned himself with these issues since 1953. With a view to his publication in 1961[49] he carried out a late follow-up of patients he had operated on previously. This series was the basis for a joint publication including the patient sample from the City Hospital Zürich-Waid (it did not appear until 1971[50]) in which the operative and non operative treatment of these fractures is compared. This was and is the only work of its type in international literature.

First and foremost, it was necessary to deal with the *"burst mortise"*, the diastasis between the tibia and fibula due to rupture of the syndesmosis. Initially, the existing threaded bolts were used. The implant is illustrated in the Guidelines and listed in "Technik" under *"additional instruments"* (Te 79). Several cases operated on from 1953–1958 were documented. It was however generally impossible to prevent secondary dislocation and arthrosis. One example is reproduced in "Technik" (Te 173).

If reduction was adequate, then oblique spiking of the fibular fracture with several K-wires was stable enough, provided the reduced inner ankle had also been stabilized. Often cerclage and hemi-cerclage wires were inserted into the fibula.

On the internal malleolus nail-like pins were inserted at first, and later screws.

In the Guidelines (Me II/34–47) the classification or division of fractures according to Danis is presented and then an emergency operation is proposed (unless there is skin damage). The first step should be stabilization of the fibula. Screw fixation of the tibia-fibular syndesmosis according to Danis was standard technique at the time. Only a *"large Volkmann's triangle"*, if it *"affected 1/4 or more of the articular surface of the tibia"*, should be treated operatively.

This instruction was included in "Technik" (Te 93). In contrast, Danis had performed reduction and screw fixation on small dorsolateral fragments as well (visualized from the dorsolateral aspect) in order to be sure of the exact position of the fibula in the tibial notch[51].

"Technik" (Te 169–208) includes a long chapter on this. The authors are Willenegger and Weber. In comparison to the Guidelines, revision and expansion of this topic took place under the obvious influence of the latter author. Numerous figures, some in duotone, promote the understanding of these complex osteo-ligamentous lesions.

One of the chief problems was posttraumatic arthrosis. Exploratory investigations by Willenegger on human cadavers (Te 172) showed that even the slightest axial deviation markedly reduced the contact surface between the tibia and talus. The work was only published in 1969[52]. The necessary test apparatus had been constructed in Waldenburg by Ms Pohler (PO). The demand for meticulous anatomical reconstruction was justified.

An overview of the new classification, based on that of Danis and still valid today, was produced by Weber (Te 178–180). The associated (sometimes isolated) ligamentous lesions are clearly illustrated as schematic representations in colour.

For the first time, small avulsions of the talus margins (*"flake fractures"*) are mentioned and illustrated (Te 183).

Operative technique became far more precise. Screw fixation, combined medullary splinting and cerclage wires on the fibula, and even *"tension band technique"* was being applied. Most importantly, the *"syndesmosis screw"*, which had been recommended in the Guidelines (Me II/39), was finally condemned.

From 1959 considerable technical development took place with regard to the treatment of these complex lesions. This evolution can be followed in detail by studying the radiographic examples in Chapter 8.

Patellar fractures. Patellar fractures were one of the earliest indications for operative treatment because of the transference of the forces of the thigh musculature across the knee to the tibia. The fragments were generally fixed by encircling them with cerclage wires and the leg was immobilized in a plaster.

The Guidelines (Me I/9, Me II/65–68) recommend osteosynthesis for fractures with lesions of the extensors whereby the "tension band technique" as introduced by Pauwels in 1946[53] (seen by Müller in Aachen (MM)) was also applied. Fixation was performed by inserting two tensioned cerclage wires into the fibrous layers on the ventral side of the patella. This created a broad area of contact between the fracture fragments when the knee was flexed. If there were several fragments, these were united by K-wires beforehand. Aftercare focused on function without a plaster. Emergency patellectomy was recommended for comminuted fractures.

The section in "Technik" (Te 218–222) contains the same information as the Guidelines and is illustrated by two drawings and two examples.

Navicular fractures of the hand. Fractures of the navicular bone of the hand and, particularly, pseudarthrosis of the same were not uncommon at that time. They caused considerable disability and discomfort and led to invalidity, which was a concern of the insurance companies.

Various operative techniques were already known but the results were uncertain. Russe[54] had elaborated the technique of revivified cancellous bone graft developed by Matti in 1931[55] (published in 1960). The procedure was, however, demanding and still required a long period of postoperative immobilization.

Screw fixation seemed to be a solution for these injuries. It was hoped that stable osteosynthesis would not only lead reliably to consolidation but also shorten the period of postoperative immobilization. This procedure had already been described and recommended in the Guidelines (Me I/6 and Me II/32f).

H. Gasser, one of Willenegger's collaborators in Liestal, had concerned himself extensively with this fracture. He is co-author of the comprehensive chapter in "Technik" (Te 242–253), which contains numerous figures. These reflect an optimism which had to be moderated later on.

Fractures of the proximal ulna. These were explained by Weber in "Technik" (Te 232–242) who concentrated on articular and paraarticular fractures of the cancellous bone.

The isolated olecranon fracture was one of the earliest indications for open reduction (Lister[56]). Traditionally, wire cerclage was performed around the triceps tendon, through a distal drill hole and crossed dorsally. Lambotte also recorded screw fixations[57].

In the early years of the AO, an axial cancellous bone screw with washer inserted into the medullary cavity was preferred. Reduction and stability were not always optimal. Nonetheless, the screw was still used occasionally until 1963.

In the summer of 1961 in St. Gallen the stable tension band technique permitting full functional aftercare, now common practice, was introduced, probably by Weber. This takes the form of a combination of splinting with parallel K-wires and tensioned and crossed cerclage wires. In "Technik" (Te 233–36) the operative procedure is described in detail.

"Technik" contains a comprehensive section on the highly unstable Monteggia dislocation fracture (Te 236–38). In addition to plate osteosynthesis of the ulnar fracture (outline drawing with radiograph), the reconstruction (or possibly artificial replacement) of the annular ligament is proposed for the radius.

Distal radius fracture. "Technik" (Te 238–242) devotes a whole section to these fractures, which were a special concern of Willenegger. The main focus is on open or percutaneous oblique fixation with K-wires inserted at the styloid process in cases of unstable oblique or multifragmentary, irreducible and open fractures. Two radiographs illustrate the technical procedure which is described in detail.

The subcapital humeral fracture. In "Technik" (Te 257–263) there are several photographs, a schematic drawing, and three radiographs showing this fracture; Bandi had developed the T-plate for its fixation. The operative technique is described exactly and illustrated. Complications, for example, late necrosis of the head, are not mentioned.

Intramedullary nailing

Intramedullary nailing of the femur and tibia were the only generally known and established osteosynthesis techniques when the AO was founded. Willenegger had been familiar with them since 1941. He, Schneider and Weller were always the advocates of these techniques within the group. Danis wrote[58] that intramedullary nailing did not conform to his fundamental principles, therefore, he was not interested in it. Perhaps he had not been aware of Küntscher's nailing technique.

Since intramedullary nailing could not ensure anatomical reduction or absolute stability, fracture healing always occurred in the presence of callus formation and since rotational malalignment was not uncommon for closed procedures, certain reservations were expressed in the Guidelines (Me I/3,1, Me II/48) and later in "Technik" (Te 49f).

The relevant part of the general section in "Technik" (Te 57–66) was written by Müller. The texts written by consensus for the Guidelines were included unchanged in the book and are illustrated. From 1961 to the beginning of 1963, indication and technique for intramedullary nailing had remained the same.

The latter is general knowledge and is taken as given. Reaming of the medullary cavity was performed manually at first and from 1960 with a power-driven tool.

The *indications* – in accordance with the terminology in "Technik" (Te 60f) – are divided for tibia and femur into *"best, good, relative"* (called *"additional"* in the Guidelines) and also for *"exceptional circumstances"* (referred to in the Guidelines as *"very relative indications"*).

- optimal indications were delayed fracture healing or pseudarthroses in the diaphyseal mid-third, and short oblique and spiral fractures at the same location.
- good indications were:
  - splinter fractures of the femur in the mid-third whereby additional fixation of the fragments with cerclage wires is necessary, provided vascularity is good.
  - transverse, short oblique and wedge fractures of the tibia, even in the presence of unfavourable soft tissue injury. Attention must be paid to longitudinal fissures.

Relative and rare indications depend on the position of the fracture on the long bone which was divided into *"sixths"*. This reminds us of the later segmental divisions in Müller's classification of fractures in 1987[59]. Additional stabilizers were applied (antirotational wires, small plates, etc.) for fractures close to the joint.

Particular features of tibial nailing (Te 62–66):

- The open procedure for intramedullary nailing is described first and was obviously preferred. It was justified on the basis of the lack of image intensifier in many places and the greater ability to control stability under vision.
- The biological superiority of closed nailing was difficult to prove and was often discussed. In the Guidelines (Me I/3,8, Me II/52) and in "Technik" (Te 62) a lesser risk of infection was attributed to the closed technique.
- For a while, (from the end of 1960) attempts were made to improve stability by inserting the thickest possible nails (up to 14 mm). The result of such extreme reaming was that the cortex was reduced to a thin shell in some places. Examples are to be found in "Technik" (Te 155).

The Guidelines say nothing about techniques of femoral nailing. In "Technik" (Te 209–213) the author once again prefers the open procedure. It is less demanding than closed nailing: reduction is more reliable, fixation (with additional cerclage wires) is more stable. The approach is described and illustrated. Reaming (14–18 mm) starts at the fracture site and is directed proximally. After reduction and temporary fixation, reaming is continued distally from the trochanteric block. If rotational alignment is not satisfactory, an additional thin, unicortically fixed plate can be screwed into position.

Complications are only discussed with reference to tibial nailing (Te 166–169):

These include: incorrect position, incorrect approach, wrong choice of nail, complications during reaming (avulsion of fissures, heat damage, weakening or elimination of the far cortex), perforation during insertion (incorrect orientation), jamming, complications at removal, and incorrect aftercare.

One of the most frequent complications – engraved on the memories of the collaborators at that time – is mentioned in "Technik" (Te 24f): The tip of a beak-shaped *"nail holder"* was inserted into the thin upper end of the AO nail. The 'beak' was supposed to lock onto a peg in the ventral hole at the top of the nail. The instrument is illustrated in the Guidelines and accompanied by a brief comment. The thing very often slipped during extraction and the *"extraction hook"*, also illustrated, regularly tore through the thin wall of the nail. In "Technik" this system is still referred to (Te 65). A solution was found later in the form of the conical thread.

Compression osteosynthesis with external tensioning devices

This technique, which was developed early by Müller, is presented in the Guidelines together with a schematic drawing. "Technik" includes a separate section (Te 71–75) on this topic. Indication and technique for arthrodesis of the knee and upper ankle are illustrated by schematic drawings taken from the Guidelines.

Angled blade plates for distal femoral fractures

These fractures were rare. In the Guidelines, the *"right-angled plate"* for supracondylar fractures was recommended and illustrated. The corresponding section in "Technik" (Te 213–217) is brief and contains two radiographic images which may belong to the diaphysis. Approach and detailed procedure are described and illustrated. The very significant widespread application of this implant was only to take place years later.

Fractures in the pelvic region

The relevant chapter VIII in "Technik" (Te 288, 290) starts with the restrictive remark that here only *"those fractures will be discussed which are particularly well-suited to osteosynthesis"*. At that time, pelvic and acetabular fractures were rare and indications and techniques not yet defined.

The section on medial *femoral neck adduction fractures* (Te 284–294) keeps to well trodden paths since this injury had been an undisputed indication for operative intervention for decades. The Smith-Petersen three-lamellar nail as modified by Böhler had been introduced everywhere.

Reduction of the femoral head was to be achieved under vision with some valgus and antetorsion and stabilized with the angled blade plate. A detailed knowledge of this technique with final impaction of the fragments can be assumed. It is clearly demonstrated by the illustrations (Te 288, 290).

To prevent necrosis of the femoral head careful osteosynthesis without distraction should be performed as an emergency operation. In children and adolescents with hard cancellous bone, screws alone should be implanted.

In elderly patients or patients in poor physical condition, the insertion of a femoral head prosthesis is recommended. This was declared for the first time in the second version of the Guidelines (Me II/64). The corresponding technique is described and illustrated by a radiograph (Te 293f).

Pertrochanteric fractures (Te 294–299). These are likewise indisputable indications for the earliest possible stable osteosynthesis procedure. The angled blade plates were the newest implants to become available for these fractures. Their application is given in detail in "Technik" (Te 294–299). Knowledge of these techniques is assumed.

For comminuted fractures, the combination of a plate with a bone cement seal was used (Te 298).

The circumstances surrounding osteosynthesis

In the appendix of the book "Technik" (Te 302–327) three problematic areas relating to the question of osteosynthesis, in terms of both theory and technique, are addressed.

Open fractures (Te 302–308)

Neither Lambotte nor Danis presented a concept for the treatment of open fractures. They expressed themselves evasively or referred to individual cases[60, 61]. Only Küntscher took up a clear position and proposed the delayed nailing technique[62].

In 1959 the French authors Gosset, Merle d'Aubigné, Michon and Vilain published works on this topic which are referred to in "Technik" (Te 303). From the summaries in the *"Annales de Chirurgie"*[63] it can be deduced that only younger surgeons attempted operative stabilization of the fracture. Extensive debridement (so-called *"parage"*) and a tension-free skin suture are emphasized. Emergency skin grafting has been abandoned.

From the ranks of the AO founders a 78 page paper originated in 1958 written by Ott on the treatment of open comminuted fractures of the lower limb with extensive concomitant soft tissue injury[64]. 30 fractures were analysed and emergency stabilization under antibiotic cover was resolutely proposed.

The *AO Guidelines* are exemplary. First of all, they take into account that 90% of infections arise from hospital germs and that more than 50% of the *"care staff"* (including the surgeons – comment by the author) are germ carriers. This explains the regulation that the wound dressing was to be opened personally by the surgeon under aseptic conditions in the operating theatre and not before. Furthermore, they recognized that there was massive germ reproduction in the wounds after 6–10 hours and therefore debridement and wound excision had to be done beforehand.

Antiseptic agents are rejected as cytotoxic. Intensive wound irrigation is performed only with physiological Ringer solution.

Attention is drawn to subcutaneous decollement and tension haematoma and to the need for postoperative suction drainage.

The long dorsal relief incision *"according to Picot"* (Fig. Te 303) is recommended. *"rotary sliding flaps or other early grafts"* (mentioned in the Guidelines) are no longer performed as emergency procedures. Wounds are sometimes covered with non adherent gauze and treated later.

With regard to treatment of the fracture itself, the first commandment was *"the absolute immobilization of the bone"*. Despite locally diminished nutrition and vitality and lowered resistance of the organism primary osteosynthesis is defended on the grounds of optimal stability, painlessness, shortened treatment time, and better functional outcomes.

But, the operation must be performed within the 8–10 hour limit and follow the described technique exactly: it should be the second and separate intervention following the completed first operation for the treatment of the wound. Only a minimum amount of foreign material should be implanted and this was to be covered with vital tissue. The text is accompanied by two figures (Te 307–308). To conclude reference is made to the good results achieved by the author of this chapter.

The text on recommended tactical and technical procedure was reproduced in structure and content almost word for word in "Technik" under the title *"Precautions"* (Te 304–306). The procedure is divided into four phases:

A *Precautions on admission:* treatment of shock, case history, general examination, radiology, antibiotic drip, preparation for the operation. Lastly (possibly under anaesthetic), opening the bandage and sterile inspection of the wound by the surgeon, colour photograph.

The wounds are subdivided into

a Internal perforation and incised wounds
b wounds with not too much traumatized tissue and relatively little contamination
c wounds with extensive damage to the soft tissues and a lot of foreign material (Me I/10,2).

In the second version of the Guidelines, the term *"contusion wound"* appears (Me II/71) and is repeated in "Technik" (Te 305).

B *Preparation of the operation:* Anaesthetic (often already administered under A), sterile shaving, disinfection by the surgeon, wound irrigation (Ringer solution), tourniquet (referred to in the Guidelines as *"restricted blood circulation in Trendelenburg's position"*), then adhesive resin (mastisol) and application of a plastic film.

C *Operation:* This was performed in two strictly separated stages:

C 1 Treatment of the wound. It commences with another extensive irrigation. In the case of a type A skin injury, careful excision of the wound margins, cleansing of the visible bone fragment and synthesis as for a closed fracture.

For contusion wounds (types b and c): careful excision of the wound margins, then debridement: wound enlargement, excision of all contaminated tissue, transverse incision of the fasciae, removal of all foreign particles by suction and irrigation. Detached bone splinters are cleaned and placed in penicillin (and put back later), torn tendons and nerves are adapted with fine catgut. Release of the tourniquet, fine ligatures.

Then follows a complete change of operating attire and instrumentation. Renewed draping and disinfection.

C 2 Treatment of the fracture. This consists of a typical AO osteosynthesis, but performed so that the implants *"are under a viable covering, on the lower leg they will generally be situated on the lateral side of the tibia"* (Me II/72, Te 306). The second version of the Guidelines and the book "Technik" require, in addition, a separate incision as far as possible away from the primary wound. Plating is preferred. To prevent gaps *"each bone fragment should be carefully replaced"*. The *"primary application of two compression plates"* was still being referred to in the first version of the Guidelines (Me I/10,4). Delayed, closed intramedullary nailing (the procedure according to Küntscher) was accepted (Te 304).

C 3 Suture of the wound. *"primary wound closure"* is described as *"desirable"* (Me II/72, Te 306). The first Guidelines state: *"in every case ..."* (Me I/10,4) and recommendations were made for relieving incisions and rotation flaps.

In the second Guidelines it is emphasized that the skin suture should *"never be under even the slightest tension"*. Large, dorsal relieving incision. If necessary, the wound *"is first to be covered with bio-gauze"* before the rotation flap procedure can be performed (Me II/72f). The same requirements are stated twice in "Technik" (Te 306), however, with the additional statement that: *"Immediate flap procedures have lost their worth to some extent"*.

D *Aftercare.* It consists of (and the texts are in agreement):

- Local: compression bandage with rubber foam, elastic support bandages, U-type plaster splint, and elevation, constant checks on circulation
- General: tetanus prophylaxis, intravenous antibiotics for at least 3–5 days, thrombosis prophylaxis, etc.
- Gradual mobilization (delayed for a few days).

Retrospectively, it is astonishing that the external fixator was not incorporated into AO technique for the stabilization of open fractures. It seems obvious that plate application away from the wound was preferred. A few years before his death Willenegger remembered *"how good the plate had been for it"* (LM).

This despite the fact that Lambotte had already thought of his clamp fixator in 1902[65] and had gained great experience with it on shaft fractures of all types by 1913 and documented them. The model he drew in 1913[66] (**Fig. 7-12**) is so versatile that it approaches even the most recent developments today. But Danis did not use the fixator either. In the AO it appears for the first time as a rigid frame construction presented in the chapter on open fractures in the second Manual published in 1977[67].

The problem of infection and osteosynthesis

The call for perfect asepsis is apparent from all communications on the operative treatment of fractures. Every implanted foreign body will increase the risk of infection. Even in "Technik" (Te 309) there are reminders. Postoperative infections were the fundamental reason why osteosynthesis as a method had fallen into discredit before.

In 1907 Lambotte wrote[68] that the only serious objection to an operation was that it exposed the patient to a higher risk of infection *"la seule objection sérieuse ... le danger que l'on peut faire courir au blessé du fait de l'infection ..."*. Danis agreed with him and stressed that postoperative infection signifies the defeat of the method *"... la défaite de principe"*.[69]

Postoperative osteitis was and is an extremely serious complication which requires very time-consuming treatment, sometimes taking years, and which is a psychological burden on surgeon and patient alike. Restoration of function and social restitution used to be the exceptions. In the general section of "Technik" it says (Te 21): *"For closed fractures treated by osteosynthesis just one single case of osteitis in a thousand is a drama ..."*.

The first mention of infection after osteosynthesis and the treatment of it is found in "Technik" (Te 309–317). The authors are Allgöwer and Willenegger.

The chapter is entitled *"Guidelines for the administration of antibiotics and the treatment of infections after osteosynthesis"*. This sounds more like the end of the road but, in fact, in-

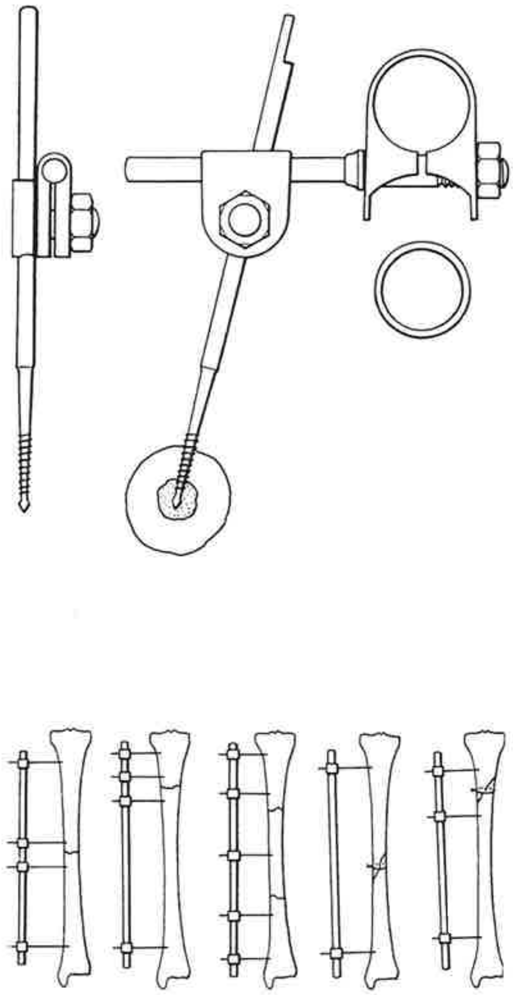

Fig. 7-12: The external clamp fixator by Lambotte 1913. The clamps permit the fixation of diverging screws in all planes and their connection to the rod (p. 76). Bottom: Application of the fixator for various types of tibial fracture (p. 80f).

fections after osteosynthesis were infrequent within the AO. Allgöwer remembers his statistics on 188 cases (Te 328–336) in which only one single late bone infection after nailing (open RTA) and one subcutaneous infection after plate fixation occurred.

Two main principles for surgery were formulated:

A For infection in the presence of a stable implant, the implants should be left in situ and local chemotherapeutic treatment (irrigation-drainage) commenced.

B The implant is only removed if there is instability and a *"periosseous callus bridge induced by means of cancellous bone grafting"* (Te 309). It may be necessary to select a separate *"non compromised"* approach in order to insert the graft.

To fight infection there was a need for a clear "antibiotic policy" which the general practitioners of the region had to be involved in. This would control the development of resistant germs.

Antibiotics should only be given in the case of manifest infection and then administered in high doses intravenously – at that time, a combination of high-dose penicillin and streptomycin.

A list of the most commonly used antibiotics, already quite numerous, and their properties and side-effects is given.

The section on *"The local application of antibiotics"* (Te312–317) was devoted primarily to a detailed description of the local irrigation-drainage as developed and practised by Willenegger for many years (already published in 1951[70]). This is a combination of mechanical cleansing and bacteriostatic surface treatment. At that time, patients from other hospitals were often referred to Liestal for this treatment.

Infection after medullary nailing was given as the best indication and all the treatment phases of an impressive example of full functional restoration are illustrated and commented on. A second example shows a fully healed subcutaneous infection after screw fixation.

These two cases with their positive course of healing leave behind a far too optimistic impression.

It seems that only a few discussions of the subject took place within the circles of the AO. At the AO Meeting of July 8–9, 1960 in Davos Ott held a lecture on *"open fractures and osteomyelitis"* (Schn II/113), which however was not mentioned in the relevant Annual Report.

The problem of infection only appears as a main topic at the Autumn Meeting in November 1963 with the lecturers: Good, Allgöwer, Willenegger and Müller (Schn II/114). That is all there is to find out. The book "Technik" had already been published by this time. The regulations given in the printed text had been drawn up about one year before.

The problem of shock (Te 318–327)

The author of this final chapter is Allgöwer. He had concentrated on pathophysiology very early on (especially burn injuries). He had gained experience with multiple fractures and polytrauma even though these conditions were infrequent at the time. Direct measurement of blood volumes and central venous pressure had been introduced. Beforehand his collaborator, Burri, had done experimental work on the method in Davos[71].

- In shock diagnosis, it is important to differentiate between *"imminent shock"* defined as *"cold normotonic tachycardia"* and actual shock defined as *"cold hypotonic tachycardia"* on the basis of the parameters: arterial blood pressure, pulse rate, peripheral circulation, and urine secretion.
- Aetiology and pathogenesis *"are not yet understood in detail"*. Blood loss is of prime importance and this, together with pseudoagglutination (*"sludging"*) of the erythrocytes leads to an impairment of the microcirculation. The consequences are toxin resorption from digestive tract or wound bacteria, and liver or kidney failure.

The problem of the formation and treatment of fat embolism (observed mainly after road traffic accidents) are discussed on the basis of current knowledge[72].

- In the treatment of shock the first few hours are crucial. Replacement of liquids and volume (mainly by blood) is essential, electrolyte solutions to combat acidosis (Ringer lactate), and low molecular Dextran, adequate pain control. Corticosteroids only in exceptional cases, no cardiovascular drugs, possibly Digitalis.
- The best parameter to assess the condition is the hourly urine output (30–40 cc.) and a venous pressure below 15 cm water column.
- After approximately two hours of intensive therapy the patient should be ready for an operation. The author advocates and successfully practises *"early operative stabilization of* (multiple) *fractured bones"* in order to prevent fat embolism later.

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Chapter 8
The individual practice of osteosynthesis and its development from 1958 to the end of 1963

The legends are translated by U. Heim

It is not possible to understand the methods and development of the AO without looking more closely at osteosynthesis techniques as practised in general and in individual cases.

In principle, the activities were in accordance with the Guidelines. In reality, considerable differences in the practical approach can be identified. These were dictated either by the variety of fracture patterns and the equipment available (which gradually diversified) or by the preferences of the chief surgeons.

The patient sample shows the creative variety that must inevitable spring from the fertile brains of independent surgeons (provision had been made for this in the Statutes § 12), provided activities remained true to the basic idea, namely, operative stability and functional rehabilitation.

This study was based on the material of the Documentation Center, the organization and methods of which were described in Chapter 6.

In the first 5 years approximately 6'000 fractures were recorded. All the cases documented and archived up until the end of 1963 were inspected (the archive is now held at the AO Center in Davos). The relevant negatives still exist, almost without exception, and can be reproduced.

In addition, syntheses for fracture dislocations, not mentioned in the Guidelines of 1961 or in "Technik" in 1963 are also documented (talus, calcaneus, forefoot, symphysis, clavicle-scapula, hand).

No doubt not all the fractures operated in the AO hospitals are to be found in the documentation (Schn II/252–255). The body of material is, nonetheless, very large and absolutely representative. The postoperative course was not always recorded. Since the focus here is on operative and technical details, these examples have still been included if they demonstrate a particular point.

The documentation also includes radiographs from the years before the foundation of the AO. These are sometimes cases with a very lengthy course that only healed after application of the new implants. Sometimes there are examples of earlier technologies in order to compare them with the new ones, either in internal discussion or in public lectures and written publications. This highlights the urgent need for alternative instrumentation: "old" implants remained in use while the "new" were gradually introduced or applied together with the existing ones.

Of these early cases only the radiographs remain. The code sheets to go with them have been lost – except in a few isolated cases (Appendix p. 223–225). This makes it impossible to assess injury to the soft tissues (open fractures?) and the functional outcome. The diagnosis of osseous infections is also uncertain. Some details are not discernable (e.g. cancellous bone graft).

Selected figures are shown here whenever visual proof seemed imperative for verification; they are enlarged copies of the stored photographic negatives. In the majority of cases, they are outline drawings of the miniature copies of the radiographs. This procedure, well known from the figures in the Manual of Osteosynthesis[1] has been chosen for the presentation of technical details. It has the great advantage of being less costly, requiring considerably less space, and of showing a typical finding more clearly. The data and additional circumstances of the injury plus the postoperative course, if known, are noted in the figure legends. Thus, it is possible to check the archive. Here and there a drawing helped out if the negatives were not to be found in the archive.

It was intended (and devised for the first version of this chapter) to list a far greater number of typical cases as proof of statements made in the text. However, this approach had to be abandoned in the interests of legibility. The material is available from the author and can be accessed at the AO Documentation Center in Davos together with the relevant documentation cards.

These cards are to be stored separately in a special place. The person to be contacted is the head of the Documentation Center.

Documents are available from the hospitals in Belp: HB; Bellinzona: MZ; Chur: AC; Freiburg i.Br.: KF; Glarus: BG; Grenchen: GG; Grosshöchstetten: SG; Interlaken: BI; Langnau: SL; Liestal: WL; Rorschach: OR; St. Gallen: MS; St-Imier: SJ; Thun: ST; Zürich-Waid: KZ.

We will start with the most frequent fracture site, fractures of the lower leg and ankle and will then turn to the other fractures.

Fractures of the lower leg

Shaft fractures

Before the AO the following treatment methods were generally accepted.

The fracture was first reduced under anaesthesia and the limb, including the foot and knee, immobilized in a plaster cast. For torsion and butterfly fractures – in which there was a tendency towards secondary dislocation due to muscle tension – several weeks of treatment by calcaneus traction preceded external fixation.

If the fracture could not be reduced or if a secondary dislocation occurred, then this was an indication to operate. For torsion and butterfly fractures this meant cerclage with several wires followed by a split plaster cast (**Fig. 8-1**). The so-called "Falzcerclage" (high compression cerclage) of Leemann, published in 1952[2], was in widespread use. However, the construction was prone to secondary loosening. This was followed by the appearance of irregular callus formation and pseudarthrosis (**Fig. 8-2**) so that this technique had to be abandoned eventually.

Intramedullary nailing was applied mainly as a secondary procedure for dislocation or delayed consolidation, generally using thin nails. Arduous manual drilling to open the medullary cavity was necessary before 1960 in order to introduce a more stable and thicker nail.

Open fractures were normally treated by wound closure and several weeks of immobilization in calcaneus traction followed by a circular plaster cast.

During the founding period lower leg fractures were by far the most frequent in all AO hospitals. There is a great volume of documentation (up to 1963 approximately 3000, i.e. about half of all the cases). The corresponding chapter in the 1963 book "Technik" is by far the largest covering 85 pages (Te 81–169). Thus, the social significance of these injuries at the time is obvious.

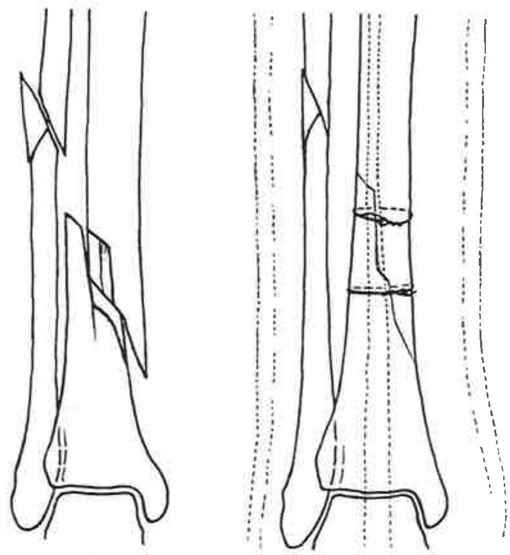


Fig. 8-1: The "traditional" Cerclage of a Tibia fracture. M. Walter born 1914: KZ 1/32. On January 23, 1958 typical spiral fracture of the lower leg. Cerclage of the Tibia, splitted plaster cast. Consolidated April 25.

Screw fixation of long torsion or butterfly fractures had been practised by Müller in various hospitals long before the foundation of the AO as a stable synthesis based on the ideas of Danis.

Indications and techniques have been given in Chapter 7. **Fig. 8-3** from May 1959 shows screw pull-out after incorrect screw positioning. If the screws are too close together, then the strength of the construction is insufficient. Necrosis may develop, as shown in **Fig. 8-4**, the fracture morphology of which is almost identical with that of **Fig. 8-5**.

For torsion and butterfly fractures in skiers, screw fixation on its own was performed at first in all AO clinics. A typical example is shown in **Fig. 8-5**.

In the winter of 1960/61 simultaneously in Chur and St. Gallen reinforcement and **securing of the screws by means of plates** commenced. At first, short plates were applied to join individual fragments (**Fig. 8-6**). Later, it was recognized that in butterfly fractures the plate should create a mechanical connection between the main fragments (**Fig. 8-7**). The plates had to be contoured and twisted slightly on the distal side to correspond to the anatomy of the tibia. There are numerous examples. Since it was necessary to drill absolutely centrally and vertically through the plate hole, there was a risk of penetrating into the joint distally (**Fig. 8-8**) (see also **Fig. 8-26**). Longer plates were used to treat more complex fractures. These were pretensioned axially which can be identified on the radiograph by the separate screw hole for the tensioning device. In "Technik" (Te 100, 115, 143–154) the examples even include the extremely long 12-hole plate (Te 99). Subsequently, plates were applied to the tibial shaft even for shorter fractures (also transverse fractures) although this had previously been an indication for intramedullary nailing.

Screw fixation and plate osteosynthesis as brand new, sophisticated operative techniques conserving the tissues and performed with fine

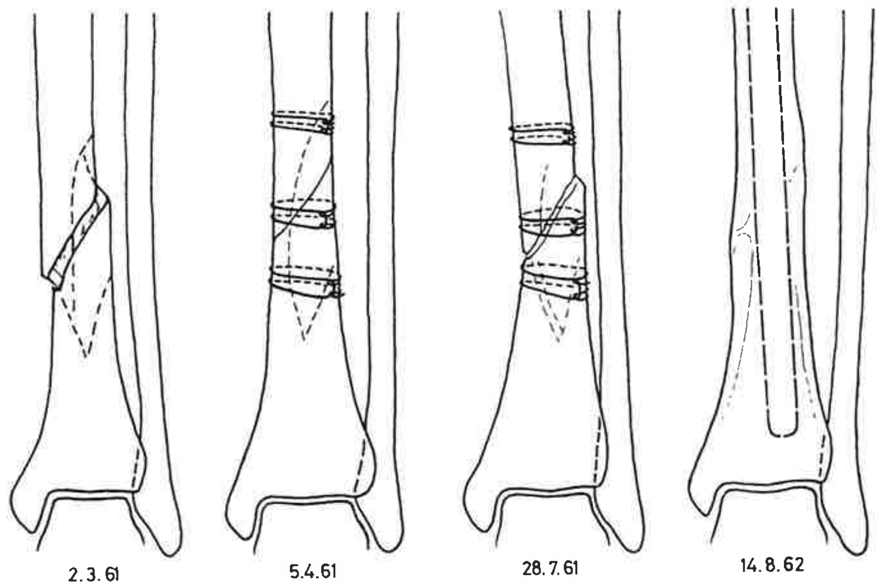


Fig. 8-2: Compression-Cerclage, displacement, medullary nail. W. Heidi born 1920: KZ 5/7. On March 2 1961 isolated Tibia fracture. Non operative treatment. April 5, 1961 compression cerclage (elsewhere). Three month later displacement, varus. On August 5, 1961 removal of the wires, intramedullary nail. Consolidated 4 month later, last X-ray August 14, 1962.

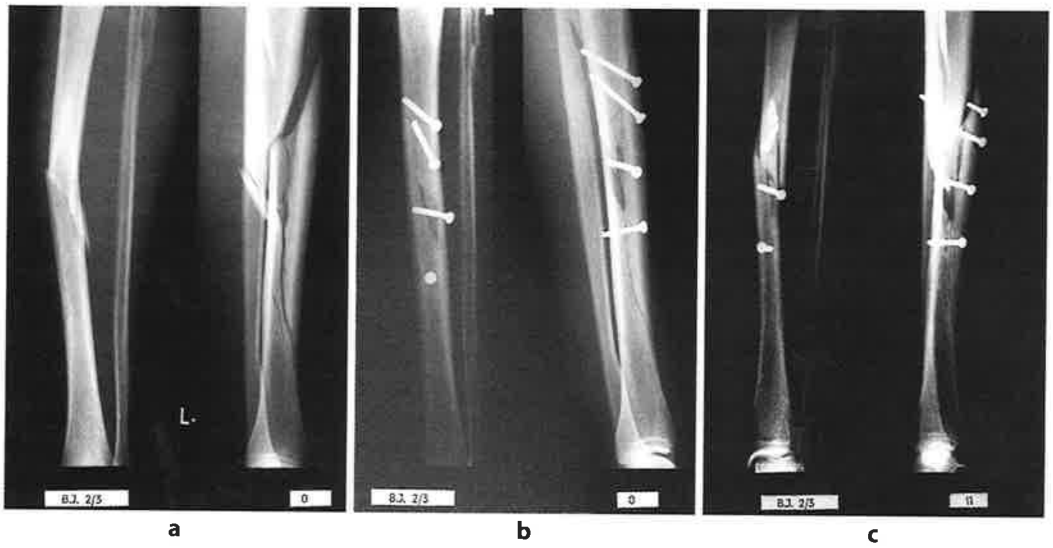


Fig. 8-3: Wrong screw positioning, secondary displacement. R. Charles born 1939: BJ 2/3 (a) On March 8, 1959 spiral fracture with a long butterfly (and a small additional wedge) fragment. (b) Next day internal Fixation with screws. The proximal ones are too steep. The small central fragment is not reduced. (c) On May 20 displacement, tear out and breakage of the screws.
Further development: on June 6, 1959 external fixator (Hoffmann type). Infection and central devitalisation. Implant removal. January 4, 1960 cancellous graft. October 19, 1960 AO medullary nail. No documents of later evolution.

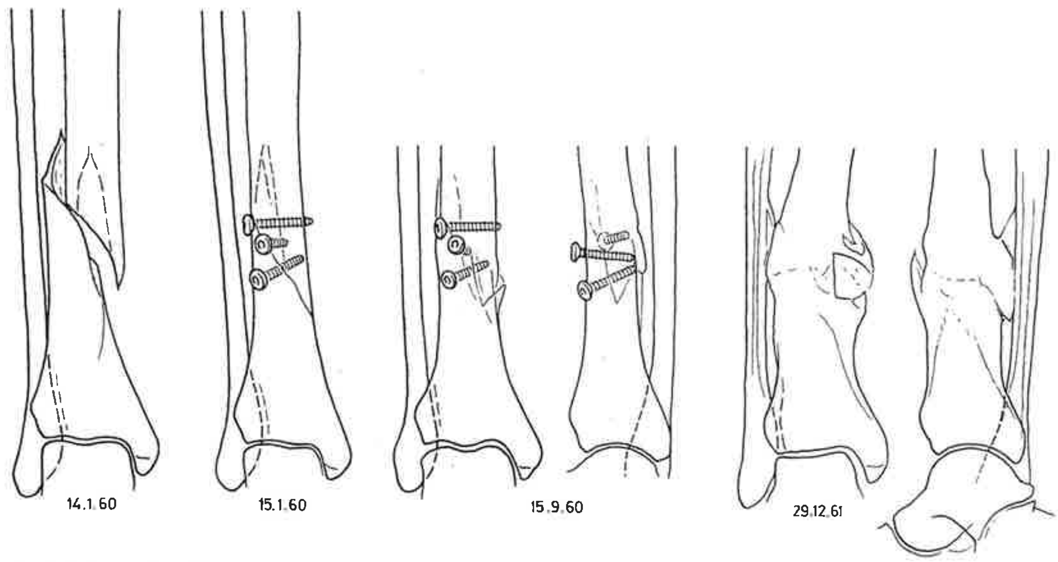


Fig. 8-4: Necrosis of the bone due to narrow placed screws. W. Otto born 1928: KZ 2/22. On January 14, 1960 isolated Tibia fracture with distal fissure. 3 very close by screws. September 15 irregular postero medial callus, loosening of the screws. December 20, 1961 cystic callus at the tibia, varus and callus at the intact Fibula. Persisting irritation in the last X-ray March 2, 1962. Later osteotomy?

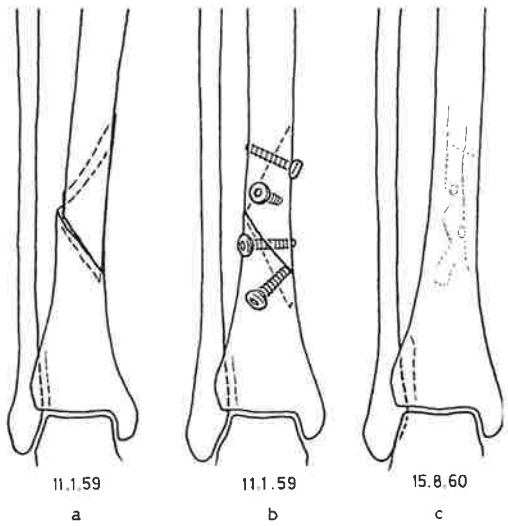


Fig. 8-5: Typical screw synthesis of the Tibia. M. Martha born 1940: BJ 1/18 (a) the fracture on January 11, 1959 (b) ORIF with 4 fawn like placed screws. (c) Consolidated August 15, 1960. No callus but screw holes still visible.

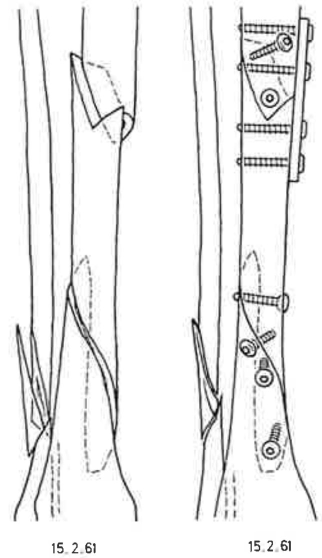


Fig. 8-6: Earliest combination of plate and screws. M-Z. Rosa born 1920: AC 13/7. On February 15, 1961 bifocal fracture stabilised proximally with a four-hole-plate and two screws, distally with 4 screws. In consolidation August 12, 1961.

instruments soon captivated the younger surgeons and fascinated them for decades. These techniques were publicized by the protagonists Müller, Allgöwer and Bandi so enthusiastically that the erroneous opinion began to develop in Switzerland and abroad that the compression plate was really the only AO technique.

Liestal was rather sceptical towards isolated screw fixation (WiH). In St. Gallen too it would seem that in 1961 screw fixation alone was no longer nurtured with as much warmth: the secondary conversion procedure for butterfly fractures which had not consolidated was intramedullary nailing. Fixation of a simple torsion fracture with screw and wide plate is shown in **Fig. 8-9**.

In Chur (Te 126–160) delayed consolidation with callus formation was observed and caused concern. The signs of irritation often subsided after temporary unloading or plaster fixation: an especially spectacular example is shown in

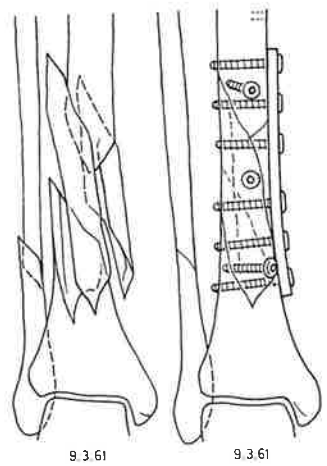


Fig. 8-7: Two butterfly fragments, screws and plate J. Hans-Joachim born 1925: AC 11/31. On March 6, 1961 injury and ORIF. The wedge fragments are fixed together with screws, the main fragments with a slightly curved compression plate. Further development not documented.

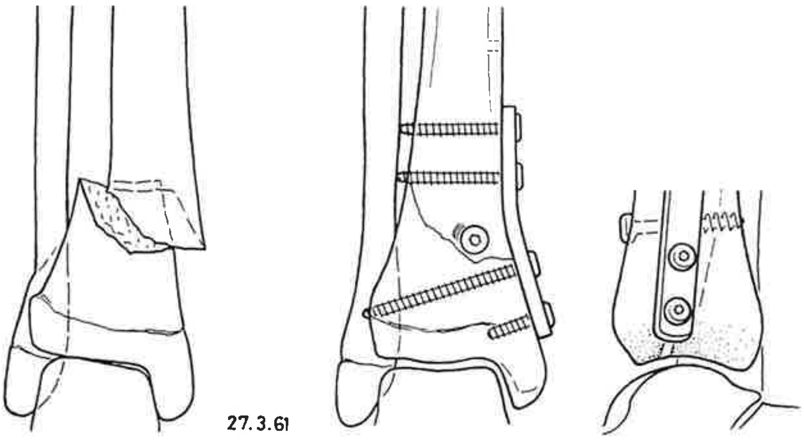


Fig. 8-8: Articular perforation by drilling. Sch. Joachim born 1946: AC 13/36. On March 27, 1961 distal oblique Tibia fracture (probably open) with an incomplete Fibula fracture. ORIF with sagittal cancellous screw and a medial five-hole-plate. The distal drill hole has perforated into the articulation (visible in the lateral X-ray). That screw is then short (cancellous screws could at this time not be introduced in a plate). Further development unknown.

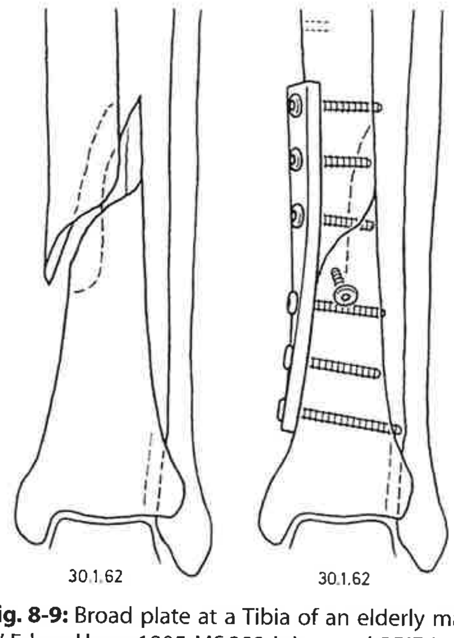


Fig. 8-9: Broad plate at a Tibia of an elderly man. W. Eduard born 1895: MS 383. Injury and ORIF January 30, 1962. Osteoporosis? The broad plate (for Femur and Humerus) is handled to fit the medial surface of the Tibia. One independent sagittal screw. Direct fracture consolidation (X-ray February 14, 1963).

Fig. 8-10. But, before and after the series published in "Technik" (Te 126–160), some second osteosyntheses had to be performed, generally intramedullary nailing (**Fig. 8-11**).

In St. Gallen the plate was occasionally applied to the lateral and dorsal aspects of the tibia. This modification proved its worth in the presence of medial soft tissue damage and in hypertrophic pseudarthroses with malalignment after conservative treatment, whereby the correct position of the plate – on the convex side – increased compression. Several examples from Interlaken and Liestal can also be found (**Fig. 8-12**).

Examples of double plating of the tibia in St. Gallen and most of the other AO hospitals are numerous from May 1961 to January 1963. In one segmental fracture treated in December 1963, four plates were applied (**Fig. 8-13**). In the book "Technik" a particularly impressive example with two plate tensioning devices is portrayed (Te 94, Fig. 102). Although the course of healing was uneventful for many cases of double plating, serious complications were also documented, e.g. extensive necroses, infections

Fig. 8-10: Irritation callus after screw Fixation. L. Marcello born 1924: AC 16/22. (a) On February 17, 1961 spiral butterfly fracture, stabilised with 6 screws. (b) June 15 first signs of irritation and screw loosening. (c) After nine month (November 7) impressive irritational callus. (d) After $1^1/_2$ year (September 12, 1962) spontaneous consolidation, callus regularised.

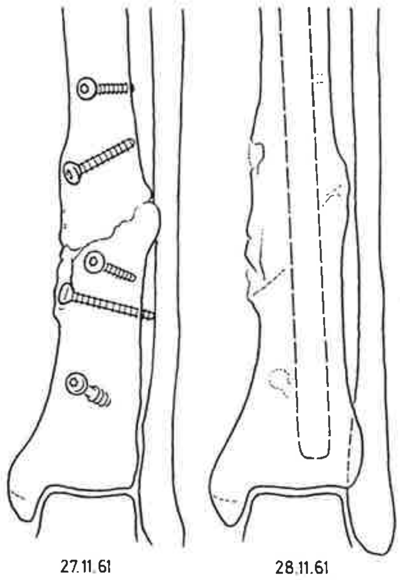


Fig. 8-11: Pseudarthrosis after screw synthesis: intramedullary nail. N. Leopold born 1921: AC 12/15. Spiral fracture with fissures April 3, 1961. After screw fixation pseudarthrosis develops. November 27, 1961 screw removal, intramedullary nail. Later development not documentated.

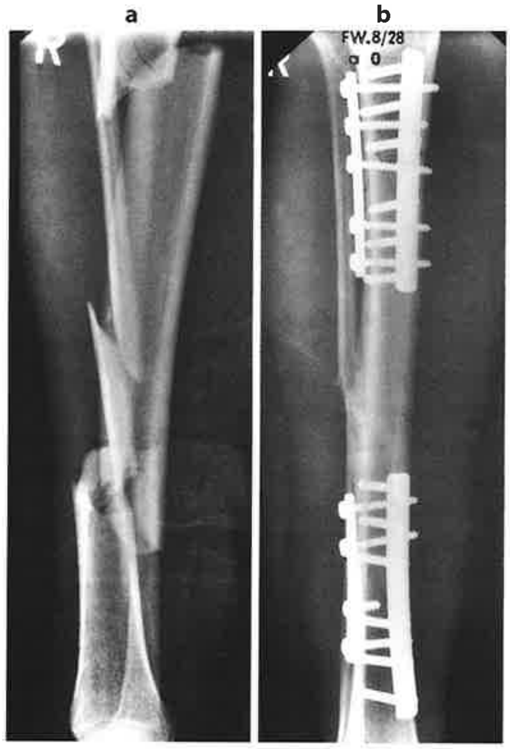


Fig. 8-13: Bifocal fracture fixed with 4 plates. R. Adolph born 1891. FW 8/28. (a) December 4, 1963 oblique fractures in the proximal an central segments. Additional wedges an fissures. (b) postop. X-ray on December 6: each segment has been stabilised with two compression plates. Both fractures are consolidated May 25, 1964.

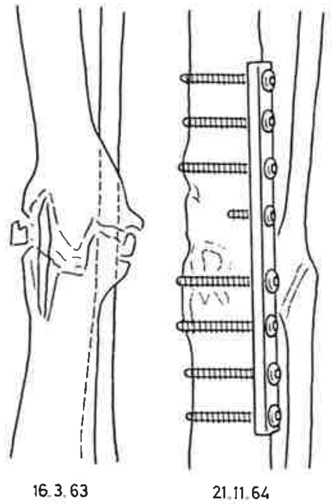
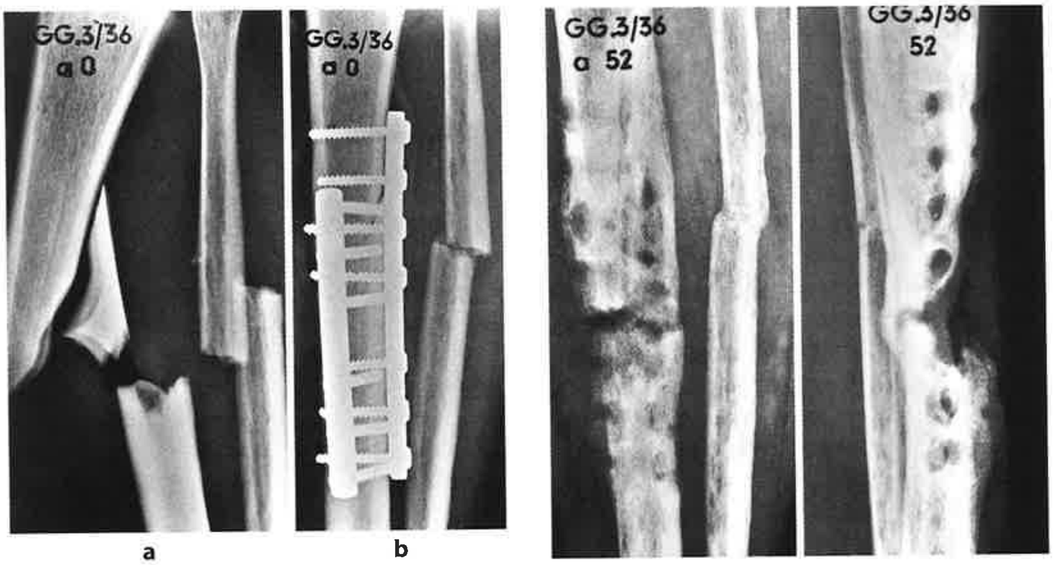


Fig. 8-12: Pseudarthrosis: plate. W. Rudolph born 1939: WL 19/33. Varus pseudarthrosis after conservative treatment. May 20, 1963 laterally placed 8-hole-plate corrects the axis. Consolidated November 21, 1964. Last X-ray June 5, 1965.

with sequestra and defects (**Fig. 8-14**). This devitalizing technique is not found in the leading clinics after 1963, although it does occur later here and there. In the treatment of cancellous bone fractures, the application of two plates continued for a long time and is sometimes still found today (proximal and distal tibia, distal femur etc).

The **semi-tubular plates** first appeared in December 1962 in St. Gallen (**Fig. 8-15**), then January 1963 in Chur, in April in Interlaken and as a second ventral plate applied to a transverse fracture in Glarus.



a b c

Fig. 8-14: Infection and necrosis after double plating. L. Josef born 1913: GG 3/36. (a) December 30, 1961 transverse fracture with wedge, probably open. (b) medially 6-hole – and laterally 8-hole-plate (13 screws). April 24, 1962 signs of irritation. (c) December 28 osteitis and defect. The last X-ray November 22, 1963 shows consolidation after cancellous graft.

Intramedullary nailing is the oldest standard technique for the tibial shaft. It had been introduced everywhere long before the foundation of the AO.

Tibial nailing with the more stable modified version by Herzog[3] was first taken up by Liestal and then in the other hospitals: **Fig. 8-16** shows an unreamed secondary nail fixation for valgus pseudarthrosis and **Fig. 8-17** a primary reamed closed nail fixation, both performed in Liestal.

The new AO nail appears for the first time in July 1960 in Langnau for the treatment of a distal transverse fracture; then in November 1960 in Chur and Grenchen (**Fig. 8-18**).

Nailing was the treatment of choice for tibial shaft fractures of various morphologies (also butterfly fractures), especially in Liestal, Grosshöchstetten, Grenchen, Langnau and Zürich-Waid. If possible, closed nailing was performed (**Fig. 8-17**). In Chur and St. Gallen fractures were more likely to be exposed, treated by open reduction, reamed from the top, and then gen-

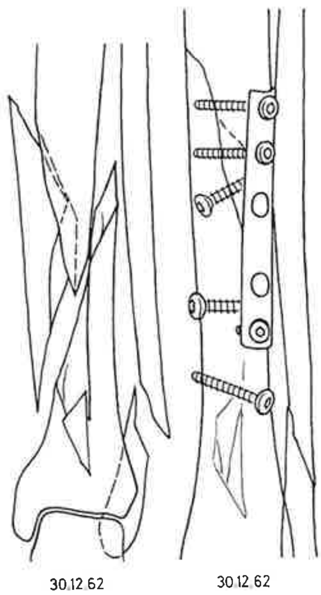
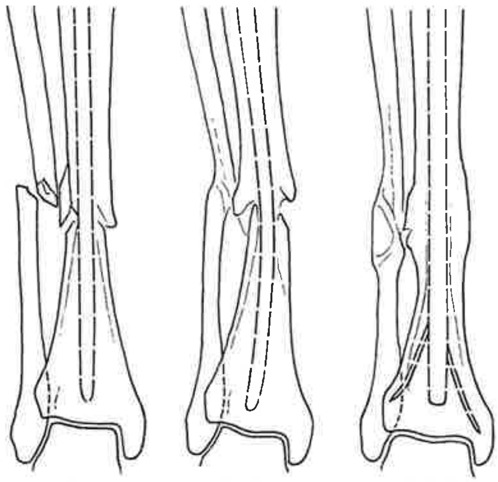
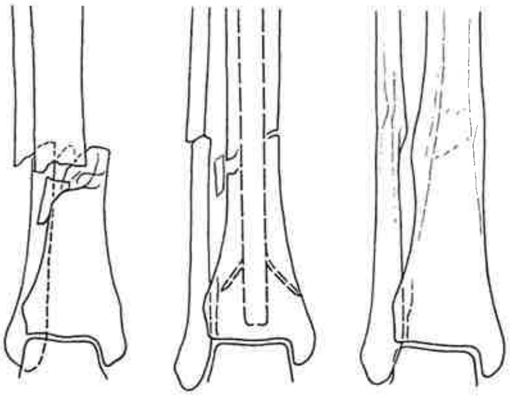


Fig. 8-15: Semi tubular plate and screws. R. Siegesmund born 1905: MS 708. December 30, 1962 spiral butterfly fracture and fissures. Screws and semi tubular plate on the anterior ridge of the tibia reuniting the main fragments. Consolidated without callous April 8, 1963.



28.12.56 a | 16.4.58 b | 11.7.60 c

Fig. 8-16: Valgus pseudarthrosis. Changement of nail. P. Richard born 1929: WL 4/26. November 14, 1956 transverse fracture with splinters. (a) December 28, 1956 thin nail (V-shaped cross section). (b) April 16 Valgus pseudarthrosis, bent nail. (c) June 26, 1958 broad Herzog nail and antirotational wires. Consolidated July 11, 1960.



26.6.60 a | 7.7.60 b | 17.7.61 c

Fig. 8-17: Primary closed and reamed nailing according to Herzog. D. Robert born 1925: WL 9/18. (a) June 26, 1960 oblique fracture with splinters (soft tissue damage?). (b) Introduction of a large Herzog nail with antirotational wires. Consolidation in progress December 6, 1960 and July 8, 1961. (c) July 17, 1961: nail removed, fracture healed.

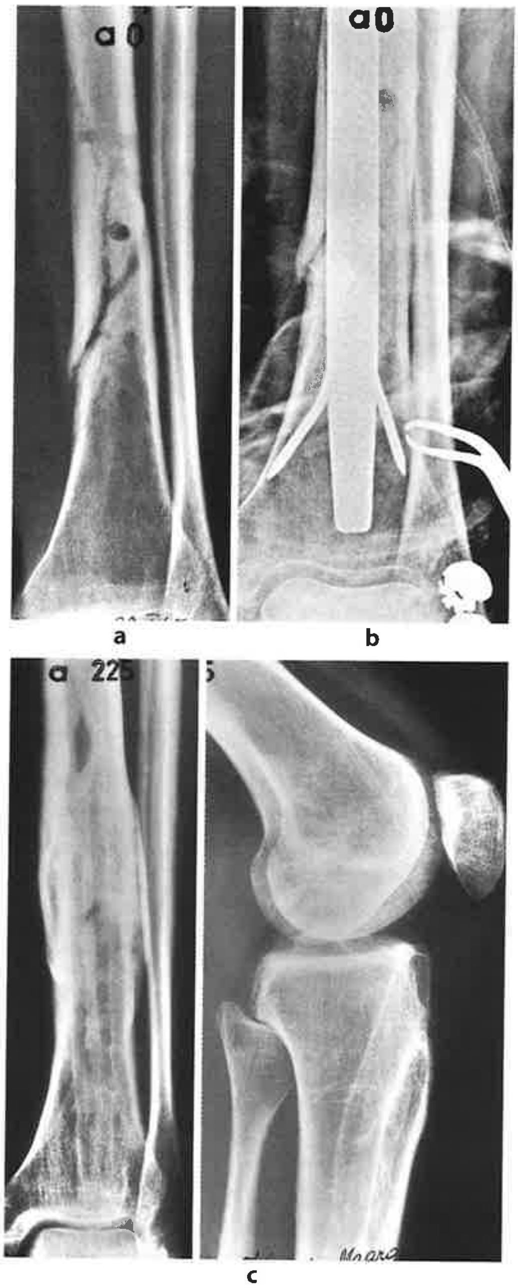


Fig. 8-18: Atrophic pseudarthrosis, large nail. K. Margot born 1933: GG 5/2a. Date of accident unknown, screw fixation elsewhere. (a) November 25, 1960 atrophic pseudarthrosis. (b) November 29 large AO-nail with antirotational wires. Consolidation visible April 11, 1961. (c) March 31, 1965 last X-ray: healed fracture, knee joint free of arthrosis, nail-canal still visible.

erally strengthened with cerclage wires (**Fig. 8-19**). On rare occasions a small plate with short screws was applied instead of cerclage wires (**Fig.8-20**). The open technique can be reliably identified by the appearance of these additional implants.

In 1961 a dorsal hole was added at the proximal end of the nail to facilitate insertion of a sagittal screw into the metaphysis. This screw blocked rotation and prevented telescopic nail slippage in comminuted fractures. It is described and illustrated in "Technik" (Te 58, 212) and also documented (**Fig.8-21**). Together with the distal antirotational wires (**Fig 8-16**), a rudimentary sort of locking procedure emerged. How often it was applied is unknown because the radiographs generally do not show the top end of the nail.

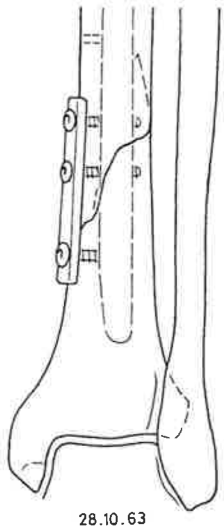


Fig. 8-20: Medullary nail combined with small plate. Sch. Klara born 1918: WL 20/31. October 20, 1963 short spiral fracture. October 28 nail and short medial compression plate. Consolidated February 6, 1964. Implants removed October 17, 1964.

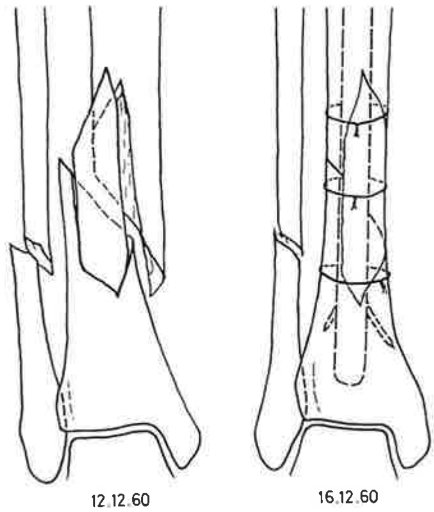


Fig. 8-19: Primary open medullary nailing. W. Karl born 1920: AC 16/30. December 12, 1960 short oblique distal fracture with wedge. Open nailing and tree cerclage wires. Consolidated August 30, 1961. Implant removed October 30, 1962.

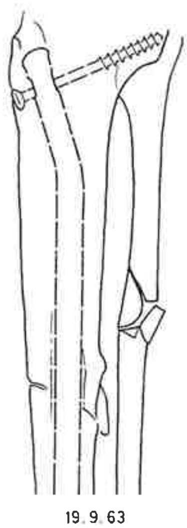


Fig.8-21: Proximal screw in the nail. P. Raffaele born 1937: AC 19/9. September 19, 1963 oblique fracture with wedges. The proximal screw in the nail stabilises rotation and length. December 20 delayed union. May 5, 1964 removal of the screw. ("Dynamisation"). The fracture is consolidated September 7, 1964. November 23, 1965 the nail is still in place.

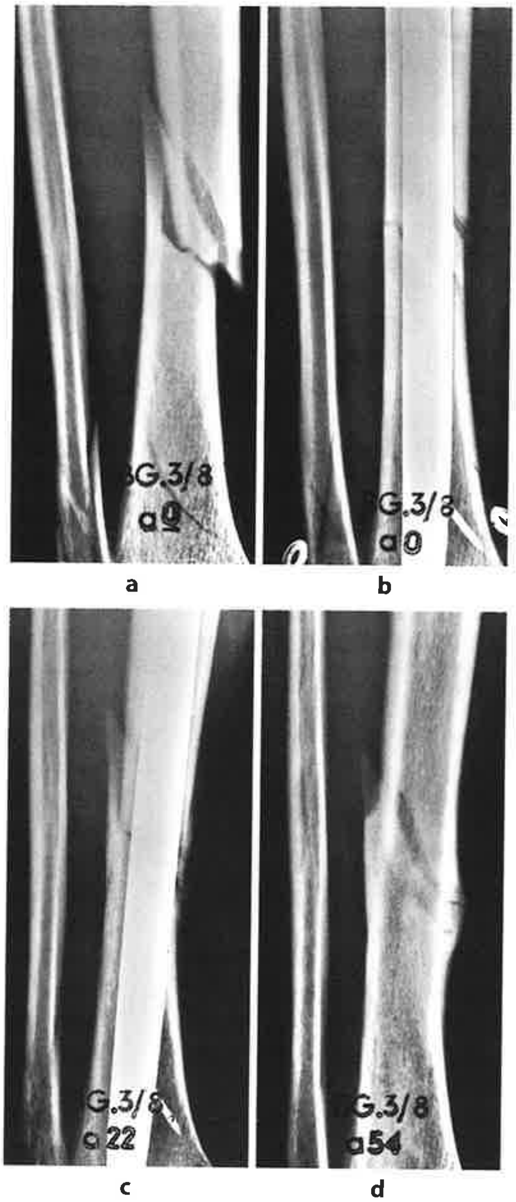


Fig. 8-22: Special broad medullary nail. M. David born 1917: BG 3/8. (a) On December 27, 1960 oblique fracture. (b) Emergency nailing probably with diameter 14 mm. (c) May 29, 1961 medial osteolytic area. (d) November 8 nail removed, consolidation still dubious. Further development unknown.

Intramedullary nailing proved its worth especially for pseudarthrosis after non operative treatment and as long as malalignment was not too severe and the callus could be drilled into, also after high compression cerclage, screw fixation and plate osteosyntheses. In these cases, the metal had to be removed first. Cerclage wires which had become loose or already snapped were left in place and closed nailing was performed (**Fig. 8-2**).

Examples of extreme reaming are to be found in "Technik" (Te 155) and in the documentation. Delayed consolidation occurred nonetheless (**Fig. 8-22**).

There are not yet examples in the documentation of the nail with conical thread at its proximal end [Schn II/259]. It is mentioned briefly in "Technik" (Te 65).

Other techniques on the tibial shaft

The alternative osteosynthesis techniques available at the time were only the external threaded tensioning device with Schanz screws and Steinmann nails. The application of these devices to treat pseudarthrosis following i.m. nailing was documented in 1958.

Primary application of the threaded tensioning device was rare: isolated cases of open transverse fracture are mentioned (**Fig. 8-23**).

Distal intraarticular tibial fractures (Pilon)

Up until 1961 K-wires and cerclage wires were used to stabilize tibial fragments (**Fig. 8-24**). Isolated early arthrodeses either with plantar nail or external tensioning device are also to be found.

A concomitant fibular fracture was always stabilized, sometimes with uncontoured medullary splints, a procedure leading to varus malalignment (**Fig. 8-25**). See also **Fig. 8-38.**

From 1961 screws come to the fore in the reduction and fixation of tibial fragments. Centring the screws proved to be a problem. It was dealt with by bending the plate distally (**Fig. 8-26**). This procedure is illustrated in "Technik" (Te 103).

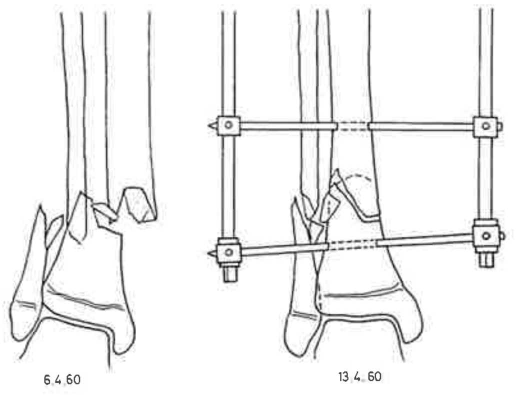


Fig. 8-23: External compression clamp in a child's fracture. M. Fritz born 1950: BJ 3/39. April 13, 1960 open distal oblique fracture. External clamp. Unhindered consolidation and growth: X-ray September 26, 1960 and April 5, 1961.

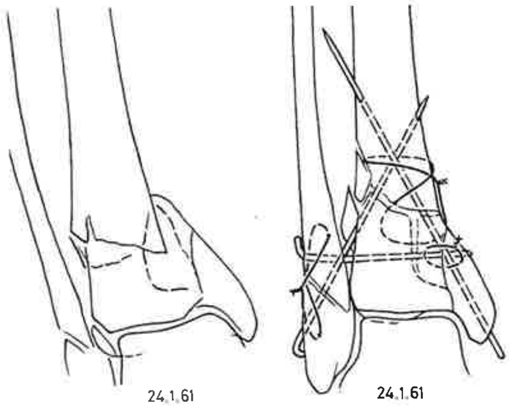


Fig. 8-24: Pilon-tibial-fracture: combination of K-wires and wire loops. F. Lucette born 1932: AC 9/23. January 4, 1961 intraarticular varus fracture of tibia and Fibula. Reduction and stabilisation with K-wires and wire loops. Consolidated April 17, 1961.

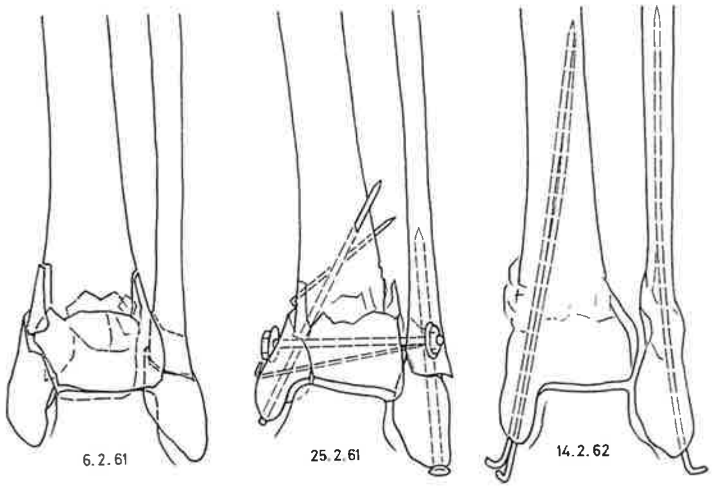


Fig. 8-25: Reoperation after synthesis of a pilon-tibial-fracture. R. Ellen born 1919: GG 2/35. February 6, 1961 antecurvation-fracture. Threaded bolt, K-wires and straight Fibula nail on February 25. This implant leads to a varus malposition. September 11, 1961 delayed union. Correction of axis September 13. Consolidated February 14, 1962. Last X-ray April 12, 1965: no arthrosis.

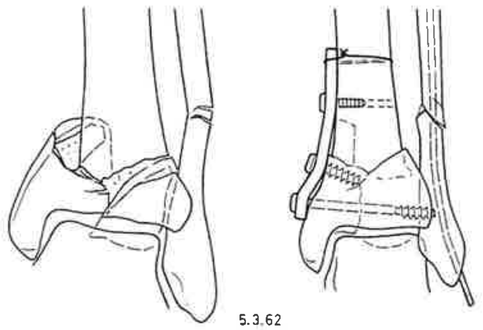


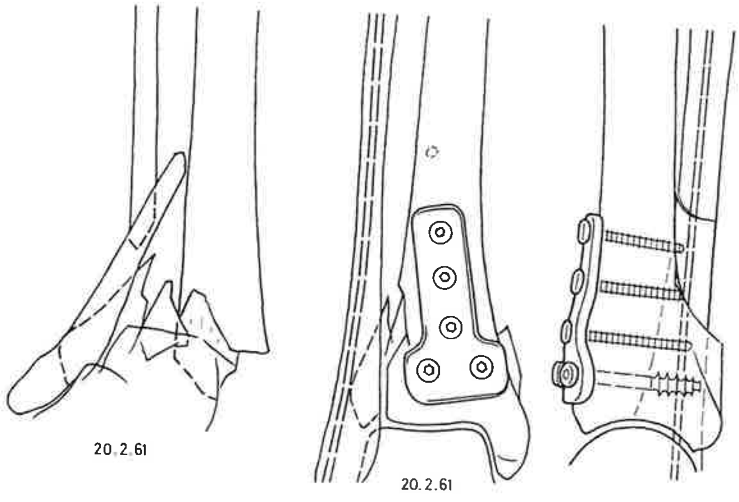
Fig. 8-26: Plate-screw neighbouring the ankle joint. L. Albert born 1920: AC 20/39. March, 5, 1962 emergency operation for a pilon-tibial-fracture: In view to place the distal screw parallel to the joint the plate end was bent. Proximally a hemi-cerclage had to replace an unstable screw. The thin Fibula nail is curved distally. This case is also reproduced in the book of 1963 (Te 103). The long lasting functional result was excellent.

The **T- and spoon plates** developed by Bandi and available in the hospitals by the end of 1961 were intended for use on the metaphysis and were to be applied on the ventral aspect of the tibia (**Fig. 8-27**).

Proximal tibial fractures

The earliest example in the documentation, January 1959, came from Interlaken (**Fig. 8-28**). Threaded bolts occasionally appear later on, but they only proved valuable in exceptional cases.

Fig. 8-27: Anterior T-Plate for pilon-tibial-fracture. K. Bertha born 1911: BJ 7/7a. Injury and ORIF on February 20, 1961: Prototype T-plate for the tibia, curved nail for the Fibula. On February 24, 1962 fracture consolidated, joint space normal, implant removed.



Next the condylar plates applied medially appear. Two figures have been borrowed from "Technik" (Te 109f) to demonstrate this (**Fig. 8-29**). This voluminous implant also served to correct malalignments.

After individual cancellous bone screws, depressions were frequent.

The first contoured straight plate on the medial aspect for a bicondylar fracture appears in January 1961 in St. Gallen (**Fig. 8-30**) and the first lateral T-plate in June 1961. In both cases, additional threaded bolts have been inserted and fixed in a plate hole. In May 1962 a typical, cranially contoured lateral T-plate for a monocondylar depressed fracture appears (**Fig. 8-31**).

Concomitant avulsions of the intercondylar eminence in complex fractures were not stabilized; isolated avulsions in adolescents were fixed into their bed with cerclage wires.

Osteotomy of the tibial tuberosity is recommended as the approach for more extensive interventions (Te 108–111), documented in St. Gallen (**Fig. 8-30**).

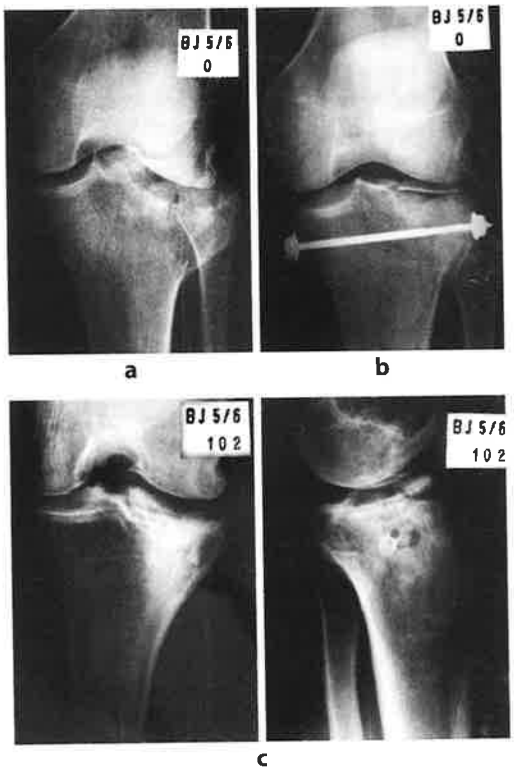


Fig. 8-28: Threaded bolt for lateral impaction in a tibia plateau fracture. E. Bertha born 1918: BJ 5/6. (a) Fracture on January 10, 1959. (b) January 13 open reduction, threaded bolt and cortico-cancellous graft (visible as a thin shadow in the a-p X-ray). (c) two years later (January 5, 1961) slight arthrosis. The documentation card of this patient is reproduced as figure 6-18 and the code-sheets in the list of documents on p. 223ff.

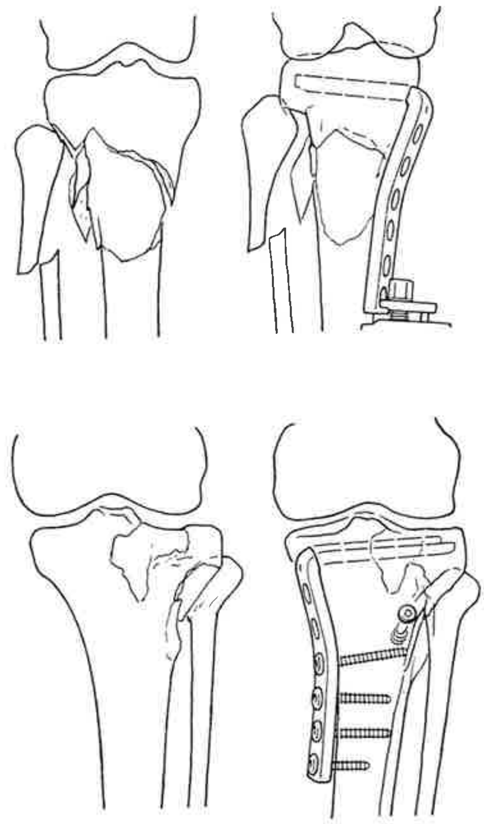


Fig. 8-29: The two functions of the condylar plate reproduced from the book "Technique" 1963 p. 109f: Compression in case of an extra-articular cancellous fracture without defect. Buttressing in case of an lateral depression. The examples are undated but early. The blades are introduced from the medial side.

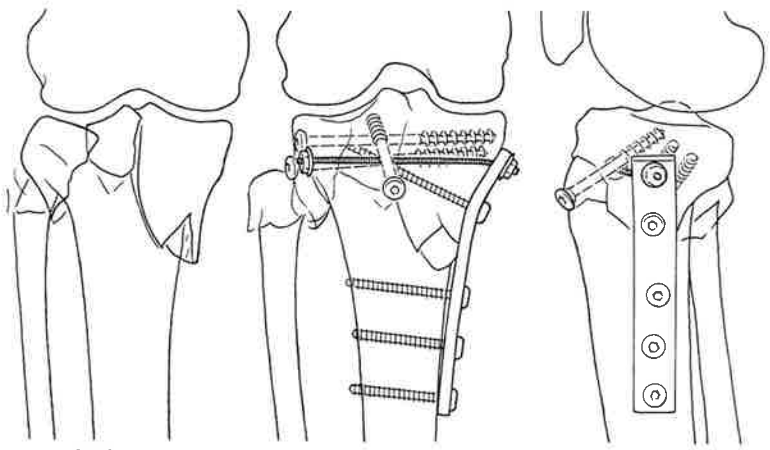


Fig. 8-30: Earliest documented plate in a tibia plateau fracture. S. Felix born 1896: MS 69. On January 27, 1961 bicondylar tibia plateau fracture involving the Fibula. ORIF with a medial 5-hole-plate, threaded bolt and lateral screws. The plate is proximally curved and the bolt fixed in the plate hole. Approach through an osteotomy of the tibial tuberosity (readapted with a sagittal screw). Consolidated on May 10, 1961. Further development unknown.

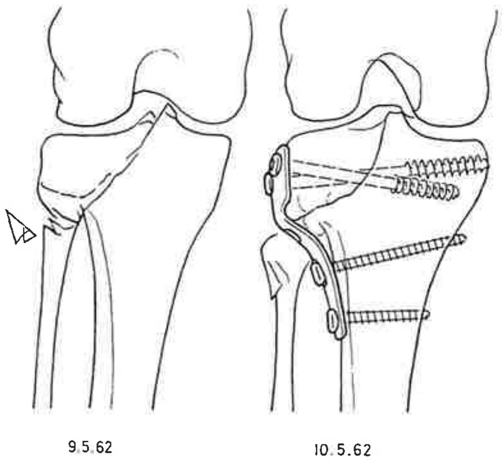


Fig. 8-31: Earliest documented lateral T-plate for a monocondylar Tibia plateau fracture. B. Albert born 1925: MS 509. Injury and ORIF on May 9, 1962: lateral depression fracture involving the Fibula. Reduced and stabilised with a T-plate. Consolidated May 10, 1963. Minimal secondary displacement.

Osteosynthesis of malleolar fractures

The documentation in the early years includes more than 800 cases of this frequent injury.

As soon as the AO Documentation in Davos was ready, Willenegger submitted all his radiographs. These are still in existence and provide a valuable insight into early techniques. The first case documented by Willenegger represents an operation performed in June 1953 (**Fig. 8-32**).

Oblique drilling through the fibular fracture using K-wires appears several times in the documentation (**Fig. 8-33**). Unbent medullary wires caused varus malalignment in the fibula, see also **Fig. 8-38**. Pins, similar to nails, inserted into the internal malleolus could not maintain an unstable fibular fracture.

From 1959 onwards the other members began to keep records and the techniques are seen to develop continuously until 1963.

Up until 1962 cancellous bone screws (sometimes with washer), perforating the syndesmosis were generally inserted *to stabilize a dislocated mortise* – that is to say, deliberately causing compression (**Fig. 8-34**). Cases of this sort were still being documented after 1963.

The first example of a horizontal *"positioning screw"* (a cortex screw with full thread) inserted after reduction between the tibia and fibula, without compressing the syndesmosis, 4–5 cm above the joint cavity, appears for the first time in September 1962 in St. Gallen (**Fig. 8-37**), then in 1963 in Liestal as well where it was inserted through a plate hole (**Fig. 8-36**). The relevant schematic representations are printed in "Technik" (Te 190, 192, 207).

Long oblique fractures of the distal fibula were initially fixed with cerclage or semi-cerclage wires; in St. Gallen after 1961, with the fine *"small cancellous bone screws"* (**Fig. 8-37**). These are mentioned in the Guidelines (Me I/5,7, Me II/41). Shorter oblique fractures were sometimes stabilized with vertical cancellous bone or malleolar screws centred onto the fracture gap. For proximal and complex fractures in-

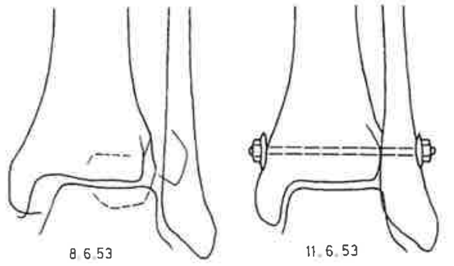


Fig. 8-32: Early document: threaded bolt for dislocation of the ankle mortise. B. Jules born 1895: WL 2/10. June 8, 1953 dislocation of the ankle mortise (proximal Fibula fracture?). Torn deltoid ligament. June 10 treaded bolt with compression. July 10, 1959 slight arthrosis.

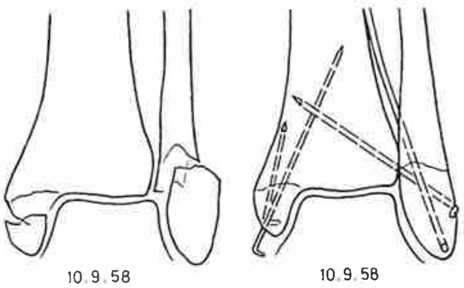


Fig. 8-33: Bimalleolar fracture, fixed with K-wires. T. Mathilde born 1895: WL 3/31. September 10, 1958 displaced fracture reduced and transfixed with K-wires. On February 26, 1960 no arthrosis.

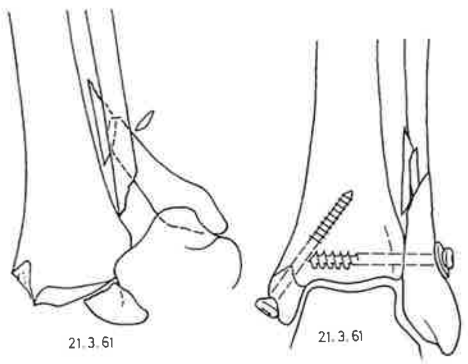


Fig. 8-34: Screw fixation of the mortise. W. Gertrud born 1904: SG 3/16. March 21, 1961 valgus-dislocation-fracture involving the Fibula shaft. Fibula and mortise fixed with cancellous screw and washer. Medial malleolar screw. July 20, 1962 shortening of the Fibula in slight valgus, arthrosis.

tramedullary wires or splints were applied more frequently after 1961. The distal end had to be bent since malalignment would otherwise develop (**Fig. 8-38**). The Guidelines refer to this problem (Me I/5,7, Me II/41), "Technik" contains an illustration (Te 188). The distally bent medullary splint (combined with cerclage wires) became a widely practised and successful technique for the fibula (**Fig. 8-39**). In the Guidelines (Me I/5,7, Me II/41) *"elastic wire fixation according to Willenegger"* is recommended as an alternative (**Fig. 8-40**). It is also illustrated in "Technik" (Te 196).

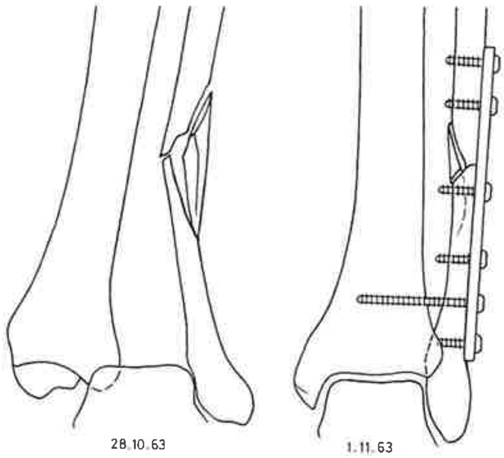


Fig. 8-36: Positioning screw trough a plate. F. Sante born 1939: WL 22/7. October 28, 1963 valgus fracture with disrupture of the mortise, Fibula shaft fracture. November 1, 1963 fixed with a 8-hole-plate. The second plate screw is transfixed into the tibia. Anatomical reduction. X-ray October 24, 1964: fracture healed, no arthrosis.

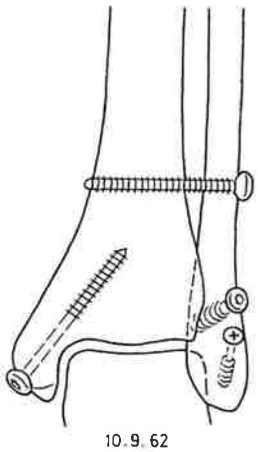


Fig. 8-35: Supramalleolar fibulo-tibial positioning screw. Z. Max born 1898: MS 599. X-ray of the accident missing. Synthesis on September 10, 1962: Fibula fixed with a cancellous and a small screw, internal malleolus with malleolar screw. Indirect stabilisation of the mortise with a higher placed horizontal cortical screw. X-ray on November 12 before removal of this screw. Fracture healed April 18, 1963. Slight remaining displacement.

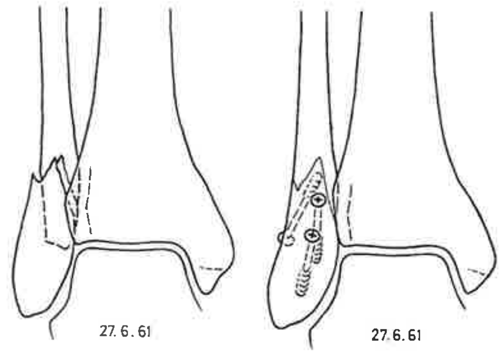


Fig. 8-37: Small cancellous screws in the Fibula. Z. Julia born 1897: MS 188. June 27, 1961 isolated oblique distal Fibula fracture: 3 small cancellous screws. October 19: consolidated, implants not yet removed.

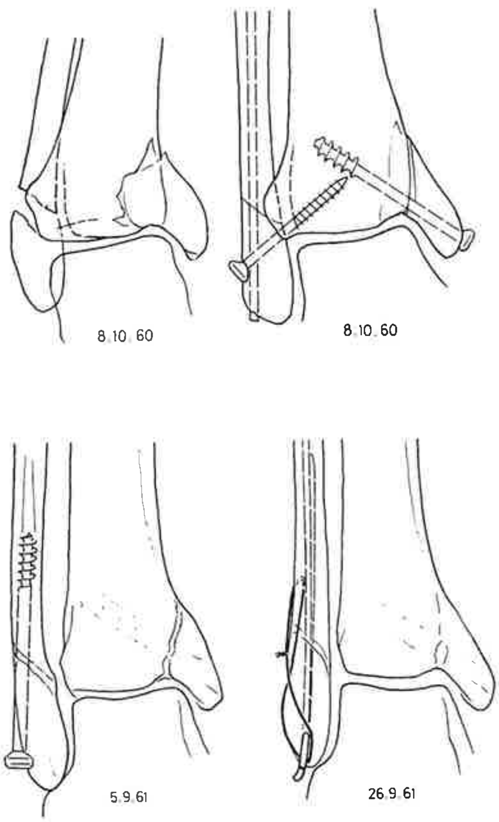


Fig. 8-38: Varus mal alignment due to a Fibula nail. C. Caspare born 1942: AC 16/35. October 8, 1960 transverse distal Fibula fracture, vertical fracture of the medial malleolus with a depressed area: lateral and medial screws. Unbent straight nail in the Fibula leads to varus mal alignment. Pseudarthrosis of the Fibula January 28, 1961, reoperated with a cancellous screw. Third operation September 26, 1961: correction of the axis, tension band technique at the Fibula. Later evolution unknown.

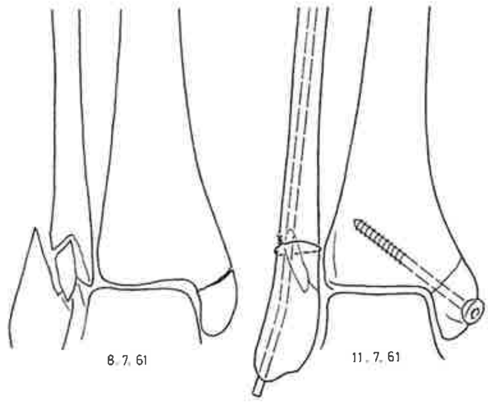


Fig. 8-39: Distally bent Fibula nail. W.-R. Febronia born 1900: AC 15/33. July 8, 1961 bimalleolar valgus fracture: Fibula fixed with a bent nail and cerclage, medial malleolar screw. Axis correct. Consolidated October 10, 1961.

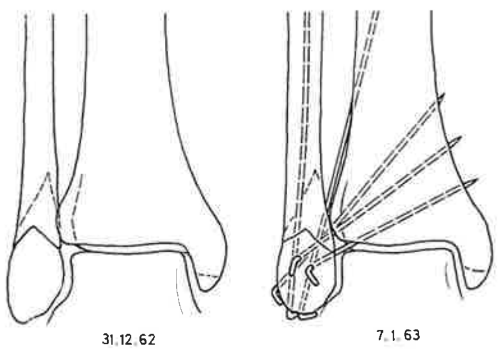


Fig. 8-40: Multiple K-wires in the Fibula ("elastic wire fixation according to Willenegger"). W. Max born 1932: WL 14/19. December 31, 1962 oblique distal Fibula fracture reduced and fixed with fawn like positioned K-wires, partly introduced into the tibia (X-ray January 7, 1963). Consolidated April 20. No arthrosis December 5, 1964.

Transverse fractures of the distal fibula were stabilized with vertical malleolar or cancellous bone screws. Axial K-wires together with a tensioned cerclage wire appear for the first time in August 1961 in St. Gallen (**Fig. 8-41**). The term *"tension band"* for this site does not occur until 1963 in "Technik" (Te 193,195 with figures). The same principle for small fragments of the internal malleolus was first documented in October 1962 in St. Gallen. Oblique fractures became the domain of the malleolar screw very early on (**Fig. 8-39**).

Vertical adduction fractures of the internal malleolus were stabilized with the horizontal cancellous bone screw as early as 1960 (**Fig. 8-42**). They are referred to in "Technik" (Te 195, 206), but not in the Guidelines of 1961.

A large **posterolateral Volkmann's triangle** should be fixed with screws *"from the front or medially from behind"* (Me I/5,7, Me II/41). In "Technik" both techniques are elaborated (Te 202). Examples appear in the documentation from 1961 (**Fig. 8-43**). A triangle fixed by a dorso-lateral approach was documented in March 1961 in Zürich (**Fig. 8-44**).

A **plate** for oblique fractures of the supramalleolar fibula is given in the Guidelines as an alternative technique (Me I 5,8, Me II 42) and is shown in "Technik" (Te 190). The documentation contains relevant examples from Liestal (**Fig. 8-36**). It is becoming apparent that the intramedullary splints will be replaced within a short time by the thin, more appropriately contoured one-third tubular plates fixed with smaller screws[4].

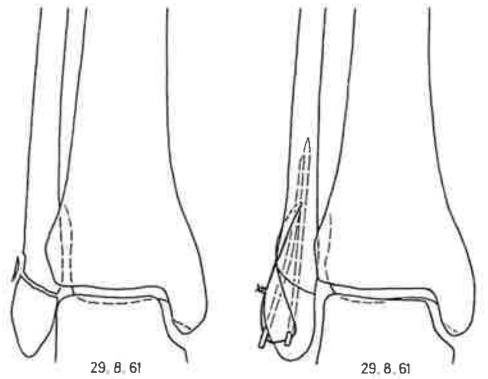


Fig. 8-41: Earliest documented tension band technique on a distal Fibula. P. Salvatore born 1934: MS 250. August 29, 1961 transverse distal Fibula fracture fixed with two axial K-wires (their ends are not bent) and a figure of 8 wire loop. Consolidated July 10, 1962. No arthrosis.

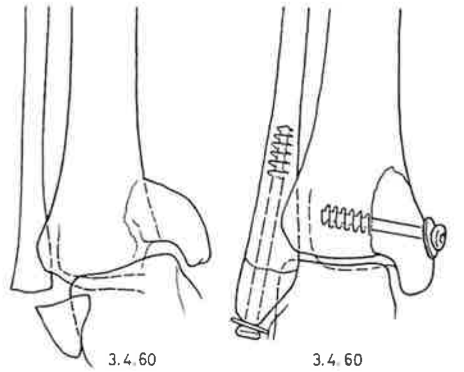


Fig. 8-42: Cancellous screws for a bimalleolar fracture. W. Ernst born 1919: BJ 2/39. April 3, 1960 displaced vertical fracture of the medial malleolus and distal transverse Fibula fracture. Both reduced and stabilised with cancellous screws and washers. Consolidated August 10. Last X-Rax March 17, 1961: beginning arthrosis.

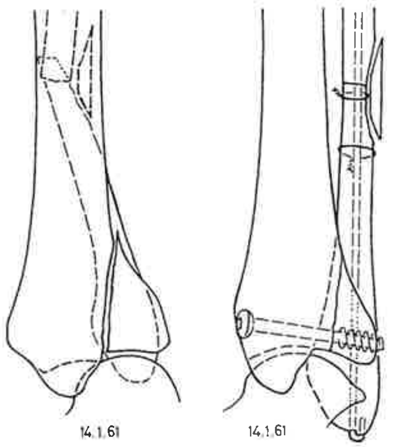


Fig. 8-43: Posterior lip fragment. Anterior approach. S. Emma born 1905: AC 13/19. January 14, 1961 Fibula shaft fracture and large articular posterior lip fragment. Reduced and fixed from front to back with a cancellous screw. Large K-wire and cerclage in the Fibula. Evolution unknown.

Patellar fractures

The documentation contains approximately 100 cases. As well as the simple, ventral cerclage, still applied now and again until 1963, the double cerclage dominates Secondary wire breakages were rare (**Fig. 8-45**). Since the fractures consolidated early, secondary dislocations did not occur. No pseudarthroses are recorded in the documentation.

The combination of K-wires (for multiple fragmental fractures) and cerclage wires (**Fig. 8-46**) generally produced good results. Screw fixation of longitudinal and polar (proximal and distal) fractures had already appeared by the end of 1960 (**Fig. 8-47**). Patellectomies are not found in the documentation, but a case of simultaneous open bicondylar femoral fracture is cited in "Technik" (Te 308).

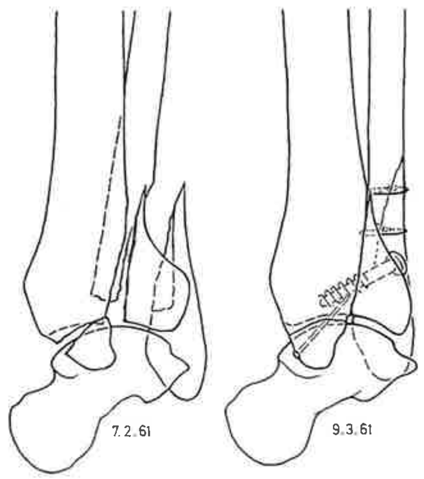


Fig. 8-44: Posterior lip fragment. Posterior approach. W. Anna born 1918: KZ 6/6. February 8, 1961 bimalleolar fracture with a large postero lateral lip fragment. Reduced and screwed by direct approach from back to front. Fibula cerclage and K-wire in the medial malleolus. January 26, 1962 consolidated. No arthrosis.

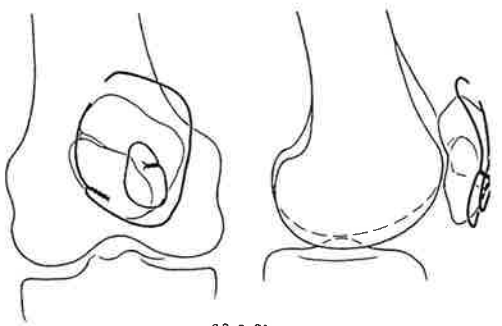


Fig. 8-45: Transverse fracture of patella. Double anterior wires. S. Emil born 1912: MS 78. Feburary 1, 1961 fracture and fixation with two anterior wire loops (tension band principle). Consolidated June 23: one loop is ruptured. Last X-ray June 12, 1962. No arthrosis.

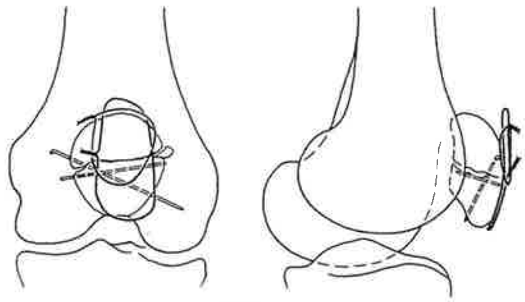


Fig. 8-46: Wire loops and K-wires. F. Franz born 1947: MS 566. July 26, 1962 comminuted fracture of the patella. The small fragments are reunited with K-wires, a double wire tension band system applied. Consolidated November 15. No arthrosis March 26, 1963.

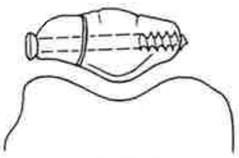


Fig. 8-47: Vertical fracture of the patella. A. Franz born 1941: AC 17/30. The displaced fracture is only visible on the axial X-ray. December 3, 1960 cancellous screw. Evolution unknown.

Fractures of the foot skeleton

The documentation contains approximately 60 records of operated fractures of the talus, calcaneus and forefoot. It had become common practice to operate on irreducible fractures, stabilizing them with the implants available at the time.

Talus fractures

Closed reduction of dislocated talus neck fractures was preferred in Chur. If anatomical reduction was unsuccessful or the diagnosis made too late, open reduction was performed and the fracture stabilized with K-wires or, more often with screws (11 documented cases), whereby postoperative necrosis was recorded. There is also an atypical neck and corpus dislocation fracture which was stabilized with a screw and temporary arthrodesis (**Fig. 8-48**).

Calcaneus fractures

Isolated screw fixations of avulsion fractures were documented. In Interlaken an upright thalamic depression fracture was fixed with two K-wires and a good anatomical result was achieved (**Fig. 8-49**).

Fractures of the forefoot

On the whole, K-wires were used in cases of severe dislocation. In isolated cases the small cancellous bone screw was inserted for fractures of the os navicular pedis, for avulsion fractures at the base of metatarsal V, and for one open fracture of the basal phalanx of the big toe (**Fig. 8-50**). The concomitant shaft fracture of bones II–V of the midfoot healed after non operative treatment.

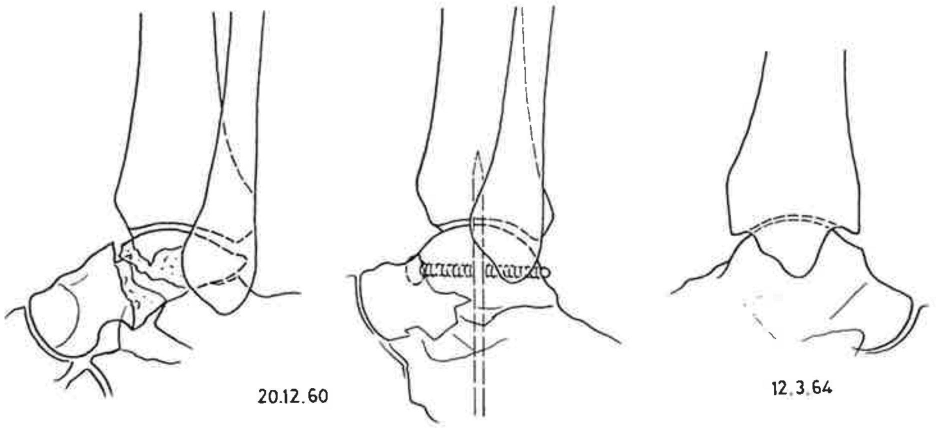


Fig. 8-48: Talus fracture: screw synthesis and arthrodesis of the subtalar joint. B. Albert born 1936: MS 1/25. December 20, 1960 comminuted fracture of the talus involving the subtalar joint. Stabilised with a screw from the anterior side. Temporary arthrodesis with plantar Steinmann nail. March 20, 1964 fusion of the subtalar joint. The dome of the talus is slightly sunk, moderate arthrosis.

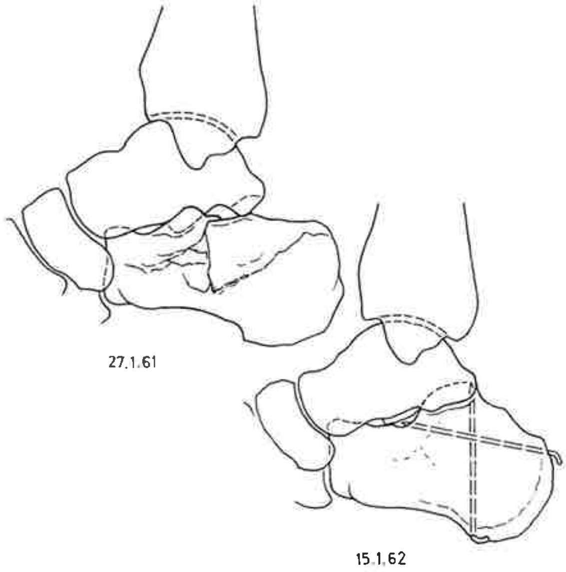


Fig. 8-49: Depression fracture of the calcaneus. E. Peter born 1924: BJ 5/19. January 27, 1960 central depression fracture of the calcaneus. Reduction and fixation with two K-wires from the posterior side. Four month later (X-ray May 27, 1960) consolidated. January 15, 1962 no displacement, slight osteoporosis, implants still in place.

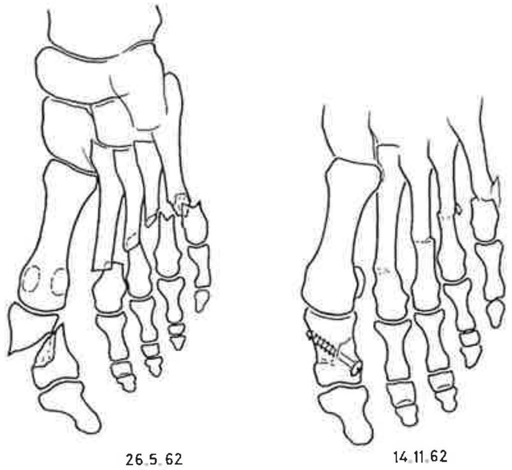


Fig. 8-50: Multiple fractures of the forefoot. R. Armando born 1944: MS 517. May 26, 1962 fractures of the great toe (open) and of the metatarsals II-V. Small cancellous screw in the great toe, traction for the metatarsals. November 14 fractures consolidated. Last X-ray May 24, 1963.

Femoral fractures

Femoral shaft fractures

This severe injury was not frequent at that time. The AO documentation contains approximately 150 operated fractures, that is, only 5% compared with the lower leg fractures.

Some fractures operated in 1956 with a lengthy course of healing have been documented: refractures after cerclage – presumably treated elsewhere – (**Fig. 8-51**) and refracture after insertion of a thin intramedullary nail whereby re-operation and insertion of a thicker implant proved successful. The arduous manual procedure of reaming restricted the calibre of the nail. A refracture after premature nail removal (6 months) was also recorded.

Intramedullary nailing remained the AO technique of choice although – especially for complex fractures – additional cerclage wires (**Fig. 8-52**, and Te 211) or small plates were necessary to achieve stabilization (**Fig. 8-53**).

From about mid 1960 thin nails could easily be replaced by thicker ones in cases of delayed healing thanks to power-driven reaming.

Occasionally screw fixation was performed on the femur. Two documented cases went on to consolidation. Eyewitnesses from that time, however, have a very clear recollection of (non documented) catastrophes after screw fixation (HU, LM). "Technik" officially condemns screw fixation on the femur (Te 210).

Early on plates begin to appear, at first for pseudarthrosis because the obliterated medullary cavity could not be reamed (Te 213). Double plating had already been performed with success in May 1959 for a pseudarthrosis resulting from Rush pin treatment (**Fig. 8-54**), also for fractures of the distal third of the shaft. Several problems with double plating were documented, including one plate pull-out, necrosis, and pseudarthrosis (**Fig. 8-55**).

Double plating on the shaft was performed occasionally even after 1963 (**Fig. 8-56**). Fixation with a single plate was only introduced later on (**Fig. 8-71**).

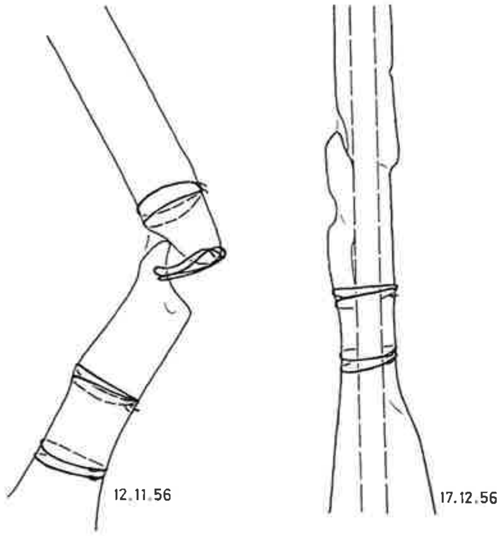


Fig. 8-51: Medullary nail in the femur after cerclage. F. Hans born 1933: BJ 1/31. Initially probably cerclage of a child's fracture. Refracture November 12, 1956: open nailing after partial removal of the wires. Consolidated April 10, 1957. Implants still in place April 27, 1959.

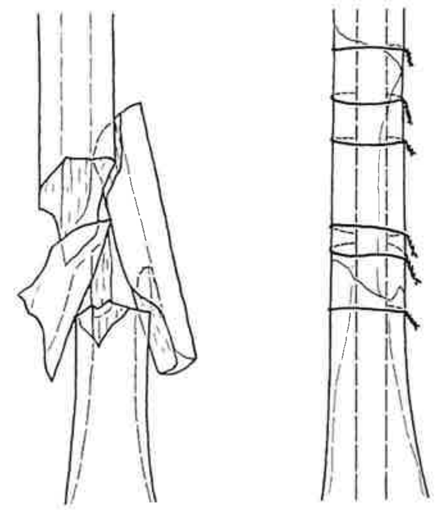


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Fig. 8-52: Typical open medullary nailing of the femur. R. Franz born 1912: MS 187. June 26, 1961 femoral nail and cerclage wires. Consolidated July 24, 1962. Implants not yet removed.

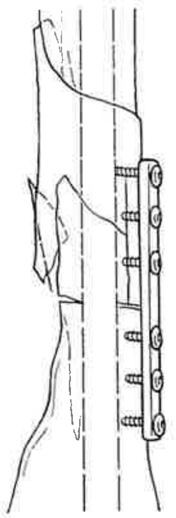

Fig. 8-53: Medullary nail combined with narrow plate. Z. Arthur born 1914: KZ 4/35a. Injury documents missing. March 15, 1961 nailing of a long comminuted fracture. One month later (April 14) additional 6-hole-plate with short screws. Consolidated January 27, 1962. Last X-ray April 24, 1962. Implants still in place.

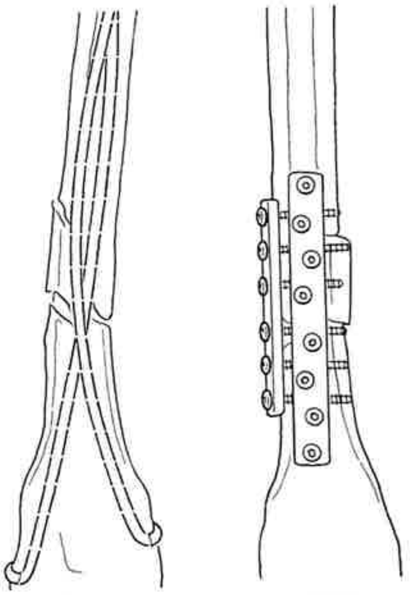

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Fig. 8-54: Pseudarthrosis of the femoral shaft stabilised with a double plate. F. Josef born 1907: KZ 2/15a. October 28, 1958 transverse femur fracture treated elsewhere with Rush-pins. Pseudarthrosis on May 14, 1959. Double plates May 23, 1959. Consolidated April 24, 1960. Implants still in place.

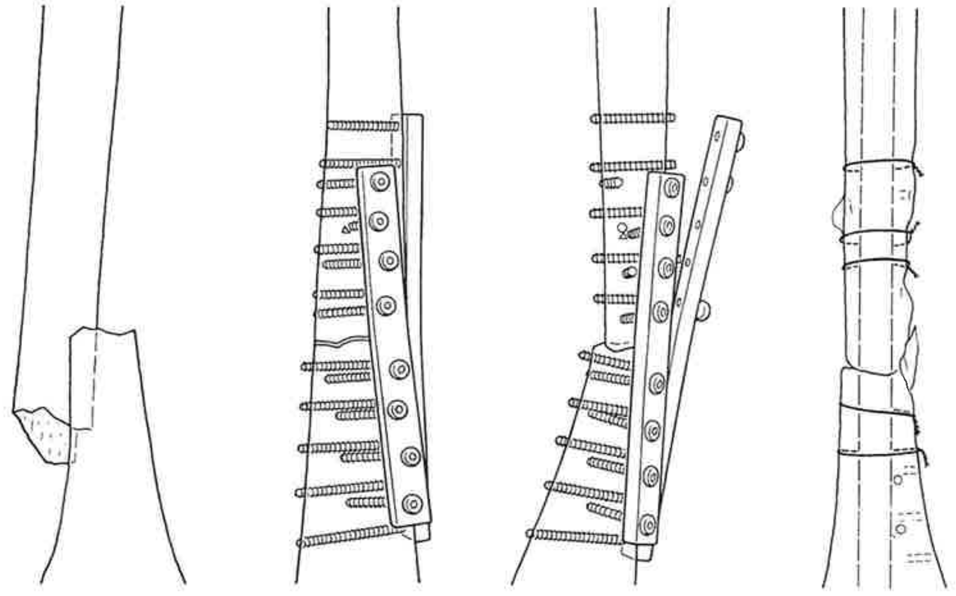
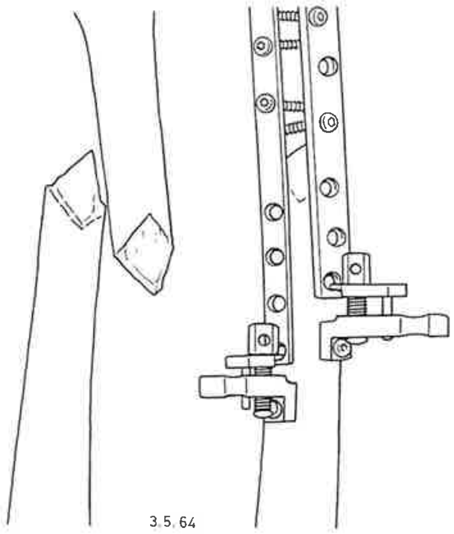


Fig. 8-55: Pull out of double plates on the femoral shaft. Sch. Otto born 1943. AC 15/13. (a) Transverse fracture August 27, 1961. (b) Synthesis with two plates. (c) November 15 pull out of the proximal screws, plates displaced, varus. (d) Secondary synthesis with nail an cerclage wires. Cancellous graft? Later development not documentated.

Fig. 8-56: Two compression devices in place. F. Paul born 1948: FW 7/39. Oblique fracture of the femoral shaft May 3, 1964 fixed with two plated (broad 6-hole- and narrow 8-hole-plate). Intraoperative X-ray shows the compression devices in situ. Evolution non documentated.



Distal femoral fractures

The documentation contains some extraarticular fractures. Intraarticular fractures, monocondylar or bicondylar, were stabilized by nail fixation from 1958 since the AO implants were not yet in existence (**Fig. 8-57**). The AO screws followed, together with threaded bolts or K-wires. The condylar plate, as illustrated in the Guidelines, appeared for the first time in December 1960 and in May 1961 in Interlaken (**Fig. 8-58**). In 1959 a faulty, incompletely documented case was recorded in Chur and in 1963 the first technically properly applied condylar plate for a complex fracture was reported from St. Gallen (**Fig. 8-59**).

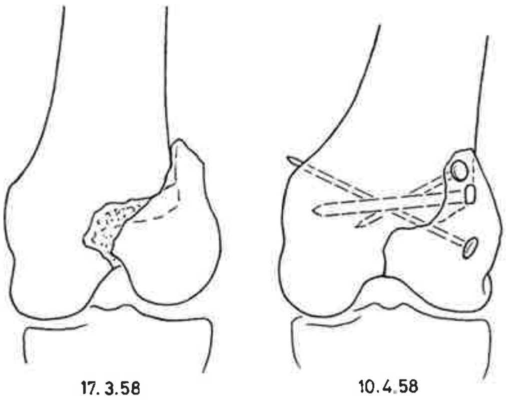


Fig. 8-57: Monocondylar fracture fixed with short nails. B.-Wilhemina W. born 1921: OR 1/16. Injury March 17, 1958: reduction and stabilisation with short nails. Slight valgus, no displacement. Consolidated April 10, 1959.

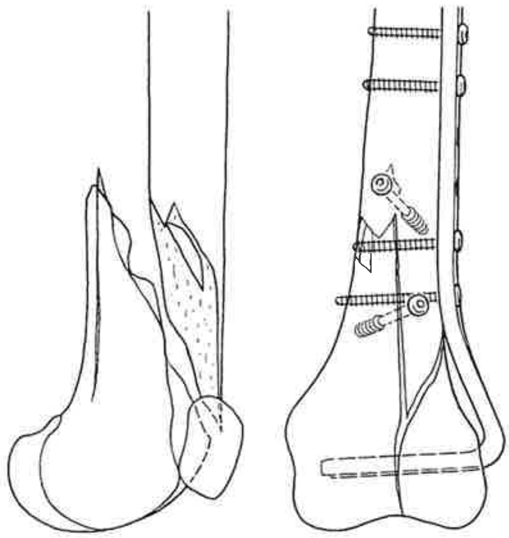


Fig. 8-58: "Right-angled"-blade plate on distal femur. A. Walter born 1895: BJ 7/9. May 14, 1961 distal spiral fracture involving the knee joint. Plate and screws on May 19, 1961. Consolidated June 4, 1962, implants still in place.

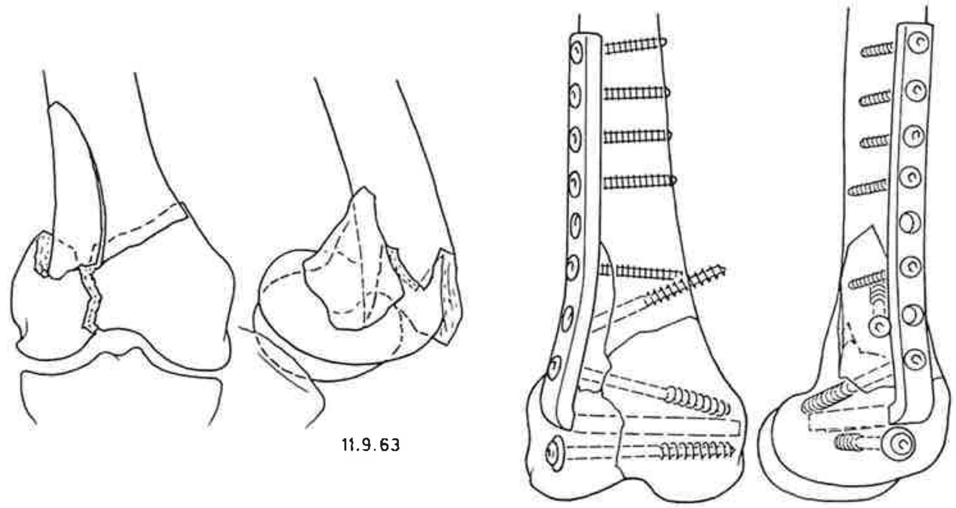


Fig. 8-59: Bicondylar fracture of femur. F. Elsa born 1899: MS 944. Displaced fracture on September 11, 1963. Condylar plate and screws. Consolidated August 13, 1964.

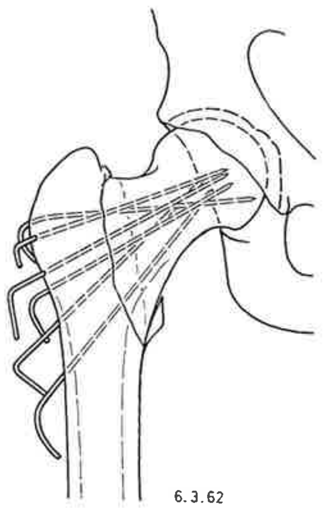


Fig. 8-60: Mulitple K-wires for a trochanteric fracture. A. Anna born 1889: WL 10/13. Moderately displaced fracture on February 20, 1962. March 6 stabilisation with mulitple fawn like placed K-wires (percutaneously introduced?). Consolidated June 16, last X-ray February 23, 1963. Implants still in place.

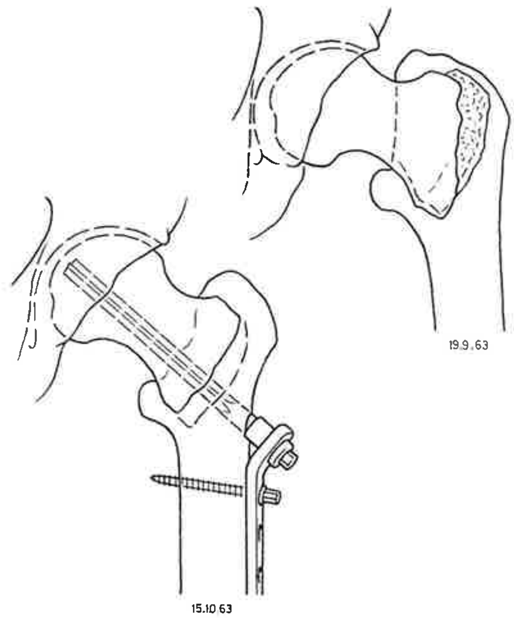


Fig. 8-61: Two part plate for trochanteric fracture. S. Hilda born 1897: KF 7/39. September 19, 1963 varus fracture. Two part plate on the X-ray October 15. No further documentation.

Proximal femoral fractures

About 300 cases are to be found in the documentation. Earlier techniques continued to be practised in some of the clinics some of the time, e.g. spiking with K-wires (**Fig. 8-60**), two-part blade plates (**Fig. 8-61**), three lamellar nails from Böhler (**Fig. 8-62**). Screw fixation also appears early (**Fig. 8-63**).

The **130° angled blade plate** appears in the documentation in the late summer of 1959 first in Liestal (**Fig. 8-64**).

Sometimes the odd subtrochanteric fracture was stabilized with other implants: straight plates (**Fig. 8-65**), intramedullary nails and cerclage wires.

The **condylar plate** appears first in St. Gallen at the end of 1962 in the treatment of a subtrochanteric fracture (**Fig. 8-66**) and at the end of 1963 for a pertrochanteric fracture. "Technik" (Te 298) is not yet aware of this implant for the proximal femur.

From the end of 1960 the 130° plates with short shaft dominate. The first one was recorded in December 1960 in Chur. There is only one documented case of early necrosis of the femoral head treated by valgus alignment osteotomy.

Plate osteosynthesis for a bilateral fracture (femoral neck on the right with plate, subtrochanteric fracture on the left with condylar plate) is shown in **Fig. 8-66.**

The first successful **femoral head prosthesis** for pseudarthrosis was recorded in April 1961 in Interlaken and – for a fresh fracture – in August 1961 in Chur (**Fig. 8-67**).

Early in 1962 in St. Gallen a **double angled osteotomy plate** for a femoral neck pseudarthrosis was recorded. It appears for the first time for a fresh fracture with an almost vertical break in July 1963 in Grosshöchstetten (**Fig. 8-68**). This combination was not mentioned in "Technik".

A rare and very worrying combination: fem-

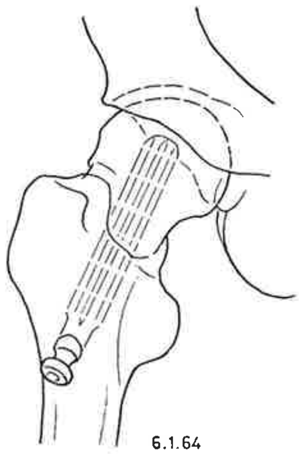


Fig. 8-62: Three laminar nail for femoral neck fracture. K. Hans born 1905: WL 22/1. Lateral adduction fracture on December 23, 1963. X-ray January 6, 1964 shows a laminar nail of Böhler's type in place. Consolidated April 18, 1964.

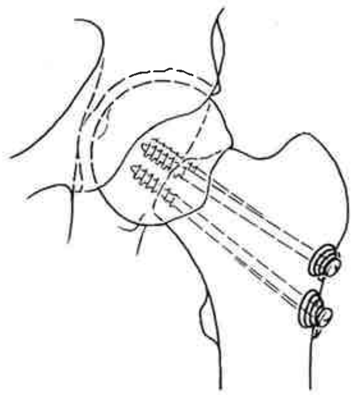


Fig. 8-63: Screw fixation of a femoral neck fracture. F. Gottfried born 1882: HB 1/11. Initial X-ray missing. On November 21, 1958 synthesis with four cancellous screws (Danis design) and spring washers. Consolidated March 17, 1960.

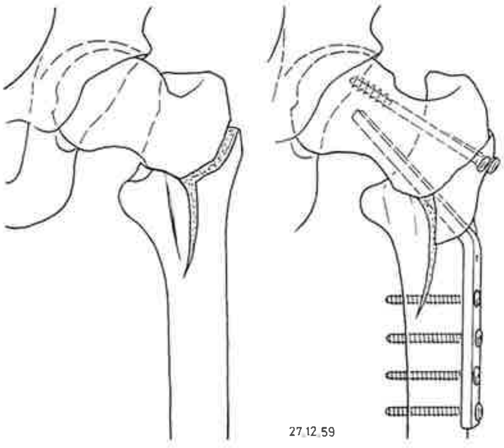


Fig. 8-64: 130° angled plate and cancellous screws. Ph. Gustav born 1909: AC 8/28. Trochanteric fracture with distal fissures on December 27, 1959. Reduction, 130° plate and screws. Consolidated March 19, 1960. Early implant removal June 10, 1960.

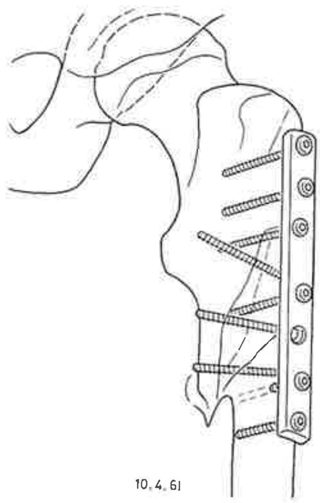


Fig. 8-65: Straight plate for a subtrochanteric fracture. L. Ruedi born 1943: MS 127. Subtrochanteric spiral fracture March 15, 1961, first treated with traction. April 10 broad straight plate and screws. Consolidated August 31. Removal of implants January 23, 1964.

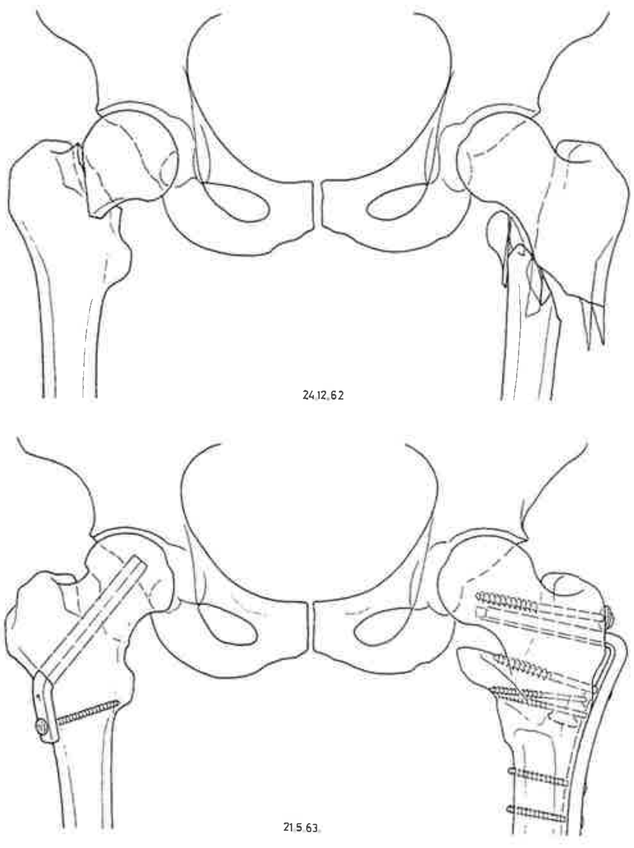


Fig. 8-66: Bilateral proximal fractures of femur. H. Erika born 1900: MS 695. Lateral fracture of the femoral neck on the right, subtrochanteric on the left side (additional trochanteric fragment). Emergency synthesis: short angled plate on the right and condylar plate with additional screws on the left side. Both fractures consolidated May 25, 1963.

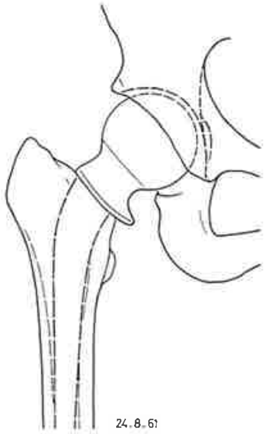


Fig. 8-67: Earliest documentated hemiprostesis in a fresh fracture. D. Camille born 1893: AC 15/25. August 14, 1961 displaced adduction fracture of the femoral neck. Head prosthesis in good position. X-ray August 24, 1961. Later evolution not documented.

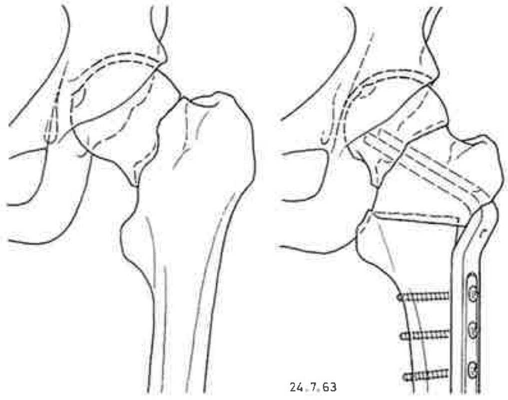


Fig. 8-68: Primary synthesis with valgus-osteotomy. E. Rosa born 1897: SG 4/17. Injury and synthesis July 24, 1963: vertical fracture line. Primary valgisation with an intertrochanteric osteotomy. Fixation with a double angled plate (here with a sliding inset). Consolidated November 22. Last X-ray July 10, 1964: no signs of head necrosis. Implants not removed.

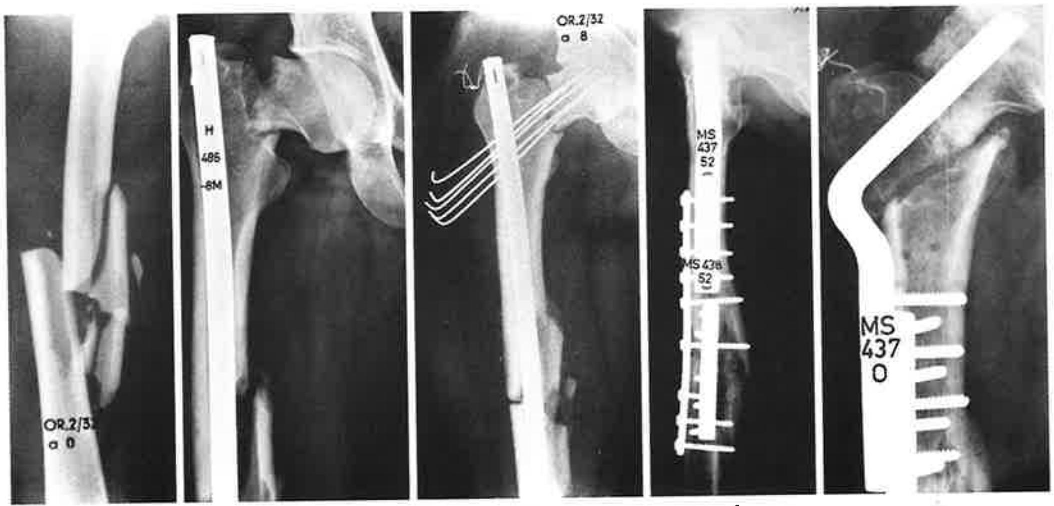


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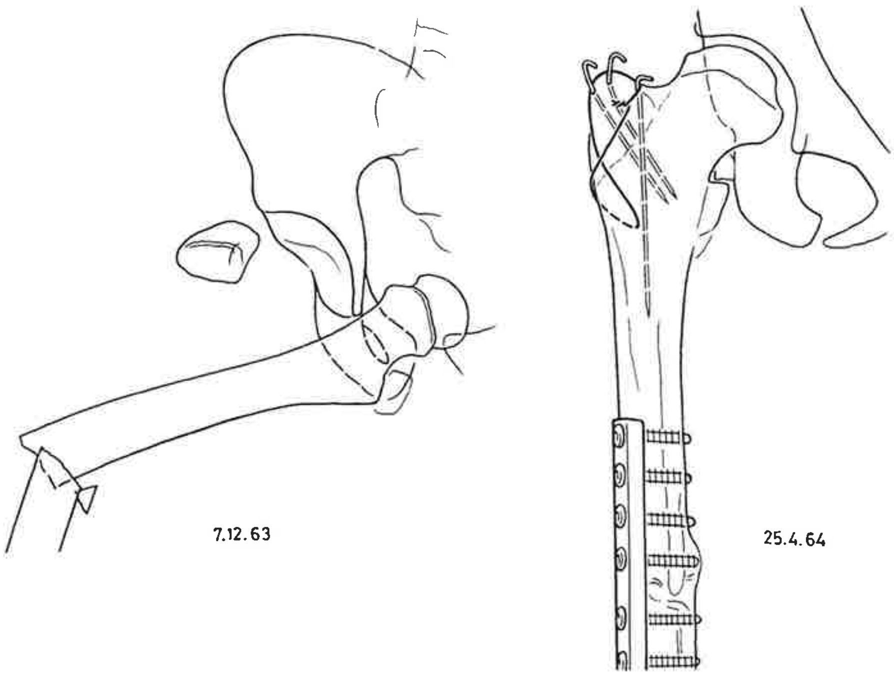
Fig. 8-69: Combined fracture of the femur shaft and neck. Secondary osteotomy. H. Margrit born 1930: OR 2/32 – MS 437. (a) May 24, 1961 shaft fracture of the femur with two wedge fragments. Intramedullary nail. (b) July 7 – probably during mobilisation – discovery of an already displaced vertical neck fracture. (c) Reduction and stabilisation with K-wires neighbouring the nail. Non consolidated December 1, 1961. Changement of hospital. (d) March 5, 1962 nail removed, double plating. (e) At the same time trochanteric valgus osteotomy with a double angled blade plate. Osteoporosis. Evolution: both fractures consolidated March 6, 1963. Last X-ray August 31, 1966: no signs of head necrosis.



oral shaft fracture with femoral neck fracture was followed up from 1961–1966 (**Fig. 8-69**).

Another rare combination: dislocation of the hip joint with avulsion of the greater trochanter and femoral shaft fractures is shown in **Fig. 8-70**. This is the first example of a single straight plate applied to the shaft and of a tension band construction on the trochanter.

Two femoral neck fractures in children stabilized with either K-wires or screws and completely healed were also documented. "Technik" (Te 284) shows an example. Many cases of screw fixation of the reduced head in epiphysiolysis in adolescents were documented.

Fig. 8-70: First single plate at the femoral shaft. Tension band fixation of the trochanter. St. Kurt born 1948: MS 1012. Dislocation of the hip joint, avulsion of the trochanter, shaft fracture with wedge. December 7, 1963 emergency reduction and synthesis of the shaft with a single plate (first case in the documentation), of the trochanter with a tension band construction. On April 25, 1964 both fractures are healing. October 26, 1965: fractures consolidated, necrosis of the femoral head.

Forearm

Shaft fractures of the radius and ulna

There are approximately 200 cases in the archives.

From 1957–1959 several coapteurs are to be found, some of them for the treatment of pseudarthrosis after nailing (**Fig. 8-71**), some for fresh fractures. The last example originated in Interlaken and is dated January 1960. These fractures consolidated with the exception of a Galeazzi fracture which never healed despite several revision operations.

The AO plate (for volar application) appears for the first time in May 1959 in Zürich for a pseudarthrosis of the radius after non operative treatment (**Fig. 8-72**).

The four-hole plate dominated at the start for both pseudarthroses and fresh fractures.

Longer plates are to be found occasionally from 1960 for multiple fragment fractures and were in regular use for pseudarthroses (**Fig. 8-73**).

It is astonishing that after osteosynthesis of simple fractures and despite the application of the tensioning device (separate drill hole) a clearly visible, fracture gap persisted (**Fig. 8-74**). The same phenomenon is apparent on the radiographs shown in "Technik" (Te 227, 230, 231). Nevertheless, consolidation was uneventful in the majority of cases.

If complications occurred after application of a short plate, it was replaced by a longer implant. Often a different plane was chosen for the second longer plate (**Fig. 8-75**). An additional cancellous bone graft is probable, but not visible.

For dorso-radial application, the plate has to be contoured to the curvature of the radius. Initially, this was forbidden because of the risk of corrosion. **Fig. 8-74** from 1960 shows an unbent plate and **Fig. 8-75** from 1962 a contoured plate from the same clinic.

There are isolated cases of successful early implant removal: In the majority of clinics, even in

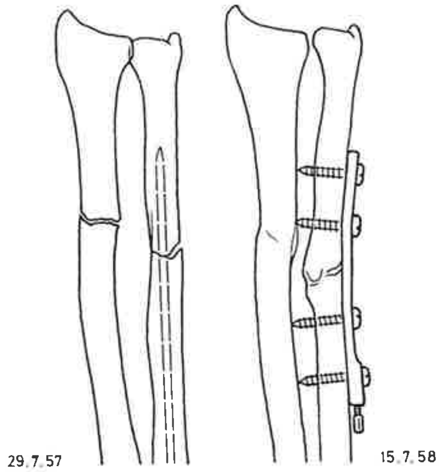


Fig. 8-71: Danis-Coapteur in a pseudarthrosis of the ulna. A. Peter born 1937: AC 6/30. July 29, 1957 shaft fracture of both forearm bones. Intramedullary nail of the ulna, radius not operated. January 8, 1958 radius consolidated. July 15 pseudarthrosis of the ulna: coapteur. Consolidated October 20, 1958. Last X-ray January 12, 1960. Implants not yet removed.

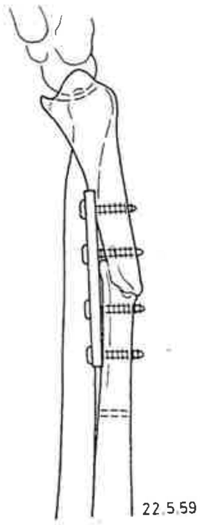


Fig. 8-72: Earliest AO-plate at the radius. W. Robert born 1933: KZ 1/24. February 12, 1959 oblique fracture of the radius shaft. Reduction and plaster of Paris cast. Secondary displacement, delayed union. On May 22, 1959 AO plate from volar approach. Consolidated May 27, 1960. Implants not yet removed.

1960, it was customary to wait one year or longer before removing the implants. No early **refractures** are documented, but some late ones.

Twice **bridging callus** was observed in a fracture of both bones. The cause may have been encroaching wedge fragments (rupture of the interosseous membrane) which had not been reduced.

The complications reported in the documentation are distributed evenly across fractures of one or both bones. Differences in prognosis are only identifiable for the three Galeazzi fractures which required revision operations.

In August 1962 the first semi-tubular plates appear (**Fig. 8-76**: the most distal screw on the ulna was secured with a counternut). One pseudarthrosis occurring after lateral plating of the ulna healed after dorsal application of a semi-tubular plate (plus cancellous bone graft) (**Fig. 8-77**).

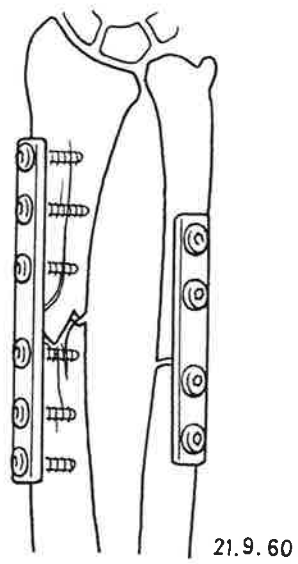


Fig. 8-74: Primary synthesis of both forearm bones. L. Benjamin born 1893: KZ 3/39. September 13, 1960 oblique shaft fractures of both bones (additional fissures in the radius). September 21 synthesis of ulna with 4-hole-plate, of radius with 6-hole-plate from a dorso-radial approach. Straight radial plate. Consolidated October 9, 1961. Implants not yet removed.

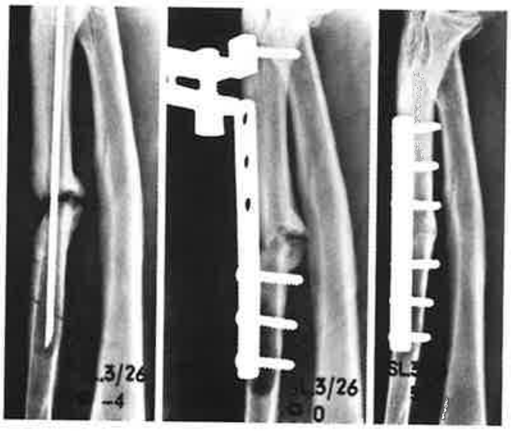


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Fig. 8-73: Pseudarthrosis of the ulna after medullary nailing, plate fixation. L. Gottfried born 1901: SL 3/26. Documents of the initial treatment (elsewhere) missing. (a) April 3, 1962 pseudarthrosis after nailing of a shaft fracture of the ulna. Defect and osteolysis. (b) May 1 stabilisation with a 6-hole-plate. Compression with tension device. (c) Consolidated April 22, 1963.

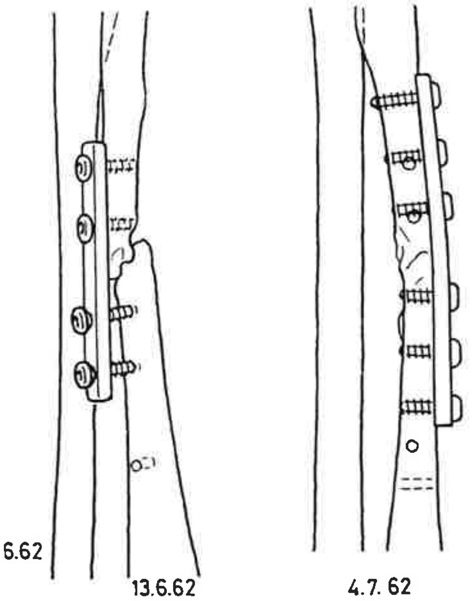

Fig. 8-75: Reosteosynthesis with a longer plate. T. Emma born 1912: KZ 5/28a. January 3, 1962 oblique radius shaft fracture: volar approach, 4-hole-plate. Pull out of plate June 13, 1962. Reoperation July 4 using a 6-hole-plate introduced through a dorso-radial approach and fit to adapt the bone. In consolidation October 26, 1962. Same hospital as 8-74.

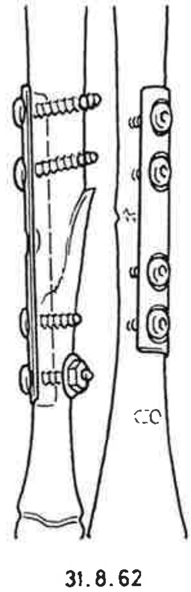

Fig. 8-76: Semi tubular plate and a threaded conternut. A. Jürg born 1949: SL 3/39. August 30, 1962 shaft fractures of both bones. Synthesis of radius with 4-hole, of ulna with 5-hole-semi-tubular-plate and threaded conternut in the distal plate hole. Consolidated December 19. Implants removed April 17, 1963.

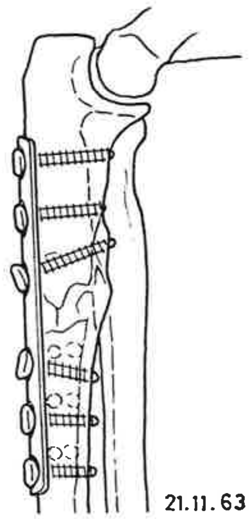

Fig. 8-77: Pseudarthrosis of ulna, semi tubular plate. F. Arnold born 1919: MS 878. First documents missing. Pseudarthrosis following lateral ulna plating. May 30, 1963 synthesis with dorsal semi-tubular plate. The central plate screws avoid the pseudarthrosis tissue (oblique position). The other screws are eccentrically introduced for compression.

Proximal fractures of the forearm bones

The documentation contains approximately 100 cases. The traditional operation for dislocated **olecranon fractures** was the crossed cerclage with only one wire which was wound round the triceps tendon and passed through a distal drill hole. It can still be found on occasion in the documentation up to 1961 (**Fig. 8-78**).

Within the ranks of the AO, the intramedullary axial cancellous bone screw with washer was at first preferred (**Fig. 8-79**). Some examples can still be found up to 1963.

The first cases of typical tension band technique came from St. Gallen in June 1961 (**Fig. 8-80**). Complications were extremely rare. In 1963 a case of secondary dislocation stabilized with a plate was recorded. For oblique fractures, an additional screw was introduced (centred over the fracture gap, likewise if the coronoid process was affected) (**Fig. 8-81**). Several examples of this exist. In "Technik" (Te 236) a combination of wire tension fixation with semi-tubular plate and a screw in the reduced coronoid process is illustrated.

The tension band technique was only taken up by the other members after 1963.

For the **isolated dislocated fracture of the head of the radius** primary resection was usual at the time. The documentation contains only three operated cases: one, possibly percutaneous, wire fixation with two K-wires in a child after severe dislocation. A similar procedure for a radial neck fracture with dislocation of the ulna in an adult led to necrosis of the head of the radius. The first synthesis (small cancellous bone screw) appears in August 1963 in Grenchen for a displaced partial fracture (**Fig. 8-82**).

The documentation also includes several **combinations of fractures of the proximal ulna and the head of the radius**. The head was always resected. Over a longer period of observation, these cases showed severe arthrosis with deformation.

From 1960 there are also several cases of **Monteggia dislocation fracture**. Ulna fracture was normally stabilized with a six-hole plate. Healing was uneventful if the head of the radius was intact. If it was resected, complications (delayed healing, refracture, etc.) were the rule.

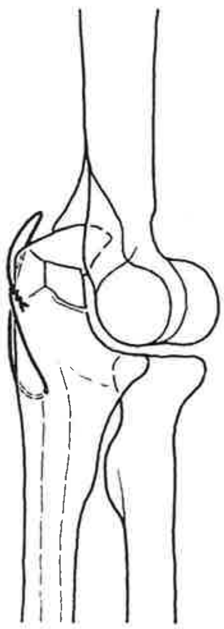

Fig. 8-78: Single wire loop in an olecranon fracture. B. Kathrin born 1887: MS 298. October 18, 1961 fracture with a depressed area. Single figure-of-eight wire-loop. Plaster splint. Consolidated February 20, 1962 implant still in place.

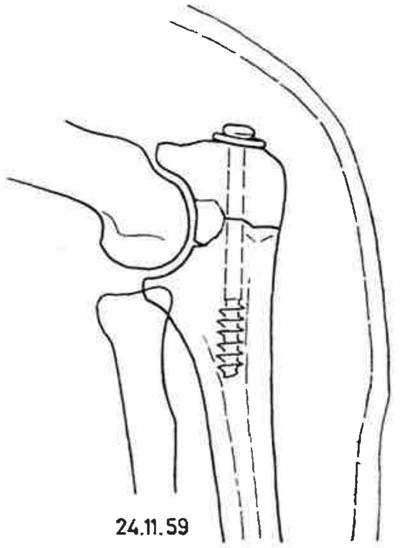

Fig. 8-79: Cancellous screw in an olecranon fracture. L. David born 1943: BG 1/13. November 20, 1959 transverse fracture with some depression. November 24 screw and washer. Plaster splint. Evolution not documented.

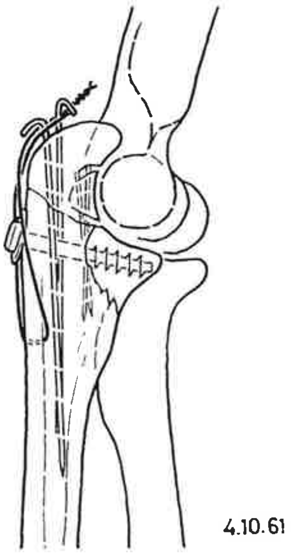

Fig. 8-81: Olecranon fracture involving the coronoid process, tension band and screw. K. Berta born 1887: MS 279. Olecranon and coronoid process fracture on October 3, 1961. Tension band system for the olecranon and screw in the coronoid. Consolidated February 7, 1962.

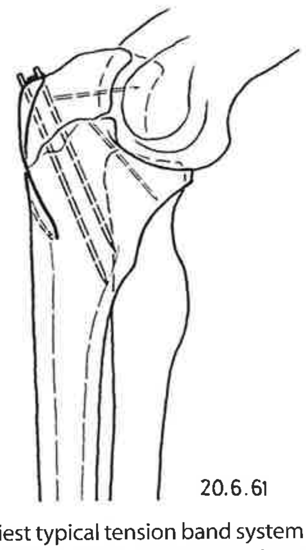

Fig. 8-80: Earliest typical tension band system on an olecranon fracture. O. Alois born 1910: MS 175. June 9, 1961 oblique fracture with central depression. Synthesis June 20, with two parallel K-wires and tighten figure-of-eight-loop. Additional small K-wires. The end of the wires are not bent. Removal of implants October 10, 1961. No arthrosis July 18, 1963.

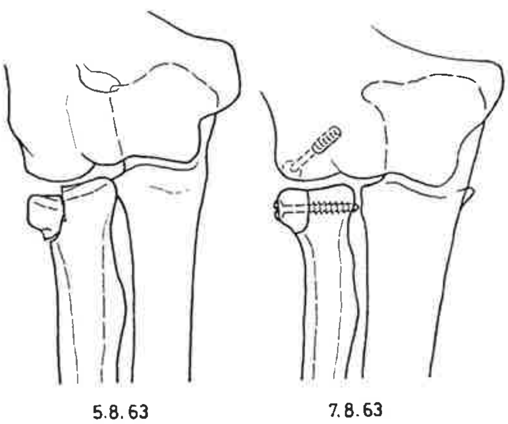

Fig. 8-82: Earliest synthesis of a radial head fracture. Z. René born 1930: GG 8/22. August 5, 1963 partial displaced fracture: August 7 small cancellous screw. introduced trough an enlarged approach (screw in the humerus epicondyle) consolidated September 3, 1965. No arthrosis.

Distal radius fractures

There are approximately 80 cases in the documentation most of which were stabilized by percutaneous wire fixation from the radius styloid. From 1961 there are also cases of screw fixation for fractures of the styloid process of the radius (cancellous bone or malleolar screws) (**Fig. 8-83**). These include a radiocarpal dislocation fracture with an additional dislocated navicular fracture (K-wire fixation).

The first dorso-radial plates appear in 1963 in Liestal and Grenchen (**Fig. 8-84**) for fractures resistant to reduction and or comminuted zones in the metaphysis of both bones.

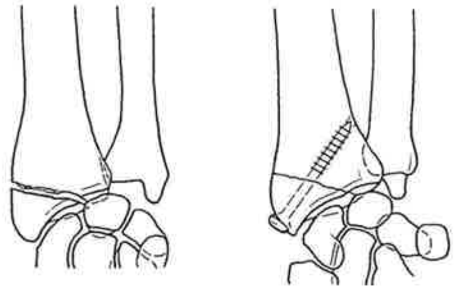

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Fig. 8-83: Screw synthesis of styloid fracture of the radius. B. Armando born 1930: MS 769. February 9, 1963 displaced oblique fracture. Malleolar screw. Consolidated June 21, implant not yet removed.

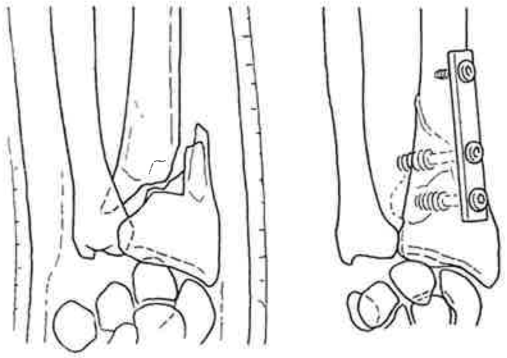

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Fig. 8-84: Earliest plate in the distal radius. S. Robert born 1931: SL 17/27. Extension type distal oblique radius fracture. Reduction unsatisfactory. Dorso-radial plate May 24, 1963. Consolidated September 9. May 27, 1964 no arthrosis, implants removed.

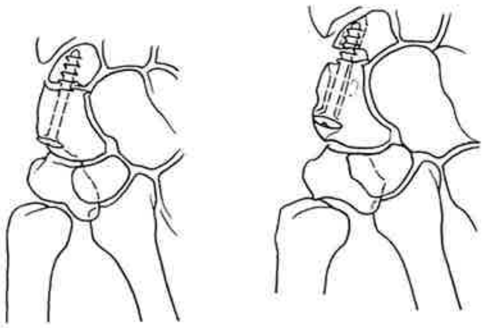
Fractures of the wrist and peripheral hand skeleton

Fractures of the scaphoid

The documentation contains 58 cases treated with small cancellous bone screws. 48 came from Liestal. The first document corresponds not to the day of the accident, but to the day the injury was discovered or the referral of the patient to the surgeon (possibly after plaster fixation). Consequently, the majority are cases with wide gaps, osteolytic foci and cyst formation.

The first case, operated in 1959, (**Fig. 8-85**) demonstrates these features and also the typical screw fixation technique.

If the position of the screw prevented compression, the pseudarthrosis did not heal (**Fig. 8-86**). Pseudarthroses with extensive cyst formation can consolidate even if the proximal fragment is small and dense. Sometimes osseous bridging occurs very late. However, non union for no apparent reason was not unusual (**Fig. 8-87**).



3.10.62 26.7.65

Fig. 8-86: Persisting pseudarthrosis after wrong technique. W. Karl born 1932: KZ 7/11. First X-ray May 29, 1962, synthesis next day. X-ray of October 3: the thread of the screw was too long, preventing an interfragmentary compression. The pseudarthrosis persists on July 26, 1965.

Fig. 8-85: Earliest screwed scaphoid fracture of the documentation. St. Adolf born 1920: WL 18/2. (a) January 6, 1959 displaced central transverse scaphoid fracture. (b) Synthesis April 29 (shortened screw head). (c) X-ray March 23, 1966: Fracture healed, no arthrosis.

a b c

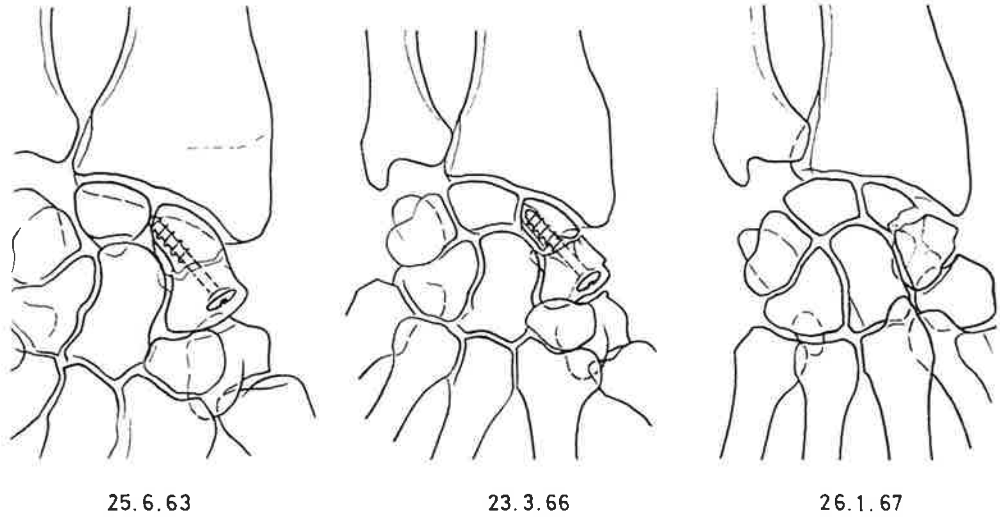


Fig. 8-87: Persisting pseudarthrosis in spite of a correct technique. M. Josef born 1947: WL 22/16. June 25, 1963 correct screw technique for a scaphoid pseudarthrosis (first X-ray June 19). Non consolidated March 23, 1966 and also after implant removal January 26, 1967.

Fractures of the metacarpi and phalanxes

67 cases were documented whereby the predominant method of fixation was by oblique crossed K-wires, possibly percutaneous.

Among these there are 15 basal fractures of the first metacarpal. A small cancellous bone screw was only inserted once successfully. The remaining metacarpal and phalangeal fractures include 12 screw fixations (of these two arthrodeses). Two cases in 1962 are of an innovative character: one paraarticular distal torsion fracture of M-V in Rorschach (vitallium screw **Fig. 8-88**), and one torsion fracture of the proximal phalanx of the thumb fixed by small cancellous bone screws in April 1962 in St. Gallen.

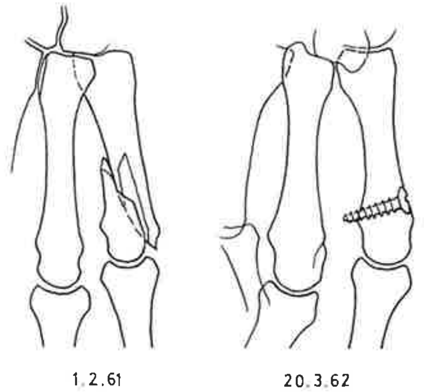


Fig. 8-88: Screw synthesis for a fracture of a fifth metacarpal. G. Joachim born 1934: OR 1/38. February 1, 1961 distal spiroid fracture. February 15 synthesis with a small vitallium screw. Small AO screws do not exist at this time. X-ray March 20, 1962: fracture healed, implant still in place.

Techniques on the humerus

Humeral shaft

The documentation includes approximately 180 osteosynthesis. At first, only pseudarthroses were operated on since these predominated until 1963. They were either the first or a revision intervention after preceding failed operations (cerclage, intramedullary nailing Rush pins, plates of other design). These patients came to the AO hospitals for secondary procedures. Up to 1959 only the Danis coapteur in various sizes had been available.

In 1961 in Chur a primary screw fixation for a wedge fracture was attempted, but it promptly dislocated and had to be reoperated.

a b

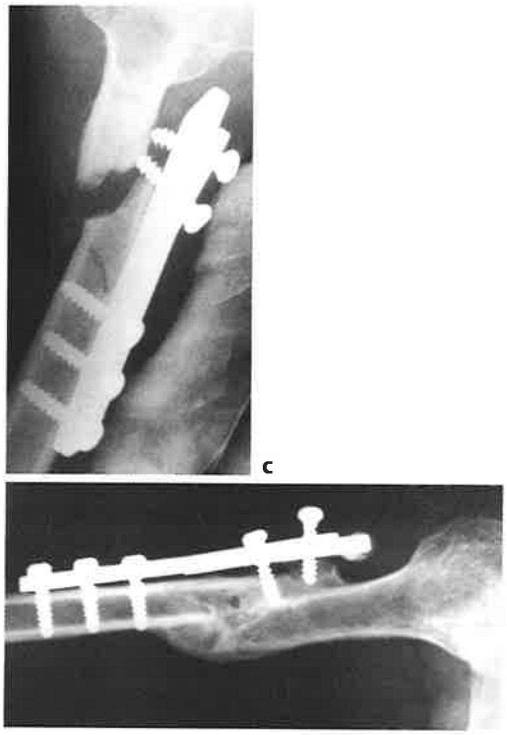
Fig. 8-89: Pseudarthrosis of the humerus after Danis coapteur, AO plate (reproduced also in Te 18). B. Paul born 1921: WL 1/1. Documents of injury and first synthesis (elsewhere) are missing. (a) Pseudarthrosis due to a too feeble coapteur on March 17, 1959. Reoperation with a prototype AO plate March 24. (b) Consolidated August 24, 1959.

Thin intramedullary nails have not proven their worth. The proximal approach was preferred in Freiburg i.B.: three successful cases were documented.

The first AO plate (a six hole prototype) was applied successfully in March 1959 to treat pseudarthrosis after treatment with a too short Danis coapteur (**Fig. 8-89**). This case is also illustrated in "Technik" (Te 18). The first (too short on the proximal side) AO plate applied to a fresh fragmentary fracture in an elderly patient consolidated despite pull-out of the proximal screws after immobilization (**Fig. 8-90**). Delayed consolidation did however also occur after correct plate synthesis in younger patients.

A typical example with a humerus plate is shown in **Fig. 8-91**. With many synthesis, attention is drawn to the fact that on the radiograph the fracture gap is still clearly visible; this is also seen on the examples given in "Technik" (Te 265–267). In cases of implant loosening (infection?) and pseudarthrosis, consolidation was achieved either by applying a longer plate in another plane and cancellous bone graft or by applying an additional second plate (**Fig. 8-92**). A revision operation in Glarus was documented in which a screw pulled the plate onto the shaft by means of a counternut (**Fig. 8-93**).

a b



c

d

Fig. 8-90: Consolidation in spite of pull out. H. Rosa born 1877: BG 1/19. (a) Wedge fracture of humerus shaft September 19, 1959. (b) 6-hole-plate (with sliding inset) September 23. The proximal screws are too short. (c) Pull out of screws October 23. Not reoperated. Plaster cast. Callus visible January 5, 1960. (d) X-ray December 5, 1960 (shoulder in abduction): consolidated. Implants in place.

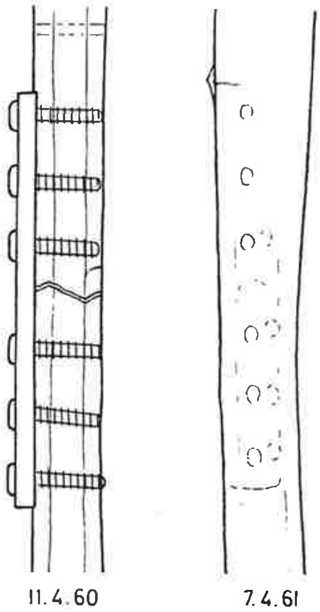


Fig. 8-91: Transverse humerus fracture, typical synthesis. B. Hanspeter born 1945: BJ 2/38. April 11, 1960 displaced fracture. 6-hole compression plate. The fracture line remains clearly visible. Signs of local irritation August 3. In consolidation November 16, 1960. Implants removed April 7, 1961.

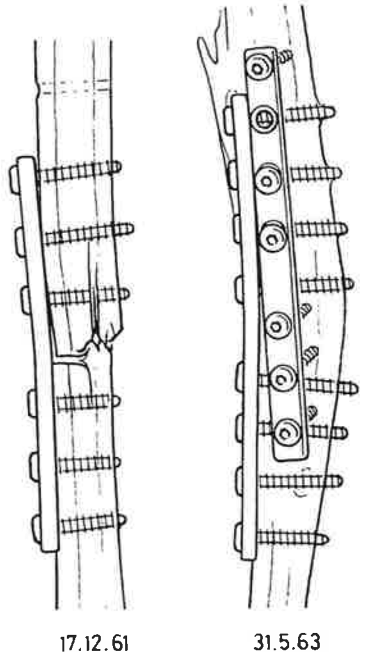


Fig. 8-92: Pseudarthrosis following a plate, reoperated with two plates. F. Italia born 1910: MS 338. December 17, 1961 displaced transverse humerus fracture with small wedge. Compression 6-hole-plate. Reduction not satisfactory. June 26, 1962 callus and loosening of screws. Reoperation July 5 with two narrow plates. Consolidated May 31, 1963.

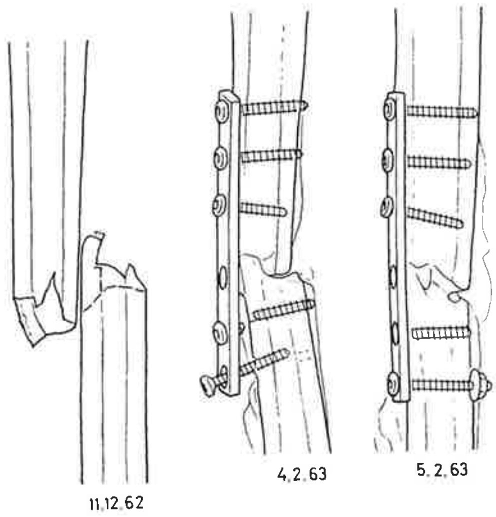


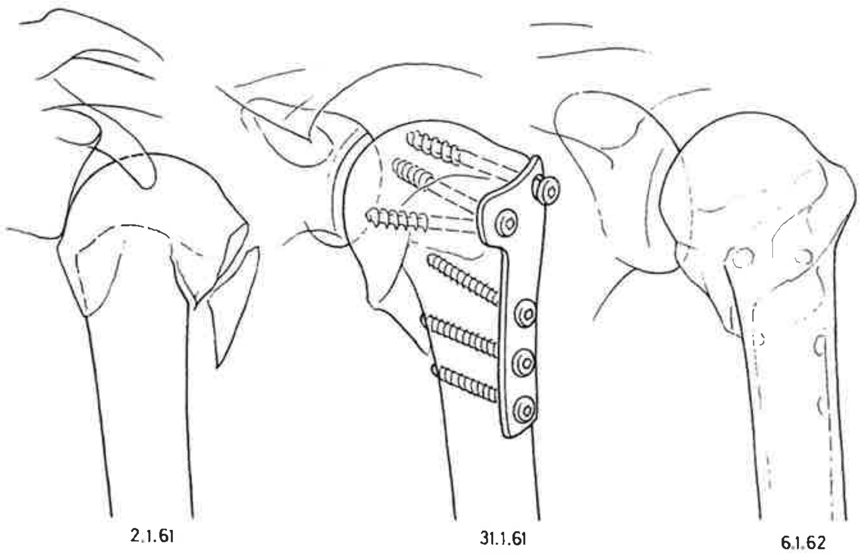
Fig. 8-93: Pull out of plate. Refixation with a counternut E. Hans born 1947: BG 3/13b. December 11, 1962 oblique humerus fracture with wedge. The 6-hole-plate is too short distally. Pull out of implant February 4, 1963. Readaptation of the plate with a threaded counternut in the distal screw. Evolution unknown.

Fractures of the proximal humerus

The documentation contains approximately 120 cases. The first appear in the summer of 1959: screw fixation of a dislocated subcapital fracture in an adolescent in Interlaken and a Rush pin in a proximal approach in 1961 in Chur. There is also an early screw fixation of the tubercle after a dislocation fracture.

The T-plate designed by Bandi especially for subcapital dislocated fractures and pseudarthroses at first seems a rather bulky prototype, but in the spring of 1961 it made its debut in its definitive slimmer form. The implant was applied successfully in the treatment of fresh fractures (**Fig. 8-94**) and pseudarthroses after non operative treatment or preceding operations. The relevant examples are numerous. Early necrosis of the humeral head after osteosynthesis of dislocated and comminuted fractures was documented in three cases. The usual observation time was however insufficient to record these very late sequelae.

Fig. 8-94: T-plate for a subcapital humerus fracture. H. Paul born 1910: BJ 17/11. January 2, 1961 subcapital valgus fracture with a depressed area. Reduction and fixation with a T-plate and separate screw. Consolidated April 4. Normal articulation after removal of implants January 6, 1962.



Fractures of the distal humerus

The documentation includes approximately 200 cases, the majority being supracondylar fractures in children which were treated by open reduction with single or crossed K-wires. Small cancellous bone screws were inserted successfully for a supracondylar fracture in St. Gallen (**Fig. 8-95**), an ulnar avulsion fracture – presumably an open dislocation – in Chur, and a pseudarthrosis of the radial condyle stabilized with a malleolar screw.

In adults, several cases of complex transcondylar fracture were treated from 1960–1963: first, reconstruction and stabilization was attempted with screws and K-wires. In November 1961 in St. Gallen a similar fracture was treated by osteotomy and fixation of the olecranon (**Fig. 8-96**). In Liestal the crossed threaded tensioning device was chosen. For only slight dislocation, the malleolar screws inserted in triangular formation were successful.

Two supracondylar pseudarthroses went on to uneventful healing early in 1961 in Chur after lateral plating and insertion of additional screws, and in St. Gallen after a double plating procedure (**Fig. 8-97**).

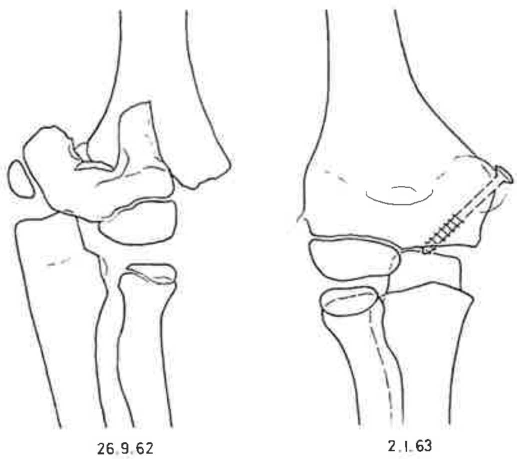
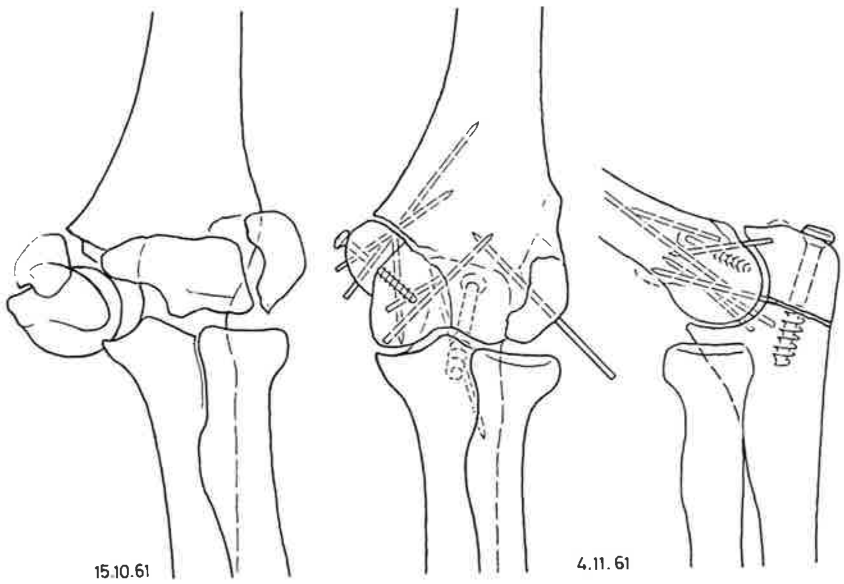


Fig. 8-95: Small cancellous screw in supracondylar child fracture. G. Reimond born 1953: MS 615. September 26, 1962 transverse supracondylar fracture with important displacement (probably open). Reduction and stabilisation with a small cancellous screw. Consolidated January 2, 1963.

Fig. 8-96: Comminuted intraarticular fracture of distal humerus. B. Anna born 1891: MS 295. Injury and first X-ray October 15, 1961 – elsewhere. Synthesis November 4: Approach trough an osteotomy of the olecranon. Reduction and stabilisation with multiple K-wires. Consolidated February 20, 1962. Later evolution unknown.



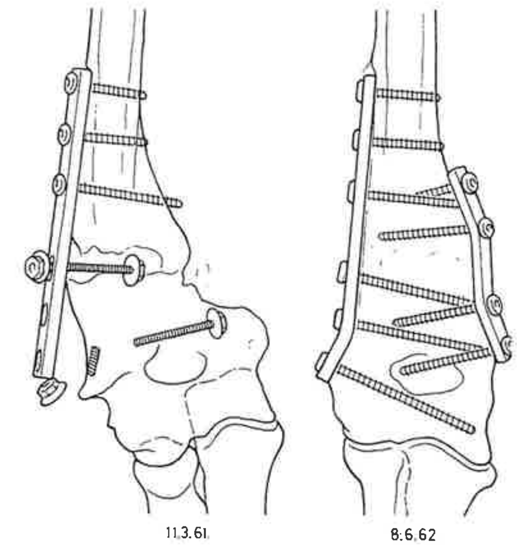


Fig. 8-97: Plate fixation of a distal humerus pseudarthrosis. K. Hans born 1916: MS 117. First documents misssing. X-ray March 11, 1961: supracondylar pseudarthrosis after synthesis with threaded bars. March 13 removal of implants and stabilisation with two contoured plates (on the radial and the ulnar side). Consolidated June 8, 1962.

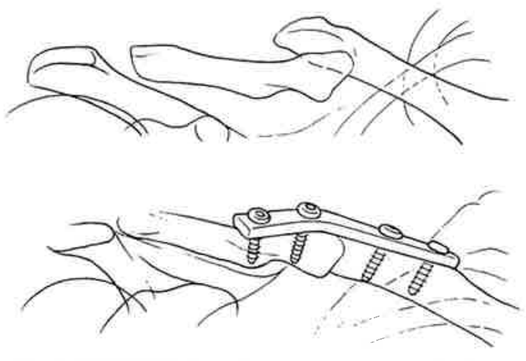


Fig. 8-98: Pseudarthrosis of clavicula, cranial plate. H. Guido born 1940: MS 1/13. Date of injury unknown. Central pseudarthrosis with shortening December 8, 1960. Synthesis with an adapted 4-hole-plate December 10. Consolidated April 12, 1961.

Clavicle and scapula

About 120 osteosynthesis procedures are recorded in the documentation, whereby the following indications and techniques can be identified:

- **Pseudarthrosis.** At the end of 1960 in St. Gallen the first case of a contoured four-hole plate applied on the cranial aspect is found (**Fig. 8-98**). In 1962 a semi-tubular plate mounted ventrally was recorded in Langnau (**Fig. 8-99**).
- **Lateral fractures** with involvement of the acromioclavicular joint. A procedure of reduction and stabilization with transacromial axial K-wires was documented and, in Freiburg i.Br., screw fixation to the coracoid process.
- Primary osteosynthesis in the **mid third** is only found in cases of extreme dislocation or central comminuted zones. Presumably these were open fractures. In 1958 an example of medullary splinting can be found. Plates appeared for the first time in November 1960 in St. Gallen (**Fig. 8-100**). In Chur in 1961 one secondary synthesis using a long plate and cerclage wires to treat a wedge fracture was documented.
- A few collector's items are also to be found in the documentation: an acromion fracture, treated and healed with a tension band system in St. Gallen in 1961, and – also from St. Gallen – synthesis to treat a pseudarthrosis of the scapular neck with upright spina and fixation with two semi-tubular plates.

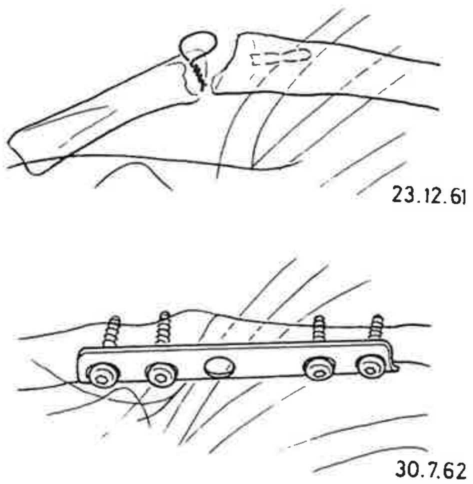


Fig. 8-99: Ventrally placed semi tubular plate for a pseudarthrosis. H. Gertrud born 1939: SL 4/1. Dates of injury and first synthesis unknown. December 23, 1961 pseudarthrosis with defect, remaining cerclage wire and broken drill bit. July 30, 1962 synthesis with semi tubular 5-hole-plate (and cancellous graft), placed anteriorly. Consolidated November 5. Implants still in place.

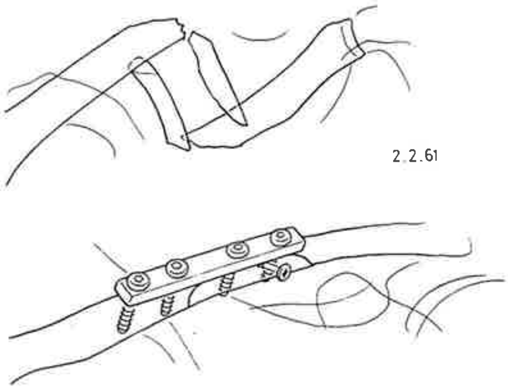


Fig. 8-100: Primary plate in a central fracture. M. Giovanni born 1927: MS 80. February 2, 1961 impressive displacement of a comminuted fracture (probably open). Stabilisation with a (too short) 4-hole-plate and small cancellous screw. Secondary displacement June 22, 1961. Further development unknown.

References

1 Müller ME, Allgöwer M, Willenegger H. Manual der Osteosynthese. Springer Berlin, Heidelberg, New York 1969
2 Leemann R. Die Falzcerclage und der Falzspanner. Helv. Chir. Acta 19, 119, 1952
3 Herzog K. Die Behandlung von Tibiabrüchen mit Rohrschlitz-Nägeln. Zbl. chir. 83, 512, 1958
4 Müller Allgöwer Willenegger 1969, p. 199 ff

Chapter 9
Epilogue (1964–1969)

The first development phase of the AO was followed by a second phase which we need to discuss briefly here because these events are also no longer common knowledge. We then conclude with the publication of the Manual in 1969[1].

The salient events in these periods have been reported in the two books by Robert Schneider in 1969 and 1983 (Schn II). Additional reference sources exist in the form of the protocols from the technical commissions (TK) and the annual reports of the Laboratory for Experimental Surgery in Davos. We will restrict this report to note form.

The **structures** of the AO and Synthes proved their worth and remained unchanged. The spokesman and the Committee were regularly confirmed in office.

Members

From 1965 new members were again admitted. These were mostly former collaborators of the pioneers now working independently: the *"second generation"* of the AO. In 1967 corresponding members were also admitted (Mathys in Bettlach, Batten in Birmingham and Rosen in New York) as well as scientific members (Wagner in Schwarzenbruck, Schenk in Basel/Bern, Straumann in Waldenburg, Perren in Davos).

1967 was a year of great change:

- Müller left St. Gallen for good, moved to Bern, and Weber became his successor. The documentation group moved from Davos to Bern.
- Allgöwer was elected director of the surgical department at the University of Basel and took the greater part of his team in Chur with him.
- Fleisch was elected head of the Pathophysiology Institute at the University of Bern.
- His successor in Davos was Perren with whom the efforts of the Laboratory (LECD) were directed primarily towards biomechanical research.
- Brussatis was elected Professor of orthopaedics in Mainz.

Instrumentation and technique

From 1964 onwards smaller implants were introduced[2]: first, the cortex screws with outer diameters of 3.5 and 2.7 mm; then the so-called 'one-third tubular plates'; and finally, – as the first of a group of moulded plates – the small, thin T-plates[3]. The requests for these items came from the younger members or collaborators and aroused little enthusiasm in the technical commission.

The existing screws and plates remained unchanged. The latter were redefined according to their function as *"tension band, neutralization or buttress"* plates[4]. Now the corresponding instruments to twist and contour the plates were made available.

The important development of the oscillating saw also falls into this period (Schn II/81).

The plans and innovations being discussed at this time in the **technical commission** are pointers towards the future:

Steinemann proposed (TK January 23,

1965) the introduction of a spherical design for the undersurface of the screw head – similar to the design of the French company Maconor. It would then have been possible to achieve *"inclination"* of the screws in the plate hole (having modified the hole appropriately), that is to say, a certain freedom of angulation. The lateral stability would have been maintained and there could be no risk of additional corrosion. The majority of medical experts would have greeted this alteration. As a *"system alteration"* the proposal was at first rejected (introduction 1968).

The team Allgöwer/Perren had already started testing a new plate with the collaboration of the engineer Russenberger. It could be demonstrated that maintaining the initial interfragmentary pressure obtained by application of the external tensioning device was subject to a great deal of scatter with a conical plate hole.

Spherical configuration of the plate hole and eccentric insertion of a spherical screw made it possible to create a tension effect within the implant itself. The development was based on an idea by Bagby in 1958[5] which, however, made use of screws with a conical undersurface to the screw head. Even with the half-tubular plates some degree of compression could be achieved[6].

The new implant was called the *"slotted"* or later on the *"tension hole plate"*. The promotors of the device were working in titanium. The initial implantations in humans were performed in 1963. Perren presented these experiments in his lectures at the AO Meetings of 1966 and 1967 (Schn II/115f) and showed a film. The first publications appeared in 1969[7,8].

In the early 1970s, the complete *"Dynamic Compression Plate System"* was introduced into the hospitals. Titanium as a material for implants was only introduced much later on.

In Chur and Davos research into shock continued, especially by Burri. Polytrauma had become more frequent. The *"Shock index"*[9] proved to be valuable in clinical practice.

The **teaching activities** and **international relations** of the AO experienced a period of rapid development at this time:

- In 1965 an AO Course was held for the first time outside Switzerland, that is, in Freiburg im Br., directed by Krauss and Schneider and organized by Koslowski and Weller. It became a regular annual event.
- In the same year, the traumatology symposia commenced in Mainz (Schweikert and Schneider)
- In 1966, three Italian friends: Bianchi-Maiocchi in Milan, Benedetti in Bergamo and Bombelli in Legnano founded the *"Club Italiano degli Amici dell' AO"* together with former participants at the Davos Courses. This association was promoted by Mathys, it expanded very rapidly and uncritically, became nebulous, and therefore never really structured.
- Also in 1966, the Davos Courses were held in German and Italian; in 1967 in French and English. Later in 1967, the first course for pelvic surgery took place.
- In 1968 a course was held in Ljubljana (Slovenia).
- The lecturing activities of the core group and the collaborators on scientific projects became very extensive. The relevant publications were issued. These are listed in the Annual Reports of the Laboratory for Experimental Surgery in Davos[10].

In 1969 in Graz the Austrian Association for the Study of Internal Fixation was established under the leadership of Spath, Brücke, Tscherne and Feischl.

In Germany a similar group was established by Koslowski and Weller a year later.

In the meantime, the producers had set up a whole chain of **agencies abroad**, and even put their feelers out into the East European countries.

It was not so easy to comply with the requests made by doctors in 1964 for a *"breakthrough"* of our instrument sets in the USA. The Instrument Company Smith Kline and French in Philadelphia commissioned by Synthes also distributed other instrument sets. The senior registrar, Segmüller in Chur, investigated the situation personally. Allgöwer and Willenegger were both aware of the situation and actively involved. The main obstacle was the widespread rejection of osteosynthesis for fresh fractures, a position defended by the Establishment.

In 1966 Mathys had undertaken a goodwill tour of Africa in his private plane, visiting numerous hospitals and demonstrating the instrument sets.

In 1969 the *"AO Manual"* was published (Springer Berlin, Heidelberg, New York) as the second AO book. the authors were once again Müller, Allgöwer and Willenegger[1]. It was, as the name states, conceived as a practical working manual. The general sections were organized in a similar way to *"Technik"* in 1963. In the specific sections, the illustrations were semi-schematic representations. These were outline drawings from radiographs from the documentation archives. This procedure permitted greater accentuation of typical findings and technical details.

References

1 Müller ME, Allgöwer M, Willenegger H. Manual der Osteosynthese. Springer Berlin, Heidelberg. New York 1969

2 Protocols of the Technical Commission 1962–1970

3 Müller Allgöwer Willenegger 1969, p. 137

4 Müller Allgöwer Willenegger 1969, p. 38, 53 ff, 63f

5 Bagby G. Janes J. M. The Effect of Compression on the Rate of Fracture Healing Using a Speciale Plate Am. J. Surg. 95, 761, 1958

6 Müller Allgöwer Willenegger 1969, p. 42f

7 Perren SM, Huggler A, Russenberger M, Allgöwer M, Mathys R, Schenk RK, Willenegger H, Müller ME. The reaction of cortical bone to compression Acta orthop. scand. Suppl. 125, 1969

8 Perren SM, Allgöwer M, Ehrsam R, Ganz R, Matter P. Clinical experience with a new compression plate "DCP" Acta. orthop. scand. Suppl. 125, 1969

9 Burri C, Allgöwer M. Klinische Erfahrungen mit der Messung des zentralen Venendruckes Schw. med. Wschr. 97, 144, 1967

10 Annual Reports of the Laboratory for Experimental Surgery in Davos, 1961–1970

Concluding remarks

Anyone approaching the AO Phenomenon today from the outside and attempting to fathom the course of events leading to its success has great difficulty finding their bearings:

- the structural and operational diversity of this gigantic movement hinders overview and insight
- at the very front one runs into the representatives of the powerful industrial companies exhibiting and promoting attractive instrumentation, but who either do not know or cannot understand the ideas of the pioneer generation who created the foundations on which today's structures have been built.
- these ideas should, however, remain the essential motivation for surgeons worldwide working with the AO implants and instruments.

The AO can, therefore, turn from a phenomenon into an enigma. This observation has been one of the driving forces for the compilation and portrayal of its history.

There are still two questions to be answered:

Is it a coincidence that the AO was founded in Switzerland? By chance, two non Swiss friends have provided quite independent answers that are however largely in accordance:

- The long-term, methodical collaboration of independent surgeons holding management positions would not have been possible in other countries where competitive hierarchical structures dominate.
- Attention to highest precision and discipline in craftsmanship (as exemplified by the clock-making industry) has been characteristic of Switzerland for generations. This equally applies to attention to hygiene, a prerequisite for optimized asepsis.
- The surgeons' idea that the producers should give up a share of the profits in order to finance research, documentation, and teaching, without jeopardizing their independence, is unique. This was only possible in a society in which a culture of "habitual" dialogue and consensus prevails and professional and class distinctions are insignificant.

For these remarks, I wish to thank Prof. O. Pohler who comes from Germany originally, but has been very much influenced by American culture, and Prof. J. M. Thomine, who worked alongside Merle d'Aubigné, professor emeritus for orthopaedics and traumatology in Rouen, guest of honour at the AO Course in Davos in 1995.

What is the basis of the unexpected international success of the AO and how has it shaped and advanced traumatology over recent decades?

- The techniques and instrumentation have some share in it because of their distribution. The AO actually only improved and added to what their forerunners Lambotte, Danis and Küntscher had devised and developed. Completeness and quality were, however, new.
- Perhaps more important, but not crucial, was the innovative and demanding method of teaching which was intended as a safeguard against slip ups in indication and technology.
- The new unconventional collaboration of the surgeons with technical designers and scientists made it possible to find practical solutions to the various unsolved questions relatively quickly. This indirectly promoted the reputation of the AO.

- In terms of doctrine, a serious problem must be faced: the exclusive representation and propagation of direct (so-called *'primary'*) diaphyseal consolidation of fractures without visible callus was, in retrospect, an error. In fact, this is only one form of fracture healing – a rarer form, associated with certain conditions and not at all a superior or more economic form of fracture healing.
- However, plaster-free postoperative mobilization could only be achieved by creating permanent and increased (so-called *'absolute'*) stability of the construction.
- For the first time, emergency osteosynthesis permitted immediate painless active movement of all joints and muscles and, after an intensive but very short psychological depression, gave the patient an immediate feeling of physical integrity, self-confidence, and personal freedom of movement. The healing phase commenced directly. This was the **new** and **crucial** aspect of the AO. Paradoxically, it transpires that the great psychologist, Böhler, as a propagator of the systematic activation and motivation of his patients would be much in accord with the AO.

The rapid development and recognition of the AO is based then, above all, on **immediate definitive** treatment associated with an ideology, exciting for doctor and patient alike, which demands that the inherent natural sloth in us all must be overcome by personal willpower.

In this entire book, I have avoided the word *'progress'*. It too readily expresses a value judgement. In my opinion, the judgement must be reserved for future generations. To what extent the errors, insufficiencies, and poor performance (we have not left them out) tip the scale, must be decided by the reader.

It seems appropriate to end with a quote from the lecture delivered by M. E. Müller on March 15, 1958 in Chur – the first written document of the AO. The entire text can be found in the appendix p. 216. Of the three goals and 5 basic principles written there, we will choose from the first goal:

"1. The immediate active use of the muscles and joints adjacent to the fracture must be a primary goal because this represents the best possible incentive for a return to normal....

The advantage of early mobilization cannot be over-estimated. A method of osteosynthesis can only prove satisfactory if it can play its part immediately after the operation".

Appendix

List of documents

Topics and Lectures at the scientific AO Meetings

(translated from Schn I/17f)

1958		
6.11	Biel	Lectures on operative techniques Discussion of osteosynthesis results
1959		
5./6.3	Zurich	Guidelines 1: General principles Guidelines 2: Screw fixation of tibia fractures Guidelines 3: Intramedullary nailing of tibia The new AO plates Malleolar fractures
3./4.12.	Zurich	Treatment of Pseudarthrosis Guidelines 1 – 5 Expected use of Ostamer
1960		
18./19.3.	Interlaken	Screw synthesis of tibial shaft fractures (Allgöwer, Müller) Intramedullary nailing (Schneider) Malleolar fractures (Willenegger) Principles (Müller) with extensive discussion of all members
8./.9.7.	Davos	Experimental research on biomechanical factors for osteogenesis and nerve-regeneration (Allgöwer, Basset, Müller) Compression plates (Müller Hip and condylar plates (Willenegger, Bandi, Bloch) Plate-nail for femoral neck (Müller, Schneider) AO flexible schaft for reaming Open fractures and osteomyelitis (Ott)
23.11.	Bern	Basis and principles (Müller) Technique and results of screw synthesis of the tibia (Allgöwer) Technique of intramedullary nailing (Schneider) Results of intramedullary nailing (Willenegger)
1961		
27./29.4	Waldenburg	Isotops for supervision of femoral neck fractures (Bessler) Femoral neck fractures (Müller) Discussion Strain measurements on compression plates (Straumann)

		Mechanical properties of metals and alloys (Krüger) The problem of corrosion on rust proof steal (Haefelfinger) Metallographic studies on implants (Krüger)
23.11.	Zurich	Discussions with the participants of the first AO-Course
24./25.11.	St. Gallen	Experiments on sheep (Willenegger) Experimental results for substitute of Arteries (Carstensen and Cain): Correct and impaired wound healing with arterial transplants Femoral neck fractures Main topic (Müller) Fractures of the humeral head (Bandi) Tibia head fractures (Allgöwer)
1962		
21/25.6.	Davos	Conference on the guidelines, general part (Müller) Tibia shaft fractures (Allgöwer) Tibia head fractures Humerus (Bandi) Elbow (Weber) Forearm (Bloch) Navicular bone (Willenegger) AO-Instrumentation (Straumann)
13.12.	Zurich	Discussion of problem cases
1963		
3./4.5	Liestal	Fractures in children (Introduction Willenegger, conclusion Müller) Information about primary bone Healing (Schenk, Willenegger, Riniker)
1963		
28.11.	Zurich	Infection prophylaxis in hospital (Good) Infections after internal fixation and their treatment (Allgöwer, Willenegger, Müller)
1964		
17.18.4.	Freiburg	Problems in the treatment of articular fractures with experimental contribution (Weller) Proximal and distal articular fractures of tibia Experiences with the screwing of the syndesmosis Prognosis of the epiphysis after perforation with K-wires
20./21.11.	Zurich	Preparations of the second edition of the AO Book (Introduction Segmüller)

Administrative Agendas of the AO Meetings

(translated from Schn I/21f)

1958			
6.11.	Biel	Production site of the SAO Scientifical Plans of the SAO Experimental facilities in the Research Institut Davos Distribution of assignements	
1959			
5./6.3	Zurich	Accounts according to the experience of the production site Research Institute	
./4.12.	Zurich	Discussion of the statutes Procedures of documentation Laboratory for experimental surgery Preparing the surgical congress 1960	
1960			
18./19.4	Interlaken	Statutes (Willenegger) Davos (Allgöwer) Biel AO-Center and Production site (Müller)	
8./9.7.	Davos	Report about the laboratory (Allgöwer) Card-index of AO (Müller) Report about AO activities (Müller) Budget problems (Allgöwer) Enlargement of AO, Introduction courses e.g. in collaboration with an extra session of the Swiss Society of Surgery, the Collège and independently also for foreign surgeons Collaboration with Universities abroad	
23.11.	Bern	Discussion of the whole standardised Instrumentation. Exchange! Course in Davos Election of a librarian	
1961			
27./29.4.	Waldenburg	Minutes, annual report, cashiers report AO-Course, Cash report Organisation of the next course Report of the laboratory for experimental surgery and collaboration with the new research institute	Standard These subjects return regularly and are called standard in the future

		The first three month of Synthes AO-Documentation Discussion of the instrumentation Publication and movies of the AO AO program for 1961-1962 Visit-tour in Bettlach and Waldenburg
24./25.	St. Gallen	Standard subjects Modification of statutes: Creation of the category of senior members
1962		
21./25.6.	Davos	Standard subjects, elections AO-price
13.12.	Zurich	Standard subjects AO-book
1963		
3.5.	Liestal	Standard subjects Discussion about the purchase of a Sterivit system for the central sterilisation of the plastic foils for the AO hospitals
1964		
17.4.	Freiburg	Standard subjects, elections Documentation (Kessler)
20.11.	Zurich	Standard subjects Decision to exlarge the AO group
1965 1.5.	Grosshöch stetten und Bern	Standard subjects Synthes and the ongoing legal law suits Before the meeting: discussion of the book chapters in groups
12./13.11	Zurich	Standard subjects Documentation about propagation of our instrumentation in Switzerland and abroad. New code sheets. The nomenclatures
1966		
29./30.4.	Liestal	Standard subjects, elections Decision to stop payments for Kessler until results are even Discussion about revision of the statutes Creation of new member categories AO Journal (Müller)
18./19.11.	Zurich	Standard subjects Modification of statutes: Creation of two new categories of membership: "Corresponding AO-members", "Scientifical AO-members"

Ziel.

Ziele und Grundprinzipien der modernen Osteosynthese beim Erwachsenen

NEP. 15.3.58

1) Maximale Wiederherst. der anatomischen Form der Funktion der verletzten Extr.

Folgende 3 Ziele sollen erstrebt werden :

1. Die sofortige ~~Mobil--postoperative~~ aktive Betätigung ~~der~~ der Muskeln und Frakturnahen Gelenke muss vor allem ermöglicht werden, denn sie stellt den besten Reiz zur Normalisierung dar. Dann braucht nach erfolgter Knochenheilung nicht noch die Folgen der Frakturkrankheit, wie Gelenksteifen und Muskelschwund, behandelt werden.
Der Vorteil dieser Frühmobilisierung kann nicht noch genug eingeschätzt werden. Nur dann kann eine Osteosynthesemethode befriedigen, wenn sie unmittelbar nach der Operation einsetzen kann.
Dabei soll nicht danach getrachtet werden die Frühbelastung zu erzwingen ! Vor der Belastung sollte die Knochenwunde weitgehend überbrückt sein.

2. Frühe u. schmerzfreie [illegible] Möglichst kurze Hospitalisation u. rasche Wiedererlangung der Arbeitsfähigkeit

2. Die Wiederherstellung der anatomischen Form des Knochens, denn nur die ideale anatomische Form kann normale Funktion auf die Dauer erzeugen. Form und Funktion sind so sehr miteinander verknüpft, dass eine veränderte Form zwangsläufig die Funktion ungünstig beeinflussen wird.

Rest hängt von der Erfüllung der 1. Ziele ab.

3. Die per primam Heilung der Fraktur ohne sichtbarer Callusbildung. Jeder überschüssiger Callus ist minderwertig, muss um- und abgebaut werden, ist unnötig, wie hunderte Beispiele es zeigen können .

4. Schonung d. Weichteile? bes. Gefässe!

Die Grundprinzipien nach denen eine gute Osteosynthese durchgeführt werden sollte sind schon seit längerer Zeit bekannt :

1. ~~(Lambotte 1890, Lane 1893)~~ : Eine lückenlose Asepsis vom Moment des Unfalles ~~an~~ bis zur Heilung, ist Grundbedingung jeder Osteosynthese, denn die Infektionsgefahr ist der einzige stichhaltige Argument der Gegner der Osteosynthese .

   Jede Gewebsinduration (Verhärtung), jede röntgenologisch sichtbare Aufhellung ~~auf~~ im Bereich einer Schraube spricht für eine leichte Infektion, für ungenügende Asepsis. Eine Schraube muss nach 6 oder 12 Monaten mindestens so fest wie zu Beginn den Knochen fixieren!

   Schonungsvolles, anatomisches Operieren Grundbedingung.
   Maske über Nase , Plastikeinlage vor Mund, Op.Schurz hinten verschlossen.
   Abdecken mit antiseptischem Mastix und Plastik.
   Hautmesser sofort wechseln, peinlichste Haemostase(oder Blutleere !)
   Schonungsvolle Reposition unter Zug . Sorgfältigste Hautnaht !
   Zur Ausschaltung der Gefahren des lokalen Haematoms, Draenieren mit Polyaethylendrains und Saugapparat (z.B. Wasserstrahlpumpe!)
   (besser als alle Antibiotica !) .

2. (Lambotte 1890, Lane 1893) : Die Osteosynthese soll die Frakturstelle in einem absolut stabilen Block verwandeln, deren Festigkeit im Laufe des ganzen Prozesses der Bruchheilung nicht nachlässt.

   Nur dann ist eine "per primam" Heilung zur erwarten. Jede überschüssige Callusbildung nach Osteosynthese zeugt von einer Unruhe im Frakturbereich! Die Erzielung einer stabilen Osteosynthese ist oft überaus schwierig. Es handelt sich aber meist um ein technisches Problem. Jedenfalls sollen stets alle Fragmente an Ort und Stelle gebracht wrden und niemals excidiert werden !

Ziele und Grundprinzipien der O. -2-

Beispiele einer stabilen Osteosynthese :
- Cerclage + Verschraubung bei langen Spiralbrüchen u. langen Schrägfr.
- Küntschner Marknagel bei Oberschenkelbrüche im mittleren Drittel nach Ausbohrung der Markhöhle bis auf 12 bzw. 14 mm und Einsetzung eines entsprechend dicken Marknagels.
- Danisplatten bei Vorderarmquerfrakturen
- Nichtsperrende Laschenschrauben nach Pohl (modif.n. Müller) bei pertrochanteren und subtrochanteren Frakturen.

3. Materialfrage : Das eingesenkte Material soll gewebeverträglich sein und das jeweils notwendige Instrumentarium soll zur Verfügung stehen.

Nur bei ungleichem Material, die Prothesen entfernen, sonst belassen genau wie die Zahneinlagen. Das Quantum des Material ist belanglos .

Nach Orsös 1925 sollen die ~~eingesee~~ versenkten Metallstücke weder einen chemischen, noch einen mechanischen, noch einen elektrischen Reiz ausüben !

4. Danis prägte den Satz 1931 ein : Zwischen den Fragmenten sollte einen axialen Druck ausgeübt werden .

Die Struktur des Knochens ist funktionell bedingt nach genauen mathematischen Prinzipien und die Knochen und Knorpelzellen richten sich stets nach den Druck- und Zugkräften aus (~~seeste~~ Bauprinzip der maximalen Materialersparnis) .

! Ein Abbau der abgestorbenen Knochenenden (Osteolyse) findet nur dann statt wenn kein axialer Druck ausgeübt wird (Müller) und die Fragmente nicht absolut ruhig gestellt sind (mikroskopische Bewegungen genügen) .

Bei Pseudarthrosen, die Pseudarthrose nur dann anfrischen , wenn ein richtiges Falschgelenk mit Knorpelüberzug und Gelenkkapsel besteht oder wenn eine hochgradige Fehlstellung nur durch Sprengung der Pseudarthrose möglich ist. Sonst heilt die Pseudarthrose (nicht Endzustand, sondern Stillstand) unter einem axialen Druck überaus rasch.

Nacheiner O. darf nie einen Zug (Extension) ausgeübt werden, da sonst beide Kräfte sich neutralisieren.

5. Müller 1951 : Es soll möglichst früh operiert werden. Ideal ist die 8 Std-Grenze die bei geschlossenen Schaftbrüche bis 12 Std verlängert werden kann. Nur in bestimmten Fällen Operation nach dem 5.Tag. Jedenfalls sollte während des Stadiums 2 der Callusbildung (Organisation der Gewebszerstörungen und des Blutergusses durch Granulationsgewebe) möglichst nicht operiert werden !

Bemerkung : Bei jeder Pseudarthrose ist vorerst das bestehende mechanisch-biologische Problem aufzudecken und die schädigende Beanspruchung zu identifizieren, damit diese vor allem ausgeschaltet werden kann.

Anwesend: Allgöwer
Bandi, Baumann, Guggenbühl
Hunziker, Ott, Schär, Schneider
Stähli SH, Willenegger
+ Sanzoni

Vortrag in Chur gehalten 15.3.58

Oeffentliche Urkunde

Vor dem unterzeichneten Notarstellvertreter des Kreises Chur, Dr. Robert Schwarz in Chur, ist heute, am 18. Juni 1959 um 16.oo Uhr, behufs Errichtung einer Stiftung erschienen:

Herr Dr. med. Martin Allgöwer, geboren 1917, von St. Gallen und Basel, in Chur.

Dieser hat dem unterzeichneten Notarstellvertreter seinen Willen mitgeteilt und ihn beauftragt, darüber vorliegende öffentliche Urkunde abzufassen.

Der Stifter verfügt :

1. Unter dem Namen
   "Laboratorium für experimentelle Chirurgie, Forschungsinstitut, Davos"
   errichte ich eine Stiftung mit Sitz in Davos.

2. Dieser Stiftung widme ich ein Vermögen von Fr. 1o'ooo.- (Franken zehntausend).
   Dieses Vermögen besteht zur Zeit in Bargeld, das gemäss Bankausweis zur Zeit auf einem Kontokorrent der Schweizerischen Kreditanstalt in Chur angelegt ist.
   Für die Verwaltung gelten die in dieser Urkunde aufgestellten Grundsätze.
   Das anfängliche Stiftungsvermögen soll auf unbestimmte Höhe geäufnet werden durch:
   - Etwaige Ertragsüberschüsse des Stiftungsvermögens
   - anderweitige Schenkungen, Vermächtnisse oder sonstige Zuwendungen Dritter.

\- 2 -

3. Das Vermögen und die Erträge der Stiftung dient zur Errichtung und dem Betrieb eines Laboratoriums für experimentelle Chirurgie im Rahmen des Schweizerischen Forschungsinstitutes in Davos.
Ergibt sich aus betrieblichen Gründen die Unmöglichkeit, das Laboratorium für experimentelle Chirurgie weiterhin im Forschungsinstitut Davos zu belassen, so entscheidet der Stiftungsrat über dessen Verlegung.

4. Die Organe der Stiftung sind folgende:

   a) ein Stiftungsrat von 1 - 5 Mitgliedern;

   b) eine vom Stiftungsrat auf die Dauer von 4 Jahren zu bestellende Kontrollstelle von 1 - 2 Revisoren. Mit dieser Funktion kann auch eine Treuhandgesellschaft beauftragt werden.

5. Dem Stiftungsrat gehören an:

   Der Stifter Dr. Martin Allgöwer als Präsident;
   Prof. Dr. Hans Willenegger, Liestal;
   PD Dr. Maurice Müller, Zumikon.

   Der Stiftungsrat ergänzt sich selbst und wählt aus seiner Mitte den Präsidenten. Kann sich der Stiftungsrat über seine Ergänzung und Organisation nicht einigen, so soll der Stiftungsrat durch den Kleinen Rat des Kantons Graubünden bestimmt werden.
   Die Mitglieder des Stiftungsrates üben ihre Funktion ehrenamtlich und mit Ausnahme des Spesenersatzes unentgeltlich aus.
   Die Annahmeerklärung der Herren Dres. Willenegger und Müller als Mitglieder des Stiftungsrates liegen vor und werden dieser Urkunde beigegeben.

- 3 -

6. Der Stiftungsrat bestimmt die Verwaltung, Anlage und Aufbewahrung des Stiftungsvermögens. Er ist für eine sorgfältige Verwaltung verantwortlich.
   Die näheren Vorschriften enthält das von ihm aufzustellende Reglement.
   Der Präsident des Stiftungsrates führt Einzelunterschrift.
   Die Rechnungsführung besorgt bis auf weiteres Herr Dr. Peter Rechenberg, Chur. Eine Annahmeerklärung wird der vorliegenden Urkunde beigegeben. Herrn Dr. Peter Rechenberg wird Einzelprokura erteilt.
   Der Rechnungsführer hat alljährlich auf den 31. Dezember die Rechnung abzuschliessen und über die Verwendung der mutmasslichen Erträgnisse und des Vermögens für das folgende Jahr einen Vorschlag zu unterbreiten.

7. Die Kontrollstelle überprüft die Jahresrechnung, überwacht die Wertschriftenverwaltung und erstattet an den Stiftungsrat über ihre Tätigkeit Bericht und Antrag.
   Für die erste Amtsperiode von 4 Jahren wird mit der Kontrollstelle Herr Alberto Lurati-Oswald, Chur, beauftragt. Eine Annahmeerklärung wird der öffentlichen Urkunde beigegeben.

8. Bei Vorliegen eines gesetzlichen Auflösungsgrundes fällt das Stiftungsvermögen unter möglichster Wahrung des Stiftungszweckes an das Kantonsspital, Chur.

9. Diese Stiftung tritt mit dem Datum der Beurkundung in Kraft und ist in das Handelsregister des Kantons Graubünden einzutragen.

NOTARIAT DES KREISES CHUR

\- 4 -

10. Diese Stiftungsurkunde wird fünffach ausgefertigt. Je ein Exemplar erhalten der Stifter, der Stiftungsrat und das Notariat. Zwei Ausfertigungen sind dem Handelsregisteramt Graubünden für sich und zuhanden der Eidgenossenschaft als Aufsichtsbehörde zuzustellen.

11. Mit der dem Handelsregisteramt Graubünden überlassenen Urschrift werden folgende Belege aufbewahrt :

    Bankausweis über die Anlage des Stiftungsvermögens;
    Annahmeerklärung der Stiftungsräte;
    Annahmeerklärung von Dr. P. Rechenberg als Rechnungsführer;
    Annahmeerklärung von Alberto Lurati als Kontrollstelle.

Chur, den 18. Juni 1959

Der Stifter :

<u>Oeffentliche Beurkundung</u>

Diese Stiftungsurkunde wurde durch den unterzeichneten Notarstellvertreter des Kreises Chur, Dr. Robert Schwarz in Chur, dem ihm persönlich bekannten Stifter, Herrn Dr. med. Martin Allgöwer, von St.Gallen und Basel, Chefarzt Kantonsspital Chur, wohnhaft in Chur, vorgelesen.

Der Stifter erklärt hierauf, die vorliegende Urkunde enthalte den genauen Ausdruck seines Willens, und er unterzeichnet die Urkunde im Beisein der Urkundsperson.

NOTARIAT DES KREISES Kanton Graubünden Schweiz CHUR

- 5 -

Die Verurkundung vollzieht sich in einheitlichem Akte ohne zeitliche Unterbrechung im Büro des Notarstellvertreters, Alexanderstrasse 8 in Chur.

Chur, den achtzehnten Juni neunzehnhundertneunundfünfzig,
den 18. Juni 1959.

Der Notarstellvertreter des Kreises Chur:

NOTARIAT DES KREISES KANTON GRAUBÜNDEN SCHWEIZ CHUR

Reg.Bd./IX 1957/61
Nr. 391

4463 **Kontrollblatt der AO Nr. 1** 17/14/6-Ø-00.826

Soll unmittelbar nach dem 1. Spitalaufenthalt ausgefüllt und mitsamt Röntgenbildern vor und nach der Operation nach Davos, Laboratorium für experimentelle Chirurgie, geschickt werden.

Spital: Interlaken
AO-Nr.: B.J. V/6
(wird in Davos eingetragen)

Name, Vorname des Verunfallten: ...ter Berta (Berta) **Jahrgang:** 1918
Adresse: Brienz
Beruf: Hausfrau
Nummer der Spitalkrankengeschichte:
Versicherung: Basler
Unfalldatum: 10.1.59
Operationsdatum: 13.1.59
Unfallhergang: Kollision mit Auto beim Schlitteln
Dauer der Hospitalisation: 44 Tage
Anlegen des Gipsverbandes: sofort ~~Tage~~ nach Operation

AO - Code-Nummer

Für jede Osteosynthese soll 1 Blatt ausgefüllt werden. Entsprechende Zahlen jeweils mit Kreis bezeichnen. 0 kann auch dann angewendet werden, wenn schon eine andere Zahl gebraucht wurde.

E und Z = Verletzter Knochen und Lokalisation:

1 **Humerus:** 1 Tuberculum majus 2 Kopf ohne Luxation 3 Kopf mit Luxation 4 Schaft 5 dist. Ende ohne Luxation 6 dist. Ende mit Luxation.

2 **Ulna, Radius:** 1 Radiuskopf 2 Radius prox. Drittel 3 Radiusschaft 4 Radius dist. Ende 5 Ulna allein 6 Beide Knochen Schaft 7 Beide Knochen sonst 8 Olecranon 9 Monteggiafraktur

3 **Handknochen:** 1 Naviculare 2 andere Carpalknochen 3 Metacarpalia 4 Phalanx.

4 **Femur:** 1 Hals 2 pertrochanter 3 subtrochanter 4 Schaft 5 supracondylär 6 condylär 7 Y-Bruch 0 andere Bruchart:

5 **Patella:** 1 quer 2 schräg 3 längs 4 Stückbruch 5 Abrissfraktur 6 inkompl. Fraktur.

6 **Tibia, Fibula:** 1 Fibula isoliert 2 Tibiakopf 3 Tibia allein 4 Tibia und Fibula 5 Malleolus tibialis isoliert 6 bd. Malleolen ohne Syndesmosesprengung 7 Syndesmosesprengung mit oder ohne Malleolenbruch 0 andere Bruchart:

7 **Fussknochen:** 1 Talus 2 Calcaneus 3 Metatarsus 4 Phalanx 0 andere Knochen:

0 **Andere Knochen:** 1 Schädel 2 Kiefer 3 Clavicula 4 Scapula 5 Wirbelsäule 6 Becken 0

A.J. DC
2916
SYST.

H = Frakturtypus:

1 quer 2 schräg 3 spiral 4 Einstauchung 5 Grünholz 6 Drehkeil 7 Mehrfragmentenbruch 8 Trümmerbruch 9 Osteotomie 0 andere Bruchart oder Refraktur, verzögerte Heilung, Pseudarthrose usw.:

T = Verletzung zusätzlich zum Knochenbruch:

1 Geschlossener Bruch ohne Komplikation 2 Offen, wenig beschmutzt 3 Offen, stark beschmutzt 4 Offen mit Knochensubstanzverlust 0 andere Verletzungen wie Bänderschaden, Gelenkknorpelverletzung, Epiphysenknorpelschädigung, Nervenverletzung, Arterienverletzung: Intraartikuläre Fraktur in Zertrümmerung d. Gelenkfläche

ZT = Behandlung:

1 Corticalisschrauben mit oder ohne Cerclage kombiniert 2 Spongiosaschrauben 3 Corticalis und Spongiosaschrauben 4 Marknagel allein 5 Marknagel mit Schrauben oder Cerclage kombiniert 6 Gerade Platte 7 Winkelplatte 8 Spanner und Steinmannägel bzw. Schanz'sche Schrauben 0 andere Therapie (konservativ, Rushnägel, Spickdrähte, Knochenspan usw.): Schraubbolzen + Knochenspan

Res E:

1 Postoperative Komplikation wie Infektion, Thrombophlebitis, Wundrandnekrosen: — 0
2 Komplikation, die einen neuen Eingriff erforderte: —

Postoperatives Ergebnis:

1 Anatomische Reposition, stabile Osteosynthese, überhaupt kein fixierender Verband 2 Anatomische Reposition, stabile Osteosynthese, fixierender Verband nach 5–12 Tagen 3 Anatomische Reposition, stabile Osteosynthese, sofort fixierender Verband 4 Anatomische Reposition, keine stabile Osteosynthese 5 Unvollständige Reposition, scheinbar stabile Osteosynthese 6 Unvollständige Reposition, keine stabile Osteosynthese.

Sonstige Diagnosen:

Bemerkung (z. B. Vorfall während Operation, Ernährungsverhältnisse eines Drehkeiles - Bei Marknagel: Länge und Dicke)
Span v. ~~Beckenkamm~~ als neues Tibiaplateau (Gelenkfläche) eingesetzt

Beiliegende Röntgenbilder: Unfallbild vom 10.1.59 (2) 0
Kontrollbilder vom 13.1.59 (2) 0
Datum: Interl. 13.1.64
Unterschrift: [illegible]

Form. ähnl.

Nachkontrollblatt der AO Nr. 2

Soll im Anschluss an die Kontrolle 4 Monate nach durchgeführter Osteosynthese ausgefüllt und zusammen mit den Kontrollröntgenbildern und der betreffenden AO-Lochkarte nach Davos, Laboratorium für experimentelle Chirurgie, geschickt werden.

Spital: Interlaken
AO-Nr.: B.J. V/6
(nach AO-Lochkarte)

Name, Vorname des Verunfallten: E.. ..er Bertha **Jahrgang:** 1918

Verlauf:

Komplikationen nach 1. Spitalentlassung: keine

Ev. neuer Spitalaufenthalt vom: 6.4.59 – 25.4.59
6.8.59 bis 13.8.59

Dauer der äusseren Fixation mittels Gipsverband, Plexidon usw., 10 Wochen.

Teilbelastung: 12 Wochen nach Osteosynthese; Vollbelastung 15 Wochen n. O.

Arbeitsfähigkeit: 50 % nach 12 Wochen.
100 % nach 35 ~~16~~ Wochen.

Ergebnis nach 4 Monaten:

Klagen: Einschränkung der Kniebeweglichkeit, wodurch starke Behinderung. Schmerzen im Knie.

Klinischer Befund: Anatomie (Länge, Rotation, Achse) normal

Atrophie, Zirkulationsstörungen, Kraft

Gelenkbeweglichkeit leichter Streck- u. starker Beugeausfall des li. Knies (ca 160° - 130°)

AO-DOK
2916
SYST...M 72

Röntgenologischer Befund: Kallus mässig

Dislokationen —

Atrophie, Dystrophie Schwellung von Knie u. Unterschenkel leichte Atrophie d. Oberschenkels

Unterschied gegenüber der gesunden Seite: Starke Einschränkung der Kniebeweglichkeit

Vorläufiges Ergebnis:
11 = sehr gut (re. = li.)
12 = gut
13 = befriedigend
14 = unbefriedigend funktionell
15 = schlecht

Bemerkungen:

Beiliegend: Röntgen-Kontrollbild vom 3.6.59 = 20 ~~24~~ Wochen nach Operation.

AO-Lochkarte

Datum: 3.6.59
Unterschrift: [illegible]

Nachkontrollblatt der AO Nr. 3

Sollte im Anschluss an die Schlusskontrolle, spätestens jedoch nach 1 Jahr, wenn möglich zusammen mit den Abschluss-Röntgenbildern und der betreffenden AO-Lochkarte nach Davos, Laboratorium für experimentelle Chirurgie, geschickt werden.

Spital:	Interlaken
AO-Nr.:	BJ V/6 *(nach AO-Lochkarte)*

Name, Vorname des Verunfallten: E... Bertha   Jahrgang: 1918

Verlauf:

Komplikationen seit der Kontrolle 4 Monate postoperativ: –

Ev. neuer Spitalaufenthalt vom: ~~5~~ 6.8.59 bis 13.8.59

Entfernung des Osteosynthesematerials 24 Monate nach der Osteosynthese.

Wenn nach 4 Monaten nicht vollbelastet wurde, wann erfolgte die Vollbelastung ohne Stock? –

Arbeitsfähigkeit: 50 % nach 12 Wochen und % nach Wochen

100 % nach ~~16~~ 35 Wochen

Abschluss der Behandlung am: Juli 1960

Rente: Übergangsrente: – % ab: Schlussrente: % ab = Monate nach Operation.

Abfindung: Summe: , % des Gliedwertes.

Kontrolle nach 1 Jahr:

A = **Anatomisches Ergebnis:** *(klinisch und röntgenologisch)*

Länge, Rotation, Achse: normal

Kallushöcker: mässig

Weichteilschwellung: abendliche Knöchelödeme nach starker Belastung

F = **Funktionelles Ergebnis:**

Subjektiv *(Angaben des Verunfallten)*: Unsicherheit u. leichte Schwäche beim

Kraft, Gehfähigkeit, Gebrauchsfähigkeit: Bergabgehen. Kein Hinken

Schmerzen: leichte Schmerzen im Knie beim Bergab-Gehen u. in tiefer Hocke

Objektiv

Hinken, Muskelkraft: Kein Hinken, leichte Schwäche des li. Beines

Muskelatrophie und Umfangmasse: Oberschenkel – 1 cm gegenüber rechts, Wade + 2 cm

Gelenkbeweglichkeit proximal von der Fraktur: Knie Strecken 170° rechts 180°

Gelenkbeweglichkeit distal davon: Beugen 65° 50°

Fussgelenk normal

Ergebnis:

A: gut

F: befr.

W: befr.

W = **Wirtschaftliches Ergebnis:**

Dauer aller Spitalaufenthalte 76 Tage

Teilarbeitsfähigkeit nach 3 Monaten

Volle Arbeitsfähigkeit nach ~~4~~ 8 Monaten

Gleiche Arbeit wie früher, leichtere, schwerere

Gleicher Verdienst wie früher, kleinerer, grösserer

Sport: nein

Militärdienst: nein

AO - DOK
2916
SYSTEM 72

Gesamtergebnis:
16 = sehr gut
17 = gut
18 = befriedigend
19 = unbefriedigend
20 = schlecht

Bemerkungen (z. B. spätere Kontrolle notwendig): –

Beiliegend: Röntgen-Kontrollbild vom 5.1.61 = ~~103~~ 102 / ~~51~~ Wochen nach Operation

Abschlussbild vom 5.1.61 = ~~103~~ Wochen nach Operation

AO-Lochkarte

Datum: 5.1.61

Unterschrift: [illegible]

STATUTEN

DER
ARBEITSGEMEINSCHAFT
FÜR
OSTEOSYNTHESE
(AO)

STATUTEN

der

Arbeitsgemeinschaft für Osteosynthese (A O)

I. Name, Zweck und Sitz

Art. 1

Unter der Bezeichnung Arbeitsgemeinschaft für Osteosynthese, im folgenden abgekürzt «A O» genannt, besteht eine Arbeitsgemeinschaft zum Studium von Fragen der Knochenbruchbehandlung und zum Zwecke der experimentellen Forschung auf diesem Gebiete. Die Vereinigung bezweckt außerdem den praktischen und wissenschaftlichen Erfahrungsaustausch auf dem Gebiete der Knochenbruchbehandlung, insbesondere der Osteosynthese.

Art. 2

Sitz der A O ist der Wohnsitz des jeweiligen Obmannes.

II. Mitgliedschaft

Art. 3

Als Mitglieder der A O können in- und ausländische Chirurgen aufgenommen werden, welche gewillt sind, sich für die Ziele der A O aktiv zu betätigen.
Sie haben ein Eintrittsgeld von Fr. 500.— zu entrichten.

Die aufzunehmenden Mitglieder müssen eine selbständige berufliche Stellung einnehmen und sollen nach Möglichkeit an zwei A O-Zusammenkünften als Gast teilgenommen haben.

Für die Aufnahme neuer Mitglieder bedarf es des Vorschlages eines Mitgliedes sowie der Einstimmigkeit aller Mitglieder der Vereinigung, auch derjenigen, die an der Versammlung nicht teilgenommen haben. Bei Ausbleiben eines schriftlichen Einspruches seitens der abwesenden Mitglieder an den Obmann bis zu der die Aufnahme behandelnden Sitzung gilt Stillschweigen als Zustimmung.

Nachtrag lt. Versammlungsbeschluss vom 24. 11. 1961: Mitglieder, die in den Ruhestand treten oder solche, die nicht mehr die Möglichkeit haben Osteosynthesen auszuführen, werden in die Kategorie von Seniormitgliedern eingeteilt.

III. Organe

a) Die Mitgliederversammlung

Art. 4

Oberstes Organ der A O ist die Mitgliederversammlung. Die alljährliche ordentliche Mitgliederversammlung, welche über den Jahresbericht des Obmannes und den Kassabericht, das Budget und den Jahresbeitrag zu befinden und die Wahlen von Vorstand und Revisoren vorzunehmen hat, soll innerhalb der sechs auf das letzte Geschäftsjahr folgenden Monate stattfinden.

Weitere Mitgliederversammlungen werden durch den Vorstand, falls er dies angezeigt findet, einberufen. Sie müssen einberufen werden, falls dies ein Fünftel der Mitglieder durch schriftliche Mitteilung an den Obmann verlangt.

Zu allen Sitzungen wird spätestens 10 Tage vorher durch den Obmann unter Mitteilung der Traktanden schriftlich eingeladen.

Die Mitgliederversammlung ist befugt, über Angelegenheiten zu beschließen, die nicht auf der Traktandenliste stehen, soweit das Traktandum kein qualifiziertes Mehr erfordert.

In jeder Mitgliederversammlung, nicht nur der Jahresversammlung, können zusätzliche finanzielle Beiträge der Mitglieder beschlossen werden.
Alljährlich sollen 2—4 wissenschaftliche Veranstaltungen stattfinden.

Art. 5

Für alle Beschlüsse und Wahlen entscheidet das einfache Mehr der abgegebenen Stimmen, jedoch gelten folgende Ausnahmen:

1. Für die Aufnahme neuer Mitglieder (siehe Art. 3, Abs. 4).
2. Eine Zweidrittel-Mehrheit aller der Vereinigung angehörenden Mitglieder ist erforderlich:
   a) für den Auflösungsbeschluß,
   b) für den Beschluß auf Ausschließung eines Mitgliedes,
   c) für die Statutenrevision.

Art. 6

Die Mitgliederversammlung beschließt über alle Auslagen und über die jeweilige Ausgabenkompetenz des Vorstandes.

Art. 7

Beschlüsse können auch auf dem Zirkularwege stattfinden.

Art. 8

Jedes Mitglied hat das Recht, ihm nahestehende Mitarbeiter und Interessenten als Gäste durch den Obmann zu wissenschaftlichen Sitzungen einladen zu lassen.

b) Der Vorstand

Art. 9

Der Vorstand besteht aus 3 auf die Dauer von 2 Jahren gewählten Mitgliedern (Obmann, Aktuar, Beisitzer oder Kassier), wobei die einzelnen Funktionäre durch die Mitgliederversammlung gewählt werden.

Der Vorstand kann die Kassaführung und das Sekretariat an Dritte übertragen.

Die Tätigkeit des Obmannes und der übrigen Vorstandsmitglieder erfolgt ehrenamtlich.

Art. 10

Der Vorstand ist für eine geregelte Kassaführung inkl. Einzug der Beiträge sowie für die Aufstellung eines Jahresbudgets verantwortlich, ebenso für die Protokollierung der Beschlüsse der Mitgliederversammlungen und Vorstandssitzungen. Er besorgt die laufende Geschäftsführung und bereitet die Mitgliederversammlungen vor.

c) Die Revisoren

Art. 11

Auf die Dauer von jeweils 2 Jahren wird eine Treuhandgesellschaft oder werden 1—2 sonstige Revisoren gewählt, welche die Kassaführung zu überprüfen und zuhanden der Mitgliederversammlung einen schriftlichen Bericht nebst Antrag betr. Genehmigung der Jahresrechnung zu stellen haben.

Auf erfolgte Einladung haben sie der die Jahresrechnung behandelnden Mitgliederversammlung beizuwohnen.

IV. Rechte und Pflichten der Mitglieder

Art. 12

a) Die Mitglieder haben den Mitgliederversammlungen nach Möglichkeit beizuwohnen.

b) Sie haben das eigene, Knochenbrüche betreffende Krankengut, statistisch nach gemeinsam herausgegebenen Richtlinien zu verarbeiten und haben Anrecht auf gegenseitige Einsichtnahme in diese statistischen Auswertungen.

c) Die Mitglieder verpflichten sich gegenseitig zu einer kollegialen und freundschaftlichen Einstellung, so daß die A O und jedes einzelne Mitglied sich auf die kollegiale Unterstützung durch alle Mitglieder verlassen kann.
Die auf praktischem oder wissenschaftlichem Gebiet durch einzelne Mitglieder erzielten Fortschritte auf dem Gebiet der operativen Behandlung der Knochenbrüche sollen allen Mitgliedern der A O zugänglich gemacht werden.
Die Mitglieder sollen bestrebt sein, sich gegenseitig nach Möglichkeit zu fördern.

d) In den Indikationen ist jedes Mitglied frei; alle Mitglieder sind jedoch verpflichtet, nach Möglichkeit die von der A O entwickelten Behandlungsgrundsätze zu respektieren.

e) Die Mitglieder haben innerhalb der vom Vorstand festgesetzten Frist die beschlossenen Beiträge zu entrichten.

V. Geschäftsjahr

Art. 13

Das Geschäftsjahr ist das Kalenderjahr. Das erste Geschäftsjahr endet am 31. Dezember 1960.

VI. Ausschluß von Mitgliedern

Art. 14

Mitglieder können ohne Grundangabe durch die Mitgliederversammlung mit dem in Art. 5 Ziff. 2 angegebenen qualifizierten Mehr ausgeschlossen werden.

VII. Liquidation

Art. 15

Wird die Auflösung beschlossen, so amten die Vorstandsmitglieder als Liquidatoren.
Ein Liquidationsüberschuß wird unter die Mitglieder gleichmäßig verteilt.

VIII. Diverses

Art. 16

Im übrigen gelten die Artikel 60 ff des ZGB.

Also beschlossen in der Gründungsversammlung, abgehalten in Interlaken am 19. März 1960.

Der Obmann:
Dr. R. Schneider

Der Sekretär:
PD Dr. M. E. Müller

Statutes

of the Association for the Study of Internal Fixation (AO ASIF)

I. Name, Purpose and Headquarters

Article 1

The term Arbeitsgemeinschaft für Osteosynthese, in the following abbreviated to "A O" refers to an association for the study of matters pertaining to the treatment of fractures and for the purpose of experimental research in this area. Furthermore, the association has as its aim the practical and scientific exchange of information in the area of fracture treatment, in particular, in osteosynthesis.

Article 2

Headquarters of the A O is the domicile of the Obmann in office.

II. Membership

Article 3

Surgeons from Switzerland and abroad can be admitted as members provided they are willing to pursue the objectives of the A O actively.
They are to pay a membership admission fee of CHF 500.-

The members to be admitted must have an independent professional status and should, if possible, have taken part in at least two A O meetings as a guest.

To be admitted as a new member requires nomination by a member and unanimity of all members of the Association including those unable to participate at the meeting. If a written objection by a member unable to participate at the meeting does not reach the Obmann before the meeting to vote on membership, abstinence is counted as approval.

Amendment according to the decision of 24.11.1961: Members who have retired or those who are no longer able to perform osteosynthesis will enter into the category of senior members.

III. Official bodies

a) Meetings of members

Article 4

The supreme body of the A O is the Meeting of Members. The Annual General Meeting of members which evaluates the annual report of the Obmann and the financial report, the budget and the annual membership fee and elects the Committee and auditors should take place within the six months following the end of the financial year.
Further meetings of members will be convened by the Committee as necessary. A meeting must be convened if one fifth of the members have made this request in writing to the Obmann.
The Obmann sends the invitation and the agendas for all meetings in writing at the latest 10 days before the meeting.
The meeting of members has the authority to make decisions on items not on the agenda provided the item does not require a qualified majority.

At each meeting of members, not only at the Annual General Meeting, a decision can be made on additional financial contributions of the members.
Annually, at least 2-4 scientific events should be held.

Article 5

All decisions and elections are decided by the majority of all votes received, with the following exceptions:
1. The admission of new members (see Article 3, paragraph 4)
2. A two-thirds majority of all members of the Association is required for
   a) the decision to dissolve the Association
   b) the decision to exclude a member
   c) revision of the statutes

Article 6

The meeting of members decides on all expenditures and on the authority of the Committee to distribute funds.

Article 7

Decisions may also be taken by circular letter.

Article 8

Each member has the right to have close colleagues and other interested persons invited by the Obmann as guests to the scientific meetings.

b) The Committee

Article 9

The committee consists of three members elected for a period of two years (Obmann, Secretary, Third Member or treasurer), whereby the individual officers are chosen by the meeting of members.
The Committee may transfer financial administration and secretarial duties to a third party.
The activities of the Obmann and the other members of the Committee are performed in an honorary capacity.

Article 10

The Committee is responsible for the correct administration of finances including collection of membership fees and writing the annual report, as well as writing the decision minutes of the meetings of the members and the Committee Meetings. It is responsible for the executive and prepares the meetings of members.

c) The auditors

Article 11

A fiduciary or 1-2 auditors are elected for a period of two years to audit the financial report and to return a written report to the meeting of members with the proposition to approve the year-end statements.
On invitation they are to attend the meeting of members which is dealing with the year-end statements.

IV. Rights and duties of the members

Article 12

The members are to attend the meetings whenever possible.

They are obliged to process their own patient samples, i.e. fractures, statistically according to the guidelines drawn up by the members and all members have the right to reciprocal access to these statistical evaluations.

The members mutually agree to a cooperative and friendly attitude so that the A O and each individual member can rely on the cooperative support of any other member.

All advances made by any member either practically or scientifically in the field of operative treatment of fractures shall be made accessible to all members of the A O. The members should make every effort to support each other wherever possible.

Each member is free in the choice of indications; but, all members are obliged to respect the treatment principles developed by the AO wherever possible.
The members must pay the membership fee by the deadline set by the Committee.

V. Financial Year

Article 13

The financial year is the calendar year. The first financial year ends on the 31. December 1960.

VI. Exclusion of members

Article 14

Members can be excluded without a reason being given by the meeting of members by a qualified majority as stated in Article 5, Item 2.

VII. Liquidation

Article 15

If a decision is taken to dissolve the Association, the committee members act as liquidators.
Any liquidation surplus is to be divided equally among the members.

VIII. Miscellaneous

Article 16

In all other points Articles 60 ff of the ZGB apply.

As decided at the founding meeting at Interlaken on 10. March 1960.

Obmann
Dr. R. Schneider

Secretary
PD Dr. M. E. Müller

N° 301 — 3685

und Angestellten
·euhandunterneh-
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in Oberbüren, als Einzelkaufmann im Sinne von Art. 579 OR weitergeführt. Die Firma lautet: **Fritz Walther.**

Graubünden - Grisons - Grigioni

16. Dezember 1960. Medizinische Instrumente.
Synthes AG, Chur, in Chur. Unter dieser Firma besteht gemäss öffentlicher Urkunde und Statuten vom 10. Dezember 1960 eine Aktiengesellschaft. Die Gesellschaft bezweckt den Handel mit und die Förderung der Entwicklung von medizinischen Instrumenten. Die Gesellschaft kann auch derartige Instrumente selbst herstellen oder herstellen lassen, Patente und Lizenzen auf medizinischen Instrumenten erwerben und Generalvertretungen und Lizenzen für medizinische Instrumente vergeben. Die Gesellschaft kann sich an anderen Unternehmungen ähnlicher Art beteiligen, einen Fabrikationsbetrieb pachten, käuflich erwerben oder errichten. Das Aktienkapital beträgt Fr. 50 000 und ist eingeteilt in 50 Inhaberaktien zu Fr. 1000. Auf das Aktienkapital sind 40 Prozent einbezahlt. Publikationsorgan ist das Schweizerische Handelsamtsblatt. Der Verwaltungsrat besteht aus 1 bis 5 Mitgliedern. Einziges Verwaltungsratsmitglied ist Dr. Peter v. Rechenberg, von Haldenstein, in Chur. Er führt Einzelunterschrift. Domizil: Steinbockstrasse 2.

16. Dezember 1960.
Aluminiumwalzwerke für China AG. (Laminoirs Chinois d'Aluminium SA) (Chinese Aluminium Rolling Mills Ltd.), in Chur (SHAB. Nr. 174 vom 30. Juli 1959, Seite 2146). Aus dem Verwaltungsrat ist John Justin Boex ausgeschieden; seine Unterschrift ist erloschen. Als neues Mitglied des

V e r e i n b a r u n g

Die unterzeichneten Aktionäre der Synthes AG, Chur, treffen für sich und ihre Rechtsnachfolger, insbesondereauch für ihre Erben folgende Vereinbarung.

1. Die primäre Zielsetzung der Synthes AG ist nicht die Gewinnerzielung für die Aktionäre, sondern die Bereitstellung von Mitteln für Forschungszwecke, die von den Aktionären bestimmt werden. Der Erfolg der Synthes AG ist nahezu ausschliesslich von der Mitarbeit von Aerzten abhängig, die auf dem Gebiete der Osteosynthese eine führende und schöpferische Funktion einnehmen.

   Die spezielle Situation der Synthes AG bedingt deshalb, dass die Aktionäre der Synthes AG gleichzeitig in der Lage sind, als Mitarbeiter der Gesellschaft im umschriebenen Sinne tätig zu sein.

2. Zur Wahrung des Gesellschaftszweckes und der Existenzfähigkeit der Synthes AG verpflichten sich die unterzeichneten Aktionäre für sich und ihre Rechtsnachfolger:

   a) Durch gemeinsamen, einstimmigen Beschluss geeignete Personen als zukünftige Aktionäre und Mitarbeiter der Synthes auszubilden und zur Mitarbeit in der Technischen Kommission gemäss Verträgen vom 21. Nov. 1963 mit den Lizenznehmern heranzuziehen.

   b) Spätestens nach Ausscheiden von zwei bisherigen Aktionären der Synthes AG, sei es nun infolge Tod oder Abtretung der Aktien, innert Jahresfrist die Nachfolge-Aktionäre durch gemeinsamen, einstimmigen Beschluss zu wählen. Als Nachfolger-Aktionäre kommen bei Eignung in erster Linie die Personen gemäss lit.a hiervor in Betracht, aber auch

-2-

Mitglieder der Arbeitsgemeinschaft für Osteosynthese oder dieser Organisation nahestehende Chirurgen.

c) Den Nachfolger-Aktionären gemäss lit.b hiervor Aktien an der Synthes AG zum Nominalwert zur Verfügung zu stellen, in der Regel in dem Umfang, als der zu ersetzende Aktionär an Aktien besass. Soll die Zahl der Aktionäre vergrössert werden, ergibt sich eine entsprechende Kürzung in der Zuteilung der Aktien. Die Zahl der Aktionäre soll jedoch, die Verwaltungsräte mit treuhänderischem Aktionbesitz nicht berücksichtigt, in keinem Fall mehr als 6 Personen betragen.

3. Verstirbt einer der Aktionäre oder wünscht er zu Lebzeiten seine aktive Mitarbeit in der Synthes AG einzustellen, so sind der betreffende Aktionär bzw. seine Miteigentümer verpflichtet, seinen Aktienbesitz an der Synthes AG zum Nominalwert an seine Mitaktionäre zu gleichen Teilen abzutreten. Die übernehmenden Mitaktionäre halten die in Frage stehenden Aktien solange, als diese nicht im Sinne von Ziff.2. lit.c hiervor Verwendung finden.

4. Mit der Uebertragung der Aktien sind Nachfolger-Aktionäre gemäss Ziff.2. lit.b und c zu verpflichten, vorliegenden Vertrag zu unterzeichnen.

5. Vorliegender Vereinbarung wurde in 5 Exemplaren erstellt, je eines zu Handen der unterzeichneten Aktionäre und der Synthes AG.

Bern ...., den 27.1.60 ......   Unterschriften:

M. Allgöwer
H. Willenegger

Agreement

The undersigned shareholders of Synthes AG, Chur, reach the following agreement for themselves, their legal successors, and especially for their heirs

1. The primary aim of Synthes AG is not profit for the shareholders but to make funds available for research purposes to be determined by the shareholders. The success of Synthes AG is almost exclusively dependent on collaboration with the surgeons who take on a leading and creative role in the field of osteosynthesis.

   The special situation of Synthes AG, therefore, requires that the shareholders of Synthes AG are in a position to act as described above as members of the Society.

2. To maintain the objectives of the Society and the existence of Synthes AG the undersigned shareholders agree for themselves and their heirs to

   a) Train suitable persons to be future shareholders and members of Synthes AG after mutual, unanimous decision and to involve these in collaboration within the Technical Commission according to the contracts of 21. Nov. 1963 with the licensees.

   b) At the latest after two former shareholders have left, either due to death or sale of shares, to elect the successors within the year by mutual, unanimous decision. As shareholders' successors such suitable persons as described in a) above are to be primarily considered, but also members of the Association for the Study of Internal Fixation (AO ASIF) or surgeons closely involved in this organization.

   c) The shareholders' successors as described in b) above are to make their shares available to Synthes at the nominal value, in general in the same number as the shareholder to be replaced had owned. If the number of shareholders is to be increased, a corresponding reduction of shares will ensue. The number of shareholders , however, not taking into account the trustees with fiducial ownership of shares, should not exceed six persons.

3. If a shareholder dies or wishes during his lifetime to desist from active collaboration within Synthes AG, he and/or his co-owners are obliged to pass the shares to Synthes AG at their nominal value, i.e. to his co-shareholders to equal parts. The accepting co-shareholders retain the shares in question until they can be utilized as described in No. 2 item e.

4. After transfer of shares the shareholders' successors are obliged according to No. 2 items b and c to sign this contract.

5. This present agreement was duplicated five times for the undersigned shareholders and Synthes AG.

Bern, 27.1.68

Signatures:
M. Müller
H. Willenegger
A. Allgöwer
R. Schneider

Anwesende Kursteilnehmer und Gäste des 1. A.O.-Kurses, Forschungsinstitut

11. - 15. Dezember 1960

Davos

Dr.med.Alfr.Abel, Chefarzt des Hütten-Krankenhauses	Dillingen /Saar
P.D.Dr.med.M.Allgöwer, Chefarzt des Kantonsspitals	Chur /GR
Dr.W.Allgöwer, Socinstrasse 45	Basel
Dr.med.G.Aeschlimann, F.M.H., Rue des Fleurs 9	Moutier /BE
Dr.med.Fr.Andina, Chefarzt, Ospedale Carità	Locarno /TI
Dr.med.W.Bandi, Chefarzt, Bezirksspital	Interlaken /BE
Dr.med.B.Barraud, FMH, Murtenstrasse 11,	Aarberg /BE
Prof.Dr.med.E.Baumann, Chefarzt, Bezirksspital	Langenthal
Dr.med.H.Baumann, FMH, Neuengasse 43	Bern
Dr. Baur, Schweizerische Unfallversicherung (SUVA)	Luzern
Dr.med.M.Berger, FMH, Seefeldstrasse 128 (Zum Posthof)	Zürich
Dr.med.H.R.Bloch, Chefarzt, Kantonsspital	Glarus
Dr.med.habil.H.Brandt, Chefarzt, Kreiskrankenhaus	Detmold Deutschl.
Dr.med.Fr.Brussatis, Rottendorfweg 41,	Münster/Westfalen
Dr.med.K.Bürgi, FMH, Buochserstrasse 9	Stans
Dr.med.Rico Caveng, FMH	Schuls /GR
Prof.Dr.K.Chiari, Allgemeines Krankenhaus (9.Hof)	Wien IX Oesterreich
Dr.med.H.U.Debrunner, FMH, Bahnhofstrasse 29	Aarau
P.D.Dr.med.L.Eckmann, Tiefenauspital (FMH)	Bern
Dr.med.R.Fischer, Chefarzt, Krankenhaus	Wattwil /St.G.
Dr.med.E.Fürst, FMH, Bellerivestrasse 31	Luzern
Dr.med.W.Glättli, FMH, Muristrasse 82	Bern
Dr.Gasser, Kantonsspital	Liestal/BL
Dr.med.U.Gruber, Forschungsinstitut	Davos /GR
Dr.med.N.Gschwend, Niederhofenrain 8	Zürich 8
Dr.med.P.Gut, Unfallklinik	St.Moritz/ GR
Dr.med.H.Halstenbach, FMH, Avenue de la Gare 8	Martigny-Ville /VS
Dr.med.K.Hauser FMH, Bahnhofplatz 3	Winterthur
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Dr.med.H.Howald, FMH, Limmatquai 30	Zürich
Dr.med.F.Jakob, Chefarzt, Krankenhaus	Davos-Platz /GR
Dr.E.Jeannet, Chef de clinique, Hôpital cantonal	Lausanne
Dr.Chr.Jost, Landamman, Chalet Linaria	Davos-Platz/GR
Dr.med.O.Keller, FMH, Chefarzt, Kant.Krankenhaus	Walenstadt /SG
Dr.med.Yves Kerner, Avenue Durante 7	Nice /France
Dr.med.C.Koechlin, Oberarzt, Kantonsspital Zürich	Zürich
Prof.Dr.med.Krauss, Univ.Klinik	Freiburg /i.B.
Dr.med.M.Landolt, Oberarzt, Stadtspital Waid	Zürich
Dr.med.M.Leder, Chefarzt, Bezirksspital	Rheinfelden
Dr.K.L.Ledermann, Kantonsspital, Chirurgische Klinik	St.Gallen
Dr.med.R.Leemann, Oberarzt, Kantonsspital	Winterthur
Dr.med.H.Mäder, FMH, Bürgerspital	Zug
Dr.med.G.Mark	Schiers/ GR
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Dr.med.H.Ch.Meuli, Kantonsspital	St.Gallen
Dr.med.R.Morger, Oberarzt, Kinderspital Basel	Basel

1.A.O.-Kurs,Forschungsinstitut Davos-Platz/GR — Blatt 2

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Dr.Münch,Basler Unfallversicherungs-Gesellschaft	Basel
Dr.med.W.Ott,Chefarzt, Städt.Krankenhaus	Rorschach
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Dr.med.W.Pfleiderer,Robert-Bosch-Krankenhaus,Chirurg.Abt.	Stuttgart Nord
Dr.med.G.Pidermann, FMH, Talstrasse 41	Zürich 1
Dr.med.O.Ramser, FMH,	Niederbipp /BE
Dr.med.H.Reber,FMH,Oberarzt, Kantonsspital	Schaffhausen
Dr.med.W.Rieben,FMH, Stadthausstrasse 45	Winterthur
Howard Rosen, M.D.,F.A.C.S. The Brevoort, 11 Fifth Avenue	New York 3 N.Y.
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Dr.med.H.Sollberger,FMH,	Gstaad/ BE
Dr,med.F.Spinas,FMH, Neuhofstrasse 74	Romanshorn/TG
Dr.med.W.Schär,FMH,Chefarzt,Bezirksspital	Langnau
Prof.Dr.med.W.Schega,Chirurg.Universitätsklinik	Mainz (Rhein)
Prof.Schenk,Anatomie	Basel
P.D.Dr.med.J.Schlegel,Kantonsspital	Zürich
Dr.med.R.Schneider,Chefarzt,Bezirksspital	Grosshöchstetten
Dr.Schnyder, Redaktor der Davoser-Zeitung	Davos-Platz/ GR
Dr.med.W.R.Schuster,FMH, Bleicherweg 54	Zürich
Dr.med.W.Stähli,Chefarzt, Spital	Thun
Dr.med.W.Stähli,Hôpital,Chefarzt	St.Imier
Dr.med.P.Steiner,Chefarzt,Krankenhaus	Thusis
Dr. Straumann	Waldenburg
Dr.med.A.Stucki,FMH,	Zweisimmen /BE
Dr.med.F.Suter,Chefarzt,Thurg.-Schaff.Heilstätte	Davos-Platz/GR
Dr.H.Vasey,Avenue de Champel 135	Genève
Dr.med.S.H.Walter,FMH, Place des Eaux-Vives 2.	Genève
Dr.med.B.G.Weber,Oberarzt,Traumatologie,Orthopädie,Kantonsspital	St.Gallen
Dr.med.Weller,(bei Prof.Krauss)	Freiburg/i.B.
Dr.med.H.Werder,Chefarzt,Kant.Krankenhaus	Grabs /SG
Prof.Dr.H.Willenegger,Kantonsspital	Liestal/ BL
Dr.med.H.A.Wyss,FMH, Nidaugasse 15	Biel
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INSTRUMENTS AO

Prix courant valable dès le 1er janvier 1962

S Y N T H E S S . A .

Route de Neuchâtel 116, Bienne 032 / 2 84 78

Remarques:

Lors de la première commande, les différents étuis ne sont vendus qu'en bloc. Les étuis I et II forment une unité et ne sont pas livrés séparément; il en est de même pour les étuis VI et VII.

Pour les commandes complémentaires, chaque article est vendu individuellement, selon le numéro du catalogue. C'est le cas également pour les instruments «livrable sur demande» et les instruments de la catégorie IX «instruments divers».

Les articles E-2 à E-7 (compresseurs externes, clous de Steinmann, etc.) peuvent être achetés séparément.

Les exécutions spéciales sont livrées si possible dans les 4 à 8 jours, moyennant un supplément de 20%.

La longueur des vis s'entend toujours tête comprise (excepté les vis pour épiphyses B-6).

Conditions de paiement: Prix net, payable dans les 30 jours. Changements de prix réservés.

I. Instrumentation pour vissage de l'os cortical

	Instrumentation complète (exécution standard)	Fr. 1'110.—
	Instruments sans le matériel de renouvellement *)	512.—
A-1	Etui en aluminium éloxé, rouge, avec plateaux, stérilisable	150.—
A-2	Vis pour os cortical, Ø 4,5 mm, longueur: 16 - 18 - 20 - 22 - 24 - 26 - 28 - 30 - 32 - 34 - 36 - 38 - 40 - 44 - 48 - 52 - 60 mm 84 pièces à Fr. 7.—	588.— *)
A-3/1	Taraud, court	30.—
A-3/2	Taraud, long	30.—
A-4	Fraise à chambrer	30.—
A-5/1	Tournevis avec manche en matière plastique	35.—
A-7/1	Guide de forage, longueur: 53 mm	12.—
A-7/2	Guide de forage, longueur: 48 mm	12.—
A-8/1	Mèche, Ø 4,5 mm, modèle long, inoxydable	13.—
A-8/2	Mèche, Ø 4,5 mm, modèle long, avec butoir, inoxydable	17.—
A-8/3	Mèche, Ø 3,2 mm, modèle long, inoxydable 2 pièces à Fr. 12.—	24.—
A-8/4	Mèche, Ø 3,2 mm, modèle long, avec butoir, inoxydable	16.—
A-9/1	Viseur avec pas de vis	120.—
A-13	Toise pour déterminer la longueur des vis	17.—
A-15	Petits tournevis à 6 pans à remettre aux patients 10 pièces à Fr. 1.—	10.— *)
A-18	Petit crochet pointu et courbe, inoxydable, pour contrôler la réduction et enlever les tissus qui se sont incrustés dans la tête des vis	6.—

	Livrable sur demande:	par pièce
A-6	Tournevis tout métal avec manche en T	Fr. 40.—
A-9/2	Viseur avec pointe	50.—
A-10	Tord-fil pour cerclage	45.—
A-11	Passe-fil	45.—
A-12/1	Fil avec œillet Ø 1,2 mm, résistant	2.—
A-12/2	Fil avec œillet Ø 1,0 mm, malléable	2.—
A-14	Pince coupante pour fil d'acier	22.—
A-16	Bobine de fil d'acier malléable Ø 1,0 mm, 10 mètres	10.—
A-17	Ecrou pour vis à corticale	2.50
B-9	Clé pour écrou des vis à corticale	16.—

II. Instrumentation pour vissage de l'os spongieux et plaques à compression

	Instrumentation complète (exécution standard)	Fr. **1'778.—**
	Instruments sans le matériel de renouvellement *)	**479.—**
B-1	Etui en aluminium éloxé, jaune, avec 2 plateaux, stérilisable	180.—
B-2/1	Vis pour os spongieux, ⌀ 6,5 mm, longueur du filetage 16 mm longueur: 25 - 30 - 35 - 40 - 45 - 50 - 55 - 60 - 65 mm 36 pièces à Fr. 8.—	288.— *)
B-3	Vis pour os spongieux, ⌀ 6,5 mm, longueur du filetage 32 mm longueur: 50 - 60 - 70 - 80 - 90 mm 20 pièces à Fr. 10.—	200.— *)
B-4	Vis malléolaires, ⌀ du filetage 4,5 mm, ⌀ de la tige 3,0 mm, longueur: 25 - 30 - 35 - 40 - 45 - 50 - 55 - 60 - 65 mm 14 pièces à Fr. 7.50	105.— *)
B-5	Vis pour scaphoïde, ⌀ du filetage 3,5 mm, ⌀ de la tige 2,0 mm, longueur: 12 - 14 - 16 - 18 - 20 - 22 - 24 - 26 - 28 mm 18 pièces à Fr. 5.—	90.— *)
B-7	Taraud pour vis à spongieuse, ⌀ 6 mm	40.—
B-10	Tournevis pour vis du scaphoïde	21.—
B-14	Rondelles la douzaine	10.— *)
A-8/5	Mèche ⌀ 3,75 mm, modèle long, inoxydable	12.—
A-8/6	Mèche ⌀ 2,0 mm, modèle long, inoxydable	12.—
E-4	Clé à mollette combinée	18.—
C-2/4	Plaque étroite, 4 trous 4 pièces à Fr. 26.—	104.— *)
C-2/5	Plaque étroite, 5 trous 2 pièces à Fr. 27.—	54.— *)
C-2/6	Plaque étroite, 6 trous 2 pièces à Fr. 28.—	56.— *)
C-2/8	Plaque étroite, 8 trous 2 pièces à Fr. 30.—	60.— *)
C-3/6	Plaque large, 6 trous 2 pièces à Fr. 38.—	76.— *)
C-3/7	Plaque large, 7 trous 2 pièces à Fr. 40.—	80.— *)
C-3/8	Plaque large, 8 trous 2 pièces à Fr. 42.—	84.— *)
C-3/10	Plaque large, 10 trous 2 pièces à Fr. 46.—	92.— *)
C-5	Guide de forage pour tendeur	20.—
C-6	Tendeur de plaque 2 pièces à Fr. 55.—	110.—
C-7	Clé à cardan, inoxydable	45.—
C-8	Guide de forage avec poignée	14.—
C-11	Clé pour tendeur de plaque 2 pièces à Fr. 3.50	7.—

	Livrable sur demande:	par pièce
B-2/2	Vis pour os spongieux ⌀ 6,5 mm, longueur du filetage 16 mm longueur: 70 - 75 - 80 - 85 - 90 - 95 - 100 - 105 - 110 mm	Fr. 10.—
B-6	Vis pour décollement épiphysaire ⌀ 6,5 mm, longueur du filetage 16 mm, avec petite tête et butoir, longueur: 50 - 60 - 70 - 80 - 90 mm	15.—
B-8	Boulon avec écrou spécial, longueur: 70 - 100 - 120 mm	14.—
B-9	Clé pour boulon de serrage	16.—
B-15	Taraud pour vis du scaphoïde	30.—
C-2/7	Plaque étroite, 7 trous	29.—
C-2/9	Plaque étroite, 9 trous	31.—
C-2/10	Plaque étroite, 10 trous	32.—
C-3/5	Plaque large, 5 trous	36.—
C-3/9	Plaque large, 9 trous	44.—
C-4/6	Plaque large avec glissière, 6 trous	60.—
C-10	Plaque spéciale pour épiphyses humérale et tibiale	56.—

Register of Names, places and notions

Frequent names and terms are marked with a * Of these only relevant reference are given. Figures are not mentioned.