the fathers of anyklos

"I would do it all in exactly the same way today"
| Editorial team

Munich, Oktoberfest 1985.
The young scientists Georg-Hubertus Nentwig and Walter Moser met for a beer. Their doodles on a beer mat were soon to grow far beyond a simple idea. Two years later – exactly 20 years ago – the NM implant was placed clinically for the first time, named after its two intellectual fathers. Today, implantologists all over the world know the system with the unusual history as Ankylos. How does a doodle on a beer mat become an implant system? iDENTity found out.

Discovery at the Oktoberfest: 10 years later the Ankylos system is on the way to standard use in dental implantology, first of all in Germany

PROFESSOR NENTWIG, DR. MOSER, IT IS SAID THAT YOU DEVELOPED THE PRINCIPLE OF THE CURRENT ANKYLOS SYSTEM TOGETHER AT THE MUNICH OKTOBERFEST IN 1985. HOW DID THIS HAPPEN?
MOSER: It all started when Professor Nentwig attended my lecture "Material science in biomedical technology". At the time he was an assistant at the clinic for oromaxillofacial surgery in Munich, I was an assistant at the Institute for Metals Science. We agreed to meet on the Wiesn to get to know each other better.

NENTWIG: There we discussed what an implant system could look like that functioned really well both technically and biologically. It was clear to me that implant dentistry had a future and I wanted to continue working in this field. However, there were a number of problems that had to be resolved. For example, the peri-implant bone was frequently atrophied to a significant degree. In two-component systems the abutments tended to loosen, which often resulted in fractures.

MOSER: Implants with damping components also proved to be prone to failure and forced the user to replace the damping elements regularly. The attempted simulation of the periodontally positioned natural tooth was a failure. In addition, peri-implant bone was often resorbed in a bowl shape after screwing the abutment in place or after the restoration.

NENTWIG: It was known to us that because of the design the connection area between the implant and abutment tended to micromovement in two-component systems and it also wasn't designed for bacteria-tightness.

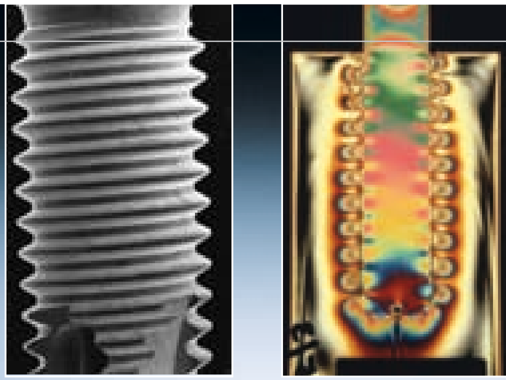

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Fig. 1a and 1b: The effect of loading in the cervical region is similar to that further in the apical direction with a constant thread (left: REM image, right: photoelastic view)

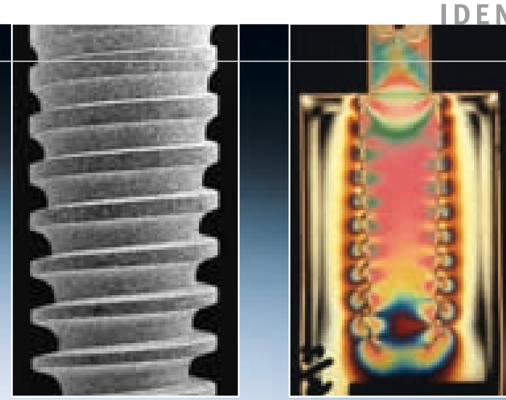

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Fig. 2a and 2b: Ankylos special thread with thread depth increasing in the apical direction and curvature of the threads: in this case the concentration of tension in the cervical region is significantly lower than in the elastic cancellous bone. The relatively rigid crestal bone is subjected to the lowest loading

This was where our efforts at improvement were concentrated. The implant systems available at that time were indication-based, for example they could only be used for edentulous mandibles or for implant-borne bridges and single-tooth crowns. The goal was a two-component threaded implant, whose body reacted biomechanically favorably under load. The abutment connection had to be able to resist heavy loading and should be bacteria-proof. The implant system should be lasting and low-maintenance even in its thinnest form and also universally applicable.

MOSER: We quickly came to an agreement on the basic principle of the self-locking tapered connection. In enginee-ring it is well known that a conical connection, with suitable design and installation, can permanently transmit high forces without play. This makes it extremely stable and reliable. Less well known is the fact that an accurate cone is free of notches. This means that this connection has no mechanical notches. Mechanically effective notches are caused by sharp cross-section transitions, such as those that occur with an external hex. As a result of the notch effect, which can also be caused by micromovement, the titanium material fails under continuo-us loading significantly earlier than non-indented designs of equivalent size. The low modulus of elasticity of titanium, which results in greater elastic deformation than, for example, with steel, has a particularly favorable effect with suitably designed conical connections.

AND WHY WAS A NEW THREAD NECESSARY?

MOSER: The load transfer is greatest in the crestal region in threaded implants with constant threads. But it is precisely there that the bone is least elastic. We discussed a thread with a non-constant thread geometry and thread depth to reduce the concentration of tension in the emergence region of the implant through the bone (Fig. 1a and 2a). This means that the depth of the threads increases from coronal to apical. At the same time the curvature of the threads increases in the apical direction. This is combined with a changing resolution of forces at the threads and a thread area enlarged when apically projected. The result is as desired, a reduced load transfer to the crestal cortical bone and a greater transfer in the elastic cancellous region. This can be visualized very well photoelastically (Fig. 1b and 2b).

"We were not yet aware of the implications"

IS IT TRUE THAT YOU DREW THE DESIGN PRINCIPLE OF ANKYLOS ON A BEER COASTER?

MOSER: Yes, but it no longer exists.

NENTWIG: We were not aware of the implications of our inven-tion at that time. When I see how the system has become esta-blished all over the world I am very pleased and I also feel some pride.

MOSER: Let me consider the conical connection again. Conical connections can have a slender design and still form a durable connection. A precisely manufactured cone is in contact with the entire lateral surface and has absolutely no micromovement after correct installation. The essential requirement for secure use is a permanent preloading, which

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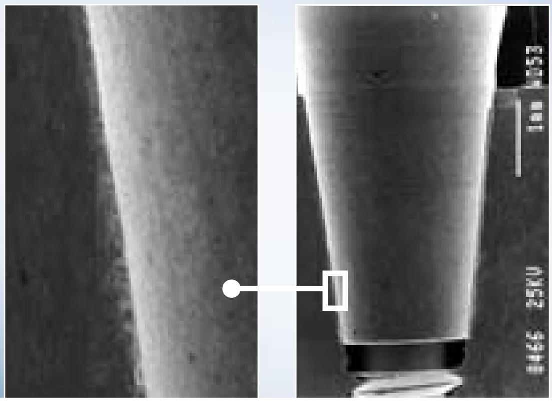

Fig. 3: The section through the cone shows that with precise manufacturing there is no gap between cone and implant. The connection is airtight and therefore also bacteria-proof

prevents micromovements even under unfavorable loading conditions. Therefore we included a retaining screw to maintain the initial preloading of the cone permanently. It is not subject to loading forces and so could be very slender. The tightening torque of the retaining screw at 15 Ncm is also only about half of that of conventional implant connections. Even so the connection is locked to prevent rotation and micromovement.

NENTWIG: The third significant feature of the conical connection in addition to the stability and permanence is the sealing. A cone with high-precision production practically forms a complete seal (Fig. 3).

IS ANKYLOS REALLY 100 % SEALED? SOME STUDIES HAVE RAISED DOUBTS.

NENTWIG: These studies were not completely methodologically correct. A conical connection with suitable, that is sufficiently precise manufacturing technology, is airtight, which means it is also bacteria-proof. In our own tests we have been able to prove this beyond a shadow of doubt. It is easy to prove this with Ankylos, because there is no unpleasant odor when an abutment component is replaced. You can literally smell the sealing.

“The role of the microgap is proven for me”

HOW DO YOU SEE THE CURRENT DISCUSSION ABOUT THE MICROGAP, MICROMOVEMENT AND BACTERIAL CONTAMINATION AS CAUSES FOR THE STILL PREVALENT BOWL-SHAPED BONE RESORPTION?

NENTWIG: I believe that animal experiments have confirmed that bacterial contamination and the degree of micromovement between implant and abutment are the cause of this phenomenon. During chewing loads with changing directional vectors the opening and closing of the peripheral joint gap induces a type of pumping effect. High-resolution video recordings taken in the Frankfurt clinic recently by Diplom-Ingenieur Holger Zipprich show this effect impressively. These recordings are available on the Internet (http://www.kgu.de/zzmk/werkstoffkunde). The pumping effect expels microorganisms from the gap spaces and as a result causes infectious infiltration in the peri-implant tissue.

Most implantologists today consider displacement of the joint gap inwards, referred to as platform switching, as helpful in reducing cervical bone loss. However, only the use of a friction-locked and keyed conical connection can guarantee that the result will be a virtual single-component implant body as given in the Ankylos system. This precludes the risk of infection of the cervical bone from the inside. In many cases bone even grows over the implant shoulder.

WHEN WERE YOU ABLE TO PLACE CLINICALLY THE FIRST OF THE IMPLANTS THAT YOU DEVELOPED?

NENTWIG: That was in 1987. We had worked with Krupp Medizintechnik to bring the system to a point where it was ready for use. I placed the first implants in September 1987.

Friends and inventors: Georg-Hubertus Nentwig and Walter Moser in 1985, the year Ankylos was invented

It was a situation involving free-end edentulism in the left mandible, which I restored with a connecting bridge. I am doing the same procedure today with very good results. Of course it requires an indication for a telescope coping for the end tooth.

MOSER: The implant system was initially referred to as NM (Nentwig-Moser) and the implants were available in eight models. It was not sold to third parties until some time in 1993. However, this phase came to a quick end with the closure of the Krupp medical division in that year.

NENTWIG: In 1993 we met Dr. Werner Groll, then with Degussa Dental and now managing director of DENTSPLY Friadent. Degussa Dental was interested in expanding its range of dental products. Our system was marketed by Degussa Dental under the Ankylos name from early 1994. In October 2001 DENTSPLY acquired Degussa Dental and also Ankylos. Since 2002 the system has been marketed by DENTSPLY Friadent.

THE DESIGN PRINCIPLE OF ANKYLOS HAS MEANWHILE BEEN IMITATED BY OTHER SUPPLIERS. DO YOU STILL SEE ANY POSSIBILITIES OF FURTHER DEVELOPMENT IN THE AREA OF THE THREAD OR THE IMPLANT-ABUTMENT CONNECTION?

NENTWIG: If I had to start again from the beginning, I would do it all in exactly the same way. The design principles and dimensions of the implant and connection are practically unchanged (Fig. 4a and 4b, editor's note). Of course there have been improvements with additional abutment lines, such as SynCone or ceramic abutments.

The formerly smooth shoulder region has been micro-roughened since 2005. This is better with the slightly subcrestal placement that is favored today. Formerly the view was that a smooth shoulder provided advantages during treatment of peri-implantitis, if that occurred. However, our check-ups have indicated that periimplantitis with Ankylos is a very uncommon event.

> "The basic design principles and dimensions have remained exactly the same"

On safari in Tanzania: 20 years after the first implant placement Ankylos is in successful use throughout the world

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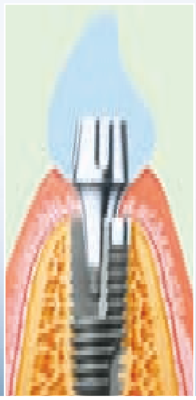

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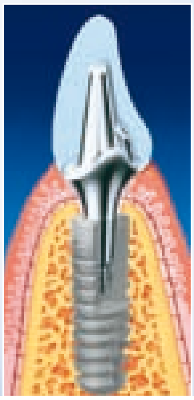


Fig. 4a: Design principle of Ankylos, as drafted in 1985 (implant with Standard abutment)
Fig. 4b: Ankylos 2007: Twenty years later the design principle and dimensions are unchanged. The only changes are the micro-roughened shoulder, a larger selection of implant sizes and abutment variations (implant with titanium Balance abutment) and the option of subcrestal placement

WHAT IS THE SITUATION WITH THE IMPLANT THREAD? WILL A THREAD STILL BE NECESSARY IN THE COURSE OF BIOLOGIZATION OF IMPLANT SURFACES?

MOSER: The geometry of the Ankylos implant thread is technically and biomechanically fully exploited. However, a thread will always be necessary for high primary stability.

NENTWIG: That is also my opinion. In addition, with the Ankylos implant the effective bone anchorage resulting from retention of the cervical bone is retained.
This means that we can place shorter implants with a comparable prognosis, as already referred to briefly above. We have documented this in a new study in which short implants were used in combination with bone training. Of 758 implants placed over a period of five years only 15 have been lost.

WHAT IS THE SUCCESS RATE OF ANKYLOS FOR ALL INDICATIONS?

NENTWIG: As of June 31, 2006, we have documented 8747 implants over a period of 16 years in the Frankfurt clinic. The loss rate is only 2 %.

> “An implant system is only as good as its practical application”

THE ANKYLOS SYSTEM IS SIGNIFICANTLY DIFFERENT FROM OTHER SYSTEMS IN ITS PROSTHETICS. COULD YOU SAY SOMETHING ABOUT THAT ALSO?

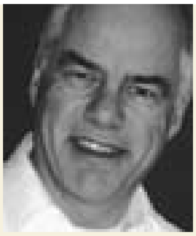
MOSER: An implant system is only as good as its practical application. For this reason during the development of Ankylos we made sure that the system is as simple as possible to use. I would like to talk about the surgical technique first. The sequence of instruments, their mechanical function and handling must be safe and well thought out. We took three times as long to develop and design in detail the instrument kit as for the implant components. Because at this time I was already living in Switzerland, we developed the prototypes in collaboration with a Swiss instrument manufacturer.

NENTWIG: As a surgeon I can confirm that the system works exactly as required. We are satisfied that the soft tissue grows over the shoulder and ensures a dense closure in the emergence region after connection of the abutment. During uncover we only have to remove the soft tissue that is immediately above the conical opening.

AND WHAT IS THE SITUATION WITH THE PROSTHETICS? ARE THERE ANY PROBLEMS WITH THE TRANSFER OF THE ABUTMENT POSITIONS?

NENTWIG: The system is extremely simple also in the prosthetic area. Prefabricated impression copings for the standard abutments are available. With the Balance abutments the selection and alignment is carried out in the laboratory. The dental technician customizes the abutments depending on the peri-implant soft tissue and fabricates a simple transfer key. My prostheticist colleagues are convinced that being able to position the abutments in the dental arch as they wish is superior. Where the endosseous implants have varying axial alignments it is easy to find a common parallel delivery direction, even with multiple implants. With the very slender abutments there is plenty of space for the soft tissue, which can be particularly important in the esthetic region. It could be said that the prosthetic system is also biologically and mechanically consistent.

PROFESSOR NENTWIG, DOCTOR MOSER, WE THANK YOU VERY MUCH FOR THIS INSIGHTFUL INTERVIEW.



Georg-Hubertus Nentwig

Born 1951, grew up in Munich, married, 1 son (11 years old). Nentwig started as an assistant in the clinic for oromaxillofacial surgery of the Ludwig-Maximilian University in Munich in 1979. In 1982 he became an oral surgeon. In 1986 he completed his habilitation in early and delayed restoration of front-tooth trauma with ceramic pins, i.e. an implantology topic at this stage. In 1988 Nentwig was appointed a C2-level professor in oral surgery in Munich.
Nentwig has been Director of the Policlinic for Dental Surgery of the University of Frankfurt am Main since 1991, which in 2002 was renamed the Policlinic for Dental Surgery and Implantology. He has been a Fellow of the Royal College of Surgeons (London) since 2003.

Walter Moser

Year of birth 1955, grew up in Ellwangen (Württemberg). Moser started as an assistant in the Department of Metallurgy of the Technical University of Munich. He became qualified as a Doctor of Engineering (Dr.-Ing.) in 1988 in Munich with a dissertation on a materials topic as part of a hip implant project. Subsequently Moser worked as a development manager at two manufacturers of orthopedic products. Since 1999 he has been technical director at a Swiss manufacturer of joint prostheses and responsible for development and marketing of surgical navigation systems.