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Magazine for Arthroplasty

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»INDIVIDUALIZATION OF THERAPY IS THE NEXT BIG STEP«

Prof. Bernardo Innocenti on ideal stem lengths for knee prostheses, metaphyseal fixation and the new Link OptiStem

Metal and cement hypersensitivity:
A double coating with LINK PorEx and CaP can be the solution

NEW: FlexiCones from LINK
All you need to know about the new Femoral and Tibial Cones from LINK

Steel or cobalt-chrome alloy?
Helmut D. Link on the advantages of cobalt-chrome alloys over steel in arthroplasty

»Cake« from the 3D printer

What at first glance looks like the side of a sugar cupcake is indeed called a »cake« by LINK's department for additive manufacturing. The name refers to the fresh block of titanium powder that comes out of the 3D printer at the end of the additive manufacturing process. The printed products hidden under the powder – in this case custom-made products with the TrabecuLink structure – are later exposed in a blasting process. Read more about LINK's special 3D printing technology on page 25.

Dear Readers,

»The world's greatest change agents have always swum against the tide.« In keeping with this quotation from the literary historian Walter Jens, who died in 2013, the intramedullary fixation of arthroplasty stems has also changed several times in the past decades. Currently, surgeons worldwide are increasingly opting for anchoring in the metaphysis or metadiaphysis.

To support this wise development, manufacturers have several options. One solution that we have adopted is to design new products from the very beginning so that they can be firmly and permanently anchored in the metaphysis. In many cases, this allows complex individual fitting problems to be solved that cannot be handled with standard implants.

For the biomechanical background of metaphyseal intramedullary implant fixation and the question of what role the new Link OptiStem modular stem can play, I recommend that you read the interviews with Prof. Bernardo Innocenti and with Prof. Michael M. Morlock and Prof. Carsten Perka.

We use additive manufacturing in interesting ways for the production of custom-made products. LINK continues to invest in this process, also known as 3D printing technology including in new high-performance machines for the production of highly complex implant geometries and surfaces. Read more about the special features of additive manufacturing at LINK on page 25.

I hope you enjoy these and the many other topics in direct**LINK**.

Regards,

Helmut D. Link

»INDIVIDUALIZATION OF THERAPY IS THE NEXT BIG STEP«

A conversation with Prof. Bernardo Innocenti about ideal stem lengths for knee prostheses, metaphyseal fixation and the new Link OptiStem.

Prof. Innocenti, the intramedullary femoral fixation of knee prosthesis stems tends more and more towards the metaphysis. Where does this trend come from?

In my opinion, the main reason for this trend is that metaphyseal fixation avoids the use of unnecessarily long stems. This reduces the risk of bone damage during surgery. Also, stress shielding is reduced and better fixation is achieved in the long term.

Stress shielding is a problem especially in the femur because the force runs from proximal to distal. What does an extension of the stem mean?

An extension of the stem proximalizes the load distribution and thus extends the area of stress shielding. For example, if the stem is ten or twelve millimeters shorter, the stress shielding effect is reduced. Especially if a revision may become necessary in the future, the implant must primarily remain firmly anchored in the bone for as many years as possible. From a biomechanical perspective, metaphyseal fixation is the best compromise in terms of stem length and stress shielding – provided the bone is of good quality.

»It is important to see the patients from a different perspective and to be able to meet their needs.«

Is there an algorithm that surgeons can use as a guideline for different bone qualities and other important parameters for the optimal stem length?

In my opinion, it is possible to define a specific path that the surgeon can follow. We are currently working on a biomechanically oriented guideline that provides surgeons with a set of solutions rather than a rule for stem lengths. Finding the right stem length for an individual patient, however, will of course remain the surgeon's task.

It seems that, sometimes, even a centrally located stem does not achieve good anchorage with the bone. What needs to be done?

In these cases there are two ways to achieve good metaphyseal fixation: The surgeon can either use an appropriate implant or use additional material to create a larger stem diameter.

As a biomechanical engineer, how do you rate the Link OptiStem in terms of the quality of the metaphyseal fixation?

I think the Link OptiStem is a very intelligent implant for two reasons. First, it transmits force from proximal to distal. Second, it combines the advantages of bone cement and metal in a way, because it allows you to load the entire intramedullary bone surface without using cement. Since the load is the force divided by the area, the surgeon reduces the overall load on the bone as the area increases. In my opinion this is a very smart solution.

»In a way, the Link OptiStem combines the advantages of bone cement and metal.«

An alternative could be the use of Femoral or Tibial Cones. When do you think surgeons should opt for a metadiaphyseal stem and when should they use cones?

If the surgeon has great confidence in the quality of the proximal bone part, a cone might be sufficient. If the fixation needs to be distalized, it may be biomechanically better to use a metaphyseal stem such as the Link OptiStem from LINK.

You and your team have conducted various studies on implant mechanics. How can surgeons make best use of the information from biomechanical studies of knee prosthesis stems?

I would like the information I provide to the surgeons to be considered as a recommendation. The idea being that

ABOUT

Bernardo Innocenti, Ph.D., is Professor of Biomechanics in the BEAMS Department, Université Libre de Bruxelles, École Polytechnique de Bruxelles in Belgium. He is also the founder and first president of CAOS-Belgium, the Belgian Society for Computer Assisted Orthopedic Surgery, and guest professor at KU Leuven in Belgium.

they would use these suggestions as a guideline at their own discretion – just as they would use a navigation system, a robot or an additional tool during surgery. They all have the same purpose: to improve the result of the surgery and increase patient satisfaction. Ultimately, however, the surgeon must also decide on the basis of the information provided by the biomechanical engineers.

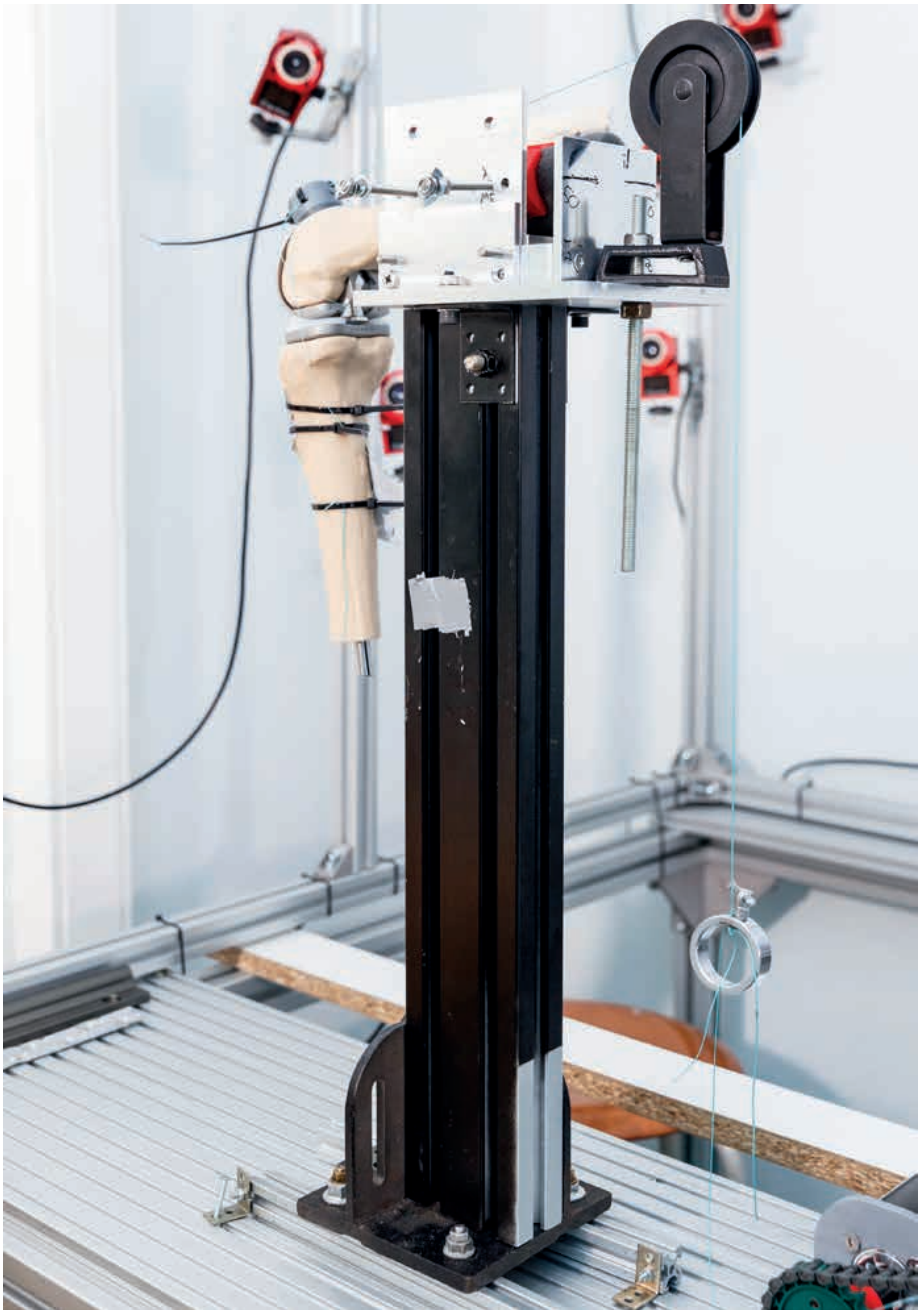
»We are working to enable surgeons to provide personalized care to their patients in less time.«

What information about a knee prosthesis is most important for surgeons?

The average patient wants to be able to walk, sit and stand up again without pain or mobility problems. As a biomechanical engineer, I have to focus on the patient's daily activities. It is therefore important to analyze the patient from a different perspective. The human being has muscles, soft tissue, bones – and then suddenly an implant is added. This means that we have changed the shape, material, strength, friction and lubrication of the joint. The data on these parameters can help improve the performance of an implant significantly. So we have to provide the surgeons with this information.

Would the information you provide lead to an individualized patient analysis and thus to a better fitting implant?

Yes, I believe so. I call that personalized treatment. To close the gap between a standard implant and a customized implant, we have to be as close as possible to each patient, because each patient is individual. The industry provides a standard implant, and we, as biomechanical engineers, strive to provide information about the specific functional parameters of the implant for each patient individually.



»Most of the techniques we use to obtain the necessary data in the biomechanics laboratory involve a lot of work« – Prof. Bernardo Innocenti

What are the most critical parameters from a biomechanical perspective?

In my opinion, there are three important parameters. The first is bone quality – the better the bone, the better the basis for stem fixation. The shape of the implant is the second important parameter because it tells us how the implant behaves in the human body.

Then the third parameter would be the lifestyle of the patient?

Lifestyle alone is not enough. Only in combination with the patient's expectations of the surgery is that the third important parameter. Of course, each patient uses his or her joints in an individual way. A man who mainly wants to sit on the couch and watch TV and a

woman who wants to ride a bike or go for regular walks cannot therefore receive the same therapy. The patient is happy if they can do what they want to do and not what others expect of them. Nowadays, people still feel young and active at 60. Therefore, we have to provide implants that correspond to the patient's activity level in their real life.

»Biomechanical engineers must know how the surgeon thinks, speaks and acts – and vice versa.«

Would it be possible to tailor the analysis of the relevant parameters individually to each patient before joint surgery to find out how the force could best be distributed homogeneously?

This is certainly possible – and it would also enable the surgeon to find out how the performance of the patient and the implant can be improved. But this would be more a question of time than money. Most of the techniques we use to obtain the necessary data are very time-consuming. This makes it difficult to make patient-specific predictions within a reasonable timeframe before surgery. We are working to shorten this timeframe because I believe that is a key to success.

Would this mean that biomechanical engineers increasingly became part of the development process of modern implants?

Yes. If you look at the significant advances in surgery over the last 20 years, then biomechanical engineers are gradually becoming part of the process. I think it is important for a company to hire biomechanical engineers to design, to interact with surgeons and to raise relevant questions. I think the ways of working still need to converge so that surgeons start talking to biomechanical engineers. But the major improvement will be that everyone understands the importance of each other. Biomechanical engineers need to know how the surgeon thinks, speaks and acts – and vice versa. This, too, is one of the keys to success and at the same time it is the only way to gradually move closer to treating all patients individually.

Prof. Innocenti, thank you very much for the interview.

The Link OptiStem is a modular stem that primarily anchors the prosthetic components of a LINK Endo-Model SL knee prosthesis system in the metaphysis.

»A high initial metaphyseal stability can be achieved with the Link OptiStem«

A conversation with Prof. Carsten Perka and Prof. Michael M. Morlock about ideal stem lengths, the trend towards intramedullary metaphyseal anchoring of knee prostheses and how the new Link OptiStem promotes this approach.

While proponents of bone cement like to use long knee prosthesis stems, critics prefer short stems so that there will be less cement to remove during future revisions. Short or long, cementless or cemented – which knee prosthesis stems would a clinician assign to which indications?

Prof. Perka: Basically, we aim for the shortest possible stem. If I need a cementless stem, it has to be relatively long, because it is often only anchored in the diaphysis. That is why we prefer cemented stems for first revisions, provided that there is enough cancellous bone. The cemented stem of a standard prosthesis can therefore be shorter than a cementless one.

What if there is not enough cancellous bone?

Prof. Perka: In this case, you have to actually consider whether a cementless or a cemented anchorage is more sensible. The data situation speaks for a metaphyseal anchorage. Because cemented does not work well when there is hardly any cancellous bone, we have to look for cementless solutions.

Prof. Morlock: Many surgeons implant long knee prosthesis stems from a gut feeling, although from a biomechanical point of view there is no need for this. Short stems can basically achieve the same stability as long, cemented stems – where sleeves or cones serve to ensure that the load is transferred as proximal

to the joint as possible. This is also the ultimate goal, as we want to match the bone load as closely as possible to that in the native joint.

What are the other advantages and disadvantages of short and long knee prosthesis sockets as well as cemented or cementless implantation?

Prof. Morlock: With short stems there is no risk that the tip of the stem will lie in the narrower area of the bone, resulting in very high stress concentrations and eventually in periprosthetic fracture. There are no reliable data indicating that the periprosthetic fracture rate is higher with short stems.

Prof. Perka: With earlier cementless stems, pain often occurred at the tip of the stem. Today, prosthetic stems can be designed in such a way so that this no longer happens. In my opinion, the future of knee arthroplasty lies in cementless stem anchoring.

From a biomechanical point of view, which parameters are decisive for intramedullary implant anchorage?

Prof. Morlock: The primary stability is the most important parameter. If the bone-implant interface survives the first eight weeks, it will last. To completely avoid stress shielding, I would basically use a surface replacement without a stem. However, a stem anchored knee prosthesis could be a good solution as a primary surgery for extremely obese patients, because the shear stress causes bending stress, which justifies a shorter stem. Otherwise, the surgeon should introduce the force as close to the joint as possible in order to reduce bone loss due to the altered force transmission.

What is the ideal stem design?

Prof. Perka: The earlier belief that cylindrical stems are necessary, which fall evenly into the medullary canal during implantation, is certainly outdated. Most medullary canals are tapered and the same applies to the metaphysis. The metaphysis is all about being able to use different anatomical stem shapes, because there is no single shape for all people.

Anchoring the knee prosthesis stem in the metaphysis is a trend that more and more surgeons are following. Why?

Prof. Perka: A long stem carries the risk of increased stress shielding. This risk is higher the further away from the joint it is anchored. The goal should therefore be to anchor the stem as close as possible to the joint surface, i.e. the metaphysis. Metaphyseal anchoring avoids stress shielding and is the better choice in the long term. If necessary, the prosthesis can also be removed more easily.

The new Link OptiStem promotes intramedullary metaphyseal anchorage – how do you rate this?

Prof. Morlock: The Link OptiStem performed very well in our tests. In my opinion it is a very good way to achieve sufficient primary stability. However, it requires a relatively large amount of bone to be removed, so it should only be implanted in cases where this is absolutely indicated.

Prof. Perka: I have implanted the Link OptiStem several times and for these cases I can say that a high initial metaphyseal anchorage stability can be achieved with this philosophy. Of course we need more data, but at the moment this anchoring mechanism seems to be a very good method.

Prof. Morlock, Prof. Perka, thank you very much for the interview.

ABOUT

Prof. Carsten Perka (left) is Medical Director of the Center for Musculoskeletal Surgery at the Clinic for Orthopedics at Charité – University Medicine Berlin, Campus Mitte, Germany.

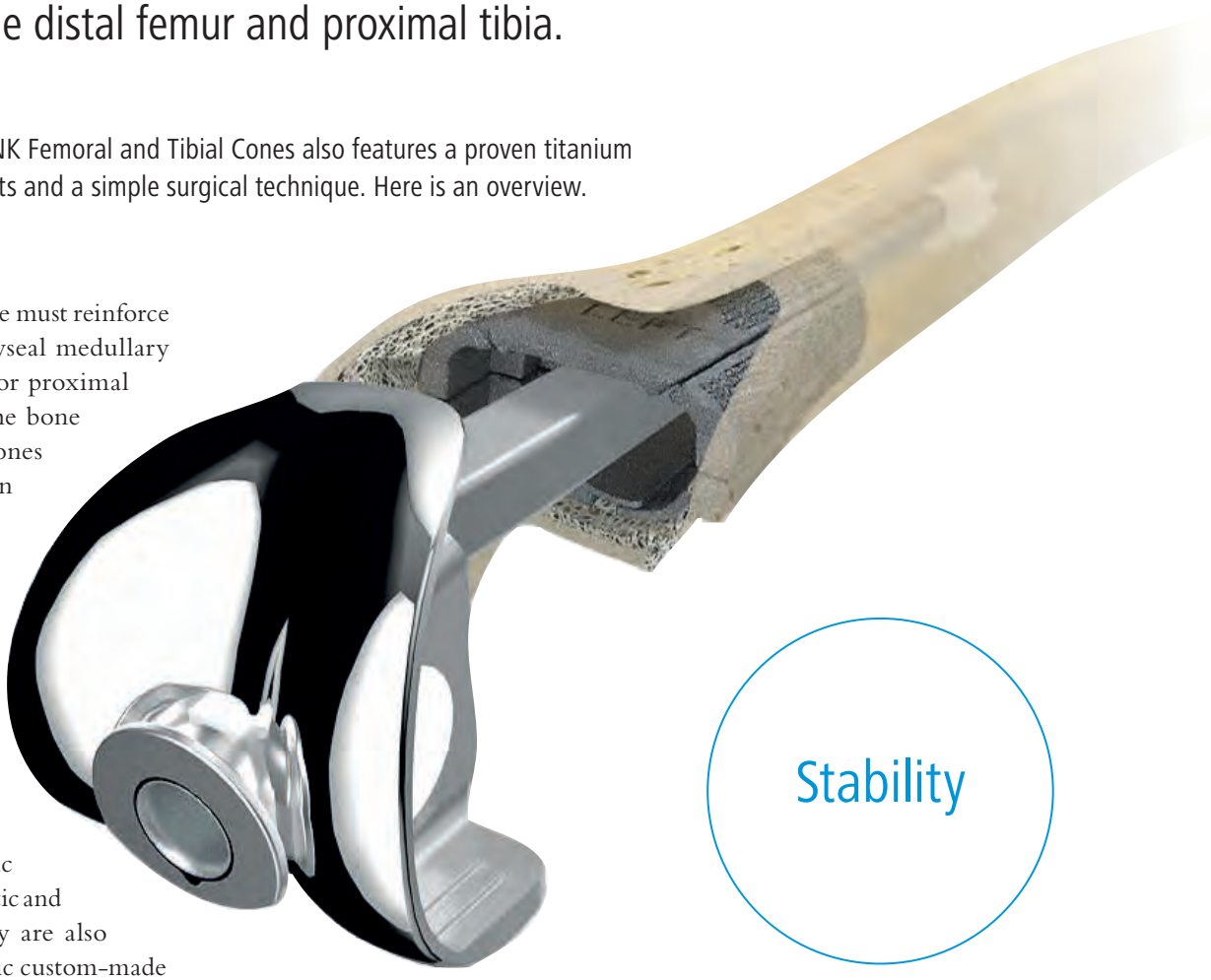
Prof. Michael M. Morlock is head of the Institute for Biomechanics at the Technical University of Hamburg, Germany.

Excellently adapted:
The TrabecuLink FlexiCones

LINK's TrabecuLink Femoral and Tibial Cones provide solid anchorage in at least two of three zones.* They are used for reinforcement in cases of metaphyseal and diaphyseal bone defects or bone loss, and thus for stabilization in the distal femur and proximal tibia.

The latest generation of LINK Femoral and Tibial Cones also features a proven titanium alloy, ergonomic instruments and a simple surgical technique. Here is an overview.

The Femoral or Tibial Cone must reinforce the metaphyseal or diaphyseal medullary space of the distal femur or proximal tibia and adequately fill the bone cavity. In addition, the cones must ensure a secure fit in combination with the respective femoral or tibial prosthesis component. At the same time, osseoconduction at the bone-implant interface should be promoted. The new TrabecuLink FlexiCones meet these important requirements due to their characteristic features: they are stable, elastic and variable. On request, they are also available as a patient-specific custom-made implant with the HX coating.



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Stable fixation: TrabecuLink FlexiCones stabilize metaphyseal and diaphyseal bone defects

* R. Morgan-Jones, S. I. S. Oussedik, H. Graichen, F. S. Haddad: Zonal fixation in revision total knee arthroplasty, The Bone & Joint Journal, Vol. 97-B, No. 2, February 2015

Elasticity

Stable fixation through high primary stability and good fit.

These features ensure that the cementless FlexiCones are particularly stable:

- High primary stability and good fit
- Cementless implantation on the bone side for bone regeneration
- Inner metal wall as protection against contact with bone cement
- Secure cement fixation of the knee prosthesis due to additional, revision-friendly notches

Elasticity through bending axes for individual adaptation.

The special elasticity of the FlexiCones results from the elastic design:

- Bending axes for individual adaptation
- Spring effect for easy surgical positioning and high primary stability
- Mechanical compression to promote bone regeneration

2 TrabecuLink Femoral Cones are available in sizes XS, S, M and L and in 3 zone (left and right), 2 zone (neutral) and proximal (neutral) versions.

3 Elastic design: TrabecuLink Femoral and Tibial Cones with spring effect for easy intraoperative positioning and high primary stability.

4 TrabecuLink Tibial Cones are available in four sizes (XS, S, M and L) and four variants (full, right half, left half and half).

FLEXICONES

High versatility due to possible applications with the entire LINK Endo-Model knee family.

TrabecuLink Femoral and Tibial Cones are highly versatile and can be used with the complete LINK Endo-Model knee family. The cones are available for all sizes of hinged knee prostheses.

The three-dimensional TrabecuLink structure promotes osseoconduction and microvascularization and thus functional bone ingrowth.

The three-dimensional TrabecuLink structure with its pore size, porosity and structure depth provides a very good basis for promoting osseoconduction and microvascularization. This is also the case when considering the protein layer that fills the structure of the bone precursor cells (fibronectin-vitronectin-fibrinogen).

The perfect tension at the compression point promotes osseointegration.

For example, the FlexiCones are inserted by press-fit and, due to their elasticity, they are compressed by the surgeon and pressed against the bone during insertion. This mechanism further promotes osseointegration.

Versatility

5 Versatile combinations: TrabecuLink Femoral and Tibial Cones are compatible with the entire LINK Endo-Model knee family.

»We use the FlexiCones from LINK regularly«

Prof. Thorsten Gehrke, Helios ENDO-Klinik Hamburg, Germany

In revision surgery of knee prostheses, the surgeon is confronted with considerable bone loss and extensive osteolysis. To fill defects and stabilize the newly implanted revision knee prosthesis, the use of metallic bone replacement has become widely accepted. Here, the »wedges and cones« play by far the most important role. In the case of the cones, these are usually so-called trabecular metal variants with a porous metal framework for optimized bone integration.

The Helios ENDO-Klinik uses rotating hinge knee prostheses in septic revision surgery on the knee joint. These often exhibit insufficient rotational stability with consecutive early loosening, especially in the metaphysis (AORI type II and III defects) (Hilgen et al., 2013). Since we began additionally using Femoral and Tibial Cones to fill defects and achieve rotational stability, the situation has improved radically (Abdelaziz et al., 2019). Due to the flexibility and adaptability of these Femoral Cones to the individual medullary cavity geometry, sufficient stability and lasting fixation of the constrained revision prostheses can be achieved even in the case of large defects extending into the diaphysis (AORI type III, zone 2 to 3 acc. Morgan Jones) (Ohlmeier et al., 2020).

The Femoral Cones in particular have contributed to a significant improvement in the quality of care in cases of massive bone loss and osteolysis. Since their introduction at the beginning of the year, we use them in about 50 percent of our septic and aseptic knee prosthesis revisions. They allow optimal adaptation to the defect situation, so that the appropriate cone can be used depending on the size and location of a metaphyseal or diaphyseal defect. The cones can be inserted relatively deep into the femoral medullary canal. This results in a long-distance fixation with good bone-metal contact for extensive osseointegration. In addition, the stepped shape allows the intercondylar part of the prosthesis to be encircled and thus provides optimum rotation prevention. The instruments for preparing and insertion of the cones are reliable and easy to handle. They thus ensure a precise fitting and reproducible fixation in the bone.

Prof. Thorsten Gehrke is Medical Director of the Helios ENDO-Klinik Hamburg in Germany and co-developer of the TrabecuLink Femoral and Tibial Cones from LINK.

GEMINI SL TKA System with LINK PorEx:
Titanium niobium nitride (TiNbN) coating significantly reduces chrome and nickel ion release*

The following case reports detail the early experiences of US surgeons Dr. Jon E. Minter and Dr. Paul B. Jacob with the GEMINI SL TKA System with LINK PorEx.** The option for a ceramic-like coating to reduce the release of chrome and nickel ions in addition to the standard LINK GEMINI SL offering is especially appealing to Dr. Minter and Dr. Jacob. Currently, very few companies offer a TiNbN coating option. In this section we discuss several different patients with a history of osteoarthritis (OA) with whom the surgeons have utilized the GEMINI SL knee system.

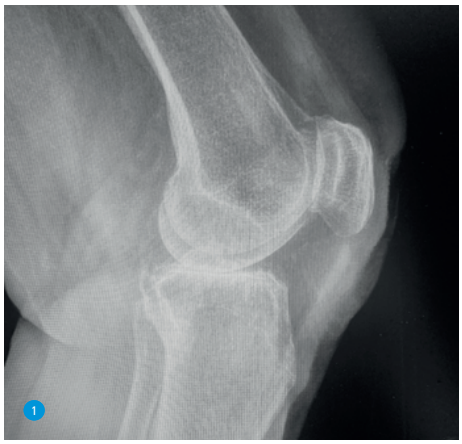
Patient 1 of Dr. Jon E. Minter is a 78-year-old female with a longstanding history of osteoarthritis with failure of conservative management. The patient additionally reported a longstanding nickel allergy. BMI was 30.

An uncomplicated health history was provided to us on initial intake. The patient demonstrated a varus deformity with tricompartmental pathology noted on clinical exam and X-ray (Figure 1). The passive range of motion was 10–130 degrees. A severe antalgic flexed knee gait was also noted. A 10 degrees flexion contracture with a fixed varus was recorded at the initial exam.

Subsequently, following preoperative medical clearance, the patient underwent elective total knee arthroplasty. Surgical findings were remarkable for palpable periarticular osteophytes, tricompartmental arthritis and a predominantly medial sleeve contracture.

Patient 2 of Dr. Jon E. Minter is a 45-year-old female with a longstanding history of traumatic osteoarthritis secondary to multiple sports injuries and subsequent related surgeries with failure of conservative management. BMI was 34.

A routine health history provided to us indicated no severe health problems. The patient demonstrated an unstable ligamentous knee joint on physical examination. Lateral compartmental collapse noted on X-ray (Figure 2). The passive range of motion was 0–115 degrees. A severe antalgic flexed knee gait was also noted. Subsequently, following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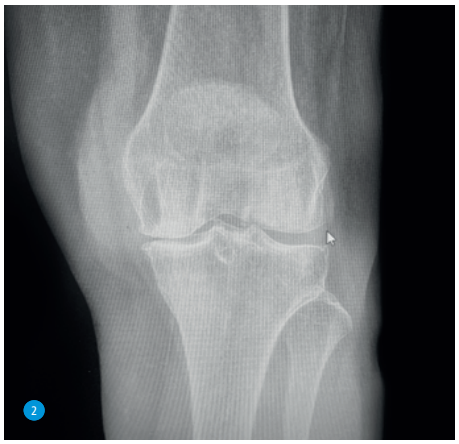
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ABOUT

Dr. Jon E. Minter, DO, is an orthopedic specialist in Atlanta, Georgia, USA.
minterje@gmail.com

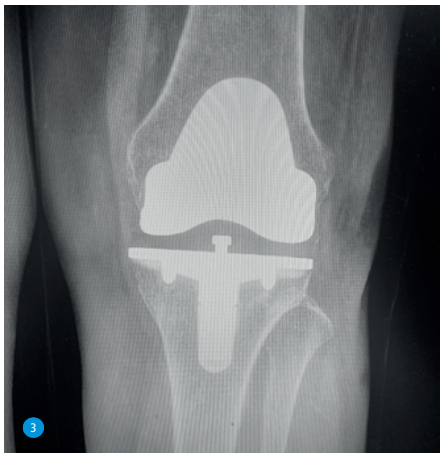
* Internal technical report: Study of the influence of TiNbN coating on the ion release of CoCrMo alloys in SBF buffer simulator testing

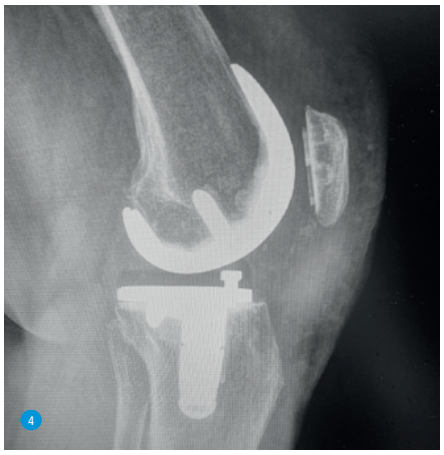
** LINK PorEx: TiNbN = titanium niobium nitride; hypoallergenic surface modification (gold colored)

preoperative medical clearance, the patient underwent elective total knee arthroplasty.

Findings were remarkable for severe tricompartmental cartilage degradation, lateral compartment collapse with anterior and posterior cruciate ligament rupture (Figure 3, 4). Surgery was performed without complication with subsequent same-day discharge. A physical therapy program was completed with routine follow up at six weeks post-surgery.

At six weeks, both patients demonstrated dramatic improvement in function with a predictable reduction in pain from preoperative levels. The range of motion for Patient 1 was 0–125 degrees, and for Patient 2 was 0–130 degrees. They will be seen again at the one-year scheduled appointment.





GEMINI SL Fixed Bearing CR with LINK PorEx.**

Patient 1 of Dr. Paul B. Jacob is a 73-year-old female with a BMI of 24 and a documented past medical history that includes hormone replacement therapy, gastroesophageal reflux and obstructive sleep apnea. She has a recorded history of nickel allergy confirmed through lymphocyte transformation testing. She had grade 4 tricompartmental osteoarthritis of bilateral knees with partially correctable varus deformities and partially correctable flexion contractures present (Figure 5).

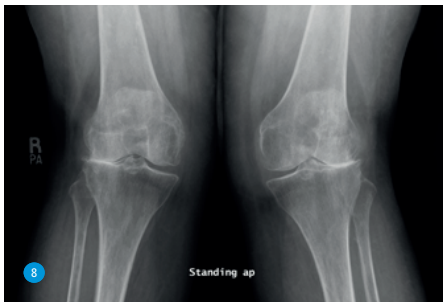
Multiple conservative measures were attempted to treat her symptoms; however, these failed. She was no longer considered an appropriate candidate for conservative treatment due to the intractable pain and loss of daily function. The patient was optimized for surgery through our pre-admission testing department and underwent elective right total knee arthroplasty. Surgical findings were consistent with preoperative radiographs demonstrating severe tricompartmental cartilage loss.

(continued on next page)

ABOUT

Dr. Paul B. Jacob, DO, is an orthopedic specialist in Oklahoma City, Oklahoma, USA. scott@drpauljacob.com

Surgery was performed without complication utilizing the LINK GEMINI SL cemented titanium niobium nitride (TiNbN) coated implant system (Figure 6, 7). The patient was discharged to home with home health within 23 hours (observation stay) of her surgery. Home Health Services included physical therapy and a single nursing visit. At her six week postop visit, her ROM was 0–136 degrees. She was requesting that we schedule the contralateral leg for total knee replacement at that office visit.



Patient 2 of Dr. Paul B. Jacob is a 71-year-old female with a BMI of 30 and a significant past medical history of comorbidities including type 2 diabetes mellitus, hypertension, rheumatoid arthritis, osteoporosis, sarcoidosis, history of pulmonary embolisms, and preoperative long-term narcotic use managed by her pain management clinic. In addition, she had grade 4 tricompartmental osteoarthritis of her bilateral knees, severe fixed valgus deformities as well as significant genu recurvatum bilaterally (Figure 8). She has a documented history of nickel allergy confirmed through lymphocyte transformation testing.

The patient was scheduled to have staged bilateral knee replacements in September 2019; however, she fell and sustained an inferior pelvic rami fracture, which postponed the surgeries. She was placed on a protected weight-bearing protocol with a walker to allow the fracture to heal and prevent further falls. She was able to have bilateral genicular knee ablations to help control her pain in the meantime. Once the pelvic fracture healed, the patient was able to proceed with the left total knee replacement. She was optimized for surgery through our pre-admission testing department. The patient underwent elective left total knee arthroplasty utilizing the LINK GEMINI SL TKA (Figure 9, 10).

Surgery findings were consistent with preoperative radiographs for severe tricompartmental cartilage loss with severe fixed valgus deformities as well as genu recurvatum. Surgery was performed without complication.

The patient was discharged to home with home health within 23 hours (observation stay) of her surgery. Home Health Services included physical therapy and a single nursing visit. At her six weeks postop visit, her ROM was 0-116 degrees. She was requesting that we schedule the contralateral leg for total knee replacement at that office visit.

Antimicrobial and osteoconductive:
Silver-coated titanium implants minimize periprosthetic infections

Younger patients in Sweden have an average infection rate of 0.9 percent when they have their first hip prosthesis. Internationally, the infection rate after revisions is about 2-13 percent; larger reconstructions carry a 12 percent risk of periprosthetic infections. A study at the University of Uppsala in Sweden aimed to demonstrate the effects of silver-coated titanium implants being used clinically on the bacterial biofilm and human osteoblasts in order to minimize or prevent periprosthetic infections. A report by Prof. Nils Hailer.

In our study we examined:

- Roughness and silver concentration on the surface
- Silver concentration in the culture
- Degree of bacterial toxicity
- Osteoblastic survivability

We used 12.5 mm large and 2 mm thick Ti6Al4V discs from LINK and defined the following three categories:

I. Corundum-blasted (GB) titanium (Ti)
II. Titanium coated with silver titanium nitride (SN) by physical vapor deposition – PorAg-DUR
III. Titanium coated with silver (1 µm) and silver titanium nitride (SSN, approx. 100 nm) – PorAg

Our test results show that

- Micro-roughness leads to deposition both in human osteoblasts and in bacteria.
- Low silver concentrations retain their antibacterial potential – with minimal osteoblast toxicity.
- Primary osteoblasts should be used for testing instead of cell lines.
- Optimization of the silver concentration on the surface of the implant could lead to further improved results.

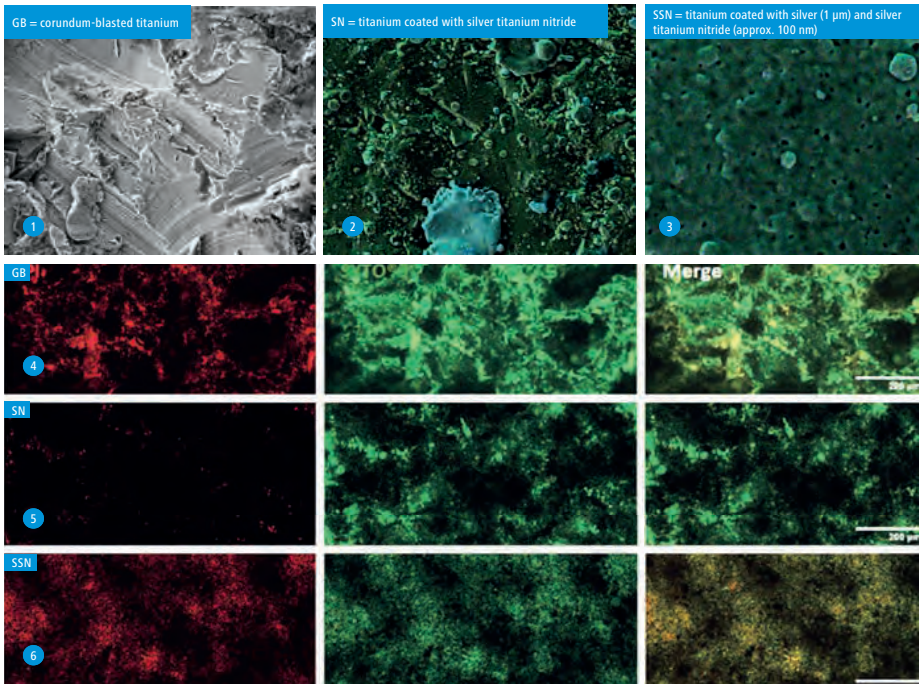


Figure 1 shows the rough, corundum-blasted titanium surface (PoroLink); the light blue area in Figure 2 corresponds to high Ag concentrations. Ti areas are light green, and darker green (2, 3) corresponds to higher TiN concentrations (N is red). In SSN surfaces the Ag concentration was twice as high (68% vs. 27%) as in SN surfaces. A more homogeneous biofilm coverage is found in GB slices (4). The biofilm is interrupted in SN (5) and SSN (6) (962 CFUs (GB), 357 (SN), 248 (SSN); SN vs. SSN p = 0.092).

ABOUT

Prof. Nils Hailer is Professor of Orthopedics in the Orthopedic Clinic at University Hospital Uppsala in Sweden.
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Double coating with LINK PorEx* and CaP** for allergy to nickel and bone cement

A 61-year-old female patient with a body weight of 85 kg and a height of 175 cm presented in autumn 2018 with a medial gonarthrosis on the left side at the Orthopedics and Trauma Surgery Clinic of the Maltese St. Josef Hospital in Krefeld-Uerdingen. For the cementless implantation of a LINK unicondylar knee prosthesis, the fact that the patient is allergic to both nickel and bone cement had to be taken into account.

With the patient's consent, LINK was commissioned to manufacture an individual sled prosthesis with cementless anchoring. *customLINK* then fabricated a modified unicondylar knee prosthesis with the following specifications:

Femoral component

- Endo-Model SL/GEMINI Facet cut from titanium (Tilastan)
- TrabecuLink structure
- CaP** coating
- Extended pins with enlarged diameter
- LINK PorEx* coated running surface

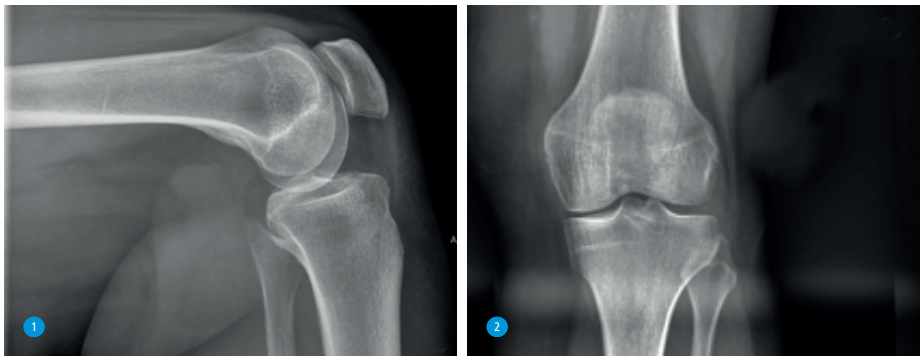
Tibial component

- TrabecuLink structure
- CaP** coating
- Extended and widened spigot
- Tibial plateau with 11 mm total height
- LINK PorEx* coating outside

Both components were manufactured by *customLINK* using 3D printing technology (additive manufacturing). The three-dimensional TrabecuLink structure and the CaP** coating on the underside and the anchoring peg were used for functional bone ingrowth and effective cell attachment.[1,2,3] *customLINK* provided a combination of standard and custom instruments for implantation.

The operation which was carried out in early November 2018, was performed without complication. At a control examination in February 2020, the left knee joint was irritation-free and fully loadable with an extension/flexion of 0-0-120°. The patient is very satisfied with the result of her operation.

* LINK PorEx: TiNbN = titanium niobium nitride; hypoallergenic surface modification (gold colored)
** CaP: calcium phosphate



The preoperative X-rays 1 and 2 show the left-sided gonarthrosis.

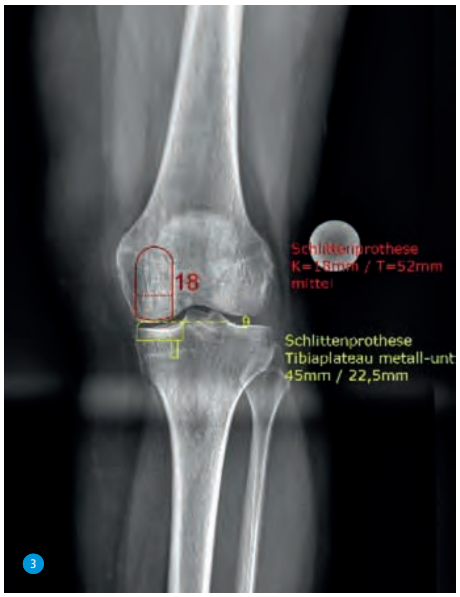
ABOUT

Dr. med. Frank Bischof is head of the Orthopedics and Trauma Surgery Clinic and Medical Director of the Maltese St. Josef Hospital, Krefeld-Uerdingen, Germany. frank.bischof@malteser.org

[1] Cecile M. Bidan, Krishna P. Kommareddy, Monika Rumpler, Philip Kollmannsberger, Yves J.M. Brechet, Peter Fratzl, John W.C. Dunlop et al. How Linear Tension Converts to Curvature: Geometric Control of Bone Tissue Growth; PLoS ONE 7(5): e36336. https://doi.org/10.1371/journal.pone.0036336 (2012)

[2] Pascal Joly, Georg N. Duda, Martin Schöne, Petra B. Welzel, Uwe Freudenberg, Carsten Werner, Ansgar Petersen et al. Geometry-Driven Cell Organization Determines Tissue Growth in Scaffold Pores: Consequences for Fibronectin Organization; PLoS ONE 8(9): e73545. https://doi.org/10.1371/journal.pone.0073545 (2013)

[3] Biomaterial test proves stronger antimicrobial effectiveness (against Staphylococcus aureus) of the titanium alloy compared to pure tantalum: Eurofins BioPharma Product Testing Munich GmbH; Department of Microbiology, Behringstraße 6/8, 82152 Planegg/München, Germany; www.eurofins.com/pharma-services, MicrobiologyMunich@eurofins.com (internal data on file)



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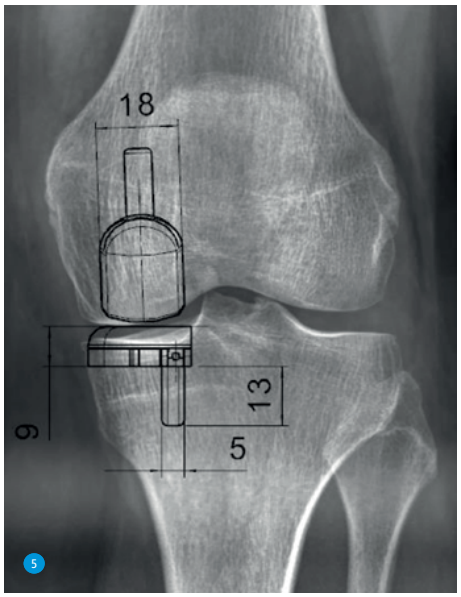

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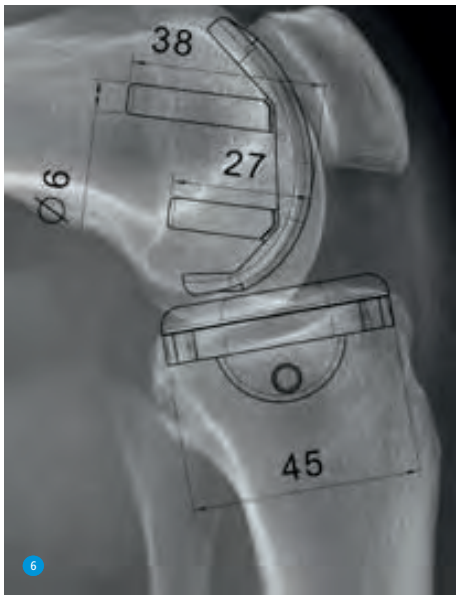

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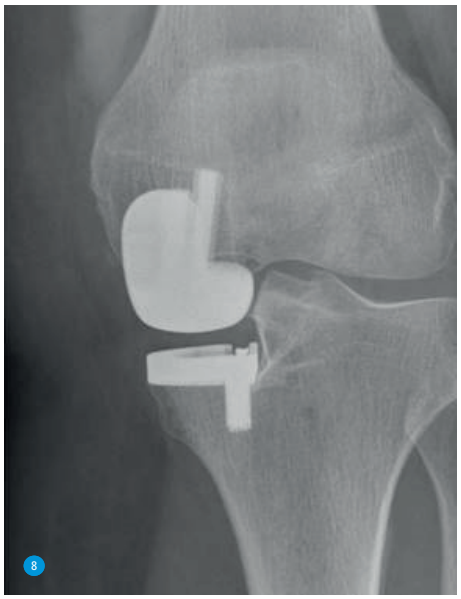
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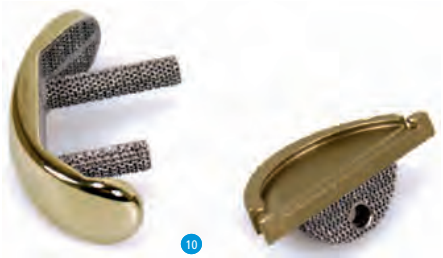
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X-rays 3 to 6 show the preoperative digital planning (3, 4 medical planning; 5, 6 planning **customLINK**). On the postoperative X-rays 7 and 8 the LINK Sled prosthesis with LINK PorEx* and CaP** coating lies virtually in situ. Figures 9 and 10: Custom-made cementless sled prosthesis with LINK PorEx* and CaP** coating from **customLINK**.

The first LINK BiMobile Dual Mobility System implant in Kenya stabilizes a dislocated hip

A 71-year-old patient with a stiffened right hip joint suffered from recurrent luxations after the joint was converted to a total hip replacement (TEP). After the last dislocation, he presented himself at St. Luke's Orthopedic and Trauma Hospital in Eldoret, Kenya.

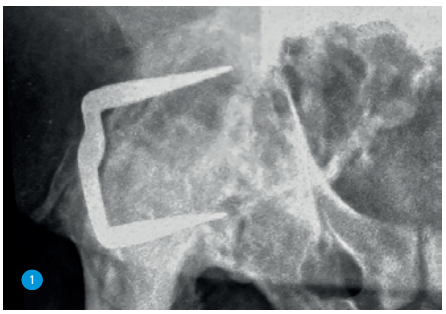
The patient's hip had already stiffened in his childhood for unknown reasons. It was not until the age of 71 that increasing pain in the right hip, right knee joint and lumbar spine led to the surgical conversion of the hip arthrodesis into a hip prosthesis in a local hospital. A cementless total hip prosthesis replaced the hip arthrodesis in August 2019. Postoperatively, a standard prosthesis did not prove successful because the unstable hip repeatedly led to femoral head luxations and the patient's ultimate presentation at St. Luke's Orthopedics and Trauma Hospital.

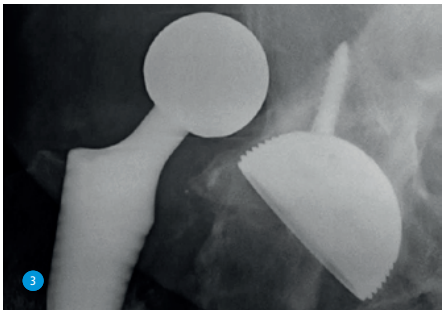
Due to the previous hip luxation, we decided on an ORIF. Intrasurgical, we found that the hip joint was unstable due to excessive former bone resection and a lack of muscle attachment in the proximal femur. Sufficient hip joint stability could not be achieved despite changing to a larger femoral head and an increased neck length, so further hip joint dislocations occurred postoperatively. Therefore, the only remaining option was to use a LINK BiMobile acetabular cup to achieve sufficient stability in the hip joint. In December 2019, we implanted a BiMobile acetabular cup – the first of its kind in Kenya. A stability-enhancing transfer of gluteal muscle was planned initially, but this proved impossible due to atrophy in the musculus gluteus maximus.

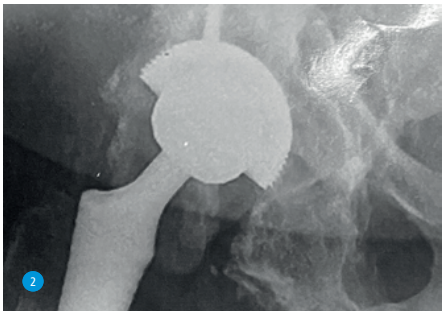
Two months postoperation, the hip remains stable. The patient is mobile with a walking aid and is very happy with the surgery outcome. He continues to receive physiotherapy.

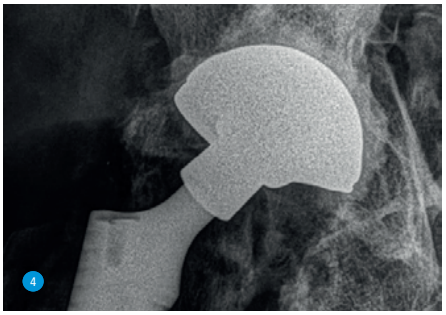
ABOUT

Dr. Kibor Lelei, MD, FRC, is an orthopedic surgeon in Eldoret, Kenya.
kiborlelei@gmail.com









The preoperative X-ray shows the arthrodesis of the hip (1); X-ray after conversion of the arthrodesis to a total hip prosthesis (2); X-ray showing the postoperative luxation (3); postoperative X-ray image with the LINK BiMobile Dual Mobility System Cup in situ (4); LINK BiMobile Dual Mobility System (5).

»The LINK Endo-Model helps me solve very complex cases with an effortless device«

Dr. Partezani Helito, since when have you been using the LINK Endo-Model in Brazil?

LINK began to distribute its products in Brazil around five years ago. We immediately started to use the LINK Endo-Model for the extraordinarily complex cases we see in our hospital. We lacked this kind of product in Brazil at that time.

Why did you choose the LINK Endo-Model for most cases?

First of all, Endo-Model is a popular product worldwide. Second, there is a lot of literature showing that the Endo-Model has excellent survival rates. For me, it is simply a product that you can trust to solve very complex cases like complex deformities and complete ligament loss, as well as treat major infection cases in a one-stage revision.

What are the main advantages of Endo-Model, from your point of view?

I believe the main advantage of the Endo-Model is that the device is easy to manage. It helps me solve complex cases effortlessly.

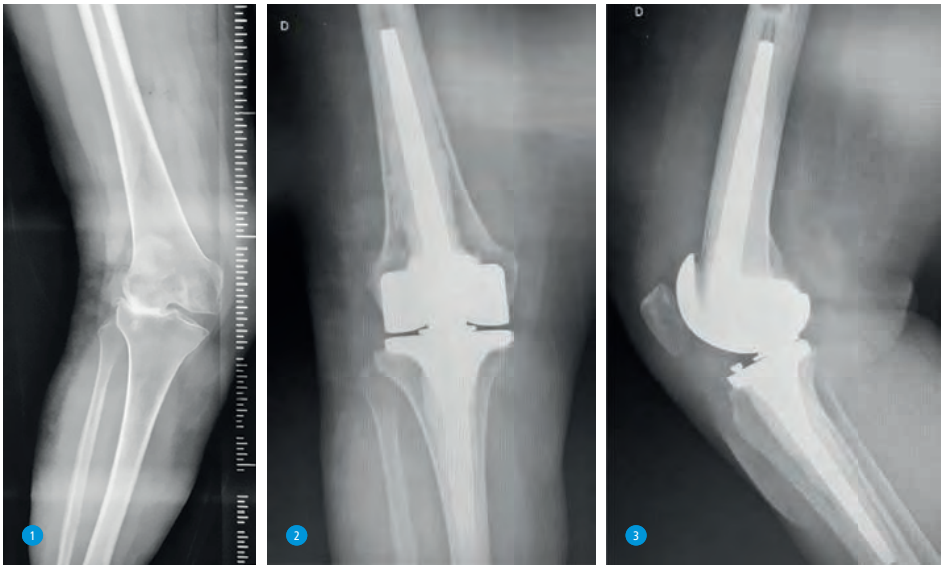
While the LINK Endo-Model is available in Brazil, other LINK products will be registered soon. Which LINK product are you looking forward to most?

In Brazil, we are looking forward to working with the LINK GEMINI SL. Especially in my hospital, which is one of the biggest hospitals in Latin America, we receive all these very complex cases from all over Central America. I plan to continue using the Endo-Model and to incorporate other LINK products in our daily routine as soon as they are available to us.

Dr. Partezani Helito, thank you very much for the interview.

ABOUT

Dr. Camilo Partezani Helito, MD, Ph.D., is an orthopedic surgeon and traumatologist at the University of São Paulo, Brazil.



Progressive deformity of the right knee joint in a 75-year-old female patient (1); LINK Endo-Model rotating hinge prosthesis standard (4), and in situ (2,3).










6TH INTERNATIONAL REVISION SYMPOSIUM

on January 20 and 21, 2020 in Berlin

LINKADEMY









31 nations at the 6th International LINKademy Revision Symposium 2020 in Berlin, Germany

More than 240 orthopedic and trauma surgeons from 31 countries came to Berlin for two days in January 2020 to take part in the 6th International LINKademy Revision Symposium. Among them were large delegations from the USA and Brazil. Chaired by Prof. Dr. Thorsten Gehrke, the participants discussed the current challenges of revision surgery in seven sessions.

This year the symposium focused on acetabular and femoral defects as well as periprosthetic infections. Among other speakers, Prof. Thorsten Gehrke (Helios ENDO-Klinik Hamburg) presented his »Practical approach to acetabular defect classification«. In his lecture, Dr. Lucian C. Warth (Indiana University Health, Fishers, USA) compared modular femoral stems with monoblock stems.

Further sessions dealt with trauma indications in arthroplasty, complex indications for total knee arthroplasty (TKA) and revisions of TKA. In this context, Dr. Camilo Partezani Helito (University of São Paulo, Brazil) reported on his experiences with the LINK Endo-Model rotating hinge knee in TKA revisions. Michael Schmitz (LINK) presented LINK's secret weapon for implant loosening: the new modular Link OptiStem. More information on this topic can also be found on pages 2–5.

They came to the 6th International LINKademy Revision Symposium in Berlin to exchange views with their international colleagues on current developments in revision surgery: Orthopedic surgeons and trauma surgeons from the USA (left) and Brazil (right).

Chairman

Prof. Dr. Thorsten Gehrke
Helios ENDO-Klinik Hamburg, Germany

Speakers

Dr. Lorenzo Andreani
University of Pisa, Italy

Dr. Pablo Corona
Hospital Universitari Vall d'Hebron, Israel

Prof. Davide Maria Donati
Clinic prevalently Oncologic, Rizzoli Orthopedic Institute, Italy

Dr. Alois Franz
St.-Marien-Krankenhaus Siegen, Germany

Prof. Bernardo Innocenti
Université Libre de Bruxelles, Belgium

Helmut D. Link
Owner, Waldemar Link GmbH & Co. KG, Hamburg, Germany

Dr. Saul Leonardo Martinez
Hospital Univers. de Santa Clara, Colombia

Prof. Dr. Georg Matziolis
Waldkliniken Eisenberg, Germany

Dr. Jon E. Minter
Northside Hospital Forsyth, Alpharetta, USA

Dr. Michael Müller
Charité – University Medicine Berlin, Germany

Prof. Dr. Andreas Niemeier
Krankenhaus Reinbek St. Adolf-Stift, Germany

Dr. Camilo Partezani Helito
University of São Paulo, Brazil

Michael Schmitz
Waldemar Link GmbH & Co. KG, Hamburg, Germany

Dr. Javier Perez-Torres
Clinica Universitaria Palermo, Italy

Prof. Goesta Ullmark
Uppsala University, Sweden

Dr. Genaro Fernandez Valencia
Hospital Clínic de Barcelona, Spain

Dr. Lucien C. Warth
Indiana University Health, Fishers, USA

Dr. Claudio Zorzi
Ospedale Sacro Cuore Don Calabria, Italy

»Steel has almost only disadvantages for prostheses«

Helmut D. Link on steel as a material for permanent implants, on the advantages of cobalt-chrome alloys in prostheses and on why steel prostheses are also unsuitable for old patients.

Mr. Link, highly developed countries like the USA and Japan no longer use stainless steel prostheses. They are still used in Germany. Why?

Compared to higher-end materials such as the proven cobalt-chrome and titanium alloys, steel is a very inexpensive raw material. However, it is more suitable for temporary implants such as metal plates, screw systems, Küntscher nails or rush pins. Steel alloys are rather unsuitable for permanent implants.

What are the disadvantages of steel?

Steel is more susceptible to corrosion than cobalt-chrome and titanium. The different types of corrosion even play a major role in modular systems made of higher-end implant materials, as can be seen from publications, particularly in the literature coming out of the UK and USA.[1a,1b] Steel is also less break-resistant – as demonstrated by one manufacturer's warnings about the weight restrictions for its thin prosthetic stems made of steel, but also by comparative tests conducted by our development company DERU.[2a,2b] Last but not least, the cobalt-chromium alloy has only 25 percent of the abrasion of steel.[3]

How does it compare in terms of affinity for bacteria?

Steel has a significantly higher affinity for bacteria, as the literature and our own studies show.[4,5] Incidentally, the disadvantages of steel prostheses were recognized very early on in the USA: The first hip prostheses by Moore and Thompson in the 1940s and 1950s were already made of a cobalt-chromium alloy.

What are the consequences of choosing very inexpensive products and thus saving money at the wrong end?

If we consider the above points, corrosion can occur in permanent implants made of steel, especially in the cone areas. It is also conceivable that there would be increased implant fractures in obese patients with small medullary cavity diameters and possibly higher bacterial loads. In order to reliably prevent higher abrasion, steel prostheses would also have to be combined with ceramic heads. However, this would

partially wipe out the advantages of the less expensive steel stems.

Could steel prostheses be used exclusively for very old patients and thus save costs?

No. Who knows whether an 82-year-old patient might have a 15-year life expectancy after all? If this patient then had problems with the artificial joint, they would have to undergo a second surgery, which is risky due to age. All patients should receive high-quality implants right from the start, no matter how old they are or what their economic situation is.

Have there ever been steel prostheses in the LINK program?

We have only used steel if its special properties, such as its high ductility, made this seem appropriate at the time. For example, in the early years of arthroplasty, pelvic replacement prostheses were made of special stainless steels, because they were easy to put into complicated forms and the flaps could be reshaped intrasurgical. Today, we manufacture pelvic replacement prostheses from a titanium alloy according to CT data, using 3D technology for an exact fit.

What material are the cemented versions of the LINK LCU hip prosthesis system made of?

Of course they are made of LINK EndoDur-S, the cobalt-chrome forge alloy from LINK. We arranged a test where we extracted tension rods from the steel prosthesis stems of a competitor system and our comparable cobalt-chrome stems and commissioned an independent laboratory to analyze the mechanical values. The result was an approximately 25 percent higher tensile strength for the LINK EndoDur-S prosthesis stems,[2c] which offers much more safety, especially with thin prostheses.

What do you think of some competitors offering cementless titanium stems and cementable steel stems for modern hip prosthesis systems?

It seems incomprehensible to me that the cemented versions of these modern cementless hip prosthesis systems, which are supposed to allow an intrasurgical change to cemented hip prosthesis systems because they have the same dimensions, are offered in steel. Particularly when faced with poorer bone quality, which forces the surgeon to switch to a cement-retained anchorage, the restoration must be as durable as possible.

Mr. Link, thank you very much for the interview.

The cobalt-chrome sample (CoCrMo, Figure 1) has a higher tensile strength than the stainless steel sample (M30NW, Figure 2). The average tensile strength is 1,087 +/- 25.67 MPa for the stainless steel sample and 1,357.08 +/- 44.59 MPa for the cobalt chrome sample. The necking at fracture of the stainless steel specimen indicates a ductile fracture, while the cobalt-chromium specimen tends to show a low-deformation fracture, indicating brittle material behavior.

[1a] Oulette, E.S. et al.: Design, material and seating load effects on in vitro fretting corrosion performance of modular head-neck-taper. J. of Arthroplasty (2019), pp. 991–1002

[1b] Rodriguez-Diaz, R.A.: Electrochemical Corrosion Behaviour of a Co20CrAlloy in Artificial Saliva. Int. J. Elektrochem. Sci.(2015)7212–7226

[2a] Dringende Sicherheitsinformation: Monolithische zementfreie und zementierte Schäfte – Nutzungseinschränkungen. Lima Corporate, 06/2019

[2b] Deru GmbH: Durchführung von statischen Zugversuchen an CoCrMo- und M30NW-Gewindekopfproben in Anlehnung an die DIN EN ISO 6892-1. Innoproof Rostock

[3] Yu Yan: Bio-tribocorrosion in biomedical and medical implants. Woodhead Publishing, 2013, p. 319

[4] DERU GmbH: Eurofins test report. Test 155874 A acc. ISO 22196 (2011), November 2015

[5] D.M. Brunette et al.: Titanium in Medicine. Springer Verlag, pp. 820–823

LINK passes on three million face masks to customers at cost price

In February, LINK passed on three million face masks from China to customers. »When we learned that our Chinese sales partner Naton also produces surgical masks, we immediately took action and decided to offer them to our customers at cost price« says LINK Managing Director Norbert Ostwald. »During the Covid-19 crisis, we were in constant contact with Naton to see if we could get hold of further masks.«

LINK customers such as the Märkisch-Oderland hospital in Strausberg, Germany, were pleased with the campaign. »We can use every mask«, said Managing Director Dipl.-Ing. Angela Krug. »The quality of the masks is impeccable, which helps our patients and us equally«, said Priv.-Doz. Dr. med. Hagen Hommel, head of the clinic for orthopedics and traumatology.

Three million face masks during loading at dawn in Beijing, China (top right); unloading from the Air China Boeing 787-9 in Frankfurt chartered by LINK (bottom left); the masks on the airfield of Frankfurt Airport in Germany (bottom right); handing over a total of 50,000 masks to the Märkisch Oderland hospital: LINK Sales Manager North-East, Thilo Brauer, Managing Director Dipl.-Ing. Angela Krug and Priv.-Doz. Dr. med. Hagen Hommel (top left).

Imprint

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Over 50 years of custom-made implants:
LINK continues to invest in additive manufacturing

LINK continues to invest in additive manufacturing (3D printing technology) – including new, high-performance machines for the production of highly complex geometries and surfaces.

The special feature of additive manufacturing at LINK, in addition to the experience of more than 50 years of planning, development and production of custom-made implants, is the short delivery time due to the large share of in-house production. In most cases, LINK delivers the ordered implants just four weeks after digital processing of the design data by *customLINK* and the surgeon's approval. The standard market lead time is six to nine weeks.

Another unique selling point is the patented TrabecuLink cell, which quickly binds proteins after implantation compared to the free diamond cell of competing products*. Further information on custom-made products can be found at www.customlink.solutions. For more information on LINK additive manufacturing, scan the QR code below.

* Joly P., Duda G.N., Schöne M., Welzel P.B., Freudenberg U., et al. (2013): Geometry-Driven Cell Organization Determines Tissue Growths in Scaffold Pores: Consequences for Fibronectin Organization. PLoS ONE 8(9): e73545. doi:10.1371/journal.pone.0073545

LINK has several of these innovative systems for additive manufacturing (1). At the end of the production process, the powdery »cake« is removed from the machine (2). The freshly manufactured implants are exposed in a special blasting cabin (3). Top: Compilation of LINK products made by additive manufacturing.

LINK®

Excellently adapted …

… the FLEXICONES

TrabecuLink Femoral and Tibial Cones

- Spring effect by elastic bending axes and compensator
- Compatible with the entire LINK Endo-Model knee family
- Broad range of sizes and design variants