

directLINK®

Edition 01/2020

Magazine for Arthroplasty

»THE PATIENT'S
RECOVERY IS
FASTER AND MORE
COMFORTABLE.«

Dr. Mikko Manninen on the use of
a custom-made LINK Endo-Model in
patients with severe knee deformities

Endo-Model from customLINK

Implantation of an anatomically adapted stem in severe native deformity of the proximal tibia – a case study

Acetabular Treatment Options

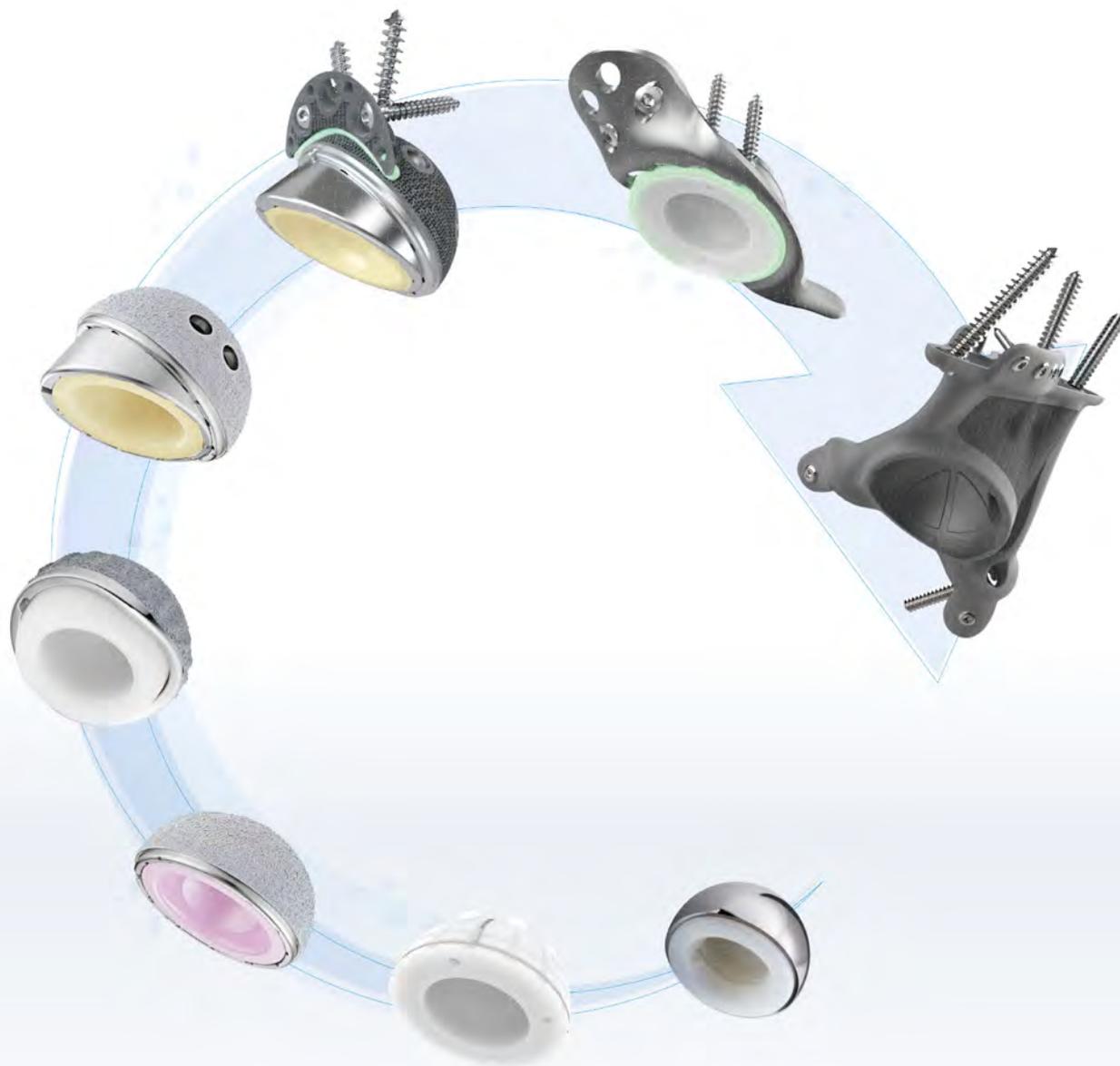
The comprehensive LINK product range for innovative surgical management of hip arthrosis at a glance

NEW: LINK OptiStem

Modular stem for precise metaphyseal anchoring; currently available cemented and cementless as custom-made product



Solutions by Indication.



Acetabular Treatment Options

LINK is known worldwide for best quality and innovative product developments. For many years we have been setting new standards in primary and revision arthroplasty of large and small joints. With our extensive range of implants, we offer the optimum solution for each individual case and every requirement – high-quality, innovative and bioharmonic. The options for acetabular treatment extend from the LINK Vario head to personalized, additive-manufactured joint replacements. Read more on pages 13-15.



Dear Readers,

When a journalist once asked a doctor what he would look out for when recruiting new senior staff, the American orthopedist is said to have replied: »They must be able to do at least one thing better than me.«

Learning from others, creating something new together or improving something that already exists – that's what LINK does. Our cooperation with internationally renowned orthopedists generates new and optimized standard products but also custom-made products from our *customLINK* department. In this edition you will find various examples of how combined efforts can be used to plan and manufacture individual implants that help patients achieve new levels of mobility and quality of life.

For example, read the interview with Dr. Mikko Manninen from Finland, starting on page 2, about the implantation of individually adapted LINK knee joint prostheses in patients with extreme malpositions; you will also find a case study on this subject starting on page 5.

Since the 1970s, almost 40,000 documented custom-made prostheses have been manufactured by LINK.

I hope you enjoy reading this edition of **directLINK**.

Regards,

A handwritten signature in blue ink, appearing to read 'H. D. Link'. The signature is stylized and written in a cursive-like font.

Helmut D. Link



**»The patient's recovery is faster
and more comfortable with a
custom-made LINK Endo-Model.«**

Finnish orthopedic surgeon Dr. Mikko Manninen on the
use of custom-made LINK Endo-Models for severe deformities
of the knee joint

Dr. Manninen, you are conducting a follow-up study on patients with lower extremity bone deformation related osteoarthritis who have been implanted with a custom-made LINK Endo-Model by you and your colleagues. What is the aim of your research?

With this study, we want to discover whether our assumption is correct and whether a custom-made LINK Endo-Model is a valid and sustainable treatment for patients with very severe lower extremity bone deformation related osteoarthritis. We also want to understand the limits of this treatment option and for which patients it presents the best available option.

How many patients are participating?

We currently have 12 patients to follow up on, which together adds up to 14 surgeries. The follow-up period is between 2 and 16 years. We aim to be ready for publishing in early 2020.

What are their diagnoses?

There are various diagnoses. One patient has severe juvenile rheumatoid osteoarthritis and, after several surgeries, extremely curved bones of the lower extremities. Another patient has osteogenesis imperfecta. And there is one patient with two operated knees due to hypophosphatemia. Also, we have patients with post-traumatic conditions and osteochondrodysplasia. We selected all patients individually for our study, without a given age structure; currently, the participants are between 48 and 70 years old.

Why did you choose a custom-made LINK Endo-Model?

I have been using LINK products for many years. Therefore, I was aware that LINK offers custom-made implants for individual patients. We have been using LINK's *RescueSleeve* since the early 2000s for complicated total femur surgeries at the Helsinki University Hospital and it

has proven very successful. At Orton Orthopedic Hospital, when we began to see an increasing number of patients with extremely curved bones and severe joint deformities of the lower extremities, we defined three treatment options for these particular patients.

What are these options?

Treatment option number one is the implantation of a standard total knee prosthesis with maximum correction of the mechanical limb axis. The second option is an osteotomy of the deformed bones in conjunction with the implantation of a standard total knee prosthesis. The third option is the implantation of a custom-made total knee prosthesis, which corrects the axis and the osteoarthritis. Over time, we have implemented all three options for corresponding patients and now need to decide for which patient a custom-made total knee prosthesis, such as the LINK Endo-Model, is the best choice, or when a standard total knee prosthesis with or without osteotomy would be a better treatment.

How did you come up with the idea of using the custom-made Endo-Model for these cases?

After excellent results using the *RescueSleeve*. We implanted the first *RescueSleeve* in a patient with rheumatoid arthritis who had a knee and a hip prosthesis, each with a long stem and severe fractures of the highly osteoporotic bone in between. She had already undergone three surgeries to attempt to establish a stable bone connection between the two long stems. However, there was no vital quality bone left. Fully opening the leg and implanting a total femur was not an option for such a fragile patient. We, therefore, asked LINK for a custom-made *RescueSleeve*. This worked well because the patient was able to walk again after the surgery. After the successful *RescueSleeve* operations, we started to plan

INTERVIEW

Dr. Mikko Manninen is an orthopedic surgeon specializing in joint replacement surgery. Dr. Manninen is chief orthopedic physician and Head of the Orthopedic Department at the Orton Hospital in Helsinki, Finland. He is also Chairman of the Finnish Arthroplasty Association.

INTERVIEW

curved stems for a hinge knee prosthesis for one revision knee arthroplasty patient with rheumatoid arthritis and quite curved femora, instead of doing osteotomies and revision surgery.

What are the advantages of a custom-made LINK Endo-Model?

The main advantage of the custom-made LINK Endo-Model is the simplicity of the implantation, providing the procedure has been carefully planned. The operating time is also shorter compared to the first two treatment options and also, the patient's recovery is much easier and faster – which is a crucial aspect. In a patient with juvenile rheumatoid arthritis and extremely curved femur and tibia on the right, both tibia and femur were osteotomized and a TC III type constrained knee implant with long stems was used. The recovery took about six months. Later, her left leg, which was also extremely curved, was operated on using a custom-made LINK Endo-Model. A few months later, she told us that this customized knee surgery was »ten times easier to recover from.« One reason for this is that the osteotomies are very painful and take a long time to heal.

What parameters do you focus on in the study?

We are interested in the longevity of the custom-made hinged knee implants of the patients in our study, i.e., how long the fixation is firm, and how often custom-made parts of the implant need be changed. These are essential questions we want to answer with this study. Firstly, we analyze the X-rays and, above all, the fixation. Then we evaluate the Oxford Knee Score, Knee Society Score, and the Functional Score, which gives us an overall picture.

Are there already initial study results?

In patients with an extensive deformity in or near the knee joint, for example, a

valgus deformity of 15 to 20 degrees, the correction of the leg axis can be performed with standard implants. Correction of the deformed bone to straighten the axis and arthroplasty is a good option for young patients, even if recovery is more difficult. Custom-made implants might be best when there is severe mechanical imbalance and osteoarthritis concurrently. In most cases where we have implanted a custom-made LINK Endo-Model, the mechanical leg axis is corrected by approximately seven degrees. Patients in particular are highly satisfied with these implants.

How important is the mechanical axis of the extremity?

Very important. I think we must concentrate more on mechanical axis correction in the future and correct as much as possible with an individualized implant. This is what makes patients happy. They recover faster and feel better and more mobile after the surgery. In many cases, a custom-made implant makes otherwise challenging surgery easier because the correction is already built into the implant.

For which other indications do you implant the LINK Endo-Model?

If I need to implant a hinged prosthesis, for example for an unstable primary or revision knee, I prefer the LINK Endo-Model. Not many boxes of instruments are required, and the implantation is simple if you're accustomed to the procedure. Another essential point is that new parts are always available from LINK. For example, if the hinge is a little worn out, the mechanics can be changed instead of the whole prosthesis. Even after many decades, the parts are still available, which is important.

Dr. Manninen, thank you very much for the interview.

ABOUT ORTON LTD.

Orton Ltd. is a Finnish healthcare organization specializing in musculoskeletal disorders, pain management, and therapeutic services. The first total hip joint replacement in Finland was performed in 1967 at the hospital, which then was known as Invalidisäätiön sairaala (Hospital of the Foundation for the Injured and Handicapped).

The Foundation was established in 1940 for the treatment, rehabilitation and vocational training of veterans injured in Finland's Winter War. The Foundation led the development of comprehensive rehabilitation and spearheaded scientific research and vocational rehabilitation. Hospital Orton has developed new treatment practices in Finland for patients countrywide.

Endo-Model EVO-M with customLINK offset stem implanted

At the Helios ENDO-Klinik Hamburg, a modular knee joint prosthesis (LINK Endo-Model EVO-M) with an offset tibial stem was implanted for the first time. »Our patient, who is a senior citizen, has had a severe malpositioning and malrotation of the tibia and femur in the left knee joint since childhood,« explains Dr. Alaa Aljawabra, senior physician in the Department of Joint Surgery at the Helios ENDO Clinic, specializing in knee and hip arthroplasty. The knee joint of the patient is almost rigid, and the patella runs very far laterally in the joint guidance.

A coupled knee prosthesis with individual offset stem was the best solution.

One option would be an osteotomy, but that entails risks such as later pseudarthrosis. The larger wound area and more elaborate soft tissue management also

mean significantly greater risk of infection. »A coupled hinged knee prosthesis with customized offset stem, as was developed by *customLINK* to suit the anatomy of the patient, was therefore the best solution for this patient,« says Dr Aljawabra.

The LINK Endo-Model EVO-M is the latest version of the Endo-Model Knee Prosthesis System, which includes all further developments.

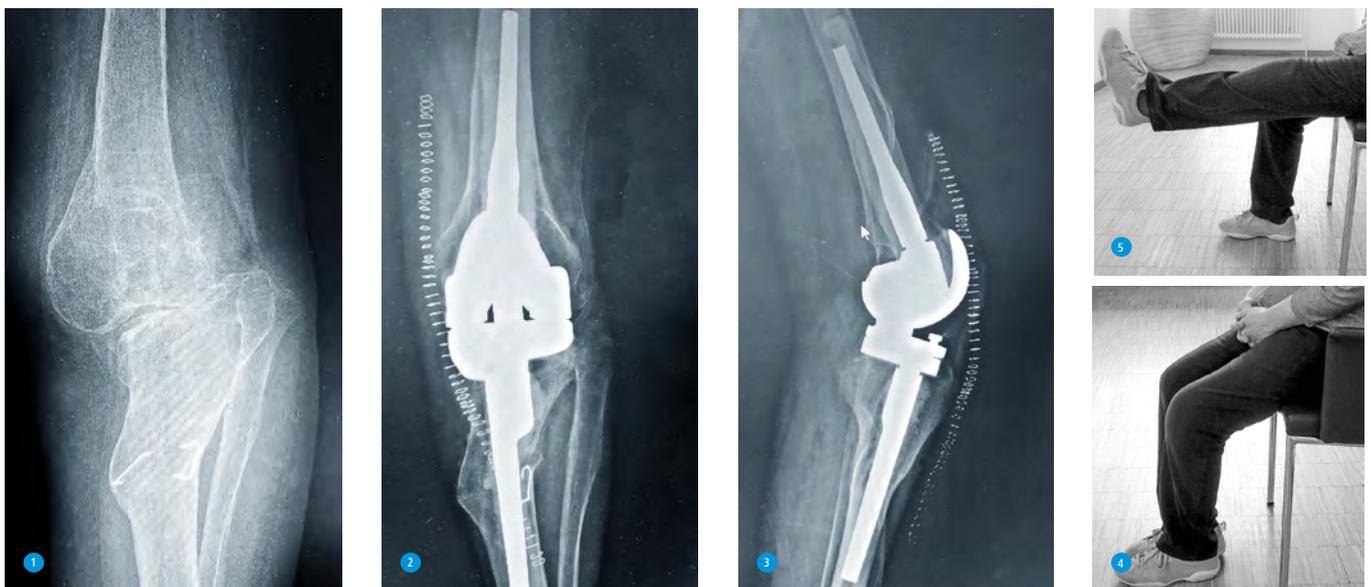
Three months postop, the patient is able to walk without crutches.

The surgery in July 2019 at the Helios ENDO Clinic went without any complications. Three months after the surgery, the patient is doing very well overall. »The recent check-up showed a complete extension and flexion of almost 90 degrees in the operated knee joint, the pa-

tient is able to walk without crutches and is pain-free,« says Dr. Aljawabra.

»The good outcome is also due in large part to the continuous exchange between surgeons at Helios ENDO-Klinik and LINK in the development of customized and new implants, which has existed for decades,« says Dr. Alaa Aljawabra. »The patient is very satisfied with the outcome of the procedure.«

Contact: **Dr. Alaa Aljawabra**
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The preoperative AP X-ray (1) shows the pronounced malpositioning of the left knee joint; the postoperative X-rays (2: AP; 3: lateral) show the Endo-Model EVO-M with offset stem from customLINK in situ; three months postoperatively the patient can fully stretch her operated leg and bend it by almost 90 degrees (5).

Custom-made LINK Endo-Model with anatomically curved stem for a patient with severe native deformity of proximal tibia

A 35-year-old male patient with a weight of 80kg and a height of 160cm presented at the Orthopedic Hospital Orton with a native deformity of the AP curvature of his proximal tibia, a subsequently extended extensor apparatus and a loosened tibial component of the prosthesis in situ – the latter being the reason for the revision.

Due to the severe mechanical imbalance and osteoarthritis, we decided together with the patient to ask LINK to provide a customized LINK Endo-Model with a curved tibial stem and lateralized femoral stem. We aimed to optimize the correction of the valgus angle, and thus enable the patient to walk without pain.

During follow-up examinations, the patient had a significantly improved gait pattern. The patient now walks pain-free.

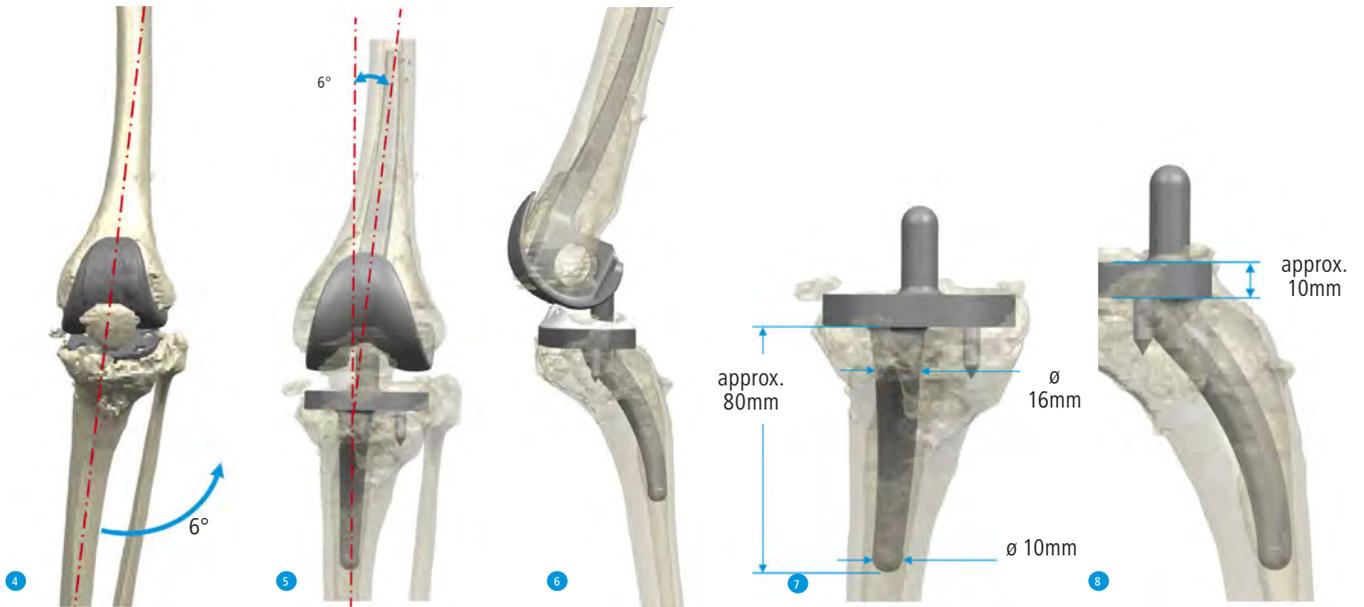
After thorough 3D planning, LINK supplied a customized LINK Endo-Model, medium component size, with anatomically curved stems. The positioning of the implant was based on the implant in situ.

The tailor-made Endo-Model was implanted on June 10th. During follow-up examinations, the patient showed no complications and a significantly improved gait pattern without pain.

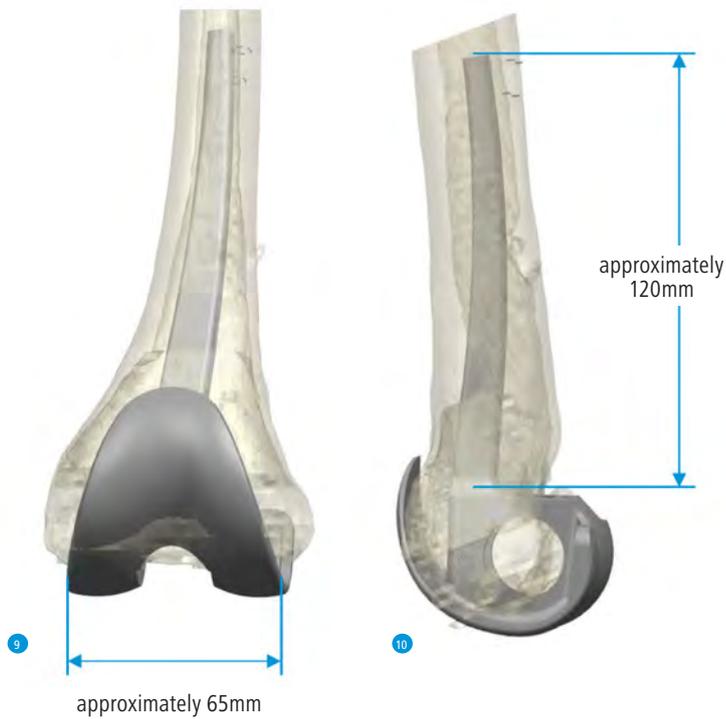


Preoperative CT-based planning: front view (1), side view (2); the preoperative X-ray (3) shows the prosthesis with the loosened tibial component in situ. A further advantage of the custom-made Endo-Model is that it can be produced on the basis of X-rays; a CT is not required.

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Implant design draft aiming to correct valgus angle (top, front view [4, 5], side view [6]). Femoral component (bottom, front view [9]; side view [10]). Note: The pin seen on the lateral side of the tibia was not implanted. Implant design draft, tibial component, curved, medium size, 6mm medial, front view (7), side view (8).



Postoperative X-rays show the custom-made LINK Endo-Model in situ; front view (11), side view (12).

Proximal tibia replacement with LINK Endo-Model SL for a traumatic tibial head impression fracture and unstable valgus defect gonarthrosis

An 81-year-old female patient who fell down a staircase suffered a multiple fragment tibial head fracture with destruction of the lateral tibial plateau on the left. After closed reduction and the application of an external joint-bridging fixator for one week, the lateral tibial plateau was openly reduced, lined with 1/2 femoral head and 2.5cc bone substitute material, and fixed using plate osteosynthesis. The X-rays showed the correct position of the implants with proper reduction of the main fragments. When the tibial head fracture was consolidated, the metal was removed in September 2018.

Later on, however, a post-traumatic, laterally accentuated gonarthrosis occurred with extensive defects of the lateral tibial head. An arthroplasty procedure was agreed with the patient due to movement restriction, which did not respond to therapy, and persistent pain symptoms.

The LINK Endo-Model SL formed the basis of the custom-made prosthesis

Because of the extensive bone defects in the lateral tibial head, LINK was asked to fabricate an individual implant for the patient. The basis of the tibial head replacement was the LINK Endo-Model SL Knee Prosthesis, in which the ventral contour of the tibial component was machined away so that the patient's tibial tuberosity could be preserved in order to protect the extensor apparatus. In the meantime, the left knee joint was completely unstable; the patient therefore initially received an orthosis.

The custom implant from customLINK was available after three weeks.

Based on the patient's CT data, *customLINK* produced the requested product within three weeks; the implantation took place in December 2018. Since LINK supplied a saw guide

exclusively made for the special design, it was much easier to cut the tibia precisely to size, and maintaining the tibial tuberosity did not pose any problem. The postoperative period at the clinic was uneventful.

The patient is almost pain-free and walks short distances without a walking aid.

During a check-up two weeks after surgery, the patient was almost pain-free and able to walk shorter distances without walking aids. Extension in the knee joint is complete, active and strong; flexion is possible up to 120 degrees and the patella is correctly adjusted in the femoropatellar groove.



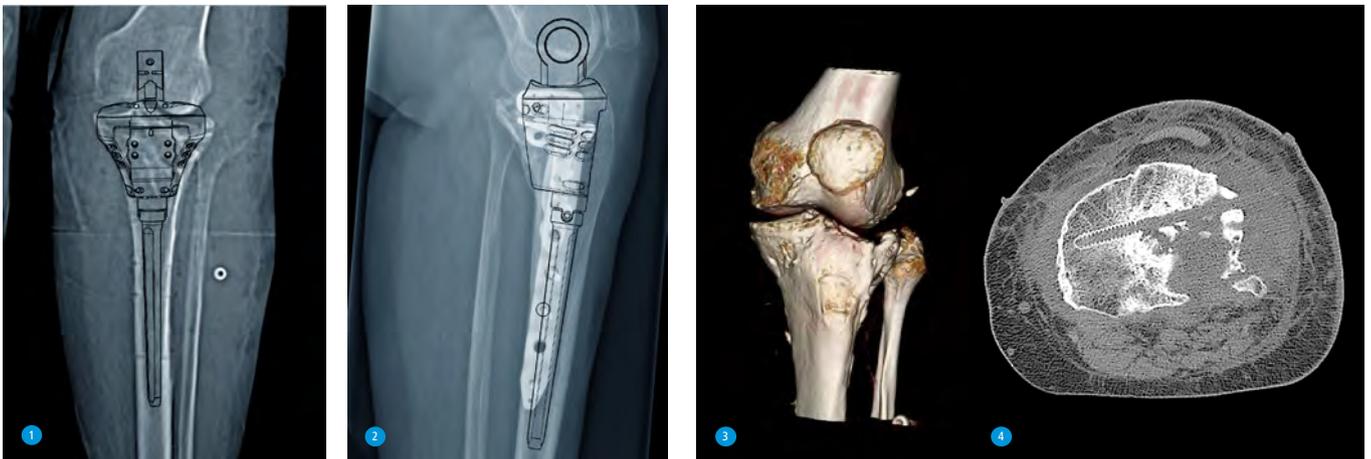
Contact: **Dr. Thomas Meißer**
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thomas.meissen@af-k.de



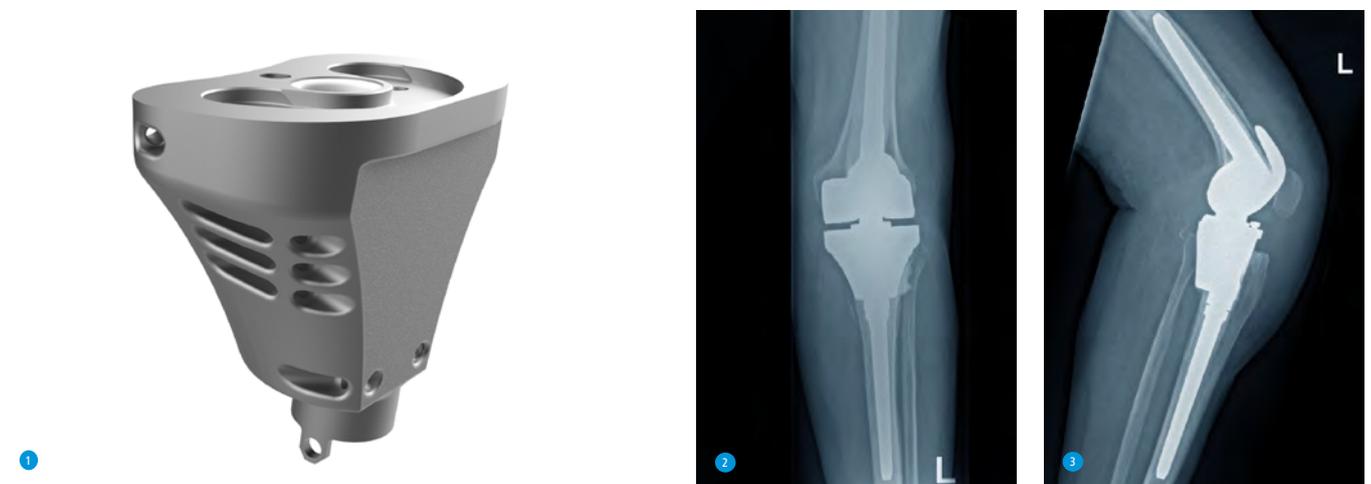
The directLINK special edition on the use of LINK megaprotheses in trauma surgery is available free of charge from www.linkorthopaedics.com.



X-rays taken in September 2018: 15 months after open reduction of the lateral tibial plateau and relining with 1/2 femoral head and 2.5cc bone graft substitute as well as fixation with bilaterally angle-stable plate osteosynthesis (June 2017), the bony consolidation of the fracture (1, 2 AP; 3, 4 lateral views) is evident.



X-ray planning of the LINK Endo-Model SL with modified proximal tibial replacement and cemented modular stem from customLINK (1, 2); preoperative CT images (3, 4) show the bony consolidation of the lateral tibial head impression fracture with the sunken lateral tibial head plateau.



Modified tibial partial replacement with machined surface to preserve tibial tuberosity (1); postoperative X-rays (February 2019) show the correct position of the LINK Endo-Model SL with the proximal tibial partial replacement (2, 3) from customLINK.

Revision of a rotationally unstable tibial component with individual TrabecuLink tibial hybrid cone in an epi-metaphyseal defect

After the primary implantation of a knee joint prosthesis in 2003, an inlay change in 2004 and a revision of the knee prosthesis in 2011, due to implant loosening, to a LINK Endo-Model rotational knee prosthesis with tibial LinkSpacer, the patient presented in 2017 due to persistent discomfort. The X-ray examination revealed a renewed loosening of the tibial, while the diagnostic arthrocentesis revealed nothing abnormal. Since the primary care clinic refused another revision due to the complexity of the procedure, the patient was referred to the Orthopedic Clinic of the Hanover Medical School in the DIAKOVERE Annastift.

While X-ray diagnostics showed tibial implant loosening and a patella baja, the femoral part of the prosthesis was firmly anchored radiologically and scintigraphically; a knee arthrocentesis again showed no microbial evidence. Clinically, a non-irritant healed scar without any sign of infection was found with a pronounced intraarticular effusion, which was seen in an X-ray image with predominantly dorsal synovial thickening. The extension/flexion was 0–5–95°.

Because the quality of life of the patient, who was 180cm tall and 96kg in weight, was severely impaired, and because of the loosening of the implant, a revision was indicated. The firmly anchored femoral part of the implant was to be retained and the rotationally unstable tibial component changed.

Massive uncovered epiphyseal defect makes the use of a standard implant unrealistic.

The strategy for the revision was to create a rotationally stable metadiaphyseal anchorage for the prosthesis with reconstruction of the epiphysis. However, due to the massive uncovered epiphyseal defect, this could not be achieved with the standard implant. CustomLINK therefore fabricated

a customized press-fit tibia hybrid cone that could be anchored in the metaphysis largely without cement, and into which the prosthesis stem was cemented. Due to the patella baja, and in order to reduce the patella impingement, the joint line was shifted tibially by 5mm to caudal.

Tibia hybrid cone with »barrier« to seal off the cement.

The tibial hybrid cone, which is partly cementless with the TrabecuLink structure in the bone and partly smooth on the outside in the area of the missing cortex of the tibial head, has an internal »barrier«, like the standard cones to seal off the cement with which the prosthesis stem was cemented. A channel in the smooth cone area allows an optional cerclage for additional stabilization. The caudal cutout on the cone allows the stem to be passed through.

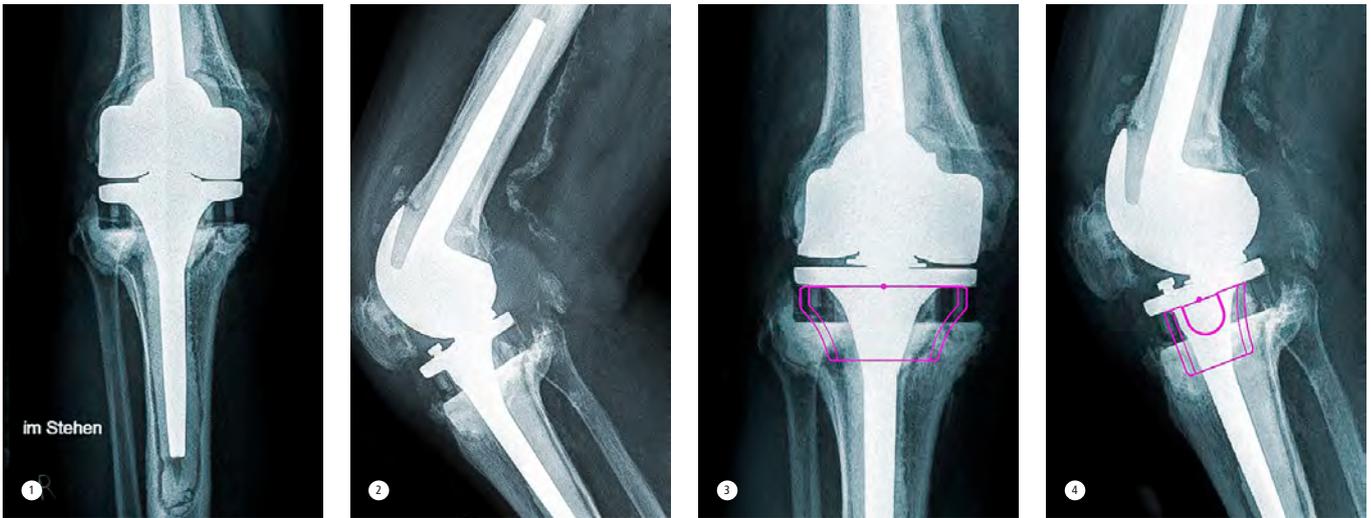
The preoperative planning was implemented intraoperatively without any restrictions. The good primary stability of the tibial hybrid cone made it possible to dispense with an additional extension of the prosthesis socket.

No postoperative complications; very good pain reduction.

Initially there were no postoperative complications. The patient was mobilized early and achieved a flexion of 90° after only a few days. The postoperative X-ray findings were normal. A hematoma infection after three weeks with the detection of Staphylococcus aureus led to dry and irritation-free wound conditions after a single wound revision with inlay change and antibiotics. Afterwards, a complication-free progress without indication of infection persistence was observed.

The patient currently describes a very good pain reduction compared to the preoperative situation without the use of analgesics.

Contact: **PD Dr. Tilman Calliess**
tilman@calliess.ch



Preoperative X-rays show a revision knee prosthesis with a correct fit and clear signs of loosening in the tibia and the retropatellar replacement (1, 2); planning approach with a standard tibial cone, which proved to be too small in the largest available version (3, 4).



CT-based planning from tibial cone of customLINK with TrabecuLink surface (blue zones) for cementless anchorage (1); tibial cone from customLINK with TrabecuLink coating (2), rear, lateral and front view; customized shape-matching additive printed compressor (3, 4).



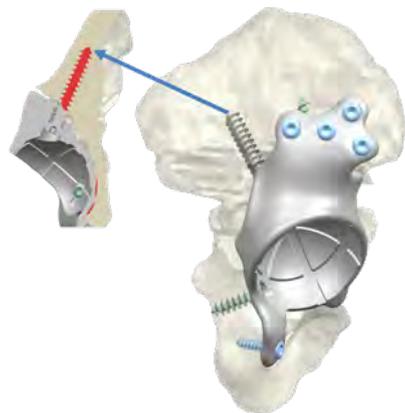
X-rays AP and lateral six weeks postoperatively: correct position of the revision prosthesis with physiological patella articulation; good press-fit of the metaphyseal tibial component; prophylactically applied securing cerclage (1, 2).

»We are seeing a rapid evolution of custom implants for complex problems!«



INTERVIEW

Dr. Jon Minter, DO, is an orthopedic specialist in Georgia, USA, specializing in the innovative surgical management of hip and knee osteoarthritis and failed joint-replacement surgery. Dr. Minter works at various hospitals in the United States, including Northside Hospital Forsyth in Atlanta, Georgia.



Pelvic Replacement from customLINK

Dr. Minter, since when have you been using LINK implants?

I have used LINK products intermittently over the years but within the last 3.5 years I have come to rely on LINK for these more significant pathological hip and knee conditions.

In which cases do you use customized LINK implants for the high-end revision of extensive areas of bone loss?

Custom implants are used for significant peri-acetabular bone loss. Standard off-the-shelf implants simply will not address the problems encountered in my practice.

What are the benefits for patients and surgeons of the customized implants?

A custom implant allows me to place the components in an optimal position and to be able to secure the implant in stable bone. Years ago, the early design of these customs required a significant amount of allograft bone. These improved custom designs offer better fixation and fill large volume defects to allow for more porous coating to be applied to the cancellous bone surfaces.

Will the use of patient-specific implants to treat complex hip conditions be standard in the future? Until now, bone substance had to be refilled in most cases.

I think we are seeing a rapid evolution of custom implants for complex problems. Regulatory agencies will have to develop standards for their use as this becomes more commonplace. Certainly for now, the custom implant's advantages are clear. Unfortunately, bone grafting, as good as it is, both homologous and allograft, provides inconsistent results.

How advantageous is a trabecular structure compared to a porous implant surface?

These differing surfaces have varying degrees of ingrowth, but the trabecular structure allows for improved high-quality ingrowth versus simple ongrowth.

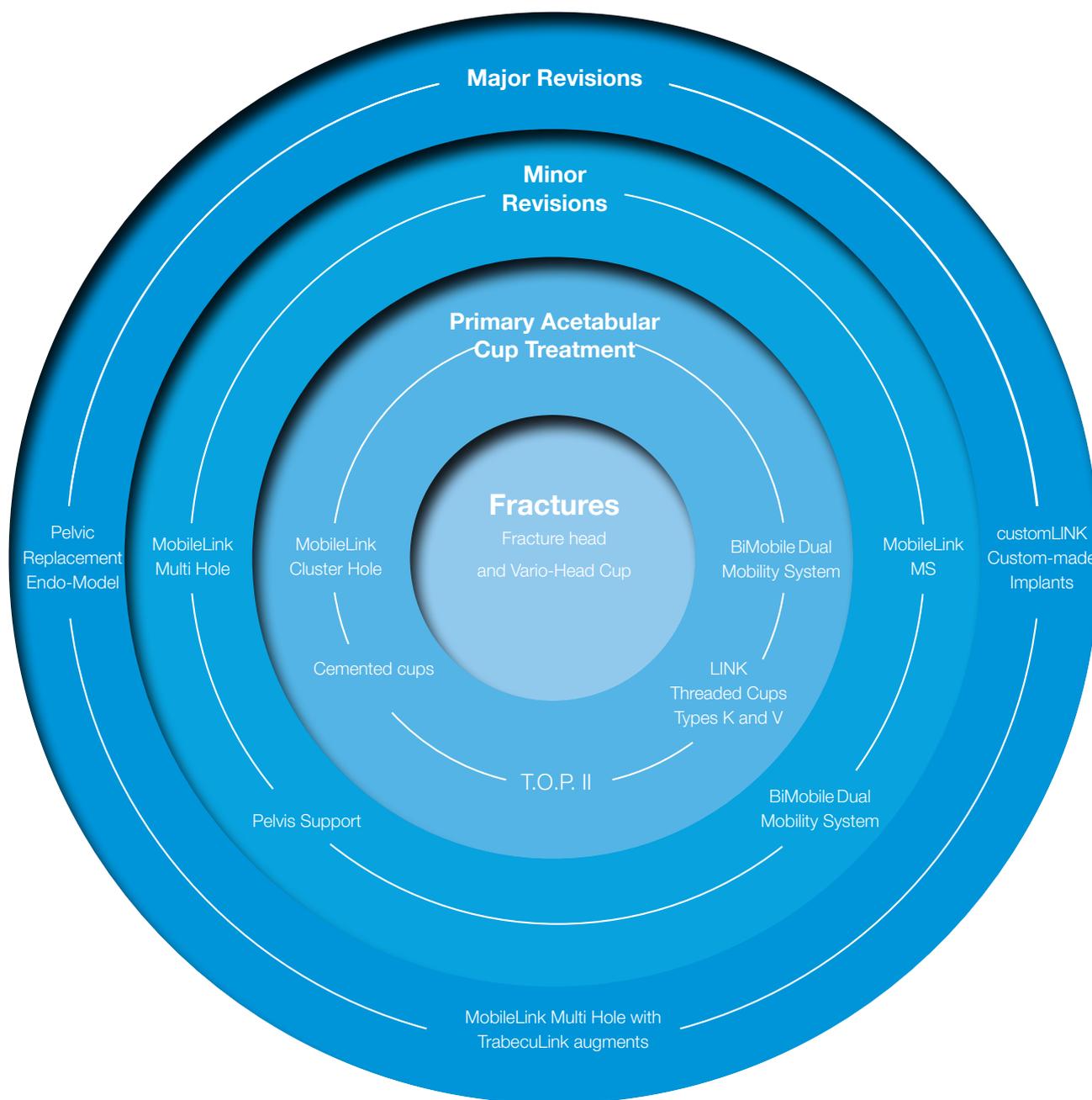
When treating a bone substance defect, where do you draw the line between using a standard implant or a customized implant?

Preliminary CT scanning allows for a more advanced evaluation of a defect. The LINK custom team reviews these and the interaction starts with the surgeon at this point. Subsequently, I can move forward with the knowledge that it has been thoroughly examined and the decision for a standard implant or a custom implant is based on this interaction and examination of the CT protocol images. My task as a surgeon is to provide the best result that I can. I have full confidence in the LINK custom devices that I have implanted so far, and my expectation is that I will continue to provide the best solution that I encounter week-in and week-out in my revision practice with LINK's help.

Dr. Minter, thank you for the interview.

Acetabular Treatment Options: The comprehensive product range from LINK

LINK has been a pioneer in arthroplasty for over 50 years. Our aim is to manufacture prostheses using the latest technologies and to offer quality »made in Germany« across all production stages. As a full-range supplier, we also have the options for acetabular treatment for every requirement in our product range – please also read the following pages.



Acetabular Treatment Options – the comprehensive Product Range from LINK

<p>MobileLINK Acetabular Cup System</p>	<p>TRUSTED QUALITY, PROVEN TECHNOLOGIES TiCaP double coating^{1,3} or TrabecuLink surface, triple secured inserts, secure face changer fixation^{2,4}</p>	<p>CUSTOMIZED SYSTEM, TAILORED TO YOUR NEEDS Prosthesis head 36mm, cup already from 50mm, color coding, high flexibility, low stock keeping</p>
<p>BiMobile Dual Mobility System Cemented/cementless</p>	<p>ANATOMICAL DESIGN Designed to minimize the risk of luxation⁵</p>	<p>SAFE IMPLANTATION Thanks to optimized and reliable instruments^{6,5,8}</p>
<p>Cemented Acetabular Cup System Lubinus, IP, FAL, FC and Endo-Model Cup</p>	<p>TRUSTED QUALITY FOR TRUSTED CARE Uniform cement coating due to spacer cams on all models</p>	<p>CUPS WITH AND WITHOUT SNAP EFFECT Standard and luxation-inhibiting versions, cups with circumferential rim for increased cement compression</p>
<p>TrabecuLINK Augments</p>	<p>TrabecuLINK SURFACE Three-dimensional structure for functional bone ingrowth^{11,12,13}, pore geometry for effective cell deposition^{11,12,13}, additive manufacturing process for the latest generation of elastic tibial cones</p>	<p>EFFECTIVE AND VARIABLE High primary stability, straight-line surgical technique¹⁰</p>
<p>NK Fracture Head and Vario-Head Cup Hemiarthroplasty for femoral neck fracture</p>	<p>ACCURACY Distance between head and acetabulum for postoperative anatomical alignment⁴</p>	<p>PROVEN SYSTEMS¹⁵</p>
<p>Pelvis Support Type RR and Type RC</p>	<p>ANATOMICAL DESIGN In atraumatic design, optionally with HX coating</p>	<p>INTRASURGICAL FLEXIBILITY Variable options for bone screws, flexible reconstruction of the center of rotation, wide size range</p>
<p>customLINK custom-made Implants</p>	<p>NEARLY 40,000 ARCHIVED CUSTOM-MADE PRODUCTS SINCE 1968 Delivery within four weeks after medical clearance</p>	<p>ADDITIVE MANUFACTURING PROCESSES, SPECIAL COATINGS e.g. SILVER, ZIRCON)</p>



For detailed information, scan the QR code. For information on all LINK products, go to www.linkorthopaedics.com.

FLEXIBLE APPLICATION OPTIONS - ONE PLATFORM, PERFECTLY ADJUSTABLE

Intraoperative flexibility, face changer, variable options for bone screws



WIDE RANGE OF APPLICATIONS

For both primary and revision arthroplasties.



FLEXIBLE, DURABLE, DEMAND-DRIVEN

7 different models, excellent register results, wide range of sizes, flexible application possibilities



VARIABLE, DEFECT ADAPTATION

Large recesses allow variable positioning, flexible screw positioning¹⁰, wide size range for different anatomies and defect situations



BROAD RANGE OF SIZES

Vario-head cup in 1mm increments, 32mm prosthesis heads are possible



MATERIAL

Pure titanium with HX coating and Porolink surface



PARTIAL PELVIC REPLACEMENT WITH STANDARDIZED INSTRUMENTS

Instructions for use and surgical technique are supplied when required.



¹Cunningham B W et al.: »General Principles of Total Disc Replacement« Arthroplasty, Spine, Vol. 28, No. 20 Suppl., 2003.
²Design Dossier W. LINK (intern)

³Ullmark G, Sorensen J, Nilsson O, Analysis of bone formation on porous and calcium phosphate-coated acetabular cups: a randomised clinical [18F]fl uoride PET study. Hip international: the journal of clinical and experimental research on hip pathology and therapy, 2012;22(2):172-8.

⁴PCT-Patentanmeldung WO 2019/140497 A1

⁵Stroh, D., Alek, et al. »Dual-mobility bearings: a review of the literature.« Expert review of medical devices 9.1 (2012): 23–31.

⁶Internal document W. Link (DOC-08847)

⁷Internal document W. Link (DOC-07974)

⁸Internal document W. Link (DOC-08846)

⁹Swedish Hip Arthroplasty Register, Annual Report 2017; www.shpr.se

¹⁰Internal document W. Link (DOC-11102)

¹¹Cecile M, Bidan, Krishna P, Kommarreddy, Monika Rumpfer, 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)

¹²Pascal 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)

¹³Steinmann SG, Compatibility of Titanium in Soft and Hard Tissue – The Ultimate is Osseointegration; Materials for Medical Engineering; WILEY-VCH, Volume 2, Page 199–203

¹⁴H. W. Buchholz und E. Strickle (engineering BASF), 1972

¹⁵Norwegian Hip Arthroplasty Register, Annual Report 2018; http://nrhweb.i.helse.net/eng/Rapporter/Report2018_english.pdf

»The intrasurgical efficiency of the MP Monoblock from LINK is excellent!«

Dr. Warth, the MP Monoblock from LINK is a trend in the USA – why?

Monoblock tapered, fluted titanium stems have gained more significant traction in the US over the last 10–15 years. Concerns regarding modular junction fatigue failure, unknown long-term potential for fretting and corrosion, and cost considerations have driven some revision surgeons away from modular options.

What are the advantages of this implant?

Cost and efficiency are important considerations. The revision burden for total hip arthroplasty is growing rapidly. Any modular junction is a potential mode of failure, and as surgeons perform revision hip surgery in younger, heavier patients, the long-term ramifications of modular implants pose a potential concern.

For which indications do you use the MP Monoblock from LINK?

The MP Monoblock was designed for the »modern« revision practice. Many surgeons have transitioned to primary femoral implants with proximal fixation, i.e. »blade« or »broach only« stems. In the revision or infection setting we are often able to remove these primary implants »from the top« without extended trochanteric osteotomy (ETO). Subsequently the proximal bone is less compromised. A revision 165mm or 195mm conical stem is long enough to obtain excellent fixation, and the simplicity and cost effectiveness of a monoblock stem makes a lot of sense in this setting. The majority of revisions performed in the »modern revision practice« fit into this category. More severe bone loss or revisions requiring an ETO require more distal fixation of 225mm or greater. Subsequently, modularity makes more sense to me in such a setting. That is

the beauty of the Monoblock MP in my opinion. In terms of femoral bone preparation, it was designed to integrate seamlessly with the Modular LINK MP. If a case turns out to be more complicated than expected, or stability is an issue, a cohesive modular option with a proven track record is at your fingertips. No other company provides such a seamless transition.

How are the first results?

We have implanted four MP Monoblocks so far. Intraoperative efficiency has been excellent, and early radiographic and clinical results have paralleled those of other monoblock or modular designs I have used in the past.

How do you rate the instruments and the press-fit?

The instrumentation was designed to enhance efficiency and transition seamlessly to the modular MP. This is one of the premier features of the system. The press fit is excellent. It is difficult to get the stem out if you want to change your anteversion for stability after final impaction of the component. This gives me great confidence in the fixation, but I make sure I am happy with my anteversion before vigorous final impaction.

The MP Monoblock does not correspond exactly to the Wagner stem. It was developed according to the design of the modular MP because this is supposed to anchor better in the bone. What is your opinion?

The initial fixation is excellent. We chose to build off the success of the modular MP and keep the design because of the excellent axial and rotational stability which has a proven clinical track record of excellent long-term biological integration.

Do you use the drill holes of the MP Monoblock?

It is rare, but I love having the option. I do not put wires through the holes as I worry about fretting and 3rd body wear in the functional joint space. I use heavy *Ethibond or polyethylene cables to support the greater trochanter when it is tenuous or in the setting of a fracture.

What is your experience of using modular prostheses for obese patients?

I do not necessarily have a weight cutoff for a modular prosthesis, I let the clinical scenario dictate my implant choice. However, I certainly have concerns about the long-term ramifications of any modular junction in a young, morbidly obese patient.

Dr. Warth, thank you for the interview.



INTERVIEW

Dr. Lucian Warth, MD, is an orthopedic surgeon in Fishers, Indiana and is affiliated with Indiana University Health North Hospital.

*Ethibond Excel is a Trademark of Ethicon, Inc.

New from LINK: MP Monoblock Hip System

Going back to the proven design features of the MP Reconstruction system, the MP Monoblock is designed to meet the needs of modern revision surgery and complete the MP Family with a new versatility.

The MP 2° taper angle and proven broad spline geometry gives the stem a superior axial stability and lowers the risk of subsidence. The rough PoroLink surface of the stem made from biocompatible TiLatan-S supports osseointegration and bone remodeling to provide long-term stability.

The low risk of subsidence combined with a high offset version minimizes the risk of luxation, while the short taper and flattened neck provide a great range of motion.

The surgical technique and instrumentation provides wide intraoperative versatility. The result is a system that allows the surgeon unlimited flexibility within the MP Family.

The instruments are designed to create a precise, reproducible relationship between the reamer, trial and implant positioning

to help predict the ideal center of rotation and support long-term stability of the hip joint.

SUTURE HOLES

Ø 3mm suture holes with smooth, polished edges



GUIDED INSERTION

Fixed instrument connection for full rotational control



NECK PORTION

2 offset options and CCD angles
A/P flattened and polished neck; short 12/14 taper



SIZE RANGE

3 stem lengths: 165mm, 195mm and 225mm
Ø 14mm–25mm

SURFACE

Rough, corundum-blasted PoroLink surface, (200x magnification)



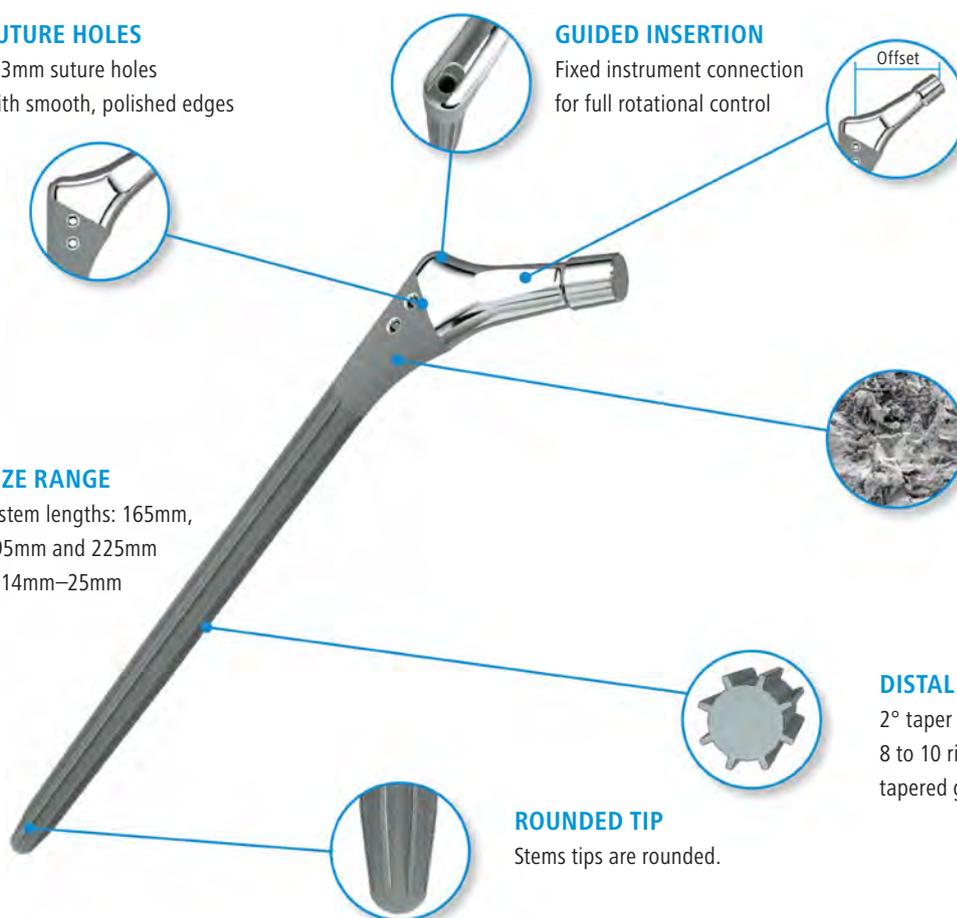
DISTAL STEM PORTION

2° taper in the distal portion, 8 to 10 ribs with broad, tapered geometry



ROUNDED TIP

Stems tips are rounded.



LINK OptiStem: New modular stem for stable metaphyseal knee joint anchorage

New from LINK is a modular stem that anchors the prosthesis components metaphyseally. The modular LINK OptiStem is currently available cementless and cemented for femoral and tibial use as a custom-made product; approval as a system has been applied for. A case study shows an application example.

A 53-year-old female patient, 160cm tall and weighing 98kg, presented with a laterally luxated patella on the left side, a clear valgus position, a loosened knee prosthesis in situ and pain in the femur.

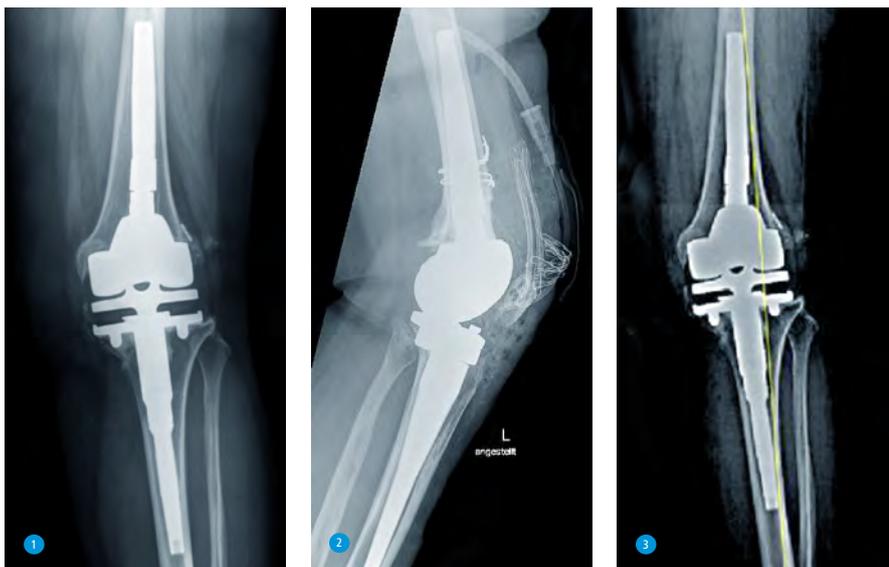
The femoral stem has a curvature corresponding to the patient's anatomy.

At the surgeon's request, *customLINK* fabricated a cementless femoral and tibial stem with femoral segment and half washer (material: Ti6AlV4) according to the patient's CT data. The femoral segment of the special design has a height of 50mm. The femoral stem has a curvature corresponding to the femoral anatomy of the patient. In addition, the planning provided for a small distance to the femoral

segment to allow slight settlement of the stem. A standard rotational knee prosthesis was planned as the joint module.

The CT planning of the tibial component includes a washer 10mm high and a tibial stem (material: Ti6AlV4). It was intended to fill the medullary canal with bone chips.

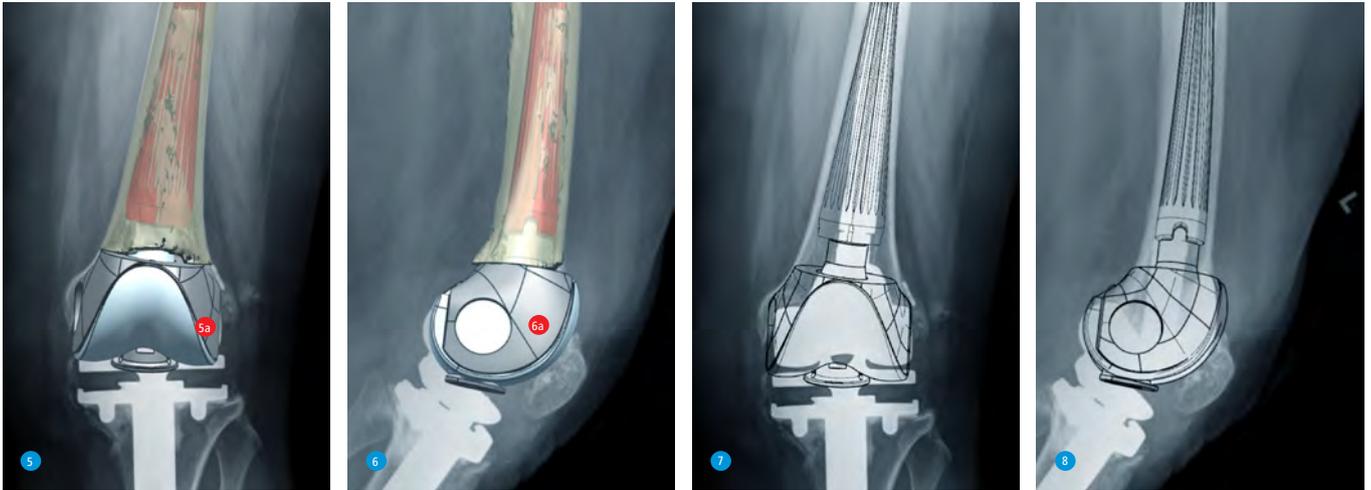
The modular LINK OptiStem is generally indicated for particularly heavy or active patients or for patients with a history of frequent loosening.



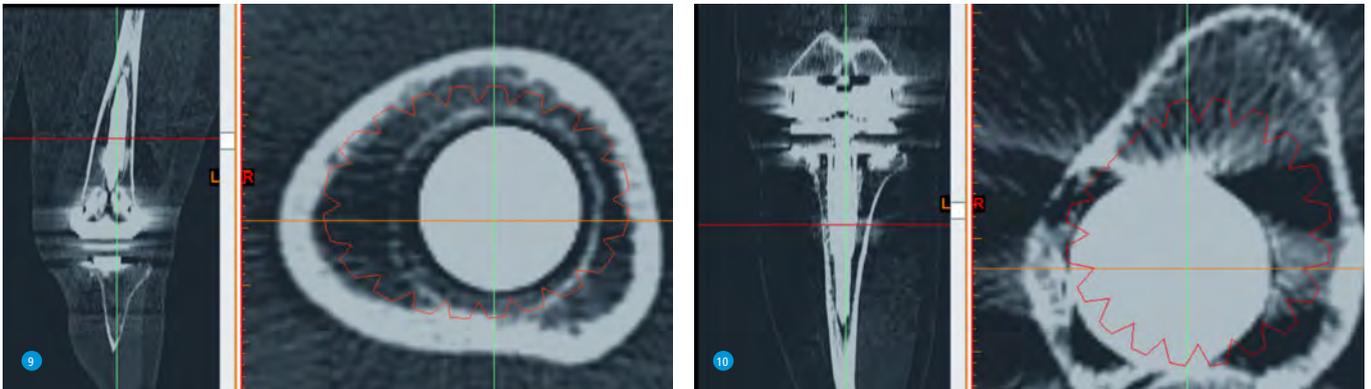
The preoperative radiographs (1, 3: AP, 2: lateral) show the valgus position and the loosened knee prosthesis in situ.



LINK OptiStem with a LINK Endo-Model SL knee prosthesis system (4).



CT planning of the femoral component (5: AP, 6: lateral); X-ray planning (7: AP, 8: lateral). In order to allow slight settlement of the stem, the planning provides for a small distance to the femoral segment. Below: CT examination in longitudinal and cross-section: femoral component (9), tibial component (10).



CT planning of the tibial component (11: AP, 12: lateral); X-ray planning (13: AP, 14: lateral); full leg X-ray (15); filling with bone chips planned.



Guests of LINK

at DKOU 2019

October 22-25 in Berlin





The Presidents of DKOU 2019 on the LINK Stand (from left to right): Dr. med. Thomas Möller (Congress President BVOU 2019), Dr. med. dent. Katrin Perka, Prof. Dr. med. Carsten Perka (President DGOOC 2019), Helmut D. Link, LINK Managing Director Norbert Ostwald, Prof. Dr. med. Paul Alfred Grützner (President DGOU, DGU 2019), Photo: © Intercongress.

DKOU 2019: International meetings and discussions at the LINK Stand

Around 11,000 participants from 60 nations, 1,800 presentations and numerous international symposia, workshops and meetings: The DKOU 2019 from October 22 to 25 in Berlin was held under the motto »Knowledge Needs Values« and thus addressed the rapid change in orthopedics and trauma surgery due to increasing economic pressure, political misdirection and shortage of personnel.

This year's focus was therefore on a range of care-related topics that addressed generalists, specialists, training assistants and experts alike. These included

diagnostics and imaging techniques, arthrosis, diseases and injuries of the spine, pain, arthroplasty, joint injuries, complications and comorbidities, age traumatology and orthopedics, and trauma management.

LINK was again represented at the DKOU this year with a large congress stand. As every year, numerous visitors, including a delegation from the Academic Sino German Friendship Symposium (see page 23), used the DKOU to discuss current developments and the latest findings in orthopedics and trauma surgery. In addition to the

challenges of the future, LINK products, such as the new SPAR-K instruments for the GEMINI SL knee surface replacement as well as the indication-specific options for acetabular treatment, were in the focus. You can read more about this on pages 13–15.

Symposium in Honor of Prof. Johan Kärrholm and Prof. Henrik Malchau



Helped to shape the Swedish Hip Arthroplasty Register over many years: Prof. Henrik Malchau (above) and Prof. Johan Kärrholm.

The Swedish Hip Arthroplasty Register organized a symposium in Gothenburg in June in honor of *Prof. Johan Kärrholm* and *Prof. Henrik Malchau*, who have officially retired. Among the numerous international speakers was LINK owner Helmut D. Link.

Prof. Johann Kärrholm had been Director of the Sweden Register since 2005. In the course of his career he was also secretary of the Swedish Orthopedic Society and a member of the board of the European Hip Society. Prof. Kärrholm has received numerous scientific awards. He has supervised over 40 doctoral students and written nearly 300 scientific publications.

Professor Henrik Malchau has held senior positions in the Swedish Register for

many years and has advised on the development of registers in Australia, Canada, New Zealand, Great Britain and the USA. Professor Malchau has published over 250 peer reviews and received three Hip Society awards. He was a co-founder and president of the International Society for Arthroplasty Register, president of the International Hip Society and an honorary member of the British Hip Society, the European Federation of Orthopaedics and Traumatology (EFORT), the Australian Orthopaedic Association and the British Orthopaedic Association.

Henrik Malchau was appointed full professor at Harvard Medical School for his scientific work.

More than 80 Participants at the 3rd LINKademy ASEAN Knee Symposium



More than 80 surgeons from nine countries participated in the 3rd LINKademy ASEAN Knee Symposium, which took place at the Renaissance Hotel in Kuala Lumpur, Malaysia at the end of August 2019. The topics covered the key aspects

of modern knee replacement, ranging from primary unicompartmental knee arthroplasties to complicated revisions and solutions for severe deformities and periprosthetic joint infection treatment.

FDA Clearance for SPAR-K Instruments

The SPAR-K instruments from LINK for use with the GEMINI SL Total Knee System have received a positive review by the US Food and Drug Administration (FDA). SPAR-K instruments are thus officially approved for the US market. Further information is available on our SPAR-K website: www.spark.linkorthopaedics.com. Just scan the QR code with a smartphone or tablet computer.



New subsidiary: LINK in Brazil



Above (l. to r.): Carlos Alves (LINK do Brasil), Helmut D. Link; right: Around 60 surgeons took part in the BioLab for total knee and hip replacement.

Since May 2019, LINK has also been represented by a subsidiary in Brazil. LINK owner Helmut D. Link was present at the opening ceremony in São Paulo.

LINK do Brasil supports the LINK sales partners Triade and Implamed in marketing and product registration. »We currently offer the LINK Endo-Model Standard and

Modular as well as the LINK MP Reconstruction Prosthesis, and will gradually register all primary and revision products of the LINK portfolio in Brazil,« says Carlos Alves, Business Manager and responsible for the subsidiary *LINK do Brasil*. The LINK implants were presented in a BioLab for total knee and hip replacement, jointly organized with Implamed

at the end of June 2019. The speakers were Dr. Wolfgang Klauser (VAMED Ostseeklinik Damp, Germany), Prof. Dr. Gilberto Camanho (Hospital des las Clinica, Brazil), Dr. Camilo Helito (Brazil) and Dr. Saul Martinez (Mexico).

20 Years Academic Sino German Friendship Symposium



On the occasion of the 20th anniversary of the Sino German Friendship Symposium, surgeons from China visited Germany to exchange know-how with their German colleagues. The common goal for 20 years: to promote progress and increase benefits for patients.

The first Academic Sino German Friendship Symposium took place in Beijing, China, in 1998. Since then, the intensive cooperation between surgeons from both countries has been very productive. To name just a few of the successes achieved: The founding of Friendship Hospitals, annual German-Chinese friendship

meetings, the visit program for long-term Chinese guests, the exchange of knowledge in orthopedics and experiences with surgical interventions – and last but not least: many valuable personal contacts.

As in the past, the 20th Academic Sino German Friendship Symposium with numerous successful meetings and exciting discussions took place in Hamburg (Helios ENDO-Klinik), Berlin (Charité Universitätsmedizin, LINK Factory) and Kiel (Lubinus Klinikum).

Study confirms: Cementless surfaces of LINK implants promote osseointegration and anchorage

Bretschneider H, Mettelsiefen J, Rentsch C, Gelinsky M, Link HD, Günther KP, Lode A, Hofbauer C, Original Research Report, Wiley Society for Biomaterials, DOI: 10.1002/jbm.b.34463.

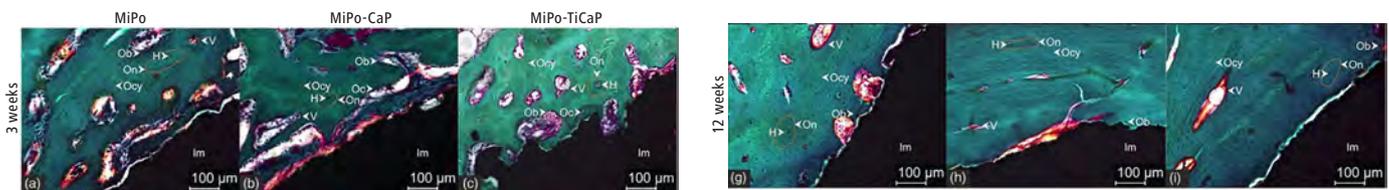
For cementless total joint replacement implants, the biological response to physicochemical surface characteristics is crucial for success and depends on fixation by newly formed bone.

In this study, the surface of TiAl6V4 (Tilastan) implants was modified by (a) corundum blasting, (b) corundum blasting followed by electrochemical calcium phosphate (CaP) deposition, and (c) titanium plasma spraying followed by electrochemical CaP deposition. All modifications resulted in a surface roughness

suitable for enhancing primary implant stabilization and favoring osteoblast adhesion and function; the thin, biomimetic CaP coating is characterized by fast resorbability and served as a chemical cue to stimulate osteogenesis.

After implantation in a full weight-bearing rabbit intramedullary distal femur model, osseointegration was investigated after 3, 6, and 12 weeks. For all modifications, new bone formation, occurring from the endosteum of the femoral cortical bone, was observed in direct contact

to the implant surface after three weeks. At the later time points, maturation of the woven bone into the lamellar bone with clearly defined osteons was visible; the CaP coating accelerated the remodeling process. The ingrowth of newly formed bone into the pores of the titanium plasma-sprayed surfaces indicates a strong interlock and finally implant fixation. Our findings indicate a positive impact of the tested surface modifications on osseointegration.



Morphological evaluation of newly formed bone around the implant after 3 and 12 weeks of implantation; a representative image of each group at high magnification (20-fold; Im, implant; V, vessel; Ocy, osteocyte; Ob, osteoblast; OC, osteoclast; On, osteon; H, Haversian canal).

LINK Products in the current medical literature

Current review of surgical management options for extremity bone sarcomas.
Cirstoiu C et al., *Efort Open Review (EOR)*, Volume 4, May 2019, DOI: 10.1302/2058-5241.4.180048.

Reduced periprosthetic fracture rate when changing from a tapered polished stem to an anatomical stem for cemented hip arthroplasty: an observational prospective cohort study with a follow-up of 2 years.
Mohammed J et al., (2019), *Acta Orthopaedica*, DOI: 10.1080/17453674.2019.1624339.

The design of the cemented stem influences the risk of Vancouver type B fractures, but not of type C: an analysis of 82,837 Lubinus SPII and Exeter Polished stems.
Chatziagorou G. et al; *Acta Orthop.* 2019 Apr;90(2):135–142. doi: 10.1080/17453674.2019.1574387. Epub 2019 Feb 11.

Evolution of the cementless anatomic stem: Risks & rewards.
Gehrke T et al., *Seminars in Arthroplasty* 29(3), February 2019, DOI: 10.1053/j.sart.2019.02.005.

Imprint

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Reduced periprosthetic fracture rate after changing from a tapered polished stem to an anatomical stem

Mohammed, J et al.; Acta Orthopaedica 2019; 90 (5): 427–432

Straight collarless polished tapered stems have been linked to an increased risk of periprosthetic femur fractures in comparison with anatomically shaped stems, especially in elderly patients. Therefore, the study evaluated the effect of an orthopedic department's full transition from the use of a cemented collarless, polished, tapered stem to a cemented anatomic stem (LINK Lubinus SPII) on the cumulative incidence of postoperative periprosthetic fracture (PPF).

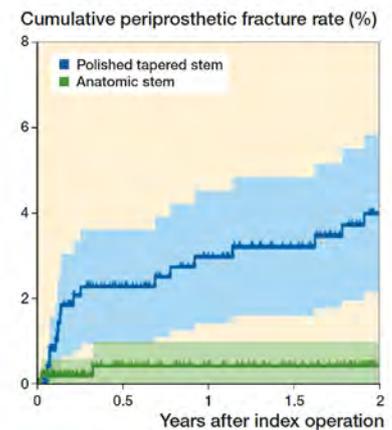
This prospective single-center cohort study comprises a consecutive series of 1,077 patients who underwent a cemented hip arthroplasty using either a collarless polished tapered stem (PTS group, n = 543) or an anatomic stem (AS group, n = 534). The authors assessed the incidence of PPF 2 years postoperatively and

used a Cox regression model adjusted for age, sex, ASA class, cognitive impairment, BMI, diagnosis, and surgical approach for outcome analysis.

The mean age at the primary surgery was 82 years (49–102), 73% of the patients were female, and 75% underwent surgery for a femoral neck fracture. The PPF rate was lowered from 3.3% (n = 18) in the PTS group to 0.4% (n = 2) in the AS group. The overall complication rate was also lowered from 8.8% in the PTS group to 4.5% in the AS group.

In the regression model only cognitive dysfunction (HR 3.8, 95% CI 1.4–10) and the type of stem (PTS vs AS, HR 0.1, CI 0.0–0.5) were correlated with outcome. The authors concluded that for

elderly patients with poor bone quality, the use of cemented anatomic stems leads to a substantial reduction in periprosthetic fracture rates without increasing other complications.



The LINK Endo-Model is the first Rotating Hinge Knee System worldwide to have an ODEP rating*.

The LINK Endo-Model Standard Rotational Hinge Knee System received a 3A high quality rating from the *Orthopaedic Data Evaluation Panel (ODEP)* of the United Kingdom in July 2019. This makes the LINK Endo-Model the first Rotational Hinge Knee System worldwide to have an ODEP rating.

A rating of 3A is given to implants that have demonstrated a better survival rate than 94.5% at 3 years based on data meeting ODEP's strict criteria for the highest data quality.**

*ODEP ratings of all knees can be viewed at www.odep.org.uk/products.aspx.

**A minimum cohort of 150 hips/knees at the start of the study (consisting of data from beyond the development center and from more than 3 centers/surgeons) with a minimum of three years follow-up and an actual survival rate better than 94.5%. All deaths, loss to follow-up, failures and indications for revisions are recorded.

Expand your possibilities.



LINK Primary Hip Replacement
LCU Hip System · MobileLink Acetabular Cup System