

direct LINK[®]

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Special Edition *LinkSymphoKnee*



INSIDE

What renowned surgeons
say about the new
LinkSymphoKnee



Prof. Georg Matziolis



Dr. Alois Franz



Dr. Giuseppe Calafiore

Dear Readers,

A lot has happened since my father founded our family business in 1948. At the time, LINK was no more than a specialty dealer for hospital supplies in Hamburg, Germany. Revolutionary implants such as the first German total hip joint prosthesis in 1963 and the Endo-Model knee joint prosthesis in 1979 were trendsetting in arthroplasty and paved the way for further groundbreaking LINK products. Today, 75 years and many innovations later, LINK is trusted by surgeons in many countries around the world.

This year, LINK launched a new implant system for primary knee arthroplasty, the LinkSymphoKnee. That is a contemporary style comprehensive knee system, based on many features and learnings from our very successful long history, including our Unicodylar Sled Prosthesis presented as early as 1968, our Gemini SL Surface Replacement and our Endo-Model Rotating Hinge Knee. Adapter between LinkSymphoKnee and Endo-Model Rotating Hinge, to step up constraints in small increments are in development. The LinkSymphoKnee system is additionally available with LINK PorEx surface modification for metal hypersensitive patients.

In this special edition of our directLINK Magazine for Arthroplasty, you will find product information on the LinkSymphoKnee as well as interviews with European surgeons who will report on their first experiences with the LinkSymphoKnee.

I hope you enjoy these and many other topics in directLINK.

Yours,
Helmut D. Link



Imprint

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HARMONY IN FORM AND FUNCTION

The new LinkSymphoKnee for primary implantation or revision is available in 14 femur sizes and 10 tibia sizes. All configurations are approved for 2-up, 2-down size compatibility. E-DUR (highly cross-linked PE with antioxidant vitamin E) is available for the articular surfaces and patella, as is LINK PorEx* surface modification for each configuration. The photo shows the LinkSymphoKnee in LINK PorEx with offset stem. Read more about the new LinkSymphoKnee in this special edition: click or scan the QR code.



* LINK PorEx: TiNbN = Titanium-Niobium-Nitride; surface modification (gold color)

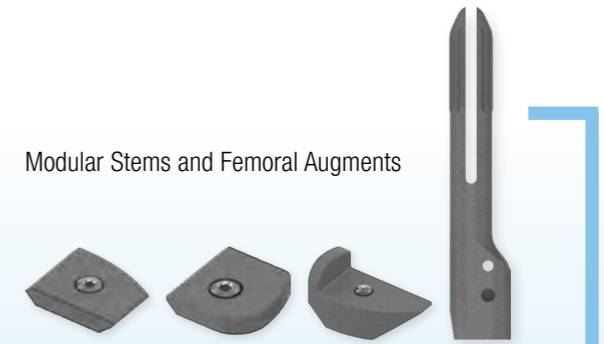
LinkSymphoKnee

Implants Combination Overview

Additional Implants



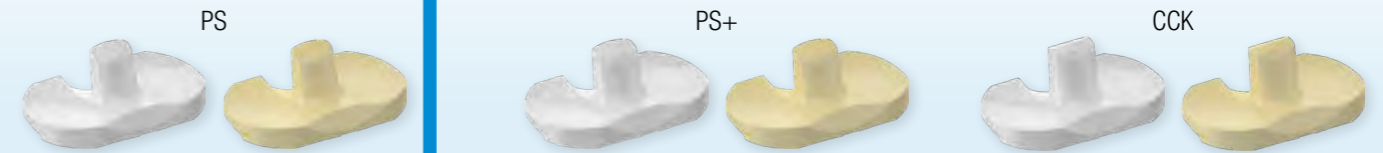
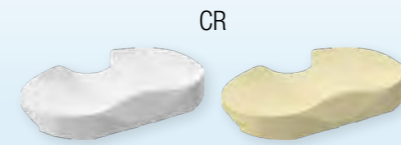
Modular Stems and Femoral Augments



Femoral Components



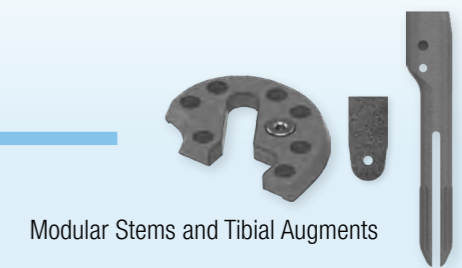
Articulating Surfaces



Tibial Components



Additional Implants



The LinkSymphoKnee Knee System is a comprehensive and easy to use knee arthroplasty system from primary to more complex revision needs. The system was first launched at the Annual Meeting of the American Association of Hip and Knee Surgeons (AAHKS) in 2022 and is also available with a LINK PorEx surface modification. The LinkSymphoKnee instrumentation is both intuitive to use and is designed to ensure very reproducible outcomes. As well, the LinkSymphonyKnee instruments and tray design is very suitable for smaller clinics. Click or scan the QR code for more information about the LinkSymphoKnee.



»I immediately had excellent confidence with the system and the instruments, which led to great postoperative satisfaction« *Dr. Giuseppe Calafiore*

Members of the development group for the new LinkSymphoKnee include German surgeons Prof. Georg Matziolis and Dr. Alois Franz and Dr. Giuseppe Calafiore from Italy. In this interview they discuss instrumentation, workflow and early clinical results.

Prof. Matziolis, Dr. Franz, Dr. Calafiore: How does the LinkSymphoKnee stand out from other implant systems?

Prof. Matziolis:

The LinkSymphoKnee exceeds my expectations and impresses me. It works flawlessly right out of the box with no major problems. It is a pleasure to implant the LSK and I have noticed that my colleagues in the clinic also prefer it to other implant systems. I am more than satisfied with the LinkSymphoKnee, I am thrilled.

Dr. Franz:

The LSK system does indeed have many advanced design features that overcome

the disadvantages of older systems. The features include the very thin anterior femoral shield, the 4.5 degree anterior cut, and the standard narrow implant. These improvements simplify the surgical process and reduce operating time. The LSK system also features an innovative design that improves patellofemoral joint motion, enhances intrinsic stability during surgery with the PS-Plus system, and covers a complete product range up to the CCK system with cementless or cemented stems, wedges and cones. These versatile options provide real benefits for surgeons and patients.

Dr. Calafiore:

Overall, the outstanding feature of this

prosthesis is the technology with which it has been designed and constructed. In its entirety, this technological configuration offers a system for preserving the posterior cruciate ligament, to a configuration with the possibility of increasing levels of constraint in the case of ligament insufficiency, to a fully constrained implant, with a simple and versatile procedure. The wide range of femoral and tibial sizes guarantees a restoration according to the knee anatomy, selecting the most appropriate AP and ML sizes.

What is the impact of the instrumentation?

Dr. Calafiore:

The LSK system's key strength compared to competitors in the market is certainly

the instrumentation. This instrumentation allows not only different implant configurations with fewer surgical trays, but also the possibility of having both a standard and a hypoallergenic version, from the initial implant to the revision. The instrumentation guarantees an extremely high level of versatility thanks to the possibility of switching from a CR configuration to a CCK configuration with the same system. This allows the surgeon to choose the best configuration in the field without the need for additional instruments.

Dr. Franz:

The instruments are actually very user-friendly, not only for the surgeon, but also for the OR nurses and the entire OR team. They are easy to maintain, easy to clean and easy to use. The number of instruments required is low and they are versatile.

Prof. Matziolis:

Instruments have a significant impact on surgical satisfaction. At the end of the day, clinical outcome and implant survival depend leastwise on the positioning as well as on the design of the implant. The LSK instruments are very well designed and allow for easy and efficient handling during surgery. The instruments are designed to be comfortable and functional.

Is there any part of the instruments that you particularly like?

Prof. Matziolis:

One instrument that I particularly like is the distal femoral cut guide, which can be adjusted to the exact degree. This allows for proper adjustment in extra-articular deformities or special cases. It also allows precise control of the distal femoral resection, which is not offered by all instruments on the market. Another instrument I appreciate is the tibial resection control instrument. It allows parallax-free axis control by

guiding the rod to the ankle. These instruments allow precise control of the resections, which I strive to achieve with near-navigational precision.

What are the advantages of the LinkSymphoKnee being available with PorEx surface modification?

Dr. Franz:

PorEx contributes to a comprehensive system, as there are always patients who have a metal intolerance. By including this option, there's no need to switch to a new system.

Prof. Matziolis:

Although only a small percentage of our patients report an allergy, we take it seriously and use coated implants when necessary. LSK is very advantageous in this regard because I don't have to change my surgical technique or instruments. I can just use a different coated implant without having to go through an additional learning curve.



LinkSymphoKnee CCK version with LINK PorEx* (available for each configuration).

* LINK PorEx: TiNbN = Titanium-Niobium-Nitride; surface modification (gold color)

Dr. Calafiore:

It is great that the LINK PorEx version is available for all configurations, which gives the surgeon more security in case of problems or uncertain history, and thanks to this possibility, our clinic will be able to treat different pathologies with a single prosthetic system.

»It is a pleasure to implant the LSK and I have noticed that my colleagues in the clinic also prefer it to other implant systems.«

Prof. Georg Matziolis

How was the transition from your previous system to the LinkSymphoKnee?

Dr. Calafiore:

The LSK instrumentation is clear and simple, and the technology is complete and intuitive, so the learning curve is faster than with other systems used in the past. These features also allow healthcare professionals to perform procedures in the operating room to support the surgeon with greater safety and agility. In my personal experience, I had immediate confidence in the system and the instruments, which led to great postoperative satisfaction.

Prof. Matziolis:

Our clinic has maintained the extension-gap-first surgical philosophy. However, the LSK instruments are designed to accommodate many other surgical philosophies. Although there was a learning curve, the transition was relatively smooth because we were already using the SPAR-K instruments with the GEMINI SL Total Knee Replacement from LINK. The instruments are designed to be user-friendly, so it was easy to get started with the new system.



The LinkSymphoKnee is available in 14 femoral and 10 tibial sizes. All configurations are approved for 2-up, 2-down size compatibility. E-DUR (highly cross-linked PE with antioxidant vitamin E) is available for the articular surfaces and the patella. The picture shows the CR version with LINK PorEx* surface modification.

* LINK PorEx: TiNbN = Titanium-Niobium-Nitride; surface modification (gold color)

Dr. Franz:

The learning curve was manageable because I was heavily involved in the instrumentation design. We were able to carefully consider and discuss each step and explain exactly why and where certain features should or should not be used. In our hospital, we implemented the LSK system on January 1, 2022, and the team was trained on the new system within a few days. It has proven to be easy to understand and learn, even for novice or less experienced surgeons.

How well do the LINK Endo-Model and the LinkSymphoKnee work together?

Prof. Matziolis:

With the CC system, we need to implant fewer Endo-Models. I am gaining initial experience with the CCK version of

the LSK, which is relatively new to the market. The advantage is that it uses the same instruments and allows specific instrumentation for intramedullar guidance when using uncemented stems. If you are using cemented stems, you can also use the primary instruments to place the CC. I think in the future we will do some of the implantations that we used to do with the Endo-Model Rotating Hinge Knee with the CCK because the instrumentation is very simple. In addition, the patella tracking may be better with the CCK than with the Rotating Hinge Knee because it limits the rotation between the femur and tibia by the CC conformity, which allows the patella to glide better. However, we need to study and confirm this further. The Endo-Model remains indicated for cases with complete collateral ligament loss. The CCK is appropriate for patients with preserved but insufficient medial ligament.



The LinkSymphoKnee is a complete system for primary and revision solutions. The picture shows the PS version with LINK PorEx* (available for each configuration).

* LINK PorEx: TiNbN = Titanium-Niobium-Nitride; surface modification (gold color)

»PorEx contributes to a comprehensive system, as there are always patients who have a metal intolerance. By including this option, there's no need to switch to a new system.«

Dr. Alois Franz

Dr. Calafiore:

The Endo-Model system integrates perfectly with the resections of the first implant, thanks to its unique radius of curvature and the 3 mm metal thickness of the condylar surface. The main indication that leads me to choose this system is in cases of significant instability of the joint, i.e. when there is a loss of a collateral ligament, an instability of the medial capsule, or when we cannot manage a space in flexion versus a space in extension.

Dr. Franz:

The CCK system is an important intermediate step between the CR system and the LINK Endo-Model. For severe deformities that cannot be treated with a CCK, you would start with the EndoModel first. There are gradations from the CR to the CCK and finally to the Endo-Model. For severe deformities, I would go immediately with the Endo-Model. Whenever the flexion-extension gap cannot be balanced, a change to the Endo-Model is necessary. With the LSK system, LINK is offering a CCK component for the first time. In the past, we had limited options and had to rely on other systems. With the introduction of the LSK system, we now have access to a wider range of options, which may result in fewer fully constrained knees being required.



The articulating surface of the LinkSymphoKnee All-Poly is identical to the PS insert.

Have you had a case where the LSK system solved a specific problem that might not have been easily solved with other systems?

Prof. Matziolis:

I can't give you a specific case, but the LSK has advantages, especially with the PS-Plus inlay, which allows for easy semi-constrain without additional stem lengthening. If we feel that something is too loose, we can simply insert a PS-Plus inlay to resolve the situation quickly and elegantly. This is something we use regularly and has contributed to the popularity of the implant.

Dr. Franz:

A major advantage of the LSK system is that I can use the PS-Plus system during surgery for minor instabilities, such as varus or valgus, without having to work on the overall construct or require stem fixation. This provides greater flexibility and allows for better customization to the individual needs of the patient. A case where the LSK system provided a great intraoperative advantage was when I identified a major medial cruciate ligament injury during

a standard primary knee surgery, which immediately led me to opt for a CCK component. The addition of just one tray to the ones already in the field allowed me to complete the surgery without any problems or waste any time that would have caused possible infections.

Dr. Calafiore:

In recent months, I have seen significant medial collateral ligament damage in primary knee reconstructions, requiring the use of a more limited CCK prosthesis. The presence of the LSK complex system was fundamental, because with some additional tools already available, I was able to complete the operation without hesitation, without wasting time that could have caused possible infections, always keeping the patient's health in mind.

Does the LSK system speed up the patient's recovery?

Dr. Franz:

A patient who was previously operated on with another system had persistent discomfort and limited range of motion. By switching to the LSK system, we were able to optimize the patellofemoral kinematics and improve flexion function. After surgery and appropriate rehabilitation, the patient quickly noticed a significant improvement in flexion and a significant reduction in pain. This allowed him to recover faster and return to normal activity sooner than expected.

Does the LSK affect your workflow?

Dr. Calafiore:

In this first year of continuous use of the LSK system, I have had excellent experiences, due to the rapid recovery of the patient in the postoperative phase, especially in the case of direct loading: the patient feels secure without any sensation of instability of the joint. All this is possible thanks to an important study

»The Endo-Model system integrates perfectly with the resections of the first implant«

Dr. Giuseppe Calafiore

on the femoral trochlea, from which a design of the femoral component was derived that allows excellent flexion just a few days after surgery. The possibility of having the LSK instrument set within the hospital structure, which allows almost all configurations, optimizes and facilitates the processes of request and delivery to suppliers, saving work and time for the professionals in charge of carrying out this work.

How would you summarize your first postoperative results with the LSK system?

Dr. Franz:

The results were comparable or better than with other systems. In particular, the flexion function has proven to be very good due to the improved design. Both users and patients have given very positive feedback. In our clinic we have used more than 300 LSK implants so far.

Prof. Matziolis:

Our initial clinical experience with LSK has been very good throughout. Patients are able to bend well very early on, but we have not yet done a comparative study.

Dr. Calafiore:

The postoperative results have been excellent, with patients able to bear full weight shortly after surgery – even the same day. There have been no postoperative problems, which indicates a smooth and efficient recovery process. Most importantly, I have not seen any complications associated with the use of the implant over the medium to long

term. This demonstrates the safety and effectiveness of the implant in facilitating a quick return to normal activity.

How did you find working with the international surgeons in the development group?

Dr. Franz:

Very stimulating, because we had very different approaches and were able to integrate them into the system. The LSK system is not a purely German system, but an international prosthesis system. Especially the topic of CCK was historically more relevant in America than the Endo-Model was in Germany or Central Europe. By working together, we were able to combine different aspects and experiences. We benefited from each other and were able to develop an innovative and versatile system that offers many advantages for both surgeons and patients.

Prof. Matziolis, Dr. Franz, Dr. Calafiore, thank you for the interview.



Dr. Alois Franz is Medical Director of the Hospital of Orthopedic Surgery and Sportmedicine at the St Marienkrankenhaus Siegen, Germany, a certified Maximum Care Center for Arthroplasty. Dr. Franz is a member of the international LinkSymphoKnee development group.



Dr. Giuseppe Calafiore, MD is a Consultant Surgeon, Knee and Hip Replacement at the Clinica Città di Parma and the Parma Clinic Humanitas Rozzano in Milan, Italy. Dr. Calafiore is a member of the international LinkSymphoKnee development group.



Prof. Dr. med. Georg Matziolis is Medical Director at the Waldkliniken Eisenberg, Chief Physician at the Clinic for Orthopedics and Trauma Surgery, and Professor of Orthopedics at the University Hospital Jena, Eisenberg Campus, Germany. Prof. Matziolis is a member of the international LinkSymphoKnee development group.

Commentary from surgeons worldwide about LinkSymphoKnee and the LINK company



Dr. Jörg Löwe is Senior Principal Surgeon of the EndoProthetikZentrum der Maximalversorgung at the Lubinus Clinicum in Kiel, Germany.

»It's particularly important for us to have an implant with a reliable surface for patients with allergies, so we don't have to do the component coating ourselves.

Another remarkable feature of the LSK system that particularly catches my eye is the predetermined breaking point of the taper adapter in the modular implants. This allows both the base plate and the taper to be recovered separately in the event of a revision. At the same time, this ensures an extremely reliable connection of the implants during implantation. The high quality of the instruments is also immediately apparent. The color coding of the moving parts greatly facilitates the intuitive handling of the instruments.«



Dr. Olaf-Thomas Bittner is an orthopedic specialist and owner of two orthopedic practices for arthroscopy and joint surgery in Gaerdelegen and Magdeburg, Germany. He specializes in surgery of the shoulder, elbow, hip, knee and ankle, as well as sports injuries to these joints.

»It is important for me to be able to present the possibility of axis control intraoperatively, and LINK as a company can offer me this possibility with the LinkSymphoKnee.

I also find the LINK CCK interesting. It offers more guidance and more degrees but has the same tibial components, so the main resection steps are the same as with the LinkSymphoKnee system. Overall, the special CCK instrumentation appears to be well thought out and user-friendly, and in my opinion, it fits well into the LINK portfolio.



Dr. Joachim Singer is head of the specialist clinic for orthopedics and trauma surgery at the Rems-Murr-Klinikum Winnenden, Germany.

»I can recall several instances in which the LSK helped me to provide my patients with a bicondylar knee prosthesis.

These included patients with advanced osteoarthritis and bony collapse of the joint surfaces or massive axial deformities with corresponding ligament instabilities, which previously required the implantation of a coupled prosthesis. We are also very satisfied with the service provided by LINK. In the case of urgent operations or the implantation of special customized LINK implants, a competent contact person from the company is always available on site.«



Will McDonald, is Co-Owner of Southern Medical Solutions in upstate Alabama, USA, a medical device distributorship that specializes in Orthopedics and General/Vascular surgery.

»I picked up LINK about two and a half years ago and it is definitely one of the best business decisions we've ever made.«

Will McDonald said in Kevin Brown's podcast »Device Nation« in May 2022. »They have been fantastic for us. Everyone at the company from logistics, to operations, to product management, their whole goal is to do anything they can to help us grow our business.«



Click or scan the QR code to go directly to the episode with [Will McDonald](#) and others



Dr. Russel G. Benuck, MD, is an orthopedist in Chicago, Illinois, USA. He is affiliated with multiple hospitals in the area, including Swedish Hospital and Northwest Community Hospital.

»I work in a community hospital. With that comes a unique patient population as well as unique staffing issues.

One of the things I like about this system is that it's a quick learning curve, not only for the surgeon but for the staff as well. With the LinkSymphoKnee device, I found that the learning curve is very steep and quick for both sides.«



Dr. Russel T. Nevins, MD, is an Orthopedic Surgeon in Las Vegas, Nevada, USA.

»All my LINK guys are an A+. I couldn't be more pleased with them.

They are there for me 24 hours a day, 7 days a week if I need anything. I'm just so thankful for the team, and I really think it has to do with the culture of LINK and that it's a family business. It's very different than the orthopedic companies I've worked with before.«



Dr. Thomas Paszicsnyek is a specialist for orthopedics and orthopedic surgery in Kindberg, Austria.

»The outstanding difference to the systems of other manufacturers, and for me the most important feature, is the common thread that runs through the LSK system. This is not available everywhere.

The LSK system allows me to perform both primary implants and revisions because the new LinkSymphoKnee is compatible with revision systems. In addition, I can use the LinkSymphoKnee in all directions and treat both regular patients and patients with metal hypersensitivity.«



Dr. Venkat R. Rapuri, MD, MS, FRCS (Edinburgh), FAAOS, is a total joint replacement surgeon in Arlington, Texas, USA. He also is Medical Director of the Total Joint Replacement Program.

»How the LinkSymphoKnee has impacted on my workday is one of the reasons why it has become my standard knee replacement.

So, if I'm doing a knee replacement, it is booked as a LinkSymphoKnee and not something else. It is my go-to basically, and that's how I book my cases. And I do close to 450 joints, of which a significant number of them are knee replacements and the majority of them are all LinkSymphoKnee systems.«



Dr. Russel Russo, MD, is an orthopedic surgeon in New Orleans, Louisiana, USA. While in Houston, he was a team physician for the Houston Texans, Houston Astros, Houston Rockets, and Houston Dynamo FC. He also served as a physician for NASA at the Johnson Space Center.

»With LINK I don't feel like just another user.

I feel like I'm really getting service. If there's something that frustrates me or that I think could be better, that's passed on immediately and I get feedback and results. They help me coordinate feedback and results from other surgeons to see where we have common ground. You don't get that kind of relationship with other companies.«

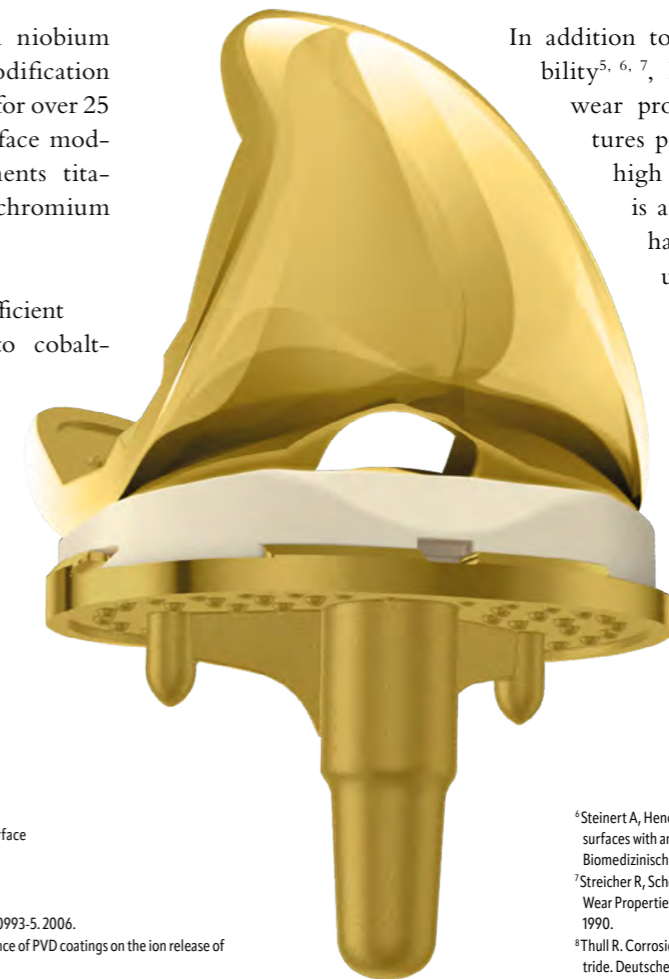


LINK PorEx* surface modification is available for all LinkSymphoKnee configurations

The LINK PorEx surface modification has been shown to significantly reduce chrome and nickel ion release.^{2,4} Here is what you need to know about LINK PorEx.

LINK PorEx is a titanium niobium nitride (TiNbN) surface modification that has been used in Europe for over 25 years. The LINK PorEx surface modification contains the elements titanium and niobium but no chromium or nickel.

LINK PorEx has a lower coefficient of friction^{2, 3, 4} compared to cobalt-chrome due to its outstanding hardness, ceramic-like abrasion behavior and optimal wetting angle when in contact with fluids. Implants with LINK PorEx surface modification exhibit optimized sliding and friction properties.



In addition to its great hardness, biocompatibility^{5, 6, 7}, high corrosion resistance^{8, 9} and wear protection, LINK PorEx also features pronounced adhesive strength and high fatigue resistance¹⁰. The thickness is around $4.5 \pm 1.5 \mu\text{m}$. In terms of hardness, LINK PorEx reaches values of approximately 2400 HV (0.1 N), compared to approximately 550 HV (0.1 N) for CoCrMo alloys.

LINK PorEx is available for all configurations of the LinkSymphoKnee system in addition to LINK products such as the Unicdylar Sled prosthesis and the Endo-Model Knee Prosthesis System.

* LINK PorEx: TiNbN = Titanium-Niobium-Nitride; surface modification (gold colour)

¹Bioserv AG. Analysis of TiNbN in accordance with ISO 10993-5:2006.

²DOT GmbH and Nordum GmbH. Examination of influence of PVD coatings on the ion release of CoCrMo alloys in SBF buffer. 2006.

³Kremling U. Investigations on the tribological behavior of a knee joint prosthesis with the sliding combination TiN-polyethylene in a knee joint simulator.

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⁵Pappas MJ, Makris G, Buechel FF. Titanium nitride ceramic film against polyethylene. A 48 million cycle wear test. Clinical Orthopaedics and Related Research. 1995(317):64-70.

⁶Steinert A, Hendrich C, Merklein F, et al. Standardized testing of bone implant surfaces with an osteoblast cell culture cyste. III. PVD hard coatings and Ti6Al4V. Biomedizinische Technik. Biomedical Engineering. 2000;45(12):349-355.

⁷Streicher R, Schön R, Semlitsch M. Tribology and Possibilities for Optimizing the Wear Properties of Metal-on-Polyethylene Combinations for Artificial Joints. 1990.

⁸Thull R. Corrosion behavior of dental alloys coated with titanium niobium oxinitride. Deutsche Zahnärztliche Zeitschrift. 1991;46(11):712-717.

⁹Thull R, Handke K-D, Karle E. Examination of Titanium Coated with (Ti, Nb) ON and (Ti, Zr) O in an Animal Experiment. 1995.

¹⁰Wilson A, Matthews A, Housden J, Turner R, Garside B. A comparison of the wear and fatigue properties of plasma-assisted physical vapour deposition TiN, CrN and duplex coatings on Ti-6Al-4V. Surface and Coatings Technology. 1993;62(1-3):600-607.

Globally connected for the best care in joint replacement surgery

LINK is a renowned name in the field of orthopedics and trauma surgery, known for its commitment to providing top-quality products and innovative solutions to customers and patients worldwide. The company is dedicated to continually developing new technologies that cater to the evolving needs of both healthcare professionals and patients.

International presence and congress participation

To showcase its latest products and solutions, LINK actively participates in major international congresses, where it engages in fruitful discussions with experts from the orthopedics and trauma surgery fields. The company's booth serves as a hub of inspiration, upholding the legacy established by its founder, Waldemar Link.

Inhouse events and industry discussions

LINK also hosts its own events at congresses, providing a platform for

discussing current trends and topics within orthopedics and trauma surgery. This fosters an environment of collaboration and knowledge-sharing among professionals in the industry.

LINKademy: A center for learning and development

The LINKademy, established in 2010, is a testament to LINK's commitment to promoting knowledge exchange and professional development in the fields of orthopedics and trauma surgery. Offering high-quality continuing education and training courses that simulate real-life operating room conditions, the LINKademy is an invaluable resource for professionals looking to enhance their skills and expertise.

Advancing knowledge for patient benefit

At the core of LINK's mission is the goal of improving patient outcomes through the advancement of knowledge in orthopedics and trauma

surgery. By offering state-of-the-art products, cutting-edge solutions, and comprehensive education and training opportunities, LINK is dedicated to empowering healthcare professionals to better serve their patients.

Primary and revision cases with the LinkSymphoKnee

Tuberosity osteotomy and patella replacement in a 74-year-old female with rheumatoid arthritis and severe patellofemoral arthritis by Prof. Georg Matziolis



Top left to right: Severe patellofemoral arthritis and pathologic tibial tubercle-trochlear groove (TTTG) distance of 22 mm. Bottom left and middle: Postoperative X-rays show the LinkSymphoKnee PS in situ; right: Medialized patella.



A 74-year-old female patient with rheumatoid arthritis presented with severe patellofemoral arthritis and a pathologic tibial tubercle-trochlear groove (TTTG) distance of 22 mm on the right side.

The patient had mild varus and significant patellar maltracking. Rheumatoid arthritis of the knee often leads to progressive cartilage destruction and joint instability.

This case was further complicated by patellar maltracking as evidenced by

patellar tilt and displacement. The pathologic TTTG distance was a significant contributing factor to the patellar maltracking.

With the patient's consent, surgery was performed via a lateral approach according to the protocol established by Keblish.

The procedure began with a tuberosity osteotomy, which involves surgical cutting and realignment of the tibial tubercle. The tibial tubercle was medialized

15 mm to correct patellar malalignment. After successful medialization of the tubercle, a medialized patella replacement was performed.

Follow-up of a unicompartmental knee arthroplasty with a subsequent revision to a semi-constrained (PS+) knee arthroplasty in a 71-year-old patient by Prof. Georg Matziolis



From top left to right: Preoperative X-rays show extensive osteolysis around the tibial component and progressive varus deviation. Bottom left and middle: Postoperative X-rays show the LinkSymphoKnee PS in situ; right: Replaced patella.

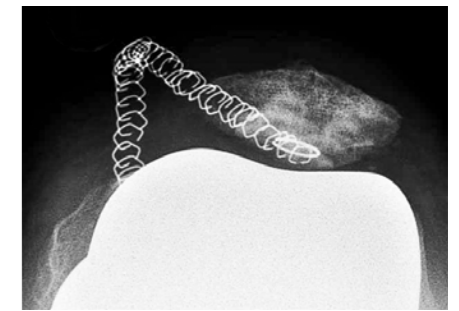


The 71-year-old patient has a history of medial unicompartmental knee arthroplasty (UKA) and patellofemoral joint (PFJ) surgery two decades ago. Recent complaints focused on pain, decreased range of motion, and a noticeable varus deformity of the left leg.

Given the patient's symptoms, the medical team determined that revision surgery to a LinkSymphoKnee (LSK) was the appropriate course of treatment. During the procedure, the osteolytic areas were filled with bone cement to

provide stability and support for the new prosthetic components. The patient also underwent a patella replacement due to excessive wear of the patellofemoral joint.

The possibility to choose a semi-constrained without additional bone cuts or stems is comfortable in such revision situations.



Prof. Dr. med. Georg Matziolis is Medical Director at the Waldkliniken Eisenberg, Chief Physician at the Clinic for Orthopedics and Trauma Surgery, and Professor of Orthopedics at the University Hospital Jena, Eisenberg Campus. Prof. Matziolis is a member of the international LinkSymphoKnee development group.

Primary and revision cases with the LinkSymphoKnee

77-year-old male patient with advanced gonarthrosis, pain and functional limitations on the right side
by Dr. Alois Franz



Top left and right: Preoperative X-rays show pronounced medial gonarthrosis on the right. Bottom left and right: Postoperative X-rays show the LinkSymphoKnee in situ.

A 77-year-old male patient presented with advanced gonarthrosis, experiencing pain and functional limitations on the right side.

Preoperative X-rays revealed pronounced medial gonarthrosis on the

right side. With the patient's consent, we proceeded to implant a posterior stabilized (PS) version of the LSK. Postoperative X-rays showed the successful placement of the LinkSymphoKnee in situ.

65-year-old female patient with gonarthrosis, massive patellar osteophytes, pain and functional limitations on the left side
by Dr. Alois Franz



Top left and right: Preoperative X-rays show gonarthrosis and massive patellar osteophytes on the left. Bottom left and right: Postoperative X-rays show the LinkSymphoKnee in situ.

A 65-year-old female patient presented with gonarthrosis, massive patellar osteophytes, pain and functional limitations on the left side.

Preoperative X-rays revealed the presence of gonarthrosis and massive patellar

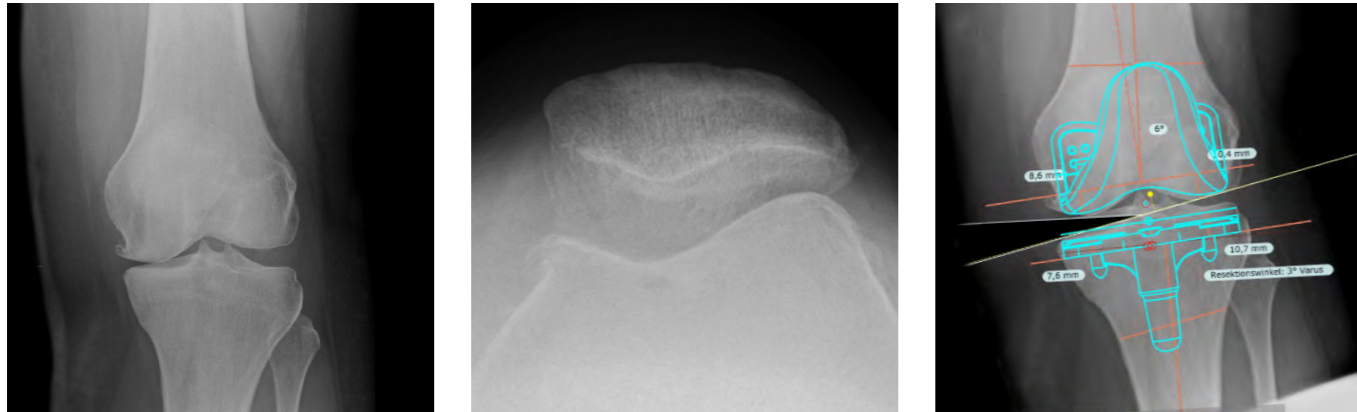
osteophytes on the left side. With the patient's consent, we proceeded to implant the LinkSymphoKnee PS. Postoperative X-rays showed the successful placement of the LinkSymphoKnee in situ.



Dr. Alois Franz is Medical Director of the Hospital of Orthopedic Surgery and Sportmedicine at the St Marienkrankenhaus Siegen, Germany, a certified Maximum Care Center for Arthroplasty. Dr. Franz is a member of the international LinkSymphoKnee development group.

Primary and revision cases with the LinkSymphoKnee

58-year-old female patient with symptomatic gonarthrosis of the left knee joint
by Dr. Jens Klingebiel



Top left and middle: Preoperative X-rays show at most mild but clearly symptomatic gonarthrosis and a slightly displaced patella; right: Preoperative planning sketch. Bottom left and center: Postoperative X-rays showing the LinkSymphoKnee in situ; right: Medialized patella.



A 58-year-old female patient in good general and nutritional health was admitted for planned total knee arthroplasty to treat symptomatic gonarthrosis of the left knee.

The patient is 169 cm tall and weighs 85 kg. The patient's pain began spontaneously approximately 15 years ago and had recently increased significantly in intensity. Due to the increase in intensity, the patient was limited in her activities of daily living. Despite conservative treatment, including analgesics and

physical therapy, there was no sustained relief of pain.

On examination, the patient had a small step gait with a slight limp on the left side. The left knee joint showed no swelling, redness, or effusion, but had marked retropatellar tenderness. Range of motion was 0/0/110° with retropatellar and medial joint space pain. Lateral ligaments were stable, and peripheral circulation, motor function, and sensation were intact. With the patient's consent, we implanted a cemented

LinkSymphoKnee, CR (cruciate retaining) version with tibial monoblock. Surgery took 33 minutes.

82-year-old male patient with increasing discomfort in the right knee joint and severe limitations
by Dr. Jens Klingebiel



From left to right: Preoperative X-rays show pronounced gonarthrosis of the right knee and a slightly displaced patella. Bottom left and center: Postoperative X-rays showing the LinkSymphoKnee in situ; right: Medialized patella.



An 82-year-old male patient presented to our clinic for total knee arthroplasty of the right knee. He had been experiencing symptoms of increasing discomfort for several years. Recently, his range of motion was severely limited.

The patient, who is 178 cm tall and weighs 78 kg, was in good general health with a normal nutritional status for his age. There was no evidence of cardiopulmonary decompensation or other medical abnormalities. Clinical and radiologic examinations revealed

pronounced gonarthrosis of the right knee, irritated skin, and massive varicose veins, including in the area anterior and medial to the knee. The patient also had a limping gait. Flexion/extension was measured as 90/10/0°.

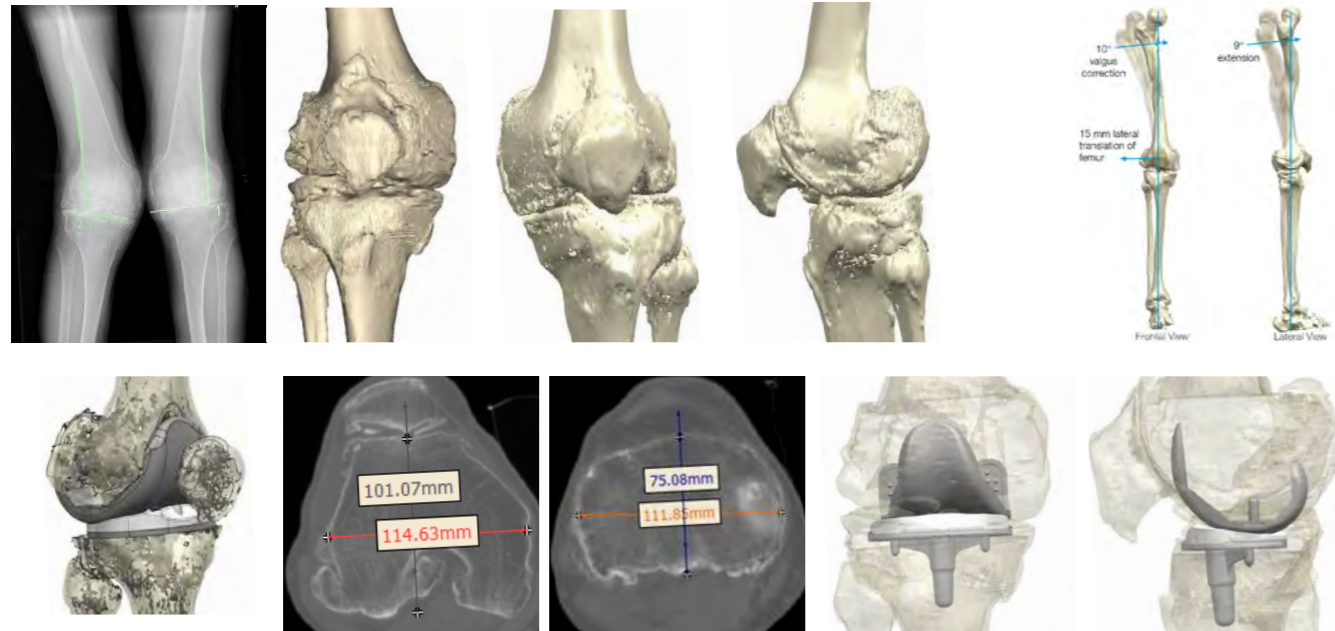
With the patient's consent we implanted a cemented LinkSymphoKnee CR version with tibial monoblock. The procedure took 28 minutes.



Dr. Jens Klingebiel is head physician of the General Orthopedics and Arthroplasty Center at the Orthopedic Clinic in Hessisch Lichtenau, Germany.

A special case: Oversized Custom LinkSymphoKnee

Achieving optimal joint stability in right and left knee arthroplasty in a 59-year-old male patient with height of 203 cm and weight of 114 kg
by Dr. Roger Paterson



Top from left: A preoperative X-ray and the preoperative bony 3D models show valgus deformity and significant degenerative joint disease of the right and left knee. Right and bottom left: Planning the implantation of a LinkSymphoKnee: Adjustments included correction of the valgus deformity by 10 degrees and extension of the femur by 9 degrees and 15 mm lateral translation. Bottom middle: Dimensions of the patient's huge femur and tibia. Right: The size relationships of the patient's bones are shown by a size 10 LinkSymphoKnee projected into the patient's 3D model.

A 59-year-old male patient with osteoarthritis and valgus deformity of both knee joints underwent knee arthroplasty at intervals of several weeks. The implant is an oversized (135% over the largest size) individual cemented LinkSymphoKnee CR prosthesis that was designed and manufactured by customLINK. The components underwent a complex manufacturing process with creation of a custom mold, TiCaP coating (double coating of titanium and calcium phosphate), and custom instruments. The patient's knee size (see dimensions above) did not allow for the largest standard implant. The patient also received a patella component cemented with X-Linked Vitamin E UHMWPE.

During surgery, a medial parapatella arthrotomy was performed to expose

the joint. Due to the size of the patella, adequate visualization of the joint space could not be achieved. Thus, the surgeon performed an articular surface resection, which allowed for improved exposure. The surgeon used a customized distal femoral cutting guide provided by customLINK to mark the desired resection level and proceeded with the distal femoral cut. The leg was placed in extension so that an initial ligamentous balance assessment could be made.

The right femur distal cut was done in valgus for functional ligament balancing given his pre-existing 6 degree valgus malunion of the proximal femoral shaft, which also demanded about 6 degrees of undercorrection of the severe preoperative valgus deformity. The PSI cutting blocks were used for both knees, backed up by computer-aided alignment. On

the right, the distal femoral cutting block was rotated to substantially reduce the planned 15 mm medial distal femoral offcut.

The surgery proceeded with the 4-in-1 femoral resections using a customized 4-in-1 cutting block. After removing resected bone and posterior osteophytes from the femur, the customized femoral and tibial trial components could be positioned. Although the surgeon was satisfied with the fit of the trial components, he felt that joint stability was suboptimal and decided to perform an additional tibial surface cut to optimize alignment and also use a varus/valgus recut guide to achieve desired alignment and balance of the femoral and tibial resections. A lateral release of the patella plus an extensive release of ITB and the femoral attachment of the lateral

ligament complex within a soft tissue sleeve was required to achieve ligament balance at the desired degree of correction of alignment.

After repositioning trial components and preparing the tibia for keel and fins, he trialed a 12 mm tibial component. Balance and fit were satisfying. Definitive tibia and patella components were implanted first using cement for fixation. The insert was locked in place and the uncemented femur impacted. In addition to the right knee arthroplasty, the patient also underwent a left knee arthroplasty in a similar way a few weeks later.

The implant for the left knee was also a custom, oversized uncemented LinkSymphoKnee CR femoral component made of CoCrMo (cobalt-chromium-molybdenum) with a TiCaP coating,

a cemented monoblock as tibial component and a tibial plateau with X-Linked Vitamin E UHMWPE.

With the residual valgus of 3 degrees on the left and 6 degrees on the right (due to the previous 6 degree valgus malunion femoral fracture), the surgeon was very satisfied. The patient's preoperative alignment was 19 degrees valgus on the right with lateral osteoarthritis and 1 degree valgus on the left with medial osteoarthritis.

At the most recent review, 3 months after the right TKR and 7 weeks after the left, the patient had full active extension of both knees and 130 flexion on the right and 110 on the left and improving.



Top and bottom: Postoperative X-rays show the oversized custom LinkSymphoKnee in situ. The cause of the patient's gigantic bones remains unresolved. His jaw and hands are not those of an acromegalic. He has short 4th metatarsals, possibly indicating pseudohypoparathyroidism of unknown significance.



Dr. Roger Paterson is Knee, Hip and Ankle Surgeon and the co-founder of SPORTSMED-SA, now known as sportsmed, in metropolitan Adelaide, Australia, and regional hubs. Dr. Paterson has particular knowledge and expertise in the biomechanics and reconstruction of the anterior cruciate ligament, and patello-femoral problems.



»The LinkSymphoKnee is simply an incredibly good knee system that is a joy to use« *Dr. Jens Klingebiel*

A conversation with Dr. Jens Klingebiel and LINK Medical Device Consultant Fabian Wallat about the purpose of vitamin E-enhanced inlays, postoperative patient reports, and the consequences of unstable instruments.

Dr. Klingebiel, how did you become aware of the LinkSymphoKnee?

Dr. Jens Klingebiel: I wanted a single knee system where the components were available in standard metal alloy and nickel-free. I also wanted the UHMWPE* to be stabilized with vitamin E, which makes it extra durable. The LinkSymphoKnee has given me all three of these benefits, and I was enthusiastic about it from the start.

Fabian Wallat: The timing was perfect. LINK launched the LinkSymphoKnee just as Dr. Klingebiel was looking for it.

Do all your knee patients receive vitamin E inlays (E-DUR)?**

Dr. Jens Klingebiel: Yes, because I believe this is the future. You can debate whether an 85-year-old patient needs a vitamin E doped inlay or not. But why shouldn't I treat all patients in the best possible way, regardless of their age? I believe that one of the main reasons why knee implants fail is the polyethylene. And if there is a way to improve this situation, it will also increase the likelihood that the prosthesis will last longer. Therefore, in our clinic, all

patients receive a vitamin E doped inlay with the LinkSymphoKnee, regardless of their age.

How do you rate the LinkSymphoKnee in terms of joint mobility and stability?

Dr. Jens Klingebiel: The system offers a level of lateral stability that I have not seen in any other bicondylar knee implant, I have used. Especially in the mid-flex plane, around 30 to 40 degrees, all other systems I know show some laxity in flexion and extension. In contrast, the LinkSymphoKnee remains stable

throughout. This high level of stability is truly remarkable. My senior surgeons say the same thing. The retropatellar contact pressure is also significantly lower. Since I have been using the system, I have not had a single patella adjustment.

You have already implanted more than 500 LinkSymphoKnees since the end of 2021. Have your overall expectations for the system been met?

Dr. Jens Klingebiel: My basic expectation when introducing a new knee system is that patients can forget about their previously painful knee after surgery. Although we only have one and a half years worth of results today, I have never seen such high early patient satisfaction as with the LinkSymphoKnee. Patients are telling us relatively early in the post-operative period that they have less pain or no pain at all. Even if they previously had a severe valgus or varus knee with a feeling of instability, they report early on that they feel confident on their feet again.

Mr. Wallat, you are responsible for the care of Dr. Klingebiel and his team at LINK. Can you give us a little insight into how you work together?

Fabian Wallat: The interaction with Dr. Klingebiel and his team is very close and has developed better and better over a long period of time. We use various communication channels, including telephone, e-mail and others, but face-to-face meetings are also an important part of our collaboration. Spontaneous questions often come up, which we then tackle together.

How did you train Dr. Klingebiel's team for the LinkSymphoKnee?

Fabian Wallat: I always base my training sessions on the wishes of the surgeons and the surgical team; for example, I

adapt the training sessions to their daily schedule. I can be available throughout the day, so everyone has the opportunity to look at the instruments and practice on an artificial bone. However, in my opinion, the most effective method is to train during a live surgery. I like to attend these surgeries and share my experiences, provide assistance and support the teams in any way I can.

Was it particularly challenging to train the surgical technique for the LinkSymphoKnee?

Fabian Wallat: No, because with the LinkSymphoKnee, and generally with LINK products, there is always a surgical technique that we suggest, but the surgeon has the freedom to modify it if he feels it necessary. So each surgeon can ensure the best possible outcome for the patient.

Dr. Jens Klingebiel: The instruments are optimal, they are easy to use. This is not always the case, as there are knee systems that are less stable and require additional pins, for example, to prevent wobbling during the sawing process. The LinkSymphoKnee is simply an incredibly good knee system that is a joy to use. Because it fits so well and because the instruments fit so well. That also makes it very quick to implant.

Dr. Klingebiel, Mr. Wallat, thank you very much for this interview.

* UHMWPE: Ultra-high-molecular-weight polyethylen: well established polyethylene in medical use

** E-DUR = highly cross-linked PE with antioxidant vitamin E



Dr. Jens Klingebiel is head physician of the General Orthopedics and Arthroplasty Center at the Orthopedic Clinic in Hessisch Lichtenau, Germany.



Fabian Wallat is LINK Medical Device Consultant and Product Specialist for the North-East Region, Germany.



Back row from left: Malte Köster da Veiga (Technical Purchasing), Melanie Bünning (Specialist Clinical Affairs – Clinical Evaluation), Amos Balzarini (Senior R&D Engineer), Marco Iredi (Head of Research and Development), Lars Timm (Production Planning), Hans-Henning Buhmann (Team Leader Production Unit CAM Programming/Industrial Engineering), Dario Lupo (Head of Marketing); front row from left: Nico Schmidt (Technical Purchasing), Leonie Butenschön (Team Leader Project Management R&D), Andreas Regenstein (Manager Quality Assurance Implant), Eugen Martens (Inspection Planning)

»We work in evolutions for patients, not pseudo-revolutions just for marketing«

A conversation with the team leaders of the LinkSymphoKnee development group Leonie Butenschön and Dario Lupo about visions, the selection of developers and the success factors of a product development.

Ms. Butenschön, Mr. Lupo, how does the development of a new LINK product begin?

Dario Lupo: I think the success of a project depends on the vision. The LinkSymphoKnee was Mr. Link's vision; he wanted to develop a completely new system, but above all a better, more complete system. The LINK company assembled the best possible team of project managers, engineers, surgeons and many other experts to achieve this. That was in 2014. In June 2021, Mr. Link's vision became reality with the first implantation of the LinkSymphoKnee in Europe.

Leonie Butenschön: Right from the start, we wanted to have a system that would meet the needs of populations around the world with their differing anatomies. That's why we put together a global team with surgeons from almost every continent.

The LinkSymphoKnee is based on the proven LINK implants such as the LINK GEMINI SL Total Knee Replacement and the Endo-Model Knee System. What is new about it?

Dario Lupo: The LinkSymphoKnee embodies LINK's slogan: Trust. Innovation. Progress. The LinkSymphoKnee

is based on decades of experience and very successful existing products. We have retained the good features of these products and made small optimizations in all areas. For example, we achieved more robust kinematics and very good fixation of the components. We have also introduced innovative materials such as the surface modification LINK PorEx and the E-DUR technology. The LinkSymphoKnee is a statement: We work in evolutions for patients, not pseudo-revolutions just for marketing.

What were the next steps in the development process?

Leonie Butenschön: After analyzing whether the project would be cleared for the US market by the Food and Drug Administration (FDA), our production department checked whether the new functions would be feasible from a manufacturing point of view. Our instrument department took care of having the instruments manufactured. Our clinical department knows all the literature on knee arthroplasty and told us what else we need to consider for the new product.

Dario Lupo: One of many important aspects is the collaboration with the production department. LINK produces everything from raw material to the finished implant from a single source. When we develop a system like the LinkSymphoKnee, this also allows us to keep an eye on the efficiency of the individual production steps.

How was the collaboration with the surgeons in the development group?

Leonie Butenschön: We had many meetings with the surgeons – for the LinkSymphoKnee it was three meetings per year. For each meeting, we manufacture prototypes that are reviewed and often tested by the surgeons. After that, we discuss what needs to be changed. At this point, we talk with production and other departments as well to find a good solution or compromise. For example, if the surgeons say that a detail of the design needs to be slimmer or »beefed up«, we present our solution at the next meeting with a new prototype.

Dario Lupo: The LinkSymphoKnee includes a large number of configurations as well as primary and revision instruments, so it required many prototypes and many sessions. In total, it took us only seven years to develop a complete contemporary knee prosthesis system for primary and revision care. Not many companies are able to do that.

Is the design affected by the fact that the surgeons come from different countries?

Leonie Butenschön: The Americans, for example, have been the driving force behind the simplicity and efficiency of the instruments. For this reason, LinkSymphoKnee instruments are simple and easy to use. The European surgeons wanted a very thin femur, and the Asian surgeons wanted a fine-tuning mechanism, very small dimensions and many adjustment options. So there were different philosophies, but together we finally found the best compromise.

How are the surgeons selected for the development group?

Dario Lupo: We always try to assemble the best possible group of surgeons. With LinkSymphoKnee, we didn't look for surgeons who only use LINK products, quite the opposite. We wanted to have surgeons with divergent experiences and backgrounds who have a different philosophy when it comes to implanting knee prostheses. The recognized scientific background was also important to us.

When is a product development completed?

Leonie Butenschön: That's the moment we call design freeze, when the surgeons say, "This is the way to go." But after that, the work continues. The most important next step is to get the product approved. For that we have to have mechanical tests done in certified labs. Some tests take up to three months. And if the results are not satisfactory, we have to rework. Finally, once we get a CE Mark and FDA clearance for the product, everything is ready for the launch phase and user training.

What is the main success factor in the development of the LinkSymphoKnee?

Dario Lupo: The development of the LinkSymphoKnee was a great team

effort because everyone was committed to the project and there was a very pleasant atmosphere between all team members. I am convinced that such a development would not have been possible without this great team of people who worked with a lot of passion and dedication and were willing to invest many hours in the success of the project.

Leonie Butenschön: We had the opportunity to turn ideas into prototypes and finally into a great product. And when you then see this product in patients, it's a great feeling.

Ms. Butenschön, Mr. Lupo, many thanks for the interview.



Leonie Butenschön, MSc, is a development engineer and Team Leader Project Management R&D at LINK.

Dario Lupo is a biomedical engineer and Head of Marketing at LINK.

»No single feature of the LinkSymphoKnee is more important than the others«

Prof. Bernardo Innocenti is a member of the international development group for the new LinkSymphoKnee. As a professor of biomechanics, he played a leading role in analyzing the prosthesis mechanics. In this interview, he explains how the new LINK implant system works.

Prof. Innocenti, what is the basic idea behind the new LinkSymphoKnee?

The main idea was to create a system as close as possible to the needs of the patients. We wanted to develop something new, of course, but above all something better. Because, when a prosthesis replaces the knee joint, the patient should be pain-free and fully mobile again and not feel the difference from a natural joint.

The LinkSymphoKnee builds in important features on existing structures and thus builds on the history of LINK products from the Sled Prosthesis to the Endo-Model Knee System. Why?

We have taken the best structures from these and tuned the individual parameters so that they work together in the best possible way. Each feature has its own history, but in the LinkSymphoKnee, no single feature is more important than the others.

How were the mechanics of the LinkSymphoKnee developed?

First, we took a close look at the design of the existing LINK knee prostheses. We analyzed how they work in detail and which of their parameters could possibly be optimized. We also listened carefully to what surgeons expect from a new implant and tried to see the mechanics of them from their point of view. The information we obtained in this way is very close to real-world data.

You have also carried out numerous laboratory tests. What did you focus on?

We evaluated various options and design features and tested kinematics, mechanical stability and congruency, among other things. For example, we analyzed the biomechanics of walking and squatting to find out where a knee joint has its performance limits. From a biomechanical point of view, walking

is important, even though it is not a very demanding activity. Squatting is much more demanding. In it, you flex the knee joint a lot, and the force acting in the joint increases significantly with flexion. We then used the biomechanical data of the knee joint during walking and squatting to develop the biomechanics of the LinkSymphoKnee.

The femoral design of the LinkSymphoKnee has a gradually decreasing flexion radius, uniform distal and posterior thickness, and graduated depth of the trochlear groove. What do these design features accomplish?

One development goal was to equally consider and optimize the performance of all three joints in the knee – the medial tibiofemoral, lateral tibiofemoral and patellofemoral joints. We developed the gradually decreasing flexion radius to reduce instability in mid-flexion. The

uniform distal and posterior thickness is designed to facilitate extension and flexion gap consistency, and the graduated depth of the trochlear groove reduces the risk of patellofemoral joint overstuffing and ligament strain. The latter endows the LinkSymphoKnee with an extension mechanism where patellar flexion, internal/external rotation or tilt can be as close as possible to physiological values.

Early users of the LinkSymphoKnee refer to it as the gentle flexing knee. What does that mean?

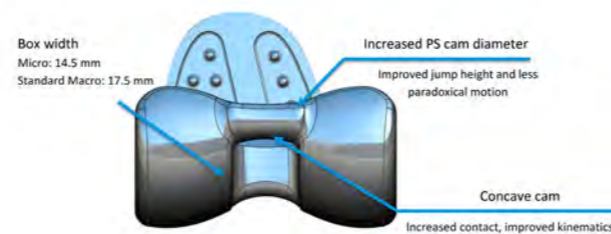
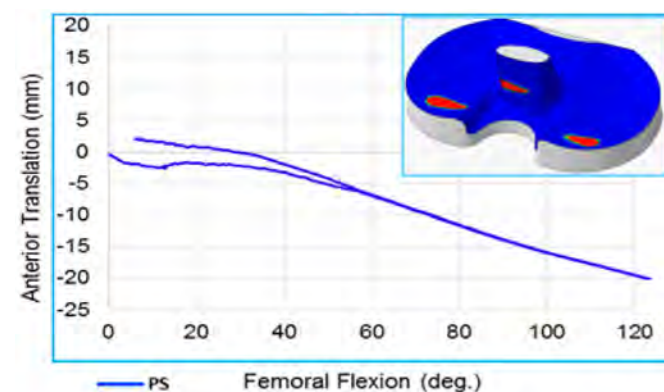
When the knee is flexed, the articulating surfaces in the joint become significantly smaller. This is at the expense of stability. Our idea was therefore to keep the articulating surfaces as large as possible over the entire range of motion and thus to develop a knee implant that functions perfectly in full extension without losing stability in flexion. An increased tibiofemoral contact area also reduces contact stress in the joint. This is what we have achieved with the high congruency. I think that's what is meant by the gentle flexing knee.

In the development group for the LinkSymphoKnee, you worked with surgeons from different countries. How was the cooperation?

It was unusual at first to interact with each other and speak the same language, but we eventually managed. Each member of the development group had their own ideas about the LinkSymphoKnee, although the goal was the same for everyone. The strong interaction between us was really a keypoint, and I think that makes the difference. Most of the time, after all, the development of a new implant is done internally, without the involvement of external clinical experts. We did it differently and in the end everyone agreed with the result because everyone could see the significant improvements compared to other implants on the market. With the LinkSymphoKnee, we wanted to design

a system that was as close as possible to the needs of patients and surgeons, and I think we succeeded very well.

Prof. Innocenti, thank you for the interview.



Left: Improved deep flexion performance of the LinkSymphoKnee; right: Improved post an cam



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.

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