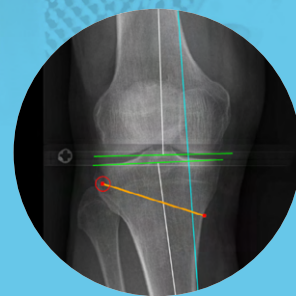
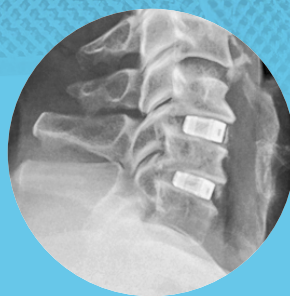
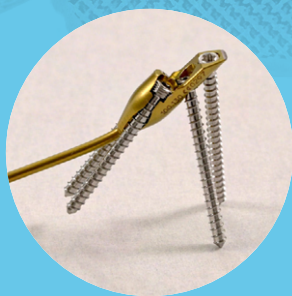
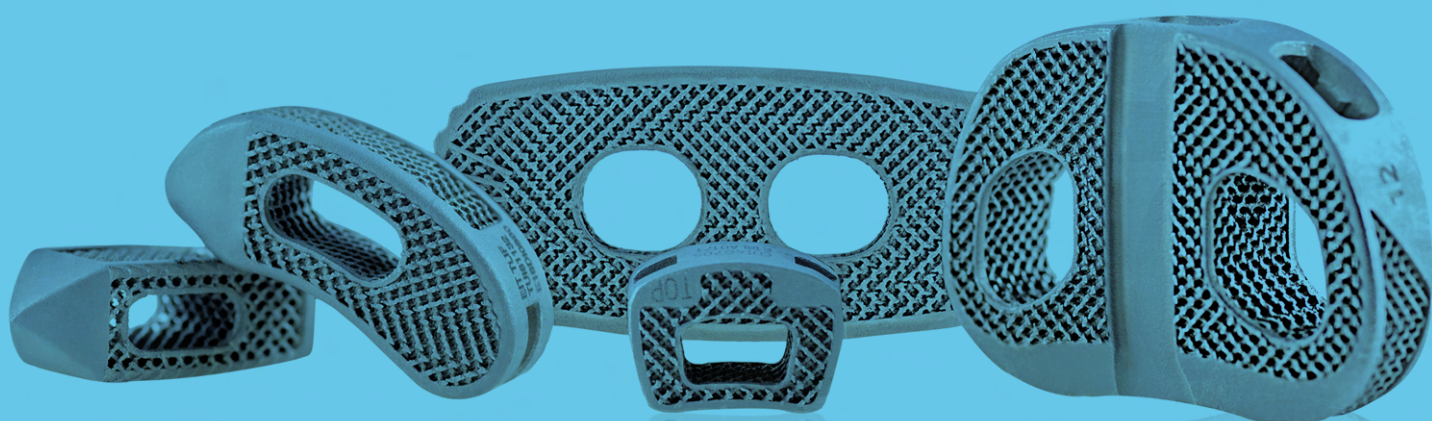


Innovations 2022





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Hazards and labeling

Due to varying countries’ legal and regulatory approval requirements, consult the appropriate local product labeling for approved intended use of the products described in this brochure. All devices in this brochure are approved by the AO Technical Commission. For logistical reasons, these devices may not be available in all countries worldwide at the date of publication.

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The AO and RIMASYS: investing in the frontier of surgical education



Figure RIMASYS' debut at the 2021 AO Davos Courses of the Shard—RIMASYS' unique mobile operating room.

For more than 60 years, the AO has built and fortified its reputation on a bedrock of partnerships among surgeons, researchers, innovators, and educators that has yielded revolutionary surgical methods and premier international educational offerings. In September 2022, the AO celebrated its ongoing collaborative founding spirit with the announcement of the organization's full-stake investment in [RIMASYS](#), a technology-driven health-tech start-up based in Cologne, Germany. This transaction concludes an initial minority investment in RIMASYS completed by the AO in February 2021.

The cooperation between the AO and RIMASYS centers on a shared strategic vision and our joint work in developing reliable, scalable solutions to engage and educate surgeons. Lifelike fracture simulations, originally RIMASYS' core technology, have already been used in several AO educational offerings. RIMASYS has showcased their cutting-edge developments in medical education and communication at the AO Davos Courses, where they created an immersive 3D platform bringing our flagship event into the virtual realm, and where they debuted their unique mobile operating room—the Shard.

RIMASYS and the AO remain separate organizations, with RIMASYS operating as a legal entity headquartered in Cologne, Germany, with its dynamic founders group committed to remaining at the helm of their company. RIMASYS retains its name, organizational structure, and business strategy while continuing as a reliable partner serving its customers and meeting its business obligations. Educational offerings such as World Surgery Tour and Trauma Academy will accelerate its growth independently.

Both parties will continue their existing partnerships; the AO continues its exclusive partnership with its industrial partner

DePuy Synthes organizing more than 900 educational global events annually while RIMASYS continues its multivendor business model and acts as a source of innovative new educational formats, products, and services for the AO's global surgeon network.

RIMASYS will benefit from the AO's expertise and extensive global reach to scale and roll out its educational offerings around the world. Meanwhile, the AO benefits from the fast-paced innovative development cycles of this agile young organization focused on enhancing surgical education, skill training, and medical device development.

"We believe that we complement each other's strengths to jointly address the long-term challenges of converging the real and digital world. Our ambition continues to best satisfy the needs of the new surgeon generation and all our partners who have supported us since the foundation of our company. Our dynamic start-up spirit will benefit from the global reach and reputation of the AO to build the professional network of the future for the surgical community—and ultimately improve patients' lives," says Marc Ebinger, CEO, and co-founder of RIMASYS.

"RIMASYS is a young, agile, and pioneering organization with a proven track record in educational innovation. With its motivated team and ambitious founders, it will help us drive innovation in online and offline education activities. We will ensure that RIMASYS retains its autonomy while receiving the support it needs to maintain its innovative spirit and unconventional solution development—we are proud to have them aboard and excited about the opportunities that this creates for both organizations," adds Florian Gebhard, president of the AO Foundation.

Cannulated Screw System CSS+

Cannulated screws are commonly used by orthopedic surgeons for the fixation of multiple fracture patterns and bone reconstructions. The screw cannulation allows placement over a guidewire to facilitate better accuracy before drilling or screw insertion. The use of cannulated screws adopts the principles of interfragmentary screw fixation and aims to optimize screw position.

In December 2021 the AO Trauma Technical Commission approved the Next Generation Cannulated Screw System Plus (CSS+) which was designed and developed by the Foot and Ankle Expert Group in collaboration with the AO primary industrial partner, DePuy Synthes.

Ranging in diameter from 2.0–7.5 mm (with 0.5 mm diameter increments from 2.0– 4.5, and 1.0 mm increments from 5.5–7.5), the color-coded screws are available in titanium with short and long partial thread as well as fully threaded (Fig 1). All implants are available in sterile and non-sterile packaging. Color-coded washers are available for every screw size (Fig 2).

The Next Generation Cannulated Screw CSS+ is indicated for use in bone reconstruction, osteotomy, arthrodesis, joint fusion, fracture repair, and fracture fixation of bones appropriate for the size of the device. Color-coded instrumentation corresponding to its color-coded screw promotes ease of use and implantation (Fig 3).



Fig 1 The comprehensive and color-coded portfolio offers various options for multiple locations and varying anatomy.

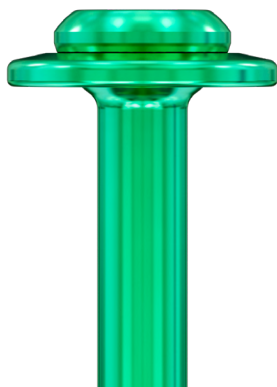
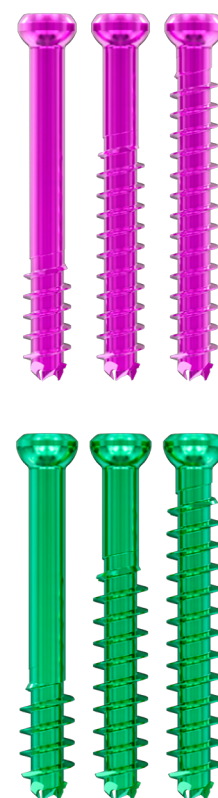


Fig 2 All screw sizes can be inserted with a compatible washer.



Fig 3 Color-coded instrumentation provides an enhanced user experience. Example shown: 1.4/2.7 mm drill guide for 3.5 and 4.0 mm screws.



In response to a clinical need for improved cutting performance the new and patented cannulated screw tip reduces the axial load needed to advance the screw; thereby achieving a more precise insertion with less, or no need for, predrilling and tapping (Fig 4).

The common problem of guidewire deflection was addressed with new cobalt chrome (CoCr) guidewires which provide a 29% higher bending stiffness compared with their stainless-steel counterparts. This ensures a straighter path and maintenance of the intended screw trajectory on insertion (Fig 5).

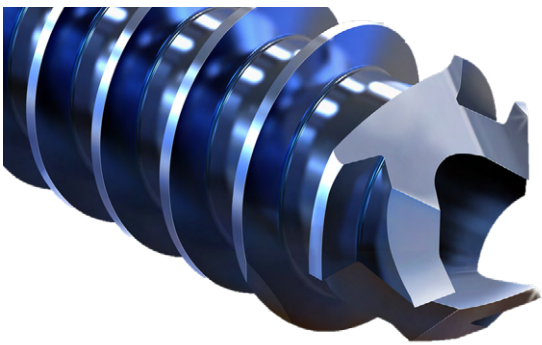


Fig 4 Innovative screw tip provides improved cutting performance and ease of insertion.

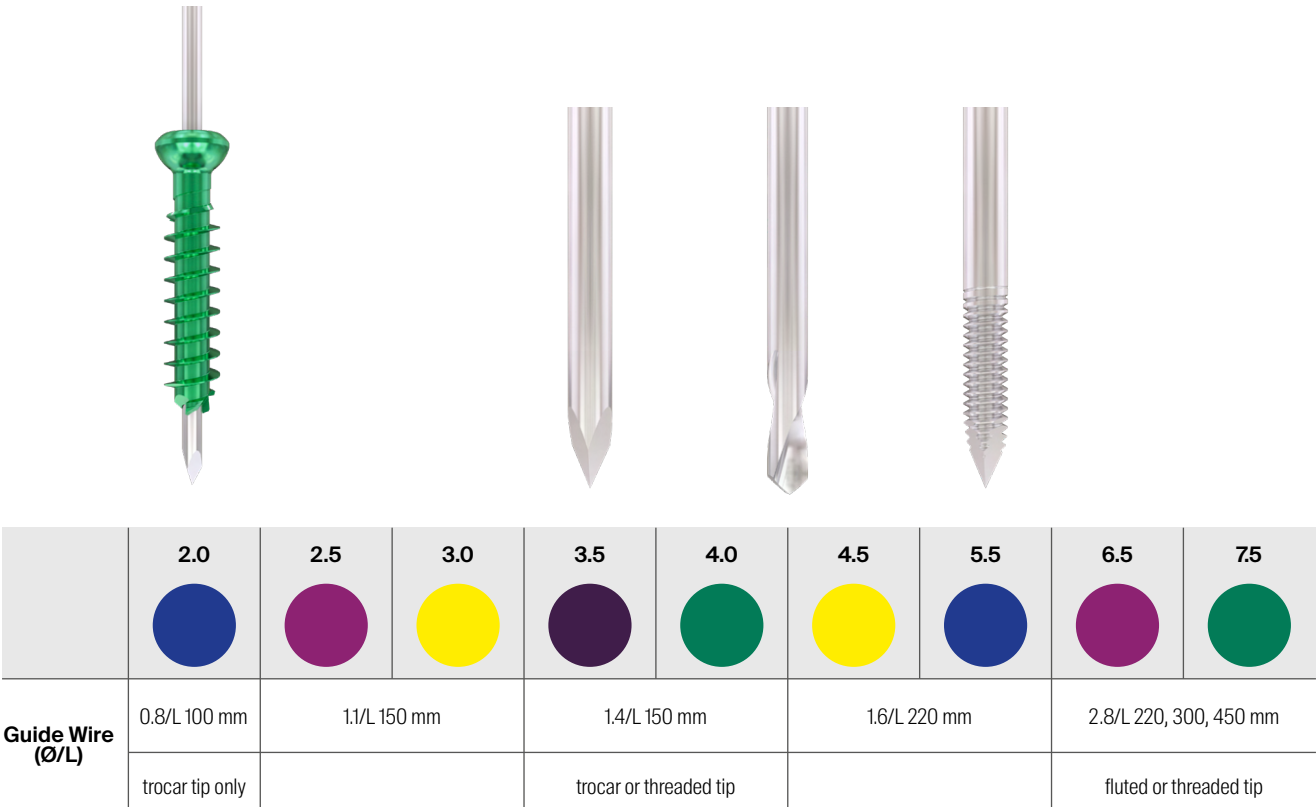


Fig 5 CoCr Guidewire enhances the screw insertion process and maintains alignment. Trocar fluted and threaded tip options are available depending on screw size.

The system is neatly divided into preconfigured sets—small, medium, and large. These sets house separate screw racks and instrument trays according to size that is designed to provide efficiency in the operating room supply sourcing (Fig 6).

Basic instruments in the sets are size appropriate and include guidewires, drill bits, drill guides, countersinks, measuring

devices, screwdrivers with handles, and drive adaptor for power insertion. Additional instrumentation is provided for the medium set and large set trays which includes tissue protectors, guide-wire sleeves, long drill bits, countersinks, screwdrivers, and guidewires. Three ergonomic screw handles are included in the set. Unique to the large trauma set (6.5 and 7.5 mm cannulated screws) is the inclusion of multiple and adjustable wire guides for accurate guide wire placement (Fig 7).

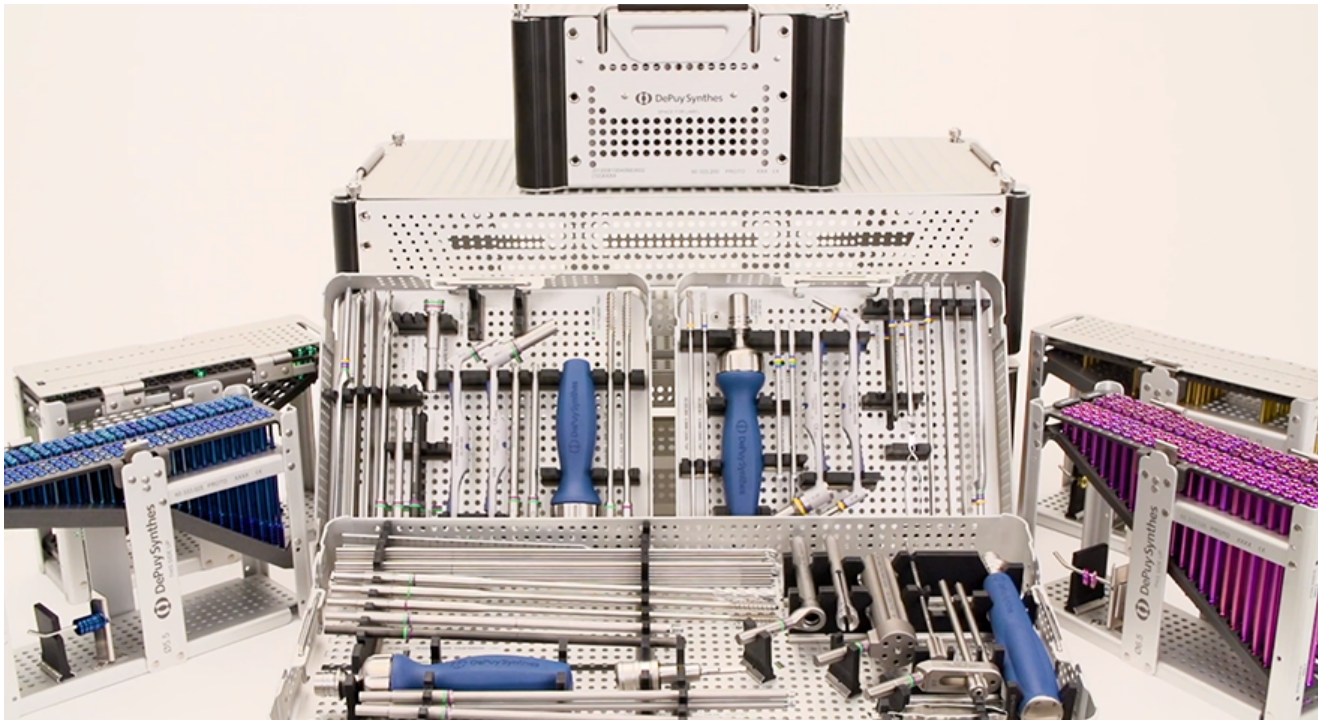


Fig 6 System configurations include screws and compatible instruments:

- Small set: 2.0, 2.5, 3.0, 3.5, and 4.0 mm screws
- Medium set: 4.5 and 5.5 mm screws
- Large set: 6.5 and 7.5 mm screws
- Large trauma set: 6.5 and 7.5 mm screws and long instruments specific for trauma use



Fig 7 Multiple and adjustable wire guides are available as modular options for both the 6.5 and 7.5 mm cannulated screws.

2D Deformity Analysis and Osteotomy Planning Tool

Clinical problem

Knee joint preservation procedures have witnessed a resurgence of interest during the last 20 years. Congenital and posttraumatic deformities may lead to overloading of a compartment or even osteoarthritis. Osteotomies around the knee help to realign the limb, shift the load from the arthritic compartment to the intact compartment, and preserve the joint as an alternative to partial or total joint replacement.

Even in cartilage and meniscal procedures a physiological alignment is a prerequisite for success. Recent research also recommends performing osteotomies in ligament procedures to reduce the risk of revision.

In posttraumatic situations deformities may hinder an adequate bone healing because of biomechanical changes. Osteotomies can realign the limb, restore physiological biomechanics, and thus support bone healing.

The final limb alignment is a key predicting factor for favorable outcomes. Several steps are essential to achieve a perfect limb alignment. A significant contribution to the success of knee osteotomy is a thorough understanding of deformity analysis and surgical planning. There are two different steps: Deformity analysis enables the surgeon to identify the location of the deformity and choose the correct location and type of osteotomy, which is subsequently accurately planned.

Traditional deformity analysis and planning with hand drawings is time consuming, especially in cases in which more than one osteotomy is needed like double-level osteotomies. Since digital x-rays became the global standard, digital deformity analyzing, and planning are of substantial interest. Several digital planning software tools are available. A user-friendly interface is a vital feature of any software solution.

Development project

The mediCAD AO Osteotomy software has been developed by the AO TC Deformity Correction Planning Task Force in collaboration with mediCAD Hectec GmbH. It is the first fully automated 2D osteotomy planning tool based on long leg x-rays in the coronal plane. The software uses artificial intelligence to automatically detect relevant landmarks that are required for the calculation of all alignment parameters needed to analyze the deformity. According to the deformity, the software provides a recommendation whether single tibial, single femoral, or double-level osteotomy is preferable to correct the alignment. Furthermore, hinge point and cutting lines are automatically suggested and correction to a default target simulated. The user can follow the workflow by accepting all recommendations unchanged, or edit them at any time, or even switch to a completely manual planning of the surgical procedure. Templating of plates and screws for fixation from various manufacturers is also possible. X-rays in several image formats can be used. The software makes it feasible to export the deformity, analyzing and planning with intermediate steps of the full procedure to be accessible in the operating room.

Availability of the mediCAD software solutions

Currently, the software must be installed on a client or clinical server to be available to the planning surgeons. A web-based version is expected by the end of 2022.

Details of planning

For digital planning of a deformity correction in the coronal plane, a long leg full weight-bearing x-ray in true AP is essential. A calibration ball or a scale is required to calibrate the planning and to measure wedge heights. A correct AP projection of the x-ray is the prerequisite to measure all angles accurately and must be controlled by the surgeon.

The software automatically detects all necessary landmarks (Fig 1). Based on their position (which can be adjusted manually) the software calculates all essential values (axis, joint lines, and angles) and delivers a detailed report. A traffic light system illustrates normal, intermediate, or pathological values.

Following the deformity analysis, the software automatically recommends a surgical procedure, eg, medial opening wedge high tibia osteotomy, depending on the type of deformity (Fig 2). The user can follow the proposed procedure or choose individual options.

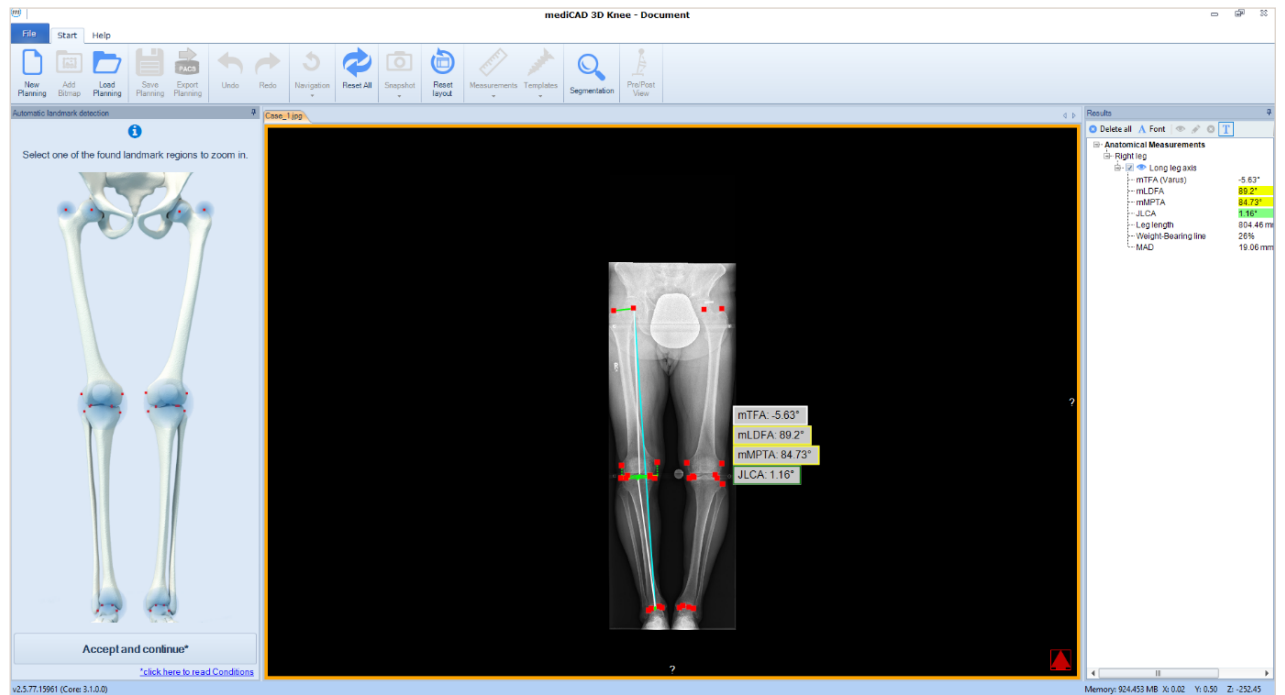


Fig 1 Detected landmarks and determined axes after automated segmentation.

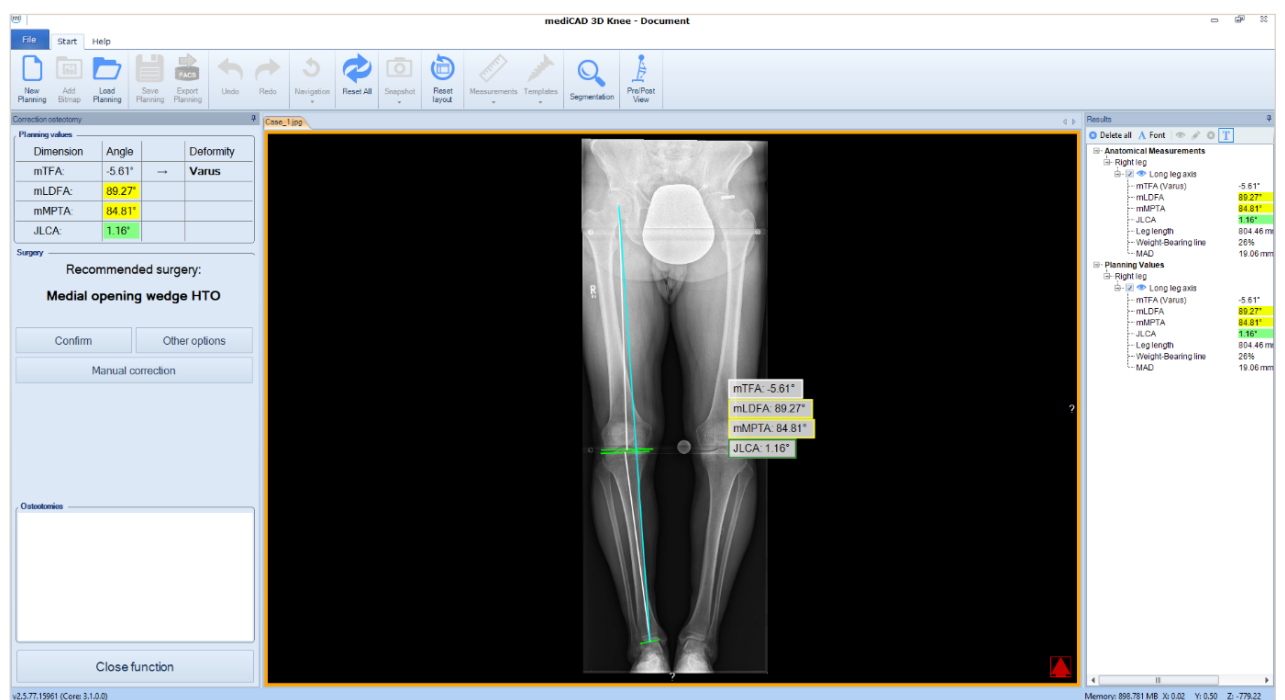


Fig 2 Deformity analysis with recommendation of osteotomy.

Once the procedure is selected, the software automatically places the cutting line and hinge point for the chosen osteotomy adapted to the individual anatomical condition (Fig 3).

Next, deformity correction is visualized to the preferred new alignment. If a monofocal correction results in pathological joint angles, the implemented algorithm recommends double-level osteotomy and balance the two osteotomies between multiple constraints and normal values such as wedge heights, mechanical medial proximal tibial angle (mMPTA), mechanical lateral distal femoral angle (mLDFA), mechanical tibiofemoral angle (mTFA); (Fig 4).

The Deformity Analysis and Osteotomy Planning Tools are offered to AO Trauma members at a discount of 20% for software licenses and 10% for services, such as on-site training, installation and alike, on the regular price as listed in official price lists in the country, where the AO Trauma member is located and working.

Please contact [mediCAD](#) if you are interested to learn more about the mediCAD osteotomy planning tool.

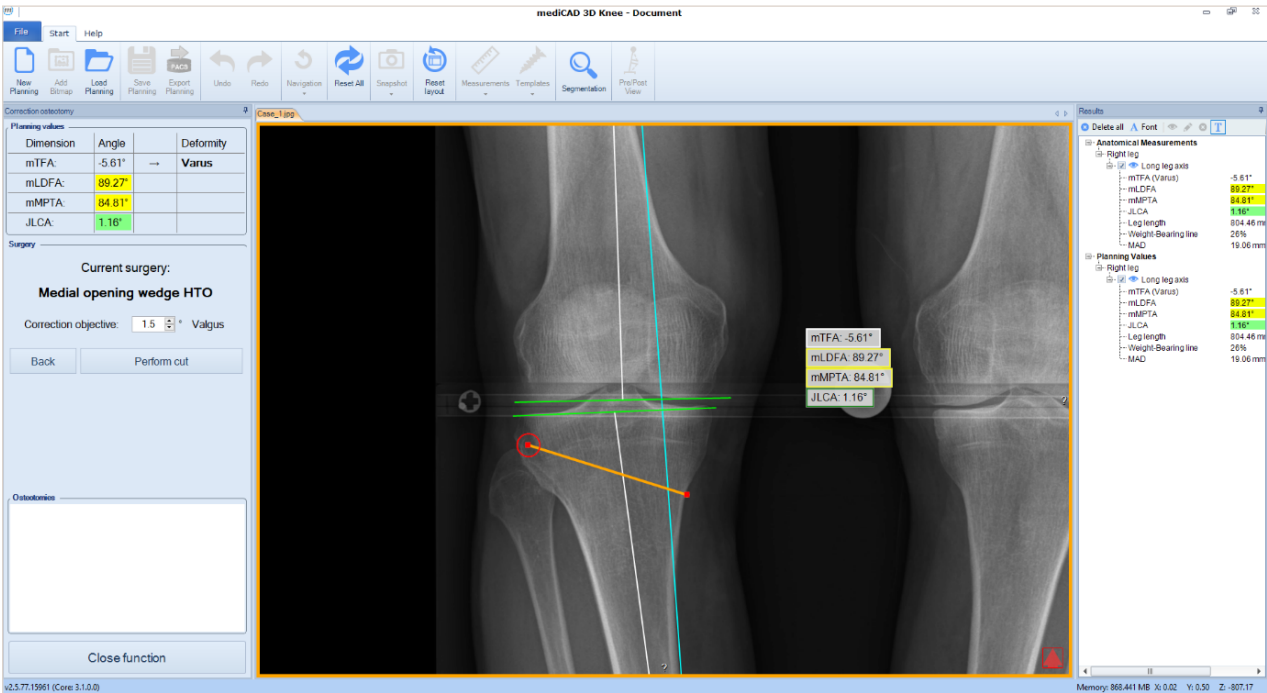


Fig 3 Proposed cutting line and hinge point.

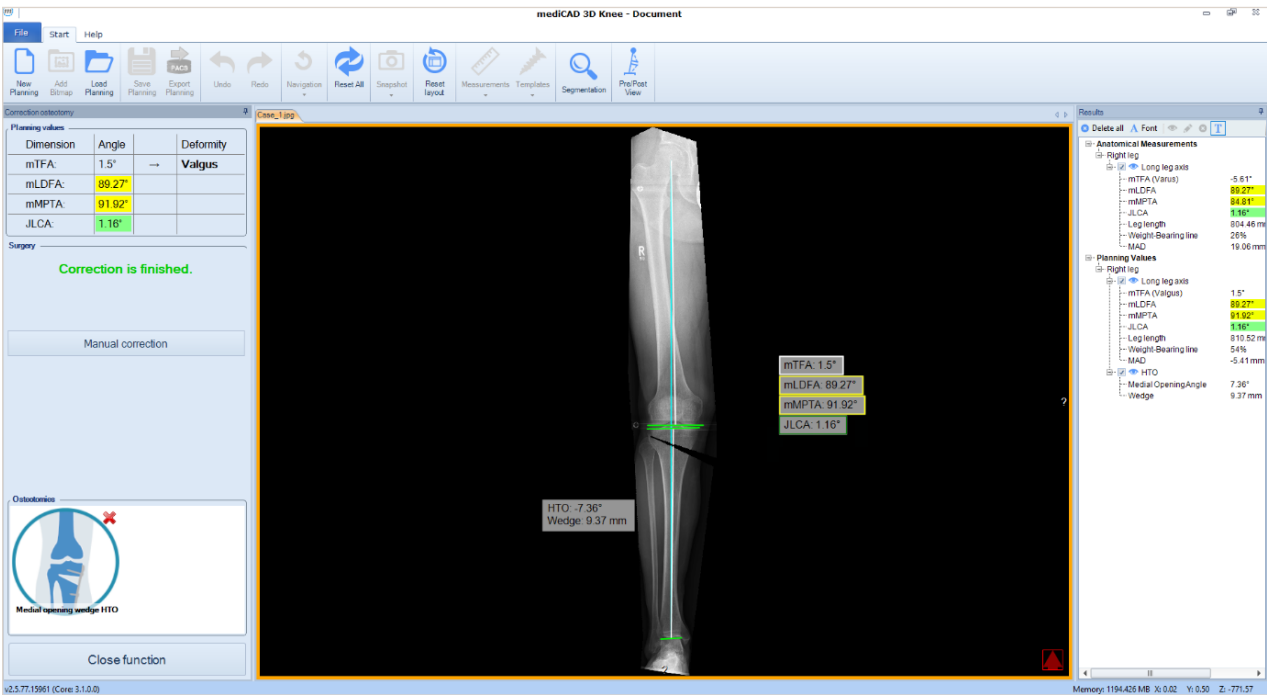


Fig 4 Simulation of proposed correction and resulting alignment.

Case 1

longer possible. Free range of motion (ROM: 0/0/150°), ligaments in sagittal, and coronal planes were stable. There was no effusion. The patient had valgus deformity which was corrected with a distal femoral osteotomy.

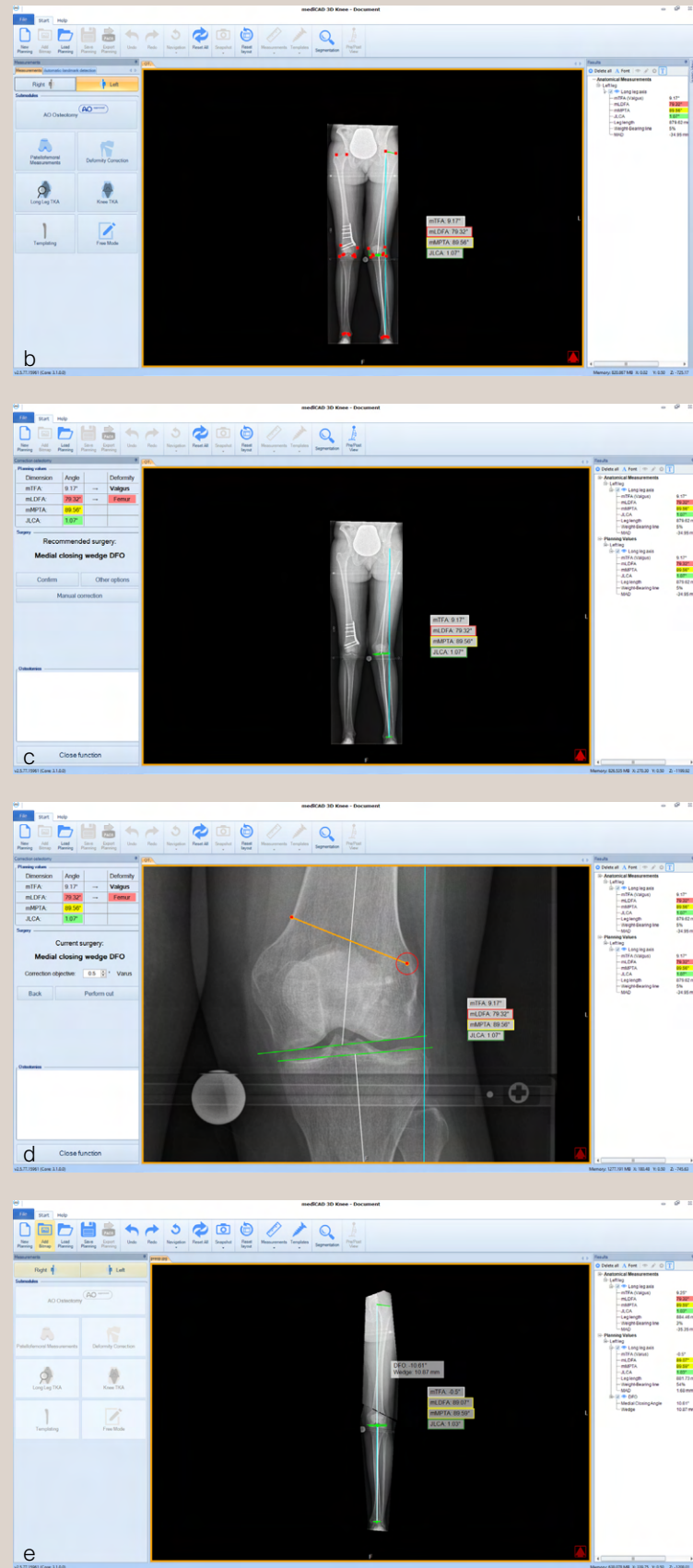
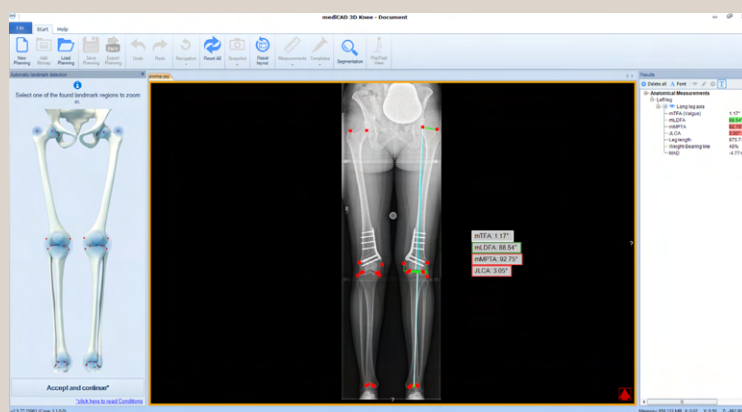


Fig 5a–e Preoperative radiograph and planning workflow based on it.



Watch the planning of this case with further explanations on video:

Distal femur osteotomy case (case 1)

Case 2

A 52-year-old man with a posttraumatic deformity 2 years after tibial plateau fracture AO/OTA 41C3.3e, PL, PM complained of pain after a normal working day. The patient was a heavy smoker. Activities like sports or hiking were discontinued.

Surprisingly ligaments in the coronal and sagittal planes were stable. There was no effusion. Pain was localized in the medial compartment. The range of motion was limited to 0/0/130°. The deformity was corrected with a high tibial osteotomy.

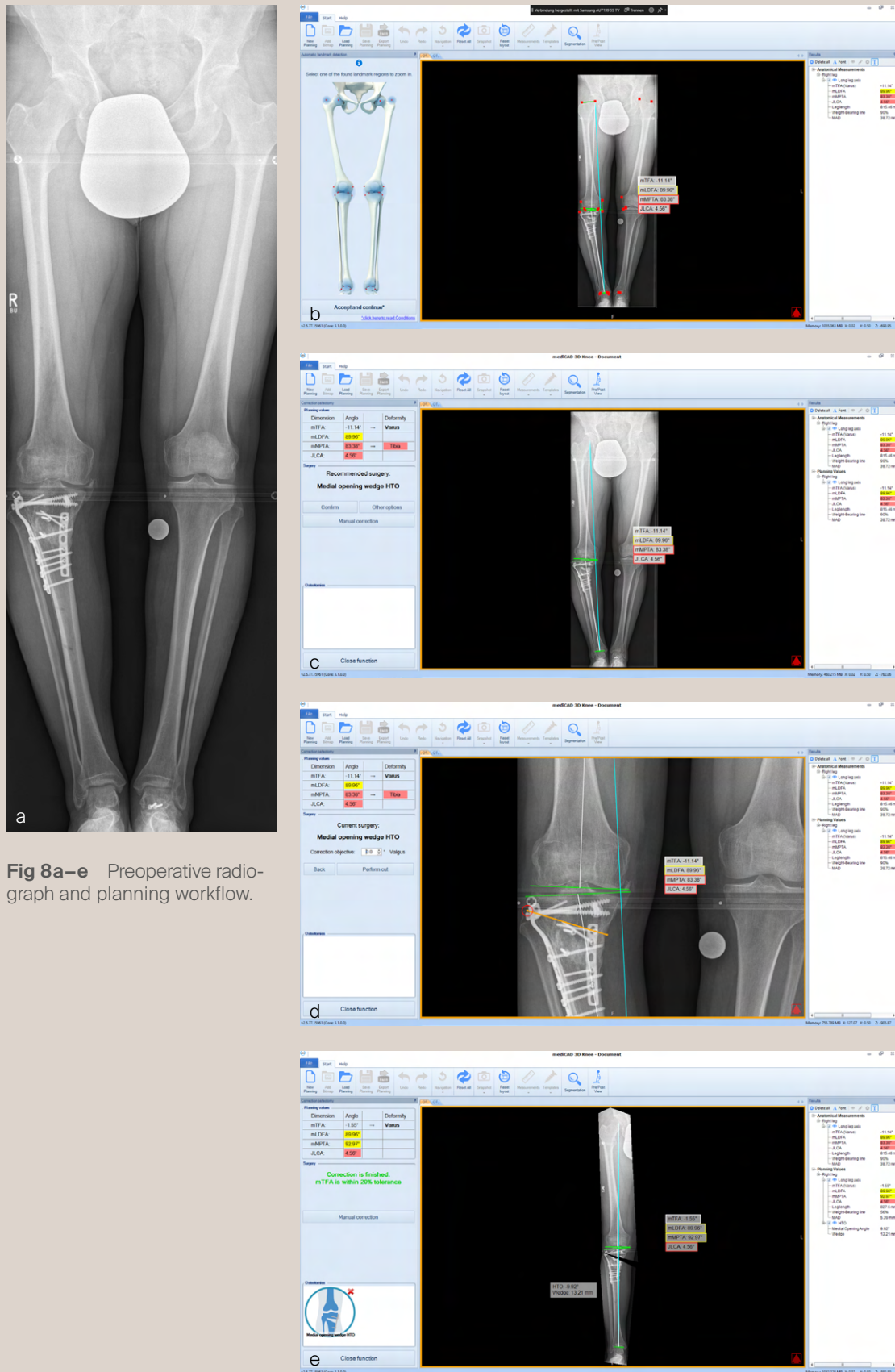


Fig 8a–e Preoperative radiograph and planning workflow.



Fig 9a–b Postoperative radiograph and analysis in the software.

Watch the planning of this case with further explanations on video:

[High tibial osteotomy case \(case 2\)](#)

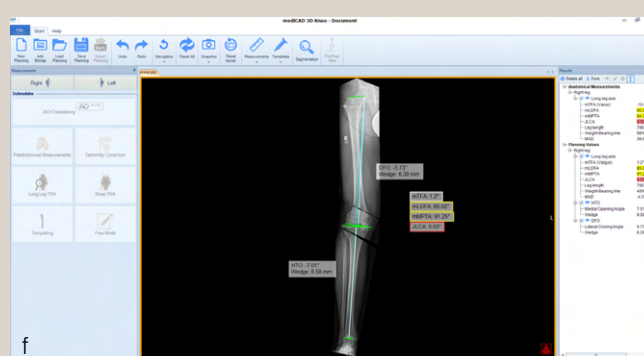
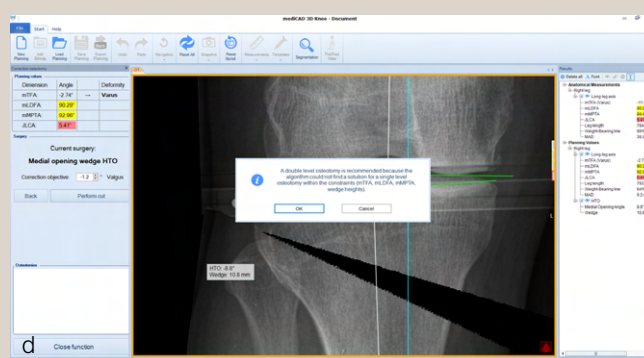
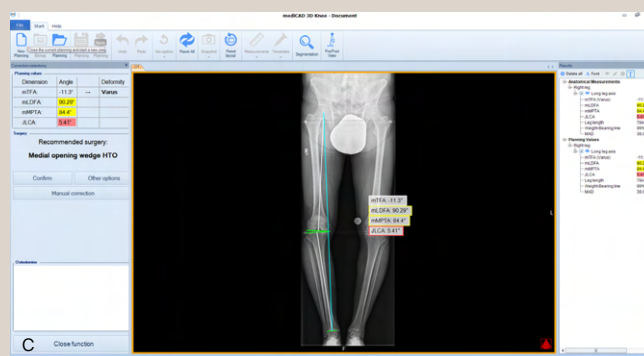
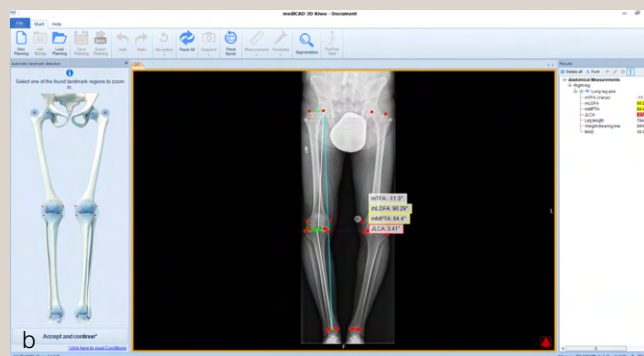
Case 3

A 52-year-old man, a heavy worker was still able to work, however he was administered painkillers. During weekends only brief bike rides were tolerable. He reported an effusion, and on that evening, further daily activities were not possible.

He complained of pain in the medial compartment. Excessive bowing legs were noticeable. Ligaments were stable in the sagittal plane but there was a medial instability in the coronal plane because of damage to the cartilage. He underwent double-level osteotomy for correction of the leg alignment.



Fig 10a–f Preoperative radiograph and planning workflow with recommendation to change to double-level osteotomy.



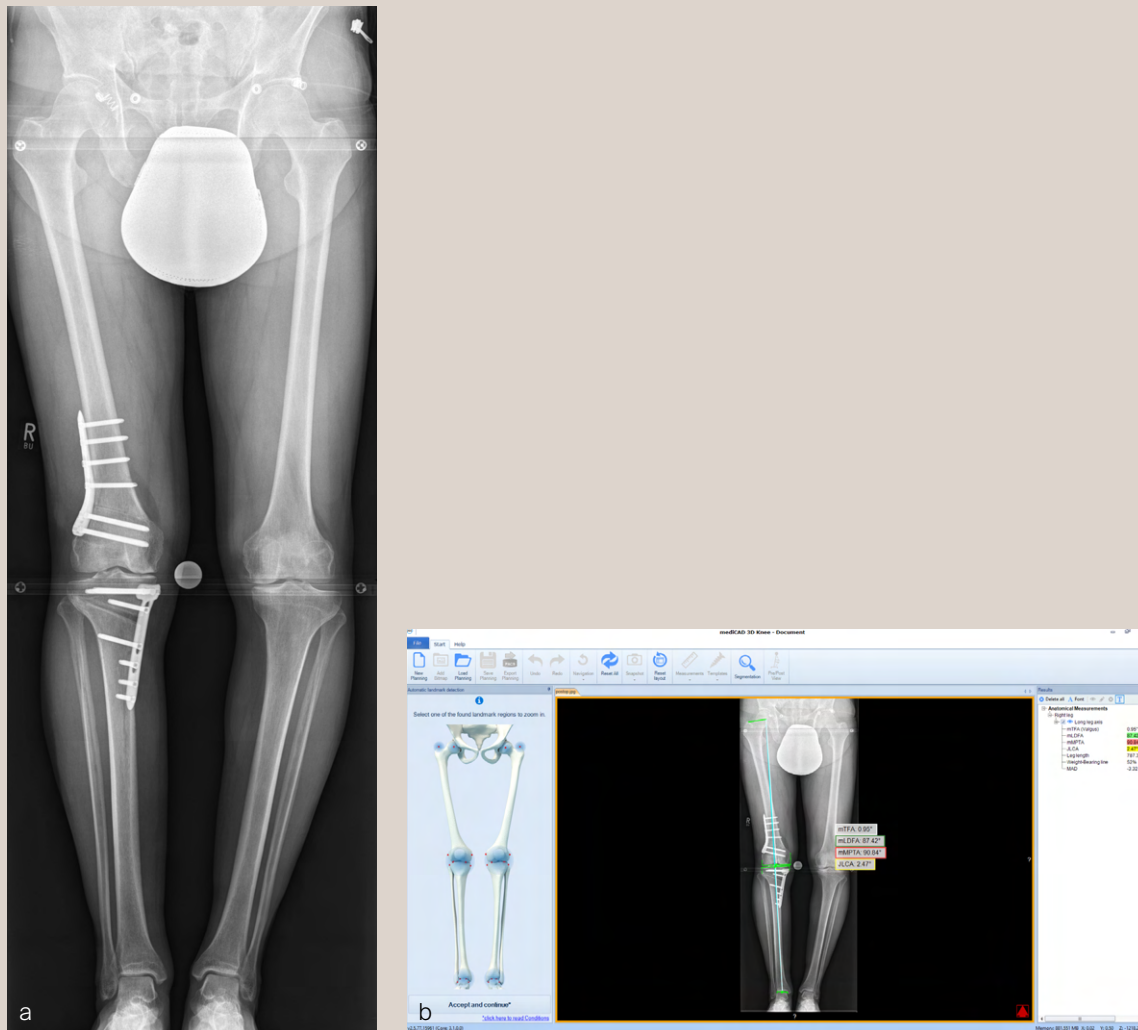


Fig 11a–b Postoperative radiograph and analysis in the software.

Watch the planning of this case with further explanations on video:

[Double-level osteotomy case \(case 3\)](#)

Distal Radius Intramedullary Nail (DRIM-Nail) for the fixation of extraarticular fractures

Distal radius fractures are the most common orthopedic injury accounting for 17.5% of all fractures in adults. These fractures generally occur from a fall on the outstretched hand, and roughly 50% of distal radius fractures are intraarticular. Diagnosis is made clinically and radiographically with orthogonal radiographs of the wrist. Treatment can be nonoperative or operative depending on fracture stability and fracture displacement as well as patients' age and activity demands.

Operative treatment involves several techniques from closed reduction percutaneous pinning (CRPP) to open reduction and internal fixation (ORIF) to external fixation for fracture reduction and stabilization. While CRPP is an appropriate option for mainly extraarticular fractures, internal fixation using plates and screws remains the most common option for the surgical treatment of distal fractures. Achieving and maintaining anatomical reduction is the primary goal of distal fracture fixation, consequently it is possible to limit loss of function which is a significant outcome for young, active, and independent patients.

The implantation of plates and screws in the distal radius is appropriate for unstable, intraarticular, compound, and/or comminuted fractures and allows stable fixation compatible with early mobilization on only protective removable splinting. Drawbacks of such internal fixation, however, is the necessity of additional soft-tissue injury for the exposure during implantation; thereafter, the potential to irritate tendons near the components, causing tendinopathy and possible tendon rupture. Currently, the most common complications directly related to distal radius plate fixation include tenosynovitis, tendon attrition, and rupture often necessitating hardware removal. The most obvious obstacle when adopting CRPP besides the limited stability of the construct and the necessity of lengthy immobilization is the extension of pins outside of the bone which can cause an increased risk of infection

In response to such potential complications in the fixation of extraarticular distal radius fractures, a collaboration between the University of Balgrist, Disrad AG, the AOTC Hand Expert Group, the AO's Development Incubator, and 4iMedical has witnessed the design and development of an intramedullary implant. With the advent of this new device, a decrease in soft-tissue complication is expected. The implant utilizes the principles of load sharing, subchondral screw divergence, and locked fixed-angle fixation. The intramedullary implant is inserted through a small skin incision at the radial styloid and does not further devascularize the fracture fragments. The limited surgical dissection and rigid fracture fixation allows for minimal postoperative mobilization and an early return to function. The newly approved DRIM-Nail is a valuable addition to the arsenal of distal radius fracture treatment options, which can rapidly have patients on the path to recovery.

Finding an industrial partner for the AO-approved DRIM-Nail is ongoing. The nail is 7.0 mm in diameter and single packed as a 'one size fits all' sterile implant. The nail itself is made from titanium and the additional 2.5 mm diameter screws for fixation (L14 mm–36 mm) are made of stainless steel (Fig 2). The instrument set is lean but comprehensive and intuitive to use. All instruments are nonsterile and validated according to 4iMedical reprocessing.

The development of the DRIM-Nail represents the eventual success of a long-standing AO Technical Commission project introduced into the Hand Expert Group in 2010 and driven specifically by Swiss member Ladislav Nagy, MD, of Balgrist University Hospital in Zurich. Following more than a decade in the making, the DRIM-Nail project has finally evolved from a concept to a market-ready product, commemorating a significant milestone in the history of the AO Technical Commission. Because of the successful collaboration with both Disrad AG and 4iMedical AG, the AO now has access to an intramedullary device for the fixation of extraarticular distal radius fractures.



Fig 1 Radiograph showing extension of pins outside of the bone when adopting the CRPP technique.

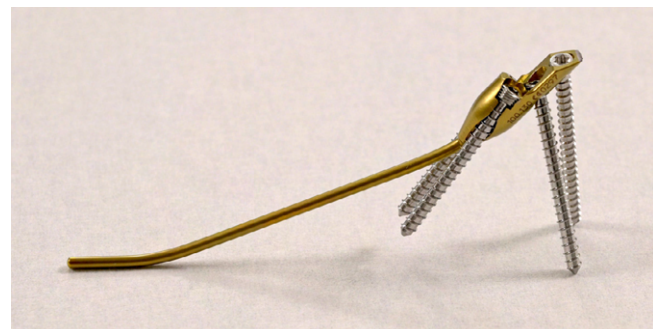


Fig 2 Assembled DRIM Nail.

Case 1

(Kindly provided by Ladislav Nagy, MD, Balgrist University Hospital, Zurich, Switzerland)

The patient was a 25-year-old woman who sustained a displaced, unstable extraarticular fracture of the left distal radius while snowboarding.

After closed reduction a dorsal re-dislocation of 25° occurred (Fig 3a). There are additional apparent signs of instability:

dorsal comminution (Fig 3a) and fracture of the ulnar styloid (Fig 3b). Therefore, a considerable potential for additional dislocation is present which is likely to occur in the cast. This young, active, and demanding patient wishes to return to her activities as early as possible. This can only be achieved with an operative fracture fixation. The nail was chosen instead of a plate. This allowed an almost instant functional use of her hand, which allowed her to return to work at 2 weeks postoperatively without additional fixation or a splint and full unprotected function of her wrist at 6 weeks.



Fig 3a–b Lateral preoperative radiograph after closed reduction showing a dorsal dislocation of 25° compared with the physiological palmar tilt and a dorsal comminution (a). AP preoperative radiograph following closed reduction highlighting the mildly displaced fracture of the ulnar styloid (b).

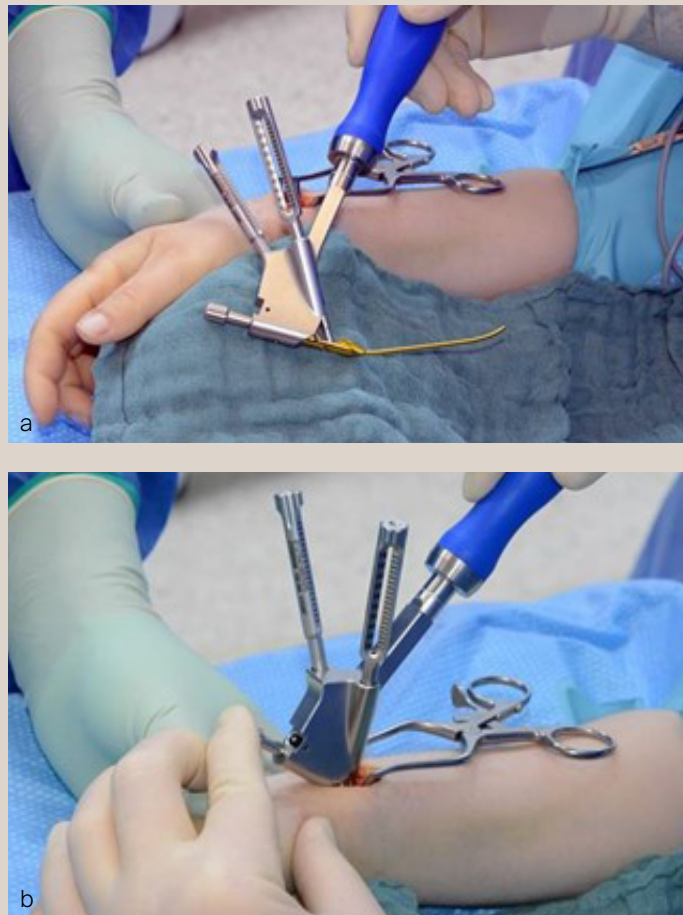


Fig 4a–b DRIM-Nail mounted in the insertion device (a) and after complete insertion (b).

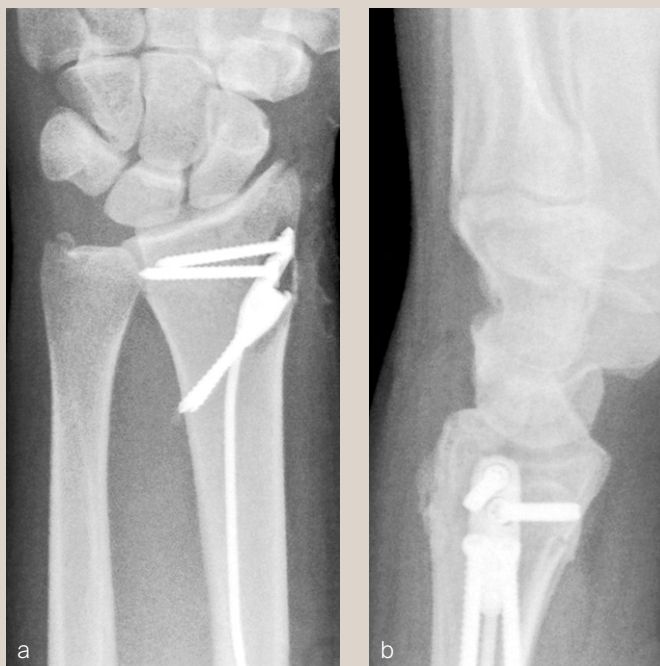


Fig 5a-b Intraoperative images after closed reduction and insertion of the DRIM-Nail.



Fig 6a-b AP and lateral radiographs after 3 months with the fracture healed in anatomical position.

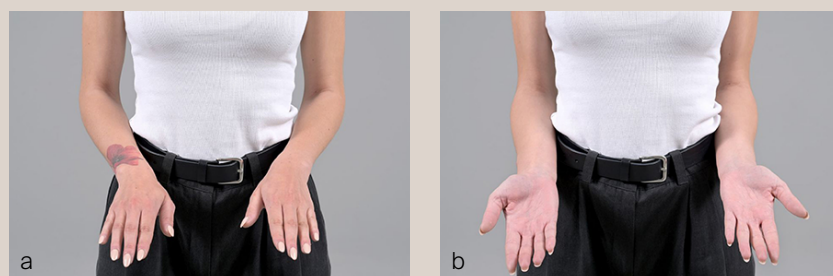


Fig 7a-b Clinical presentation of a symmetrical wrist function in pronation and supination.

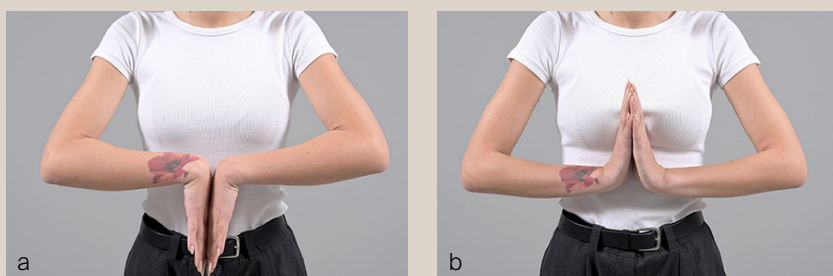


Fig 8a-b Clinical presentation of a symmetrical wrist function in flexion and extension.



Fig 9 Scar representation 3 months postoperative.

CONDUIT™ Interbody Platform

The CONDUIT™ Interbody Platform is a comprehensive 3D printed solution consisting of five cage designs for lumbar and cervical spinal fusion procedures. CONDUIT™ Implants come in various heights, footprints, and lordotic angles to address anatomical variety and facilitate vertebral fusion.

In 2021 the Spine AO Technical Commission already approved the CONDUIT™ Interbody Platform Lumbar Cage devices, the first release to use trademark technology from Germany's Emerging Implant Technologies (EIT) since it was acquired by Johnson & Johnson Medical GmbH in 2018. The CONDUIT™ Interbody Platform demonstrates advancement in cage technology using 3D printing.

The CONDUIT™ 3D Printed Titanium Cages Cervical were approved in 2022 as well.

CONDUIT™ Lumbar Cages

Lumbar interbody fusion (LIF) is an established treatment for degenerative spinal disorders. Lumbar interbody fusion involves the placement of an implant (cage, spacer, or structural graft) within the intervertebral space after discectomy and end plate preparation.

Currently, LIF is performed using six main approaches:

1. Posterior lumbar interbody fusion (PLIF)
2. Transforaminal lumbar interbody fusion (TLIF)
3. Minimally invasive transforaminal lumbar interbody fusion (MI-TLIF)
4. Oblique lumbar interbody fusion/anterior to psoas (OLIF/ATP)
5. Lateral lumbar interbody fusion (LLIF)
6. Anterior lumbar interbody fusion (ALIF)

Patient expectations and increasing demands for shorter hospital stays and early return to work have resulted in more innovative surgical techniques to reduce iatrogenic injury and postoperative morbidity. The development of new techniques attempts to shorten surgical times and achieve faster recovery with reduced complications.

The platform contains 3D printed cellular titanium implants that feature porous macro-, micro-, and nanostructures designed to mimic cortical and cancellous bone to facilitate intervertebral fusion.

CONDUIT™ Implants are designed with an interconnected pore structure making them 80% porous (700 µm pore size) compared with the typical 50–90% porosity of natural cancellous bone [1–6] (Fig 2).

In vitro studies [1] have reported more significant osteoblastic differentiation in human stem cells cultured on similar porous titanium constructs than solid titanium surfaces. In vivo studies with similar porous titanium materials show that bony in-growth increases at the 500–700 µm pore size range compared with larger or smaller pores [2–4].

All CONDUIT Implants undergo acid etching and heat treatment to promote microscale and nanoscale surface roughness. Surface roughness has been shown to benefit cell differentiation and proliferation in in vitro studies of osteoblast-like cells cultured on similar roughened titanium materials [7, 8]. Similar titanium materials with nanoscale features have been shown in in vitro studies [9] to increase osteoblast adhesion compared with conventional titanium materials.



Fig 1 Image depicts (left to right) straight PLIF, curved TLIF, cervical-, lateral lumbar-, and anterior lumbar implants for spinal fusion procedures.

The implants' porous structure enables excellent visualization both intraoperatively and postoperatively on imaging modalities without interference (Fig 3).

Proprietary 3D printing technology leads to a cellular design that offers a Modulus of Elasticity like bone (Fig 4) [10] aiming to reduce stress shielding and implant subsidence [11].

Conclusion

The CONDUIT™ Interbody Cage Platform provides a range of cages that have 3D printed Titanium Technology, attractive bone contact characteristics, and surface roughness to promote and to improve bony fusion. Nanoscale surface technology represents a significant innovation in intervertebral fusion science.

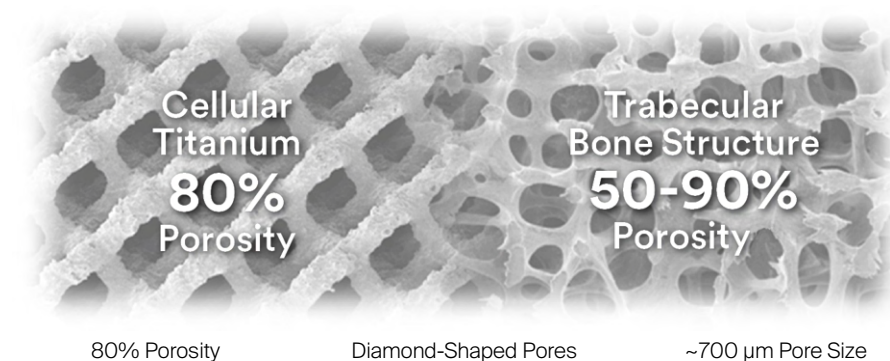


Fig 2 Interconnected porous structure that mimics cortical and cancellous bone.

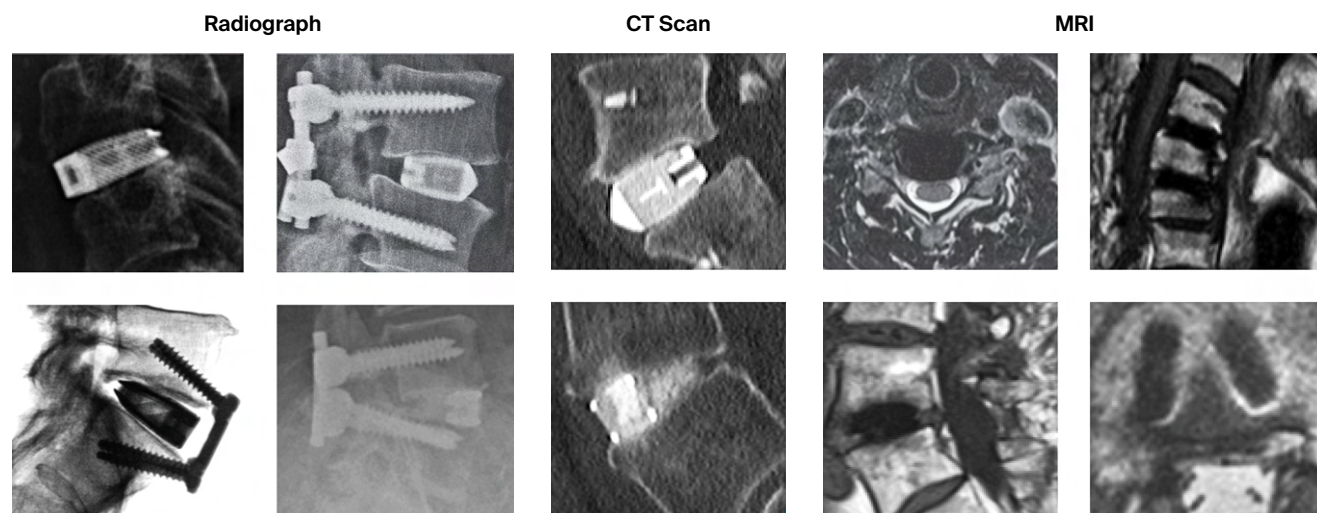


Fig 3 Visualization of the implant on radiograph, computed tomography (CT), and magnetic resonance imaging (MRI).

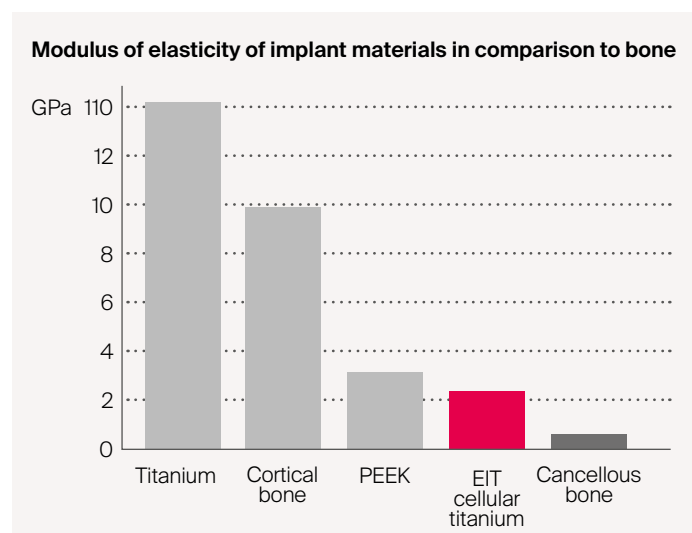


Fig 4 Modulus of the elasticity of implant materials compared with bone [10].

Clinical case

(Kindly provided by Matthew Scott-Young, MD, Gold Coast Spine, Gold Coast, Australia)

Patient medical history

A 72-year-old man with a 20-year history of chronic low back pain and radiculopathy to the right leg that was worse than to the left. An electromyography revealed bilateral L4, L5, and S1 radiculopathies. Conservative treatment failed. Discography triggered concordant pain in discs L3-4, L4-5, and L5-S1. Visual analog scale (VAS) backpain score was 90; VAS right leg pain score, 75; VAS left leg pain score, 65; Oswestry Disability Index, 56; and Roland-Morris Disability Questionnaire, 22.

Surgery

The patient underwent L3-S1 anterior reconstruction with indirect decompression (utilizing the UNLEASH™ ATP Procedural Solution L3-5 and ALIF L5-S1) and Percutaneous Posterior Segmental Pedicle Screw Fixation (Fig 5). Systems used were the following:

- INSIGHT® Lateral Access System (L3-L5)
- CONDUIT™ Lateral Interbody (L3-L5)
- CONDUIT™ ALIF Interbody and Aegis plate (L5-S1 with SYNFRAME® Access and Retractor System)
- VIPER PRIME® Screws: Posterior Pedicle Screw Instrumentation L3-S1



Fig 5a–b Preoperative and postoperative AP radiographs.

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CONDUIT™ Cervical Cages

The Cellular Titanium Cervical Cages are intervertebral body fusion devices intended for use for anterior cervical interbody fusion in skeletally mature patients with cervical disc degeneration and/or cervical spinal instability, as confirmed by imaging studies (radiographs, computed tomography [CT], and magnetic resonance imaging [MRI]), which results in radiculopathy, myelopathy, and/or pain at multiple contiguous levels from C2-T1.

The EIT Cellular Titanium Cervical Cages are also to be used with supplemental anterior fixation systems that have been cleared for use in the cervical spine. The cages are designed for use with autogenous and/or allogeneic bone graft to facilitate fusion.

To allow optimal fit for patients and to address anatomical requirements to correct spinal alignment and sagittal profile, the CONDUIT Cervical System is offering various footprint sizes (12 x 16 mm and 14 x 18 mm), lordotic angles (4° and 8°), and heights (4–10 mm in 1 mm increments). They come in asymmetric design dome-shaped cranial surface and flat caudal surface, the width and depth of the vertebral end plate is in ratio of 1.3–1.4, the anterior rim is larger than the posterior width, and the lateral wedge design allows maximal contact of the uncovertebral joint (Fig 6).

Due to the implant's porous structure the height of the implant is slightly (0.25 mm) higher than the trial.

The texture and architecture of the CONDUIT Implants facilitate fusion by acting as cellular titanium scaffold. The porosity of the implants (approximately 80%) provides excellent clinical imaging on x-ray, MRI, and CT and is leading to a Modulus of Elasticity like bone.

The cages are designed for central grafting.

An implant retrieval case study (n = 1, cervical system explant 2 years postoperatively) displayed extensive bone in-growth end plate-to-end plate, indicating mechanical loading throughout the implant and mature, lamellar bone, and healthy bone marrow in direct contact with the titanium scaffold without fibrous tissue interface formation.

Conclusions

The Conduit Cervical cage is a 3D printed titanium cage design that allows graft and facilitates anterior cervical interbody fusion surgery. The cellular titanium material as such is attractive to bone, and the cage line addresses individual anatomical variety and creates optimal end plate to cage interface.

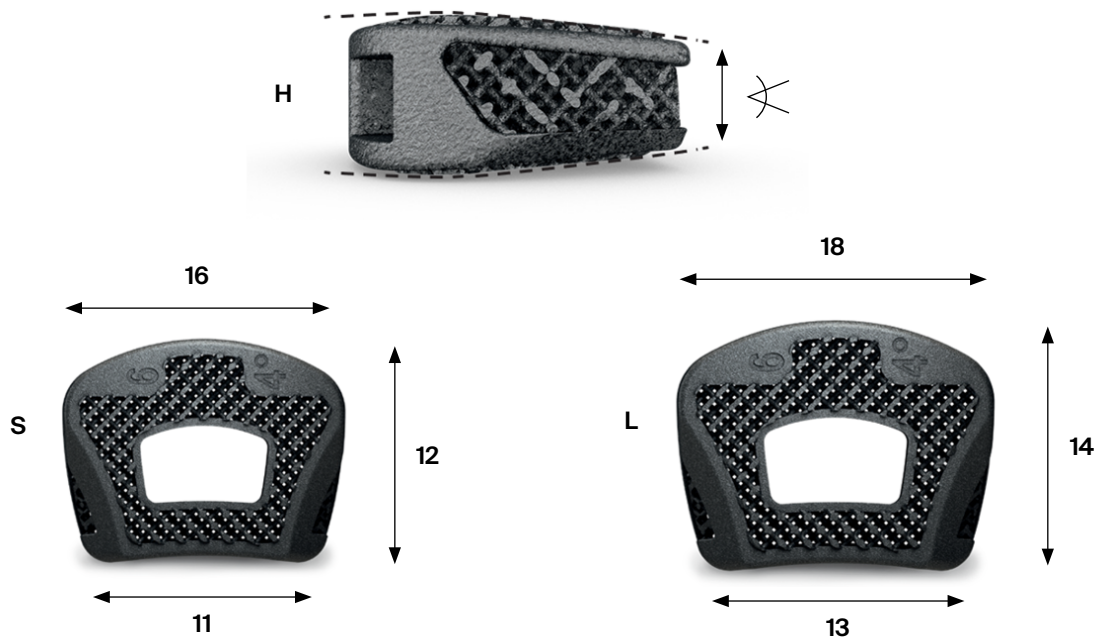


Fig 6 Image showing implant geometry.

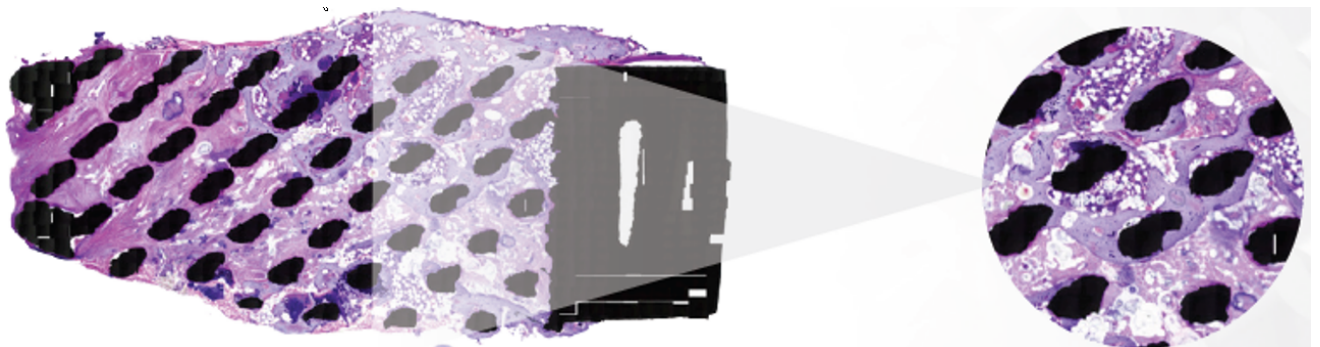


Fig 7 Histological slice (H&E staining) of a CONDUIT™ Cervical System explant 2 years postoperatively.

Clinical case

(Kindly provided by Maarten Spruit, MD, St Maartenskliniek, Nijmegen, Netherlands)

A 70-year-old man presented with neck pain, but predominantly arm pain bilateral L>R for 4 years. The patient experienced loss of sensation in C6 dermatome L. The conservative care and pain management was not effective.

A medical examination revealed the following:

- Multidirectional decreased range of motion
- Spurling test positive L
- Loss of sensation C6 L
- Symmetrical reflexes, no hyperreflexia
- No pathological reflexes
- Romberg negative
- Adson negative
- No shoulder impingement

- Numerical Rating Scale (NRS) neck 3 and arms 7
- Neck Disability Index (NDI) 28
- Electromyography: radiating signs C6, but no denervation

The radiograph indicated:

- Degenerative discs and spondylosis C3-4-5-6-7
- No translational instability on flexion-extension
- Loss of lordosis (Fig 8)

A magnetic resonance imaging demonstrated cervical spinal stenosis with cord compression C5-6 L, foraminal stenosis C5-6 L, and C6-7 bilateral (Fig 9).

A computed tomographic scan showed large posterior osteophytes C5-6 and spondylosis anterior (Fig 10).

The diagnosis made was cervical radiculopathy L>R C5-6 and C6-7 and non-symptomatic spinal cord compression C5-6.

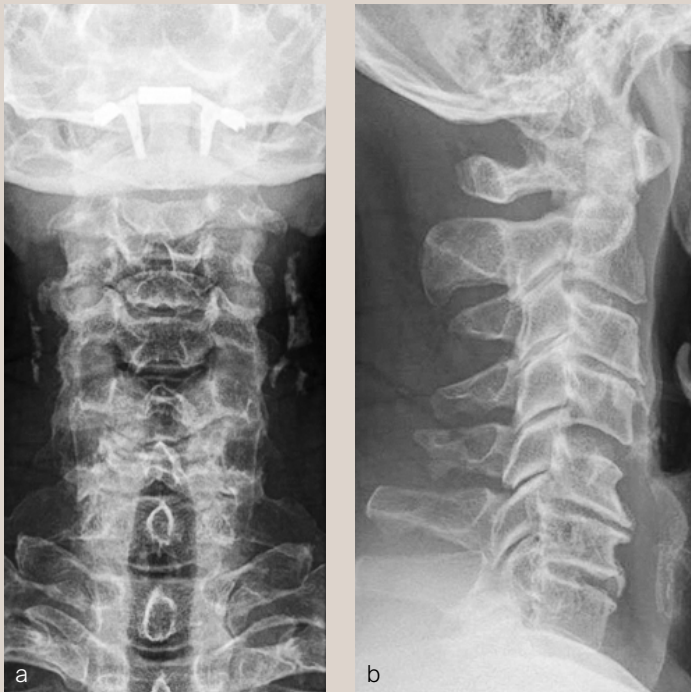


Fig 8a-b Preoperative AP and lateral views of the cervical spine.

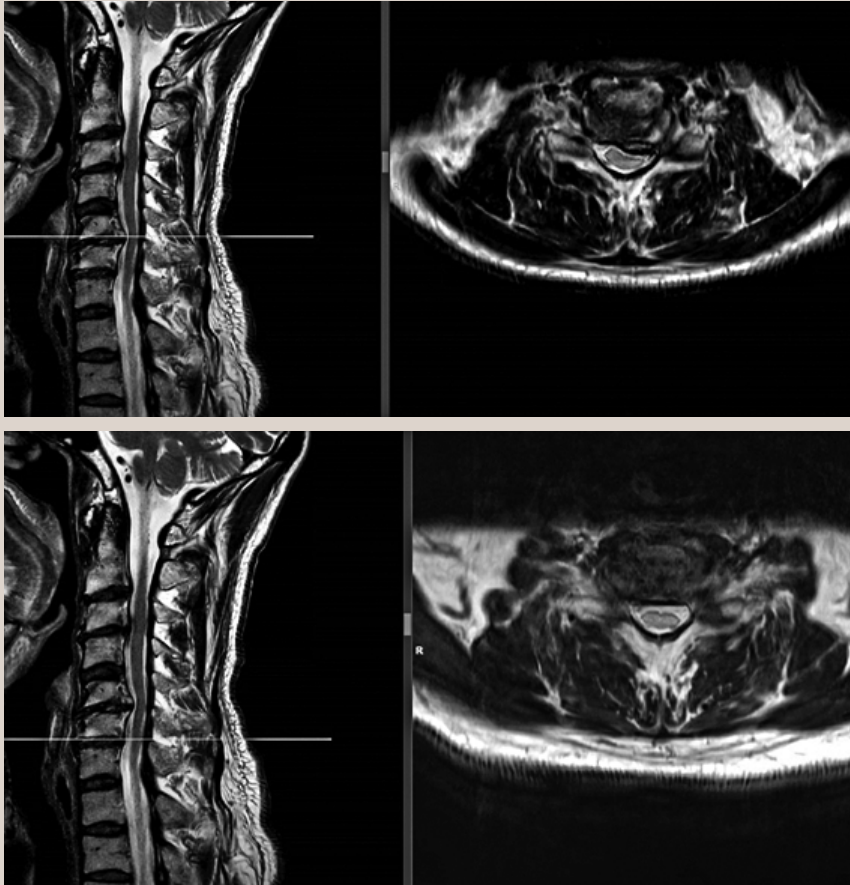


Fig 9 Magnetic resonance: preoperative lateral and axial views of cervical spine C5-6 and C6-7.

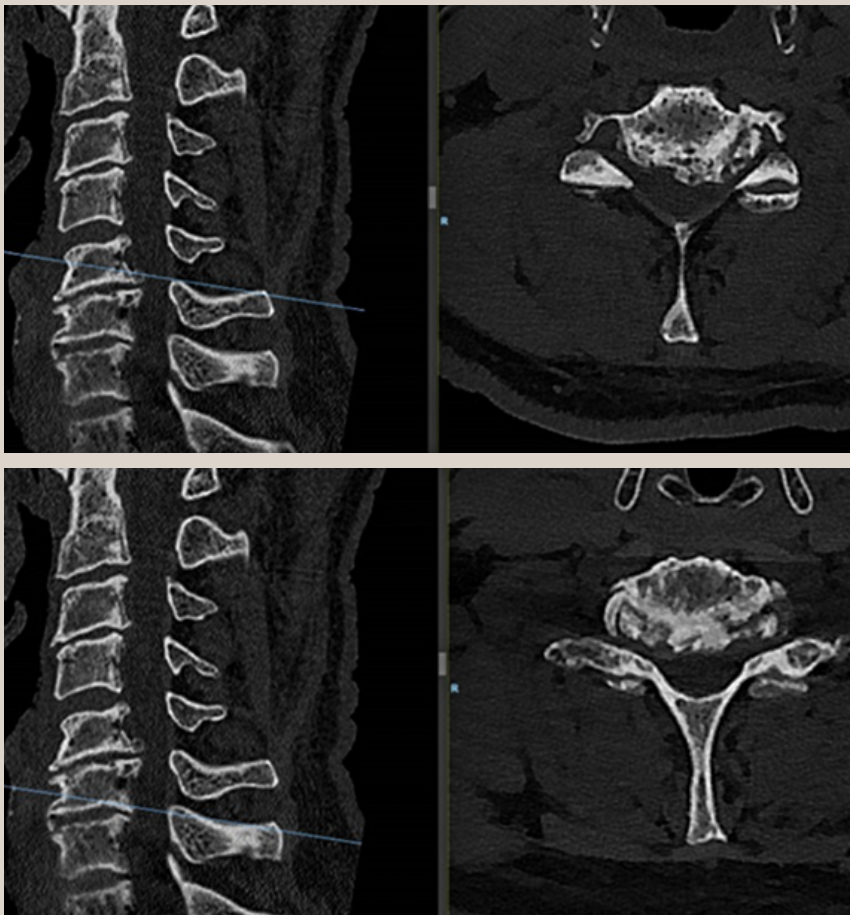


Fig 10 Computed tomography: preoperative lateral and axial views of cervical spine C5-6 and C6-7.

Surgical treatment

The patient underwent anterior decompression and fusion C5-6-7 with Conduit stand-alone cages C5-6-7. Restoration of lordosis C5-7 (Fig 11).

Follow-up at 3 months

The patient had an uneventful recovery, with neither neck nor arm pain, but with good residual range of motion. He had persistent loss of sensation C6 dermatome L.



Fig 11a-b Postoperative AP and lateral views of cervical spine 3 months after anterior decompression and fusion C5-6-7 with stand-alone Conduit cages.

Update from the Smart Digital Solutions Task Force

Results of survey on wearable technology in the orthopedic trauma community

Survey shows that smartphone technology is the most broadly distributed wearable system to measure general patient activity

Reliably monitoring physical function is tremendously valuable in returning orthopedic trauma patients to preinjury activity levels. Noting the rise in the use of wearable technology, AO Technical Commission's Smart Digital Solutions Task Force (SDSTF) conducted a cross-sectional expert opinion survey asking AO Trauma members about their current and anticipated uses. The study [now published](#) in *Injury*, a leading trauma journal, successfully demonstrated that wearable technology is an area of interest in the orthopedic trauma community. The survey's three best-represented countries were the United States, Germany, and India; however, surgeons from across the globe participated.

Most valuable, most used, and most wanted wearable technologies

Just over one-fifth of respondents already used wearable systems as part of their clinical work. The most-used technology was smartphones, which allow physicians to measure a broad spectrum of outcomes. In descending order, the three technologies considered most valuable were smartphones, pressure sensors, and accelerometers. The most-wanted outcome parameters were measures of general patient activity, kinematic and kinetic gait parameters, as well as general gait analysis.

Research vs clinical practice gap

Interestingly, the survey results highlighted a reversal of the normal gap between research and clinical practice:

“Despite its predominant use among survey respondents, smartphone technology is not commonly used for measuring outcomes in orthopedic trauma literature. Their use is mainly limited to remote imaging and case assessment, determination of range of motion, relaying training information, and fall risk determination.”

Barriers and challenges to further adoption of wearable technology in orthopedic trauma care

The greatest perceived obstacles to clinical use were cost, validity, and patient compliance. Considering that most patients in many areas already own smartphones, the additional cost of implementing app-based monitoring technology is very low. According to the survey, more difficult impediments to overcome are questions relating to user data and validity:

“Questions about data availability, validity, and safety of acquisition still need to be addressed. Current reviews regarding wearable assisted measurement of activity and fall risk show that, while many different systems are available, few have clear standards regarding which parameters need to be monitored to obtain clinically relevant outcomes.”

Resolving these issues will require dedicated research, although the survey authors are confident that the presented analysis can help guide this young field toward more accurate, low-cost wearables with improved patient acceptance.

For further information details, please refer to the survey publication: [Wearable technology in orthopedic trauma surgery: an AO Trauma survey and review of current and future applications](#) *Injury*. 2022;53(6):1961–1919.



Update from the Osteoporotic Spine Surgery Task Force

White Papers on Techniques and Considerations for Surgery of the Osteoporotic Spine

The AO Technical Commission is delighted to share the White Papers on Techniques and Considerations for Surgery of the Osteoporotic Spine.

Developed by expert spine surgeons of the AO Technical Commission's Osteoporotic Spine Surgery Task Force and specialists in endocrinology and bone health (see contributors below), the White Papers are based on literature review and expert opinion and give recommendations for osteoporotic spine surgery in three key focus areas:

01

**Medical
Osteoporosis
Management**

[Click to explore content](#)

02

**Surgical
Planning and
Technique**

[Click to explore content](#)

03

**Junctional
Failure
Prevention**

[Click to explore content](#)

The mission of the AO's Osteoporotic Spine Surgery Task Force is "to achieve optimal implant-bone fixation strength and construct stability to prevent early implant failure and late fusion/junctional failure with residual deformity."

Over the last year, the OSSTF has come up with recommendations for:

- Which surgical patients aged 50 years or older need bone quality assessment and with what investigations
- Surgical Risk Category Algorithm
- Medical management of osteoporosis in surgical patients

Surgical planning and technique: literature standards, recommendations, and opportunities for further research and development.

Junctional kyphosis and failure prevention: standards from literature, preoperative implant stress evaluation at upper end of long constructs, and opportunities for development for soft-landing devices.

We hope you find these recommendations useful.

[Download the full slide deck here](#)

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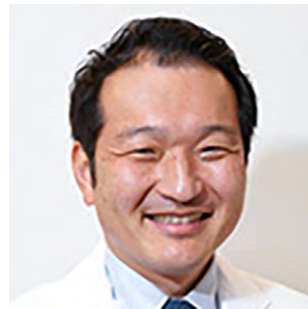
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Update from the Anti-Infection Global Expert Committee

AO Technical Commission brings together global key opinion leaders at fourth FRI consensus meeting

The AO Technical Commission (AO TC) hosted a consensus meeting October 11, 2022, on definitions for fracture-related infection (FRI) and nonunion. The event which brought together global key opinion leaders was conducted alongside the Orthopaedic Trauma Association's 38th Annual Meeting in Tampa, United States.

This consensus group aims to develop consensus-based guidelines in the field of FRI and nonunion, paving the road for more uniform clinical protocols and higher-quality clinical research in the future.



Fig 1 Expert Consensus Group members taking part in the meeting (back row, left to right) Fintan Moriarty, Charalampos Zalavras, Robert O'Toole, Jong-Keon Oh; (second row from back, left to right) Mario Morgenstern, Leonard Marais, Andre Trampuz, Michael Verhofstad, Jolien Onsea, Saam Morshed; (third row from back, left to right) Peter Giannoudis, Carlos Sancineto, Geertje Govaert; and (front row, left to right) Kevin Tetsworth, cochairpersons Willem-Jan Metsemakers and Bill Obremskey, and Martin McNally.

The recent consensus meeting in Tampa built on previous international FRI consensus meetings held in Davos, Switzerland, in 2016 and Zurich, Switzerland in 2018, where participants explored topics including the definition of FRI and subsequently, diagnostic and treatment principles for FRI. The topic of nonunion, which was addressed for the first time at the 2022 consensus meeting, is connected to the topic of FRI and requires greater consensus among the clinical community.

Historically, the quality of the clinical literature available on fracture-related complications has suffered from both the lack of clear definitions and widely accepted or adopted protocols regarding the diagnosis and treatment of complications like FRI. The AO is addressing this clinical need by bringing together a broad panel of expert surgeons and scientists with extensive clinical experience in FRI and nonunion; these experts represent professional organizations including the AO, the European Bone and Joint Infection Society (EBJIS), the Orthopaedic Trauma Association (OTA), and the PRO-IMPLANT Foundation.

Previously, a [definition of FRI](#) was successfully established at the first FRI consensus meeting in 2016. Following the second consensus meeting in 2018, the group published guiding principles for the diagnosis and treatment of FRI:

1. **Govaert G, Kuehl R, Atkins BL, et al.** Diagnosing fracture-related infection: current concepts and recommendations. *J Orthop Trauma*. 2020 Jan;34(1):8–17.
2. **Metsemakers WJ, Morgenstern M, Senneville E, et al.** General treatment principles for fracture-related infection: recommendations from an international expert group. *Arch of Orthop Trauma Surg*. 2020 Aug;140(8):1013–1027.
3. **Metsemakers WJ, Fragomen AT, Moriarty TF, et al.** Evidence-based recommendations for local antimicrobial strategies and dead space management in fracture-related infection. *J Orthop Trauma*. 2020 Jan;34(1):18–29.
4. **Depypere M, Kuehl R, Metsemakers WJ, et al.** Recommendations for systemic antimicrobial therapy in fracture-related infection: a consensus from an international expert group. *J Orthop Trauma*. 2020 Jan;34(1):30–41.



Fig 2 Consensus cochairperson Willem-Jan Metsemakers (standing) addresses members of the expert consensus group, including Bill Obremskey (far left), Michiel Verhofstad (second from right) and Bob O'Toole (far right).



Fig 3 Cochairperson Bill Obremskey (left, Vanderbilt University Medical Center, Nashville, United States) and Saam Morshed (right, University of California San Francisco, United States).

Since these documents were published, the term FRI has steadily gained traction in the trauma and scientific community. The availability of guiding principles for the diagnosis and treatment of FRI will promote improvements in patient care and outcomes globally. In the future, the aim is to develop a similar set of recommendations for nonunion.



Fig 4 Fintan Moriarty (left, AO Research Institute Davos [ARI], Switzerland) and Jong-Keon Oh (right, Korea University Guro Hospital, Seoul, South Korea).



Fig 5 Consensus meeting participants included (left to right) Len Marais (University of Kwazulu-Natal, South Africa), Martin McNally (University of Oxford, United Kingdom), Mario Morgenstern (University Hospital Basel, Switzerland), Kevin Tetsworth (Royal Brisbane Hospital, Australia), and Carlos Sancineto (Hospital Italiano de Buenos Aires, Argentina).

Slongo wins AO Technical Commission's 2022 Recognition Award

Theodor “Theddy” F Slongo, MD, from Bern, Switzerland, is the recipient of the AO Technical Commission (AO TC) 2022 Recognition Award. He has been an active member of the AO TC since 1997 and has chaired several groups, including the External Fixation Expert Group and the Pediatric Expert Group.

As an exceptionally experienced and world-renowned orthopedic pediatric surgeon, Slongo's involvement with the AO TC began with the conceptual design and development of new implants for children, perhaps most notably the Titanium Elastic Nail intended for diaphyseal fracture fixation. More recently, his vast experience and innovative mind have driven the development of external fixator systems including the creation of the MAXFRAME® Multi-Axial Correction System, the first solution to provide precise 3D planning, simulation, and correction of complex deformities.

Slongo has continually demonstrated true innovation in product development via his tendency to consider disruptive technologies, often supporting distinct adaptations to surgical techniques and procedures if the result achieves improvements in functional outcomes for his patients.

In addition to his practical ability to help develop new solutions, Slongo is an outstanding teacher with decades of experience as an AO educator. He brings extensive clinical knowledge to his courses, workshops, and live surgery sessions, and his students appreciate his sharing of an array of tips and tricks for complex situations.

The AO TC honored Slongo for his unflagging dedication to the improvement of patient care by supporting research and development, fostering clinical evidence, and sharing his knowledge and experience in education.



Fig 1 Theodor Slongo, MD, accepting the AO Technical Commission 2022 Recognition Award, Davos, Switzerland, December 10, 2022.



Fig 2 AO President Florian Gebhard, Theodor Slongo, and Michael Raschke at the award ceremony.



Fig 3 Onlookers during the AO Technical Commission 2022 Recognition Award.

AO Technical Commission Experts Symposia reconvene in Europe and Southeast Asia

Two AO Technical Commission (AO TC) Experts Symposia took place in Norway and Singapore in 2022, reconvening international trauma and spine surgery authorities following a pandemic pause.

AO TC Experts Symposia are fundamental to fulfilling the AO TC's quality-assurance mandate for newly developed devices when they become available for surgeons; they are invaluable for defining remaining unmet clinical needs that still need to be addressed by existing solutions. The symposia format allows for open, confidential exchanges between clinicians and industry partners to justify initiating new development projects.

The events' engaging format sparked animated exchanges at the 2022 AO TC Experts Symposia through faculty-led subject introductions and participant-submitted case discussions. These dialogues were further enhanced by symposia moderators who concluded the sessions by defining corresponding clinical needs.

15th AO TC Trauma Experts Symposium (Europe)

Fifty-seven surgeons from 21 countries attended the 15th European edition of the AO TC Trauma Experts Symposium on August 26–27, 2022. The event was in Oslo, Norway—the first time the symposium was hosted outside of Germany. Chaired by the Past-President of AO Trauma Germany, Michael Raschke, the program was divided into five sessions:

- VA-LCP Clavicle Systems
- VA Locking Patella Plating System
- Periprosthetic Fracture Fixation of Femur
- Proximal Tibia Fractures
- Double Plating Femur

Michael Kowaleski (veterinary) from North Grafton, Massachusetts, USA, won the symposium's most interesting case presentation award for delivering a deformity case of a dog which underwent prior high-tibial osteotomy (Tibial Plateau Leveling Osteotomy, TPLO).

The 16th AO TC Trauma Experts Symposium (Europe) will be in August 2024 in Florence, Italy, and chaired by Raschke.



Fig 1 Participants in the 15th AO TC Trauma Experts Symposium (Europe), Oslo, Norway, August 2022.



Fig 2 Left to right: AO TC Trauma Chairperson Michael Raschke, AO President-Elect Tim Pohlemann, case presentation winner Michael Kowaleski, and AO President Florian Gebhard.

3rd AO TC Spine Experts Symposium, Singapore

The third AO TC Spine Experts Symposium was in Singapore, led by AO TC Spine Chairperson Maarten Spruit. The symposia brought together 25 participants from 13 countries, and—as with the AO TC Trauma Experts Symposium—the event featured five diverse sessions:

- Arthroplasty versus ACDF for Radiculopathy
- Laminoplasty versus Laminectomy (± fusion) versus ACDF for Myelopathy
- Upper Cervical Pathology Requiring Fusion: C1-2 or C0-2
- Cervical Deformity: Anterior versus Posterior versus Combined
- Robotics/Navigation/AR/VR: Gateway to Next Level Cervical Surgery and Results?

This year’s case winner was Torphong Bunmaprasert from Chiang Mai, Thailand, who presented a case on an acute traumatic lateral atlantoaxial dislocation associated with locked atlas lateral mass and odontoid process fracture.

The fourth AO TC Spine Experts Symposium is planned for September 2024.



Fig 3 Third AO TC Spine Experts Symposium.



Fig 4 AO TC Spine Experts Symposium 2022 case winner Torphong Bunmaprasert (left) with Maarten Spruit (right).

Clinical performance of the Femoral Neck System

The Femoral Neck System (FNS) is an implant system developed for use in osteosynthesis of femoral neck fractures (FNFs). In comparison to total hip arthroplasty, osteosynthesis of FNFs preserves the femoral head and is a valuable treatment option for younger patients. Before the development of the FNS, osteosynthesis for FNFs were commonly done using sliding hip screws (SHS) or cancellous screws (CS), but on average the reported complication rates have been high.

The FNS received CE marks in 2017. In the past years, clinical studies—all retrospective studies—began to appear in the literature. These studies point to a lower complication rate for the FNS compared with the SHS or the CS. However, due to the retrospective study design, these results are weakened by the numerous potential confounding factors. Under the lead of Karl

Stoffel and Christoph Sommer, AO ITC Clinical Operations and Clinical Science conducted the first prospective, observational study on the FNS in 125 patients followed up for 1 year, which was published in 2022. The study revealed a lower complication rate within 1 year after surgery and a restoration of patients' hip function and quality of life to preinjury level. The article also considered whether it is appropriate to treat patients aged between 60 and 80 years with osteosynthesis.

For details, refer to the original publication: Stoffel K, Michelitsch C, Arora R, et al Clinical performance of the Femoral Neck System within 1 year in 125 patients with acute femoral neck fractures, a prospective observational case series. *Arch Orthop Trauma Surg.* (Dec 2, 2022). <https://doi.org/10.1007/s00402-022-04686-w>. Online ahead of print.

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<https://doi.org/10.1007/s00402-022-04686-w>

TRAUMA SURGERY

Clinical performance of the Femoral Neck System within 1 year in 125 patients with acute femoral neck fractures, a prospective observational case series

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Abstract
Introduction Osteosynthesis of femoral neck fractures (FNFs) is an important treatment option, especially for younger patients. We aimed to assess the rate of early implant-related complications in FNF osteosynthesis using the Femoral Neck System (FNS).
Patients and methods Consecutive patients diagnosed with displaced or nondisplaced FNFs were treated with FNS in this prospective, observational, multicenter investigation. Patients were followed up for minimally 3 months and up to 12 months if radiologic bone union and no pain was not achieved beforehand. Predefined treatment-related adverse events (AEs, defined as implant failure, loss of reduction, iatrogenic fractures, deep infection, and surgical revision), radiologic bone union, and patient-reported Harris hip score (HHS) and EQ-5D-5L index score were assessed.
Results One hundred and twenty-five patients were included in the study. Thirty-eight (30.4%) fractures were displaced (Garden III and IV), and 87 (69.6%) were nondisplaced (Garden I and II). Predefined treatment-related AE rate at 3 months was 8 patients, 6.4% (95% CI 2.8–12.2), and at 12 months, 11 patients, 8.8% (95% CI 4.5–15.2). Cumulative incidences of bone union were 68% at 3 months, 90% at 6 months, and 98% at 12 months. The mean changes of HHS and EQ-5D-5L index score between preinjury and at 12 months were -7.5 (95% CI [-21.1] to [6.2]) and -0.03 (95% CI [-0.21] to [0.15]), respectively, neither were statistically significant.
Conclusion The current study on osteosynthesis of FNFs with the FNS resulted in treatment-related complication rates of 6.4% (95% CI 2.8–12.2) at 3 months and 8.8% (95% CI 4.5–15.2) at 12 months. On average, patients returned to preinjury function and quality of life. The current study may also indicate that the conventional wisdom of treating stable FNF in patients aged between 60 and 80 years with osteosynthesis may need to be reconsidered.
Registration The study is registered with ClinicalTrials.gov (registration number: NCT02422355).

Keywords Femoral neck fractures · Fractures · Implants · Femoral Neck System

Introduction
Femoral neck fracture (FNF) is a devastating disease and can have high complication rates following surgery. Although arthroplasty has been shown to be superior to osteosynthesis in terms of reoperation rate, function, and quality of life in older patients with displaced FNFs, osteosynthesis is still an important option in managing non-displaced FNFs for all age groups and in displaced FNFs in younger patients, where femoral head preservation is a priority [1].
Sliding hip screws (SHS) and cancellous screws (CS) are 2 commonly used implants for osteosynthesis in FNFs. Recent meta-analyses confirmed that the 2 methods resulted in similar reoperation rates, postoperative hip function, complication rates, and quality of life [2, 3].
Whether FNFs are managed with SHS or CS, the complication rate can be high, with reported reoperation rates of 18–27% [4–7] and a failure rate of up to 43% [8]. The

Florian Gebhard passed away during the course of this study. Wolfram Weschenfelder substituted Florian Gebhard until the completion of the study.

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Springer

Technology Transfer in a fireside chat: the AO's power as an innovation driver

The current medical technology (medtech) landscape presents various hurdles for developing, proving, and introducing meaningful solutions to the most pressing clinical problems in musculoskeletal repair. [AO Technology Transfer Board](#) members Dr Robert Frigg and Prof Anita Ignatius say the AO is uniquely positioned to help innovators conquer those hurdles to improve patient care and outcomes.

In an online AO fireside chat, Frigg and Ignatius detail the challenges of translating research into real-life innovation and the evolution of medtech product development over the past two decades and offer expert insights to young innovators facing a complex regulatory framework. Frigg is chairman of [4lmedical](#), a Swiss-based musculoskeletal system solutions developer and manufacturer. Ignatius, a research and development expert and director of the University Hospital Ulm's (Germany) [Institute of Orthopaedic Research and Biomechanics](#), is the AO Foundation Board liaison within the AO Technology Transfer Board.

Substantial knowledge gained

Several areas of research offer significant potential to address and provide meaningful solutions to musculoskeletal repair problems, Ignatius points out.

"During the last decade, substantial knowledge has been gained on the mechanisms of regeneration, as well as on novel implant designs, biomaterials, and improved surgical procedures," she notes. "However, translation of such novel discoveries into clinics needs to be improved."

Furthermore, she says, current research strategies focus primarily on specific disorders, frequently presuming an otherwise healthy patient.

"But patient situations are often much more complex. Regeneration is considerably altered in aged or diseased patients with, for example, diabetes or osteoporosis, or in traumatized or infected patients," Ignatius explains. "Consequently, novel treatments have sometimes shown little effect when translated into real-life settings, despite promising preclinical results. Such shortcomings illustrate the need for a better understanding of how tissue regeneration is altered under compromised conditions."

In parallel to this more basic science perspective, Ignatius says several novel therapeutic opportunities have evolved in the last few years. These include personalized therapies, novel biomaterials, cell-based therapies, customized implants, and

variable technologies or artificial intelligence that open new avenues for treating musculoskeletal disorders.

"Many of these technologies are provided by other disciplines—for example, material science and engineering—and require a tight interdisciplinary approach to make them reality for our field. Notably, many of these innovative fields are already addressed by the AO with its [preclinical research](#) at the AO Research Institute Davos (ARI) and by the [AO Innovation Translation Center](#)," Ignatius says.

Evolution of the medtech industry

At the same time, the way ideas become solutions has evolved, Frigg notes.

"[In the] early days, a surgeon had an idea to solve a clinical problem. Industry would take over the idea and bring up a solution—a product—out of that," he says. "Today, industry is a little bit reluctant to take projects; they want to take in solutions—ideas already developed to a stage where they can really prove the advantage in the clinic to get the key opinion leaders."

Frigg says innovators are also under pressure to demonstrate the clinical success of their ideas early on. In earlier days, development meant introducing an implant or solution into the market, studying it, and showing across time the advantages that solution offered for patients.

"Today, you really have to prove that your solution improves health care, delivers and advantageous for the patient, and that's very difficult," in an early stage, he says. "How can you get this data? It is very expensive to prove the clinical advantage of a solution. You need the patient, you need the surgeon, and you have to follow-up the aftercare—all of this will influence the success of your product."

Challenges in translation of ideas

Challenges exist in academia, too, when it comes to translating research into real-life innovation, Ignatius says, noting that exploratory research constitutes a big part of basic research but is insufficient for direct translation. Additional challenges include the difficulty of capturing impactful research findings, the fact that academia and industry have different cultures and divergent definitions of innovation, and that translation in academia often fails because clinical criteria such as clinical need, practicality, patient benefit, and commercial value are not considered at all. "The infrastructure in academia has often not supported transdisciplinary approaches in a systematic way," Ignatius states.

Frigg notes that the complex regulatory framework means that young innovators need external help to bring their ideas to life—and to patients. “Building up a medical company takes too much time and too much money, so if an inventor’s idea is to bring a product to the market, he or she needs help and that’s what companies like 41medical can do for them,” he says.

The AO: a powerful resource

The AO—with the largest global network of trauma surgeons and researchers working together to improve patient care and with collaborative relationships with more than 300 universities worldwide—is a powerful resource for innovators.

“This is a really big research network,” Ignatius says, pointing out that all AO research activities stem from clinical problems. Moreover, she says, preclinical and clinical research are closely integrated within the AO, and the AO’s preclinical research addresses complex research questions and brings various disciplines

together under one roof. Meanwhile, the AO ITC drives innovation, creating clinical evidence with hundreds of AO Technical Commission experts, while the AO’s [Development Incubator](#) and [Strategy Fund](#) drive innovation with both funding and expertise.

“I think the AO is the ideal setting to translate innovation into the clinics,” Ignatius says.

Frigg agrees, emphasizing the AO’s role as an innovation driver bringing together the key building blocks—such as supporting intellectual property protection and the inside of a global network of key opinion leaders—which create value for potential acquirers of inventors’ translational projects.

“That’s what I feel is very important and what we can do with the support of the entire AO,” Frigg says.

[Watch the complete interview](#)



“If an inventor’s idea is to bring a product to market, he or she needs help and that’s what we do,” Dr Robert Frigg.



“The AO is the ideal setting to translate innovation into the clinics,” Prof Anita Ignatius.

Patient is on the mend following first-in-human application of Biphasic plate

A 64-year-old German patient is on the path to what his surgeon believes will be fast, robust bone healing, after having the newly CE-marked Biphasic Plate DF (Distal Femur) implanted to repair a complex floating knee injury.

The first-in-human application of the device took place on March 9, 2022, by Christoph Sommer, Dr med, chief trauma surgeon at Kantonsspital Graubünden in Chur, Switzerland. Sommer is chairperson of the AO Technical Commission's Lower Extremity Global Expert Committee and has been an AO faculty member for more than 30 years.

"The patient was driving a car while on holiday in Mexico and was hit from the left side. He had serial rib fractures, a nasty, open fracture of his left elbow, and an open, complex floating knee injury—a comminuted distal femur fracture—and a proximal tibia fracture on the left side, as well as a proximal tibia fracture on the other side," Sommer explains, noting that after about 2 weeks of care in Mexico, the patient was flown back to Switzerland by Rega Swiss Air-Rescue. "He arrived at our

hospital with an external fixator on his left knee and elbow and was in generally good shape. First, my colleague fixed his elbow and right tibia; and, unfortunately, the patient had also an injury to his left radial nerve that had to be reconstructed."

Strong and durable—allowing optimal motion

It was immediately clear to Sommer that the left knee injury required open reconstruction and plate fixation.

"The knee needed better reduction and stronger fixation than just this joint-bridging external fixator—that was quite clear. I think the biggest risk without this surgery would have been intra- and extraarticular nonunion of the femur because it was a multi-fragmented and open fracture," Sommer says. "The goal, of course, was to stabilize both legs and bring all fractures back to healing and functioning as well as they were before the accident: intraarticular congruency with well-aligned bones (correct length, rotation, and axis), as well as a moveable, stable and hopefully pain-free joint."



Fig 1 The Biphasic Plate DF—made possible by the AO Innovation Translation Center (AO ITC) Technology Transfer—is a new solution devised by the AO Research Institute Davos (ARI) in Switzerland, Queensland University of Technology (QUT) in Brisbane, Australia, and the Swiss manufacturer, 4iMedical AG. With Development Incubator resources from AO ITC, the development phase of the distal femur version started in 2018; CE certification as a class IIB medical device was granted in April 2021.

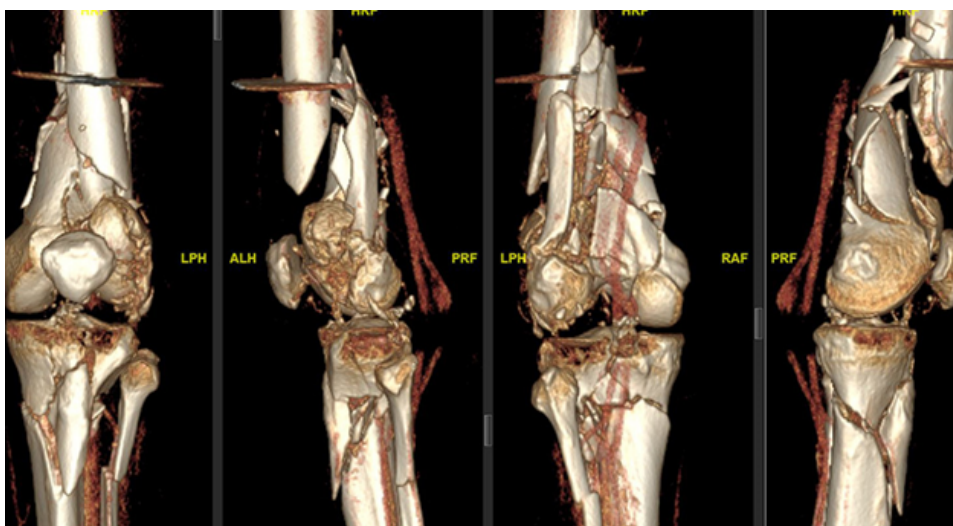


Fig 2 Computed tomographic images.

Sommer says he chose the Biphaseic Plate DF because it not only allows bridging between the joint and the shaft but also seems to be a durable implant without plate failure before bone healing.

“The bridging construct has been proven by animal experiments, and the plate is very strong and durable,” he says, noting that at the same time the Biphaseic Plate DF allows for a certain degree of motion, which is an advantage and promotes the callus formation essential to fracture stabilization. In contrast to conventional plates, the biphaseic plate due to its specific design allows for a defined motion of the fractured site while avoiding too much motion by loading. Overloading should not occur.

“That’s why I think it’s a good implant, especially for this case, where I expect a long healing time due to the high impact by the initial trauma and the delayed presentation to us,” says Sommer.

Following the 4-hour and 15-minute surgery and a second surgery a week later to correct a valgus-misalignment at the tibia level, the patient was treated at Kantonsspital Graubünden for 11 more days before being transferred to a rehabilitation center near Zurich.

“So far, his rehabilitation is going well. He starts walking with American crutches,” the surgeon reports, noting that he highly values innovations like the Biphaseic Plate DF that improve patient outcomes. “Innovation is very important. Twenty years ago, I thought, ‘Oh, we can fix everything. We have our implants, so we don’t really need new solutions,’” he says. “But now we have completely different implants than we had 20 years ago. Innovation, for me, is a new product or technique that adds value for our patients—and that value is what makes the difference. The AO’s Development Incubator is a valuable resource for people around the world to find support for their innovative ideas and bring them to market.”

‘The reason I do this work’

For ARI’s Markus Windolf, coinventor of the Biphaseic Plate DF, the first-in-human application of the solution was an exciting event.

“The prospect that this solution could speed up patient recovery and restore quality of life is really the reason I do this work,” says Windolf, ARI’s Deputy Program Leader Biomedical Development, Focus Area Leader Concept Development, and inventor of 16 international patents.

“It has always been my wish for an idea that came out of my head to reach clinical practice—reach the patient—and this is the first time that has happened with the Biphaseic Plate DF. It was a long journey, and the first-in-human application is very satisfying for me. This is what I always wanted to achieve when I went into health care as an engineer,” he says. “Nonetheless, we have to remain realistic here. This is only the first patient. Time will show if the Biphaseic Plate can create a real benefit in trauma care.”

Windolf visited the patient during his stay at Kantonsspital Graubünden.

“The patient was pleased that I had visited to ask how he was doing,” Windolf says. “I had the chance to explain the principle of the plate to him. He seemed proud to be the first patient in the world to have had this plate implanted. After explaining it to him, he sounded pretty confident that it could do some good in his case.”



Fig 3 Left to right: Markus Windolf and Christoph Sommer.

‘Having a real impact’

Biphaseic Plate DF coinventor Devakar Epari echoes Windolf’s sense of satisfaction that years after he and Windolf first discussed the plating concept during their 2014–2015 fracture healing research collaboration at QUT, the plate is now contributing to a patient’s recovery.

“It feels amazing and it is certainly the most significant professional contribution that I’ve made, which spans teaching, research, and innovation,” says Epari, an associate professor of biomedical engineering at the QUT School of Mechanical, Medical and Process Engineering. “I feel a great sense of satisfaction that my work, and not only the Biphaseic Plate DF but the many years of research before it, is having a real impact.”

Going forward, the development team will continue to support clinicians in using the Biphaseic Plate DF to collect data to determine the extent of benefits it provides to patients, with an eye to scaling up and demonstrating that the concept can address other anatomical areas, such as the lower tibia or upper arm.

“We are proud to support this project and the excellent project team with the AO’s Development Incubator,” says Roland Herzog, Head of the AO ITC’s Technology Transfer. “It is by innovations like the Biphaseic Plate DF that we can support the AO mission of promoting excellence in patient care and outcomes in trauma and musculoskeletal disorders.”

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A win-win-win scenario: patients will be ultimate beneficiaries of the AO's Clinical Study Hub

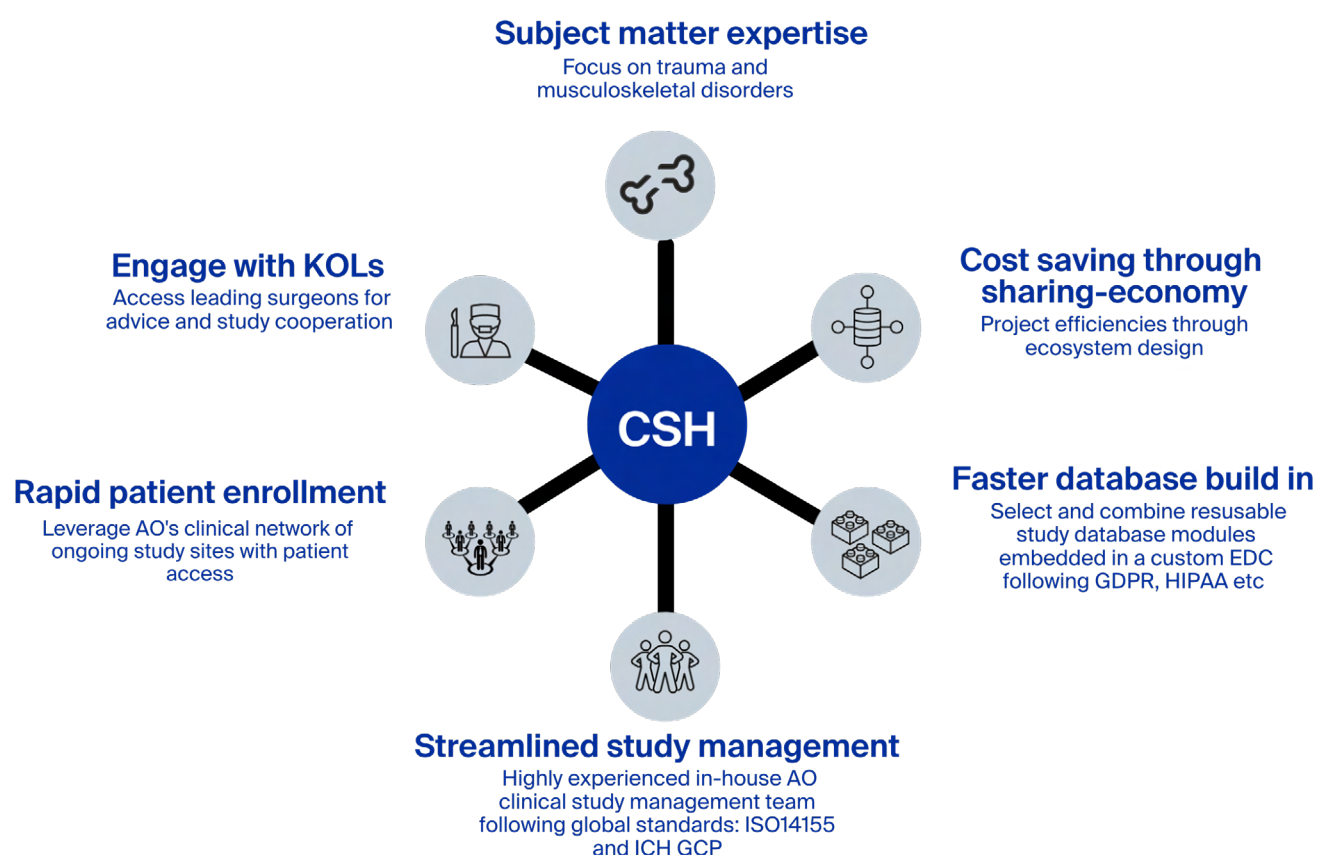


Fig 1 The AO's Clinical Study Hub.

With a backbone fortified by deep AO surgical, research, and technological expertise, an initiative project to run and connect clinical studies as services in orthopedics is getting a significant boost from [Strategy Fund](#) resources made available through the AO Innovation Translation Center (AO ITC) Technology Transfer.

The AO's Clinical Study Hub (AO CSH) project, led by Yabin Wu, AO Spine Knowledge Forum Manager, brings together the sharing economy concept with the AO's in-depth clinical study know-how and an up-to-date technical solution for data management. The resulting collaborative network will enable high-quality, global studies more effectively and efficiently than traditional approaches.

At its core, the AO CSH is designed as one large, overall prospective clinical project consisting of multiple ongoing sub-projects (studies). Every study will operate as a clinical study

service for the client and with a group of service users, and each study will be integrated into the overarching project domain both thematically and procedurally.

Its need is evident; in the past two decades of academic research, clinical studies in spine research alone have dramatically increased the number of publications from nearly 200 in 2000 to more than 1000 in 2017. At the same time, evidence-based clinical studies have become crucial in the spine device industry where evidence is necessary for product development and regulatory reporting. A boom in the global orthopedic devices market is expected to continue and along with it the need for support in clinical studies.

The AO CSH concept grew out of the vision of the AO Spine Knowledge Forum key opinion leader surgeons. They wanted to build the largest research data repository of spine surgery, and attempts have been made in the Knowledge Forums.

"In 2019, I shared a preliminary business plan about AO's Clinical Study Hub with AO Spine Director, Jayr Bass, who was very supportive. He encouraged me to apply for the Strategy Fund," says Wu. "We soon gained support also from the head of AO ITC Clinical Science, Alexander Joeris, and he joined forces to the application." Since then, a medical advisory board has been established, including key opinion leaders Hans Jörg Meisel, Dr med (Germany), Jeffrey Wang, MD (United States), and Tim Yoon, MD (United States).

Strategy Fund support will make possible the development of a new, customized information technology solution with data capture capability and the establishment of a dedicated team to drive the AO CSH project forward. The pilot phase focus will be on spine degenerative-related studies.

The AO CSH is envisioned as a scalable approach that initially will serve the AO's own need for high-quality, cost-effective truly global clinical studies. The platform will eventually be offered to industrial partners and orthopedic research groups who have the same need.

The aim of AO CSH is a win-win-win scenario benefiting all involved. "Clinical study clients will meet their clinical study need with higher quality, in less time, and at a lower budget more effectively," he says. "Participating surgeons and clinical centers will receive sufficient technical and financial support

to more easily join international studies; the AO's Clinical Study Hub will maintain its long-term sustainability; and the AO as the owner of the AO CSH will produce a large, global, collaborative clinical study network, and extend its leadership in clinical evidence and knowledge generation."

"The beautiful part of this project is that it really demonstrates the AO's global network of expertise. The AO has a wide global network of surgeons who are eager to participate in clinical studies, the research know-how from the AO ITC Clinical Evidence team, as well as a group of committed key opinion leaders with knowledge and passion."



Fig 2 Yabin Wu, AO Spine Knowledge Forum Manager

Latest release takes OSapp virtual osteosynthesis learning platform to a new level



Fig 1 At the DKOU 2021 in Berlin, Germany.

More than 100 new units in 32 lessons, a new structure representing the novel knowledge hub concept, a fresh look, and an improved user experience—all this and more awaits you in the latest release of **OSapp**, the AO's interactive, virtual osteosynthesis software tool and learning platform.

OSapp content is organized as an expanding knowledge hub designed to illustrate and explain the biomechanical principles underlying bone healing and fracture fixation. Interactive virtual models, based on existing and validated biomechanical parameters, facilitate the learning and, crucially, better understanding of the biomechanical principles, stated [Peter Varga, PhD, AO Research Institute Davos \(ARI\) Biomechanics and Modeling Focus Area Leader](#). The development of OSapp continues to be supported by ARI and the AO's [Strategy Fund](#). The OSapp Medical Advisory Board (MAB) has prioritized collaboration and integration with other highly regarded AO

educational fora, including AO Milestones and the AO Education Institute through the Residents Education Task Force, and further evolution of close links with the AO Surgery Reference content.

The MAB, led by Simon Lambert, MD, emphasized that OSapp aims to complement and augment education in biomechanics through knowledge delivery, virtual simulations, and case-based exercises; it is a learner-based educational multimodular program designed to enhance the comprehension of relevant biomechanical principles fundamental to fracture care. The knowledge hub comprises four main themes (basic principles; the principles of internal fixation; the principles of external fixation; and special topics [eg, complementary educational material for the AO Skills Lab stations]), together with a free configurator and case-based biomechanics challenges, including cases derived from the ICUC library.

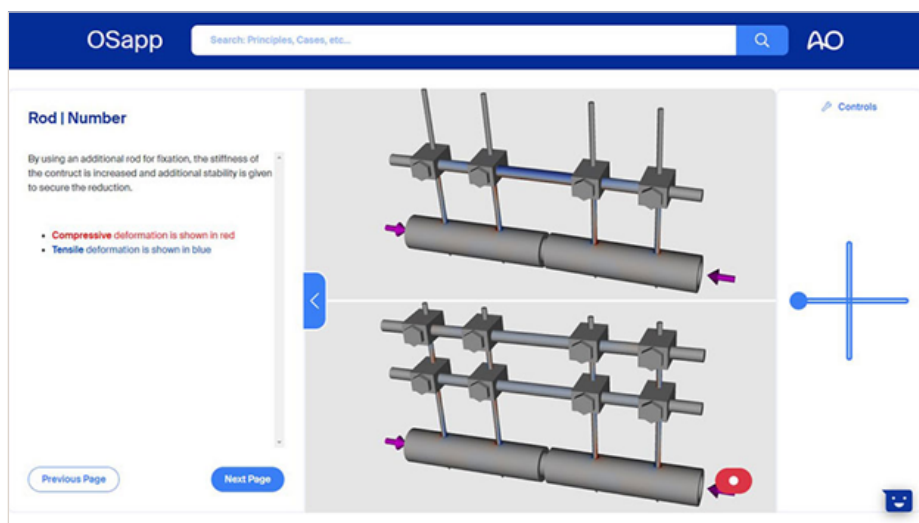


Fig 2 Rod/Number

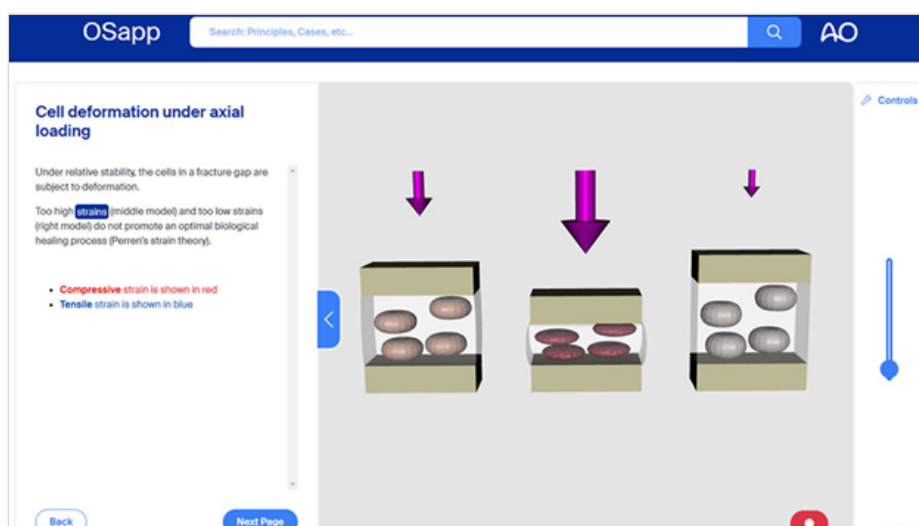


Fig 3 Cell deformation under axial loading.

The latest OSapp release will be demonstrated in the exhibition at the AO's flagship annual event, the [AO Davos Courses](#), December 4-16, 2022. OSapp's new user interface is enriched by a navigation tool supporting the new knowledge hub structure, which emulates the user-friendly AO Surgery Reference style and includes an intuitive search function.

"Importantly, this latest release is easier to use because the navigation is much better configured to the way users think," said Dominic Mischler, a project leader on ARI's Biomedical Development team.

OSapp will be piloted to participants during two [AO Trauma](#) educational events at the AO Davos Courses 2022. It will be

used to augment educational content throughout the [AO Trauma Course—Basic Principles of Fracture Management for Swiss Residents](#), including a case-based biomechanics challenge as part of Prof Reto Babst's lecture on biomechanical principles and pitfalls. During that course, OSapp will also augment faculty presentations with animations illustrating biomechanical principles and it will also complement four Skills Lab stations with virtual content. Moreover, during the second week of the AO Davos Courses, OSapp will also augment the Skills Lab portion of the [AO Trauma Course—Basic Principles of Fracture Management](#).

Try OSapp today: it is free to use and only a click away. [Access OSapp](#)

Investigating new Flexible, 3D-Printed Fracture Models



Fig 1 Prof Dankward Höntzsch presenting at the AO booth, German Congress of Orthopedics and Traumatology (DKOU 2022), Berlin, Germany.

With three successful pilots to its credit and a presence at the AO Davos Courses 2022, a new [Strategy Fund](#)-supported project—Flexible, 3D-Printed Bone Models—is a step forward for musculoskeletal education as well as surgical planning. The brainchild of past [AO Technical Commission](#) (AO TC) member Dankward Höntzsch, MD, the flexible and manipulable fracture models are an improvement over existing bone models because they allow simulation of both fracture reduction and osteosynthesis.

It is not surprising that the concept originated with Höntzsch: He calls himself “technically oriented” and might have become a carpenter if he had not pursued a career in medicine. Höntzsch was the 2016 recipient of the AO Recognition Award for AO TC members for his significant career contributions to the AO and who achieved meaningful impact on product innovation and patient care. He explained that the idea for the Flexible, 3D-Printed Bone Models originated at a course he was supervising.

“3D-printed bone models are common at courses, and I was looking at the 3D-printed bone model that I was holding in my hand. No one was complaining about this kind of model, but I noticed that it doesn’t make much sense because all the fracture fragments are fixed,” he noted. “You cannot move anything. You can only look at and touch the model—nothing more.”

What did make sense in Höntzsch’s ever-inventive mind was a flexible fracture model that course participants could manipulate to simulate reduction and fixation.

“As soon as I got home from that course in Cologne, Germany, I went right to my cellar workshop and began tinkering—giving form to my idea,” he recalled. “First, I made some prototypes with some springs but those didn’t work.”

As luck would have it, Höntzsch had a connection to [marengo swiss](#) in Pfäffikon (canton of Zurich, Switzerland). With 30 employees, the company specializes in engineering and design for mechanical development and had already collaborated successfully with Höntzsch on the development of a ceramic and friction-based clamp for external fixators.

“I knew that marengo swiss had a 3D printer, so in one of my meetings with them in Pfäffikon, I took my idea and initial prototypes with me,” said the retired surgeon from Tübingen, Germany. “At the end of the meeting, I put my prototype on the table and asked, ‘Can you make this?’”

Within a week, marengo swiss had created a prototype Flexible, 3D-Printed Fracture Model.

“I am not easily impressionable, but their speed impressed me,” Höntzsch said.



Fig 2

Simulation of osteosynthesis

Höntzsch and marenco swiss were off and running on another collaboration. In spring 2022, they filed an international patent application shared with marenco's Raffael Heierli (head of engineering and a member of the company's executive board) and Bedran Atici (design development engineer).

"Prof Höntzsch was immediately enthusiastic about our results and recognized the potential applications of these Flexible, 3D-Printed Fracture Models," said marenco swiss CEO Rolf Spichtig. "The biggest challenges were translating the scanned data into the language of the 3D printer: The better this translation succeeds, the more realistic the printed model will be. Second, imaging of the different categories of fractures is challenging; from simple fractures to more comminuted fractures, more and more fragments are added. With our tentacle system, these fragments stay on the bone and can be pushed into their original position."

"For us, the collaboration between medicine, modern technology, and engineering performance is enormously exciting," Spichtig said.

Höntzsch agreed, emphasizing that in addition to serving as a teaching tool, the Flexible, 3D-Printed Fracture Models can be used for surgical planning.

Novel dynamic screw-suture stabilization system for syndesmotic repair provides better anteroposterior translation and axial tibiofibular joint stability—a biomechanical investigation

The quest for optimal treatment of acute distal tibiofibular syndesmotic disruptions is still in full progress. Using suture-button repair devices is one of the dynamic stabilization options; however, they may not be always appropriate for stabilization of length-unstable syndesmotic injuries. Recently, a novel screw-suture repair system was developed to address such issues (Fig 1). This implant system provides the fixation of a screw and the flexibility of a suture, addresses the limitations of suture-button constructs related to both the lack of tension control and medial soft-tissue disruption, and enables precise anatomical syndesmotic fixation.

The aim of this project was to investigate its performance compared with a suture-button stabilization of unstable syndesmotic injuries.

Eight pairs of human anatomical specimens, namely lower legs, were scanned by computed tomography (CT) under 700 N

single-leg axial loading in 5 foot positions—neutral, 15° external/internal rotation, and 20° dorsiflexion/plantarflexion in three different states: (1) preinjury (intact); (2) injured, characterized by complete syndesmosis and deltoid ligaments cuts simulating pronation-eversion injury types III and IV as well as supination-eversion injury type IV according to Lauge-Hansen; (3) reconstructed, using a screw-suture (FIBULINK, Group 1) or a suture-button (TightRope, Group 2) implant for syndesmotic stabilization, placed 20 mm proximal to the tibia plafond/joint surface (Fig 2).

Next, all specimens were biomechanically tested over 5000 cycles under combined 1400 N axial and $\pm 15^\circ$ torsional loading. Clear space (diastasis), anterior tibiofibular distance, talar dome angle, and fibular shortening were measured radiologically from the CT scans. Anteroposterior, axial, mediolateral, and torsional movements at the distal tibiofibular joint level were evaluated biomechanically via motion tracking.

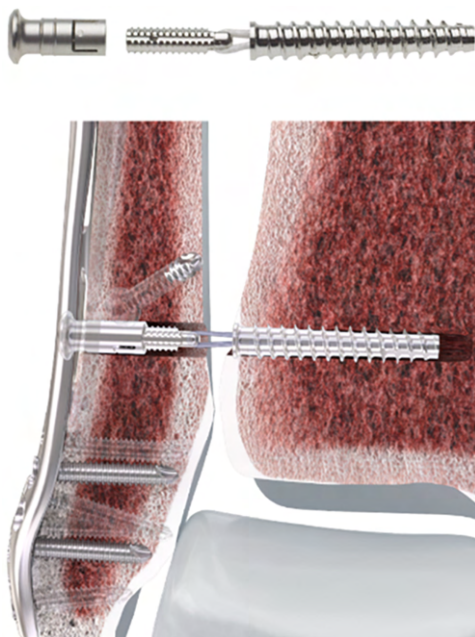


Fig 1 The novel screw-suture repair system for precise anatomical syndesmotic fixation.

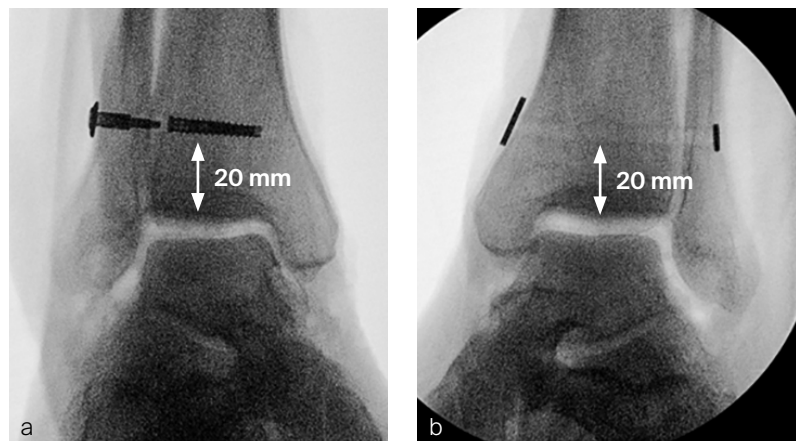


Fig 2a-b AP radiographs of reconstructed specimens using a screw-suture (FIBULINK, Group 1, **a**) or a suture-button (TightRope, Group 2, **b**) implant for syndesmotic stabilization, placed 20 mm proximal to the tibia plafond/joint surface.

In each group clear space increased significantly after injury ($P \leq .004$) and became significantly smaller in reconstructed compared with both preinjured and injured states ($P \leq .041$). In addition, after reconstruction it was significantly smaller in Group 1 compared with Group 2 ($P < .001$). Anteroposterior and axial movements were significantly smaller in Group 1 compared with Group 2 ($P < .001$; Fig 3). No further significant differences were identified nor detected between the two groups ($P \geq .113$).

Although both implant systems demonstrate an ability for stabilization of unstable syndesmotic injuries, the screw-suture reconstruction provides better anteroposterior translation and axial stability of the tibiofibular joint and maintains it over time under dynamic loading. Therefore, it can be considered as a valid option for treatment of syndesmotic disruptions.

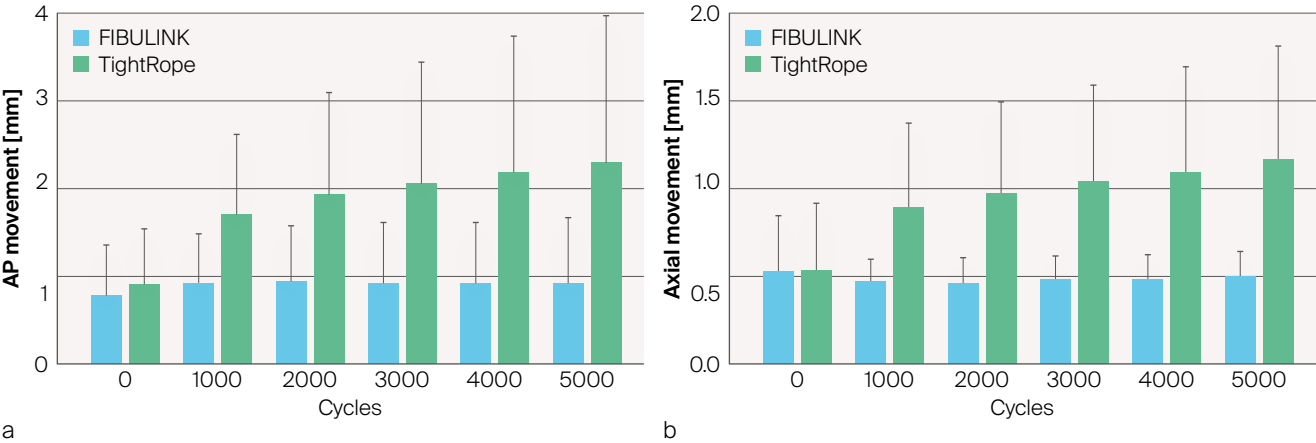


Fig 3a-b Anteroposterior (AP, **a**) and axial (**b**) movements at the distal tibiofibular joint level of the specimens in Group 1 (FIBULINK) and Group 2 (TightRope) at the beginning of the cyclic test and after 1000, 2000, 3000, 4000, and 5000 cycles.

Lateral rim variable angle locked plating versus tension band wiring of simple and complex patella fractures—a biomechanical investigation

Treatment of both simple and complex patella fractures is a challenging clinical problem. It aims to restore the integrity of the extensor mechanism and the congruity of the patellofemoral joint. Controversy exists regarding the most appropriate fixation method. Tension band wiring aiming to convert tensile forces on the anterior aspect of the patella into compression forces across the fracture site is the standard of care; however, it is associated with high complication rates. Recently, lateral rim variable angle locking titanium and steel plates have been developed for treatment of both simple and comminuted patella fractures (Fig 1). The low-profile plates have variable angle locking holes enabling up to 15° screw angulation to target small fracture fragments and to avoid fracture lines and other implants. They allow surgeons to achieve stable fixation in simple and complex patella fractures using bicortical, interfragmentary screws in a multiplanar fashion around the rim of the patella. These plates also minimize soft-tissue irritation and can be cut and contoured with dedicated instruments according to the patient anatomy and various fracture patterns. Sutures can be placed through the plate windows to anchor soft tissues to augment the repair.

The aim of this project was to investigate the biomechanical performance of the recently developed lateral rim variable angle locking plates versus tension band wiring used for fixation of simple and complex patella fractures.

Sixteen pairs of human anatomical specimens, the knees, were used to simulate either two-part transverse simple AO/OTA 34C1 or five-part complex AO/OTA 34C3 patella fractures by means of osteotomies, with each fracture model being created in six pairs. The complex fracture pattern was characterized by a medial and a lateral proximal fragment, together with an inferomedial, an inferolateral and an inferior fragment mimicking comminution around the distal patellar pole. The specimens with simple fractures were pairwise assigned for fixation with either tension band wiring through two parallel cannulated screws, or a lateral rim variable angle locking plate. The knees with complex fractures were pairwise treated with either tension band wiring through two parallel cannulated screws plus circumferential cerclage wiring, or a lateral rim variable angle locking plate (Fig 2).

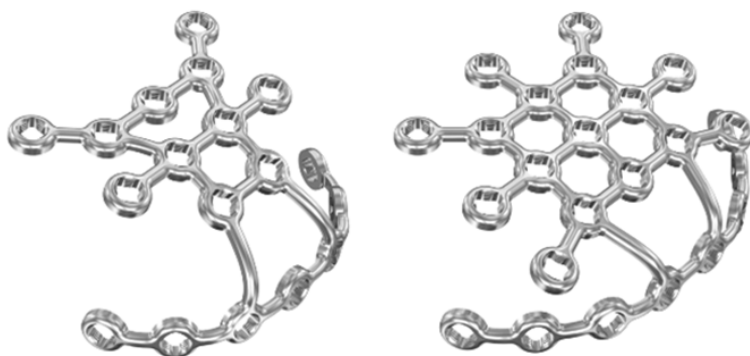


Fig 1 Variable Angle Locking Lateral Rim Patella Plates 2.4/2.7 designed for treatment of simple and complex patella fractures.

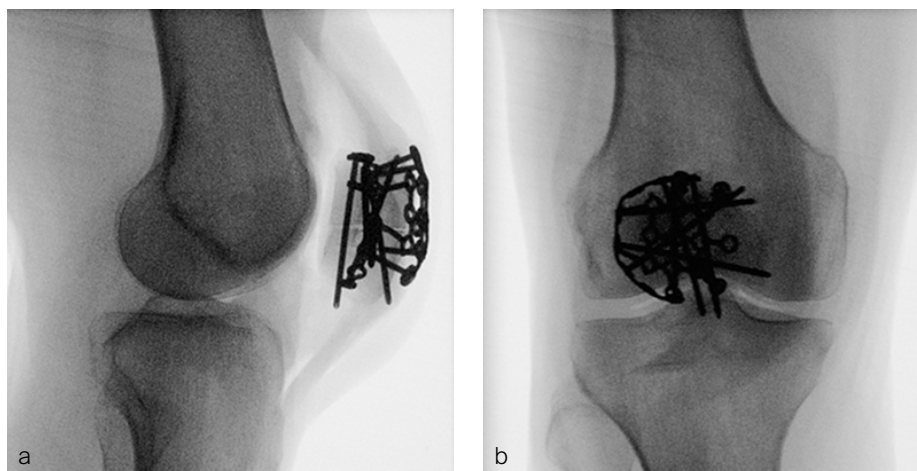


Fig 2a–b Exemplified mediolateral (a) and AP (b) radiographs of specimens with complex fractures treated by lateral rim locked plating.

Each specimen was tested over 5000 cycles by pulling on the quadriceps tendon, simulating active knee extension and passive knee flexion within the range of 90° flexion to full knee extension. Interfragmentary movements were captured by means of motion tracking.

For both fracture types, the longitudinal and shear articular displacements, measured between the proximal and distal fragments at the central aspect of the patella between 1000

and 5000 cycles, together with the relative rotations of these fragments around the mediolateral axis were all significantly smaller following the lateral rim variable angle locked plating compared with the tension band wiring ($P < .01$; Fig 3).

From a biomechanical perspective, lateral rim locked plating of both simple and complex patella fractures provides superior construct stability versus tension band wiring.

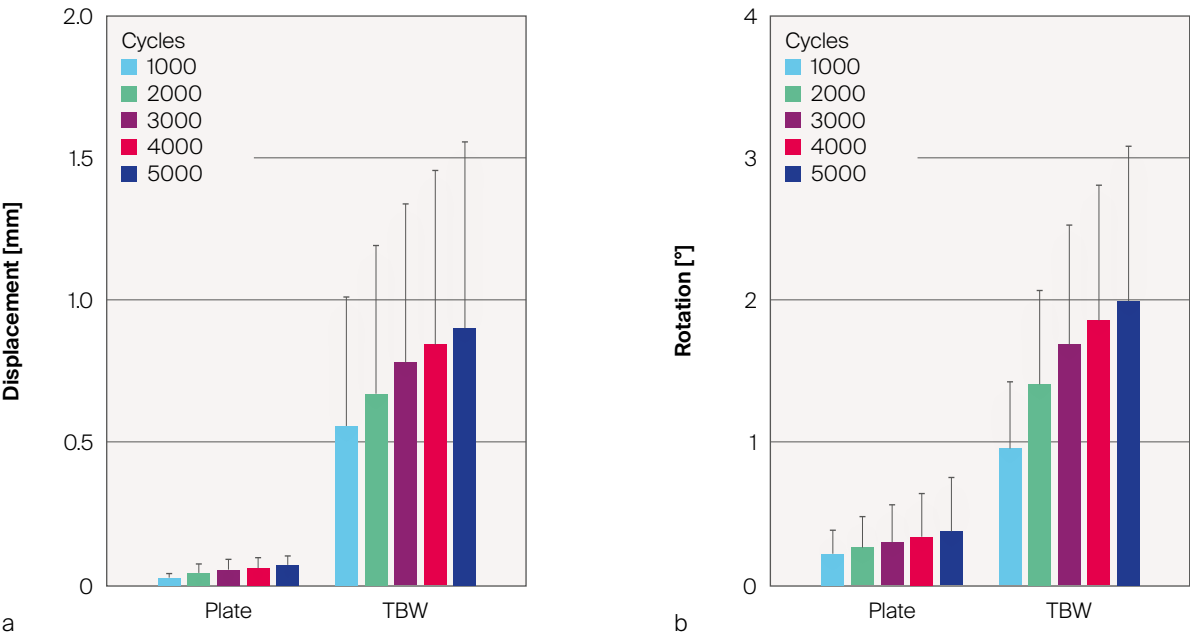


Fig 3a–b Articular displacement at the central aspect of the patella (**a**) and rotation (**b**), both measured between the proximal and distal fragments after 1000, 2000, 3000, 4000, and 5000 cycles and featuring complex fractures fixed by either lateral rim variable angle locked plating (Plate) or tension band wiring (TBW) in terms of mean and standard deviation.

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