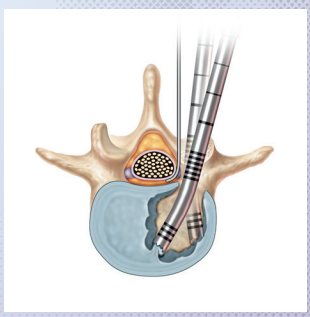
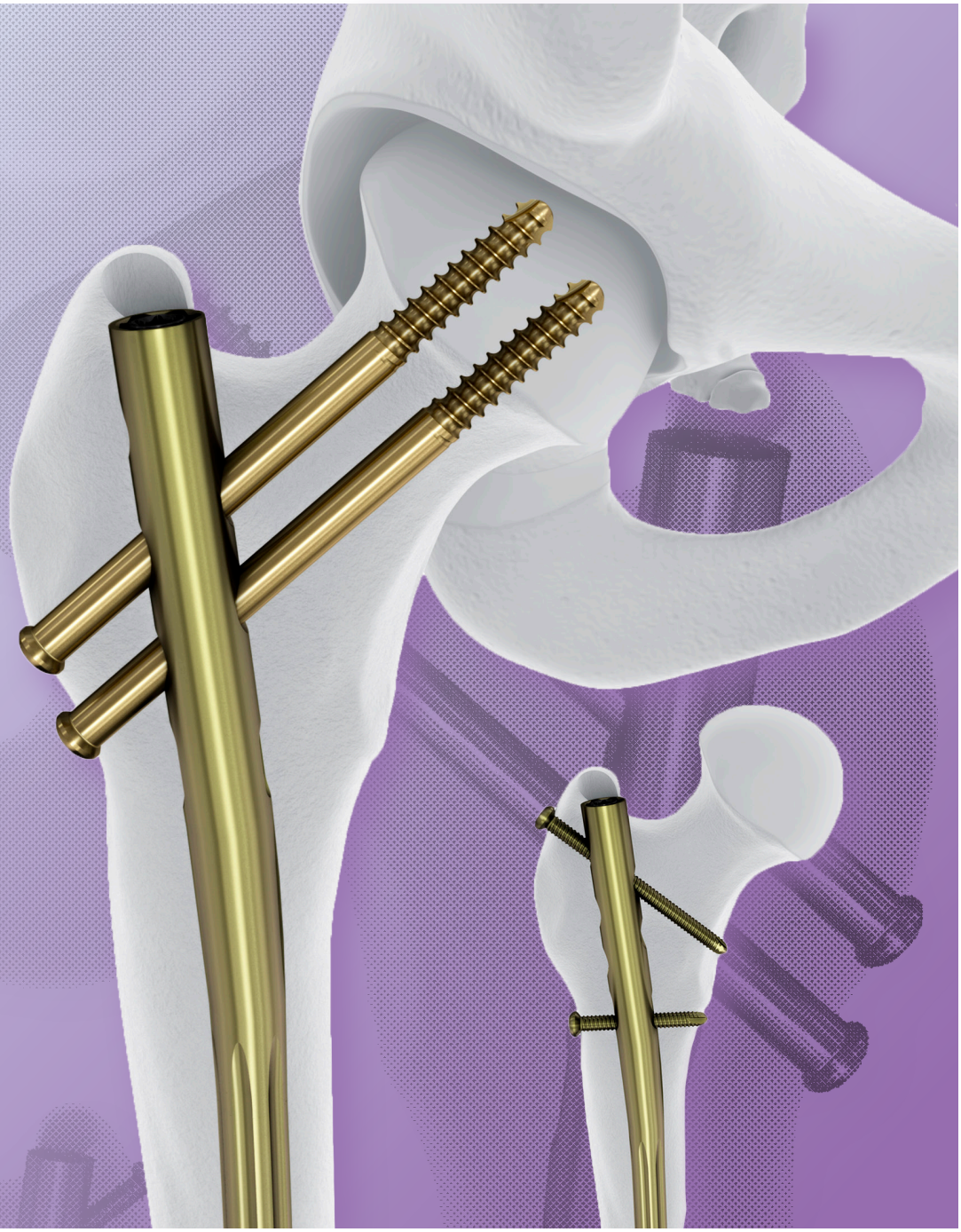
AO Foundation

AOTK System

Innovations 2018





AOTK System “Innovations” is compiled by the AOTK team (from left to right): Karsten Schwieger, Ursula Eberli, Christoph Nötzli, María Alvarez Sánchez, Vanessa Schenk, Regina Brun, Géraldine Pozzan, Sarah Carbis, Claas Albers, Lois Wallach.

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EDITORIAL

Dear reader,

Welcome to the 2018 edition of the AOTK System Innovations magazine. The AOTK is delighted to inform you about the newly approved trauma, spine, CMF, and vet products in collaboration with our industrial partner, DePuy Synthes. In addition to the usual showcase of AOTK innovations, this issue contains summaries of the AOTK Meet the Experts' sessions and the AOTK Experts' Symposia in 2017. Contributions from the AO Research Institute (ARI), AO Clinical Investigation and Documentation (AOCID), as well as the AO Education Institute (AOEI) complement the content of this year's edition.

In our lead article, we introduce the Femoral Recon Nail (FRN), which is the most recent innovation from the Intramedullary Nailing Expert Group. The FRN system offers surgical entry point and locking options to accommodate varying preferences, enabling surgeons to treat a broad range of complex femur fractures. The nail was designed to enhance anatomical fit and to avoid complications like distal cortical impingement. The streamlined insertion instruments include features to facilitate implant placement and to reduce surgical time and complexity. After an intensive development time of 6 years, this nailing system will have major impact on advancing worldwide patient care.

The Veterinary Expert Group developed a solution for the treatment of physeal fractures of the proximal tibia in foals, the LCP T-Plate 4.5. Traditional fixation methods, which rely on dynamic compression plating and tension band wiring, have limits in terms of achieving adequate stability. The new plate solution offers stacked combi-holes in the T-part of the plate for improved screw fixation in the epiphyseal fracture fragment. New indications for the use of this plate are under investigation.

AOTK (CMF) provides an insight into the use of patient specific implants (Titanium 3D Printed Plates) and customized surgical guides in the workflow from planning to the surgical procedure. The other CMF product to have obtained approval is a second generation injectable polymer system, which was successfully modified to improve usability.

AOSpine TK is proud to inform us about two newly launched products to address the increasing demand for solutions to improve minimally invasive surgery (MIS). Viper Prime is an innovative all-in-one instrument system that eliminates the need for guidewires, Jamshidi needles, and additional pedicle preparation instruments in minimally invasive spinal fusion surgery. In one bench study, the Viper Prime system demonstrated a 33 percent reduction in the time required to insert a pedicle screw compared to traditional MIS techniques. The Concorde Clear MIS Discectomy Device is a specially designed tool to enhance MIS discectomy procedures. It will provide for more efficient disc clearing and endplate preparation in less time than using standard discectomy tools.

A major step forward in AOTK's goal to realize more innovative ideas from its own medical members was taken when provisions were included in the terms of the Cooperation

Agreement between the AO Foundation and DePuy Synthes, signed in 2015, to allow the AOTK System to work with third parties on project proposals declined by DePuy Synthes. AO Spine TK used this opportunity to propose two projects for collaboration with third parties: the development of an anterior spinal deformity system with NuVasive, and a biological allograft solution in osteoporotic spine fractures with Lenoss Medical. The AO Foundation Board decided in March 2018 that the AOTK can go ahead with these projects by developing a Memorandum of Understanding with these companies as part of the AOTK Off Ramp process. We will keep you informed about these and upcoming third party collaborations, which are an essential part of strengthening, globally opening, as well as enhancing independence for AOTK innovation endeavors.

One of the strategic AOTK initiatives is the investigation of smart sensor technology to monitor patient performance and compliance in general and fracture healing specifically. Supported by AOTK, ARI focuses on such technology and its use in fixation devices. In this issue, ARI reports on a concept to incorporate a measuring and recording unit in an internal fixator to determine the status of bone union. The orthopedic and trauma world will witness an increasing number of applications with smart sensor technology in the near future and the AOTK is well positioned to appropriately address this trend.

One of the strengths of the AOTK is its flexible structure to reflect the needs of all stakeholders in medical product development. The initiation of Task Force teams such as the Periprosthetic Fracture Task Force, or the Anti-Infection Task Force (a report on which is included in this edition) has allowed us to target very specific unmet clinical needs. The formation of Task Force teams and small project teams is a promising and attractive way to meet medical needs as well as provide a fast and efficient product development process provided that these entities are embedded in a suitable structure. With that in mind, the AOTK organized a workshop at the AOTK Chairmans' meeting during the Trustees Meeting in Basel, to explore the potential benefits and opportunities of an AOTK restructure. Utilizing a systematic approach, all workshop participants analyzed the current as well as a possible future structure encompassing past, current, and future perspectives. The information obtained will be used in the following steps to adapt the AOTK structure with the aim of optimizing product development under the framework of defined clinical needs and priorities as well as available resources. We will keep you updated about this process in future AOTK Innovations magazines.

We hope that you enjoy reading the 2018 edition of AOTK System Innovations magazine and would like to emphasize that none of the articles in this magazine substitute for the AO's surgical techniques and teaching tools. You can obtain more information about AOTK on the AO Foundation website. Please do not hesitate to contact AOTK at any time as we welcome your feedback and involvement.

Yours faithfully

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FEMORAL RECON NAIL SYSTEM

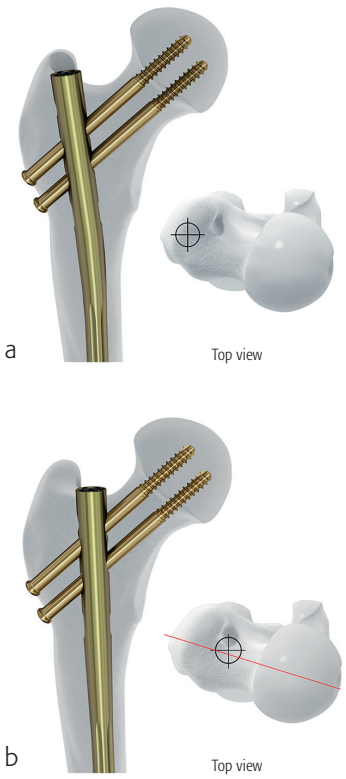

Fig 1a–b
Femoral Recon Nail entry points. The FRN for tip of the trochanter entry point (a). In the AP view, the nail insertion point is on the tip or slightly lateral to the tip of the greater trochanter, in the curved extension of the medullary cavity. This represents a point, 5° lateral of the femoral shaft axis, measured from a point just below the lesser trochanter. The FRN for piriformis fossa entry point (b). The entry point for the piriformis fossa nail is in line with the medullary canal in the AP and lateral views.

Clinical challenges and design solutions

Obtaining the correct entry point is a key requirement in every intramedullary nailing procedure to avoid complications, especially valgus/varus deformities. In 2006, the AOTK (Trauma) approved the Expert Lateral Femoral Nail (Expert LFN) as an antegrade femoral nail designed to be inserted through an entry point lateral to the tip of the greater trochanter. This entry point was chosen because of the perceived ease of access to the entry site, because of the potential lower risk for an avascular necrosis, and less damage to the abductor mechanism since splitting of the gluteus medius is not needed and the damage of the gluteal medial tendon attachment is minimized. These perceived benefits of the Expert LFN are well known among the surgeon community. The choice of the entry point depends on several factors including the fracture characteristics, associated injuries, and the technical familiarity of the surgeon with each nailing method. Many surgeons use nails that are designed for various entry points, as shown in these numbers: 9% lateral entry point, 28% piriformis fossa entry point, and 63% greater trochanter entry point nails.

Regional characteristics also play an important role in deciding the femoral nail entry point. For example, in the US, many surgeons are trained to use nails with a piriformis fossa entry point, but in other regions the greater trochanter is the option most frequently used.

In order to offer surgeons the choice of most used entry points, the Intramedullary Nailing Expert Group (INEG) decided in 2012 to develop a next generation nail system for a piriformis fossa entry point as well as for a trochanter tip entry point (**Fig 1**), the Femoral Recon Nail (FRN) system.

In addition to offering nails for different surgical entry points, the FRN system is also designed to solve a potential operative complication called distal cortical impingement (**Fig 2**) [1]. This is often the result of the antecurvature bow of the patient's femoral anatomy being greater than the curve of the nail. This geometrical mismatch may lead to anterior perforation of the cortex, which could require revision surgery. The nails of the FRN system are specifically designed to enhance the anatomical

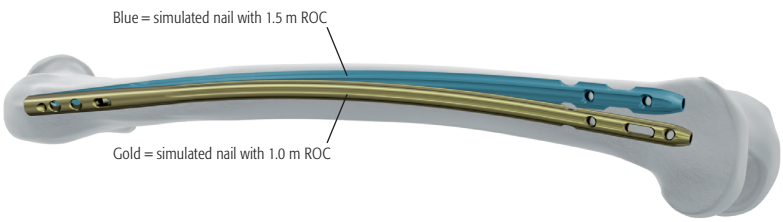

Fig 2
The simulated nail in blue color with 1.5 m ROC might cause distal cortical impingement. A smaller ROC of 1.0 m facilitates an improved anatomical fit of the FRN as shown by the gold nail.

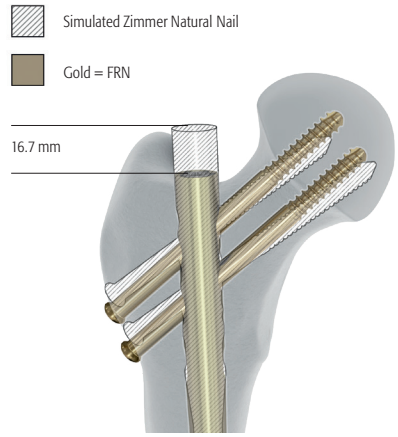

Fig 3
Illustration of the reduced proximal nail protrusion of the FRN compared to the Zimmer Natural Nail.

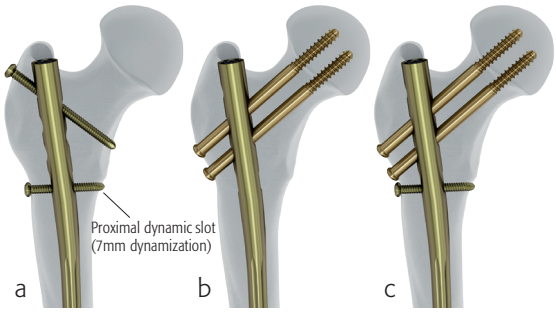

Fig 4a–c
Standard and reconstruction locking modes. A LM screw can be placed below the 2 recon screws with the aim of improving the fixation, which can be beneficial in subtrochanteric fractures.

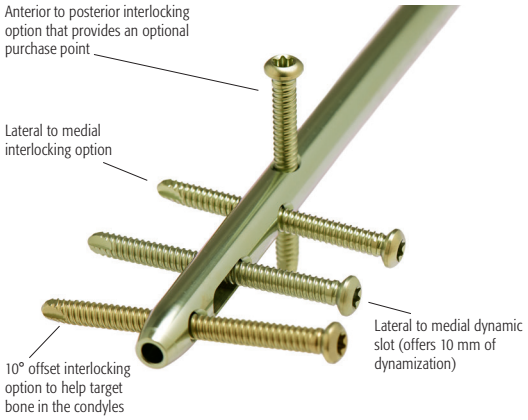

Fig 5
Distal locking options.

fit by reducing the nail radius of curvature (ROC) to 1.0 m. This value is based on a multiethnic 3-D computational study [2] performed to identify the best ROC for the new nail.

Another anatomical aspect is that some nails can lead to a too proud nail position. The shorter proximal nail end of the FRN reduces the risk of nail prominence compared to the Zimmer Natural Nail (**Fig 3**).

Proximal and distal locking influence the anchorage of the nail in the bone and the stability provided at the fracture site. Achieving adequate implant anchorage can be a clinical challenge, especially in metaphyseal areas and in osteoporotic bone. The configuration of proximal and distal locking is also influenced by the fracture pattern and location. The FRN offers a choice of standard and reconstruction locking modes (**Fig 4**) to allow for the treatment of a variety of femoral fracture types. The nail is equipped with four distal locking options, including an oblique distal hole offset of 10° to better target bone in the condyles and an A/P hole that provides an optional purchase point and improves stability with this multiplanar configuration (**Fig 5**). There are proximal (7mm) and distal (10mm) slots in the nail to allow dynamization if required. If the nail is inserted very distally, it can happen that the distal dynamization slot can't be used. In such a case the use of the proximal dynamization slot is helpful to avoid the risk of nail protrusion into the knee joint.

Nail geometry

The cannulated left and right nails are made of titanium alloy (TAN) and are provided in the following diameters and lengths:

- 9 mm and 10 mm distal nail diameters with non-fluted shaft: 280 mm – 480 mm in 20 mm increments
- 11 mm, 12 mm, and 14 mm distal nail diameters with fluted shaft: 300 mm – 480 mm in 20 mm increments.

All nails with a distal nail diameter of 9 mm to 12 mm have a proximal nail diameter of 13 mm. The nail with a distal nail diameter of 14 mm has a proximal nail diameter of 14 mm. These proximal nail diameters are smaller than those of the Expert LFN and as such require less bone volume to be removed. Although the proximal nail diameters are smaller, mechanical testing has shown that the median fatigue limits of the FRN are significantly higher than the ones of the Expert LFN in standard and reconstruction locking modes.

The nail is designed for two 6.5 mm titanium recon screws in 130° CCD recon locking holes in the reconstruction locking mode at an anatomic anteversion of 14°. All nails use 5.0 mm titanium locking screws, and 5.0 mm angular stable locking screws can also be inserted to provide angular stable fixation.

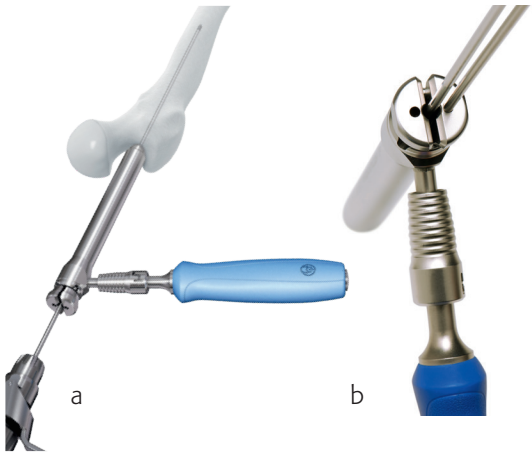

Fig 6a–b
Handle, protection sleeve and multihole wire guide (a). Correcting the position of the second guide wire by 5 mm relative to the first guide wire (b).

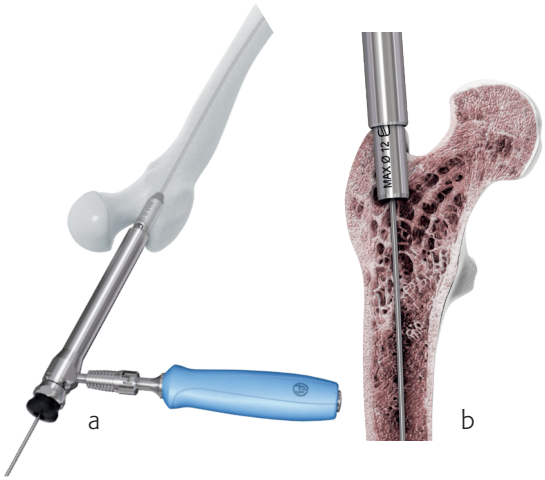

Fig 7a–b
Assembled handle with protection sleeve, reamer protection tube and trocar (a). Inserted reamer protection tube to protect the proximal metaphysis (b).

Fig 8
Illustration of the QUICK CLICK Self Retaining Technology between the screwdriver and the connecting screw as well as between the insertion handle and the nail.

FRN instruments

The instruments for the FRN were designed based on surgeon needs and had the focus to facilitate surgical technique. For the accurate insertion of the guide wire, the FRN system offers a multihole wire guide (**Fig 6**). If the first guide wire is inserted in an incorrect position, a second guide wire can be inserted through one of the additional holes in the multihole wire guide at 5 mm from the central hole. The wire guide can also be rotated in 90° steps to facilitate the insertion of a second guide wire.

There is an optional reamer protection tube that can be inserted into the bone after opening the femoral canal. This instrument is used to help protect the proximal metaphysis during reaming avoiding undesired enlargement of the entry point or reaming of the lateral wall (**Fig 7**). The reamer protection tube can only be used with reamer heads up to 12 mm (for 9 mm, 10 mm, and 11 mm nails).

Orthopedic instruments should be intuitive to allow the surgeon and the operating room teams to focus completely on the patient and the procedure. The FRN system is designed to address the need to increase the procedural efficiency in the operating room as described in the following. The QUICK CLICK Self Retaining Technology is designed to ensure a fast and effective assembly of the insertion handle to the nail (**Fig 8**), potentially improving surgical efficiency and reducing OR time.

Placement of the guide wires for the recon screws is a critical step in the nailing procedure influencing the clinical success of the implant. Radiolucent insertion handles with radiographic indicators and the optional guide wire aiming device assist in guide wire placement (**Figs 9** and **10**), which can reduce the required OR time to achieve accurate guide wire positions. The instruments allow the surgeon to identify the predictive pathway of the guide wires before actually inserting any.

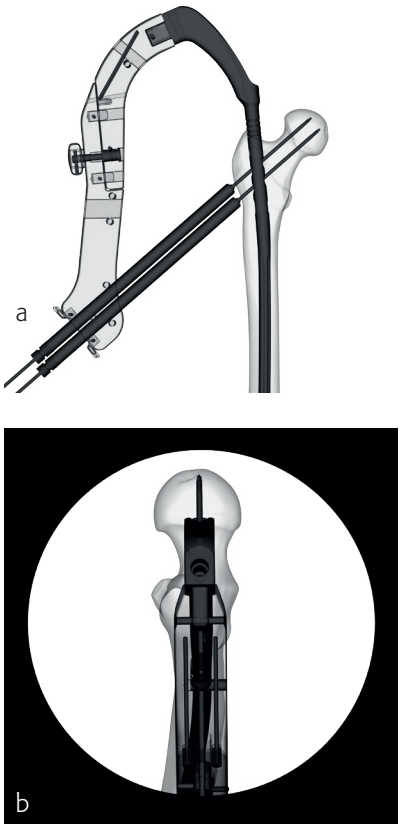

Fig 9a–b
Radiolucent insertion handle with radiographic indicators assist in guide wire placement (a). This is especially beneficial in the true lateral view (alignment of the axis of the femoral neck parallel to the axis of the femoral shaft) to place the guide wire in the correct position (b).

Indications

The FRN system is intended for treatment of fractures in adults and adolescents (12–21 years) in which the growth plates have fused. Specifically, the system is indicated for:

- Subtrochanteric fractures
- Ipsilateral neck/shaft fractures
- Femoral shaft fractures
- Impending pathologic fractures
- Malunions and nonunions.

In summary, the FRN system offers surgical entry point and locking options to accommodate varying preferences, and enables surgeons to treat a broad range of complex fractures with increased procedural efficiency in the operating room.

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2 **Schmutz B, Amarathunga J, Kmiec S, et al**. Quantification of cephalomedullary nail fit in the femur using 3D computer modelling: a comparison between 1.0 and 1.5m bow designs. *J Ortho Surg and Research*. 2016; 11(1):53.

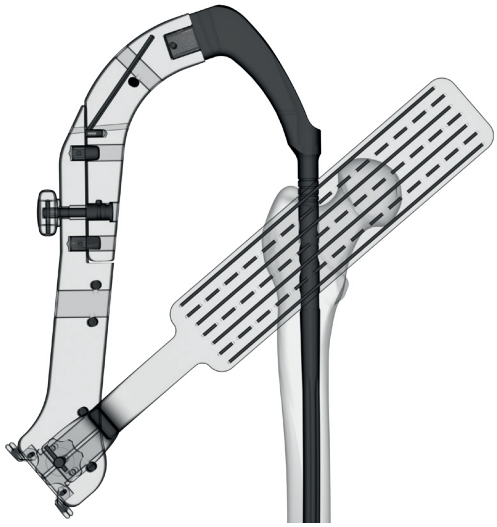


Fig 10
The optional guide wire aiming device can be mounted to the aiming arm to help adjust the height of the nail by visualizing the expected path of the recon screws in the AP view.

Case provided by Christopher Finkemeier, Carmichael, USA

Case 1: Subtrochanteric femur fracture

An 86-year-old patient fell at home while dressing, sustaining a subtrochanteric left femur fracture (**Fig 11**). The CT scan confirmed no involvement of the intertrochanteric region or the piriformis fossa. Fixation was with FRN for piriformis fossa entry point in reconstruction locking mode and transverse locking (**Fig 12**).

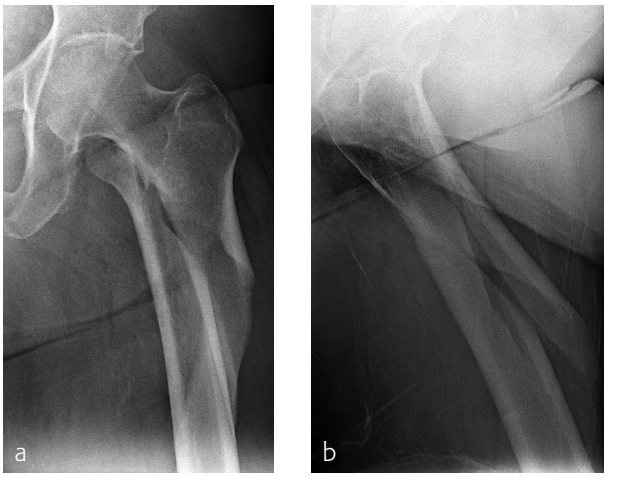


Fig 11a–b
The AP (a) and lateral (b) x-rays of the left hip.

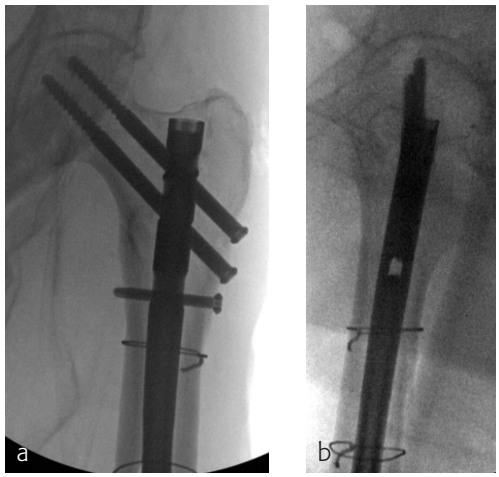


Fig 12a–b
a AP image of the left hip after cerclage wire reduction of the long subtrochanteric extension. Piriformis reconstruction nail with two recon screws and one LM screw to optimize proximal fixation.
b Lateral image of the left hip after cerclage wire reduction of the long subtrochanteric extension and nailing.

Case provided by Martin Hessmann, Fulda, Germany

Case 2: Left femur fracture

A 70-year-old female patient suffered an AO 32-B3 fracture of the left femur (**Figs 13** and **14**). Fixation with the FRN for a tip of the trochanter entry point (nail diameter 10 mm; nail length 400 mm; reaming to 12 mm) in standard interlocking mode (**Figs 15** and **16**). Proximal locking with antegrade and transverse dynamic locking positions. Distal locking with two lateral to medial locking screws in static locking position.

Fig 13a–b
Preoperative AP x-rays.

Fig 14a–b
Preoperative LM x-rays.

Fig 15a–b
Postoperative AP x-rays.

Fig 16a–b
Postoperative LM x-rays.

Douglas Campbell, Jonathan Dwyer, Boyko Gueorguiev, Andrew Sands

TRAUMA

Nitinol implants offer a new fixation technology in orthopedic trauma and reconstructive surgery

In 2016, DePuy Synthes acquired BioMedical Enterprises Inc (BME) a leading manufacturer of nitinol orthopedic implants for small bone fixation. BME, founded in 1991, was one of the first US manufacturers of nitinol implants for musculoskeletal fixation. Nitinol is a metal alloy of nickel and titanium with two elements present in roughly equal atomic percentages. The word "Nitinol" is derived from its composition and place of discovery: Nickel Titanium—Naval Ordnance Laboratory. Nitinol alloys exhibit two closely related and unique properties: shape memory effect and superelasticity.

When nitinol is cooled down below its transformation temperature its crystal structure changes from austenite to martensite. In the latter phase it can be easily deformed to a new shape, however, when the alloy is heated again through its transformation temperature it reverts to its "normal" austenite crystal structure and recovers the predetermined shape (or memory shape) originally defined by forging and heat treatment. This process is known as shape memory effect. If the recovery of the original shape is prevented by constraining the alloy in the deformed shape, a large amount of stress can be generated. In the surgical setting, this stress can be used for generating a compressive or distractive force when a nitinol implant is released from its constraint. The transformation temperature can be adjusted by alloying and processing. For clinical applications it is chosen well below room temperature.

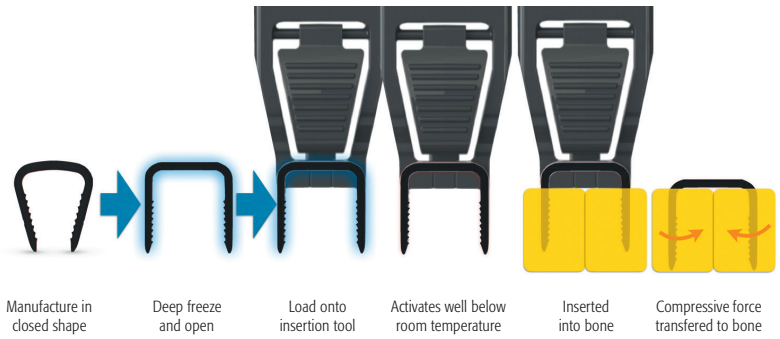
Nitinol also shows a superelastic behavior, a very springy and rubberlike elasticity, if it is deformed in its normal crystal structure (above the transformation temperature). At a certain stress, a large elastic deformation of up to 8% is possible without plastic (permanent) deformation. The undeformed shape is recovered when the stress is removed. In a postoperative setting, this behavior results in the implant recompressing the fracture or fusion site even after the bone fragments have been subjected to outside forces.

Both nitinol material properties (ie, shape memory effect and superelasticity) offer unique benefits in medical applications. Moreover, nitinol is highly biocompatible and corrosion-resistant, which makes it very attractive for use in orthopedic implants. At the time of the BME acquisition, Ciro Römer, the Company Group Chairman of DePuy Synthes, stated that "the BME portfolio will be integrated into our trauma platform, where we will be able to expand the availability of these solutions, increase the pace of innovation in this area, and reach more patients around the world". The product portfolio of BME includes Nitinol Staples, implants

Fig 1
Each implant is machined from nitinol in its final shape, with converging staple legs, and heat-treated to maintain this shape at room temperature (austenite crystal structure). Subsequently the implant is cooled down below its transformation temperature to become easily malleable (martensite crystal structure). The legs are then pulled back out to parallel orientation and the implant is loaded onto a sterile insertion tool. Following this, the implant is activated in the insertion tool while reaching room temperature (higher than the transformation temperature). Activated means that the implant tries to regain its original shape with converging legs but is constrained by the insertion tool. When inserted into bone and then released from the insertion tool, the implant's legs are constrained by the bone fragments and a compressive force is effectively transferred from the insertion tool to the bone fracture or fusion site. The implant behavior is not dependent on the temperature in the operating room or the human body because of the much lower transformation temperature.

Fig 2
From left to right: Speed, Speed Shift, Speed Arc, Speed Titan, Speed Triad, Elite.

made of nitinol in staple shape that provide continuous active compression, due to the above-mentioned properties, throughout the healing process. These implants are produced and applied as shown in **Fig 1**.



Compared with screws, Nitinol Staples offer the advantage that due to their superelastic properties compression is kept even in case of some bone resorption or under repetitive motion. There are a variety of implants and inserters available, depending on the geometry and compression strength required. The implants come ready to use on a sterilized, preloaded, fully disposable insertion tool. The insertion technique is simple, fast, and repeatable. The system offers very accurate implant placement with small surgical exposure.

After the acquisition of BME, Depuy Synthes approached the Foot and Ankle Expert Group (FAEG) and the Hand Expert Group to investigate potential applications of Nitinol Staples. The first Nitinol Staples products with limited AOTK approval are the following (**Fig 2**): Speed, Speed Shift, Speed Arc, Speed Titan, Speed Triad, Elite.

Evaluation by the Nitinol Staple Task Force

A special task force was appointed to evaluate the new technology based on the nitinol mechanical features and the specific products offered by BME, as well as the current clinical experience from a variety of clinical applications. The task force came to the following conclusions.

Principles for the application of compression staples resulting from their mechanical features and functions:

- Compression staples should be chosen based on their form/shape to provide optimal compression in a given situation
- Uniaxial compression staples can only provide compression in the direction of their axis and lead to immediate loss of compression if placed obliquely to their axis of loading
- Uniaxial compression staples provide almost no resistance against shear forces
- Bi- or multi-directional compression staples can only provide limited resistance against shear forces or bending out of their primary axis of (pre)loading

- Compression staples do not provide the compression force at the bone surface where they are placed, but at the "depth" of their legs (indeed, at the "tips" of the legs)
- Compression staples provide limited resistance against pullout.

As a result, the axis of Nitinol Staples should be oriented more or less perpendicular and through the center of the contact area between the fragments, where the compression should be applied. Compression staples should not be applied, where shear and/or bending forces are applied during weightbearing (lower limb) or functional movement (upper limb). Compression staples alone cannot provide long lasting stable fixation between fragments under multiaxial loading.

Indications and contraindictions

Indications for using compression staples include the following:

- Compression staples are indicated to support reduction and temporary fixation
- Compression staples are indicated to support stabilization by limiting movement between fragments and providing compression in distinct directions.

Contraindications include:

- Compression staples are not indicated as primary stabilization/fixation implants where multiaxial movement between the fragments is possible/expected
- Compression staples are not indicated in bone stock with poor quality, especially in the areas around the tips of the legs; the legs are effectively unicortical
- Nitinol, the material of the compression staples, is based on a high percentage (55%) of nickel, which can lead to complications in patients with nickel allergy.

Clinical need:

- Compression staples may reduce operation time due to their easy and fast application
- Compression staples can support primary fixation, by a secondary application of compression.

Alternative fixation concepts are available for most configurations, but they might be more difficult to apply and/or more time consuming.

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SPINE

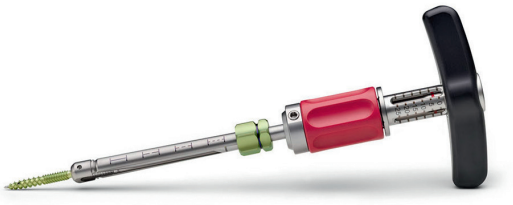


Fig 1
The new instrument, the Viper Prime inserter, eliminates the need for Jamshidi needles, taps, and guide wires. The screw has to be loaded onto the inserter, which requires that the screw size (length and diameter) is selected based on preoperative imaging and planning.

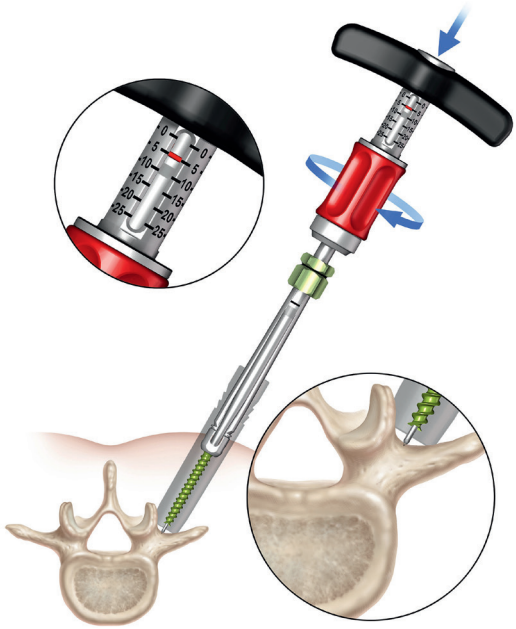


Fig 2
The stylet is advanced by turning the red stylet control handle clockwise. The extension of the stylet relative to the screw tip is displayed by the red line visible through the drive tube window on the stylet depth gauge. There is also an audible click every 1 mm of extension. In the fully retracted position the stylet extends 3 mm beyond the tip of the screw, which allows proper docking to the vertebral body.

Viper Prime System

Background

The last resort and ultimate treatment option for low back pain is fusion surgery, which is performed worldwide in more than 1 million cases per year. Acceptable clinical results are achieved in only 65% to 75% of cases, which emphasizes the need for improvement in this surgical procedure. In one of seven cases there is an approach related problem, which explains the demand for optimizing the surgical approach and technique. Minimally invasive techniques to perform spinal stabilization have gained popularity in recent years due to the demonstration of reduced complications, less blood loss, and less perioperative muscular damage during the procedure compared to conventional open spine surgery. Additionally, minimally invasive approaches yield less postoperative pain, less narcotic usage, a shorter hospitalization, and quicker recovery than traditional open surgery. A number of minimally invasive systems (eg, Expedium Spine system, Viper 2 system) have been developed to provide immobilization and stabilization of spinal segments as an adjunct to fusion in the treatment of acute and chronic instabilities or deformities of the thoracic, lumbar, and sacral spine. Although the benefits of these minimally invasive systems are substantial, there are still some procedure-related disadvantages. Surgeons are often required to navigate small channels involving several procedural steps, instrument passes, and management of guide wires. In order to address these aspects, the Lumbar Degenerative Expert Group (LDEG), together with DePuy Synthes, have developed the new Viper Prime system as the next generation system for minimally invasive pedicle screw and rod placement from a posterior approach.

Innovative design features

The Viper Prime system introduces a novel technique for percutaneous pedicle screw placement that eliminates the need for Jamshidi needles, guide wires, and pedicle preparation instruments. Utilizing an innovative self-starting screw tip design and a stylet (guide wire) that is fully controlled by the screwdriver, surgeons can target pedicles and insert the screw with one single instrument (**Fig 1**). Since the stylet is controlled by the inserter (**Fig 2**), this technique is safer and requires less radiation as compared to traditional techniques where Jamshidi/guide wire positions need to be established freehand and to always be checked by fluoroscopy.

The surgeon uses the Viper Prime inserter for targeting, establishing the trajectory with the stylet, and advancing the screw in one single procedure (**Fig 3**). The stylet can be extended up to 25 mm to define the correct transpedicular corridor.

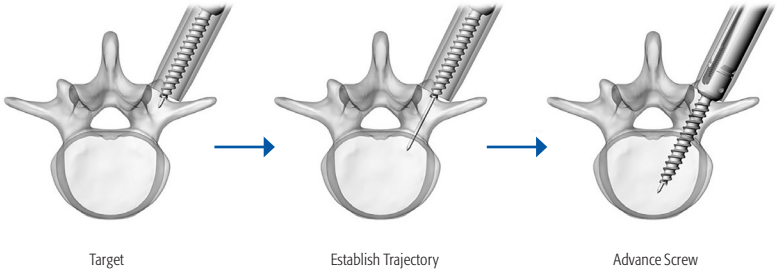


Fig 3
The Viper Prime inserter assembly is inserted through the incision (and through an optional dilator) to dock the stylet tip on the bony anatomy of the desired level. Targeting, establishing the trajectory, and advancing the screw in one single procedure is achieved without changing the instrument.

Once the stylet has been extended to establish the trajectory, the surgeon must hold the red stylet control handle while rotating the proximal modular handle (palm handle or T-handle) of the inserter clockwise to advance the screw into the pedicle over the extended stylet (**Fig 4**).

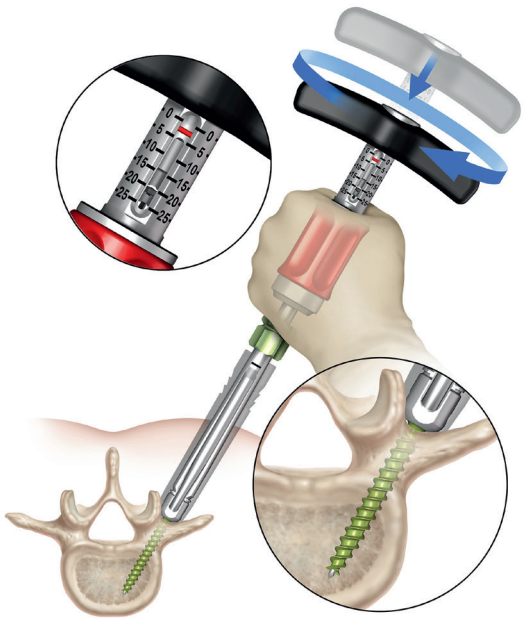


Fig 4
Insertion of the screw over the stylet. It is critical to always hold the red stylet control while advancing the screw. Holding the red stylet control handle will retract the stylet as the screw is advanced into the pedicle. If the red stylet control handle is not held, the stylet will remain extended and advance in front of the screw, potentially leading to an anterior wall breach, neurological damage, or damage to the great vessels.

In addition to the standard screw the Viper Prime system also offers a cortical fix fenestrated screw (**Fig 5**). This screw has two different thread shapes (quad lead thread and dual lead thread) designed to optimize the purchase in the pedicle as well as in the vertebral body. The fenestration allows for the option of cement delivery (with CONFIDENCE High Viscosity Spinal Cement) for augmented screw fixation in patients with poor bone quality (eg, osteoporosis).

Viper Prime's reduced number of procedural steps and instruments improves the quality of life for the surgeon and nurses. All the instrumentation fits neatly into a 1-level case to minimize the amount of product on the back table in the OR.

The new insertion technique reduces the time to complete screw insertion compared to traditional minimally invasive techniques by about

Fig 5
The X-Tab Head and Cortical Fix Fenestrated Screw.

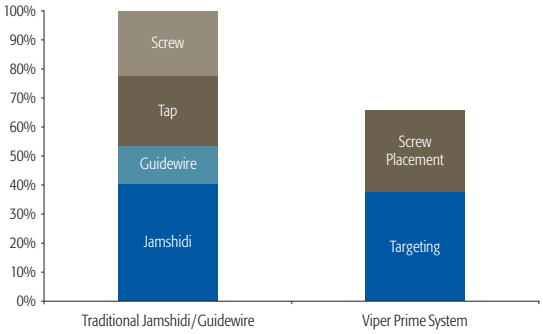


Fig 6
Cumulative time (by percentage) for each step in the Jamshidi/guide wire technique compared to the Viper Prime system technique. The "screw and tap" steps are analogous to the "screw placement" step. The "Jamshidi and guide wire" steps are analogous to the "targeting" step.

33%. This was shown by a cadaveric evidence generation study conducted by 8 surgeons across 7 levels each (**Fig 6**).

The instrumentation is available to accommodate both a standard fluoroscopic MIS procedure along with a navigated inserter (**Fig 7**), which is compatible with the Brainlab, Stealth, and Stryker navigation systems. In the navigated version, due to safety reasons (no fluoroscopic control) the stylet only comes out by 5 mm.

In summary, the Viper Prime system allows surgeons to realize the benefits of minimally invasive surgery without the need for guide wire management and complex instrument systems.

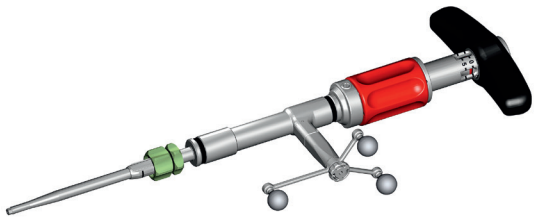


Fig 7
Navigated inserter.

Case provided by Pujan Kavakebi, Innsbruck, Austria

Case: 52-year-old with low back pain

A 52-year-old male patient presented with low back pain and S1 radicular pain on the left side for 3 weeks. The laboratory tests of the blood showed enhanced inflammation signs. The MRI showed an infection of the L5/S1 disc (**Fig 8**). Indications for minimally invasive spondylodesis with intervertebral cage (**Figs 9–13**).

Fig 8
Preoperative MRI image showing an infection of the L5/S1 disc.

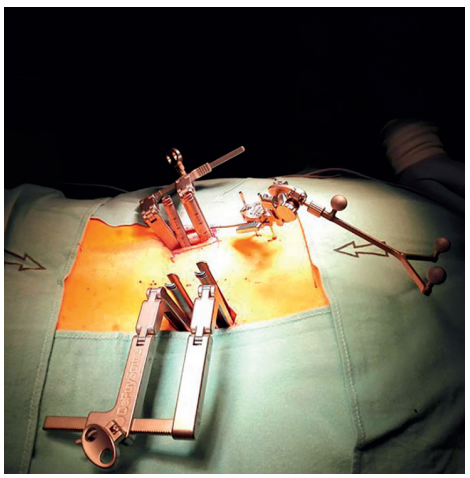


Fig 9
Intraoperative image of the distracting tool.

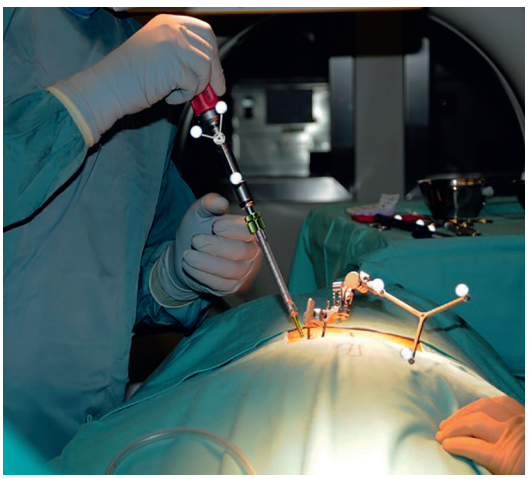
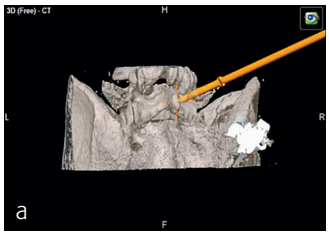
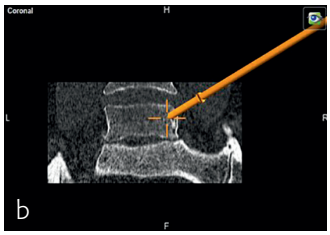
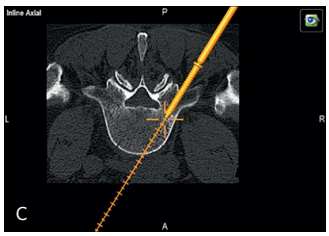


Fig 10
Navigated Viper Prime inserter.







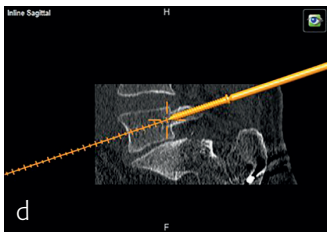
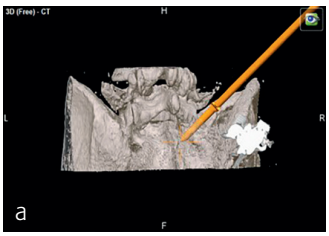
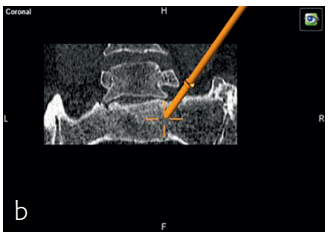
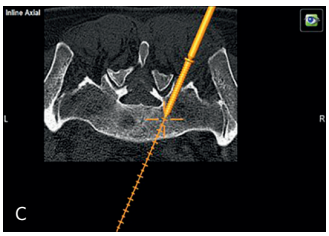


Fig 11a–d Intraoperative screenshot of navigation in L5.







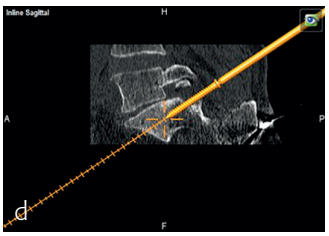


Fig 12a–d Intraoperative screenshot of navigation in S1.

Fig 13a–b
The postoperative x-rays.

Fig 1
Endoscopic view of the endplates showing that more discectomy would be required.

Fig 2
The CONCORDE Clear MIS Discectomy Device is sterile packed and disposable.

CONCORDE Clear MIS Discectomy Device

Minimally invasive surgery (MIS) is the fastest growing field in spinal fusion surgery because it has been shown to result in fewer complications compared to open surgery in treating degenerative disc disease. As this procedure becomes more popular, there is a high clinical demand to simplify MIS techniques and to develop new instruments that can improve the efficiency of the procedure.

Interbody fusion is one of the gold standard procedures in the treatment of lumbar degenerative disc disease. Most of the surgical steps of this procedure are well defined and daily practice has shown efficacy and goods results using this procedure. The removal of the disc is still performed using the traditional tools developed at the beginning of disc surgery 1950/1960. Time seems to be adequate for the development of new tools.

It is estimated that 140,000 discectomies concomitant to interbody fusion procedures will be performed across Europe, Middle-East, and Africa in 2018, of which a growing number will be minimally invasive.

Discectomy in spinal fusion surgery typically requires the surgeon to work through a small surgical field with limited visibility. Traditionally, it requires several instruments and multiple instrument passes to make sure that the disc is cleared, and that the endplates of the vertebrae are prepped for implants. Multiple passes increase the risk of nerve root injuries.

Although surgeons assume that posterior discectomy performed with traditional tools can adequately prepare the vertebral endplates for fusion, cadaveric studies have shown that an aggressive discectomy usually removes no more than 60% of the disc material [1]. In a recent cadaver course, participants were asked to work consecutively 20 minutes on the disc removal through a tubular portal. An endoscope control was then performed for direct visualisation of the endplates. To the surprise of the participants, they had to admit that the disc preparation was not as good as they had anticipated. They all agreed that complementary discectomy and endplate preparation was needed (**Fig 1**).

The newly developed CONCORDE Clear MIS Discectomy Device (**Fig 2**) will provide for more efficient disc clearing and endplate preparation in less time than using standard discectomy tools. As such, it simplifies discectomy in minimally invasive spinal fusion surgery. As it collects disc material, surgeons are able to quantify and estimate the volume removed during the procedure.

The CONCORDE Clear MIS Discectomy Device is a single-use instrument that removes the degenerated disc and prepares the endplates using readily-available standard hospital suction (**Figs 3** and **4**). The instrument

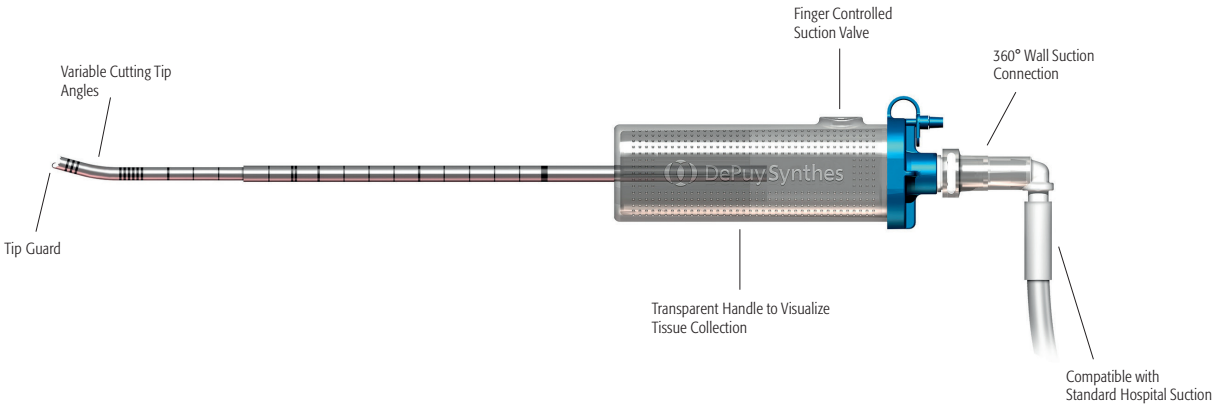


Fig 3
Design features of the CONCORDE Clear MIS Discectomy Device. The finger controlled suction valve assures that suction is only present when activated. The location of the valve indicates the tip direction. The tip guard reduces the penetration risk of the anterior annulus and minimizes clogging of the tip.

is available in angles of 15°, 30°, and 40° and two lengths (220 mm, 270 mm) to accommodate various approaches. The diameter of the tube is 5 mm. The cutting edges shear the disc material from the endplates while the suction draws the disc material into the transparent handle, which allows surgeons to immediately see the collection of disc material. This discectomy technique requires fewer tool passes and instrument exchanges when compared to traditional techniques. The time saved from reduced instrument steps/passes may lead to reduced OR costs.

The CONCORDE Clear MIS Discectomy Device and the Viper Prime system (outlined in the preceding article) are innovative solutions to meet the increasing demands for MIS in spine surgery.

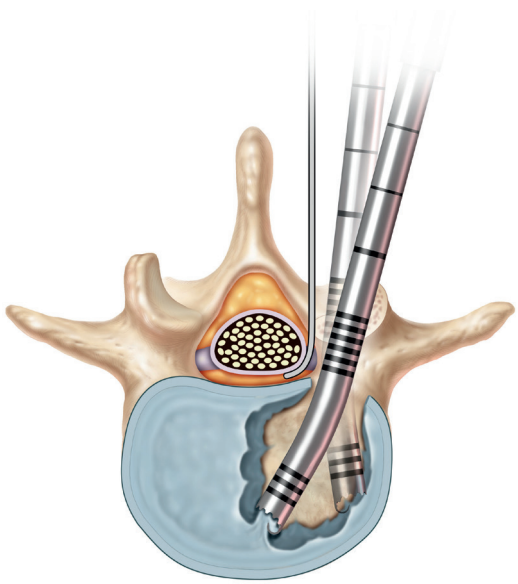


Fig 4
Removal of disc material with the CONCORDE Clear MIS Discectomy Device.

References

1 **Vialle EN, Vialle LRG, Gusmão MS.** Transforaminal lumbar discectomy: quantitative study in cadavers. *Coluna/Columna.* 2009; 8(2):134–138.

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CRANIOMAXILLOFACIAL

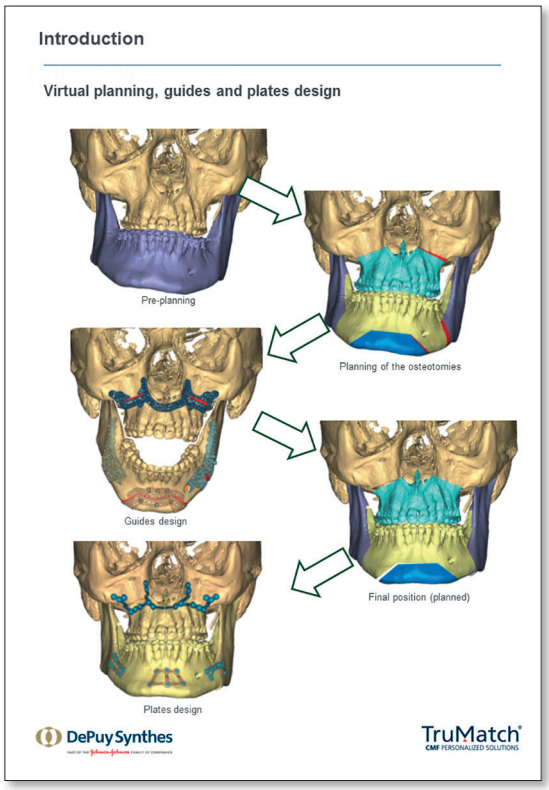

Fig 1
The steps in virtual planning.

Surgical technique guides and design guidelines for 3-D Patient Specific Implants

New techniques of three-dimensional imaging as well as rapid developments in computer-aided design (CAD) and computer-aided manufacturing (CAM) are changing the face of modern medicine. With the use of digital treatment planning and patient-specific templates, complex surgical procedures can especially be improved; this is true in terms of feasibility and accuracy, and in terms of operating time and clinical outcome. The increasing number of patient specific implant (PSI) options now available in craniomaxillofacial surgery can make treatment planning challenging for surgeons. Although the workflow for timely and accurate planning, production, and delivery of PSI has been well established, the specific steps to use them during surgery is less clearly defined.

The AOTK (CMF), specialized expert groups, and PSI industry partners have identified the need for support for surgeons in treatment planning to improve both clinical reliability and work flow efficiency. They identified an opportunity to clarify the specific surgical steps involved in using this new technology through the creation of detailed technique guides. This will allow surgeons to avoid having to develop a PSI treatment plan from scratch with each new patient. Although technique guides are available for non-PSI implants and devices, due to the custom nature of PSI technology, regulations regarding their design and use remain less established. This can place the onus on the surgeon alone to determine clinical indication, identify the treatment goals, design the device parameters, and incorporate them all into the surgical plan. Although industry staff and engineers are available as a technical resource in PSI planning, the AOTK has identified value in providing surgeons using PSI materials with a stepwise technique guide created by AO clinical experts.

As a first step in this initiative, a technique guide for the TruMatch Orthognathics Platform has been developed with the oversight of the AOTK (CMF), which explains all surgical steps in detail, including insights from experts into how to maximize both safety and accuracy (**Figs 1–5**). This project follows the AOTK principle that AO experts involved in the development of a device are also in best position to provide guiding advice on their indications and use.

The potential benefits and actual limits of an integrated 3-D virtual approach for the treatment of patients and requirements for craniomaxillofacial surgery are discussed comprehensively from our experience using 3-D virtual treatment planning clinically. The next steps for this initiative will be to design additional publications that will offer this same guidance during the online designing process of the TruMatch PSI products.

Le Fort I

Mark/perform osteotomies

- Consult the case report to visualize the cutting planes and their orientation
- Mark or perform partial cuts with the guide in place, then remove the guide (Fig. 1, 2, 4)
- For segmental maxillary movements, use the guide to mark the planned vertical osteotomy (Fig. 4)
- For planned bone excision, ensure both the upper and lower (or left and right for segmental) osteotomies have been marked with the guide (Fig. 2)
- Ensure all osteotomies have been marked or cut along the entire length of the guide
- Remove guide

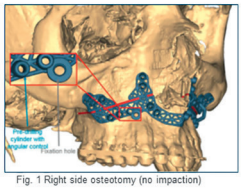

Fig. 1 Right side osteotomy (no impaction)

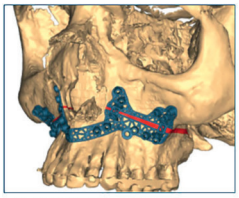

Fig. 2 Left side osteotomy (impaction)

Fig. 4 Guide for segmental maxillary split

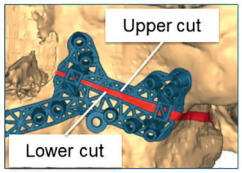

Fig. 3 Marking of both upper and lower cuts

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Le Fort I

Attach plate (upper skull)

- Fixate one screw in the predrilled holes of each of the 4 pillars, alternating sides
- Check if it's a passive fit and correctly positioned (Fig. 2)
- Place remaining screws

Precaution

- Ensure that from this point forward that retractors or bite-gags do not put pressure on the positioned maxilla to avoid implant deformation and displacement

Technique tip

- For segmental maxillary osteotomies, a final splint can be used for stability and accuracy in addition to the maxillary plate. The splint is left in place during the BSSO procedure. If the BSSO will be performed using patient specific plates and guides, then follow the "Splint control" technique described in the "BSSO" section of this guide.

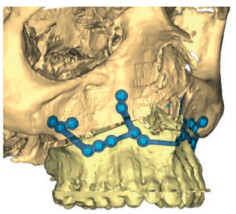

Fig. 1 Right side osteotomy (no impaction)

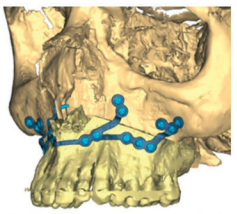

Fig. 2 Left side osteotomy. Impaction, check for passive fit

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Fig 2–3
Le Fort I: Use of the osteotomy guide and application of the corresponding plate resulting from virtual planning.

BSSO – Option 2: Splint Control

Predrill posterior plate fixation holes

- Predrill at least two posterior implant fixation holes (Fig. 1)
- *If an intraoral approach is used, predrill at least two of the posterior holes, either the ones closest to the lateral osteotomy, or the superior holes, depending on which are the easiest to access intraorally*
- The rest of the posterior holes can be drilled through the plate once it is fixated to the mandible, after performing the osteotomy, when it is more mobile and easier to access

Notes

- Use a 1.4mm drill bit with stop for 1.85mm screws
- The length of required stop is given by adding 2mm to the screw length (e.g. 8mm drill bit with stop for 5 & 6mm long screws)

Fig. 1 Predrilling of the posterior holes

Mark anterior plate fixation holes

- Only mark the anterior plate fixation holes either using a drill bit or a surgical marker (Fig. 2)
- Do not drill them completely
- This will allow maximum flexibility with final positioning (with aid of final splint)

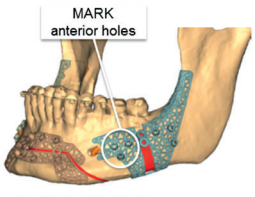

Fig. 2 Marking of anterior holes

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Genioplasty

Place and attach plate (mobile segment)

- Fixate the implant on the mobile segment
- Insert all screws

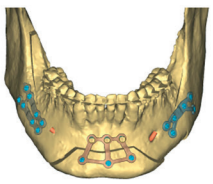

Fig. 1 Right side osteotomy (no impaction)

Place and attach plate (mandible)

- Position mobile segment and implant to the mandible and hold the construct
- Plate shall be flush on the bone in all regions.
- If this is not the case, check for potential bone interferences; consult the case report to help identifying these regions
- Do not force the plate for fitting, keep removing bone until the plate fits
- Insert all screws in previously drilled implant fixation holes

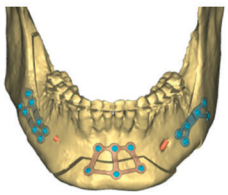

Fig. 2 Right side osteotomy (no impaction)

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Fig 4–5
Use of the osteotomy guides and application of the corresponding plates for the correction of the mandible resulting from virtual planning.

Fig 1
Rapidsorb injectable polymer system.

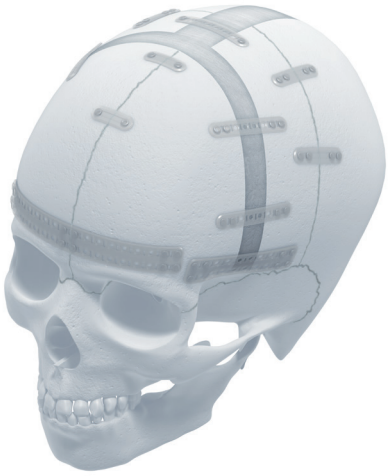

Fig 2
Rapidsorb IPS can be used for a variety of adult and pediatric indications.

Rapidsorb Injectable Polymer System

The Rapidsorb injectable polymer system (IPS) was developed to offer a faster alternative to the fixation of resorbable plates with resorbable screws. The goal was to avoid the three steps – drilling, tapping, and twist insertion – required with resorbable screws, by using a novel delivery system that injects polymer into a predrilled hole (**Fig 1**). The new battery-operated system simplifies fixation to only two steps (drilling and filling).

The fastener cartridge allows seamless delivery of polymer into multiple holes. The risk of screw insertion failure through stripping or breaking is eliminated. Since fixation occurs through the delivery of the polymer in a semi-solid state, the need for multiple screw sizes is also eliminated. The starter kit includes the Rapidsorb IPS shell, the cap, and a fastener cartridge that produces approximately 15 fasteners. The material provided in the fastener cartridge is the familiar Rapidsorb 85:15 poly (L-lactide-co-glycolide).

Indications

- The Rapidsorb IPS is intended for use in nonloadbearing fracture repair and reconstructive procedures of the craniofacial skeleton (excluding the upper and lower jaw) in pediatric and adult populations (**Fig 2**). Rapidsorb IPS fasteners are designed to be used for the fixation of Rapidsorb plates, meshes, and sheets.
- In addition, Rapidsorb IPS implants and instruments may be used with Rapidsorb meshes and sheets in nonloadbearing applications for maintaining the relative position of and/or containing bony fragments, bone grafts (autograft or allograft), or bone graft substitutes in craniofacial reconstruction (excluding the upper and lower jaw).

Christoph Lischer, Fabrice Rossignol, Jeffrey P Watkins

VETERINARY

Fig 1
Illustration of the 4-hole LCP Equine T-Plate 4.5 on a foal's tibia.

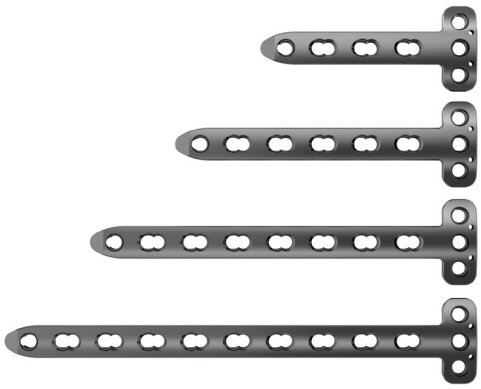

Fig 2
Illustration of the LCP Equine T-Plate 4.5 portfolio.

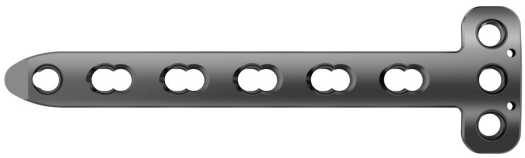

Fig 3
Top view of the 6-hole plate showing the stacked combi-holes and K-wire holes in the head of the plate. The straight portion of the plate features standard combi-holes and a single stacked combi-hole at the tip of the plate.

Equine T-Plate

Background

Physeal fractures of the foal's proximal tibia are challenging cases to manage due to limited implant purchase in the small epiphyseal fracture segment and the relatively soft bone in the epiphysis and metaphysis. To avoid support limb complications in active foals, they must return to full weightbearing on the affected limb immediately after surgery. Furthermore, the proximal location of the injury precludes the use of external coaptation to support the repair.

Currently, the recommended method of fixation is to use a standard plating technique, with a single screw in the proximal end of the plate engaging the epiphyseal segment. Single plate fixation is typically augmented with a transphyseal screw/wire fixation or, in large foals, a second plate.

The Equine T-Plate is designed to provide a single implant solution with multiple locking screw fixation in the epiphyseal segment as well as the ability to place locking screws throughout the length of the plate to augment fixation in the soft immature foal bone.

Plate design

The AOTK approved LCP Equine T-Plate 4.5 (**Fig 1**) is indicated for the treatment of physeal fractures of the proximal tibia in foals. The plate is made of 316L stainless steel, is compatible with the Large Fragment system, and available in the following sizes (**Fig 2**):

- 4-hole plate (91 mm)
- 6-hole plate (127 mm)
- 8-hole plate (163 mm)
- 10-hole plate (199 mm)

The screw trajectory is designed to optimize bony purchase. Furthermore, cortex screws can be applied through the plate in lag fashion to compress the metaphyseal fracture common in type 2 physeal fractures of the proximal tibia in foals. Additional wire holes allow temporary fixation with K-wires in the epiphysis, and combi-holes allow cortex screw and locking screw fixation at the discretion of the surgeon (**Figs 3** and **4**):

- Stacked combi-holes in the head of the plate accept locking and cortex screws
- Standard combi-holes in the straight portion of the plate allow screw selection as well as the opportunity to provide dynamic compression between fracture segments with cortex screws
- Incorporation of locking technology permits a fixed-angle device to increase construct stability and augment fixation in soft immature bone.

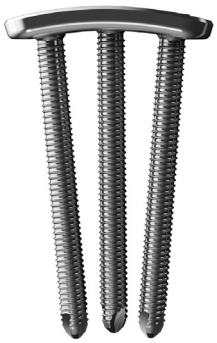

Fig 4
Side view of the Equine T-Plate indicating the screw trajectories (angulation of 5° inwards) in the precontoured head of the plate.

Versatility

The Equine T-Plate, which incorporates locking technology, is intended to enhance fixation in short fracture segments where traditional plate fixation would be inadequate. Although the plate has been designed to treat physeal fractures of the foal's proximal tibia, there are a wide variety of other applications including physeal or metaphyseal fractures of other long bones as well as partial carpal and tarsal arthrodesis.

Case provided by Fabrice Rossignol, Paris, France

Fig 5a–b
Preoperative x-rays: Dorsopalmar (DP) (a) and flexed dorsomedial-palmarolateral oblique (DMPLO) views (b).

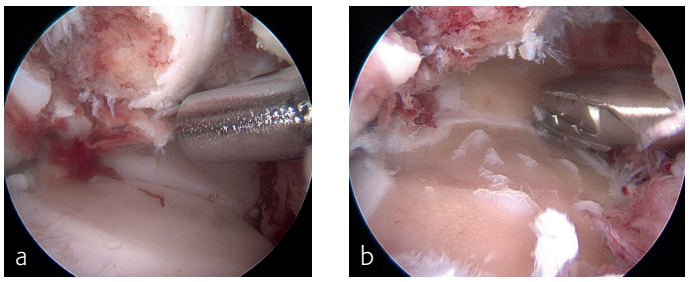

Fig 6a–b
Arthroscopic cartilage removal by using motorized (shaver/burr) instrumentation.

Case 1: Elective partial carpal arthrodesis in a warmblood broodmare

A 4-year-old French warmblood broodmare weighing 570 kg presented with a 5-day history of severe right forelimb lameness following an unwitnessed paddock accident. The limb had been stabilized in a Robert-Jones bandage with caudal and lateral splints prior to referral. The x-rays confirmed a slab fracture of the third carpal bone as well as a comminuted biarticular fracture of the fourth carpal bone (**Fig 5**). An arthrodesis of the carpometacarpal and middle carpal joint was elected.

The day after admission, the mare was placed under general anesthesia in dorsal recumbency for a partial carpal arthrodesis of the right carpometacarpal and middle carpal joints. The middle carpal joint was examined arthroscopically, and all visible articular cartilage was removed by using a combination of manual (bone curette) and motorized (shaver/burr) instrumentation (**Fig 6**). A 4.5 mm drill bit was used to drill across the carpometacarpal joint surfaces. A cancellous bone graft harvested from the sternum was loosely packed into the repair through an arthroscopic portal with the leg in flexion. Following graft insertion, implants were placed using a minimally invasive technique, tunneling the plate under the skin and joint capsule, and stab incisions for screw insertions. A 6-hole LCP Equine T-plate 4.5 was applied to the dorsal aspect of the limb deep to the extensor tendons and joint capsule through an enlarged arthroscopic portal between the extensor carpi radialis and common digital extensor tendon using a plate passer. A 4.5 mm cortex screw was placed in the first hole of the shaft of the plate to compress the plate to the bone. Two 5.0 mm locking screws were placed

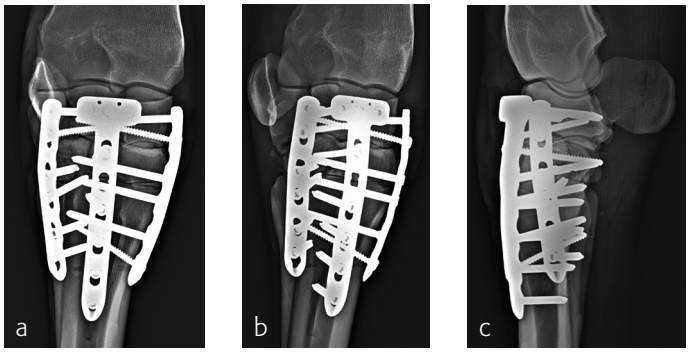

Fig 7a–c
Postoperative x-rays: DP (a), dorsolateral-palmaromedial oblique (DLPMO) (b), and lateromedial (LM) (c) views.

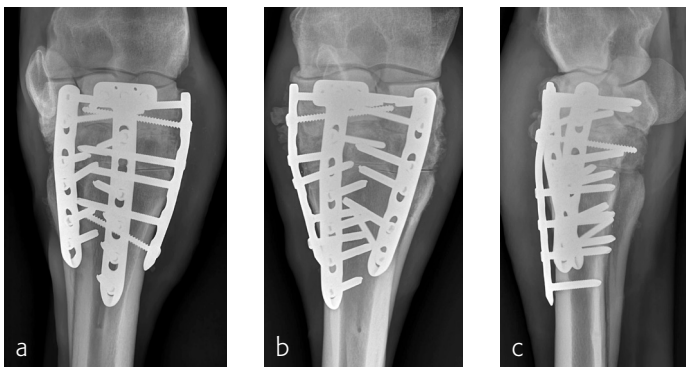

Fig 8a–c
Five-month postoperative x-rays: DLPMO (a), DP (b) and DMPLO (c) views.

Fig 9
Very good cosmetic aspect of the carpus at 5 months postoperative with partial degree of flexion.

in the holes of the horizontal portion of the plate to engage the intermediate carpal bone. A third 5.0 mm locking screw was placed into the radial carpal bone using the last hole of the horizontal portion of the plate (**Fig 7**). All remaining holes were filled with 5.0 mm locking screws except the second hole, which was left empty because the hole was directly over the carpometacarpal joint. A 6-hole narrow LCP 4.5 was applied dorsolaterally and a 6-hole narrow LCP 4.5 was placed dorsomedially in a similar manner. The skin incisions were closed in routine fashion, and a sterile dressing and full limb cast were applied. The mare recovered uneventfully from anesthesia with head and tail assistance.

The cast was removed 24 hours postoperatively, and a Robert-Jones bandage with caudal and lateral splints was maintained for 1 month. The mare made excellent postoperative progress with immediate full weightbearing on the operated leg. At 5 months postoperatively, radiographic evaluation confirmed excellent healing of the fracture and almost complete fusion of the middle carpal and carpometacarpal joints with preservation of the radiocarpal joint (**Fig 8**). At one year postoperatively, the mare showed a very good cosmetic aspect of the carpus, as well as an excellent locomotion at three gates, with only minor mechanical lameness due to reduction of carpal flexion (**Fig 9**).

Case provided by Thijs de Bont, Brussels, Belgium

Case 2: Complete distal radial fracture in a 4-hour old foal

A 68 kg Warmblood foal was presented for evaluation and treatment of a complete open fracture of the left distal radius sustained during parturition 4 hours earlier. The fracture had occurred when the mare laid down against the wall of the stables while the foal was partially through the birth canal. The foal had been recumbent since birth. The limb had been partially stabilized with a full limb bandage and lateral splint prior to admission. The x-rays confirmed the presence of a complete slightly oblique (proximomedial to distolateral) open fracture, just proximal of the distal radial physis (**Fig 10**). Extensive maceration of the medial soft tissues just proximal of the carpus was noted, with a 0.5 cm full thickness skin laceration. The foal was stabilized and was taken to surgery a few hours following admission.

The foal was anesthetized and placed in dorsal recumbency. The left forelimb was placed in extension, clipped, prepared, and draped for aseptic surgery. A cranial approach to the distal aspect of the radius was made. The fracture was reduced, and a 6-hole LCP Equine T-Plate 4.5 was placed beneath the extensor carpi radialis (**Fig 11**). Two 5.0 mm locking screws were placed in the

Fig 10a–d
Preoperative x-rays: LM (a), DP (b), DLPMO (c), and DMPLO (d) views.

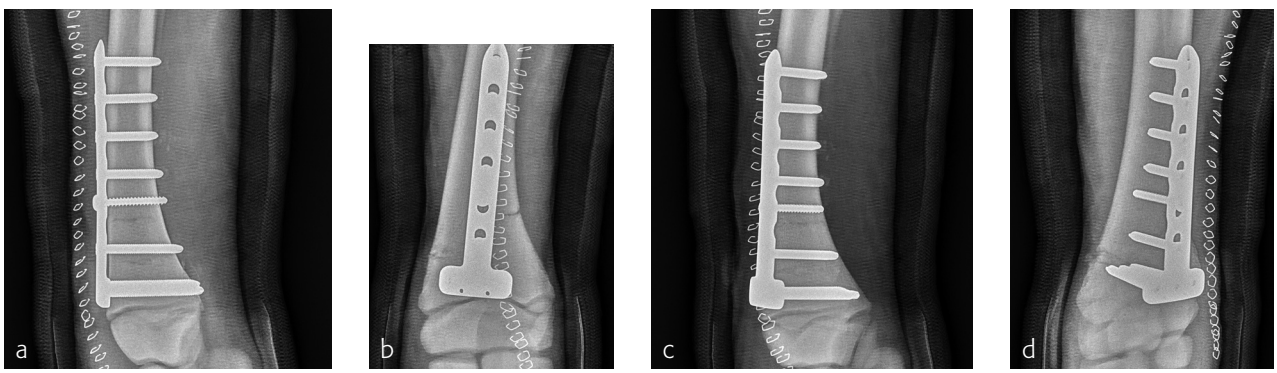

Fig 11a–d
Postoperative x-rays: LM (a), DP (b), DLPMO (c), and DMPLO (d) views.

Fig 12a–b
Appearance of the limb following cast removal 28 days postoperatively before (a) and after (b) application of the palmar elastic.

Fig 13
Appearance of the limb 7 weeks following surgery.

horizontal portion of the plate to engage the distal portion of the radius, just proximal of the distal radial physis. A 4.5 mm cortex screw was then placed into the second hole of the shaft of the plate, to provide interfragmentary compression and compress the plate to the proximal portion of the bone. The remaining holes were filled with 5.0 mm locking screws. The presurgical planning had included placing a second lateral LCP plate, however, the foal's physiological status deteriorated. Further fracture fixation was therefore abandoned, and the surgery site was closed. A tube cast was placed from the level of the fetlock to the proximal radius. The foot and pastern were left free to minimize flexor tendon laxity. The foal was placed in sternal recumbency and required 2 hours of assisted ventilation before she started to breath spontaneously. Following surgery, she stood unassisted and was able to ambulate and suckle.

The cast was changed every 7 days and was replaced with a two-layer full limb bandage 28 days postoperatively. Carpal hyperextension was counteracted with an elastic band taped to the palmar aspect of the limb under tension, to prevent hyperextension when the limb was loaded (**Fig 12**). Tensions were adjusted depending on the increasing weight and strength of the foal. Once the cast was removed, the foal was hand walked daily.

Postoperatively, the foal was noted to have a moderate carpus valgus deformity. Radiographic assessment, however, showed that the lateral deviation was not due to malalignment of the fracture. A gradual improvement in the degree of valgus deformity has been seen with growth as the foal has matured (**Fig 13**). Radiographic healing of the fracture has proceeded quickly with very little callus formation (**Fig 14**).

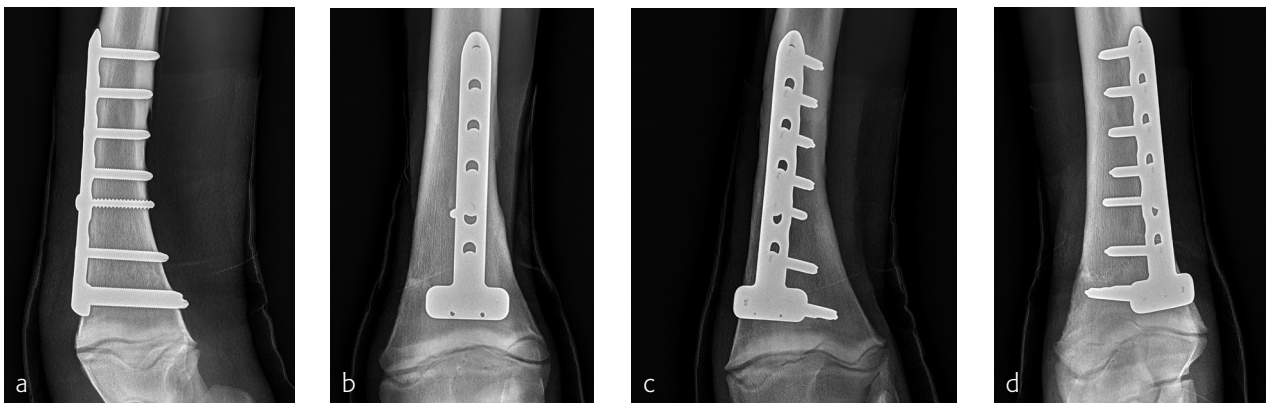

Fig 14a–d
Postoperative x-rays at 9 weeks: LM (a), DP (b), DLPMO (c), and DMPLO (d) views.

The two cases presented here demonstrate the utility of the Equine T-Plate to provide solid fixation in short fracture segments. Specifically, the T-portion of the plate can be used to engage up to 3 locking screws in fracture segments where standard plate fixation would be inadequate. In addition, case 2 also shows that even in neonatal bone, where the holding power of standard cortex screws can be a limitation, multiple locking screw fixation provides a strong, stable construct. Case 1 demonstrates that the Equine T-Plate has application in other locations, where fixation is limited by close proximity to a joint. Many additional indications exist where the ability to provide multiple locking screw fixation is limited by proximity to a joint or physis and the Equine T-Plate will provide a useful solution.

AOTK MEET THE EXPERTS

Each year, the AOTK System conducts the AOTK Meet the Experts sessions as an essential part of the Davos Courses offerings. These sessions inform the audience about the latest AOTK approved products as well as hot topics in trauma and orthopedic surgery. Expert surgeons with direct involvement in the development of new implants, instruments, and surgical techniques explain in lectures and practical demonstrations the clinical impact of these innovations. Consequently, participants obtain first-hand information from experts in their fields. To reach a broader audience, most of the AOTK Meet the Experts sessions are run as webinars, which are accessible worldwide via the internet. All sessions are recorded for later viewing via the AO Approved Solutions page on the AO Foundation website or on the Vimeo video channel.

The following is a summary of the seven AOTK Meet the Experts sessions held in 2017.

Fig 1
Christoph Nötzli (AOTK Manager of the EFEG), Theodor Slongo (EFEG Chair) and Spence Reid (EFEG voting member) explain the hardware and software of the MAXFRAME system.

Complex Deformity Corrections in Long Bones Using External Fixation: Theodor Slongo, Spence Reid, and Christoph Nötzli

The MAXFRAME multi-axial correction system is an innovative computer assisted hexapod ring fixator system approved in September 2017 (see AOTK Innovations 2017) after 10 years of development in the External Fixator Expert Group (EFEG). The long project development time was required because the system not only consists of new hardware but also of a unique software for assisting surgeons in treatment planning. The system allows 3-D correction in all 6 degrees of freedom while maintaining independence from the ring mounting. The session started with an introduction to the hardware (**Fig 1**), which facilitates an improved surgical workflow. X-rays were used to demonstrate the Perspective Frame Matching method of the software, which is a new technology that reduces manual inputs and treatment plan error. The software is needed to calculate the treatment plan, which dictates the daily strut length changes to correct the relational position between 2 bone fragments from deformed to corrected alignment.

Innovations in Osteotomies Around the Knee: Steffen Schröter, Ryohei Takeuchi, and Stefan Döbele

High tibial osteotomy (HTO) is an established surgical procedure for the treatment of knee osteoarthritis in all age groups. This joint preserving surgery has steadily gained importance over the past decade, especially in the Asia Pacific region where the number of HTO procedures is rapidly increasing. Feedback has been received from surgeons in Asia Pacific that the existing medial TomoFix plates do not fit well and may cause skin irritation due to the gap between the plate and the bone. Furthermore, there is a worldwide request for instruments that assist the surgeon to define the osteotomy line and to perform stable bi-planar cuts while

Fig 2
Steffen Schröter (JPEG voting member), Stefan Döbele, and Ryohei Takeuchi (JPEG voting member) explain the use of the guiding instruments in a practical session.

Fig 3
Jonathan Dwyer answers live webinar questions while Matias Sepulveda and Theodor Slongo apply the external fixator to an artificial bone model.

Fig 4
AO Recon experts Stefaan Nijs, Martin Jaeger, Michael Glanzmann, and Chunyan Jiang inform the audience about the latest trends in shoulder arthroplasty.

protecting posterior neurovascular structures. Picking up these clinical needs, the Joint Preservation and Osteotomy Expert Group (JPEG) developed a new anatomical shaped medial HTO TomoFix plate, guiding instruments, and a retractor (see AOTK Innovations 2017). In the Meet the Experts session, Steffen Schröter and Ryohei Takeuchi (**Fig 2**), voting members of JPEG, addressed the unique design features and benefits of the new plate and instruments, which assist in performing the HTO procedure in a more reproducible and safe way. The session included a practical demonstration of the new hardware on an artificial bone model, as performed by Stefan Döbele, a surgeon involved in the validation of the surgical technique.

Management of Challenging Pediatric Humeral Supracondylar Fractures with the Lateral/Radial Small External Fixator: Theodor Slongo, Jonathan Dwyer, and Matias Sepulveda

Traditional reduction and fixation methods (eg, with K-wires) for pediatric humeral supracondylar fractures are associated with a high complication rate of up to 30%. Complications include varus/valgus deformity, flexion/extension deformity, and ulnar nerve injury. The presenters of this Meet the Experts session (**Fig 3**) explained how to diminish these complications by using a small lateral/radial external fixator. Pediatric surgeon Theodor Slongo emphasized that when applying this fixation method it was not required to initially achieve a good reduction. Instead, the pins of the external fixator are used like joysticks to manipulate the bone fragments and to obtain a good alignment, which eases the procedure. The session illustrated the surgical technique and how injuries of the radial and ulnar nerve can be avoided by placing the pins in the correct position. The presenters, voting members of the Pediatric Expert Group (PAEG), presented clinical cases to the audience and concluded the session with a practical demonstration of the instrumentation on an artificial bone model, as performed by Matias Sepulveda.

Recent Trends in Shoulder Arthroplasty: Martin Jaeger, Michael Glanzmann, Stefaan Nijs, and Chunyan Jiang

AO Recon delivered a very comprehensive Meet the Experts Session about shoulder arthroplasty (**Fig 4**). Firstly, Michael Glanzmann reported on the newest trends in shoulder arthroplasty to treat osteoarthritis. Based on data from the Schulthess Clinic, where he is working as a shoulder and elbow surgeon, the number of reverse arthroplasties was found to be increasing and that these procedures represented the vast majority of shoulder replacements. Another trend is that stemless protheses are more frequently used. Resurfacing shoulder arthroplasties offer the advantage that the center of rotation of the head is independent of the axis of the shaft, which is especially beneficial in deformity cases and malunions. Data from the clinic showed that the outcome of resurfacing

and stemmed arthroplasties was similar at the 2-year follow-up. However, he pointed out that at his institution there was a higher rate of glenoid loosening in the resurfacing group as compared to the stemmed arthroplasty group at 5 years follow-up.

Chunyan Jiang, a voting member of the Upper Extremity Expert Group (UEEG), continued with a presentation on the use of reverse shoulder arthroplasty for cuff tear arthropathy. With modern reverse prostheses the center of rotation is medialized, which reduces the torque on the glenoid component. Furthermore, the lowered position of the humerus relative to the glenoid allows it to restore the deltoid tension. A medialized center of rotation also has potential drawbacks such as mechanical impingement and notching, although he outlined methods to reduce this risk. He concluded his lecture emphasizing that glenoid fixation and proper implant version are key issues for a successful reverse shoulder arthroplasty. In future, 3-D preoperative planning and patient-specific instruments may further help facilitate these surgical procedures.

Stefaan Nijs, another UEEG voting member, addressed in his presentation the topic of shoulder replacement for proximal humeral fractures. The presentation included a comprehensive overview of the clinical evidence provided by the literature. Stefaan shared his scheme to treat proximal humeral fractures. Arthroplasty was considered a good treatment option in osteoporotic patients over 63 years of age if there was no posteromedial support and if the tuberosities cannot be reduced. A reverse prosthesis should be considered in elderly patients if the tuberosities are comminuted and if there is a pre-existing cuff tear. However, nonoperative treatment also has its place in low demand patients.

Martin Jaeger, also a UEEG voting member, described in his talk the role of shoulder arthroplasty for the treatment of fracture sequelae of the proximal humerus. He pointed out that shoulder arthroplasty for fracture sequelae is a demanding surgery. In elderly patients a reverse shoulder arthroplasty is likely to be the best option, especially if the tuberosities are displaced and if the humeral head is decentered.

Fig 5
Fabrice Rossignol, Jeffrey Watkins, and Christoph Lischer from the Veterinary Expert Group present the advantages of the LCP Equine T-Plate 4.5.

Application of the New Veterinary LCP T-Plate 4.5 in Physeal Fractures of the Proximal Tibia in Foals: Jeffrey Watkins, Christoph Lischer, and Fabrice Rossignol

Three voting members of the Veterinary Expert Group (VEEG) explained in their Meet the Experts session how to improve the treatment of physeal fractures of the proximal tibia in foals (**Fig 5**) (see the Veterinary section in this edition). Jeffrey Watkins pointed out that fractures of the foal's proximal tibia were challenging to manage due to the limited implant purchase in the small epiphyseal fracture fragment. Traditional fixation methods, which rely on dynamic compression plating and tension band

wiring, have their limits in achieving adequate stability. The T-section of the new LCP Equine T-Plate 4.5 is contoured and has three stacked combi-holes for improved screw fixation in the epiphyseal fracture fragment. Christoph Lischer explained the design features and benefits of the new plate and demonstrated the surgical technique in a type 2 physeal fracture of the proximal tibia using a bone model. He pointed out that special attention was required during plate contouring such that the locking screws didn't penetrate the articular surface. With the proper technique, the plate could be used to facilitate fracture reduction.

Fig 6
Christian Matula and Stephen Lewis explain the function of the Piezoelectric system.

Optimizing Surgical Cranial Access: Christian Matula and Stephen Lewis

Neurosurgeons Christian Matula and Stephen Lewis embarked on a "safari" to highlight the innovations AOTK (Neuro) have brought to the field over the past ten years. Suitably dressed wearing safari hats (**Fig 6**) the presenters led the audience on a highly entertaining and informative session through the developments that improved neurosurgery. One of these was the Anspach EG1 high speed electric system, which is a powertool designed to cut and shape spinal and cranial bone. To achieve this purpose, various attachments are offered, some of which were shown in a practical demonstration during the session. Another milestone was reached by the development of the Piezoelectric system, which consists of an ultrasonic handpiece and a variety of cutting tips. The advantages of this system include increased cutting precision and safety because it spares the adjacent soft tissues. After addressing strategies and methods for dural repair, the presenters outlined the MatrixNeuro low profile plating system, which facilitates rapid reattachment of cranial bone flaps. Other topics discussed were intracranial pressure monitoring and intraoperative navigation. The session was concluded with the announcement that, emerging from AONeuro, a new organization called Global Neuro (https://www.globalneuro.org/) would be formed. The mission of Global Neuro is to educate clinicians to improve patient outcomes in neurosurgery. Christian and Stephen used the stage to celebrate the launch of this organization.

Fig 7
Pujan Kavakebi explains the navigated inserter of the Viper Prime system.

Overview of MIS Pedicle Screw Insertion and Viper Prime Technique: Andreas Korge and Pujan Kavakebi

Spine surgeons Andreas Korge (voting member of the Lumbar Degenerative Expert Group) and Pujan Kavakebi, presented in their Meet the Experts session the new Viper Prime system (see the Spine section in this edition). They explained the importance of minimally invasive procedures for pedicle screw insertion and how this was addressed with the newly developed implants and instruments. The session focused on the design features and clinical benefits of the innovative system. Pujan Kavakebi led the audience step by step through the surgical technique by demonstrating the navigated version of Viper Prime on an artificial bone model (**Fig 7**).

Manuela Ernst, Markus Windolf

NEWS FROM ARI

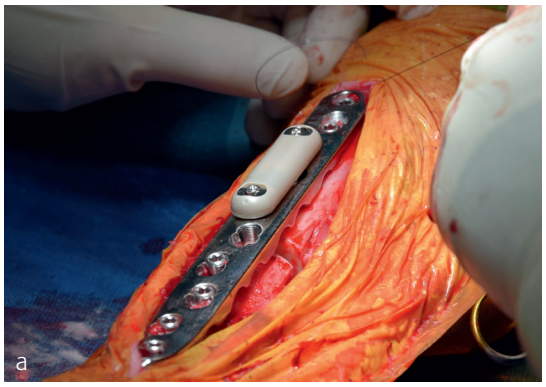

Fig 1a–b Sheep experiment.
a Instrumented plate with an AO Fracture Monitor prototype attached, which was pre-calibrated for load and displacement.
b Animal after operation at ARI's animal facility. Data was downloaded with a conventional smartphone once or twice per week.

AO Fracture Monitor—implantable sensor system for continuous monitoring of bone healing

The use of sensor technology for health monitoring is becoming increasingly important and will further impact our daily lives. However, bone healing assessment in the aftercare of trauma patients may not be keeping pace with new developments. The consequences of using the highly subjective current gold standard (radiographic follow-up) may include extended recovery periods or unspecific rehabilitation protocols. We believe that access to quantitative and continuous information on healing progression and patient activity will transform trauma care for more robust fracture healing on the one side and timely and specific reaction to healing disturbances on the other.

The AO Research Institute (ARI) is therefore developing an implantable sensor system for monitoring of bone healing in an x-ray free and quantitative manner [1]. The sensor is intraoperatively attached to a conventional locking plate and continuously monitors the deflection of the implant under weightbearing as a measure for the state of healing. Data is wirelessly transmitted to the patient's smartphone for remote data collection. Physicians and rehab doctors may access patient data at any time for individualized therapeutic decision making.

The key capabilities of the system are presented in the following by way of example. In a Swiss mountain sheep, a transverse tibial osteotomy was stabilized with a conventional locking plate and equipped with an AO Fracture Monitor prototype (**Fig 1**). Healing and activity data were recorded over 9 weeks and compiled into a healing curve (**Fig 2**).

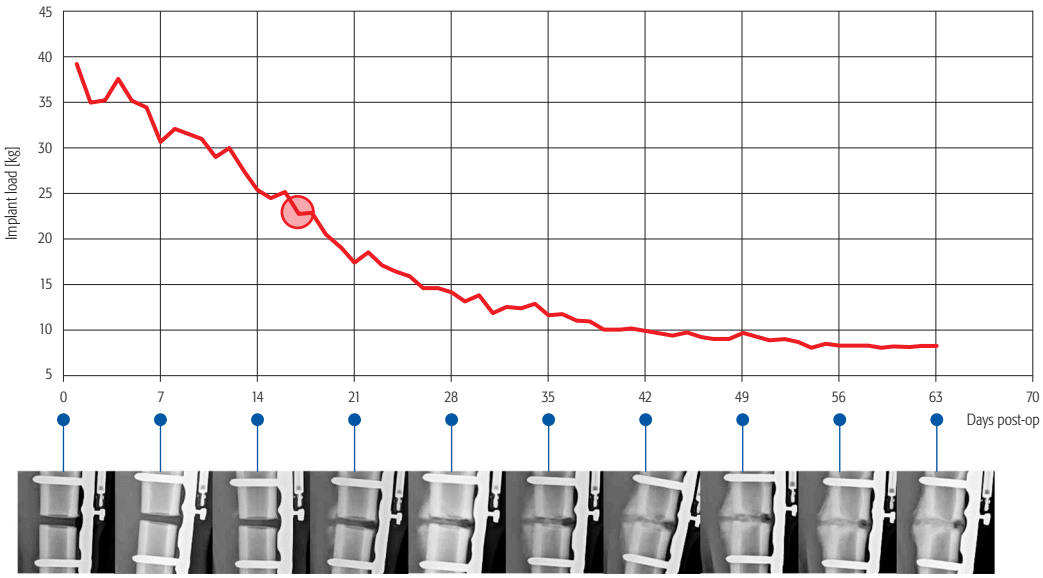

Fig 2
Recorded healing curve over time. Each data point represents daily average plate load. The signal drops with ongoing callus healing (see x-ray sequence below the graph). The circle indicates an arbitrary data point at day 17 (see Fig 3).

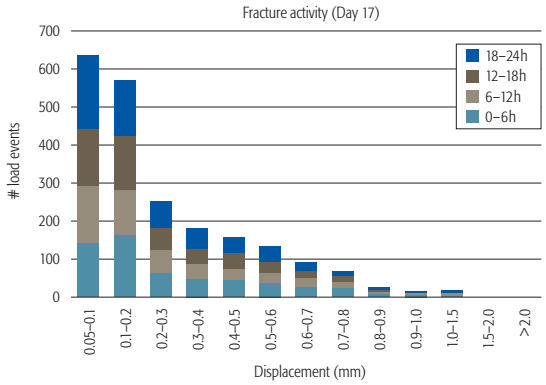

Fig 3
Daily data set example. Fracture activity histogram at day 17 postoperative. A total of 2154 loading events were detected in the fracture over 24 hours. The diagram shows breakdown of these events into 13 intensity bins in terms of interfragmentary displacement magnitude from micromotions > 50 µm to macroscopic displacements > 2 mm. The colors indicate breakdown into four 6-hour intervals during the day.

From an early maximum, the curve characteristically declines as an indicator of the progression of healing. Digging deeper into the data behind each point in the curve allows in-depth analysis of fracture loading and activity patterns over the day-cycle (**Fig 3**). Short-term or long-term analysis (**Fig 4**) of fracture activity provides valuable information to individualize rehabilitation protocols in the future.

A first clinical trial on a fracture monitoring system for external fixation has already been completed. A second clinical study is currently ongoing. While earlier phases of the project have been strongly supported by AOTK and AOTrauma, the concept is now running through the AO Development Incubator for development into an implantable medical device and clinical introduction.

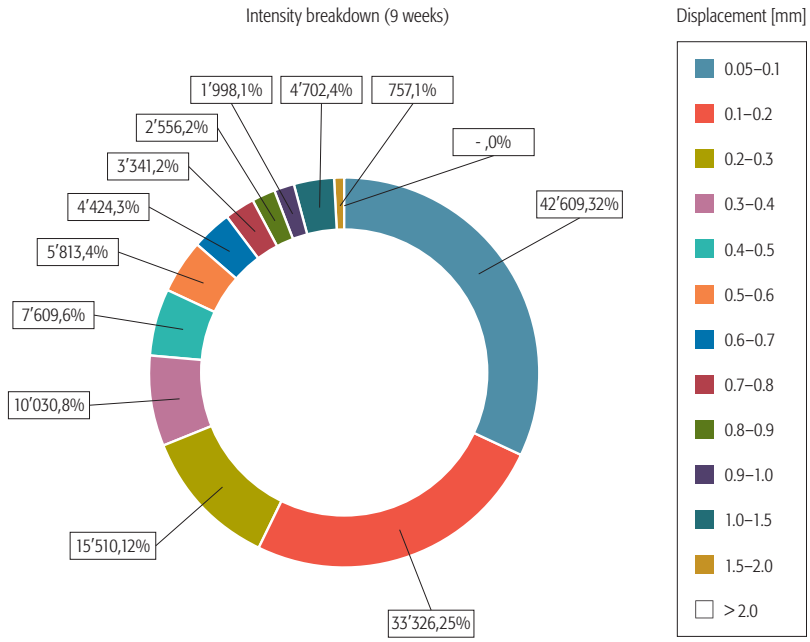

Fig 4
Breakdown of the loading events into intensities over the full monitoring period. Tags contain total number of load events and their respective percentage. Here, colors indicate interfragmentary displacement magnitudes. Similar data is available on loading magnitudes as well.

References

1. **Windolf M, Ernst M, Schwyn R, et al.** A Biofeedback System for Continuous Monitoring of Bone Healing. Proceedings of the International Conference on Biomedical Electronics and Devices 2014; Angers, France:243–248.

Maio Chen, Alexander Joeris, Elke Rometsch, Christoph Sommer

NEWS FROM AOCID

With a team of clinical investigation specialists, AOCID supports AOTK's decision making process by conducting high quality clinical trials and generating clinical evidence. Aside from creating evidence for surgical products and techniques, AOCID also critically appraises clinical studies and health economic analyses. Both are areas with great impact on healthcare practice and patient well-being. Two recent examples are the case evaluation of the variable angle locking compression plate and the critical evaluation of the PROFHER trial. For a complete description of our palette of services, please go to: www.aocid.org.

Excessive early VA LCP breakage?

The VA LCP Condylar Plate 4.5/5.0 (see AOTK Innovations 2016, page 13) has an advantage over traditional fixed angle locking plates by allowing the locking screws to be inserted at various angles thus avoiding other implants in the screw insertion paths or poor-quality bone. In 2016, Tank et al compared in a single center study the early failure rate among three plating systems, the less invasive stabilization system (LISS), traditional LCP, and VA LCP. The authors concluded that VA LCP had a higher and earlier mechanical implant failure rate in OTA/AO type 33-C fractures and warned surgeons against using the VA LCP for metaphyseal fragmented distal femur fractures [1] (**Fig 1**).

Due to a lack of certain information in the paper, such as the details on plate application, screw density, and fracture patterns, Mark Lee and Karl Stoffel, voting members of the Lower Extremity Expert Group (LEEG), in a letter to the editor outlined their reservations on the paper's conclusions and recommended that further analysis was warranted [2]. The original authors, although agreeing that a larger sample size may be helpful, after addressing some aspects of the critiques, reaffirmed their caution to surgeons.

The LEEG believes that a premature conclusion to discontinue the usage of the VA LCP would deprive both surgeons and patients of a powerful tool in surgical treatment of distal femoral fractures, and decided that proper review of the circumstances for failure was necessary for two reasons:

- To understand how and why the plates had failed
- To find potential solutions to the problem

Subsequently, an image review meeting was convened to evaluate each case presented in the original 2016 paper (with images provided by one of the authors). The analysis of the cases indicated:

- Malpositioning of the plate in the sagittal plane resulted in a significantly higher mechanical failure rate

- The choice of implant (LCP, VA LCP, or LISS), fracture classification, and open vs closed fractures had no statistically significant impact on the rate of mechanical failure of fracture fixation.

Based on these results, it was decided by the LEEG and approved by AOTK (Trauma) to increase the number of cases, ie, additional cases from three LEEG-member sites will be added to the image review and statistical analysis. This retrospective study is currently underway.

Fig 1a–b
Malpositioning of a VA LCP condylar plate. The postoperative x-ray (a) demonstrates the VA LCP condylar plate placed too anteriorly, both distally and proximally, in a 60-year-old patient. The patient suffered plate breakage at 6 months (b). Both x-rays are lateral view, demonstrating the sagittal plane position of the plate.

To operate or not to operate? — The PROFHER trial

Sound methodology, a crucial ingredient of a good clinical trial, includes not only a competently conducted trial with precise and accurate data, but also an appropriate study design, and accurate analysis and interpretation of the data. With assistance from AOCID, the AOTK Upper Extremity Expert Group (UEEG) responded to the recent PROFHER (PROximal Fracture of the Humerus Evaluation by Randomization) trial, as a clear demonstration of this point.

The UEEG was alarmed by the recent PROFHER trial by Handoll et al. The original study was conducted as a multicenter randomized trial with

a patient population of 250 and concluded that there was no significant difference in outcome between surgically and nonsurgically treated displaced proximal humeral fractures [3, 4].

Although the PROFHER trial was conducted with the highest level of study design, a critical appraisal of the trial, conducted by AOCID with the support of UEEG voting members and Prof Allan Hackshaw, Prof of Epidemiology and Medical Statistics, University College London, as an independent reviewer, uncovered a number of issues at the methodological level. These included: 1) patient inclusion criteria (the patients included did not have to meet the well accepted displacement criteria of the Neer classification [5]); 2) undescribed surgeon experience (75% of the surgeons had contributed only 1 or 2 patients each suggesting limited experience with this type of fracture); 3) no stratification for treatment types (types of surgery that may have a different outcome depending on the fracture severity); and 4) given the circumstances that the number of crossovers from the surgical to the nonsurgical group (13%) was significantly higher than vice versa (2%), a per-protocol analysis (p-value<0.001) should have been done. With these methodological issues, the UEEG disagrees with the generalized statement of the PROFHER trial.

Based on this critical appraisal, a letter to the editor of the Bone & Joint Journal (where the PROFHER 5-year follow up results were published) was developed, in which the UEEG's concerns regarding the PROFHER trial were clearly stated.

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NEWS FROM AO EDUCATION INSTITUTE

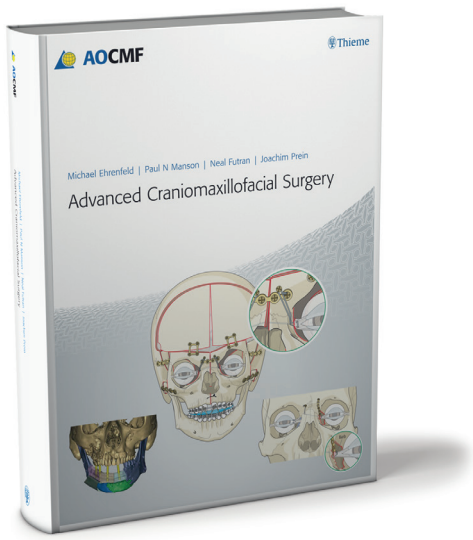

Fig 1
Advanced Craniomaxillofacial Surgery from AOCMF.

New CMF book explores advanced techniques in facial, head, and neck surgery

AOCMF will soon publish a new book specializing in the more complex treatment options in craniomaxillofacial surgery. Featuring more than 1,100 expertly drawn illustrations and images, *Advanced Craniomaxillofacial Surgery* (**Fig 1**) is the comprehensive and highly anticipated follow-up to the earlier AOCMF publication *Principles of Internal Fixation of the Craniomaxillofacial Skeleton* published in 2012. The books editors are a who's who of AO experts in this field and include Michael Ehrenfeld, Paul Manson, Neal Futran, and Joachim Prein, but it has been ably supported by contributions from more than 80 renowned international authors.

The book outlines sophisticated treatment techniques in skeletal and soft-tissue analysis for the disciplines of craniomaxillofacial, trauma, tumor, and orthognathic surgery, as well as facial and esthetic surgery. The focused expertise of seven disciplines is synthesized together to offer comprehensive and unique interdisciplinary perspectives, namely: oral and maxillofacial surgery, plastic and reconstructive surgery, otolaryngology, neurosurgery, ophthalmology, oculoplastic surgery, and head and neck surgery. Nowhere else has there been such a thorough and comprehensive multispecialty approach presented in the head and neck region.

With review and discussion on the latest in microvascular surgery, skeletal analysis, computerized surgical planning, and personalized implant creation, and giving rise to new principles, techniques and possibilities, *Advanced Craniomaxillofacial Surgery* is expected to become a highly sought-after publication. AOCMF members receive membership discounts on this publication. For further information about the book visit www.Thieme.com.

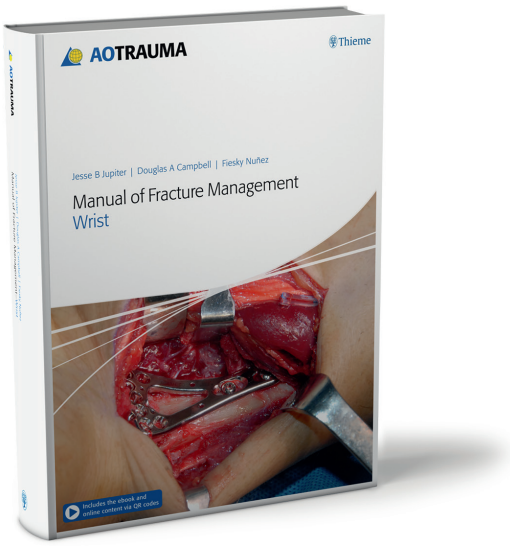

Fig 2
Manual of Fracture Management—Wrist from AOTrauma.

Fracture management of the wrist detailed in new publication

The new AOTrauma publication *Manual of Fracture Management—Wrist* (**Fig 2**) examines the management of traumatic and reconstructive problems of the distal radius, distal ulna, and the carpals, the key components of the human wrist. In a rapidly changing field of practice, orthopedic care of wrist fractures and disorders is becoming ever more complex as new technologies, plates, and methods merge and evolve with existing principles and techniques.

Ideal for both new and experienced upper extremity surgeons, the *Manual of Fracture Management—Wrist* includes the following key features:

- Case descriptions and treatment options for a wide variety of fracture and injury types, nonunions and malunions, osteoarthritis, and postoperative complications
- More than 2,000 high-quality illustrations and clinical images (**Fig 3**)
- Access to an online video library of the key wrist surgical approaches.

As with the recently published *Manual of Fracture Management—Hand*, this publication comprises two major sections: an indepth outline of the major surgical approaches and principles used in wrist surgery, and a detailed description of common to complicated treatment procedures using clinical images from real patient cases. The reader might already have an understanding of the principles of bone healing and basic orthopedic surgery, however, the use of real cases for enhanced illustration adds an immediate and interesting touch to learning and is used to show the recommended procedure and when providing an alternative perspective. AOTrauma is proud to bring you this worthwhile and highly informative medical text. Membership discounts apply. For further information about the book visit www.Thieme.com.

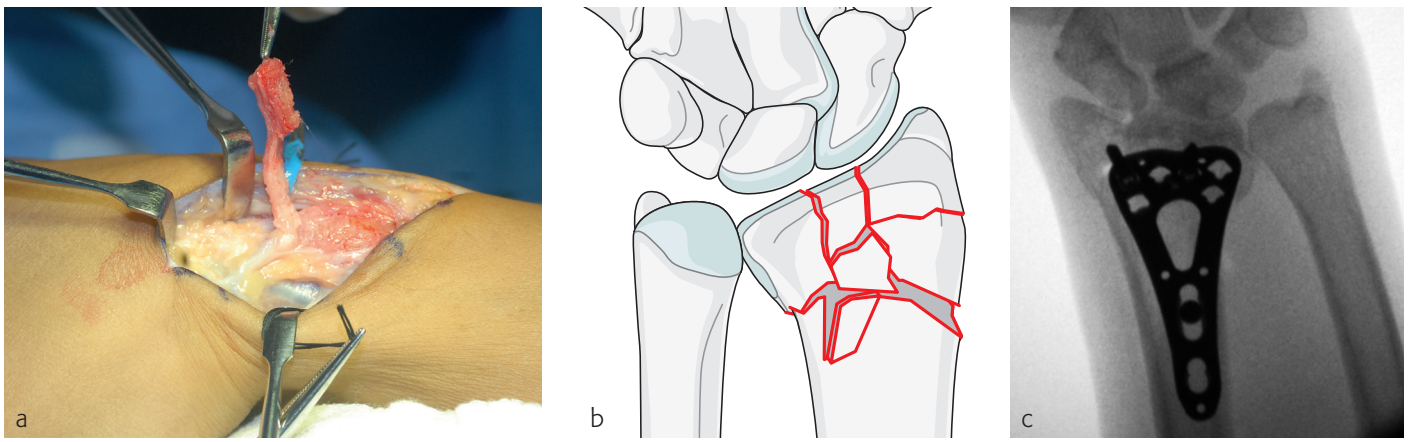

Fig 3a–c
Includes more than 2,000 clinical images and illustrations.

AO Videos move to new hub

The AO Education Institute and AOIT have successfully launched the new video hub "AO Videos" (**Fig 4**). The result is a centralized high-end video delivery platform serving the needs of the AO community and the entire organization.

To ensure a consistent viewer experience, the complete collection of high-value AO educational video resources has been upscaled to the 1080p high-definition (HD) standard from its current delivery formats. Additionally, for the promotion of the new video hub, well positioned banners have been set up on the landing pages of all AO websites.

The intuitive user interface, simple navigation, and top search capabilities will now make videos easy to find and you can view the extensive video archive at the highest quality on all devices.

The new video hub is found at: aovideos.aofoundation.org.

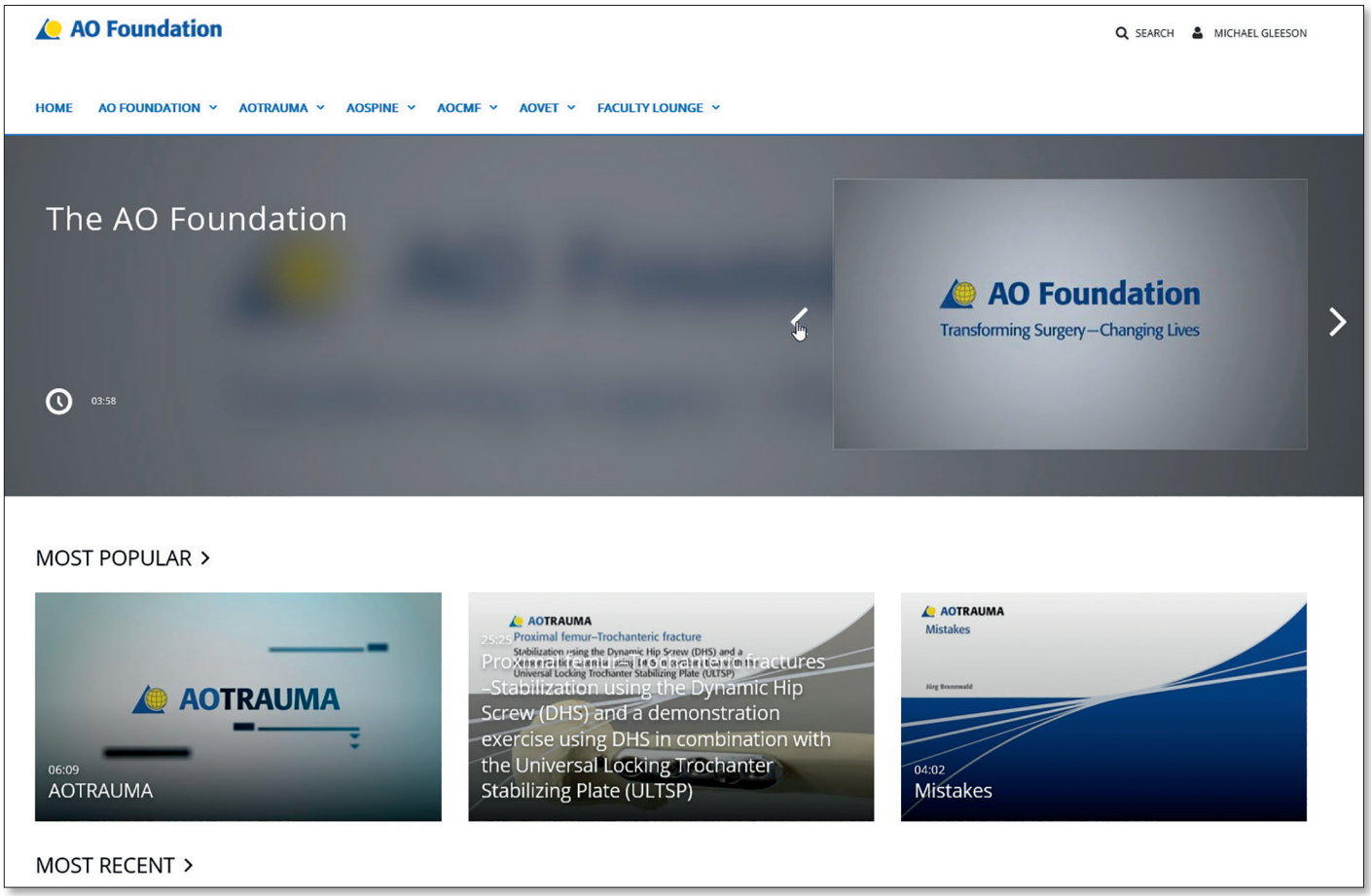

Fig 4
The new AO Videos web hub.

NEWS FROM AOTK

AOTK Experts' Symposia

Since the last edition of the AOTK Innovations magazine, three AOTK Experts' Symposia have been organized in Europe, Latin America, and Asia Pacific. AOTK Experts' Symposia are intended to review the clinical performance of AOTK approved technology, which is an essential aspect of the AOTK's approach to quality assurance. By open exchange of clinical experiences with new medical devices, their indications and use can be expanded or limited. Another important goal of these events is to identify unmet clinical needs and develop ideas on how to address them. By conducting the symposia in different continents, regional differences can also be revealed in terms of implant usage and surgical technique. The AOTK Experts' Symposia are thus a key element to drive innovation and to evaluate implant performance, which is fundamental for evidence-based development. Feedback is frequently received from symposium participants that learning from each other's experiences is an essential additional value. The symposia are also meant to be unique opportunities for newcomers to present their challenging cases in front of a panel of expert surgeons.

The event format is similar for all symposia to ensure consistent and comparable outcomes. The program is built upon individual sessions (usually up to five) to cover a variety of surgical topics that have been identified as burning and controversial. Each session is opened by a key-note lecture, setting the stage for later case discussion in that area. One of the prerequisites for attending an AOTK Experts' Symposium is submitting a challenging or special clinical case related to the defined sessions. These cases are reviewed and selected for presentation beforehand by symposium faculty, guaranteeing that the most interesting cases can be shared with all symposium participants. Finally, each session is summarized by a conclusion and clinical need definition, which is followed up in the AOTK Expert Groups and Task Forces.

The quality of sessions largely depends on the quality of submitted cases. To stimulate and encourage case submissions, prizes are awarded to those participants with the most interesting case presentations. Prizes are also meant to be acknowledgments for openly sharing cases that might not have been so successful in terms of clinical outcome. The most effective learning is often learning by mistake. At this point we would like to thank all symposium participants for their honest contributions to advance patient care.

The following is a summary of the highlights of the above mentioned three AOTK Experts' Symposia, which were all related to trauma and orthopedics.

AOTK Experts' Symposium in Europe

The 12th European AOTK Experts' Symposium took place in Mainz, Germany, on November 3 and 4, 2017. Chaired by Pol Rommens from the University Medical Center of the Johannes Gutenberg University Mainz, this symposium addressed the following five topics: Femoral neck fractures; Proximal tibial plateau fractures–implant portfolio and surgical approaches; TFN-Advanced Proximal Femoral Nailing system (TFNA); Pelvic insufficiency fractures; and Periprosthetic fractures at the femur. Thirtyseven surgeons from 15 European countries openly and sometimes controversially discussed their clinical experiences (**Fig 1**). Two of the sessions were dedicated to recently approved implants: the Femoral Neck system and the TFNA. Karl Stoffel (see the AOTK Innovation Award section in this edition) explained in his keynote lecture the rational for developing the Femoral Neck system and reported about the first clinical case worldwide. The topic of periprosthetic femur fractures was chosen to discuss the most recent treatment strategies for these challenging fractures. The results were taken back to the Periprosthetic Fracture Task Force to ensure that these findings were considered in new implant innovation. The winner of the best case presentation on the first day was Alexander Hofmann (Westpfalz Klinikum, Kaiserslautern, Germany), who presented a challenging case in the session about proximal tibial plateau fractures. He underlined that new implants would be beneficial for posterior buttressing via the posterolateral approach. This subject is currently under investigation by the Lower Extremity Expert Group (LEEG). An Sermon (University Hospital Leuven, Belgium) was the winner of the case presentations on day two. She presented an extraordinary case of a multifragmentary fracture of the femur. After repeated failed fixation by nailing, final treatment was performed by a complex segment transport over a TFNA utilizing a monolateral external fixator.

Fig 1
Participants of the 12th European AOTK Experts' Symposium in Mainz, Germany.

AOTK Experts' Symposium in Latin America

The 3rd Latin America AOTK Experts' Symposium was held in Panama City, Panama, on March 2 and 3, 2018. Rodrigo Pesantez (LEEG voting member) from the Fundación Santa Fe de Bogotá chaired the symposium, which attracted 25 participants to exchange their clinical experiences in Spanish (**Fig 2**). The program was divided into five sessions: External fixation; Geriatric pelvis and acetabulum fractures; Tibial plateau fractures; Periprosthetic fractures at the femur; and Challenges in proximal femoral nailing/role of augmentation. One highlight of the external fixation session was the presentation of the recently introduced MAXFRAME multi-axial correction system (see AOTK Innovations 2017). During the case presentations it became obvious that there was a need for external fixator systems that facilitate joint motion (especially the knee, elbow, and wrist joints). A similar finding to the 12th European AOTK Experts' Symposium was that the combination of a locking plate and an intramedullary device was a favorable option for fixing complex periprosthetic femur fractures. Another outcome was that in Latin America, most surgeons would fix posterolateral tibial plateau fractures using a fibula osteotomy and flexible plates (like one third tubular or distal radius plates (off-label use)). The prizes for the best case presentations at the two symposium days were awarded to Fabio Suarez (Hospital Militar Central, Bogota, Colombia) for his external fixator case and to Renny Cardenas Quintero (Hospital Central de San Cristóbal, Venezuela) for his case in the session about proximal femoral nailing.

Fig 2
Participants of the 3rd Latin America AOTK Experts' Symposium in Panama City, Panama.

AOTK Experts' Symposium in Asia Pacific

The 12th Asia Pacific Experts' Symposium was held in Hong Kong, China, on May 13, 2018 (**Fig 3**), alongside the AOTrauma Asia Pacific Current Concept Courses. Theerachai Apivatthakakul (voting member of the AOTK (Trauma)) from the Chiang Mai University Hospital Chaired the Asia Pacific Symposium for the second time in a row. The event offered 43 surgeons an open platform to present their most challenging and interesting clinical cases in the following areas: Periprosthetic fractures at the femur; Proximal tibial plateau fractures–implant portfolio and surgical approaches; Femoral neck fractures; and Subtrochanteric fractures. As such, the program covered three topics already addressed at the previous European and Latin American symposia allowing excellent comparisons between regions. The session about periprosthetic femur fractures revealed that bridging the whole femur was an appealing method to prevent peri-implant fractures. The AOTK Periprosthetic Fracture Task Force addressed this technique in the development of new implants. Another finding was that sometimes a distal medial femur plate was needed in addition to a distal lateral femur plate to provide adequate stability, not only for periprosthetic fractures but also for regular fractures. The concept of double plating at the distal femur is currently driven forward by the LEEG. In the session about tibial plateau fractures Jong-Keon Oh (Chair of the AOTK Asia Pacific Expert Group) presented a modified anterolateral approach to expose the posterolateral corner. He shared his technique of using a rim plate in addition to an anterolateral plate, which wraps around the posterolateral corner to provide adequate fixation. The winner of the best case presentation was Surasak Jitprapaikulsarn (Buddhachinaraj Hospital, Phitsanulok, Thailand), who contributed two cases in the tibial plateau fracture session and the subtrochanteric fracture session.

Fig 3
Participants of the 12th Asia Pacific Experts' Symposium in Hong Kong, China.

We would like to thank all symposium Chairs for their efforts and enthusiasm making the AOTK Experts' Symposia possible and so effective. The AOTK is excited to announce that it will expand its successful trauma symposium format to include the areas of spine and CMF.
In 2019 following symposia are planned (at the time of printing, exact dates were not yet fixed):

- 1st CMF AOTK Experts Symposium, March, 2019
- 13th Asia Pacific AOTK Trauma Experts Symposium, May, 2019
- 2nd Spine AOTK Experts Symposium, September or October, 2019
- 6th US AOTK Trauma Experts Symposium, September or October, 2019
- 14th European AOTK Trauma Experts Symposium, October or November, 2019.

Fig 1
Members of the AITF in Davos, Switzerland in December 2017.

News from the Anti-Infection Task Force

Since its inaugural meeting in August 2016, the Anti-Infection Task Force (AITF) has focused its efforts on pioneering work to improve the diagnosis, prevention, and treatment of infection. Chaired by Michael Raschke (Münster, Germany), the AITF (**Fig 1**) is composed of global key opinion leaders in the field of infection, including orthopedic and trauma surgeons, microbiologists, infectious disease specialists, and scientists.

At their first meeting, held in Münster, Germany, AITF members discussed the most pressing unmet clinical needs and formulated a priority list of projects including:

- Diagnostic criteria for the definition of fracture-related infection (FRI)
- Visualization of infection
- Development of a registry for infection risk assessment
- App for infection diagnosis and treatment recommendations
- Development of treatment protocols for open tibial fractures; disseminated via AO Education
- Clinical study for the ETN PROtect.

Since then, the task force has met twice annually and has set up specialized project teams to drive forward selected projects.

FROST registry

The FROST (Fracture-Related Outcome Study for operatively treated Tibial shaft fractures) project team first met in February 2017 with the remit to develop a registry to monitor outcomes, including infection, following tibial shaft fractures. Funding for the registry was approved by the AOTK (Trauma) and DePuy Synthes in December 2017, and it is planned that the first patients will be enrolled in Q4 2018.

The FROST registry aims to build evidence in the field of tibial shaft fractures by prospective data collection in a structured and systematic way via the implementation of a global registry. The registry will gather data from 12–15 sites in Europe, North America, South America, and Asia Pacific, and aims to enroll 1000 patients presenting with tibial shaft fractures (AO fracture type 42). Ultimately, data from this registry will assist the clinical decision-making process and will improve patient care.

Fracture-related infection consensus meetings

Fracture-related infection is a significant global problem. A recent systematic literature review undertaken by Willem-Jan Metsemakers revealed that only 2% of randomized controlled trials in fracture care use any kind of standardized definition of infection [1]. Furthermore, an online survey he organized and distributed to 80,000 members of the AO Trauma network in August 2017 revealed a clear lack of consistency in the treatment of FRI between trauma centers worldwide. The heterogeneity in FRI treatment can be attributed to the lack of consensus on the diagnosis

Fig 2
Willem-Jan Metsemakers and the attendees of the consensus meeting in Davos 2016, discuss the development of a definition of FRI.

Fig 3
Members of the international consensus group in Zurich, 2017.

Fig 4
Consensus meeting Chairs Willem-Jan Metsemakers (center) with Martin McNally of the EBJIS (left) and William Obremskey of the OTA (right).

and treatment of FRI and in turn to the lack of evidence-based guidelines. Members of the AITF saw a clear opportunity to address these clinical problems by leveraging the reputation and global reach of the AO Foundation to bring together key opinion leaders to reach a consensus on clinical approaches to FRI.

Firstly, a definition of FRI was established at a consensus meeting of experts, which took place in Davos, Switzerland, in December 2016 (**Fig 2**). The meeting was supported by both the European Bone and Joint Infection Society (EBJIS) and the AO Foundation, and was led by Prof Metsemakers. The consensus definition of FRI has since been published as a consensus paper [2], and represents a crucial first step in standardizing approaches to FRI.

Subsequently, broad consensus on diagnosis and treatment principles for FRI was achieved at a second meeting held in Zurich, Switzerland in February 2018. Supporting the meeting were 35 experts and key opinion leaders in the field of FRI including trauma surgeons, infectious disease specialists, a plastic surgeon, clinical researchers, and research scientists (**Figs 3** and **4**). Representative organizations included the EBJIS, the Orthopedic Trauma Association (OTA), and the Pro-Implant Foundation.

The experts reached consensus on topics including diagnosis, treatment concepts such as local antimicrobial strategies and soft tissue management, and standardization of outcome measurements. Recommendations for the diagnosis and treatment of FRI will be published in 2018. Members of the AITF agree that trauma surgeons worldwide need access to a single reputable site to access these FRI recommendations, and they are seeking to develop an app to achieve this aim. The availability of such guiding principles should enable improvements in clinical studies on infection incidence, costs of treatment, effectiveness of treatment strategies, and outcomes for patients.

Other projects guided by the AITF:

ETN Retrospective Study: a retrospective study to gather long-term data on the clinical efficacy of antibiotic-coated tibial nails. Participants will include patients treated between 2005 and 2016 with UTN PROtect or ETN PROtect. The coordinating site will be University Hospital Münster, Germany.
Bacteriophage Therapy: A study to explore the use of bacteriophages as a prevention and treatment modality for FRI using a contaminated plate model. This study will be run by the AO Research Institute (ARI) in Davos.

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Fig 1
Daniel Buchbinder congratulates Tim Pohlemann for his outstanding contributions to the AOTK System.

AOTK (Trauma) welcomes new Chair

Michael Raschke was elected as new AOTK (Trauma) Chair, commencing his 5-year term in July 2018. He follows in the footsteps of Tim Pohlemann, who has been Chair of AOTK (Trauma) since 2009.

In 2017, Tim had already handed over the AOTK Executive Board (TKEB) Chairmanship to Daniel Buchbinder and remained a voting member of the TKEB to ensure a smooth transition period. In addition, he has continued to lead AOTK (Trauma) until Michael took over this year. In a farewell speech at the AOTK Chairmans meeting during the Trustees Meeting in July 2018, which marked his last appearance in an official AOTK role, Tim underlined the importance that the AOTK has had in his life (**Fig 1**). "I am an AOTK child," he said deeply moved, expressing that the AOTK had been and always will be in his heart. Tim accepted a new function in the AO Foundation Board to effectively position the AO Foundation towards industry.

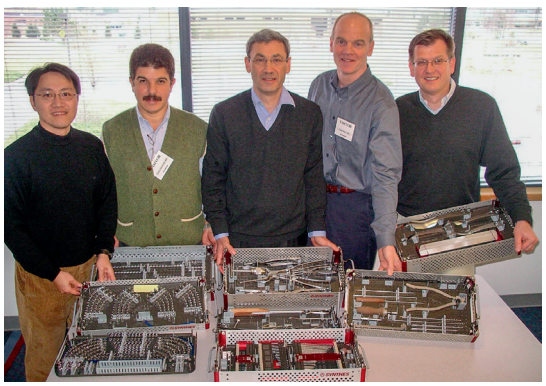

Fig 2
Tim Pohlemann (far right) and his PEEG colleagues presenting the new Pelvic Set after approval in 2004.

Tim started his work for the AOTK in 1991 when he became a voting member of the Pelvic Expert Group (PEEG). Chairing this group from 1996 until 2005, he led the development of the Pelvic C-Clamp and the Pelvic Set (**Fig 2**), which were game changers in pelvic surgery, and markedly influenced patient care. As successor to Norbert Haas, Tim was appointed as Chair of the TKEB as well as Chair of the AOTK (Trauma) in 2009. In these functions Tim witnessed a restructure of the industrial partner DePuy Synthes and a rapidly changing healthcare environment, challenging factors that required clear-sighted and visionary positioning of the AOTK and its specialties. He made sure that evidence-based development became a key element in every single AOTK project. This strategy strengthened the AOTK collaboration with CID and ARI for the benefit of the whole AO Foundation. The focused registry study concept was established to specifically prove the clinical values of new implants, instruments, and surgical techniques. Since the very beginning of his tenure as the AOTK (Trauma) Chair Tim has emphasized the introduction of smart sensor technology to monitor patient performance. Being a pioneer himself bringing sensor technology into the clinical setting (together with the former AO Development Institute), he established a partnership with Moticon GmbH to advance a pressure measuring insole concept for long term application. The newest generation pressure measuring insoles are now used in several clinical studies initiated by the AOTK to analyze patient performance. Tim was significantly involved in the elaboration of a new contract, which allows, under certain conditions, the collaboration with alternative companies outside DePuy Synthes and Johnson & Johnson.

Fig 3
Michael Raschke reports on the findings of the BMTF at the AOTK Chairmans Meeting in Davos 2015.

Fig 4
Michael Raschke and Gerhard Schmidmaier receive the AOTK Innovation Prize in 2013. From left to right: Daniel Buchbinder, Michael Raschke, Gerhard Schmidmaier, Tim Pohlemann, and Robert McGuire.

Michael takes over the AOTK (Trauma) Chairmanship with the knowledge that the partnership with DePuy Synthes and collaborations with third parties will be major topics in his tenure. There are a lot of challenges and opportunities that demand his attention in this context. Michael has already gained a lot of experience in the AOTK during his term as Chair of the Biomaterials Task Force (BMTF) from 2011 to 2016 (**Fig 3**). In this period, the BMTF established a vision for the future of biomaterials and identified unsolved clinical problems, where the use of biomaterials could lead to potential improvements in treatment outcomes. Long and short term needs were determined.

In 2013 Michael was awarded the prestigious AOTK Innovation Prize in recognition for his contribution to the development of the PROtect Nailing family (**Fig 4**). The antibiotic coated Expert Tibial Nail PROtect (ETN PROtect) was developed as a solution to implant surface bacterial colonization in cases with an increased risk of local bone infection. It represents one of the first major attempts to address the issue of infection in fractures.

Recognizing that infection is one of the most serious and distressing complications in orthopedic procedures, the AOTK formed an interdisciplinary Anti Infection Task Force (AITF) in 2016. Due to his expertise in treating infections Michael was elected Chair of this group, which had its inaugural meeting in Münster, Germany, Michael's home town. Since Michael took over as lead of the AOTK (Trauma), Michiel Verhofstadt followed him as Chair of the AITF.

One of the strengths of the AOTK has always been its flexible and adaptable structure to address unmet clinical needs. Having successfully led two task forces, Michael will use this experience to effectively shape the AOTK (Trauma) Expert Groups and Task Forces for the future.

The AOTK System would like to take this opportunity to wish Tim Pohlemann and Michael Raschke a successful start in their new roles.

Fig 1
María Alvarez Sánchez joins the AOTK team.

AOTK welcomes new colleague

In September this year, the AOTK team welcomed new colleague María Alvarez Sánchez (**Fig 1**) into her role as AOTK Expert Group Manager. María replaced Melissa Forster, who accepted a new job at Depuy Synthes. We would like to take this opportunity to thank Melissa for her extraordinary dedication and contribution and wish her all the best in her new adventures.

María completed a Master's in Sports Science in Madrid, Spain focusing on exercise physiology. She moved to Switzerland eight years ago and joined the University of Zurich as Research Assistant at the Institute of Veterinary Physiology and subsequently at the Institute of Anatomy. During this time, she worked in basic research and completed an off-label phase III clinical trial. María joined the AO Foundation in 2014 to work as Research Project Manager in AOSpine where she was responsible for the Knowledge Forums Trauma, Spinal Cord Injury, and Degenerative/Biologics. In her new AOTK role, María takes over the responsibility of managing several AOTK (Trauma) Experts Groups. Furthermore, María will leverage her research knowledge to closely collaborate with AOCID on AOTK initiated clinical studies.

In her private life María enjoys being outside in nature, preferably combined with sports. She saves those days with bad weather for baking, to the delight of friends and colleagues. Any time there is music playing in the background, you might find her tapping (or dancing) to the rhythm.

The AOTK is glad that María joins the team and wishes her the best of success in her new role.

Fig 2
Géraldine Pozzan appointed AOTK Symposia and Event Manager.

New role for AOTK team member

We are pleased to announce the promotion of Géraldine Pozzan (**Fig 2**) to her new role as AOTK Symposia and Event Manager effective from April 1, 2018.

Géraldine joined the AOTK System in 2011 as an Assistant and has developed her skill set to enable this well-deserved step into management. In her new function, Géraldine assumes responsibility for the organization and implementation of the AOTK Experts' Symposia and has carved a path for the introduction of Spine and CMF events into the Symposia calendar. Additionally, Géraldine will manage a small team of Assistants to facilitate the successful operation of the AOTK System.

We wish Géraldine all the best for her new position.

Fig 1
Daniel Buchbinder (left), who received the AOTK Innovation Prize in 2016, presents the certificate for the 2018 award to Karl Stoffel.

AOTK Innovation Award

The 2018 winner of the AOTK Innovation Prize is Karl Stoffel, MD, PhD, who is Deputy Head of the Department of Orthopedic Surgery and Traumatology at the Kantonsspital Baselland. Based on the decision of the AOTK Executive Board (TKEB), this prestigious AOTK prize is awarded to individuals or groups for leading involvement and innovative contributions to a project. Daniel Buchbinder (TKEB Chair) presented the certificate to Karl Stoffel in an award ceremony on July 12, 2018 at the AOTK Chairmans Meeting, which was held alongside the Trustees Meeting in Basel (**Fig 1**). The prize was given to Karl Stoffel in acknowledgement of his outstanding contributions to two projects described below.

Femoral Neck system

Karl Stoffel, voting member of the Lower Extremity Expert Group (LEEG) since 2012, supervised and guided the development of the Femoral Neck system (see AOTK Innovations 2017). This implant is a fixed-angle gliding fixation device that allows minimally invasive fixation of femoral neck fractures. Karl's innovative ideas influenced the design of the implant and instrument set as well as the surgical technique, which allows the surgery to be performed with high efficiency. During the development of the product, he supervised a biomechanical study conducted in the AO Research Institute to analyze the stability of the Femoral Neck system as compared to traditional fixation methods (see AOTK Innovations 2015). The Femoral Neck system was released to the market in 2017 and Karl performed the first surgery worldwide. In collaboration with AOCID, AOTK initiated a focus registry study with Karl as the principal coordinating investigator, to analyze the clinical performance of the implant system. This study is part of the evidence generation strategy of the AOTK to prove the benefit of its new developments.

Modular plating system for periprosthetic femur fractures

Realizing the growing significance of periprosthetic fracture management, the AOTK formed a Periprosthetic Fracture Taskforce (PFTF) with Karl Stoffel as the Chair. The mandate of the PFTF was to develop new solutions for periprosthetic fracture fixation of the femur. Three parallel development projects were initiated in collaboration with DepuySynthes as industrial partner. One of these projects, a new modular plating system, heavily relied on Karl's design input and expertise. This system has the potential to set the new standard for plating of periprosthetic femur fractures. The LEEG is now the responsible group for the modular plating system until product launch.

The AOTK congratulates Karl on his achievements and is looking forward to a continuing fruitful collaboration with him to further advance patient care.

Dankward Höntzsch

PORTRAIT: STEFFEN SCHRÖTER

Steffen Schröter is a trauma and orthopedic surgeon by profession with a special interest in deformity correction of the lower limb. With his extensive expertise, he has become a voting member of the Joint Preservation and Osteotomy Expert Group (JPEG) of the AOTK (Trauma).

Steffen was born in Reutlingen, a 120000-inhabitant town in the southern part of Germany, in 1975. After finishing school, he served 15 months of his civilian service in the emergency rescue service. As a trained paramedic, he rode in the ambulance to road accidents, which sparked his ambition to study medicine at the Eberhard Karls University in Tübingen, Germany. Towards the end of his study, in 2002, he took the opportunity to spend 4 months of his practical medical year at the Kantonsspital Lucerne working for Alexander Staubli, a renowned specialist in deformity correction. During this period, he got to know the first generation of the TomoFix system, an internal fixator system for osteotomies to treat knee osteoarthritis, which was developed within the AOTK under the lead of Philipp Lobenhoffer. Steffen was fascinated by the potential this implant system offered and supported Alexander Staubli in clinical studies analyzing patient outcomes after deformity correction. As a special reward for his support, he was given a copy of the AO bible, the *AO Principles of Fracture Management*. Steffen gladly recalls his time in Lucerne as the one that established his first contact with the AO Foundation and initiated his passion for trauma surgery and deformity correction.

After graduation from medical school in 2003, he started his residency at the Department of Trauma Surgery and Joint Replacement at the Klinikum Friedrichshafen. Günther Tauber was his first teacher in traumatology. In 2007, Steffen accepted an appointment at the Berufsgenossenschaftliche (BG) Unfallklinik Tübingen, one of the biggest Trauma centers in Germany. He names Kuno Weise, at that time the clinic head, and Ulrich Stöckle, current clinic head, as very influential personalities on his career.

From the very beginning of his employment at BG Unfallklinik Tübingen, and inspired by his Lucerne experiences, Steffen focused on deformity correction and published various scientific papers about this topic. For one of these papers he received an award for best publication. In 2016, he summarized his findings in a thesis titled “Open wedge high tibial osteotomy, precision and results”.

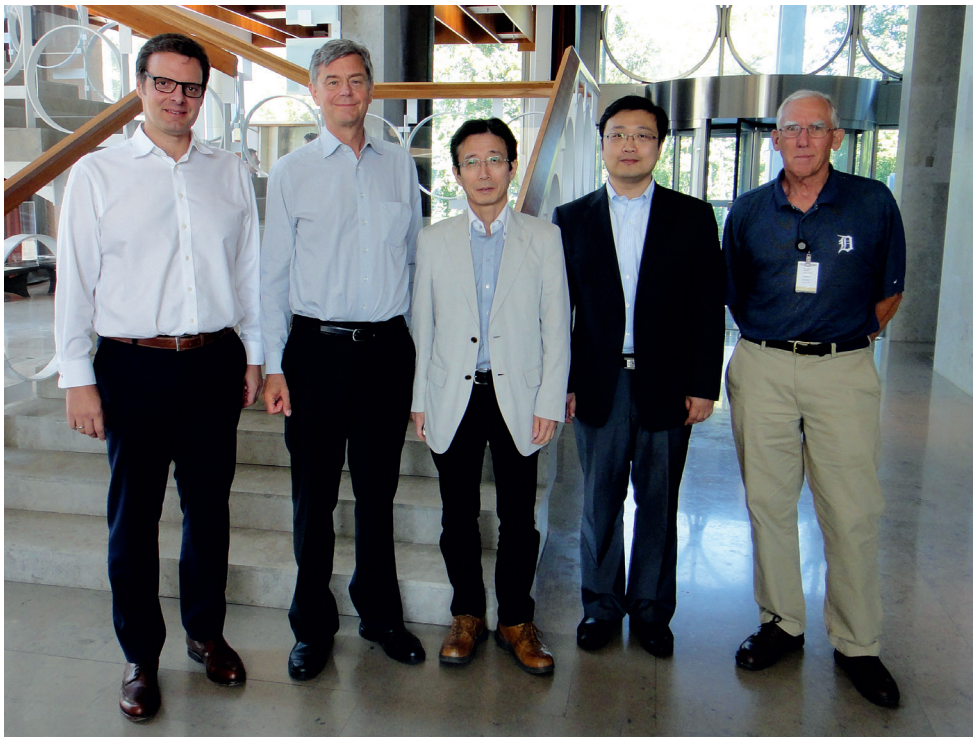

Fig 1
Voting members of the JPEG in 2015. From left to right: Steffen Schröter, Philip Lobenhoffer, Ryohei Takeuchi, Ye Huang, and Robert Teitge.

Fig 2
Steffen and his JPEG colleagues during an anatomy lab to test new devices.

Already as a young resident, Steffen had brought innovative ideas to application in clinical practice, thereby raising the attention of surgeons involved in the AO Foundation. Steffen's first direct contact with the AOTK was in 2009 when he was invited as a guest to a Knee Expert Group (KNEG) meeting chaired by Philipp Lobenhoffer to report on the findings from his osteotomy related studies. His presentations were received with great interest, which led to further guest attendances at future KNEG meetings. At that time the KNEG dedicated most of its development activities to improve osteotomy procedures and was therefore renamed the Joint Preservation and Osteotomy Expert Group (JPEG) with Steffen becoming a voting member in 2012 (**Fig 1**). Steffen was delighted to work together with his JPEG colleagues, among them Alexander Staubli, who was so influential at the beginning of his career, and Philip Lobenhoffer, the inventor of the TomoFix system. Steffen immediately proved himself to be a valuable member of JPEG by becoming involved in the development of a new medial high tibial osteotomy (HTO) plate (TomoFix Anatomical), guiding instruments to assist in osteotomy procedures, as well as a radiolucent retractor to improve the safety of surgery (**Fig 2**). These implants and instruments were approved by the AOTK in 2017 (for further information, see AOTK Innovations 2017, page 13) (**Fig 3**). In December 2017, during the Davos Courses, he participated in a well-attended AOTK Meet the Experts session titled "Innovations in Osteotomies Around the Knee" (see the Meet the Experts section in this year's edition), which was broadcast globally via the internet (**Fig 4**). Steffen and his JPEG colleagues currently focus their efforts on new projects, such as a hinge plate, a medial distal femur osteotomy plate, and an osteotomy planning software. Preoperative planning is an important part of all osteotomy procedures and Steffen continues to emphasize the importance of offering an appropriate software package for this purpose.

Fig 3
Steffen in the OR during HTO surgery at the BG Unfallklinik Tübingen.

Fig 4
Meet the Experts Session where Steffen explained the benefits of the new osteotomy plate and instruments.

When asked what he values most about his work for the AOTK System, Steffen said that it is that AOTK facilitates exchange among international expert surgeons to drive innovation forward. It is especially this international aspect that he sees as the main advantage in collaboration with industry to address unmet needs from various regions. He also greatly appreciates the input from other AOTK Expert Groups. "This cross fertilization is very beneficial because you need to think beyond boarders and out of the box," he says, referring to the Tibia Plateau Leveling Osteotomy (TPLO) instrumentation developed by the Veterinary Expert Group. Inspired by this development, Steffen and other members of JPEG successfully applied the TPLO concept to humans at the distal tibia and distal femur.

During one JPEG meeting, Steffen got to know David Elson, a surgeon from England, who presented his experiences in setting up and running a large osteotomy registry in the UK. Steffen was convinced that such a registry would be of great benefit in Germany and explored ways to realize it. Due to his networking capabilities and persistence he succeeded to define a registry concept, which will be realized in 2018 with the support of the German Knee Society.

Steffen is a passionate researcher. Stimulated by the ARI developed X-in-One, which is a simplified navigation system for implant or instrument positioning and tracking (see AOTK Innovation 2017, page 53), he started to investigate the potential of this promising concept to facilitate rotational corrections. A clinical feasibility trial under his lead is currently running at the BG Unfallklinik Tübingen.

The AOTK has started a strategic initiative to foster smart sensor technology in an effort to obtain more information about fracture healing and patient performance in the rehabilitation period. Several clinical studies were initiated in which a wireless pressure measuring insole is used to record patient weightbearing. Steffen is principal investigator of one of these studies, which aims to document weightbearing in patients before and after HTO surgery (see AOTK Innovations 2017, page 57).

Fig 5
Steffen and his older son Lasse enjoying time on the ski slopes. For Lasse it was his first skiing holiday.

Apart from his development work in the AOTK and his research interests, Steffen is increasingly involved in AOTrauma Education activities. As international expert in deformity correction, he presented the webinars "Osteotomies Around the knee" in 2016 and "Failure of Osteotomies Around the Knee" in 2018. Both events reached a broad audience spreading the knowledge about osteotomies as joint preserving procedures around the globe. In April 2017, Steffen chaired his first AO course (Osteotomy in Posttraumatic Deformity) in his home town, Tübingen, which was a special honor for him. If you are interested in deformity corrections you should not miss the chance to attend the osteotomy course in Madrid, Spain, on April 29 to May 1, 2019 in which Steffen is responsible for the program together with JPEG chair Philipp Lobenhoffer.

Steffen has taken over as mentor of all medical fellows at the BG Unfallklinik Tübingen. With distinct dedication, he takes care of AO fellows in such a way that they remember their fellowship time in traumatology as one of special value. In addition to the traumatology fellows, Steffen also takes care of long term fellows up to one year (especially from Japan) in the area of deformity correction.

In his private life, Steffen likes riding his bike but also has a passion for fast cars as shown by his favorite dining place in Tübingen called Boxenstop, which is also a museum for racing cars. Steffen is a passionate skier and is very familiar with the ski slopes of Davos. Above all, Steffen enjoys spending time with his family. He is married to wife Christina, an attorney by profession, and has two sons, Lasse, 4 years, and Ole, 1.5 years (**Fig 5**). Inspired by Christina, he ran a marathon in Mallorca, which he vividly remembers as a special experience, especially for his knees, as he humorously remarks.

The AOTK System is very much looking forward to continuing the fruitful collaboration with Steffen for many years to come.

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