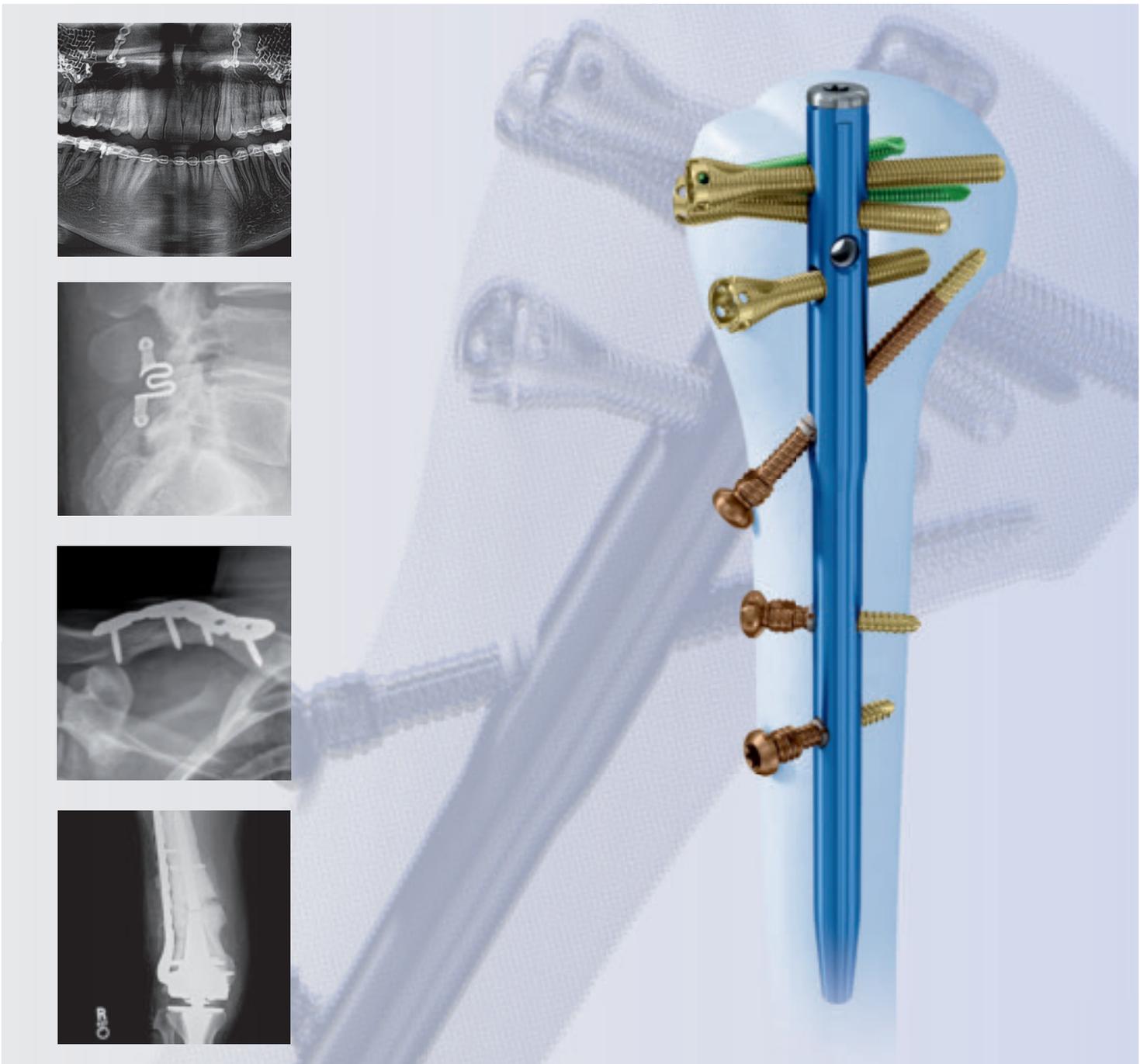


**TK System**

Innovations

2 | 2011



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DUE TO VARYING COUNTRIES' LEGAL AND REGULATORY APPROVAL REQUIREMENTS PLEASE CONSULT THE APPROPRIATE LOCAL PRODUCT LABELING FOR APPROVED INTENDED USE OF THE PRODUCTS DESCRIBED IN THIS BROCHURE. ALL DEVICES IN THIS BROCHURE ARE AOTK APPROVED. FOR LOGISTICAL REASONS, THESE DEVICES MAY NOT BE AVAILABLE IN ALL COUNTRIES WORLDWIDE AT THE DATE OF PUBLICATION.

Dear reader,

We live in interesting times with many different challenges around the world. For the AO Foundation, the change announced by our industrial partner, Synthes, should open up new opportunities. Until the merger with Johnson & Johnson is formalized as planned in Q1 2012 we will continue with our known working structure and keep you updated as required.

In the lead article of this issue, the Upper Extremity Expert Group provides a comprehensive overview of new treatment strategies of midshaft clavicle fractures in light of increasing need for surgical treatment of such fractures. Various options are available and will be discussed.

In trauma we also highlight the multiloc humeral nail featuring the new screw-in-screw technology which will be expanded to other implants for different anatomical areas. Preliminary biomechanical data indicate that a multiloc construct with screw-in-screw and calcar screw outperforms all other tested devices. A clinical study will be conducted to validate these findings.

The computer-assisted surgical trauma module 3.0 for two-dimensional image intensifier image-based navigation offers dedicated workflows for navigated treatments in most body regions including inferior and superior extremities, the spine, and the pelvis. This is complemented by generic navigation workflows without localization presettings for regions, and C-arm projections specified by the surgeon during a given procedure.

In spine, two additions to the matrix system are provided. Matrix MIS is a minimally invasive option for the treatment of degenerative and traumatic conditions while matrix 5.5 deformity system is designed to provide biomechanically sound instrumentation for complex posterior pathological challenges.

The vertebral body stent system is a minimally invasive, percutaneous, reconstructive option

for vertebral body fractures and may be used with vertecem V+. The NFlex system is a semirigid rod for posterior lumbar stabilization designed to be used with either pangea or click'X pedicle screws. The oblique posterior atraumatic lumbar system is a comprehensive set of posterior interbody implants and instruments designed to facilitate fusion of the lumbar spine. Stenofix is an interspinous implant designed to provide indirect decompression by functioning as a spacer between the spinous processes for one or two motion segments.

In CMF, the artificial sterilizable skull is the first autoclavable, one-piece human skull model intended for aiding initial plate contouring in the operating room, and for visualizing facial structures. Three forceps address bone/fracture reduction in specific regions of the mandible. The transpalatal distractor system consists of specialized implants and instruments specific to surgically assisted palatal distraction osteogenesis. The sternal zipfix system achieves sternal closure following sternotomy by stabilizing the sternum and promoting fusion using PEEK biocompatible implants that represent an alternative to cable ties.

The column Portrait, features Vinzenz Smekal, from Austria, who is a trauma surgeon with a special emphasis on sports traumatology. He currently has a special focus on treatment concepts following clavicle fractures, having successfully completed an interesting randomized controlled trial. We encourage you to follow his example and to share your talents with us.

Once again, we would like to stress that none of the articles in this publication is a substitute for the AO's surgical techniques or the AO teaching tools. You can obtain more detailed information on these devices from the AO or from the official technical guidelines and documentation.

If you have any comments or questions on the articles or the new devices, please do not hesitate to contact any one of us.

Yours faithfully,



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Norbert Südkamp, Martin Jaeger

## MIDSHAFT CLAVICLE FRACTURES—CHANGE OF PARADIGMS



**Fig 1**  
3.5 mm LCP superior clavicula with extension/3.5 mm LCP superior anterior clavicula with extension (short versions of both plates are identical).



**Fig 2**  
3.5 mm LCP superior clavicula with extension (long version).



**Fig 3**  
3.5 mm LCP superior anterior clavicula with extension (long version).

Fractures of the clavicle are common injuries, representing 3–5% of all fractures and occurring with an incidence of 64 per 100,000 [1]. They are seen in up to 45% of all injuries of the shoulder girdle and are located in the midshaft area in approximately 80% of cases [2].

Midshaft clavicle fractures occur either isolated, or in combination with other injuries. Until recently, the nonoperative treatment was considered the gold standard, avoiding surgery-specific risks. Therefore midshaft clavicle fractures are either redressed in a figure-of-eight-bandage for several weeks or immobilized in an arm sling (eg, Gilchrist bandage). Two prospective randomized studies comparing both methods across 234 participants in total were not able to detect significant differences in functional or other outcome parameters reported for either trial [3].

The main purpose of these bandages is initial pain relief. Fracture reduction is not usually performed. The fractures typically heal in the preexisting deformity, in which remodeling can be observed to various extents. However, often a shortening of the affected clavicle can be observed. This results in a shift of the scapula with a change in tensioning of the affected shoulder girdle muscles. Healing with a shortening of 2 cm or more shows a clinically significant deterioration of results [4–7]. In addition, the development of a nonunion is well known and not uncommon after nonoperative treatment. The incidence depends on the type of fracture and ranges from 6 to 15% [4]. Khan was able to determine a calculated probability of nonunion at 24 weeks after clavicle shaft fractures depending on age, sex, comminution, and displacement [8]. Females over 70 years of age with displaced and comminuted fractures have the worst prognoses with an estimated likelihood of nonunion at 49%.

Previously just the following, rare indications for surgery were generally accepted:

- Risk of fracture perforation
- Open fractures
- Neurovascular injuries
- Additional blunt chest trauma with ipsilateral rib fractures
- Shortening of more than 2 cm

In contrast to this, several studies with a high level of evidence have recently been published, and are able to show that surgical treatment has significantly better results [7, 9–16]. One major advantage of surgery is the ability to achieve and maintain reduction of the fracture to



**Fig 3**  
3.5 mm LCP superior clavicle.



**Fig 4**  
3.5 mm LCP superior anterior clavicle.



**Fig 5**  
LCP Clavicle hook plate.

avoid nonunion and shortening. But even if there is just a slight displacement of the fracture, stabilization with a plate or nail provides both improved pain relief and quicker return to activities of daily living. Therefore, it now seems justified to extend the range of indications for surgery.

The Canadian Orthopaedic Trauma Society published a prospective randomized multicenter trial in 2007 [10]. They compared nonoperative treatment with plate fixation of displaced midshaft clavicle fractures of 132 cases. At 1-year follow-up the clinical results in terms of Constant and DASH scores improved significantly at all time-points. The mean time of radiographic union was 16.4 weeks after surgery with a lower rate of malunion and nonunion compared with nonoperative treatment. Compared to the nonoperative group, patients treated with plate osteosynthesis were significantly more likely to be satisfied with the appearance and function of the shoulder.

Meanwhile, further prospective randomized studies have been published which also demonstrate the superiority of plate fixation of midshaft clavicle fractures compared to nonoperative treatment [7, 11]. Minimally invasive intramedullary fixation methods were also able to show excellent results superior to nonoperative treatment with high level-1 evidence [7, 9, 11–13]. However, in contrast to plate fixation the range of indications is reduced and has to be respected to avoid known complications, such as “telescoping”, secondary implant migration, and secondary loss of reduction. In particular, complications are frequently seen in comminuted fractures. They should be treated by plate fixation. In order to extend their spectrum of indications, nailing systems with angular stability are being developed, since the so-called “end cap” is not sufficient to stabilize these fractures.

Using plate fixation angular stable systems prevail nowadays. They provide both biomechanical and clinically superior results. At present, various precontoured plates are available. At first glance they seem to be user-friendly since intraoperative bending of the implants according to the shape of the clavicle seems to be less often necessary. In addition, it is beneficial to have a template in multifragmentary fracture situations to allow reduction of the fragments against the plate. The clavicle has a complex three-dimensional structure with high variability [17, 18]. Consequently, it is not easy to fix all clavicles with just one plate shape, the plates may require bending adjustments in some cases.

There is no evidence currently available as to whether the superior, anterior, anteroinferior, or anterosuperior placement is clinically more favorable. Each position has different advantages and disadvantages in terms of its biomechanics, the interference with muscle attachments, the risk of injury of neurovascular structures during placement of angular stable screws, and prominence of plate position requiring later implant removal.



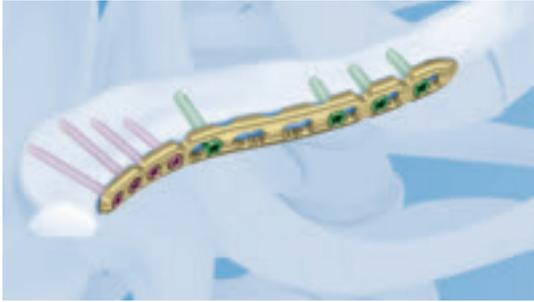
**Fig 6**  
**Titanium elastic nail with end cap.**

Recently published hints demonstrate that unicortical fixation using precontoured plates and locking screws has a similar biomechanical profile to gold standard nonlocked bicortical screws in cyclic axial compression and load to failure [19]. This may be a factor in lowering the risk and incidence of iatrogenic neurovascular structural damage while drilling, and may also result in lower refracture rates after implant removal. Especially in the midshaft area these structures are very close to the clavicle, resulting in a tip contact of screws in up to 20% of cases [20–22].

Synthes offers a variety of anatomical precontoured plates: the superior, anterosuperior, and anterior clavicle plates. The anterosuperior clavicle plates are also offered with a so-called lateral extension accepting insertion of six 2.7 mm-head locking screws. This also helps to extend the range of indications for even lateral comminuted clavicle fractures. Open reduction and plate fixation can be classically performed via a sabre-cut incision. Alternatively a minimally invasive approach can be used very nicely and is recommended by the authors. The 3.5 mm clavicle hook LCP and the titanium elastic nail complete the repertoire. It is therefore possible to address every midshaft clavicle fracture individually.

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**Fig 1**  
Anterior clavicle plate with lateral extension.



**Fig 2**  
Anterior clavicle plate without extension with screws.

### 2.7/3.5 mm VA-LCP Anterior Clavicle

Up to now, the 3.5 mm LCP clavicle plate system has consisted of the superior anterior clavicle plate which fits on the superior end laterally and twists midshaft to fit anteriorly on the medial aspect. The superior clavicle plate is without the twist but with a lateral bow and flat superior design.

An anterior clavicle plate has been included in the set to

- Decrease the potential of screw pullout, as positioning of the plate on the anterior side of the clavicle functions like a buttress and limits the pullout risk of the lateral/distal fragment [1]
- Increase the safety of the technique as the risk to injury of the neurovascular structures is lower when drilling and screw placement is achieved from front to back, aiming away from subclavicular structures, compared to a superior to inferior direction [1]
- Improve the fit of the plate for smaller (slimmer) patients and thereby decrease an irritation of the soft tissues [1]

The new precontoured 2.7/3.5 mm variable angle LCP anterior clavicle plate comes in two versions: shaft/medial plates available in 6, 7, and 8 holes, and lateral extension plates available in 7, 9, 10, 11, and 12 holes. The combination holes accept 3.5 mm locking, 3.5 mm cortex, and 4.0 mm cancellous bone screws. The lateral extension plate accepts 2.7 mm variable angle and locking screws, 2.7 and 2.4 mm cortex screws. All plates have reconstruction plate segments and plate undercuts, and are available in stainless steel or titanium.

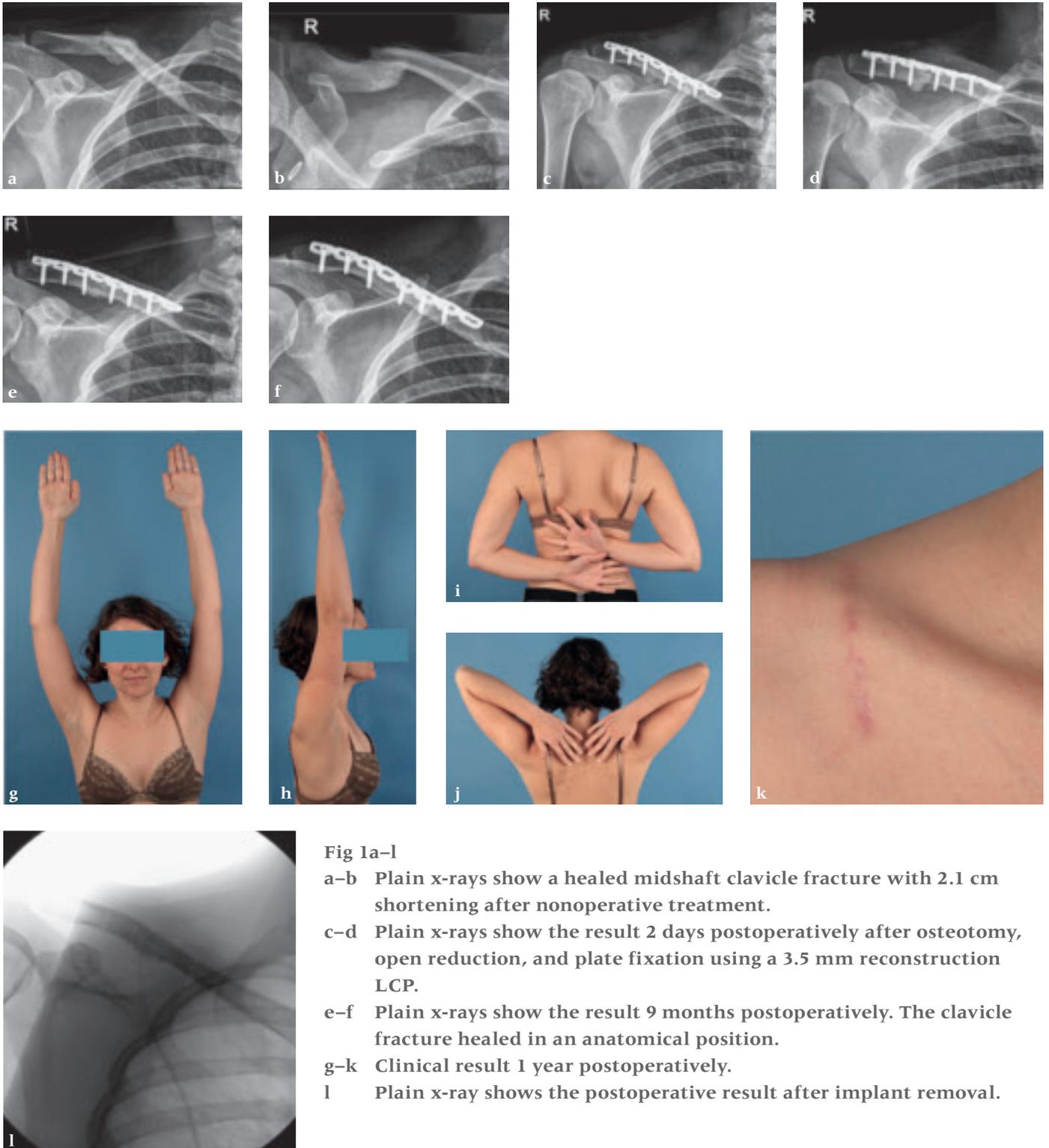
Biomechanical tests comparing plates with medial or lateral extensions on the basis of a 3.5 mm reconstruction plate have shown much higher strength in compressive bending in static and superior resistance in dynamic tests.

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**Case 1: A 30-year-old woman sustained a midshaft clavicle fracture. It healed with 2.1 cm shortening over 4 years after nonoperative treatment.**

Case provided by Norbert Südkamp and Martin Jaeger, Freiburg, Germany

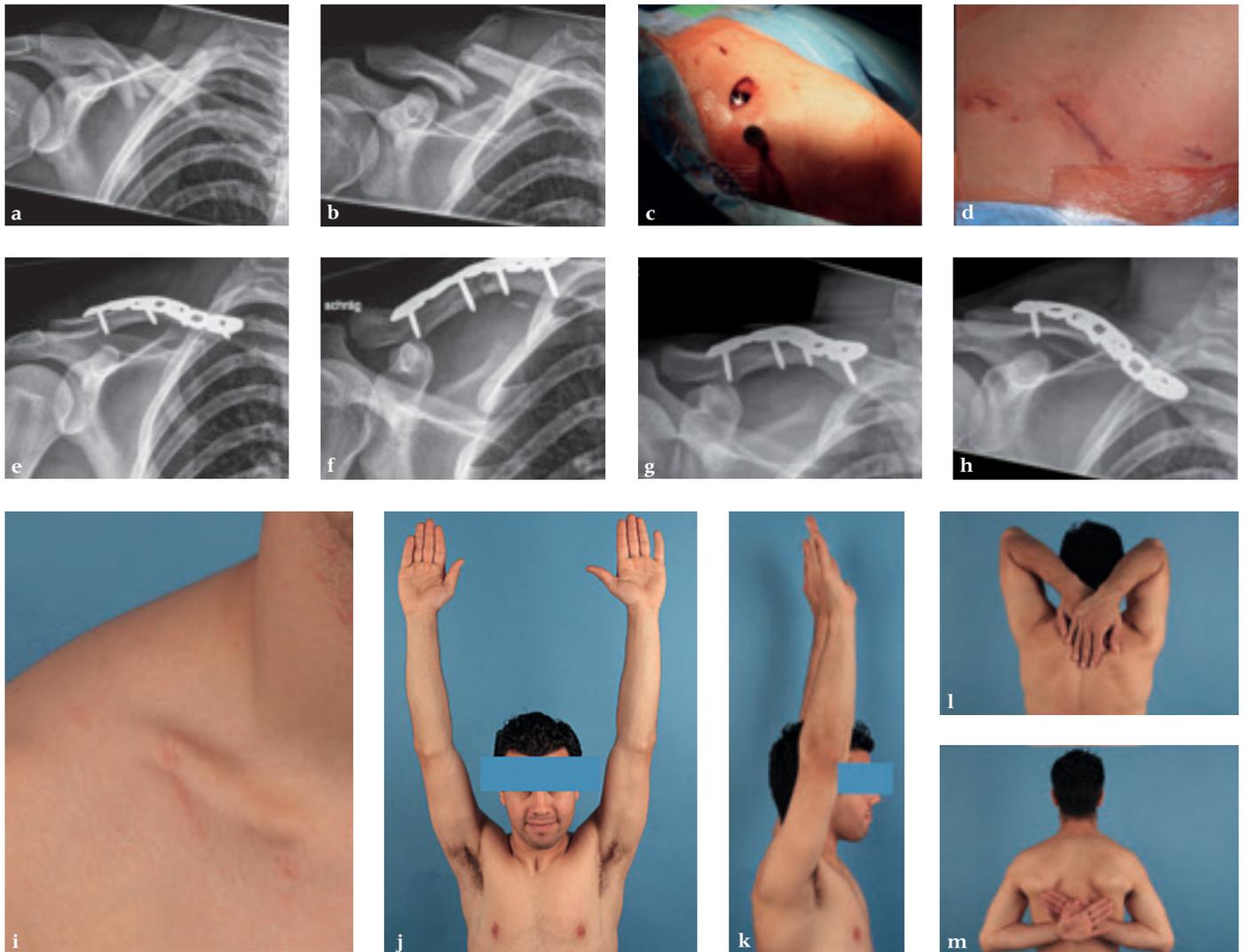


**Fig 1a-l**

- a-b Plain x-rays show a healed midshaft clavicle fracture with 2.1 cm shortening after nonoperative treatment.
- c-d Plain x-rays show the result 2 days postoperatively after osteotomy, open reduction, and plate fixation using a 3.5 mm reconstruction LCP.
- e-f Plain x-rays show the result 9 months postoperatively. The clavicle fracture healed in an anatomical position.
- g-k Clinical result 1 year postoperatively.
- l Plain x-ray shows the postoperative result after implant removal.

**Case 2: A 29-year-old man sustained a midshaft clavicle fracture while playing soccer.**

Case provided by Norbert Südkamp and  
Martin Jaeger, Freiburg, Germany



**Fig 1a–m**

**a–b** Plain x-rays show a midshaft clavicle fracture.

**c–d** Intraoperative images show the minimally invasive plate fixation using an anterosuperior clavicle plate. Note: the most medial and lateral locking head screws are inserted via stab incisions.

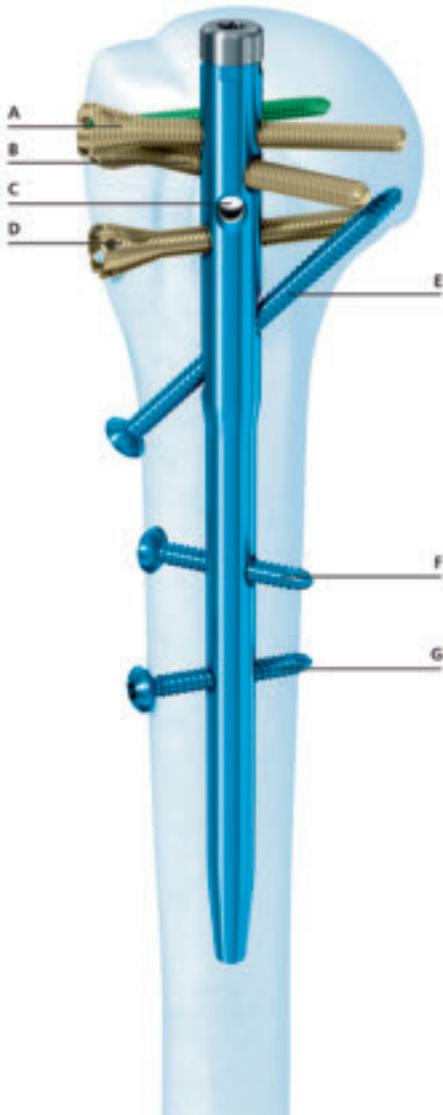
**e–f** Plain x-rays show the result 2 days postoperatively.

**g–h** Plain x-rays show union in the anatomical position 9 months postoperatively prior to implant removal.

**i–m** Clinical result 9 months postoperatively.

Martin H Hessmann, Stefaan Nijs, Boyko Gueorguiev, Damiano Schiuma, Martin Kloub, Markus Windolf, Michael Plecko

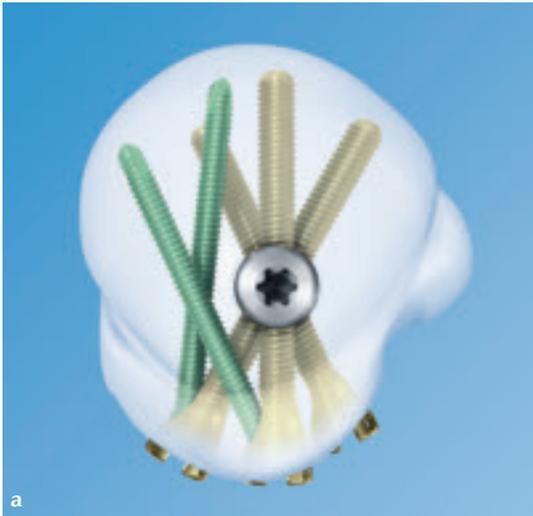
## TRAUMA, UPPER EXTREMITY



### MultiLoc Proximal Humeral Nail

Angular stable plating and nailing are well-established procedures to treat proximal humeral fractures. However, the complication rates of these treatment options remain high, mainly due to the complicated fracture pattern, the complexity of the local anatomy, compromised vascularity after fracture of the humeral head, and poor bone anchorage due to osteoporosis. The multiloc proximal humeral nail (multiloc PHN) was developed in an effort to improve nailing osteosynthesis stability and thus expand the indications for nailing at the proximal humerus. The new nail is intended for the treatment of fractures of the proximal humerus, including two-part surgical neck fractures, three-part fractures, and four-part fractures. Recent clinical studies revealed good clinical results for Xmas tree type intramedullary nailing devices in complex fracture patterns [1]. The stability provided by plate and nail osteosynthesis was analyzed in a biomechanical study [2].

**Fig 1**  
**Multiloc proximal humeral nail.** The three lateral screws (greater tuberosity, levels A, B, and D) must be used in any fracture situation as they ensure the basic stability of the construct. The anterior screw (minor tuberosity, level C) increases the stability of the construct. It may be used in fractures with a minor tuberosity fragment if the fragment is large enough to accommodate the screw head. Additional locking screws (greater tuberosity, levels A, B, and D) may be inserted through the screw heads of the lateral screws to increase stability of the osteosynthesis. The ascending screw (level E) supports the medial calcar region which can be helpful in medially comminuted fractures. The two distal locking screws (levels F and G) are located in different planes to reduce implant toggling in the humeral canal.



a



b

**Fig 2a–b**  
Optional secondary 3.5 mm locking screws can be placed through the multiloc screws (screw-in-screw) for improved stability, especially in poor quality bone. The additional screws provide a large support area without increasing the entry area.

The multiloc PHN is a Xmas tree type nail with an innovative screw-in-screw technology, which allows treatment of both simple and complicated fractures (Fig 1). The nail is cannulated and has a straight design to allow for a central nail insertion in line with the medullary canal. The multiloc PHN includes four multiplanar and angular stable proximal locking options, one ascending locking option, and two distal locking options. Through the screw heads of the multiloc screws (counter-sinkable head design with a locking inner thread in the screw head, four suture holes, and blunt screw tip), additional 3.5 mm locking screws may be inserted into the humeral head to enhance stability (Fig 2). This screw versatility is beneficial to address the various fragments in complex fractures and is thus a clear advantage over the expert humeral nailing system or the unreamed humeral nail/PHN system. The design of the multiloc PHN allows the 3.5 mm locking screws to be inserted into the densest bone in the humeral head, which is postero-medial [3].

Angular stability of the proximal locking holes is achieved through a polyethylene inlay with bore holes which are slightly smaller in dimension than the screws. Ascending and distal locking is compatible with 4.0 mm locking screws (nonangular stable) or 4.0 mm angular stable locking system screws (angular stable). The ascending screw is specifically useful in varus type fractures with medial comminution. A biomechanical study showed the improved stability provided by the ascending screw and the multiloc screws of the new nail (see AO Research Institute: Biomechanical Evaluation of Three Different Locking Options Using MultiLoc PHN for Intramedullary Nailing of Proximal Humeral Fractures in a Three-Part Fracture In Vitro Model on page 12). The 160 mm long left and right cannulated nails are available in diameters of 8.0 mm and 9.5 mm. The diameter of the nail thus can be adapted to the width of the medullary cavity, which is especially useful in elderly patients with osteoporotic bone. Longer shaft nails will be released at a later point in time as a line extension.

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**Case 1: A three-part valgus impacted fracture of the proximal humerus in a 47-year-old woman.**

Case provided by Martin H Hessmann, Fulda, Germany

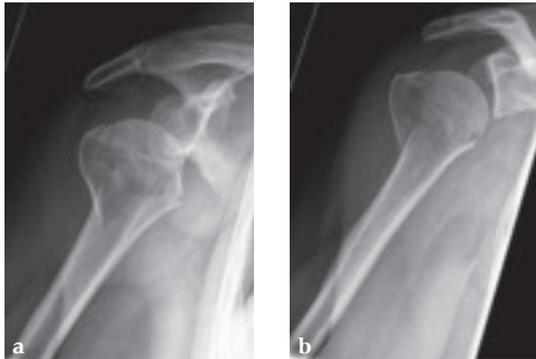


Fig 1a–b  
Injury films.



Fig 2a–b  
Postoperative results after stabilization with the multiloc PHN. Three multiloc screws were used for the fixation of the head fragment. The greater tuberosity was large and was fixed with two screws and an additional suture.

**Case 2: Three-part valgus displaced fracture of the proximal humerus in a 63-year-old man.**

Case provided by Stefaan Nijs, Leuven, Belgium

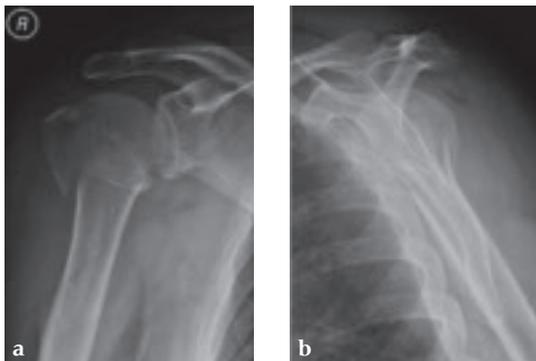


Fig 1a–b  
Injury films.



Fig 2a–b  
X-rays 3 months postoperatively. The tuberosities have been reduced and fixed using intertubercular sutures. To reconstruct the medial support a calcar screw has been used. This determines the height of the nail. Therefore a 1 cm end cap has been used to get support for the proximal end of the nail in the part of the bone with the best bone quality.



Fig 3a–d  
Clinical images show 3-month postoperative functional result.

**Case 3: Three-part varus displaced fracture with head-split component in a 60-year-old woman. This case is an illustration of the application of the new nail in a borderline indication. Head-split fractures remain a challenge whatever implant is used for fixation.**

Case provided by Stefaan Nijs, Leuven, Belgium

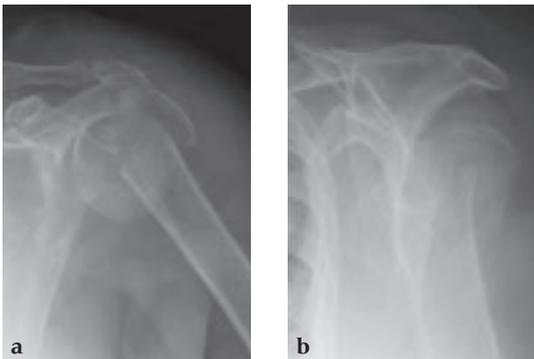


Fig 1a–b  
Injury films.

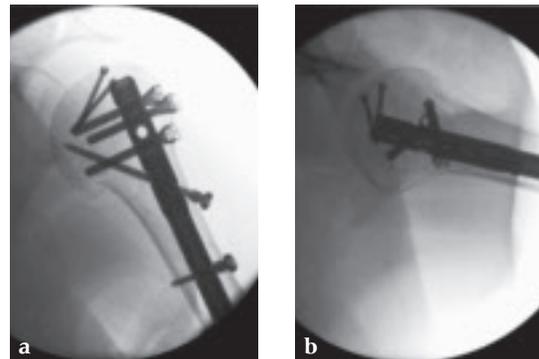


Fig 2a–b  
Intraoperative image intensifier control views.

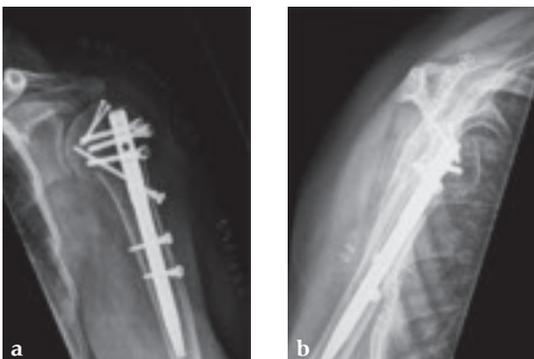


Fig 3a–b  
Postoperative x-rays. Additional headless compression screws have been used for fixation of the head-split fragment.

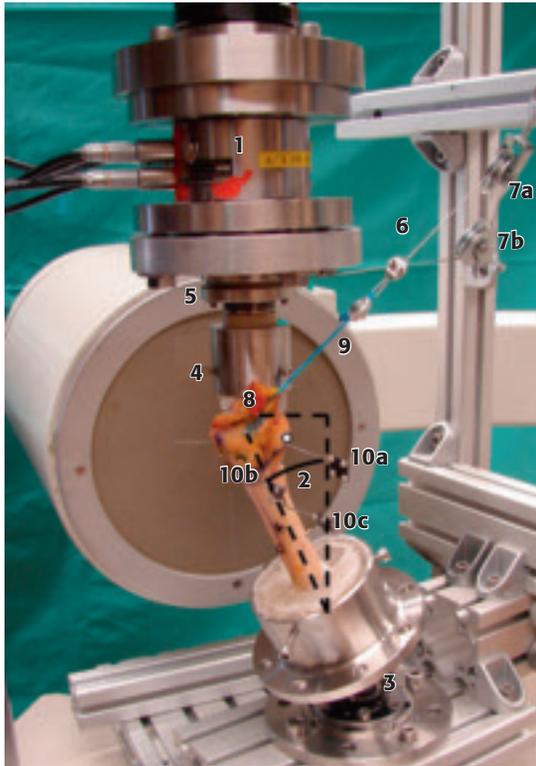


Fig 1

**Test set-up:**

- 1) Load cell
- 2) 25° lateral angulation of the humeral shaft axis
- 3) Cardan joint preventing displacement and axial rotation of the sample
- 4) Custom-made PMMA cup simulating glenoid fossa fixed in a metal cylinder
- 5) Custom-made notched flange allowing decoupling of axial and torsional movements of the machine actuator
- 6) Cables transmitting machine-torsional movements to the sutures
- 7a-b) Two pulleys
- 8) Attachment of the sutures to the muscle tendons
- 9) Direction of the pulling force acting on the anchor in an angle of 110° to the shaft axis in the mediolateral plane
- 10a-c) Three marker sets attached to the humeral head, greater tuberosity fragment, and shaft; the white full circle represents the most medial aspect point of the humeral head on the osteotomy level taken into account for evaluation of the head migration

### AO Research Institute: Biomechanical Evaluation of Three Different Locking Options Using MultiLoc PHN for Intramedullary Nailing of Proximal Humeral Fractures in a Three-Part Fracture In Vitro Model

**Objective**

The treatment of unstable three- and four-part proximal humeral fractures remains challenging. Clinical outcomes using standard osteosynthesis treatments are not yet satisfactory, especially in osteoporotic bone. That is why optimization of the implant design accounting for good quality and osteoporotic bone is of major interest. An extended version of multiloc PHN intramedullary nail was recently developed for simple and complex fractures of the proximal humerus. In addition to the possibility for multiplanar distal fixation with two angle-stable locking screws (ASLS) and three proximal humeral head screws (standard), this nail introduces the screw-in-screw concept including one additional locking screw in each of the proximal screws. Later on, a calcar screw starting in the lateral cortex of the shaft and ending in the cancellous bone of the humeral head calcar region can be optionally purchased. The purpose of these design adaptations is to improve implant anchoring to bone and support the head fragment, thereby increasing construct stability.

M1	M2	M3
Initial axial stiffness [N/mm]		
425.25	386.90	517.55
Axial displacement after 5000 cycles [mm] (at 50 N valley load)		
0.70	0.70	0.15
Varus tilting after 5000 cycles [deg] (at 50 N valley load)		
0.58	0.30	0.22
Cycles to failure (criterion 3 mm axial displacement)		
13,150	15,900	22,500

**Table 1**  
**Median values of the parameters of interest in the three study groups with standard multiloc PHN configuration (M1), two additional screw-in-screw (M2) and two screw-in-screw plus one additional calcar screw (M3) locking options.**

The aim of this biomechanical study was to investigate three different locking options using multiloc PHN (short) for intramedullary nailing of proximal humeral fractures, and answer the question whether its design adaptations with two additional screw-in-screw and a calcar screw provide a better interfragmentary stability compared to the standard version with three proximal screws in an established anatomical specimen biomechanical three-part proximal humeral fracture model.

### Materials/methods

Eighteen fresh frozen anatomical specimen humeri (-20°C, 9 female and 9 male donors, mean age 74.8, range 50–96), dissected from soft tissue, excluding the supra- and infraspinatus tendons, were randomly assigned to three study groups and instrumented with either standard, two additional screw-in-screw, or two screw-in-screw plus one additional calcar screw option according to predefined steps.

A recently introduced biomechanical in vitro testing model for three-part proximal humeral fractures simulated with a transversal wedge and a sagittal cut, including cyclic axial loading with increasing peak load (0.05N/cycle, 2Hz) and simultaneous pulling forces at the rotator cuff was used (Fig 1) [1]. Interfragmentary motions were analyzed using motion tracking. Statistical differences between the study groups were detected by ANOVA and Bonferroni PostHoc tests. Significance level was set to  $P > .05$ .

### Results

The multiloc PHN with a calcar screw and two screw-in-screw showed a superior initial axial construct stiffness, minimal axial displacement, reflecting highest head stability against migration along the nail, and highest number of cycles to failure during the cyclic test (Table 1). In addition, both options with two screw-in-screw aiming volumes in the posteromedial humeral part with better bone quality were superior with regard to varus tilting of the humeral head, compared to the standard configuration.

### Conclusion

All three multiloc PHN locking options performed very well biomechanically compared to other existing implants for the same indications and would be a good choice for treatment of proximal humeral fractures. The configuration with a calcar screw and two screw-in-screw was superior in most aspects (compared to the other two configurations) while both options with two screw-in-screw showed better behavior with regard to varus collapse, confirming that the screw-in-screw concept can be used to increase osteosynthesis stability in poor bone quality.

### References

1 Brianza S, Plecko M, Gueorguiev B, et al (2010) Biomechanical evaluation of a new fixation technique for internal fixation of three-part proximal humerus fractures in a novel cadaveric model. *Clin Biomech*; 25:886–892.

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## TRAUMA, LOWER EXTREMITY

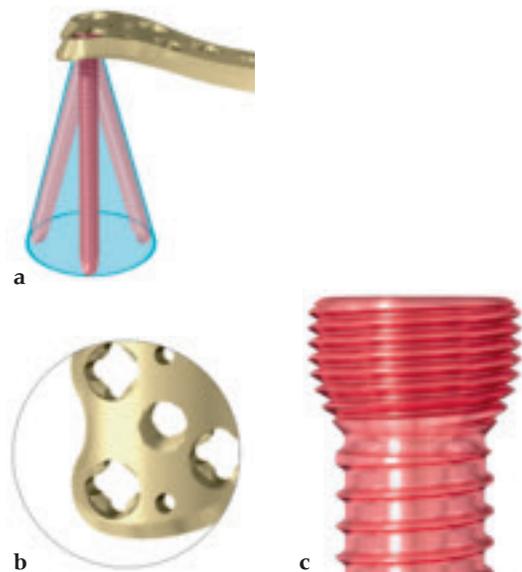


**Fig 1a–b**  
4.5 mm VA-LCP curved condylar plate.

### 4.5 mm VA-LCP Curved Condylar Plate

The 4.5 mm VA-LCP curved condylar plate (Fig 1) is part of the variable angle (VA) periarticular plating system that merges variable angle locking screw technology with conventional plating techniques. It was designed with a focus on creating a simpler implant that could be used for virtually all fracture, nonunion, and malunion indications in the distal femur, regardless of the complexity of the fracture pattern, the quality of the bone, or the presence of adjacent prostheses. A detailed design comparison of this implant with the currently available distal femoral implants is noted in Table 1. Specific advantages include:

1. Variable angle technology. Five VA screw holes surround the central fixed-angle screw hole in the plate head (Fig 2). These allow the surgeon to place screws around stems and adjacent to distal femoral prostheses, achieving stability in worst-case scenarios. Screw holes in the shaft component of the implant are VA combination holes, allowing screw placement around proximal femoral stems or through endosteal implant holes. If a different screw trajectory is desired than can be obtained via the 30° cone of locked angulation (Fig 2a) or with a conventional 4.5 mm cortex screw, the locking periprosthetic attachment plate can be attached to the VA combination hole.
2. Smaller distal footprint with contoured edges to limit irritation of the iliotibial band. This smaller footprint was allowed by using all 5.0 mm screws in the head of the plate. The central 95° fixed-angle screw hole is still present to allow the surgeon to use the plate as a reduction tool.
3. Sagittal plane anterior bowing begins at the first combination hole rather than more proximally. The radius of curvature is R1100 mm, which is consistent with current literature describing the average femur.



**Fig 2a–c**

- a Screws can be angled within a 30° cone around the central axis of the plate hole.
- b–c Four columns of threads in the VA locking hole provide four points of threaded locking between the VA-LCP plate (b) and the variable angle locking screw (c), forming a fixed-angle construct at the desired screw angle.

4. Intuitive and simpler aiming arm design. The insertion handle attaches at the first combination hole. The advantage is a clear radiographic visualization of the joint and the plate position on the lateral view. The disadvantage compared to the LISS is the required incision length for plate insertion via the aiming arm which is a few centimeters more (approximately 7 cm total length). The aiming arm also has slots between the holes, allowing for slightly larger stab incisions through the skin and iliotibial band, thereby easing cannula insertion.
5. Simplified screw options. The plate can be inserted using locking and nonlocking options with just two screw types: 5.0 mm VA locking screws and 4.5 mm nonlocking screws. This simplifies the scrub technician's role in surgical assistance with drill bits and screws. If desired, there are nine different screw options to choose from and to place in the modular screw racks. All 5.0 mm VA locking screws have to be tightened with 6Nm with a T-handle with torque-limiting function.

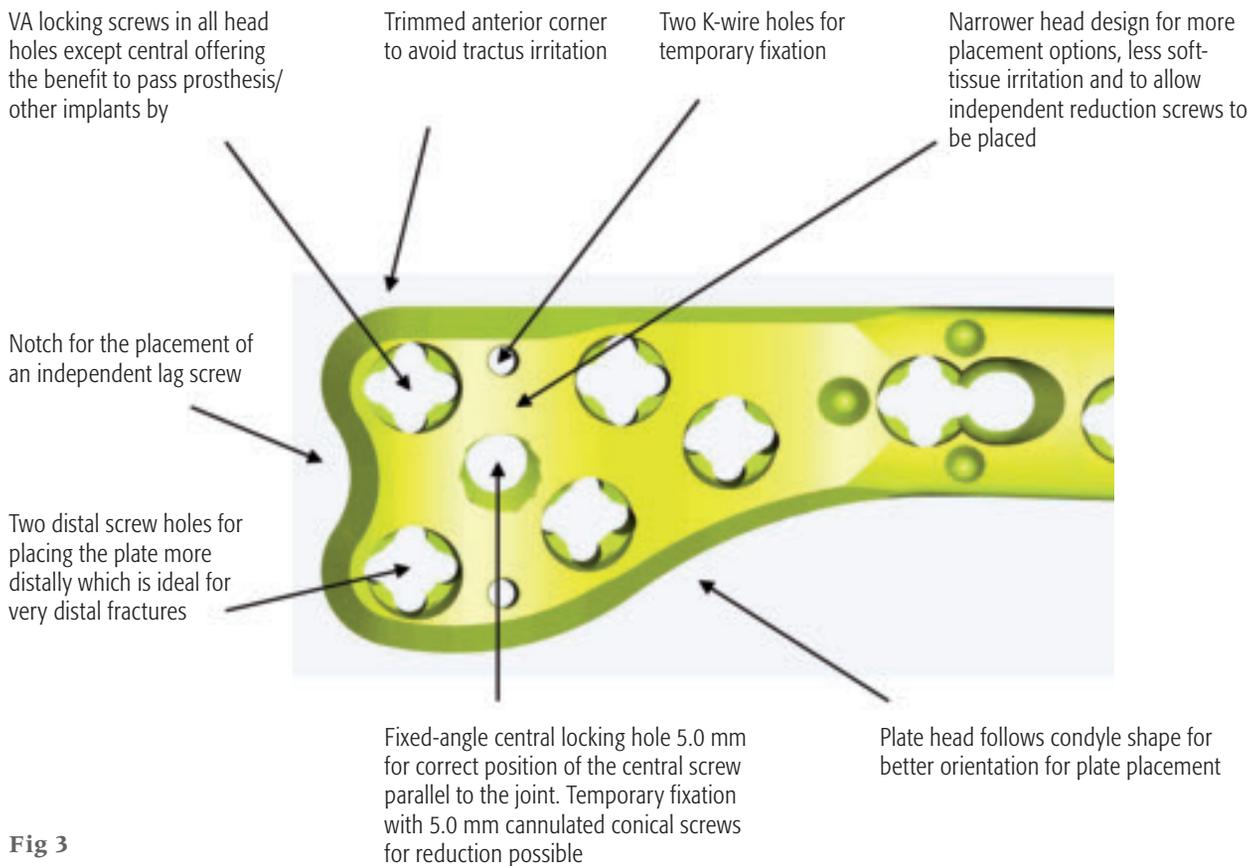
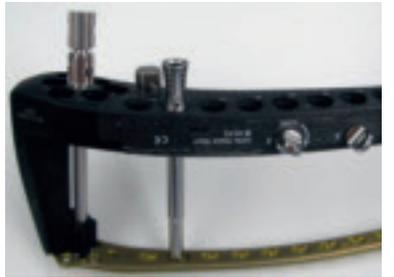


Fig 3

	4.5 mm VA-LCP curved condylar plate	4.5 mm LCP condylar plate	LISS/LCP distal femur plate
<b>Head design</b>	<ul style="list-style-type: none"> <li>• Plate head to shaft offset on coronal plane: 8.45 mm</li> <li>• Fixed-angle central screw hole is 5.0 mm</li> <li>• Five 5.0 mm VA locking holes surrounding the central screw hole</li> <li>• Plate thickness: 4.1 mm</li> <li>• Plate width: 32 mm</li> <li>• Two K-wire holes</li> <li>• Footprint matches 4.5 mm LCP condylar plate</li> <li>• Tips of plate head hug bone (tighter radius than predecessors) to minimize soft-tissue irritation</li> </ul>	<ul style="list-style-type: none"> <li>• Plate head to shaft offset on coronal plane: 9.85 mm</li> <li>• Fixed-angle central screw hole is 7.3 mm</li> <li>• Five 5.0 mm locking holes surrounding the central screw hole</li> <li>• Plate thickness: 3.0 mm</li> <li>• Plate width: 38.1 mm</li> </ul>	<ul style="list-style-type: none"> <li>• Plate head to shaft offset on coronal plane: 8.45 mm</li> <li>• Fixed-angle central screw hole is 5.0 mm</li> <li>• Six 5.0 mm locking holes surrounding the central screw hole</li> <li>• Plate thickness: 2.8 mm</li> <li>• Plate width: 33 mm</li> <li>• Two K-wire holes</li> </ul>
<b>Shaft design</b>	<ul style="list-style-type: none"> <li>• Anterior bow starts at first combination hole</li> <li>• Anterior bow radius: R1100 mm</li> <li>• Plate is straight on coronal plane</li> <li>• 4.5 mm VA-LCP consists of 5.0 mm VA locking and 4.5 mm compression hole</li> <li>• Limited contact cut</li> <li>• Available in 6–22 holes, 158.8–438.8 mm (linear length)</li> <li>• Plate thickness: 5.4 mm</li> <li>• Plate width: 17.5 mm</li> </ul>	<ul style="list-style-type: none"> <li>• Anterior bow starts at eighth combination hole</li> <li>• Anterior bow radius: R1100 mm</li> <li>• Plate is straight on coronal plane</li> <li>• 4.5 mm LCP consists of 5.0 mm locking and 4.5 mm compression hole</li> <li>• Limited contact cut</li> <li>• Available in 6–22 holes, 170–457.8 mm (linear length)</li> <li>• Plate thickness: 5.2 mm</li> <li>• Plate width: 17.5 mm</li> </ul>	<ul style="list-style-type: none"> <li>• Anterior bow starts at fifth hole</li> <li>• Anterior bow radius: R835 mm</li> <li>• Plate flares outward 5° on coronal plane after fifth hole</li> <li>• 4.5 mm LCP consists of 5.0 mm locking and 4.5 mm compression hole</li> <li>• No limited contact cut</li> <li>• Available in 5–19 holes, 156–436 mm (linear length)</li> <li>• Plate thickness: 5.6 mm</li> <li>• Plate width: 16.15 mm</li> </ul>
<b>Aiming arm design</b>	<ul style="list-style-type: none"> <li>• Insertion handle attaches at first combination hole</li> <li>• Insertion handle is secured onto plate by a single point of fixation, VA locking portion of combination hole</li> <li>• Insertion handle and plate interface uses 3 spherical pins and dimples design (similar to LISS / LCP DF)</li> <li>• Target 3–18 holes, both VA locking and compression hole</li> </ul> 	<ul style="list-style-type: none"> <li>• Insertion handle attaches from the head of the plate to first combination hole</li> <li>• Insertion handle is secured onto plate by two points of fixation, first combination hole and any screw hole on the head</li> <li>• Insertion handle and plate interface uses two points of fixation and friction design</li> <li>• Target 2–18 holes, both LCP locking and compression holes</li> </ul> 	<ul style="list-style-type: none"> <li>• Insertion handle attaches at head of plate</li> <li>• Insertion handle is secured onto plate by one point of fixation, central screw hole</li> <li>• Insertion handle and plate interface uses 3 spherical pins and dimples design</li> <li>• Target 1–13 holes, only locking hole</li> </ul> 
<b>Material</b>	<ul style="list-style-type: none"> <li>• 316L SS</li> <li>• TAN</li> </ul>	<ul style="list-style-type: none"> <li>• 316L SS</li> </ul>	<ul style="list-style-type: none"> <li>• 316L SS</li> <li>• TAN</li> </ul>
	<ul style="list-style-type: none"> <li>• System includes dedicated handles for installing protection sleeve and threaded guides</li> <li>• Scalper handle instrument can complete stab incision through the aiming arm hole, it is larger than LCP condylar aiming arm hole</li> <li>• Easier insertion of protection sleeve with completed stab incision</li> <li>• Slotted aiming arm allows long incision to be made through the aiming arm using standard long scalper</li> </ul> 	<ul style="list-style-type: none"> <li>• System includes dedicated handles for installing protection sleeve and threaded guides</li> <li>• Scalper handle instrument can make stab incision through the aiming arm hole</li> </ul>	<ul style="list-style-type: none"> <li>• Better visualization of plate fit on the bone because insertion handle does not cover plate head</li> </ul>

**Table 1**  
**Design differences between 4.5 mm VA-LCP curved condylar plate and 4.5 mm LCP condylar and LISS/LCP distal femur.**

The following cases demonstrate the use of the 4.5 mm VA-LCP curved condylar plate in simple and more complex situations.

**Case 1: A 30-year-old man was involved in a motor vehicle collision and sustained an isolated extraarticular multifragmentary supracondylar femoral fracture (33-A3).**

Case provided by Matt Graves,  
Jackson, USA



Fig 1a-b  
Preoperative AP (a) and lateral (b) x-rays.

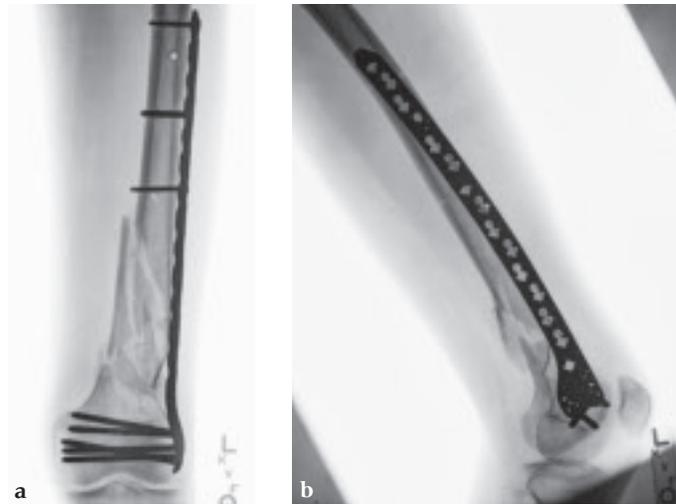


Fig 2a-b  
Six-week follow-up: AP (a) and lateral (b) x-rays.

**Case 2: A 69-year-old man following revision total knee arthroplasty with a megaprosthesis, requiring an osteotomy of his femoral shaft for realignment of his femoral component. The patient developed a nonunion of his osteotomy and subsequently fractured the stem of his megaprosthesis.**

Case provided by Matt Graves,  
Jackson, USA



Fig 1a-b  
Preoperative AP (a) and lateral (b) x-rays.

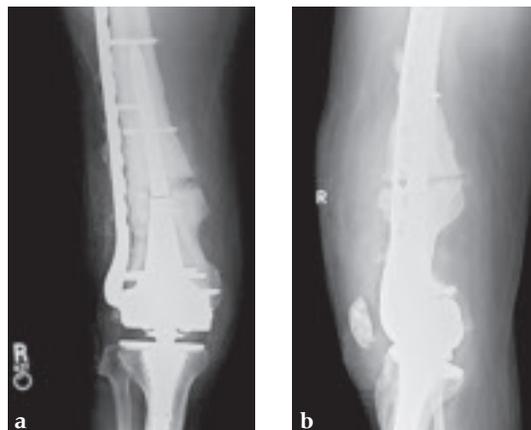


Fig 2a-b  
Postoperative AP (a) and lateral (b) x-rays.

Surgical treatment of this nonunion consisted of compression plating using the VA-LCP curved condylar plate. The arthroplasty components were stable. The proximal piece of the stem was extremely well fixed. Variable-angle locked screws were targeted between his femoral shell and stem in the distal segment allowing excellent distal fixation such that an articulated tensioning device could be attached proximally and the nonunion could be compressed and the alignment improved.

**Case 3: A 53-year-old man with hypotestosteronism, low vitamin D levels, and calcium metabolism problems. Recalcitrant atrophic nonunion of his distal femur after three surgical attempts with an extension and flexion contracture of his knee.**

Case provided by Matt Graves, Jackson, USA

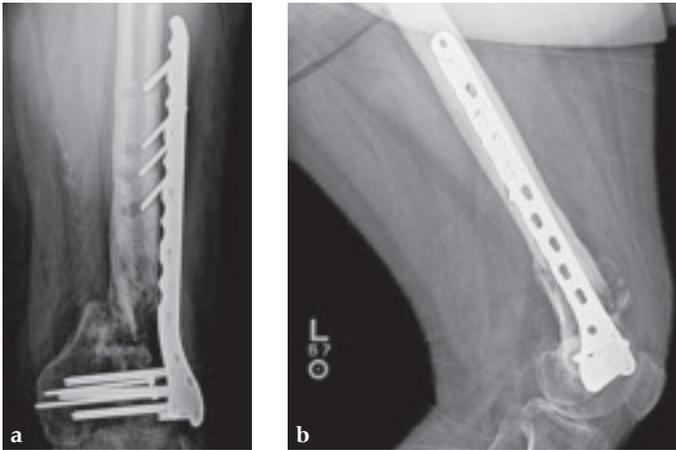


Fig 1a–b

Preoperative AP (a) and lateral (b) x-rays.

The VA-LCP curved condylar plate was used to avoid previous enlarged screw holes and allow for stable fixation in the patient's osteoporotic distal segment. Secondary to his metabolic and mechanical problems, the decision was made to proceed with an endosteal implant and place interlocking screws through that implant from the VA-LCP curved condylar plate. The combination of the retrograde/antegrade femoral nail and VA-LCP provides a very stable mechanical environment for the expected prolonged healing response.

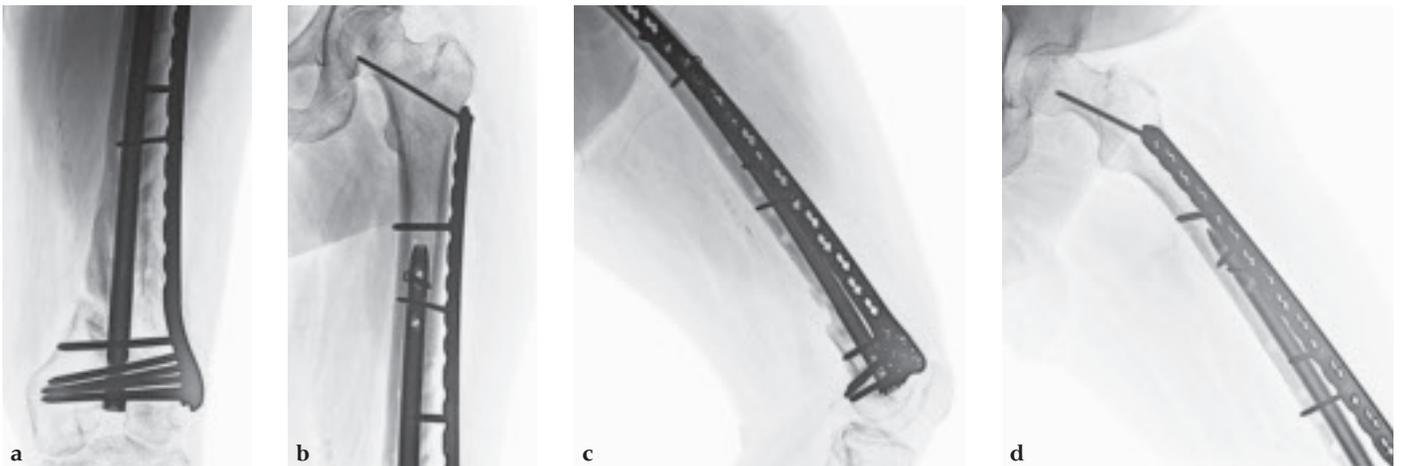


Fig 2a–d

Two-month follow-up: AP (a, b) and lateral (c, d) x-rays.

Florian Gebhard

## TRAUMA, COMPUTER-ASSISTED SURGERY



**Fig 1**  
Navigation used in an operating room setting.

### Trauma Navigation Module 3.0

The new trauma two-dimensional (2-D) navigation module was developed together with Brainlab to support the broad range of indications and to improve speed, first-pass accuracy, and radiation efficiency in trauma procedures. Trauma 3.0 offers dedicated workflows for navigated treatments in most regions of the body including inferior and superior extremities, the spine, and the pelvis, complemented by generic navigation workflows without localization presetting for regions. Those allow navigating in C-arm projections without prior region definition, just as specified by the surgeon.

All workflows support targeting of trajectories, eg, for drilling or for the placement of wires or screws. Where appropriate, the software supports specific planning or navigation tools to answer specific questions, eg, fragment alignment in long bone fractures. The software additionally offers for appropriate indications a virtual aiming device, which necessitates neither image intensifier images nor reference fixation to the bone.

Clinical benefits of the use of the trauma module can be summarized:

- First-pass targeting accuracy reduces iatrogenic trauma by trial and error approaches
- Improved fracture alignment and implant positioning reduces fracture malalignment
- Virtual image intensification, planning, and navigation reduces invasiveness of implant placement
- Virtual image intensification reduces radiation exposure

### Fast C-arm image registration

Registration of C-arm images is a crucial step in the trauma navigation workflow. To face this, the new xSpot registers even tricky projections in specific indications easily and within seconds for reliable and accurate navigation image data. The system offers:

- Wireless carbon registration device
- Autoclavable—no draping
- Works with almost all C-arms
- Fast, reliable, and reproducible result



**Fig 2**  
xSpot C-arm registration.



Fig 3  
Access through bone man.

### One program for many different indications

Because there are as many different indications as injuries, the scope of trauma 3.0 navigation meets the challenges facing trauma surgeons in their daily practice. The optimized user interface gives intuitive access to most of the anatomy via the “bone man” surgical reference guide. This allows for:

- Accurate, quick, and easy guidance in most regions of the body for many different tasks
- Specific workflows for specific tasks
- Generic approaches for universal tasks
- Based on AO techniques and workflows

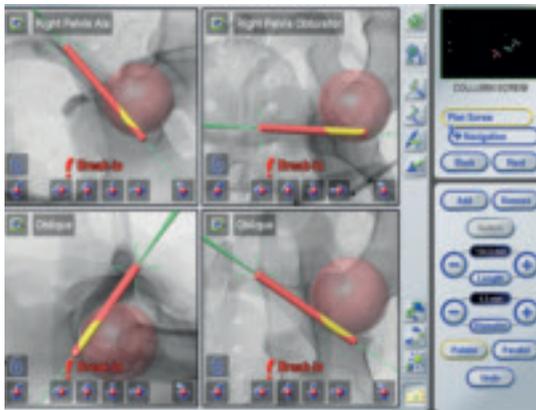


Fig 4  
Break-in/break-out warning for spherical targets, collision check.

### Time-saving and innovative trauma navigation tools

Virtual tools on the screen add vital information during procedures and smart planning tools speed up intraoperative planning, such as

- Angulation template
- Automatic axis detection in long bones
- Cutout warning for femoral and humeral head
- Collision check for acetabular screws

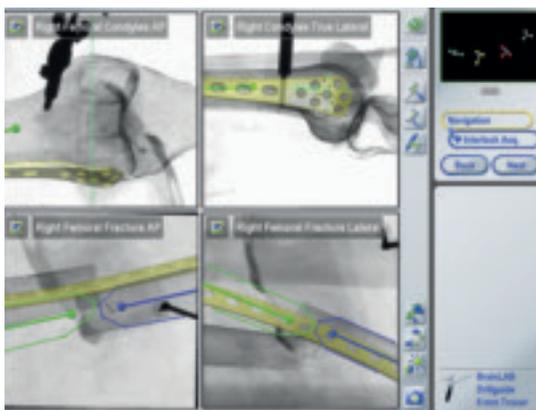
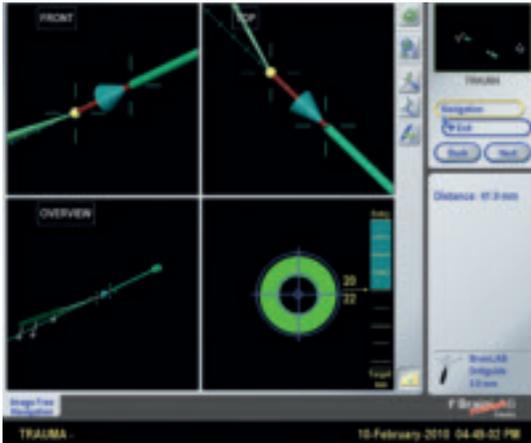


Fig 5  
Navigated positioning of LCP-DF with simultaneous fracture reduction control.

### Reduces invasiveness through new implant handling

The integration of dedicated implants into trauma navigation helps to extend the potential of many less-invasive implant lines by targeting entry points on the smallest access paths or placing interlocked plates while virtually checking implant and fragment positions. Among the integrated implants are Synthes locking compression and dynamic locking compression plates, as well as the LFN. (Regulatory approval for the respective handles pending at the time of print.)



**Fig 6**  
Image-free navigation: the pointer determines the target. A drill guide aims towards the target. A cone indicates both entry depth and remaining distance to target for a drill.



**Fig 7**  
Navigation platform “Kolibri” for navigation with trauma 3.0.

### Introduce trauma navigation to arthroscopic procedures

The new pinless and x-ray-free trauma navigation concept “image-free navigation” works without bone references and without x-ray imaging. This opens up arthroscopic procedures and articular lesions to treatment, even when accessibility is reduced. Pin placement or retrograde access to lesions can be fully supported by trauma navigation.

### Navigation systems bring trauma navigation to the surgeon’s hands

The trauma 3.0 software runs on a Brainlab navigation system. This consists of a computer and monitor suitable for intraoperative use, a stereoscopic camera and navigated instruments for referencing and targeting.

System configurations range from small mobile trolleys, as shown in Fig 7, to fully integrated ceiling-mounted systems, adapted to specific needs of the surgeon. Different software applications (like the described trauma 3.0 software) may run on the system and cover—beneath trauma—eg, arthroplasty, spine, CMF, or neurosurgical navigation, depending on the individual system configuration.

Trauma-relevant applications enable the use of intraoperative imaging, eg, different C-arm types for 2-D navigation, and 3-D image intensification, or intraoperative CT for 3-D navigation, depending on configurations.

Keith Mayo, Robin Peter

## TRAUMA, PELVIS



Fig 1  
Short, standard, and long versions of the 3.5 mm quadrilateral surface plates.

### 3.5 mm Quadrilateral Surface Plate

The increasing number of acetabular fractures in elderly, osteoporotic individuals has added new technical challenges to surgical management. A common group of fracture patterns in this population is the anterior wall or column often with an associated posterior hemitransverse. These injuries frequently also include quadrilateral surface comminution which can make both reduction and stabilization more difficult. The 3.5 mm quadrilateral surface plate was developed to provide a more effective way to deal with these issues, for example, a way to deal with the quadrilateral surface enbloc for reduction, allowing buttress stabilization, which is independent of bone density.

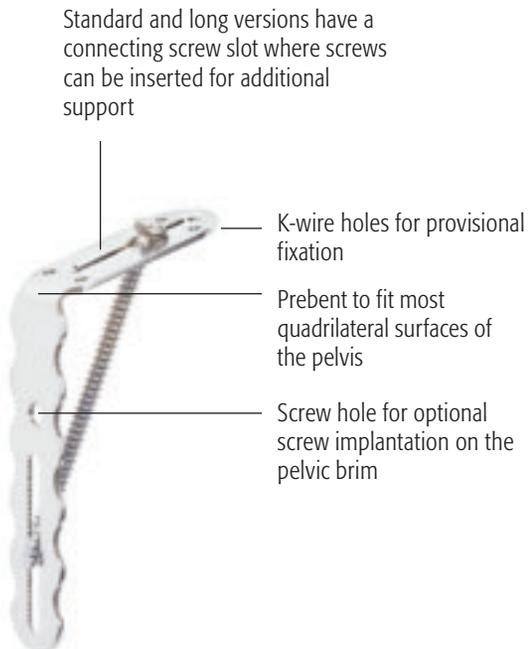


Fig 2  
Design features of the 3.5 mm quadrilateral surface plates.



**Fig 3**  
Provisional fixation of the 3.5 mm quadrilateral surface plate with two parallel K-wires, an asymmetrical reduction forceps, a straight ball spike and an overlying low-profile pelvic reconstruction plate.

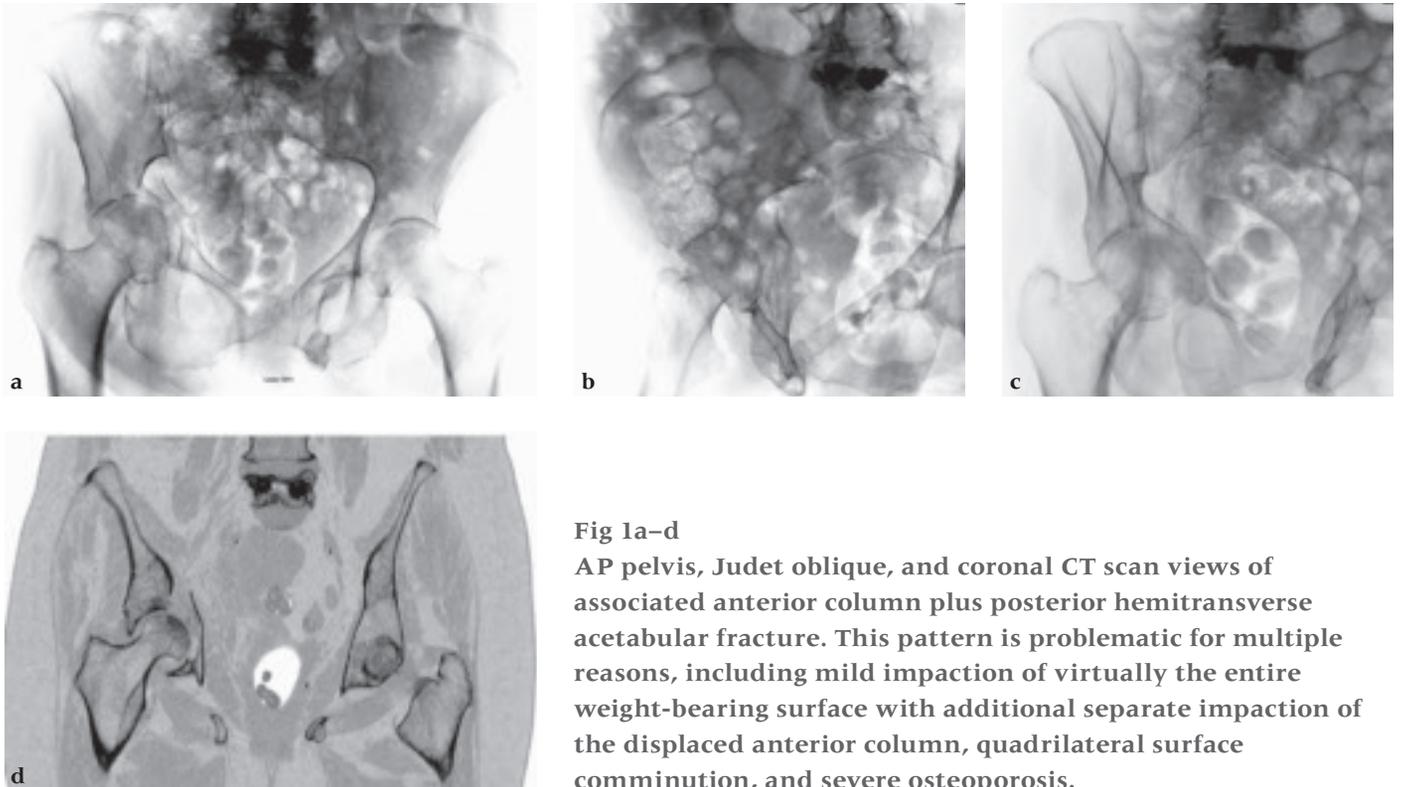
The new 3.5 mm quadrilateral surface plates are intended for use in acetabular fracture patterns amenable to an anterior surgical approach, which have an important component of quadrilateral surface comminution. They are typically used in conjunction with pelvic reconstruction plates. There are three plate sizes (short, standard, and long) available (Fig 1) which are made of 316L stainless steel and are part of the 3.5 mm low-profile pelvic system. The standard and long plate versions have a connecting screw slot where triangulated buttress screws can be inserted for additional support (Fig 2). These interconnecting screws should be 2 mm longer than the actual length measured to ensure that the screw engages the serrated teeth of the plate at the quadrilateral surface. All plates are prebent to fit most quadrilateral surface anatomy, but minor contouring may still be necessary. Reconstruction plates are often placed on the pelvic brim or the endopelvic surface over the 3.5 mm quadrilateral surface plates to aid final plate fit and provide additional buttress function (Fig 3, Fig 4).



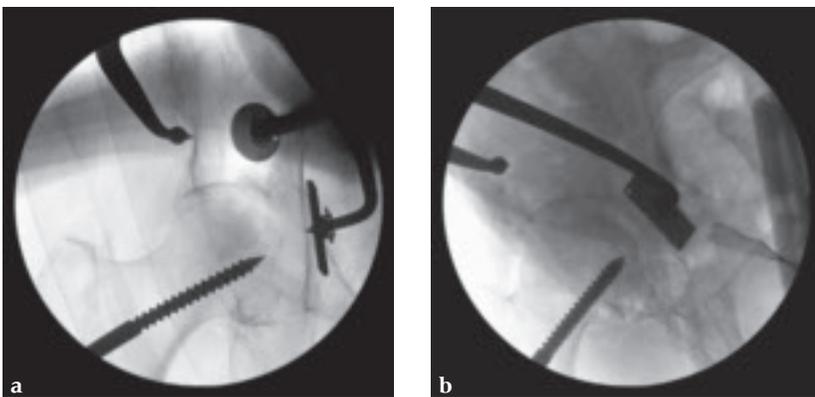
**Fig 4a–b**  
Applied 3.5 mm quadrilateral surface plate with reconstruction plate on the pelvic brim (a) or endopelvic surface (b).

**An elderly woman with steroid-dependent chronic obstructive pulmonary disease on home oxygen sustained an anterior column plus posterior hemitransverse acetabular fracture in a ground-level fall from her electric scooter.**

Case provided by Keith Mayo, Tacoma, USA

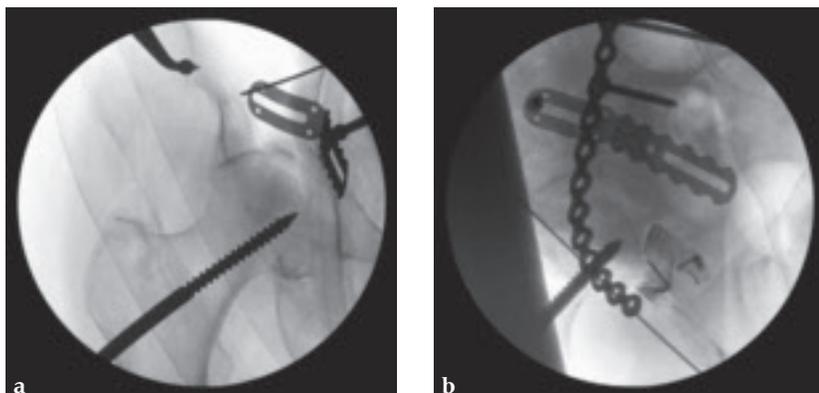


**Fig 1a–d**  
AP pelvis, Judet oblique, and coronal CT scan views of associated anterior column plus posterior hemitransverse acetabular fracture. This pattern is problematic for multiple reasons, including mild impaction of virtually the entire weight-bearing surface with additional separate impaction of the displaced anterior column, quadrilateral surface comminution, and severe osteoporosis.



**Fig 2a–b**

Intraoperative AP hip and iliac oblique image intensifier images of a portion of the reduction sequence utilizing distal/lateral traction through a Schanz screw, ball spike (picador) with disc and asymmetrical reduction clamp with disc. The remaining area of incompletely reduced articular surface was a free, thin osteochondral fragment retrieved through the anterior column fracture. It was reoriented and trapped between the lateral articular surface, displaced anterior column, and femoral head. Despite multiple attempts this position could not be further improved. Cancellous autologous bone graft was used to buttress this area through a small internal iliac fossa cortical window.



**Fig 3a–b**  
 AP hip and iliac oblique image intensifier views show initial quadrilateral surface plate placement with the aid of an asymmetrical clamp and subsequent introduction of overlying pelvic brim reconstruction plate. In this case a locking pelvic brim plate was chosen because of the severe osteoporosis.



**Fig 4a–c**  
 AP pelvis and Judet oblique x-rays 9 months postoperatively. The patient started full weight bearing at approximately 10 weeks postoperatively. The fractures healed without secondary displacement. The patient returned to preinjury (relatively limited) activity level with no significant residual pain complaints.

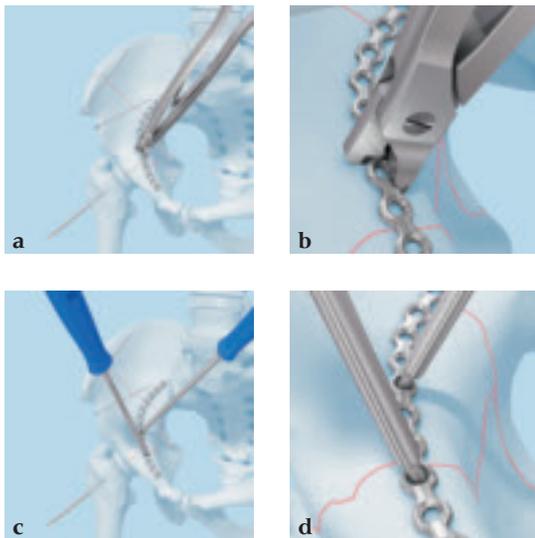
Note: In this case the quadrilateral surface plate has been useful both as an interim reduction aid and to augment prior stabilization constructs. In effect, it provides a "prosthetic" cortex for the quadrilateral surface as well as enhancing posterior column stability in a way not possible with typical anterior to posterior column lag or position screws alone.



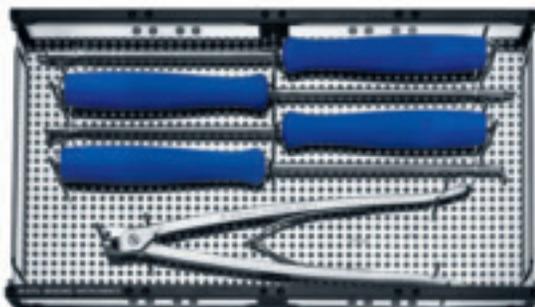
**Fig 1**  
In situ bending pliers for in-plane plate bending.



**Fig 2a-c**  
In situ bending and twisting handles with straight, 120°, and 90° pins.



**Fig 3a-d**  
In situ bending instruments used for plate contouring.



**Fig 4**  
Modular tray for in situ bending instruments.

### In Situ Bending Instruments for Pelvic Plates

The contouring or prebending of plates used for open reduction and internal fixation of pelvic and acetabular fractures can be a difficult and time-consuming task due to the complex three-dimensional anatomy of the pelvic skeleton. Once these plates are positioned on the bone, a final in situ adaptation of their contour is frequently required, especially when using longer plates. This is particularly true for ilioinguinal or other extended approaches. The current state-of-the-art procedure of plate contouring to match the pelvic anatomy includes the use of bending presses and pliers which may only be used outside the body. The precise contouring of plates may therefore require repeated cycles: removing the plate from the bone, bending, reinsertion, and so on. To date, no specific instruments were available for intraoperative, in situ bending of plates. Some surgeons use a pair of large screwdrivers inserted into two of the plate's holes to achieve flexion-extension bending and twisting, although the screwdrivers are not designed or intended for this usage. Furthermore, no dedicated tools are available to increase or decrease the plate curvature (in-plane bending) in situ.

A specific instrument set has therefore been developed to allow for in situ plate contouring of 3.5 mm reconstruction plates in their older and newer designs:

- 3.5 mm low-profile reconstruction plates (straight, curved, and J-shaped)
- 3.5 mm wide-angle reconstruction plates
- 3.5 mm DCP reconstruction plates, straight and curved

These newly designed in situ bending tools are specifically intended for use only with 3.5 mm reconstruction plates. They are not suitable for bending or twisting of 3.5 mm reconstruction plates with locking or coaxial screw holes, regular plates (nonreconstruction plates), nor are they suitable for larger (4.5 mm) reconstruction plates.

The instrument set consists of one special in situ bending plier, which provides in-plane bending through a powerful three-point grip (Fig 1). This plier will prove particularly helpful when a reconstruction plate is already partially fixed to the bone and requires additional bending. Several special in situ bending and twisting handles, designed to be inserted into the plate's holes, are also provided. These levers are designed for plate twisting and flexion-extension bending. They are fitted with silicone handles, and come with three different tip designs (straight, 90°, 120°) (Fig 2) to allow for their use in various anatomical locations (Fig 3). The instruments are provided in a modular tray (Fig 4) which can be customized for different instrument combinations.

The challenge of in situ pelvic plate contouring is well known to surgeons performing pelvic or acetabular open reduction and internal fixation procedures. This new instrument set should prove helpful in this respect, while also improving the quality of reduction. The tools provided in this new set are easy to use and should save time, while avoiding the need for repeated, and sometimes frustrating, plate contouring outside the surgical wound.

James B Hunter

## TRAUMA, PEDIATRICS



**Fig 1**  
Varization osteotomy with the LCP pediatric hip plate.



**Fig 2a–b**  
The etching determines the angle of the femoral neck screw (100°, 110°, 130° available).



**Fig 3**  
Aiming block for screws.

### 2.7 mm LCP Pediatric Hip Plate

The 2.7 mm LCP pediatric hip plate is intended for use in infants up to 3 years, depending on weight, size, and bone quality. It is part of the LCP pediatric hip plate system for stable fixation of varus, valgus, and derotation osteotomies and fractures in pediatric orthopaedics. It incorporates the technique of the locking compression plate into a system dedicated to pediatrics.

This plate addresses the clinical problem of hip displacement in young patients as a result of late presentation or failed conservative management of developmental dysplasia of the hip (DDH).

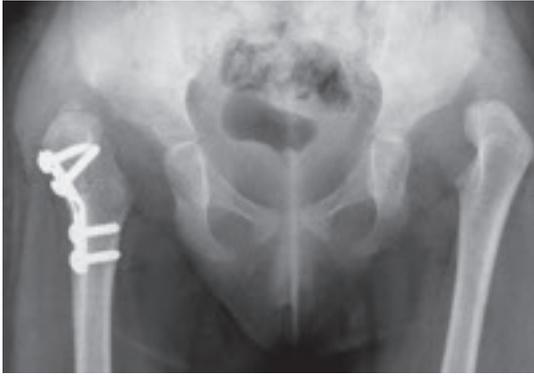
Prior to the development of this plate the only solution for proximal femoral osteotomy in this group of patients was the infant angled blade plate based on a one-third tubular plate. The issues with this were weakness, poor rotational control, and the lack of guided insertion. The 3.5 mm LCP pediatric hip plates are too bulky for infants at the age required, which is generally around 18 months.

The 2.7 mm LCP pediatric hip plate was developed to close the gap for treatments of infants up to 3 years, depending on weight, size, and bone quality. The specific indications include:

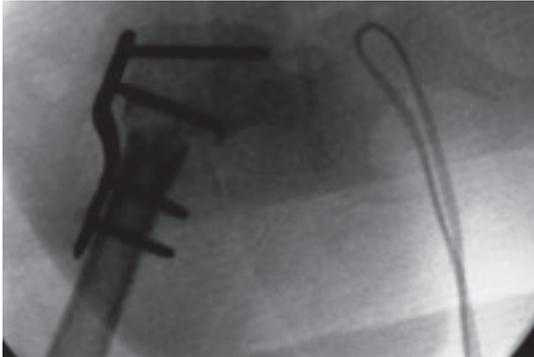
- Neglected dislocation of the hip in combination with open reduction
- Idiopathic coxa valga
- Severe hip dysplasia

The implant completes the LCP pediatric plate portfolio with a full range of plates with a choice of angles. The locking compression functionality reduces the risk of a primary and secondary loss of correction. The plate can be used in locked internal fixator mode or as a compression plate as required. Although in the 3.5 and 5.0 mm LCP hip plates stability negates the need for external support, with the 2.7 mm plate a hip spica is recommended in all cases; the cast is frequently required for other elements of the surgery, such as open reduction of the hip.

The 2.7 mm LCP pediatric hip plate is available with neck shaft angles of 100°, 110° for varus osteotomies, and 130° for pure derotation osteotomies.



**Fig 1**  
X-ray shows the situation at presentation.



**Fig 2**  
Right hip postoperatively.



**Fig 3**  
Left hip postoperatively.

**An 18-month old girl presented with developmental dysplasia of the hip. She had failed conservative management with a Pavlik harness, and redislocated following open reduction and femoral osteotomy of the right hip. She underwent revision open reduction and femoral osteotomy of the right hip, followed by the same procedure on the left hip 6 weeks later.**

Case provided by James B Hunter, Nottingham, UK

Stefan Rammelt, Andrew K Sands, Jan Ljungqvist, Diarmuid De Faoite

## TRAUMA, FOOT



**Fig 1**  
Hindfoot arthrodesis nail.



**Fig 2a–d**  
Nail views.

### Hindfoot Arthrodesis Nail (HAN)—A Study Designed to Answer Severe Clinical Problems

#### Background information

Treatment of patients using tibiotalar calcaneal arthrodesis aims to eliminate deformity, pain, and instability with the creation of a stable, plantigrade foot for ambulation. However, it results in a completely stiff ankle and subtalar joint, considerably limiting global foot function. It is therefore reserved as a salvage option in cases of severe malfunction and arthritis at both the ankle and subtalar joints, and otherwise intractable deformities in rheumatoid arthritis, Charcot arthropathy, or paresis. In severe cases amputation may be the only viable option available.

#### Nail

The hindfoot arthrodesis nail enables an intramedullary approach for the fixation and the fusion of the ankle and of the subtalar joints. The HAN is indicated to facilitate tibiotalar calcaneal arthrodesis to treat severe foot and ankle deformity, arthritis, instability, and skeletal defects. These include, but are not limited to, neuroosteoarthropathy (Charcot foot), complete avascular necrosis of the talar body, failed joint replacement or failed ankle fusion, distal tibial fracture nonunions, severe osteoarthritis, rheumatoid arthritis and pseudoarthrosis, and reconstruction after tumor resection.

Special features of the HAN are a 12° angulation that corresponds with the physiological hindfoot valgus in the frontal plane and the different locking options in the tibia, talus, and calcaneus. The latter include locking screws, a spiral blade, and a combination of both that offers the highest biomechanical stability. All the implants are made of titanium alloy.

#### Study

The objectives of this retrospective study were to document the current clinical experience gained from the use of the HAN in the treatment of patients with various ankle and foot pathologies.

In addition, information was collected relating to surgical details, functional and quality of life outcomes after HAN procedures (SF-36, AAOS-FAOQ and numeric rating scale of pain). Seven participating clinics (four from Europe and three from the USA) recruited 38 patients who underwent ankle arthrodesis using the HAN. A large socioeconomic benefit appears to stem from hindfoot fusion with the HAN in properly selected patients because a high proportion of patients who were on sick leave prior to surgery were able to return to work. Early findings appear to indicate that HAN offers a safe and reliable salvage option for patients undergoing tibiotalar calcaneal arthrodesis. More detailed information on the results will be released in a full manuscript to be submitted for peer review in late 2011.

**A 64-year-old man presented with severe ankle and subtalar arthritis accompanied by large cysts in the talus and calcaneus. Eighteen months after hindfoot fusion with the HAN he walked without pain.**

Case provided by Stefan Rammelt, Dresden, Germany



**Fig 1a-f**  
a-c Preoperative x-rays (a-b) and CT scan (c).  
d-f The ankle and subtalar joints are solidly fused in an orthograde position. Note the position of the nail within the calcaneus along its physiological axis.

Mark Lenz, Alberto Fernandez dell'Oca, Stephan M Perren, Dankward Höntzsch, Markus Windolf

## TRAUMA, MIO

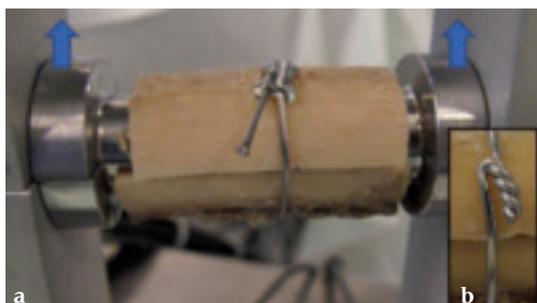


Fig 1 a–b

- a** Test setup. Cortical half-shells mounted on cylindrical metal bars with a cable cerclage closed by a crimp. Cyclic loading (blue arrows) tend to separate the half shells against cerclage tension. In addition to cables, cerclage wires were investigated.
- b** Conventional wire cerclage tightened by a twist.

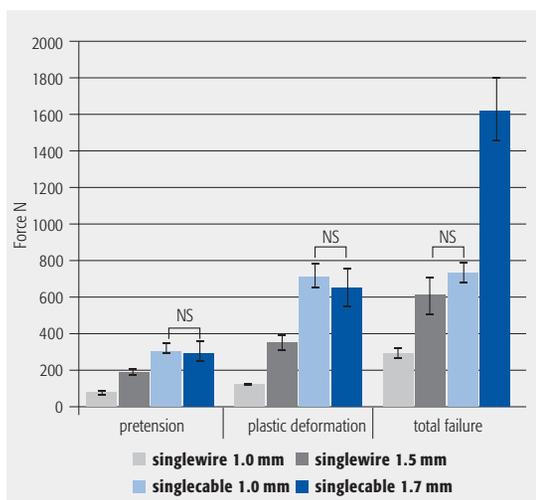


Fig 2 Mean pretension, load at onset of plastic construct deformation, and load at total failure for each cerclage type. Differences between the groups were statistically significant ( $P < .001$ ) except comparisons marked with (NS). Error bars indicate standard deviation.

### AO Research Institute: Cerclage—An Underestimated Technology with Good Potential

#### Objective

Cerclage technology is regaining acceptance among surgeons due to the increasing number and demands of periprosthetic hip fractures. Combined with a splinting plate or shaft of prosthesis, cerclages are less loaded compared to a cerclage-only use [1]. New instruments allow cerclage application through a minimally invasive approach [2]. With the introduction of cables and crimps, cerclage performance, in particular the locking procedure, has been optimized in recent years [3]. Lasting and reliable cerclage tension which is essential to provide stability to the fracture site can now be created. This was not possible with former locking technologies. The authors investigated the mechanical performance of cable cerclages in comparison to conventional wire cerclages under cyclic loading with respect to clinical application.

#### Materials/methods

Two cortical half-shells of fresh frozen human femoral shafts were mounted on a testing jig (Fig 1). Four groups comprising two cerclage cables ( $\text{Ø}1.0 \text{ mm}$ ,  $\text{Ø}1.7 \text{ mm}$ ) and two cerclage wires ( $\text{Ø}1.0 \text{ mm}$ ,  $\text{Ø}1.5 \text{ mm}$ ) were investigated with six specimens per group. Cerclages were wrapped around the cortical shells and were tightened to maximum tension. Cerclage cables were closed by a crimp, cerclage wires were closed by a twisted knot (Fig 1). Specimens were loaded with a sinusoidal cyclic force. Peak load, starting from 100N was monotonically increased at 0.2N/cycle until construct failure occurred. Cerclage pretension, load leading at onset of plastic construct deformation as well as load at total failure were identified. Statistically significant difference between the two groups were analysed by univariate ANOVA ( $P < .05$ ).

#### Results

Cerclage pretension, load at onset of plastic deformation, and load at total failure are shown in Fig 2. Cerclage cables failed solely by rupture of the cable. No crimp loosening was observed. Cerclage wires failed because of unravelling of the twist or wire breakage at the innermost turn of the twist. Differences between the groups were statistically significant ( $P < .001$ ) for pretension, beginning of plastic deformation, and load to total failure with exceptions indicated (Fig 2).

### Conclusion

Compared to wire cerclages, cable cerclages tolerated significantly higher load before plastic-construct deformation and total failure occurred, which seems to partially explain the poor outcome of former cerclage wiring. Load to total failure could be increased by choosing cerclages with a larger diameter. Cable cerclages with crimp closure generate a significantly higher pretension compared to wire cerclages. Cable cerclages used with the appropriate diameter could be recommended from a mechanical standpoint, since optimal retention capacity of cerclages is highly dependent on sufficient lasting cerclage tension. New cable cerclage technology is promising, further investigations are ongoing to evaluate the adaptability for specific applications.

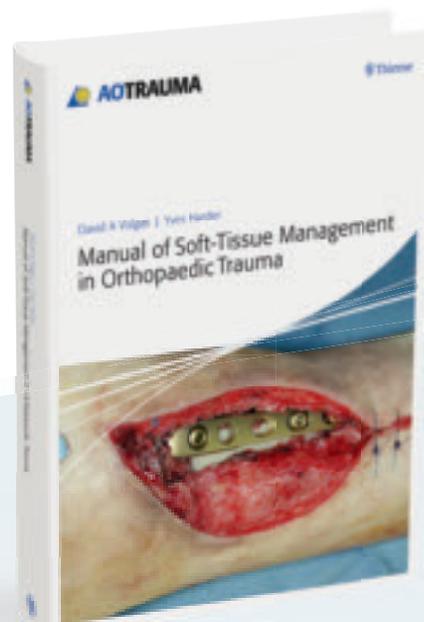
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# New release in December 2011

Editors David A Volgas | Yves Harder

## Manual of Soft-Tissue Management in Orthopaedic Trauma



Number of pages: **336**  
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- 2 Basic anatomical principles and functions of soft tissue and bone
- 3 Mechanisms of soft-tissue injury
- 4 Healing of soft tissues and bone
- 5 Preoperative assessment and classification of soft-tissue injuries
- 6 Treatment strategies
- 7 Stabilization of the wound
- 8 Principles of wound closure and coverage
- 9 Wound conditioning
- 10 Wound closure and coverage techniques
- 11 Complications
- 12 Cases

A fracture first and foremost is a soft-tissue injury, the best possible outcome of which strongly depends on correct decision making at the right time and state-of-the-art soft-tissue handling. In order for orthopaedic and trauma surgeons to address these issues comprehensively without being plastic surgeons themselves, a certain level of interdisciplinary understanding has to be acquired.

This textbook provides that knowledge applicable in every-day clinical situations, focusing on interdisciplinary treatment strategies and basic soft-tissue techniques. High-quality videos and carefully selected case studies further illustrate this comprehensive approach and the complex process of decision making.

Surgeons will, among other things, be able to expand their knowledge regarding:

- Assessment of soft-tissue injuries
- Correct choice and handling of instruments
- Emergency department management
- Adequate debridement and wound conditioning
- Options and choice of wound closure and coverage

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Nils-Claudius Gellrich, Michael Rasse, Lim Cheung, Richard Baillot

## CRANIOMAXILLOFACIAL



**Fig 1**  
Sterile artificial skull model.



**Fig 2**  
Matrix mandible preformed reconstruction plate contoured using the sterile artificial skull.

### **Sterile Artificial Skull**

The new artificial sterilizable skull is the first autoclavable, one-piece human skull model intended for aiding initial plate contouring in the operating room, and for visualizing facial structures.

There is a need for sterile artificial skulls for any craniomaxillofacial (CMF) surgeon who provides CMF reconstructions. The clinical reality is that surgeons worldwide have individual methods to address this need due to the difficulty and lack of anatomical reference points in cases with large bone defects. However, the skull model needs to be mechanically strong for intraoperative contouring of plates, meshes, and biomaterials.

The patient's anatomy is essential for a proper and adequate reconstruction of the defects. Improper contouring of the plates may lead to complications resulting in functional and/or aesthetic problems that require secondary surgery.

This sterile artificial skull model is an approximation of the average craniofacial anatomy, originating from data from up to 2000 analyzed CT scans. These scans were used to develop the matrix midface preformed orbital plates and the matrix mandible preformed reconstruction plates (Fig 2), launched in 2008 and 2009, respectively. The manufacturing material is polyphenylsulphone, which allows the skull to be steam sterilizable, reusable, cleanable, and biocompatible.

This new product—the sterile artificial skull—contributes to a more appropriate hard-tissue reconstruction in the CMF region, especially in cases of trauma, tumor, and craniofacial deformity. It provides a unique aid, always available and ready to use even in emergency cases.

**Case 1: Camouflaging of deficient zygomatic prominences by mesh augmentation.**

A 19-year-old man with a typical-angle Class III appearance is shown preoperatively (Fig 4a) and postoperatively (Fig 4b). After preoperative planning, a bimaxillary osteotomy with advancement of the upper jaw and backwards movement of the lower jaw following bisagittal split osteotomy was performed. Alternative options to augment the malar bone are surgical osteotomy of the malar bone with outwards movement of the zygomatic prominences, high Le Fort I osteotomy with one-piece movement of the maxilla together with the zygomatic prominence, using other biomaterials than meshes to augment these prominences. In this case, the average prominence in an adult Caucasian patient was mimicked by contouring a 0.6 mm thick, 3-D mesh using the artificial skull.

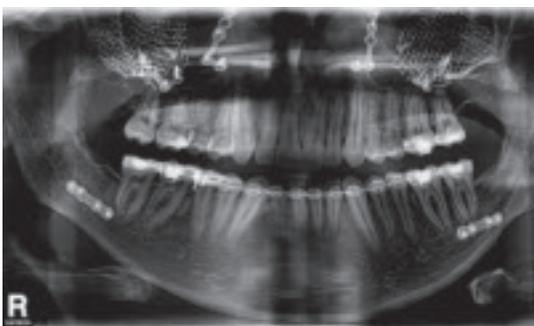
Case provided by Nils-Claudius Gellrich, Hannover, Germany



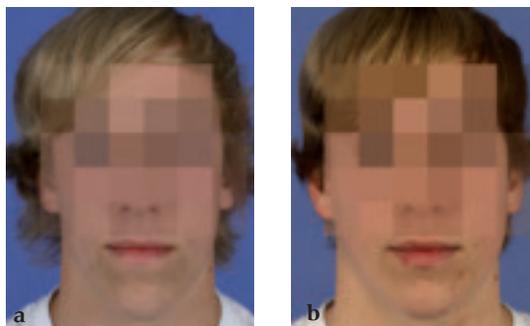
**Fig 1**  
Intraoperative contouring of the 3-D meshes using the sterile artificial skull model.



**Fig 2**  
Two 3-D meshes to the malar prominences, ready to be inserted into the patient and finally individualized in situ before fixation.



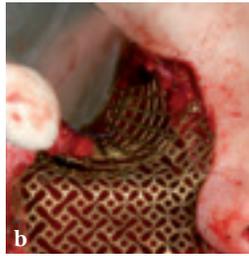
**Fig 3**  
Postoperative orthopantomogram showing the four-plate fixation of the advanced maxilla and the two-plate fixation after bisagittal split osteotomy in the mandible. Additionally, two meshes are shown in the projection of the malar prominences.



**Fig 4a–b**  
The patient before (a) and 6 months after (b) bimaxillary surgery, including augmentation of the bilateral malar prominence.

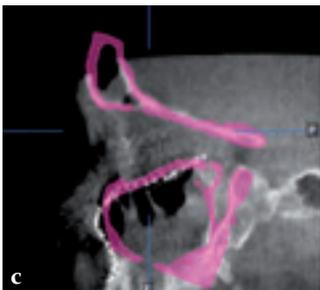
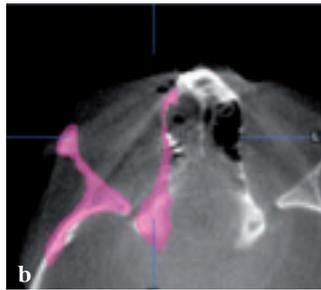
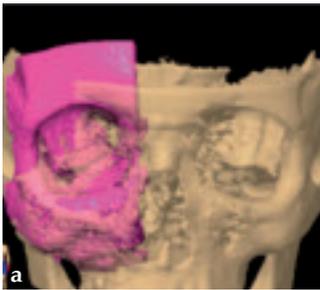
**Case 2: A 19-year-old woman had an extended sinonasal carcinoma in the right maxillary sinus area. Fig 2 shows four views of the virtual preplanned computer-aided design; the reconstruction is represented in pink (Fig 2a). The three remaining multiplanar views show the overlapping images of the virtual preplanned reconstruction (pink) and reconstruction result performed by using two individualized 3-D meshes (one for a three-wall-reconstruction of the orbit and one for reconstructing the right midfacial prominences).**

Cases provided by Nils-Claudius Gellrich, Hannover, Germany



**Fig 1a–b**

Through a modified transfacial approach (without additional infraorbital or transconjunctival release incision) the two prebent meshes are shown in situ after final in situ individualization using intraoperative navigation. Screw fixation is mandatory to allow for secure positioning of the meshes.



**Fig 2a–d**

Intraoperative view of the result of the sterile moulding of a 1.3 mm orbital fan plate to reconstruct three orbital walls, ie, medial wall, orbital floor, and lateral wall of the right orbit plus the 0.6 mm 3-D mesh to reconstruct the paranasal pillar, right nasal bones, infraorbital rim, lower part of the lateral orbital rim, malar prominence, and anterior maxillary sinus wall.



**Fig 3**

Three-dimensional mesh is preformed using an artificial sterilized skull to camouflage the temporal region. Prior to radiotherapy, a reentry via a coronal approach was performed in the patient to adequately wrap the individualized 3-D meshes with vital soft tissues, by performing an ipsilateral temporalis flap. To prevent consecutive temporal hollowing of the right temporal area and to camouflage the temporal region, a 1.3 mm mesh (0.6 mm thickness) which had been preformed using the skull model (Fig 3) was placed. The opening above the zygomatic arch is required to allow appropriate vascularization of the pedicled temporalis flap.



**Fig 4**  
Postoperative CT scan after temporalis flap is made and correction of the temporal contour using the 3-D mesh shown in Fig 3. In the right nasoorbito-ethmoidal area a plate can be identified which allows an appropriate reposition of the medial canthal ligament by using a cantilever (Hammer) technique.



**Fig 5**  
Postoperative image of coronal approach. A stealth incision was used without additional shaving. Wound closure is provided with staples which can be easily removed 10 days later.



**Fig 1**  
Mandibular reduction forceps.

### Mandibular Reduction Forceps

Stable internal fixation of mandible fractures is easier if facilitated by instruments maintaining reduction while the plates are adapted and applied to the fractured bone. The three forceps designs presented here address bone/fracture reduction in specific regions of the mandible. The forceps can attach in 1.5 mm or 1.8 mm drill holes, they are used single-handedly, and their ratcheting mechanism allows for adjustment while compressing the fracture (Fig 1).

#### Reduction forceps with points, ratchet 205 mm (Fig 2)

These forceps are designed to maintain the mandible arch against lateral slaying in two different ways.

#### Bone reduction forceps, angled, large (Fig 3)

The right-angled tips provide compression with an angle for mandible fractures via an intraoral or an extraoral incision as well as soft-tissue retraction at the fracture site.

#### Bone reduction forceps, small with toe-in tip (Fig 4)

These forceps are designed to maintain the bone reduction in the symphyseal and parasymphyseal areas of the mandible until the fracture is plated.



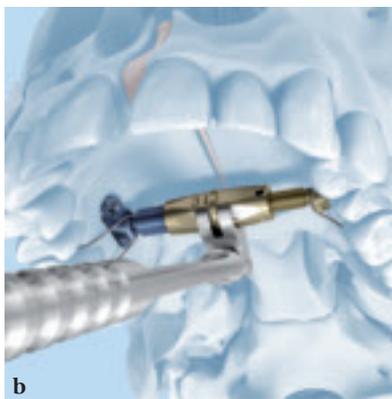
**Fig 2**  
Reduction forceps with points, ratchet 205 mm.



**Fig 3**  
Bone reduction forceps, angled, large.



**Fig 4**  
Bone reduction forceps, small with toe-in tip.



**Fig 1a–c**  
Transpalatal distractor system.

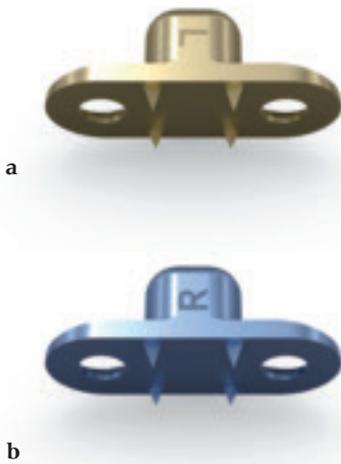
### Transpalatal Distractor System

The transpalatal distractor system consists of specialized implants and instruments specific to surgically assisted palatal distraction osteogenesis. The transpalatal distractor is intended for single use as a bone-borne maxillary retainer and gradual expander with a callous distraction policy. This device, made of titanium, consists of an interchangeable and adjustable distractor body, which is manually activated, and two footplates that are fixed to the palatal bony shelves with 1.5 mm cortex screws (matrix midface).

The transpalatal distractor is indicated in surgically assisted rapid palatal expansion for correcting maxillary transverse deficiencies in skeletally mature patients.

Over the past decades, distraction osteogenesis has been popular for lengthening procedures in long bones and bone-segment transfer. Today, it is of increasing importance in the CMF field. During distraction woven bone forms in the distraction gap. The distraction's progress must be fast enough to prevent bony bridging and slow enough to permit the bone's differentiation. Distraction of 1 mm per day, in one to four steps, has been found to be adequate. An advantage of distraction osteogenesis is that it allows for reconstruction of skeletal deformities in a controlled fashion with the native bone [1].

Transverse maxillary hypoplasia [2] is a clinical entity characterized by diminished growth of the maxilla in the transverse dimension, leading to anterior and posterior crowding of the maxillary dentition. This constriction of the maxillary arch occurs spontaneously or in association with congenital cleft lip and palate deformities. Clinical manifestations include unilateral or bilateral palatal crossbite, dental rotation or tilting, and malocclusion. An adequate transverse maxillary dimension [3] is an important factor of stable occlusion, and it positively affects facial aesthetics. A narrow and V-shaped dental arch, dental crowding, a posterior crossbite, unaesthetic black buccal corridors upon smiling and maxillary transverse deficiency are generally interrelated. The underlying structural abnormalities may secondarily lead to gingiva-periosteal and periodontal disease, speech pathology, nasal airway obstruction, and—when a cleft palate is present—alveolar ridge collapse and oronasal fistula. The corrective goal of expanding the transverse dimensions of the palate allows for normal position and function of the dentition, improvement in occlusion, airway and speech, and optimization of aesthetic appearance. Maxillary transverse deficiency and malocclusions can be corrected with slow orthodontic expansion, rapid palatal expansion, surgically assisted rapid palatal expansion, or two-segmented Le Fort I type osteotomy with expansion at different growth status [4].



**Fig 2a–b**  
Left (a) and right (b) footplates with spikes.

Surgically assisted rapid palatal expansion takes advantage of bone formation at the maxillary edges of the midline while they are separated by an external force.

The amount of desired expansion is an important factor for selecting maxillary expansion in adults. In general, an orthodontist can camouflage transverse maxillary deficiency of less than 5 mm with orthopaedic or orthodontic forces alone. When the maxillary transverse deficiency is greater than 5 mm, surgical assistance is required.

The transpalatal distractor system consists of a central body, plus left and right threaded pins that join with the respective footplate (Fig 3). They are fixed to the bone via four spikes on the bottom of the footplate (Fig 2).

Each rotation of the central body from one number to the next expands the transpalatal distractor by 0.33 mm. Therefore, a full rotation (360°) would achieve an expansion of 1 mm.

Further rotation of the central body is prevented by inserting a blocking screw completely through one of the three threaded holes on the footplate's left side (Fig 3).

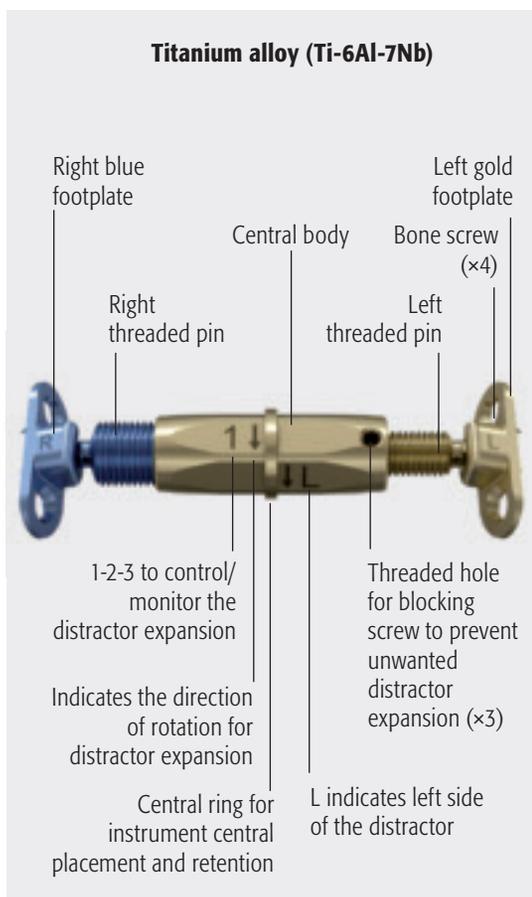
### Recommendations

Ensure before the procedure that the safety wires are in the operating room.

The preferred surgeon position relative to the patient's body while implanting the distractor is the "top of the patient head" position, since it facilitates facial symmetry observation. The bigger diameter screws are also preferred.

### References

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**Fig 3**  
Transpalatal distractor: parts and central body symbols.

**A 17-year-old girl with a long face and vertical maxillary excess. Class II malocclusion, narrow maxilla, hypoplastic cheekbones, and nasal deformity. The steps shown in Fig 1–Fig 6 show a normal implantation procedure of the transpalatal distractor following surgical planning and standard osteotomy.**

Case provided by Maurice Mommaerts, Bruges, Belgium

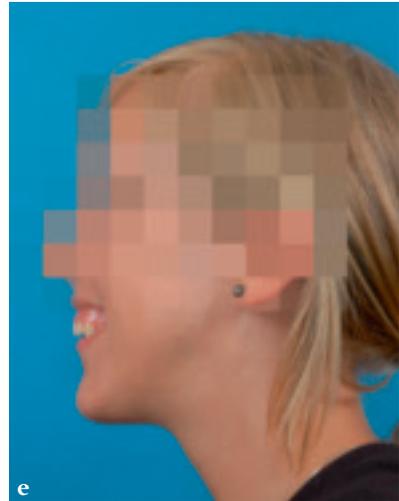


Fig 1a–e



Fig 2  
Marking palatal incision for footplate placement.



Fig 3  
Securing footplate to the bone.



**Fig 4**  
Assembly of the distractor body into the footplates.  
The bone mobility is then verified via device  
activation and there is standard surgical closure.



**Fig 5**  
Blocking the distractor with the blocking screw.



**Fig 6**  
Anchoring the distractor body to the teeth via a wire  
to prevent accidental dislodgement.  
Postoperative distraction is achieved using an activation  
instrument that joins with the distractor central body.  
A rotation from one number to the next etched on the  
central body, expands the distractor 0.33 mm. Activation is  
recommended 0.33 mm once per day. After distraction is  
complete, the distractor is blocked again with the blocking  
screw during the consolidation period.



Fig 1a–b  
Sternal zipfix system.

### Sternal Zipfix System

The sternal zipfix system primarily consists of polyetheretherketone (PEEK), biocompatible implants, which are similar to cable ties, and an application instrument. The purpose of this system is to achieve sternal closure following sternotomy by stabilizing the sternum and promoting fusion.

The implant itself comprises a removable stainless steel needle for peri-sternal application, the body with a ratchet mechanism, and a flat locking head. The application instrument is used to tension the implant, without over-tensioning it, and also to cut it.

**Case 1: A 66-year-old man with a history of chronic obstructive disease, obesity (BMI of 32.8), and transient ischemic attack was scheduled for a coronary artery bypass operation for stable angina. The patient's angiogram showed three-vessel coronary disease with good left ventricular function and an echocardiogram sinus rhythm.**

**The hybrid sternal closure technique with stainless steel wires and sternal zipfix has been used in the authors' institution in 50 patients without any instance of sternal instability or dehiscence.**

Case provided by Ted Elenbaas and Sander Wolters, Eindhoven, The Netherlands

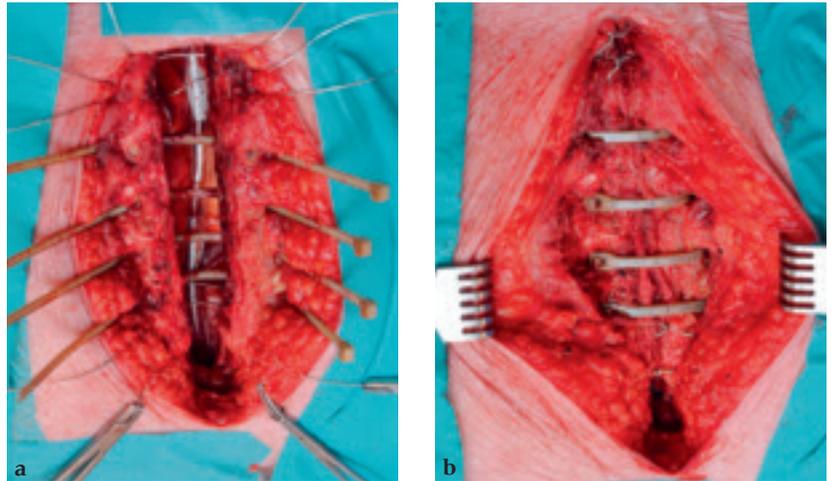


Fig 1a-b

- a Preclosure. The patient underwent coronary artery bypass surgery with two distal grafts, left internal mammary artery to the left anterior descending coronary artery, and a saphenous graft from the aorta to the right descending posterior coronary artery. The branches of the circumflex artery were too small and calcified to be bypassed.
- b Final closure. The sternal closure was performed with three stainless steel wires in the manubrium, four sternal zipfix on the sternal bodies and two wires distally in the xiphoid region.

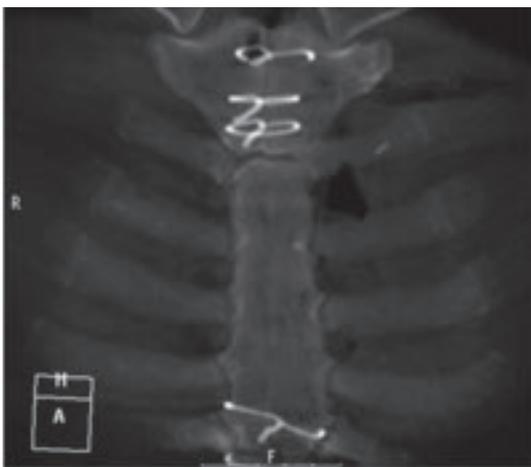


Fig 2

The postoperative procedure was uneventful. The patient was extubated after 3 hours and transferred to the normal ward after 6 hours. There were no complications and no complaints of sternal pain or instability, and the patient was discharged after 6 days.

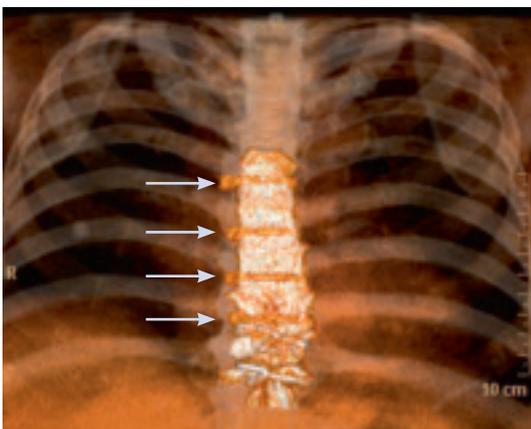


Fig 3

Although the sternal zipfix cannot be detected with normal x-ray, the implants can be viewed with a CT scan and digital imaging techniques. The patient underwent a CT scan on the third postoperative day to evaluate the sternal closure. The CT scan showed a perfect alignment of the sternal halves. Postoperatively there was good wound healing with no signs of infection.

**Case 2: A 55-year-old woman, who previously underwent ventricular septal defect closure at 5 and aortic valve reconstruction at 31, required aortic valve replacement due to symptomatic aortic valve insufficiency. The patient was morbidly obese with a BMI of 45. Due to the high risk for sternal instability and/or deep sternal wound infection, closure was performed using the sternal zipfix system. The zipfix provides quick and reliable stable fixation of the sternum even in patients that are at a higher risk to develop a sternal instability or a deep sternal wound infection.**

**The postoperative course was uneventful and the patient was discharged on postoperative day 7 with no signs of sternal instability or wound healing problems. At 18 months follow-up the wound had healed completely and the sternum was stable, with no signs of infection.**

Case provided by Roman Gottardi, Salzburg, Austria

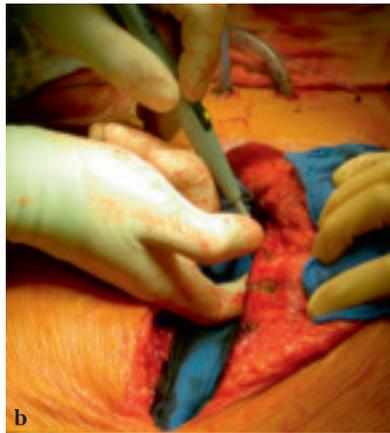


Fig 1a–b

After systemic heparinization was reversed with protamine and hemostasis was achieved, the first to fifth intercostal spaces were dissected with minimal mobilization of the pectoral muscle allowing passage of the zipfix.

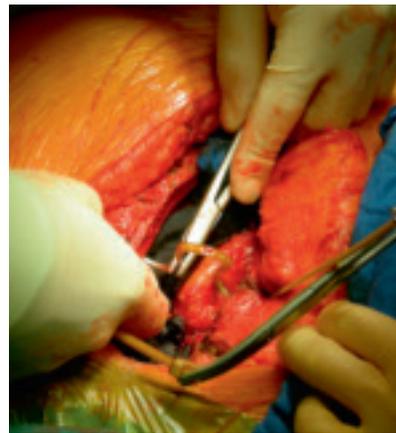
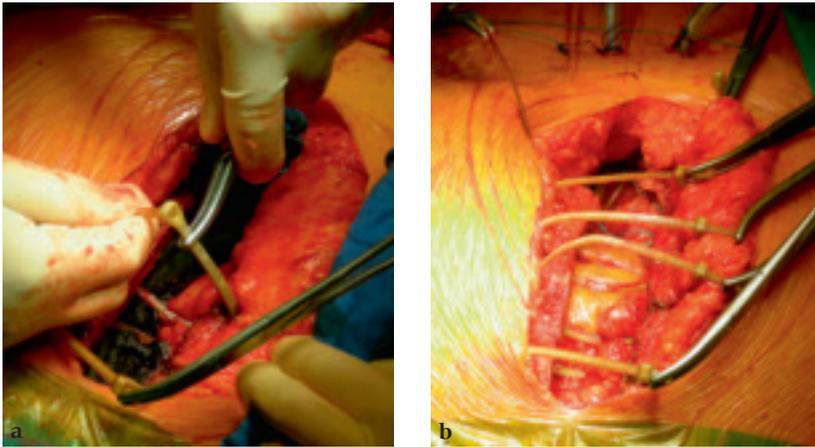
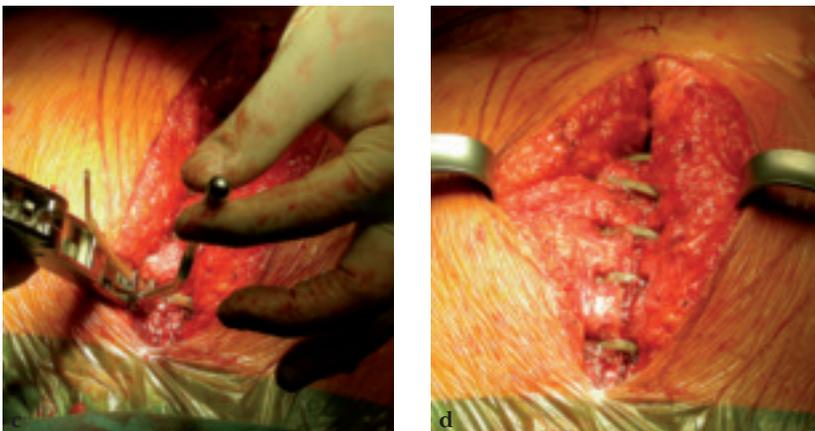
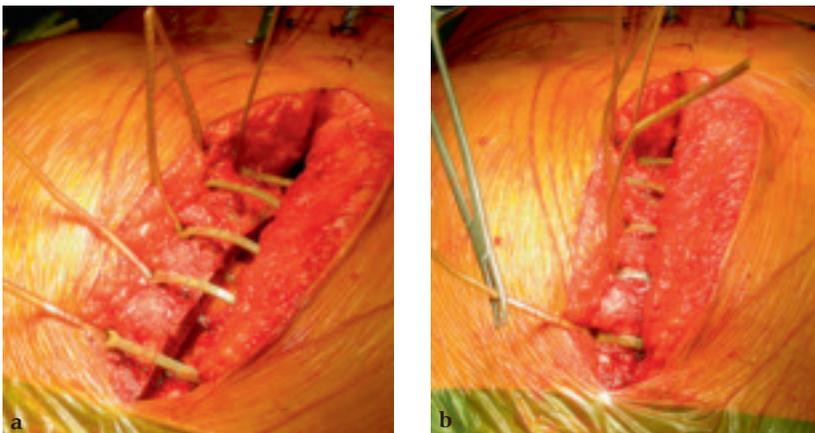


Fig 2

Then five zipfix implants were passed peristernally through the intercostal spaces with special attention to avoid injury to the internal mammary arteries.



**Fig 3a-b**  
The needles were cut and the sternal halves approximated gradually by tightening all zipfix manually.



**Fig 4a-d**  
When good approximation was achieved the zipfix was finally tightened and cut using the application instrument.

Roger Härtl, Jean Ouellet, Andreas Korge, Robert McGuire, Paul Heini

## SPINE

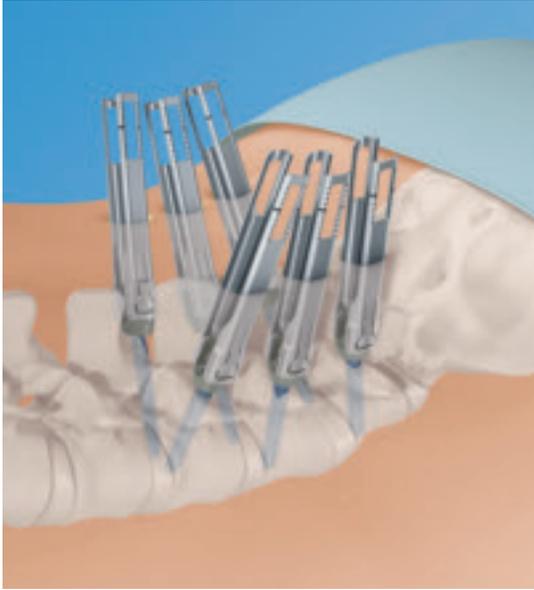


Fig 1

### Matrix 5.5 Deformity and Matrix MIS

The matrix spine system is a universal set of instruments and implants that accommodates both open and minimally invasive surgery (MIS) approaches for deformity, degenerative, and trauma indications. The system is composed of pedicle screws, preassembled polyaxial pedicle screws, monoaxial screws, hooks, locking caps, transconnectors, rods, and polyaxial head implants.

The matrix 5.5 deformity spine system is designed to provide biomechanically sound results for complex posterior pathological challenges. The matrix polyaxial and monoaxial pedicle screw features dual-core, double-lead threads, threaded T25 StarDrive recesses, 50° of angulation with rod reduction features located at the top of the screw head. The matrix 5.5 deformity polyaxial heads can be removed and replaced intraoperatively without removing the bone screw. The 5.5 mm diameter rod material options include titanium, Ti-6Al-7Nb, and CoCr with multiple-length curved precontoured and hex-end versions.

Locking caps are square-thread design with a saddle on the underside to prevent skiving during rod reduction. The saddle is designed to pilot the locking cap to the screw head to minimize cross threading. The snap-on transconnector is a preassembled implant. It features an arched telescoping body. The jaws of the transconnector have the ability to swivel and are spring loaded for tension application until final tightening.

The matrix MIS is a minimally invasive instrument system for use with the matrix spine system. Matrix MIS allows for minimally invasive rod and screw insertion for thoracolumbar pedicle fixation. Pedicle trauma is minimized by using muscle-sparing approaches to expose patient anatomy.

This system uses cannulated pedicle screws attached to screw-mounted tissue retractors. This combination allows pedicle screw insertion and rod introduction with minimal tissue disruption. The system is applicable to single and multi-level procedures requiring posterior instrumentation.

Matrix MIS uses the same locking cap and pedicle screw technology as matrix 5.5 deformity and matrix degen.

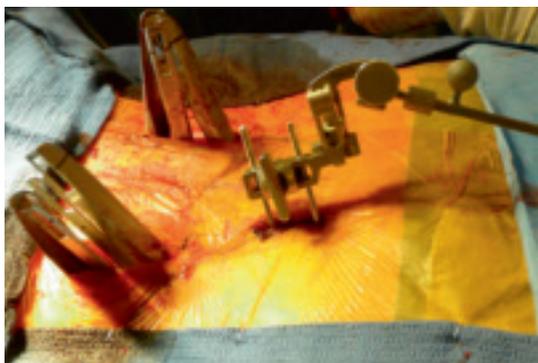
The 5.5 minimally invasive rods are prelordosed with 100 mm or 200 mm bend radius. The 100 mm bend rods are available in 35–85 mm lengths in 5 mm increments. The 200 mm bend rods are available in 60–130 mm lengths in 5 mm increments.

Unique to matrix MIS are cannulated pedicle preparation instruments, screw-mounted tissue retractors, and a rod introduction instrument

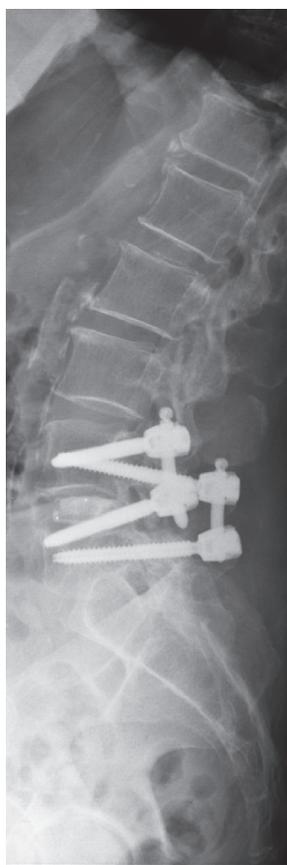
#### Cases provided by Roger Härtl, New York, USA



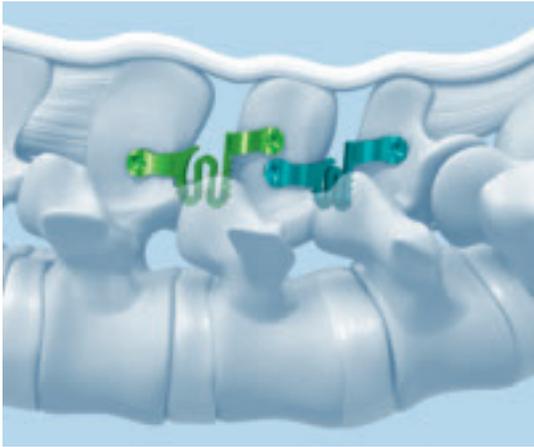
**Fig 1**  
Matrix MIS case with Brainlab navigation.



**Fig 2**  
Matrix MIS case.



**Fig 3**  
Lateral x-ray view of matrix TLIF case.



**Fig 1**  
Staggered wings facilitate double-level implantation.



**Fig 2a–b**  
A 66-year-old man with L3/L4,  
implant size 10.

### StenoFix

StenoFix is an interspinous implant used after decompressive surgery. The device is intended for use as a space holder between the spinous processes for one or two lumbar levels L1–S1. The resulting effects on the posterior elements are preservation of the foraminal height, reduction of stress on the facet joints and reduction of pressure on the posterior annulus.

The W-shaped spring allows for dampening of high axial loads. The implant is designed with divergent wings to ensure implant insertion. For an optimized anatomical fit the shape of the cranial radius of the implant fits into the natural concavity of the superior spinous process. Further, the wings facilitate double-level implantation.

The stenofix implants are available in sizes 8–16 mm in 2 mm increments. Construction material is titanium alloy and supplied sterile. Each implant is color coded along with trial implants of the same size and shape.

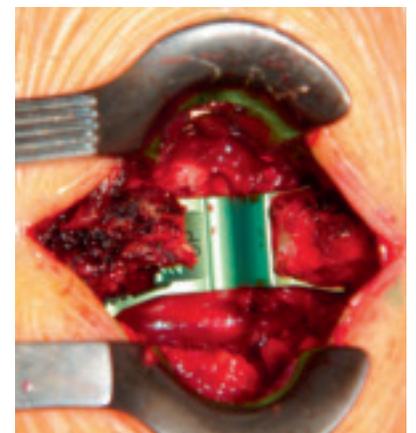
**A 56 year-old-man had low-back pain for 10 years, with 2 years of sciatica radiating into the left leg. He had no sensory or motor deficiency.**

**Nonoperative treatment failed completely. Surgery included decompression of level L4/5 and implantation of an interspinous stenofix L4/5 device size 12. He had a normal postoperative course with rapid decrease of pain.**

Case provided by Andreas Korge, München, Germany



**Fig 1**  
X-ray shows dynamic  
extension 3 months  
postoperatively.



**Fig 2**  
Intraoperative view with  
original stenofix implant  
in place.



**Fig 1**  
NFlex construct.

### NFlex Stabilization System

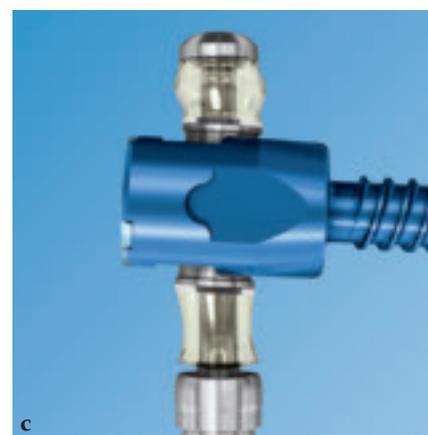
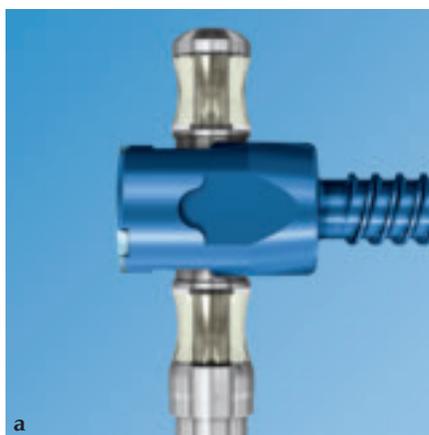
The NFlex stabilization system is a semi-rigid rod for posterior lumbar stabilization. The rods are designed to be used with either the pangea or click'X pedicle screw systems.

NFlex enables dynamic stabilization of the posterior lumbar spine. Principles of dynamic stabilization include decreased stiffness compared to traditional rigid stabilization and increased load sharing with surrounding anatomical structures. Dynamic constructs provide less resistance to spinal loading and motion. The NFlex rod motion allows more load transmission to the anterior column than rigid fusion.

The main goal of the NFlex surgical technique is to implant the rod so that the patient can utilize the full range of motion and load-sharing capabilities of the device.

The NFlex stabilization system features precurved and straight rods for mono- and multisegmental posterior stabilization. The rods feature dynamic and solid ends for transitional rigidity. A titanium ring allows for sliding and toggling coupled motion. The polymer sleeve bumper allows for controlled titanium ring motion in flexion, extension, lateral bending, and axial rotation at the dynamic level. Finally, a titanium alloy tapered core provides transitional rigidity.

Lengths of the NFlex rods are 40–85 mm in 5 mm increments. The set also includes a 150 mm straight rod. Four trial implants are provided, corresponding to the various rod lengths from 40–85 mm. In addition, a 150 mm long bending template is included in the set to establish the contour of the 150 mm straight NFlex rod.



**Fig 2a–c**

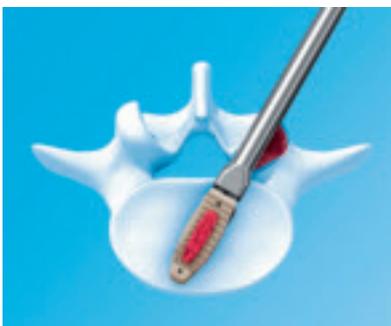
The NFlex rod motion allows more load transmission to the anterior column than rigid fusion.



**Fig 1**  
OPAL implant holder for revolve technique.



**Fig 2**  
OPAL with posterior fixation.



**Fig 3**  
Proper positioning.

### Oblique Posterior Atraumatic Lumbar (OPAL) Spacer System

The oblique posterior atraumatic lumbar (OPAL) spacer system is a comprehensive set of implants and instruments designed for posterior interbody fusion of the lumbar spine. These polyetheretherketone (PEEK) implants accommodate both bilateral posterior lumbar interbody fusion (PLIF) and unilateral transforaminal lumbar interbody fusion (TLIF) applications.

Oblique posterior atraumatic lumbar implants can be inserted using a self-distracting revolve technique or standard technique. The self-distracting, bullet-shaped nose aids in insertion. The design features an axial canal for autograft material and convex surfaces for anatomical fit.

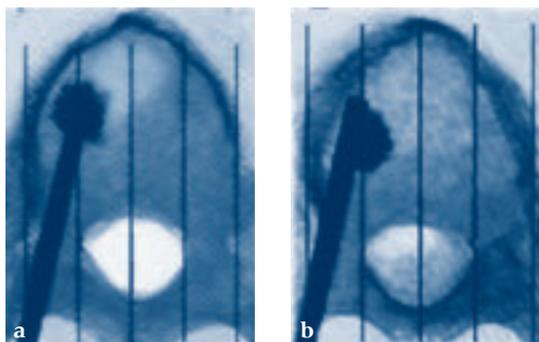
The OPAL standard spacers are offered in two footprints and heights from 7–17 mm. The OPAL revolve spacer is available in six footprints and heights ranging from 10–15 mm.

The two implant offerings accommodate a traditional straight implant insertion or a less invasive insert and rotate technique. The revolve spacer is specifically designed for the rotate technique. The spacer is rotated 90° in situ providing intervertebral distraction. The beveled edge on the spacer allows for easy rotation.

The implant is designed with pyramidal teeth to provide resistance to migration. Two radiographic marker pins enable visualization. Bio-compatible radiolucent polymer allows clear assessment of fusion.



**Fig 4**  
OPAL implant.



**Fig 1a–b**  
Comparison of flow behavior between a front-opening (a) and a side-opening (b) needle.



**Fig 2**  
All needles can be used for injection of cement through the front or through a side opening for better control of cement flow.



**Fig 3**  
Vertecem V+ syringes have wide integrated wings and reinforced syringe pistons to guarantee excellent force transfer combined with good tactile feedback.

### Vertebral Body Stent (VBS or Stentoplasty) and Vertecem V+

The vertebral body stent (VBS) system is a minimally invasive, percutaneous, reconstructive treatment for vertebral body fractures.

The VBS system is intended for the reduction of painful vertebral compression fractures and/or creation of a void in cancellous bone in the spine for the treatment of levels ranging from T5–L5. It is intended to be used in combination with a legally marketed polymethylmethacrylate (PMMA)-based bone cement adequately indicated for use in vertebroplasty or kyphoplasty procedures.

### Vertecem V+

Vertecem V+ is for percutaneous injection of PMMA as filler material within (eg, stentoplasty) or without (vertebroplasty) an intervertebral framework. Many different products are available on the market to cover both solutions.

The vertecem V+ is unique because it:

- Is ready to use directly upon mixing (no need to wait for the cement to reach the right viscosity)
- Offers prolonged working time (less stress for the surgeon through reduced time constraints/the opportunity to perform multilevel interventions)
- Offers better visibility under x-ray through the incorporation of more radiopacifiers, which are also distributed more evenly inside the PMMA cement

The vertecem V+ syringe kit offers syringes in 5 x 2 mL and 8 x 2 mL sizes. The design features strong syringes, color coding for different volumes, and ergonomic handling.

The vertebroplasty needle kit features 8 gauge (blue), 10 gauge (yellow), and 12 gauge (green) diamond- and beveled-tip needles. It also offers an optional biopsy solution for 8 gauge and 10 gauge needles.

The design of this product achieves three goals:

1. Long working time: (up to 27 minutes at room temperature) therefore less stress for the surgeon during the intervention and enough time for multilevel procedures.
2. Increased initial viscosity: Ready to use directly upon mixing. Potentially lower risk for leakage and shorter operative time.
3. Better x-ray visibility: Better control of cement flow and thus less risk of leakage.

Brian Beale, Randy J Boudrieau, Rico Vannini, Aldo Vezzoni, Kenneth A Johnson, Alessandro Piras, Michael P Kowaleski

## VETERINARY



Fig 1



Fig 2



Fig 3

A 2.0 mm TPLO plate can be seen intraoperatively using three 2.0 mm locking screws proximally and three 2.0 mm cortex screws distally. The jig pin of the small jig is accommodated nicely by a notch at the proximal, caudal aspect of the plate.

### Tibial Plateau Leveling Osteotomy (TPLO)

#### Procedure

Cranial cruciate ligament tears are a common cause of hind limb lameness in the dog. Medium- and large-size dogs are commonly treated using the tibial plateau leveling osteotomy (TPLO) procedure. Small dogs and cats can suffer the same injury and have traditionally been treated using ligament reconstruction with an extracapsular prosthetic ligament. While this technique can provide adequate results in many small dogs and cats, it does not address underlying shear loads on the stifle that can lead to failure of the replacement ligament and recurrent instability. The slope of the dog's tibial plateau is much greater than their human counterpart, which results in increased shear loads on the canine stifle and a tendency for cranial tibial translation. Over time, this repetitive force can lead to damage and rupture of the cranial cruciate ligament. The TPLO procedure dynamically stabilizes the knee by eliminating cranial tibial subluxation during the weightbearing phase of locomotion. The slope of the tibial plateau of many affected small dogs may be particularly excessive and many surgeons prefer to treat these patients similar to larger dogs using a TPLO.

#### TPLO 2.0 and 2.4 mm Small Stature Plates

The TPLO system is indicated for osteotomies of the canine proximal tibia and combines plates with a basic instrumentation set. The TPLO plates are precontoured to match the anatomical configuration of the medial aspect of the proximal tibia with a limited contact design and optimal screw placement in the proximal region of the tibia. The plates are available in left and right configurations and feature locking screw technology.

Until recently, the plates were available in four different profiles: 2.7 mm, 3.5 mm small stature, 3.5 mm, and 3.5 mm broad. Now the 2.0 and 2.4 mm TPLO plates have been added to the system for use in small dogs and cats. The plates and screws are available in 316L stainless steel. The TPLO plates can accommodate locking or cortex screws that correspond to the size of the plate used.

The design of the 2.0 and 2.4 mm TPLO plates has been modified from that used with the larger TPLO plates to better align the TPLO plate with the proximal diaphysis of the tibia in small dogs and cats. The plates are placed on the medial surface of the tibia. The plate fits very proximally and just distal to the articular surface. In addition, the neck of the plate sits directly over the osteotomy cut. The screw size and pattern provides sufficient strength in tibias of the dog and cat. The locking holes are appropriately angled so that the screws will not penetrate the joint or the osteotomy when the plate is applied with proper technique.

The head of the plate is also designed to accommodate the placement of a new small positioning jig. This new minijig will be released soon.

Tibial plateau leveling osteotomy can be performed through a small medial incision over the proximal tibia when using arthroscopy to inspect and treat intraarticular structures. Patients will typically walk on the leg soon after surgery. It is recommended to restrict activity for 8 weeks to walking only. The osteotomy typically is healed within 8 weeks and return to function can begin progressively after radiographic evidence of healing. Long-term prognosis is excellent. The implants are typically left in place for the life of the patient, unless implant removal is necessary due to clinical problems.

**Case 1: An 11-year-old female, spayed, 13.6 kg cocker spaniel had a complete tear of the left cranial cruciate ligament. A 2.4 mm TPLO plate was perfect for this dog due to the excessive slope of the tibial plateau (30°) and the size of the dog. Three 2.4 mm locking screws were used proximally and three 2.4 mm cortical screws were used distally. The contour of this plate matches the contour of the bone almost perfectly. The plate is also designed to optimize the angle of the proximal screws so that they engage the most dense and thickest bone and avoids penetration of the stifle joint.**

Case provided by Brian Beale, Houston, USA



Fig 1a–b

Preoperative x-rays.



Fig 1c–d

Postoperative x-rays.



Fig 1e–f

Two-month follow-up x-rays.



**Case 2: A 10-year-old female, spayed, 6.0 kg cat had a partial tear of the left cranial cruciate ligament, meniscal mineralization, and a medial meniscal tear. The cat was treated with a partial meniscectomy and TPLO. A 2.0 mm TPLO plate was perfect for this cat due to the slope of the tibial plateau (25°) and the size of the cat. Three 2.0 mm locking screws were used proximally and three 2.0 mm cortex screws were used distally. The contour of this plate does not perfectly match the contour of the proximal tibia, but use of locking screws in this segment avoids any potential angulation of the segments as the screws are tightened. The cat healed uneventfully and returned to normal function.**

Case provided by Brian Beale, Houston, USA

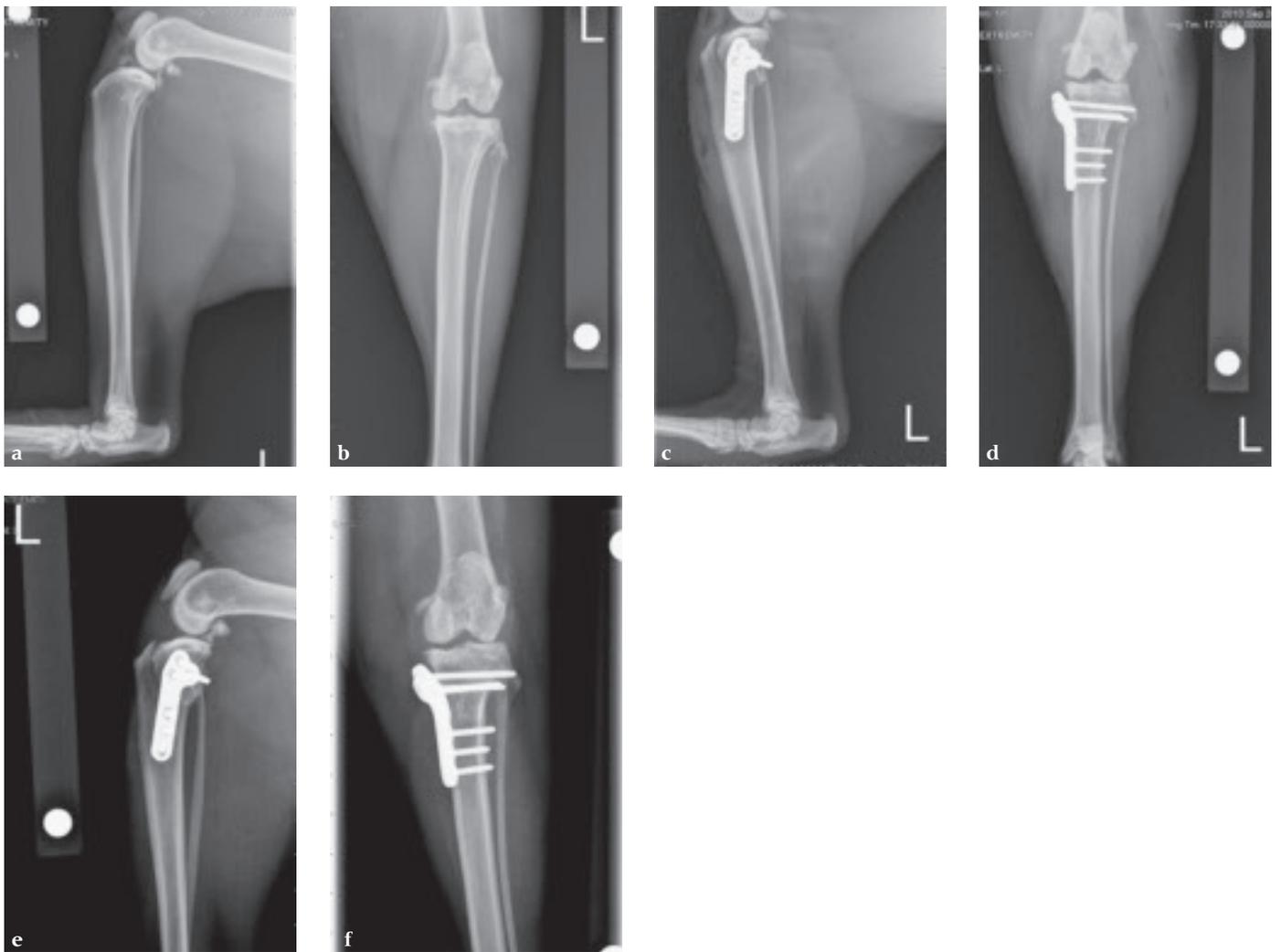


Fig 1a-f

a-b Preoperative x-rays.

c-d Postoperative x-rays.

e-f Two-month follow-up x-rays.

Michael Blauth

## PORTRAIT: VINZENZ SMEKAL



**Fig 1**  
**Vinzenz and his father at the base camp of a skiing expedition to Mount Ararat (5,165 m) in eastern Turkey, on the border of Iran and Armenia.**



**Fig 2**  
**Vinzenz with his wife, Lisa, and children Jana, Lena, and Luis.**



**Fig 3**  
**Vinzenz instructing at an international human specimen course in Innsbruck.**

Vinzenz Smekal is a trauma surgeon with a special emphasis on sports traumatology. He works at the University Department for Trauma Surgery in Innsbruck, Austria, as the leader of the knee team.

Born in 1967 in Innsbruck, Vinzenz completed school and military service, then studied at the Medical University, Innsbruck. He completed his doctoral thesis on “Assessment of renal resistance index by color Doppler sonography in patients with nephroptosis” in 1996 and began training there as a resident in the Department of Radiology. One year later, he moved to the Department of Trauma Surgery at the same hospital. He interrupted his residency twice during winter seasons to work in different trauma departments in various hospitals in skiing areas to gain more experience in fracture treatment. He completed his residency as a trauma surgeon in 2004 and became a sports traumatologist in 2008. In 2010 he defended his habilitation thesis “Elastic stable intramedullary nailing of displaced clavicular fractures in adults.”

His special interests include minimally invasive fracture treatment and open and arthroscopic joint surgery, especially of the shoulder and knee. He participated in human specimen instructional courses on shoulder arthroscopy and surgery under the patronage of the AGA and SECEC as an instructor and faculty member. He has been a member of AO faculty since 2005.

His research focus is clavicle fractures. In his first prospective randomized comparative study between elastic stable intramedullary nailing and nonoperative treatment of displaced clavicular fractures, he proved the advantages of early surgical intervention. However, in further research it became obvious that especially comminuted clavicle fractures showed the highest failure rate due to implant-related complaints. Due to his expertise, Vinzenz became the medical leader in the AO Foundation's development of a new intramedullary implant. He now enjoys working with other motivated AO surgeons to improve patient care.

Besides his research area, his other main activity is knee surgery. In recent years Vinzenz has organized several educational events and one national human specimen course on multiligament injuries of the knee. In 2011 he chaired an international congress with a human specimen workshop and live surgery on patellofemoral disorders.

Vinzenz lives in a village near Innsbruck with his wife, and three children aged 16, 4, and 2. He is a family man, having grown up with five siblings. His free time belongs to his family with whom he enjoys skiing, swimming, hiking, and photography. When he was younger, he was an enthusiastic mountaineer, a hobby which he shared with his father, who is also his best friend. Vinzenz is looking forward to introducing this hobby to his children when they are a bit older.

Claas Albers, Aradhna Sethi

## TECHNOLOGY INNOVATION PROGRAM IN DAVOS 2011



Fig 1  
Foot and Ankle Expert Group.



Fig 2  
Intramedullary nailing work group.

The AOTK System manages the development and approval of new techniques, methodology, and products that support improved patient care. The AOTrauma Education Commission is responsible for integrating these innovations into AOTrauma education activities.

AOTK and AOTrauma Education have partnered together to offer an extensive Technology Innovation Program (TIP) during the AO Davos Congress of Courses this December. Technology Innovation Program is a series of events taking place throughout the two weeks of the AO Courses that provide participants and faculty with the opportunity to understand and discuss with experts the implications of new techniques, methodology, and products.

Steve Schelkun, a TIP coordinator, says that in the past, the only way a surgeon could be introduced to the new technology was by way of a course where the new devices were used in the practical exercises. This provided exposure to those surgeons who could attend the course and respectively the specific devices taught at that one course attended. However, experience has shown that most surgeons are interested in all of the latest innovations. Therefore, there must be a better way to inform course participants in Davos about as many innovations as possible.

So, in 2010, the TIP's coordinators presented the first innovations workshop related to the LCP variable angle dual column distal radius plate at the Davos courses. Attendance was amazing and the comments favorable. The TK process was showcased through a clinical problem by the Hand Expert Group, and the clinical results were presented from two surgeons who performed many of the first clinical trials. It was approached from an education standpoint and the clinical problem was stressed, the solution proposed, results of the clinical trials, indications, and surgical techniques were presented. The session concluded with tips, tricks, and techniques to maximize the best results and minimize potential pitfalls.

Since there is a large number of participants through the Davos Courses, AOTrauma felt that this would be an ideal opportunity for maximum exposure to some of the new and recent technological innovations that have been approved through the TK. A secondary purpose will be to showcase the work and process of the Expert Groups and Technical Commission who work conscientiously and consistently to create or enhance technologies for improved patient care.



**Fig 3**  
**Tim Pohlemann.**

Steve Schelkun enthuses “[i]n 2011, we plan a series of daily Innovation Workshops. These will be held during the afternoon breaks to allow maximum attendance and feature either a hands-on practical exercise or a ‘Meet the expert’ demonstration of the new technology. It will be a great opportunity to see new products, possibly get hands-on experience, and ask questions of the expert surgeons who helped develop or test the new implants.”

#### **What does this mean for the participants?**

Claas Albers, Director, TK System, believes that his new series of daily workshops will give the Davos course participants a fantastic opportunity to get in touch with dedicated experts in their fields, get to know the latest AOTK-approved technology, and most importantly, ask questions about their clinical applications. The experts, in return, will get an initial feedback that may have implications for further developments in the future.

#### **AOTrauma and the TK System**

Talking of the ties between AOTrauma and the TK System, Tim Pohlemann, Chairman of the TK System, says that for everyone in the TK System (which celebrates its 50th anniversary this year), working closely with the AO Specialties is a matter of the heart. The achievements of the TK System in the recent past to coordinate internal workflows ensure effective integration of AO-approved technology into the various educational offerings by AOTrauma. This series of events at the Davos courses marks another highlight in the close collaboration between the two units.

**As the Davos courses not only feature Trauma but also CMF and Spine, there will be modules covering new products from CMF, Spine, and Trauma at the TK System booth over the two weeks.**

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