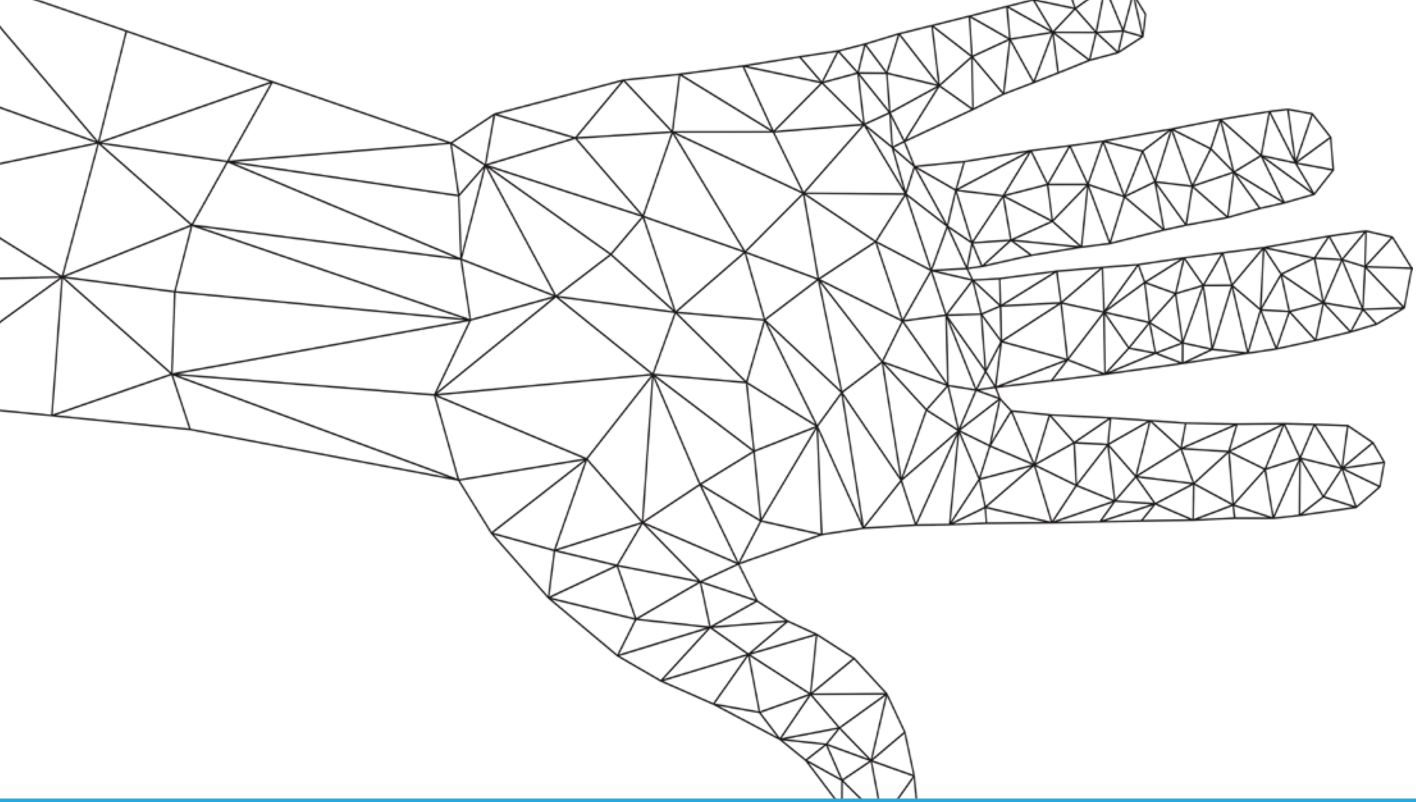


SURGICAL TECHNIQUE HAND & WRIST

Biointelligent osteosynthesis with Shark Screw® Allograft

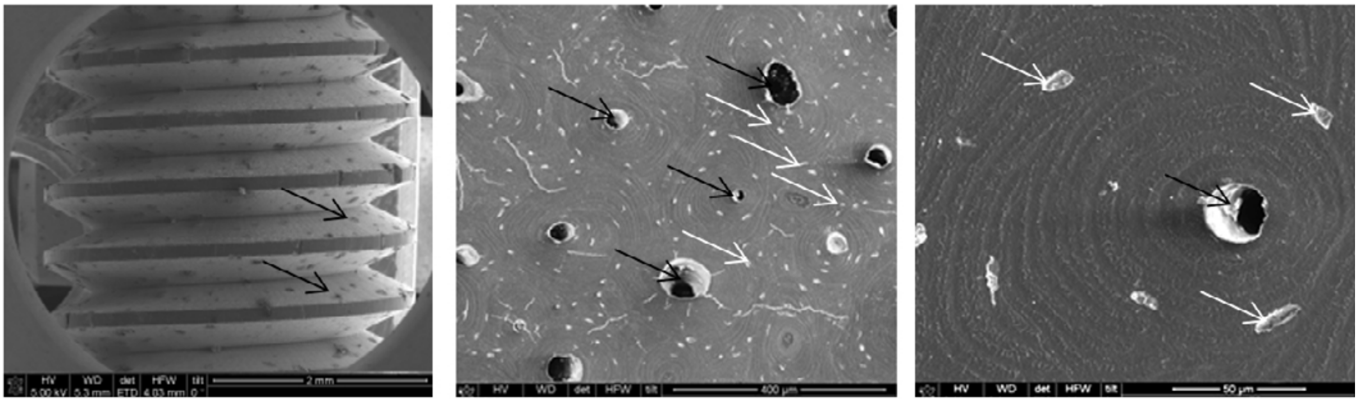
2nd version © Surgebright Inc.

Inhalt

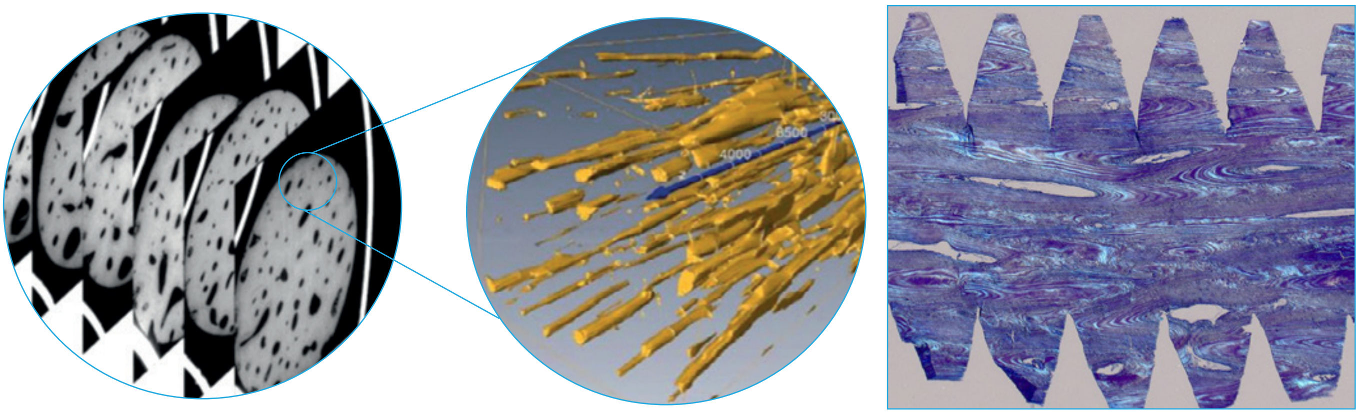
Histomorphology

Inner Structure of Shark Screw®

The natural scaffold of the Shark Screw® with its channel and cavity system provides a guiding structure for cells and cell fluids. Progenitor cells settle inside the allograft and continuously differentiate into the cells that bone requires. These channels serve as the foundation for the formation of new, stable bone tissue with arteries, veins, lymphatic vessels, and nerves. These cells and structures form the basis for the fusion of a fracture or arthrodesis.



The figure shows an electron micrograph of a sterilized Shark Screw®. From left to right: 1) Shark Screw® | 2) & 3) Osteons, Haversian channels (black arrows), osteocytes (white arrows), concentric special lamellae and switching lamellae between the osteons. Graz University of Technology FELMI-ZFE Institute for Electron Microscopy and Fine Structure Research.[12]

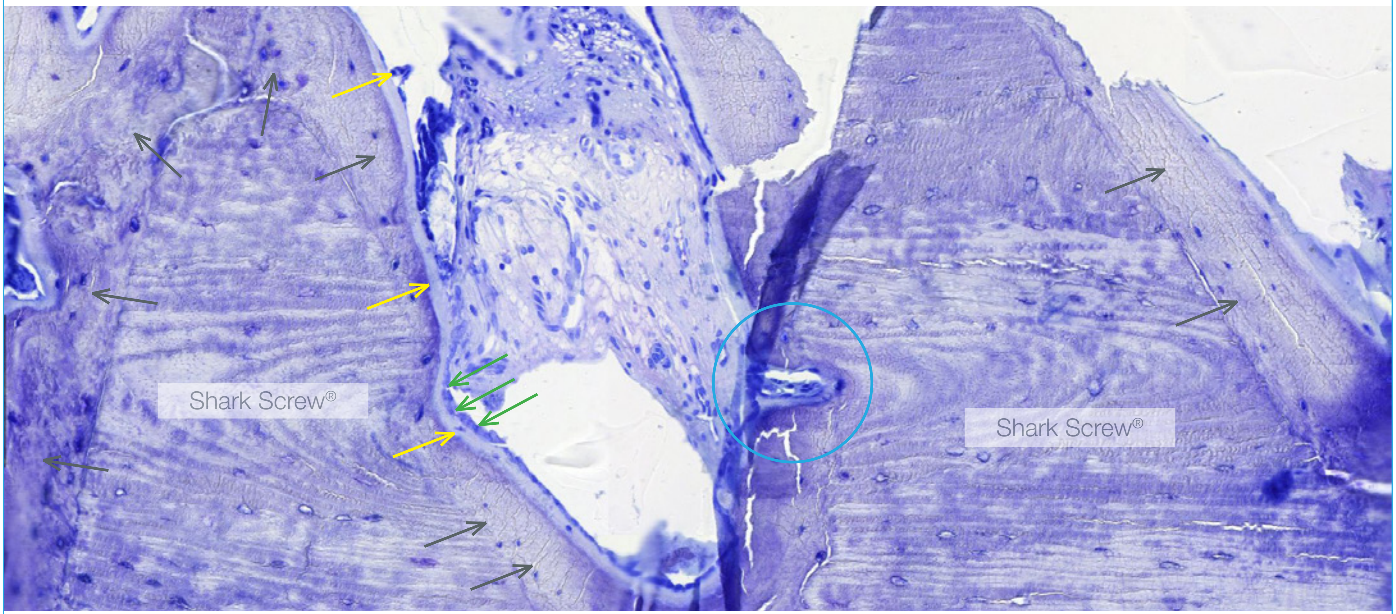


The manufacturing process is preserving the natural scaffold of cortical bone. The natural haversian channels are a guiding structure for cells. This channel system was visualized with an electron microscopy scan, in which sequential sections (200 µm) were scanned and the Shark Screw® was reconstructed in 3D. Right Fig.: Histological cut of a Shark Screw® after sterilization. The Haversian channels are cell-free.[12]

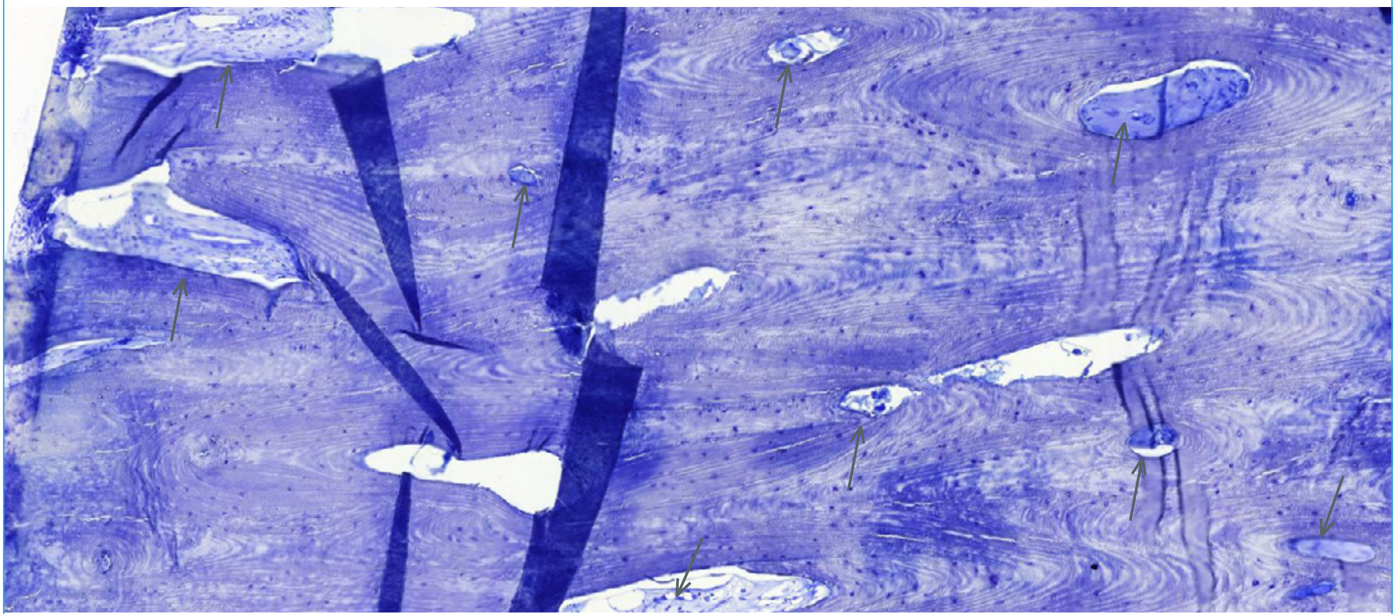
Histomorphology

Natural Bone Remodeling

Bone remodeling with the Shark Screw® was investigated on an explant 10 weeks postoperatively. The Shark Screw® was completely revascularized and colonized by bone cells. Lamellar bone formed along the threads, indicating primary (direct) bone healing. No inflammation or rejection reactions were observed. (Bricic, 2021)



Histological image of the Shark Screw®. Newly formed lamellar bone is firmly attached to the threads of the Shark Screw® (gray arrows). Osteoid (light line/yellow arrows) and osteoblasts (green arrows) are present on the lamellar bone. Osteocytes are found within the already mineralized bone. A newly formed Haversian channel–cutting cone–can be seen between the patient's bone and the Shark Screw® (circled). The patient's bone and the graft together form a stable bone-healing unit (Elliott DS et al., 2016).



Vascularization of the Haversian channels of the Shark Screw®, section from the center of the 10 weeks post op explanted graft (gray arrows).

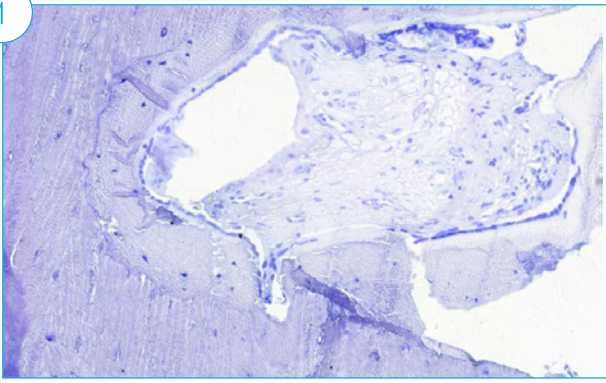
Histomorphology

Natural bone remodeling

What happens with Shark Screw® in the patient's bone?

The following figures illustrate the revascularization, cell colonization, and remodeling processes of the Shark Screw®. The research was conducted using light microscopy. (PD Dr. Mathias Werner Vivantes Berlin) and scanning electron microscopy (SEM) (Prof. Dipl-Ing. Dr. Harald Plank FELMI Graz) on an explant 10 weeks after the initial surgery.

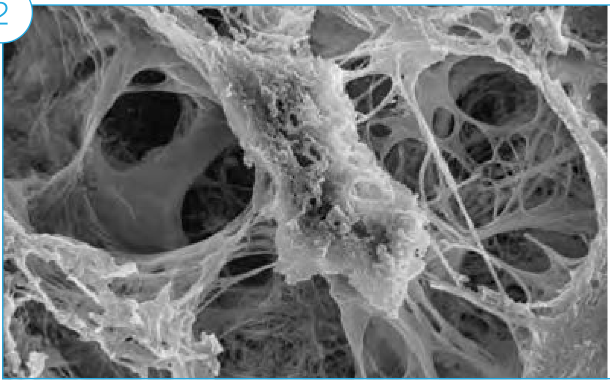
1



Thread of the Shark Screw® & patient bones

Highly structured lamellar bone fits to the thread contour without a connective tissue layer. There are no inflammation or rejection reactions. Patient bone and graft form a stable bone healing unit. (Elliott DS et al., 2016)

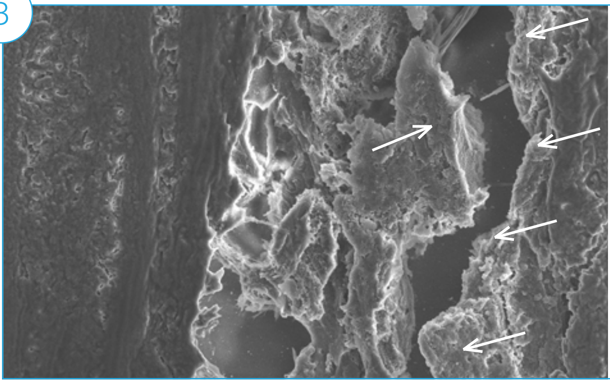
2



Mesenchymal stem cells & osteoprogenitor cells

These migrate into the Shark Screw® graft. There they find ideal conditions to differentiate into the cells needed for bone remodeling - osteoblasts for bone formation and chondrocytes for cartilage formation.

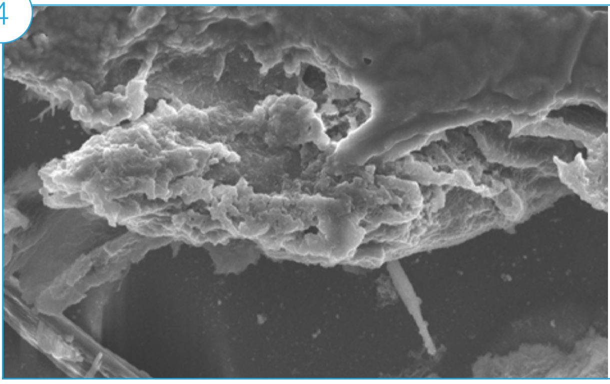
3



Osteoblasts

Osteoblasts (white arrows) form the basic bone substance and are primarily responsible for the organic matrix of the bone tissue. Countless biochemical substances, such as growth factors, hormones, messenger substances and proteins regulate bone remodeling inside the Shark Screw®.

4



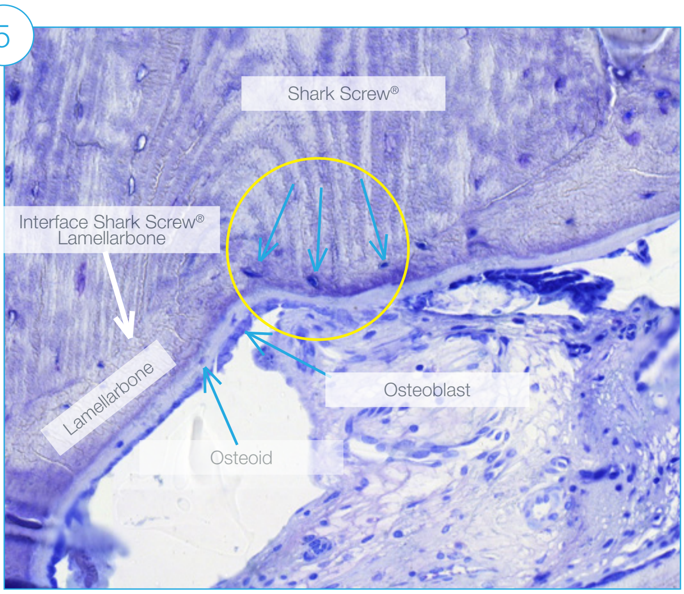
Osteoid producing osteoblast

Highly active osteoblasts secrete osteoid - the basic bone substance. This is gradually mineralized and the osteoblasts differentiate further into osteocytes.

Histomorphology

Natural bone remodeling

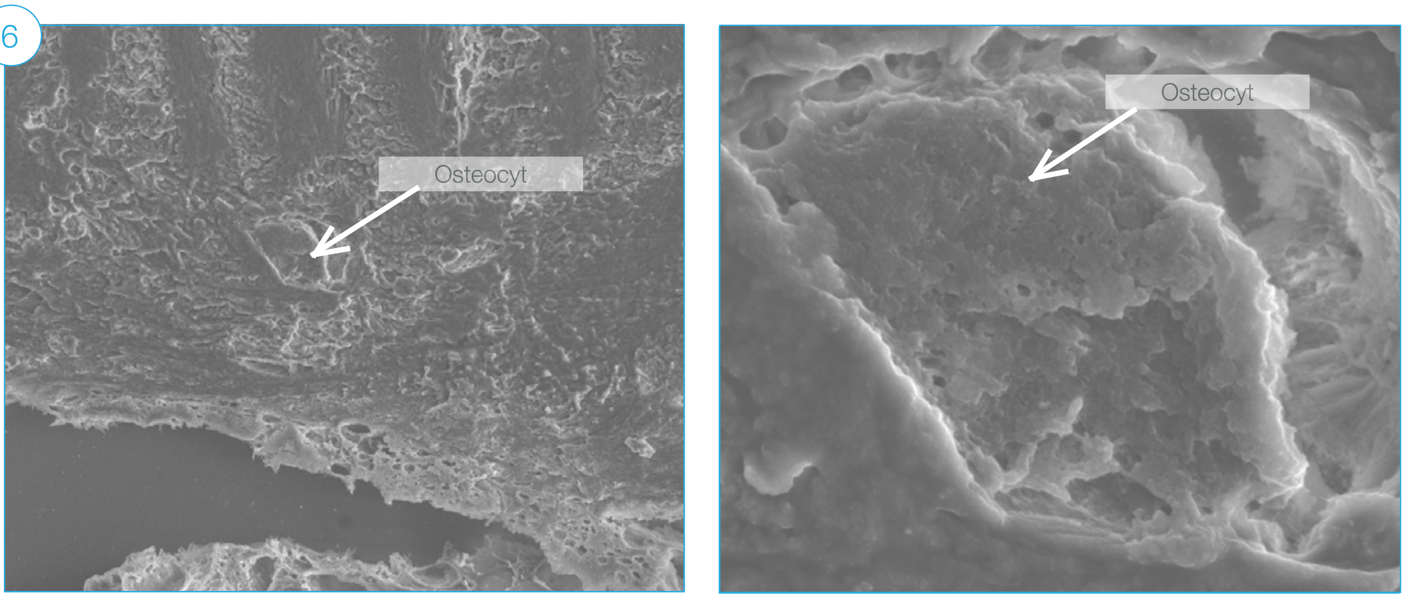
5



Thread of the Shark Screw® & patient bone

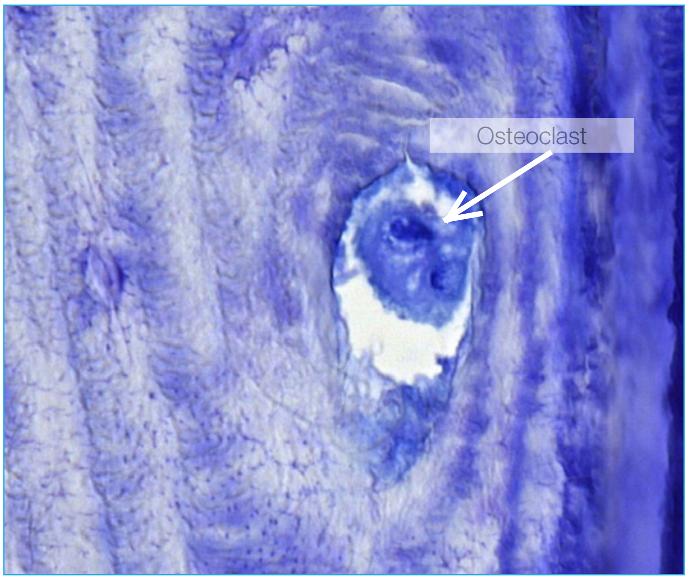
The yellow circle highlights the osteocytes in a light microscopy picture.

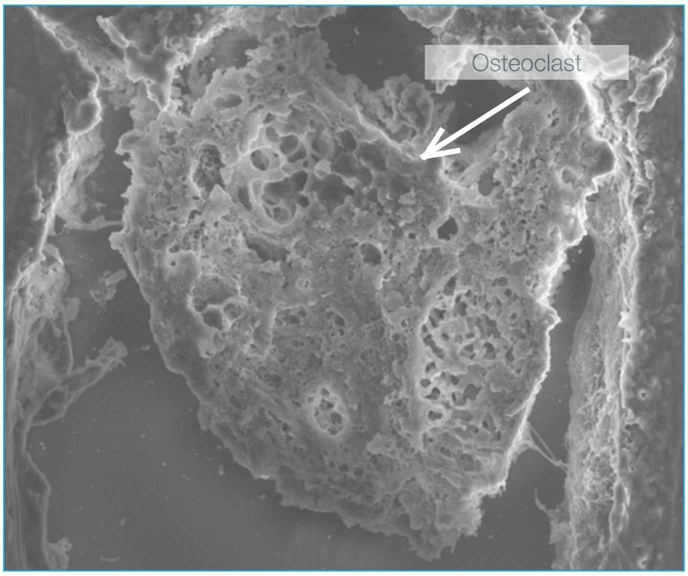
6



Osteocyte

Osteocytes are the most abundant cells in our bone, numbering approximately 42 billion. They are completely embedded in the bone and develop from osteoblasts. Their network of projections, with which they are connected to each other via canaliculi, is impressive. They secrete messenger substances that promote both bone formation and bone resorption. (Kurth A. & Lange U., Fachwissen Osteologie, 2018)





7 Osteoclasts

Osteoclasts, here in a Haversian channel of the Shark Screw®, resorb the bone material of Shark Screw®. By secreting cytokines, osteoclasts can promote or inhibit the local recruitment, differentiation and activity of osteoblasts. These particular phagocytes are in constant exchange with osteocytes and osteoblasts and can significantly influence them (Sims, N. A., & Martin, T. J., 2014). This constant crosstalk among bone cells enables remodeling of the graft in patient bone.

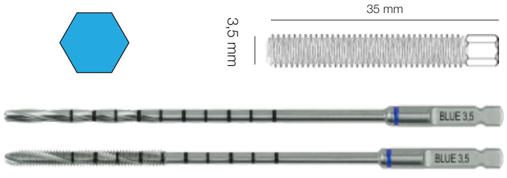
READ

THE

PUPLICATION

Instrumentation

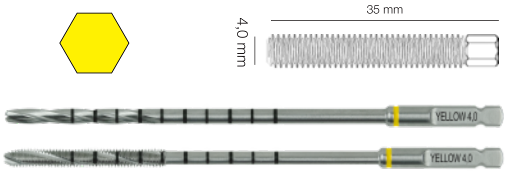
Shark Screw®



Shark Screw® cut 3,5mm Ø blue allograft screw

Cannulated drill for 3,5mm Ø Shark Screw® cut

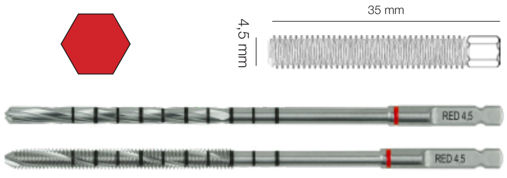
Cannulated tap for 3,5mm Ø Shark Screw® cut



Shark Screw® cut 4,0mm Ø yellow allograft screw

Cannulated drill for 4,0mm Ø Shark Screw® cut

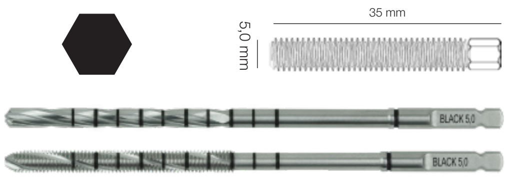
Cannulated tap for 4,0mm Ø Shark Screw® cut



Shark Screw® cut 4,5mm Ø red allograft screw

Cannulated drill for 4,5mm Ø Shark Screw® cut

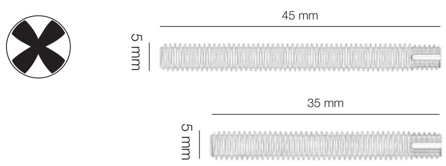
Cannulated tap for 4,5mm Ø Shark Screw® cut



Shark Screw® cut 5,0mm Ø black allograft screw

Cannulated drill for 5,0mm Ø Shark Screw® cut

Cannulated tap for 5,0mm Ø Shark Screw® cut



Shark Screw® diver 5,0mm Ø black allograft screw

Cannulated drill for 5,0mm Ø Shark Screw® diver

Cannulated tap for 5,0mm Ø Shark Screw® diver

General surgical technique

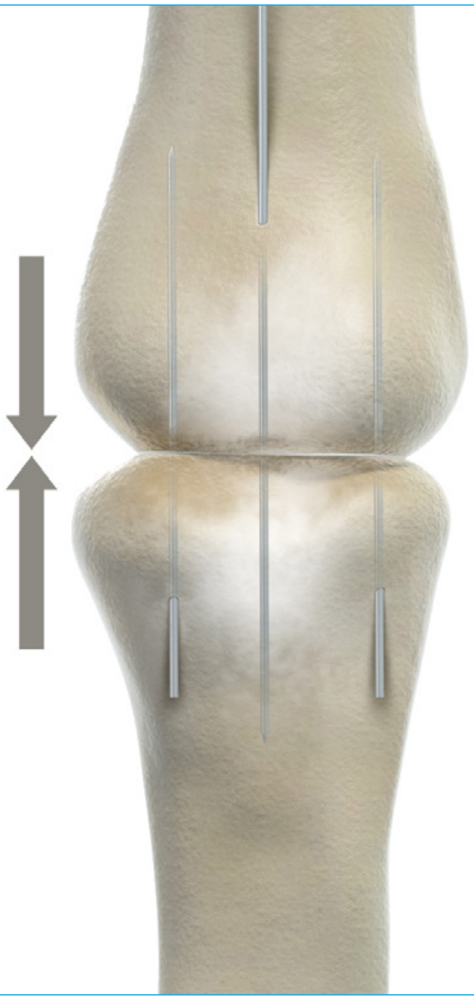
Shark Screw®

1

Preperation, reduction, compression

Surgery with the Shark Screw® always follows the same steps, regardless of the region of the body in which it is used. The fracture surfaces / the de-cartilaginized, opposing joint surfaces / the osteotomy surfaces are freshened with a thin drill (1.0 or 1.5 mm) and then adjusted to each other. They are brought under compression from the outside, possibly by using a reduction clamp.

2



Positioning the 1.6 mm K-wire

After repositioning the joint surfaces, insert a 1.6 mm K-wire, which represents the direction and position of the Shark Screw® to be inserted later. **Primarily, a 1.6 mm K-wire should always be used for pre-drilling, as it cannot bend during insertion and is directionally accurate.** A 1.1 mm K-wire can bend during insertion and could be drilled off when over-drilling! Use fluoroscopy to check the position of the guide wire.

Temporarily 1.1 mm fixation K-wires

In addition, one or two thin K-wires (1.1 or 1.2 mm K-wire) are always placed temporarily. They are intended to keep the two pieces of bone to be fixed as stable as possible during drilling and tapping. They must be placed as close to the outer edge as possible so that they do not interfere with drilling and tapping later on. Now the two pieces of bone can no longer slip and the specified compression is kept stable.

IMPORTANT!

- Always use a 1.6 mm K-wire for pre-drilling
- Drill stepwise to minimize generated heat and ensure vital bone
- You are replacing patient bone with allogeneic bone. You put bone were bone belongs!

3

Drilling the core hole

The 1.6 mm K-wire is now removed and replaced with a 1.1 mm K-wire, which can then be used as a guidewire for the cannulated instrumentation.

Drilling should always be carried out stepwise to minimize the heat generated during drilling.

Start with the thinnest (blue) drill. This makes it possible to determine the ideal thickness of the graft for the respective region and the respective recipient. Choose the graft as thick as possible, as the load-bearing capacity increases with the diameter. The more mass of donor bone is available in the form of the screw-bone bridge, the more stable the connection between the two pieces of bone to be fixed is.

4

Tapping

After drilling the core hole, proceed with tapping using the matching tap. Use the inserted 1.1 mm K-wire as a guidance. Drills, taps, and the Shark Screw® allografts are color coded. (e.g. to use a Shark Screw® allograft in a diameter of 4.0mm (yellow) you must perform drilling and tapping with the yellow instruments)

5

Rinsing the canal

After tapping, the canal must be carefully rinsed with saline solution to remove any bone fragments that may remain inside.

6

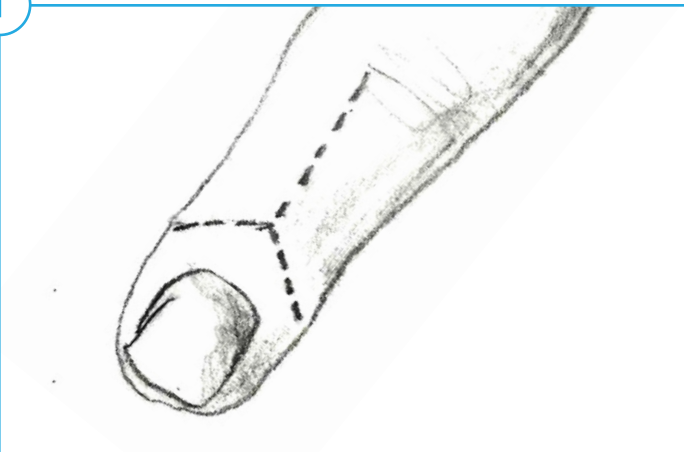
Inserting the Shark Screw® allograft

Insert the desired Shark Screw® allograft almost without any resistance using the screwdriver. Make sure that the screw is in the correct axial position when it is placed on the drilled channel. The head of Shark Screw® cut must not be inserted into the channel. (left picture) The Shark Screw® is held in place solely by the self-locking effect of the narrow thread and never by the screw head. In contrast to Shark Screw® cut, the head of Shark Screw® diver can be inserted below bone level. (right picture) In these cases, the screw head does not need to be cut off and serves as an additional bone bridge. After inserting Shark Screw®, cut off protruding screw parts with the oscillating saw or a burr.

!

If small bone parts remain in the channel they may prevent the screw from being screwed in. If resistance is encountered intraoperatively, it must not be overcome by force under any circumstances. In the event of major resistance, the screw should be removed, tapping and rinsing should be repeated and then the screw can be reinserted. Shark Screw® screws can not be resterilized. They must be inserted directly from the original sterile packaging without prior manipulation.

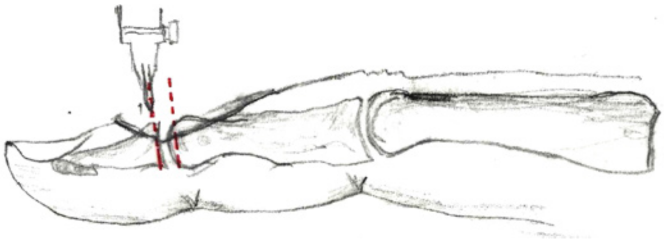
1

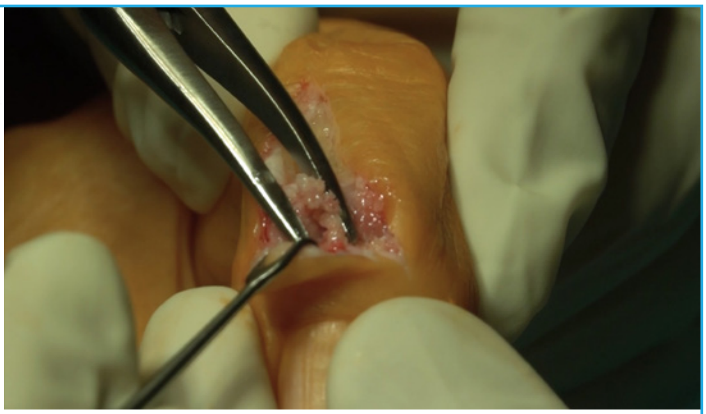


Step 1:

Y-shaped skin incision to allow free access to the joint. The incision is extended proximally to approximately 2 cm distal to the proximal interphalangeal (PIP) joint. We first remove the dorsal exophytes using a Luer rongeur. After transecting the collateral ligaments, we remove the remaining lateral and, if present, volar exophytes.

2





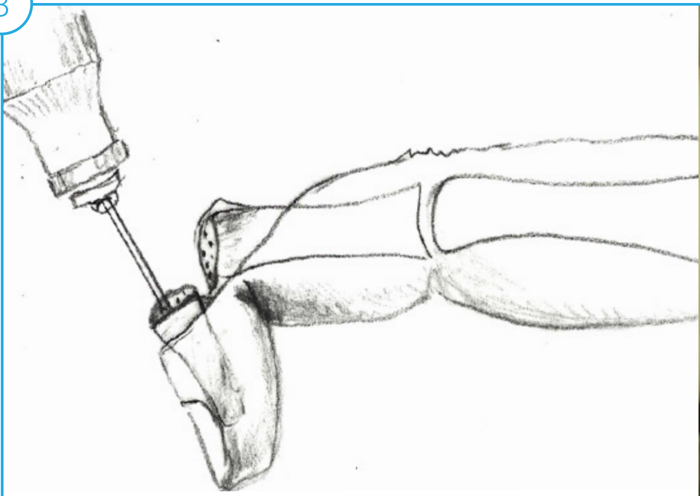
Step 2:

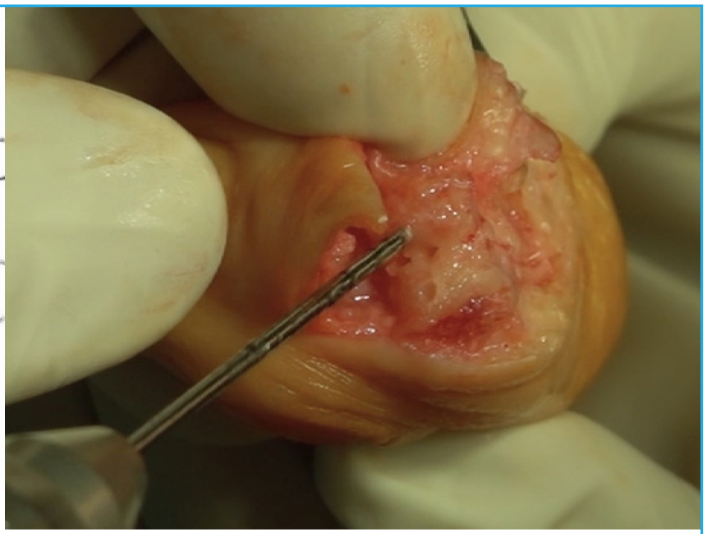
We remove the cartilage using a Luer rongeur, a sharp curette, or scraping movements with the oscillating saw. Sometimes this is easier to perform with the DIP joint in full flexion.

!

In cases of bone defects, it may be necessary to perform the DIP joint arthrodesis from a distal approach through the fingertip.

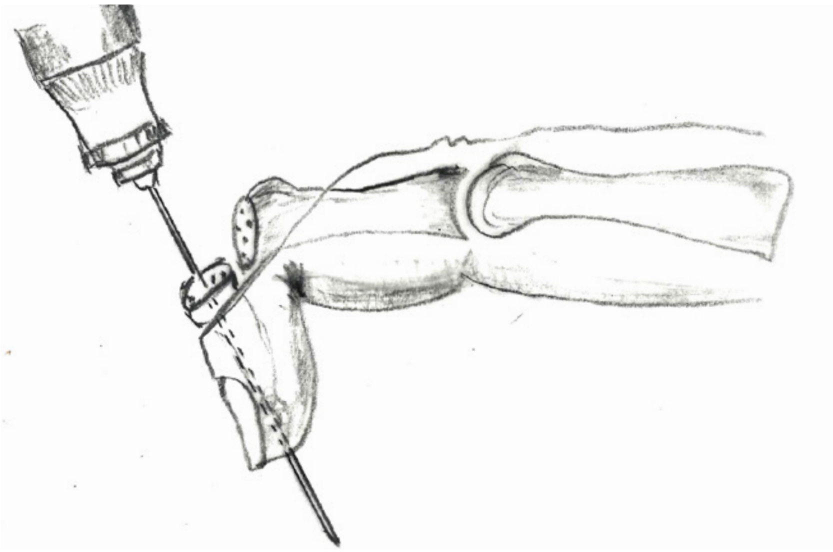
3





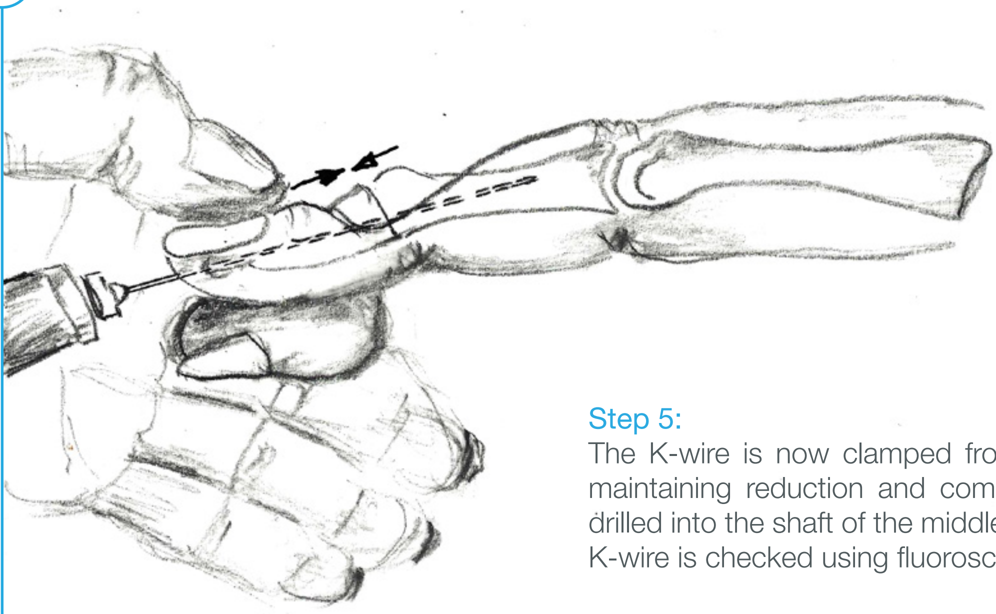
Step 3:
Next, we refresh the sclerotic bone of both DIP joint surfaces using the tip of a K-wire or a small-diameter drill.

4



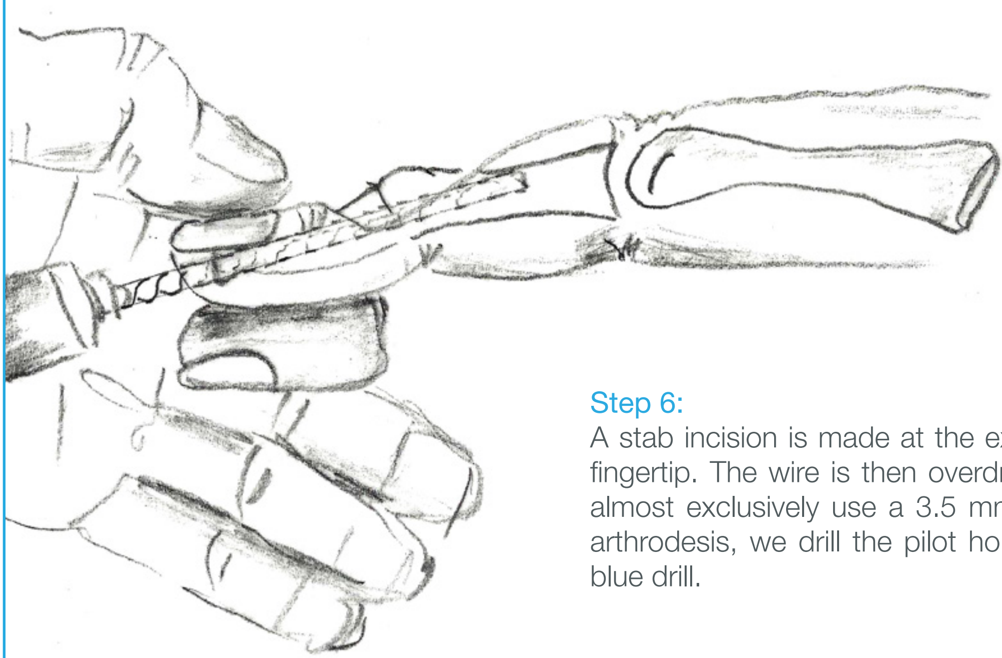
Step 4:
We now check the alignment of the arthrodesis, the rotation, and how the debrided and refreshed joint surfaces are positioned in relation to each other. A double-pointed 1.1 mm K-wire is inserted from proximal into the center of the base of the distal phalanx and drilled centrally through the shaft until it exits through the skin at the fingertip.

5



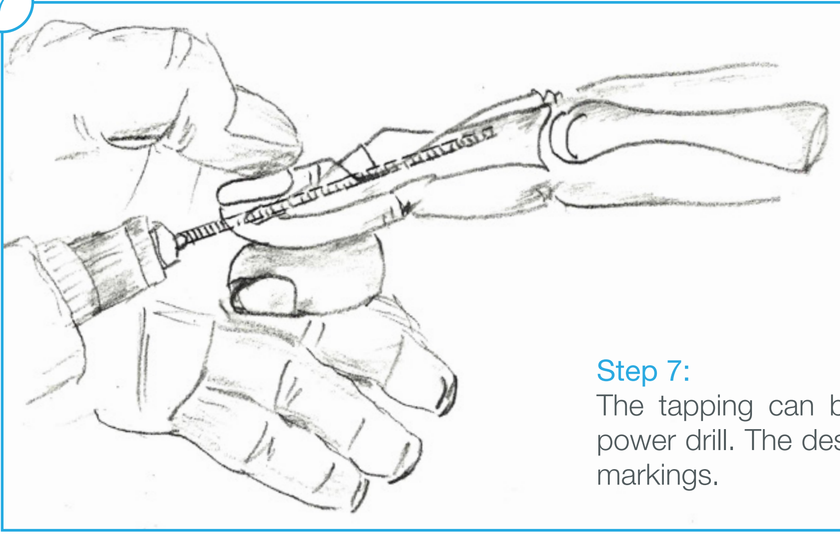
Step 5:
The K-wire is now clamped from the distal end and, while maintaining reduction and compression of the DIP joint, is drilled into the shaft of the middle phalanx. The position of the K-wire is checked using fluoroscopy.

6



Step 6:
A stab incision is made at the exit point of the K-wire at the fingertip. The wire is then overdrilled, and tapped. Since we almost exclusively use a 3.5 mm Shark Screw® cut for DIP arthrodesis, we drill the pilot hole over the K-wire using the blue drill.

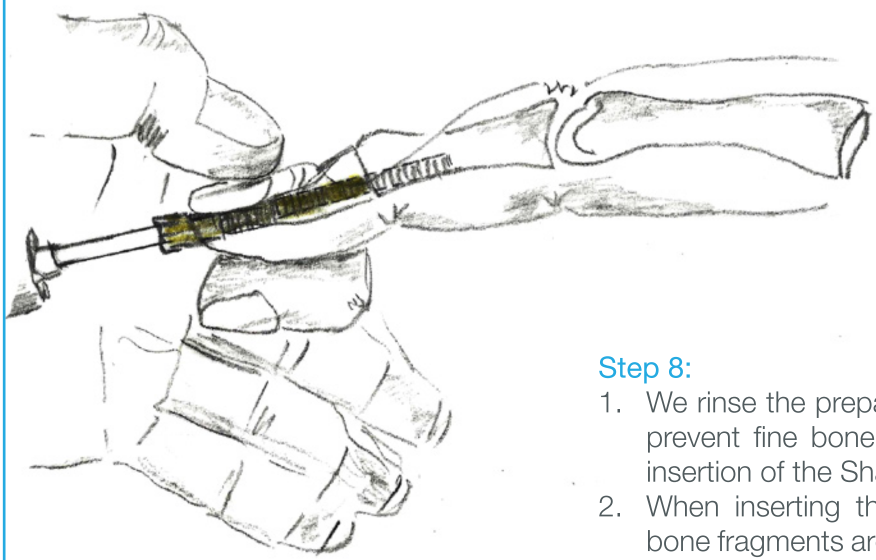
7



Step 7:

The tapping can be performed either manually or using a power drill. The desired depth is indicated by the lateral laser markings.

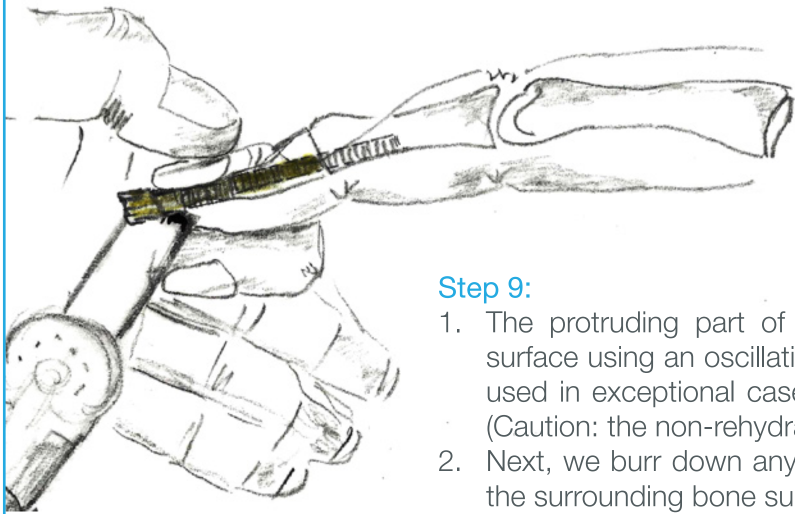
8



Step 8:

1. We rinse the prepared canal with sterile saline solution to prevent fine bone debris from blocking the path during insertion of the Shark Screw®.
2. When inserting the Shark Screw®, we ensure that the bone fragments are firmly compressed against each other.

9



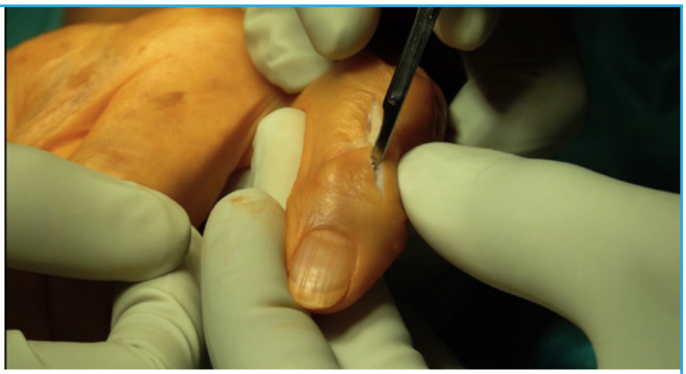
Step 9:
1. The protruding part of the screw is cut off just above the bone surface using an oscillating saw. Alternatively, a Luer rongeur may be used in exceptional cases when there is not enough space to saw. (Caution: the non-rehydrated bone screw is brittle!)
2. Next, we burr down any slightly protruding graft bone to the level of the surrounding bone surface.

Postoperative Management*

Short cast or Stark splint for 6 weeks.

STREAM
SURGICAL
VIDEO

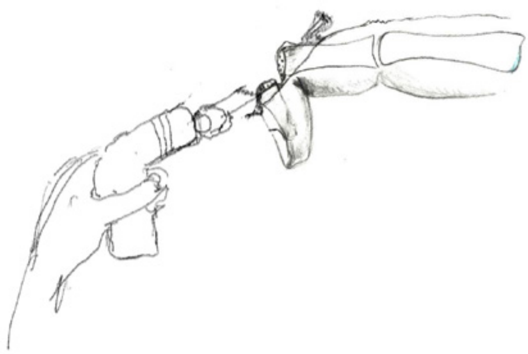
1



The press-fit technique using the Shark Screw® is a suitable minimally invasive option for DIP joint arthrodesis. The fingertip remains completely untouched.

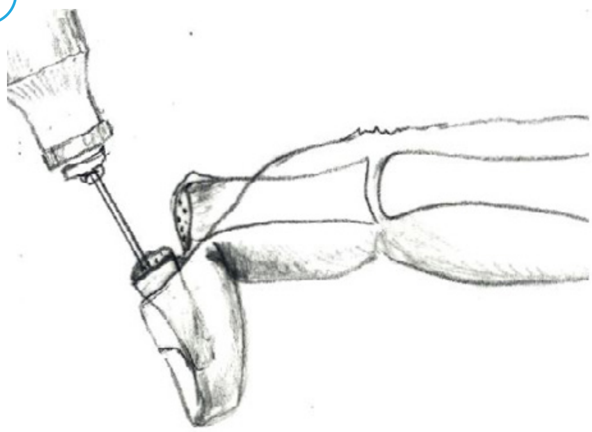
A short Y-shaped skin incision is made. Underneath, the extensor tendon is transected at an oblique angle so that it can later be reattached to the distal stump (to cover the arthrodesis site). Exophytes are removed using a Luer rongeur, and the collateral ligaments are transected to allow maximum flexion of the DIP joint.

2



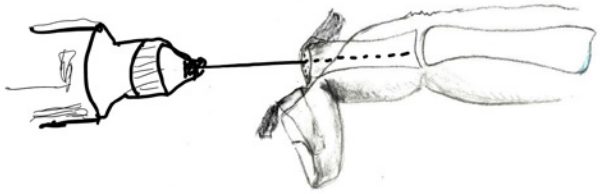
We remove the cartilage using a Luer rongeur or an oscillating saw. This is best done with the DIP joint in full flexion. The distal extensor tendon stump must be carefully elevated a few millimeters from the distal phalanx to allow unobstructed resection.

3



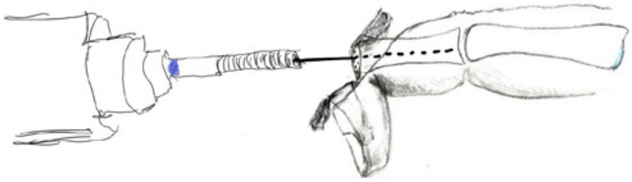
We refresh the sclerotic bone of both DIP joint surfaces using the tip of a K-wire or a small-diameter drill.

4



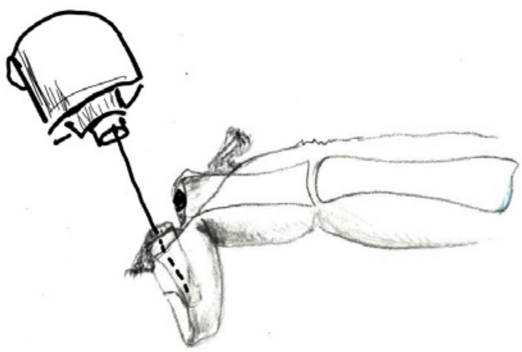
We now check the alignment of the arthrodesis, the rotation, and how the debrided and refreshed joint surfaces fit together. A 1.1 mm K-wire is inserted centrally into the intramedullary canal of the middle phalanx. This serves as a guide for pilot drilling and tapping for the appropriate Shark Screw®, usually with a diameter of 3.5 mm (blue).

5



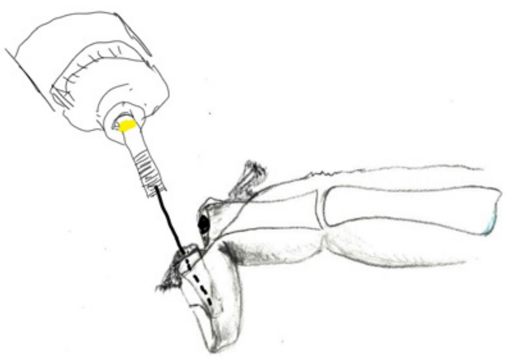
The pilot hole is drilled over the K-wire, and tapping is performed using the instruments marked in blue for the 3.5 mm Shark Screw®.

6



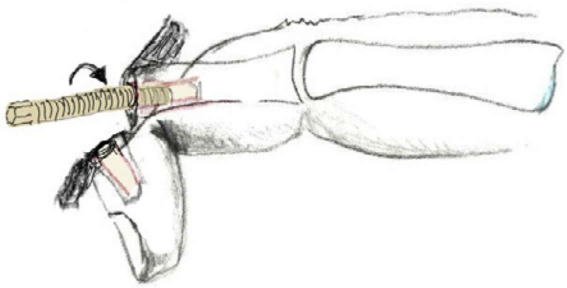
From proximal, a 1.1 mm K-wire is inserted into the shaft of the distal phalanx and drilled centrally through to the tip of the phalanx.

7



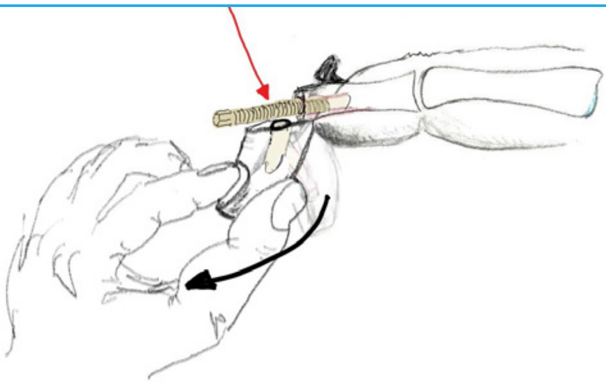
The pilot hole is drilled over the K-wire. Since the Shark Screw® will be press-fit later, the distal pilot hole must be one size larger than the hole in the middle phalanx. For example, if a blue 3.5 mm Shark Screw® is used, the distal hole must be drilled using the yellow drill (outer diameter 3.25 mm). No tapping is performed in this step.

8



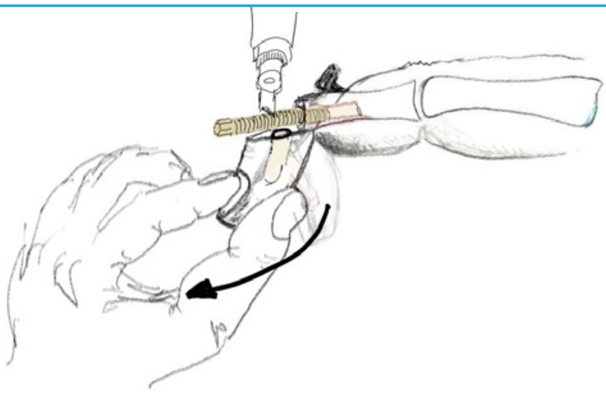
The Shark Screw® is inserted into the tapped thread of the middle phalanx to a depth of approximately 10 to 12 mm, depending on the achieved stability.

9



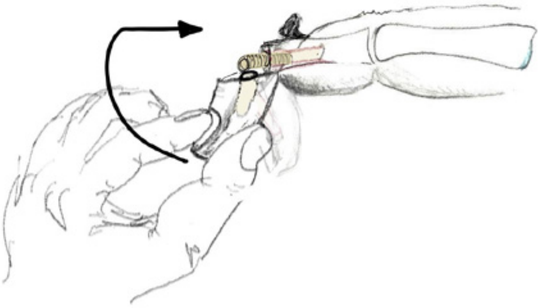
The distal phalanx is placed under maximum traction to identify the point at which the Shark Screw® should be cut, ensuring that the distal phalanx can still be securely press-fit onto the screw afterward.

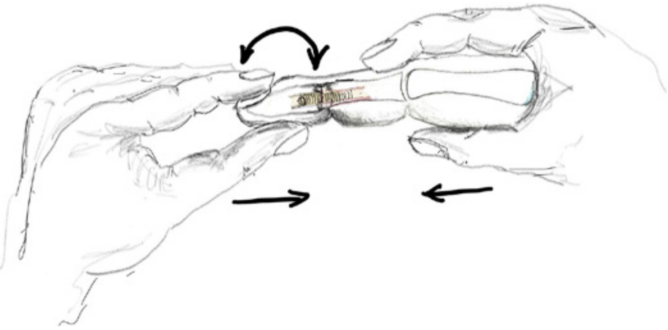
10



The Shark Screw® is cut at the previously marked point using an oscillating saw.

11





With maximum traction applied to the distal phalanx and gentle pressure on the Shark Screw® using the surgeon's fingernail, the distal phalanx is press-fit onto the Shark Screw®. By carefully rotating the distal phalanx back and forth (similar to squeezing a lemon), the former joint surfaces can be optimally aligned and compressed against each other, with the Shark Screw® maintaining the compression.

Postoperative Management*

We provide our patients with a short plaster splint or a Stark splint for 6 weeks.

DIP arthrodesis on the index finger using the press-fit technique, and on the middle finger using the screw-in technique, in which the Shark Screw® is inserted from distal through the fingertip.

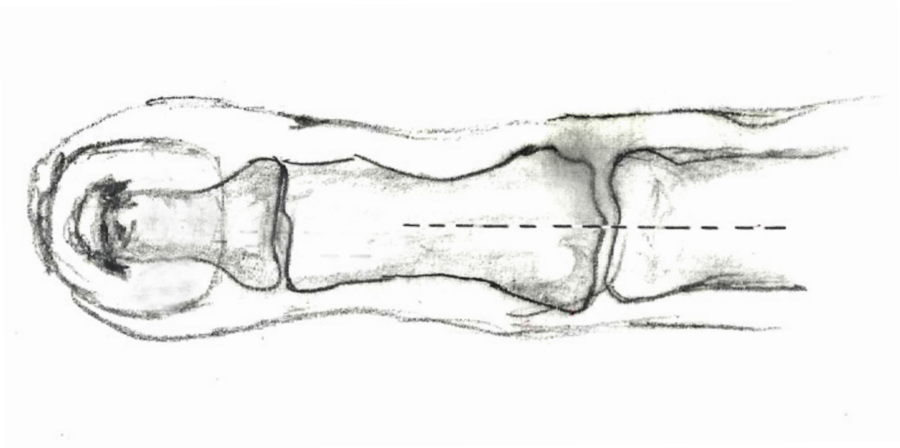
Radiographic follow-up of a DIP arthrodesis

The clinical case shows a radiographic follow-up of a DIP arthrodesis using the Shark Screw®.
X-ray images from left to right: preoperative AP | clinical AP | postoperative AP | 4 weeks postoperative AP.

PIP-Arthrodesis

Surgical Technique

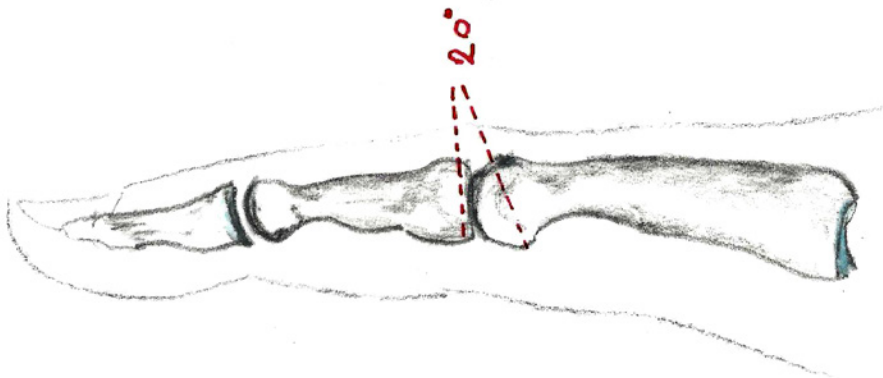
1



Step 1:

1. A straight skin incision is made directly over the PIP joint to allow free access to the joint. The incision extends from 10 mm distal to the PIP joint to approximately 20 mm proximal to it. The extensor aponeurosis is split longitudinally, and the dorsal and lateral exophytes are removed using a Luer rongeur.
2. After transecting the collateral ligaments, any remaining lateral and, if present, volar exophytes are removed.

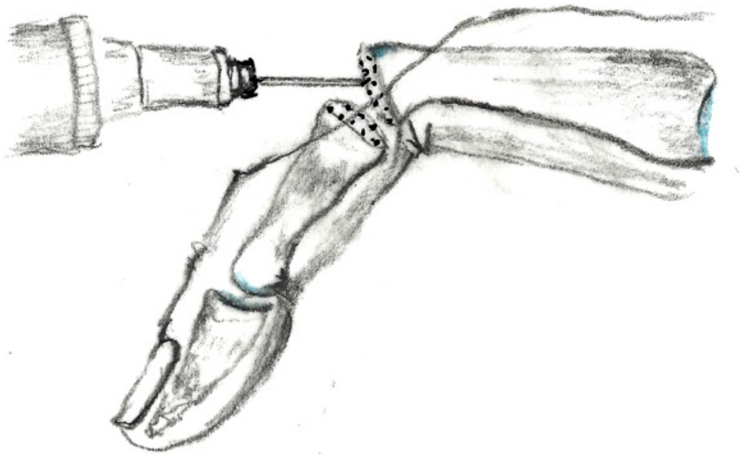
2



Step 2:

1. Depending on the extent of joint surface damage, cartilage is removed using a Luer rongeur or an oscillating saw to create congruent joint surfaces. Only the articular cartilage is removed, with no osteotomy performed, as the debrided joint allows for optimal adjustment to the required flexion angle.
2. For arthrodesis of the index and middle fingers, the fusion angle is approximately 20°. For the ring and little fingers, the angle should be increased to around 30° (reference values). Of course, the final angle is discussed and agreed upon with the patient during the preoperative consultation.

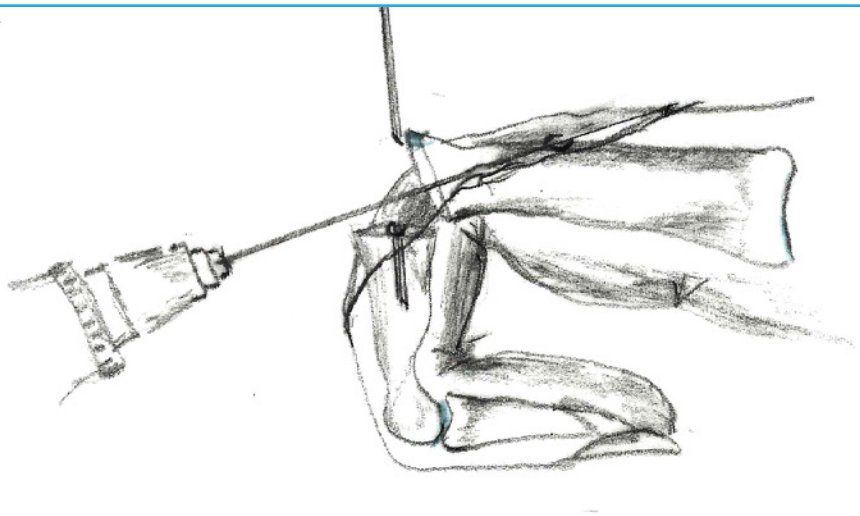
3



Step 3:

1. Next, we refresh the sclerotic bone of both joint surfaces using the tip of a K-wire or a small-diameter drill.
2. We then check the flexion angle of the arthrodesis, as previously agreed upon with the patient. We also verify the rotation and ensure that the debrided and refreshed joint surfaces are aligned flush with each other.

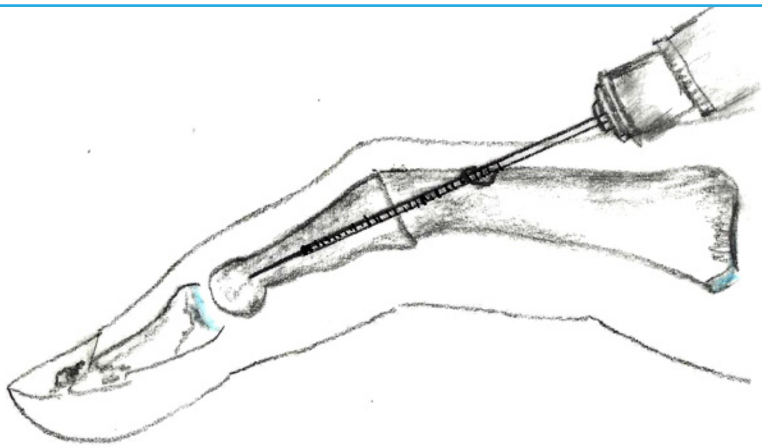
4



Step 4:

A double-pointed 1.1 mm K-wire is inserted from distal, taking the desired flexion angle into account, into the center of the trochlea of the proximal phalanx. It is then drilled centrally through the shaft of the proximal phalanx until it exits through the dorsal cortex approximately 15 to 18 mm proximal to the PIP joint.

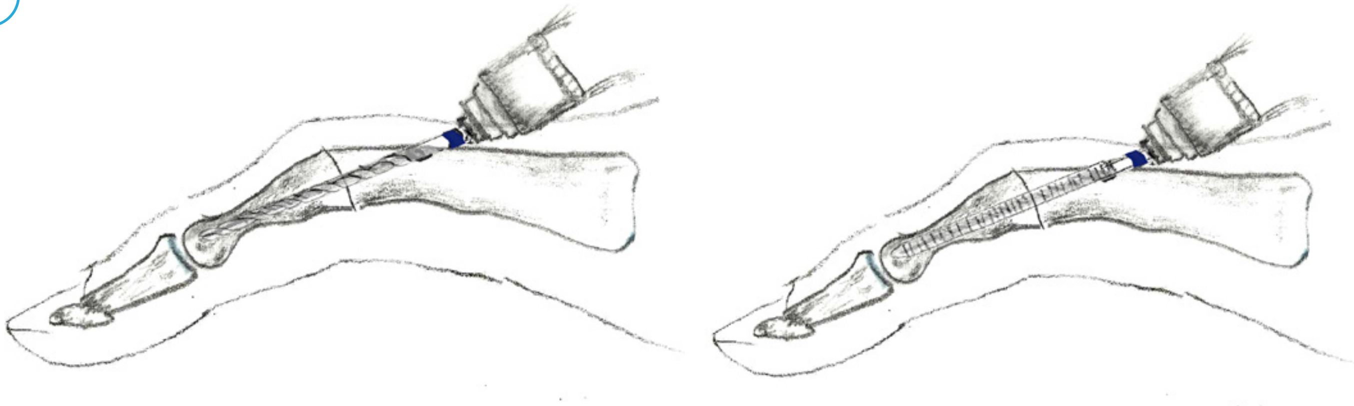
5



Step 5:

The K-wire is inserted proximally and drilled centrally into the shaft of the middle phalanx under reduction and compression of the PIP joint. K-wire position is confirmed using fluoroscopy.

6



Step 6:

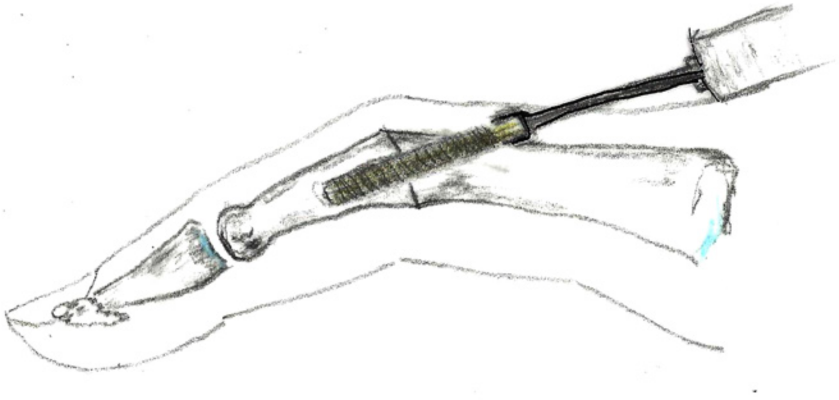
1. The pilot hole is drilled from proximal over the K-wire, followed by tapping. Drilling begins with the smallest drill bit (blue) and is gradually increased to the largest possible diameter for optimal fit.

2. Tapping can be performed manually or using a power drill. The desired drilling depth is indicated by the lateral laser markings.

!

Ensure that a stable bone bridge of at least 10 mm remains between the entry point of the Shark Screw® cut into the proximal phalanx and the PIP joint. If the bone bridge is shorter, there is a risk of fracture during drilling and tapping.

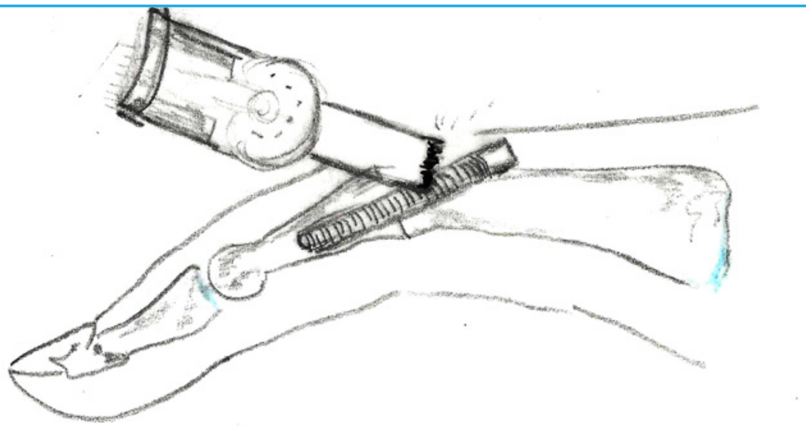
7



Step 7:

The prepared canal is rinsed with sterile saline to prevent fine bone debris from obstructing the insertion of the Shark Screw®. During insertion, care is taken to ensure that the bone fragments are firmly compressed against each other.

8



Schritt 8:

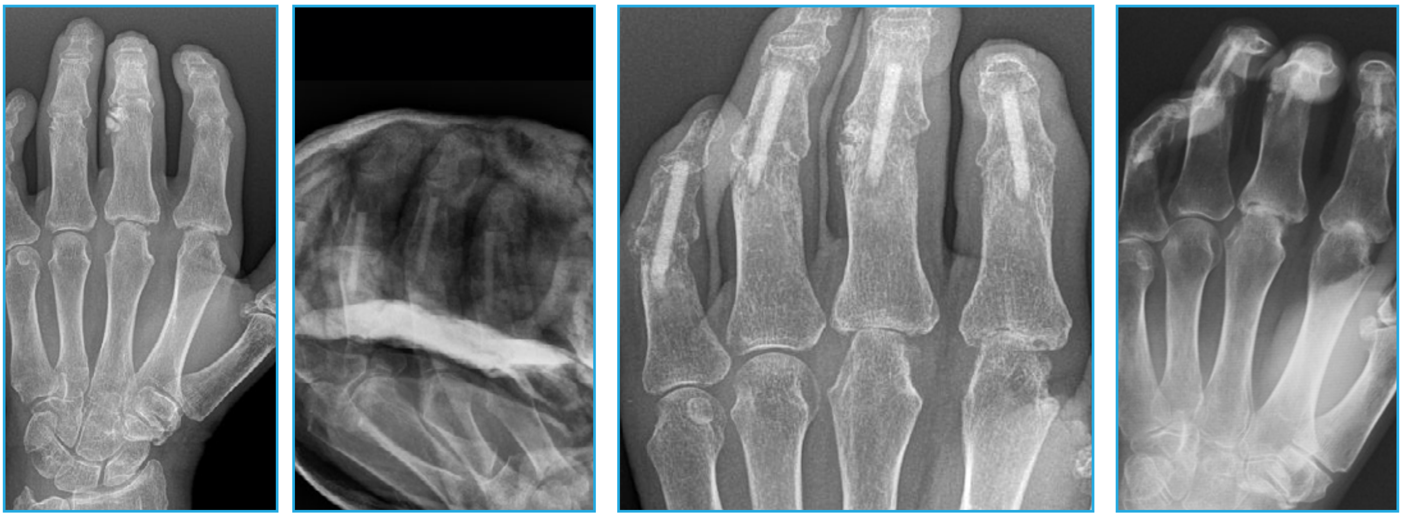
The protruding part of the screw is cut flush with the bone surface using an oscillating saw. The remaining graft bone is then contoured to the level of the surrounding bone.

Postoperative Management*

Patients are provided with a short finger splint for 6 weeks.

Radiographic follow-up of a PIP joint arthrodesis

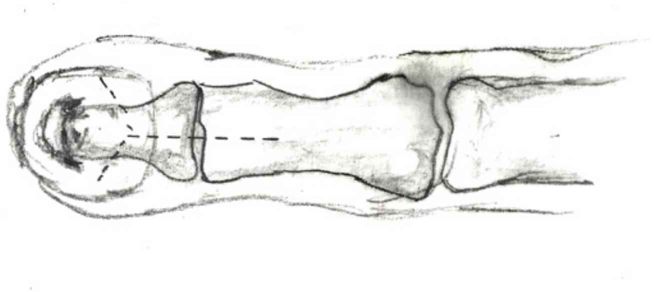
X-rays from left to right: preoperative AP view | preoperative lateral view | postoperative with short soft cast | 6 months postoperative | 12 months postoperative AP view | 12 months postoperative lateral view



Radiographic follow-up of a PIP joint arthrodesis

X-rays from left to right: preoperative (scleroderma with severe flexion deformities of PIP joints 2-5) | postoperative (status post corrective osteotomy and arthrodesis of PIP joints 2-5) | 8 weeks postoperative | 1 year postoperative

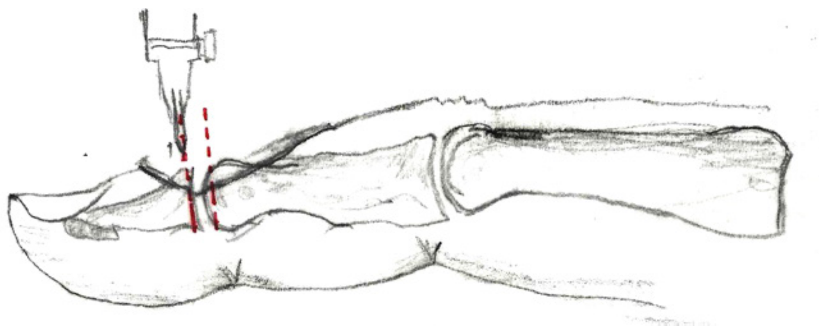
1



Step 1:

1. A Y-shaped skin incision is made to provide clear access to the joint. The incision is extended proximally to approximately 2 cm distal to the MCP I joint.
2. Dorsal osteophytes are first removed using a Luer rongeur. After transecting the collateral ligaments, the remaining lateral and, if present, volar osteophytes are excised.

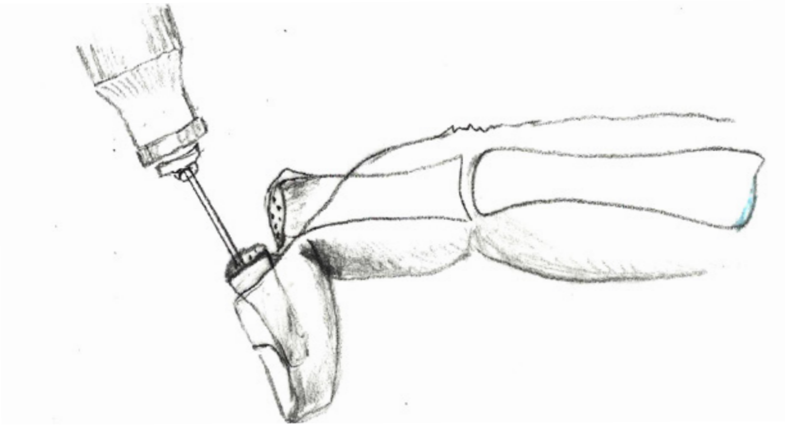
2



Step 2:

Cartilage is removed using a Luer rongeur, a curette, or an oscillating saw. This is usually more effective when the IP joint is held in maximum flexion.

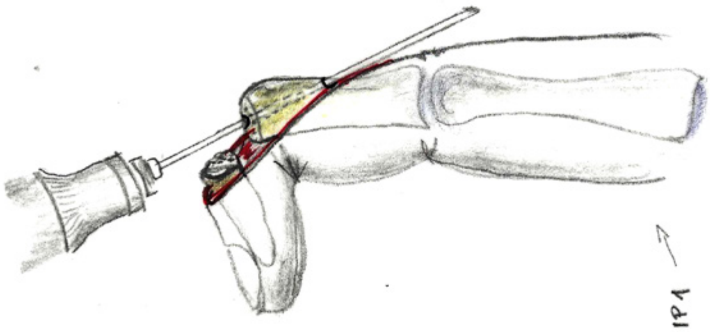
3



Step 3:

1. The sclerotic bone of both IP joint surfaces is then refreshed using the tip of a K-wire or a small drill bit.
2. Next, the flexion angle of the arthrodesis is checked (10–20° of flexion with slight opposition, no ulnar deviation), as previously agreed upon with the patient. Rotation is also assessed, along with confirmation that the debrided and refreshed joint surfaces are aligned flush with one another.

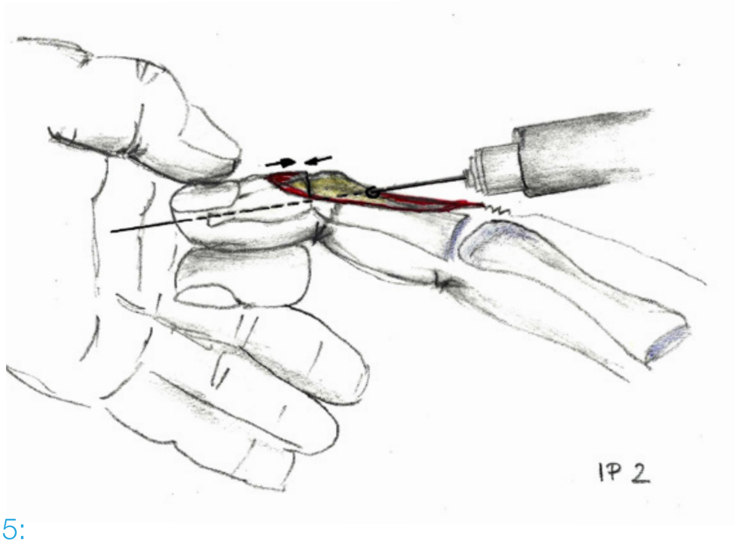
4



Step 4:

A double-pointed 1.1 mm K-wire is inserted from distal to proximal, accounting for the desired flexion angle, and advanced into the center of the trochlea of the proximal phalanx. It is then drilled centrally through the shaft of the proximal phalanx until it exits the dorsal cortex approximately 15–18 mm proximal to the IP joint.

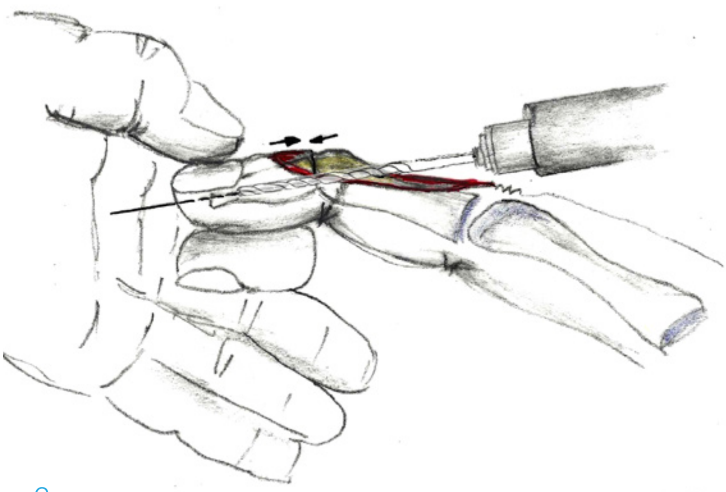
5



Step 5:

The K-wire is then clamped proximally and drilled centrally into the shaft of the distal phalanx under reduction and compression of the IP joint, until it exits through the tip of the thumb. K-wire position is confirmed using fluoroscopy.

6



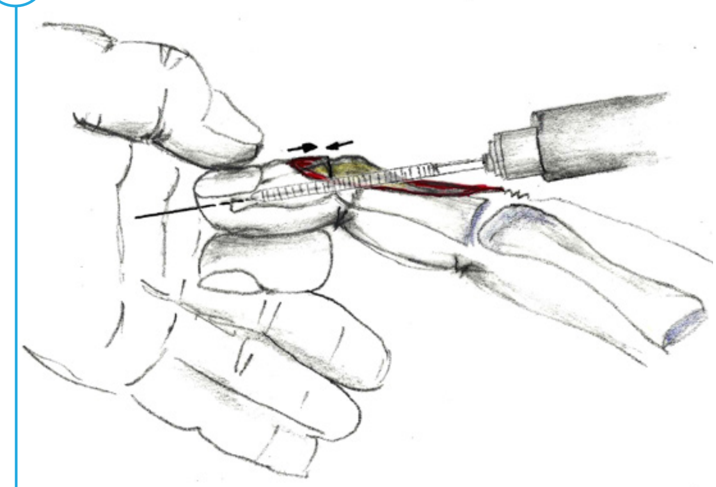
Step 6:

The pilot hole is then drilled from proximal over the K-wire, followed by tapping. Drilling begins with the smallest drill bit (blue) and is gradually increased to the largest suitable diameter for optimal fit.

!

Ensure that a stable bone bridge of at least 10 mm remains between the Shark Screw® entry point in the proximal phalanx and the IP joint. If the bone bridge is shorter, there is a risk of fracture during drilling and tapping.

7



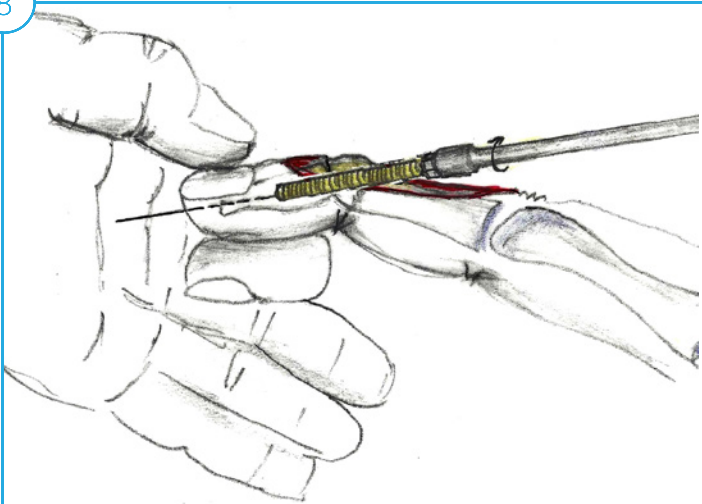
Step 7:

Tapping can be performed manually or using a power drill. The desired drilling depth is indicated by the lateral laser markings.

!

Before inserting the Shark Screw®, the drill canal must be thoroughly rinsed with sterile saline to prevent fine bone debris from causing the screw to jam during insertion.

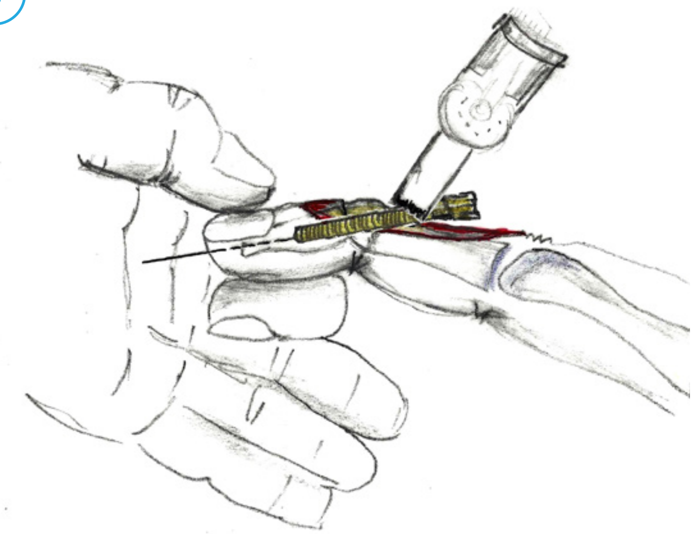
8



Step 8:

During insertion of the Shark Screw®, care is taken to ensure that the bone fragments are firmly compressed against each other.

9



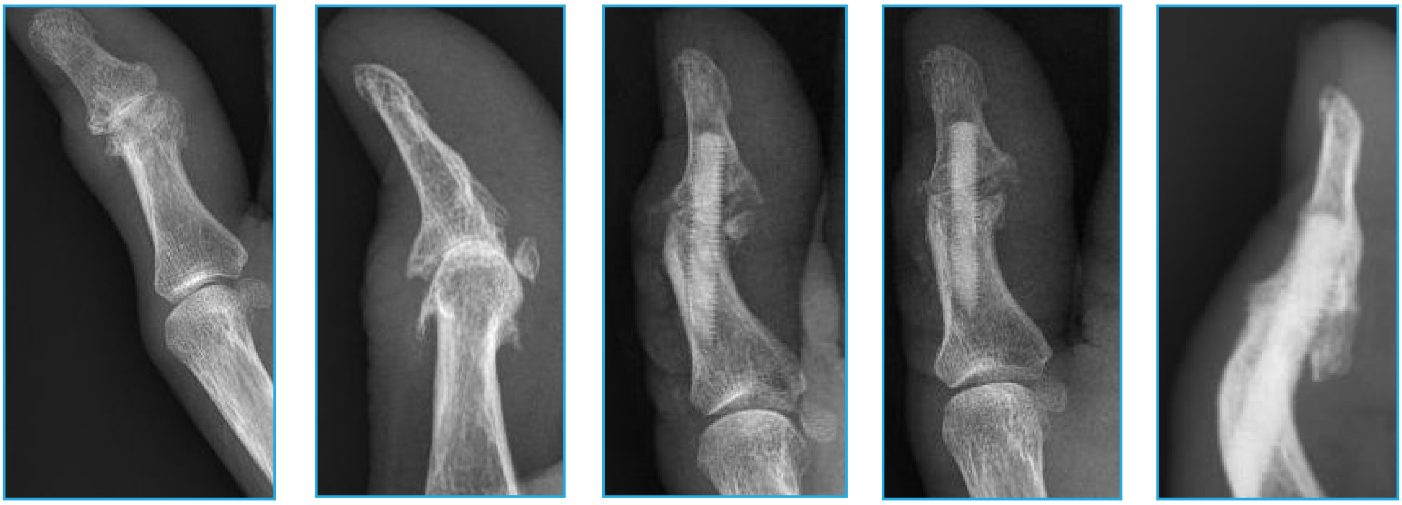
Step 9:
The protruding part of the screw is cut flush with the bone surface using an oscillating saw. Any remaining graft bone that extends beyond the surrounding surface is contoured back to the level of the adjacent bone.

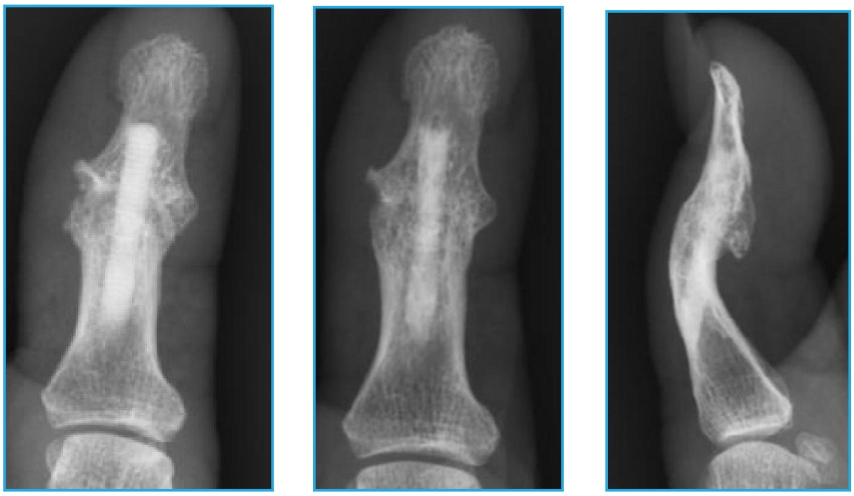
Postoperative Management*

Patients are treated with a short cast splint for 6 weeks. For an additional 2 weeks, the operated thumb should remain non-weight-bearing.

!

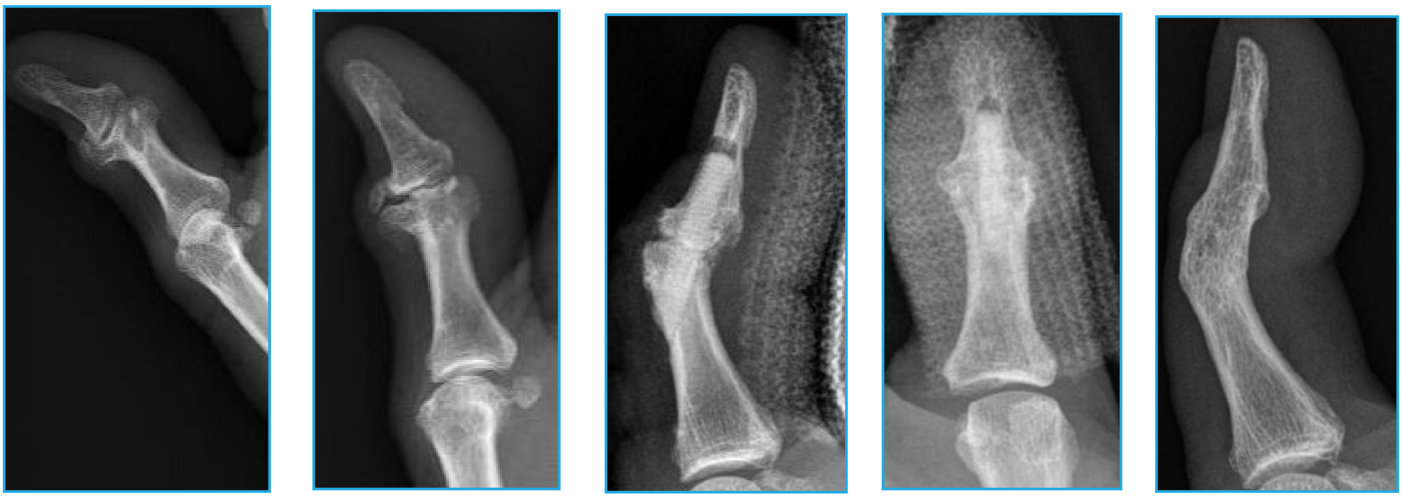
Arthrodesis of the IP joint is often performed using the intramedullary „dowel technique“ (see DIP arthrodesis using the dowel technique on pages 18 to 21). The main advantage for the patient is that the tip of the thumb remains intact with this method.





Radiographic follow-up of thumb IP joint arthrodesis using the Shark Screw®

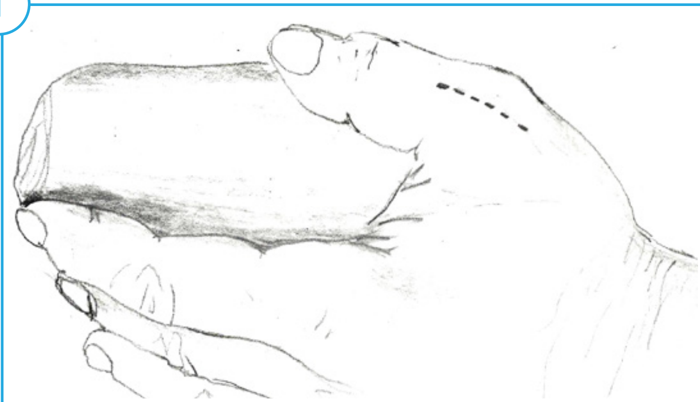
X-rays from left to right:
Row 1: preoperative AP view | preoperative lateral view | postoperative lateral view | postoperative AP view | 3 months postoperative lateral view
Row 2: 3 months postoperative AP view | 1 year postoperative AP view | 1 year postoperative lateral view

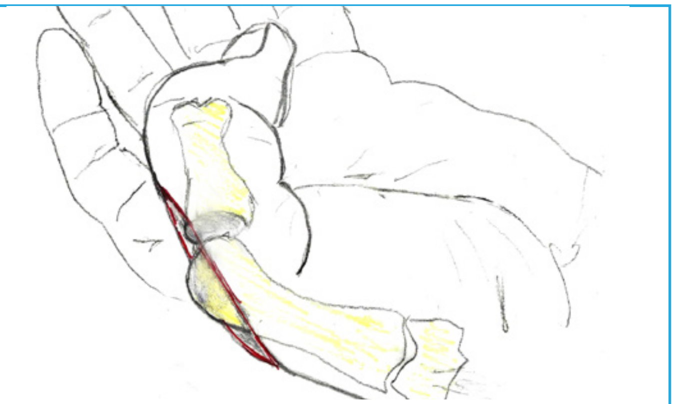


Radiographic follow-up of thumb IP joint arthrodesis using the Shark Screw®

X-rays from left to right: preoperative oblique view | preoperative lateral view | postoperative lateral view with short Bycast splint | postoperative AP view with short Bycast splint | 1 year postoperative lateral view | 1 year postoperative AP view

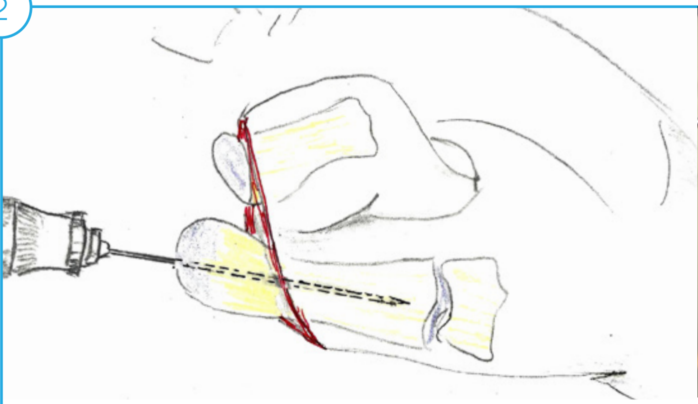
1

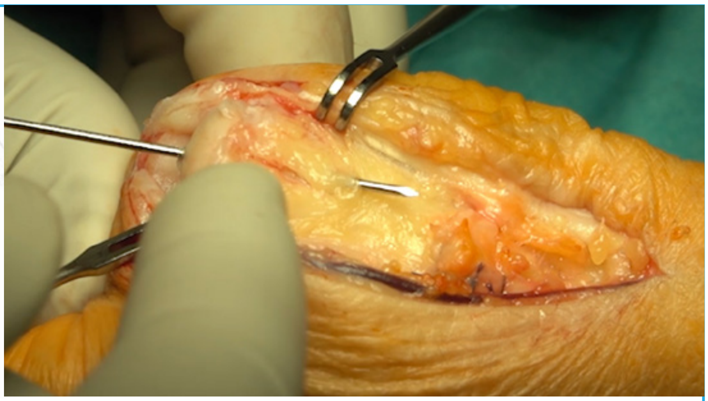




Step 1:
A straight dorsal skin incision is made over the thumb MCP joint. The extensor aponeurosis is split longitudinally, the collateral ligaments are transected, and the first metacarpal head is exposed by opening the joint. Osteophytes are removed.

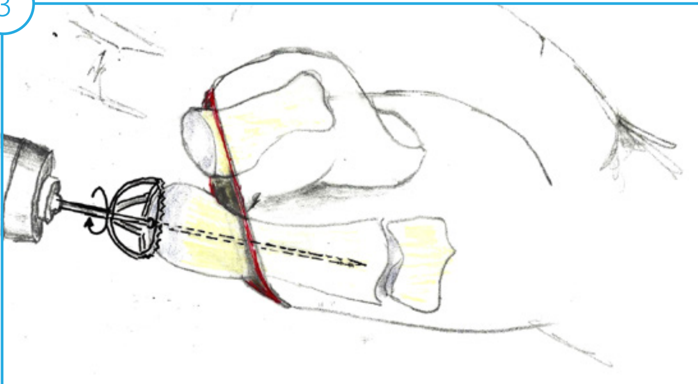
2

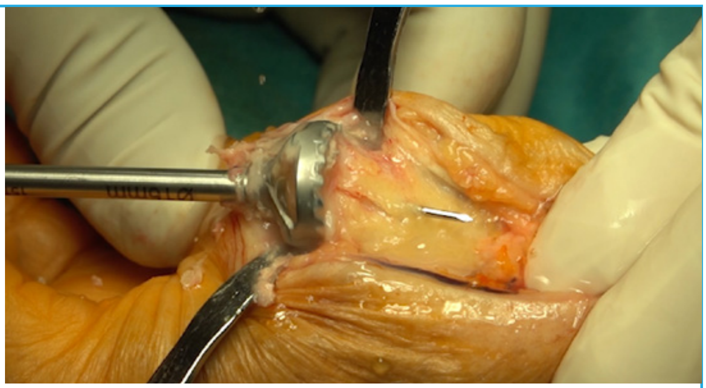




Step 2:
A 1.6 mm K-wire is inserted centrally from distal over the metacarpal head and advanced deep into the shaft of the first metacarpal. The K-wire represents the future trajectory of the Shark Screw® cut and perforates the dorsal cortex of the first metacarpal bone approximately 15–20 mm proximal to the MCP I joint, depending on the desired arthrodesis angle.

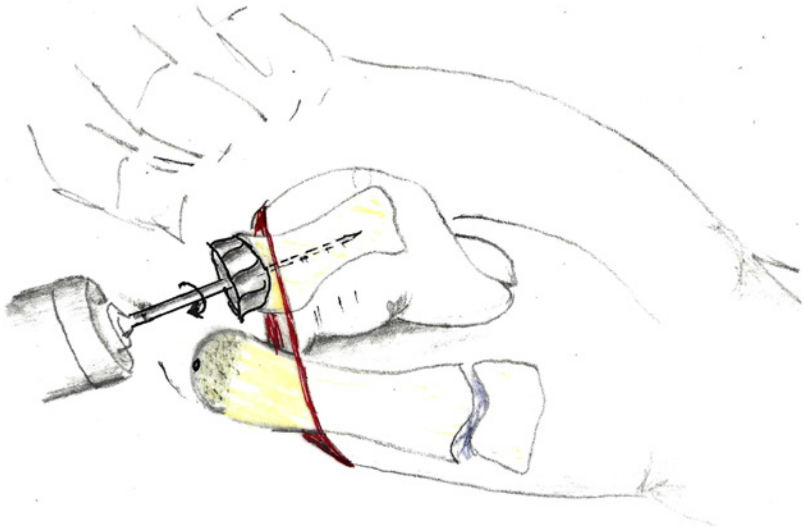
3





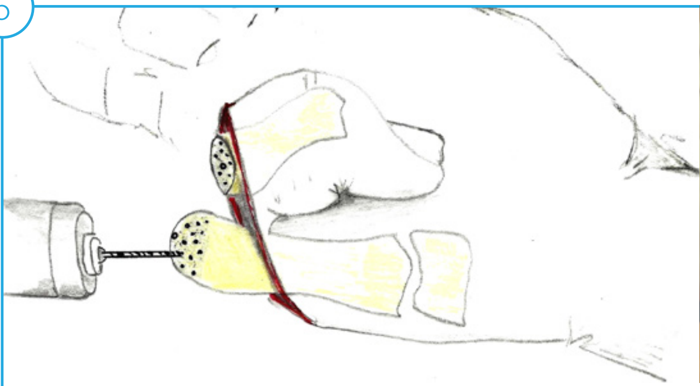
Step 3:
A 16 mm cup burr is guided over the K-wire to remove the remaining cartilage and refresh the sclerotic subchondral bone until the transition to cancellous bone is reached.

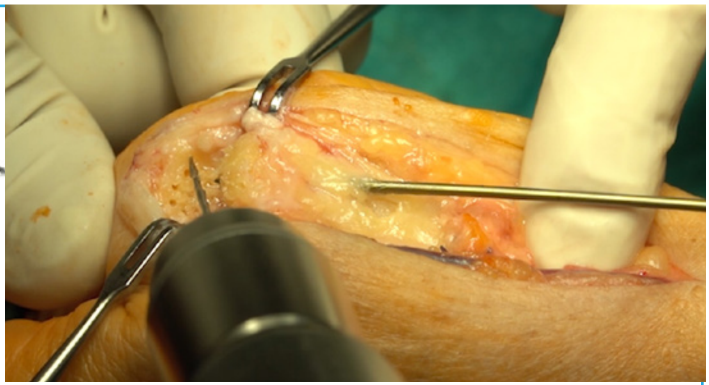
4



Step 4:
A central 1.6 mm K-wire is also drilled into the base of the distal phalanx, followed by cartilage removal and refreshing of the subchondral bone using the cone burr.

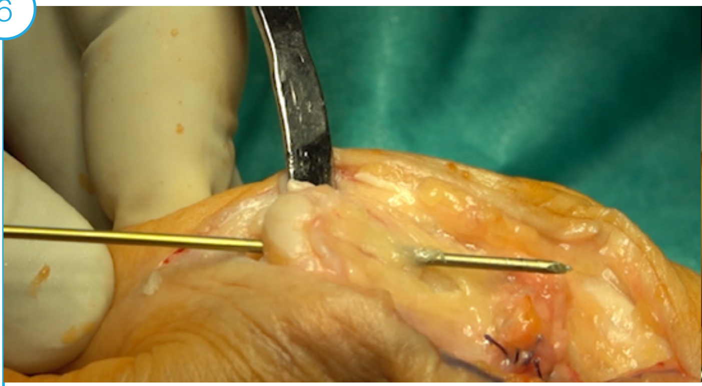
5

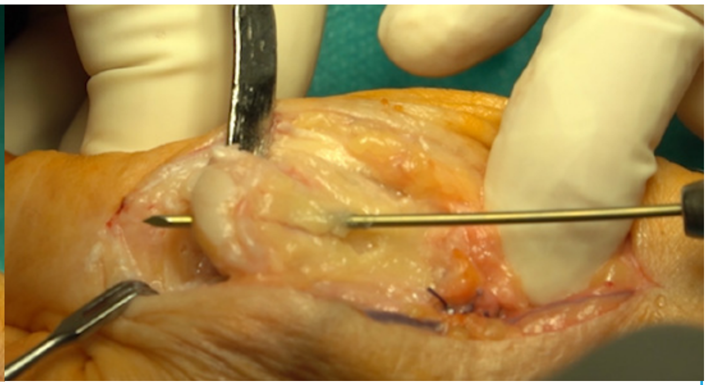




Step 5:
The partially sclerotic bone is refreshed using a thin 1.0 mm drill bit or a fine K-wire. The bone dust remains in place.

6



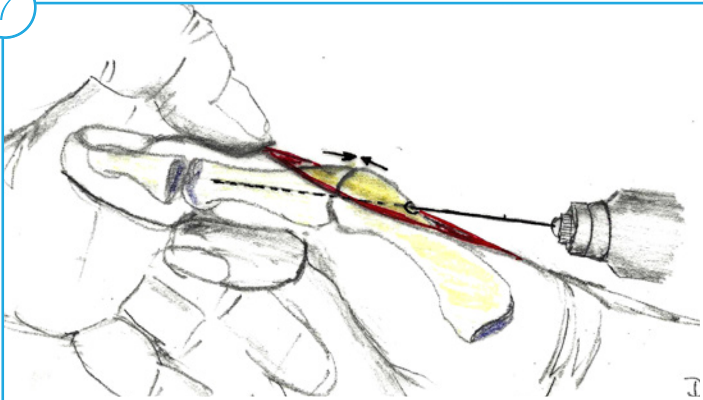


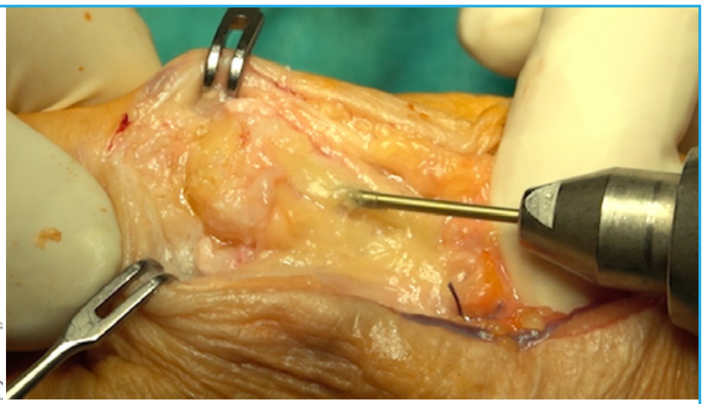
Step 6:
The 1.6 mm K-wire defines the trajectory and position of the future Shark Screw® cut and should establish an angle of approximately 10°-20° between the proximal phalanx and the first metacarpal. The K-wire is advanced from the center of the metacarpal head toward the shaft of the first metacarpal. The exit point of the K-wire must be at least 15 mm proximal to the arthrodesis site to ensure that the remaining dorsal cortical bridge is sufficiently thick. Drilling and tapping will thin this cortical bridge. After these steps, at least 10 mm of dorsal cortex should remain intact.
The inserted 1.6 mm K-wire is then clamped proximally into the drill, and the two debrided joint surfaces are aligned at the desired arthrodesis angle.

!

Ensure that 10-15 mm of cortical bone remains between the entry point of the later-inserted Shark Screw® cut and the arthrodesis site to prevent fracture of the cortical bone bridge.

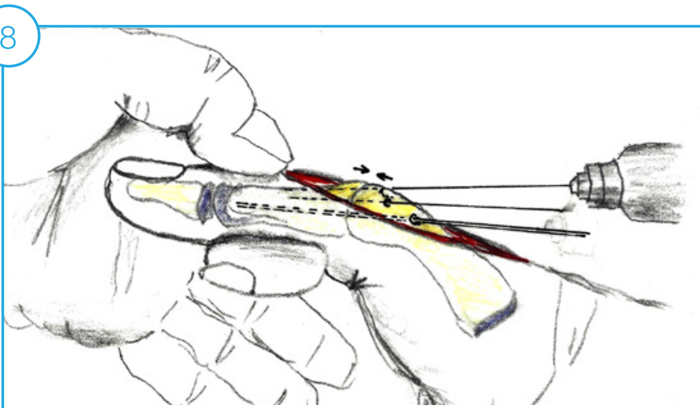
7

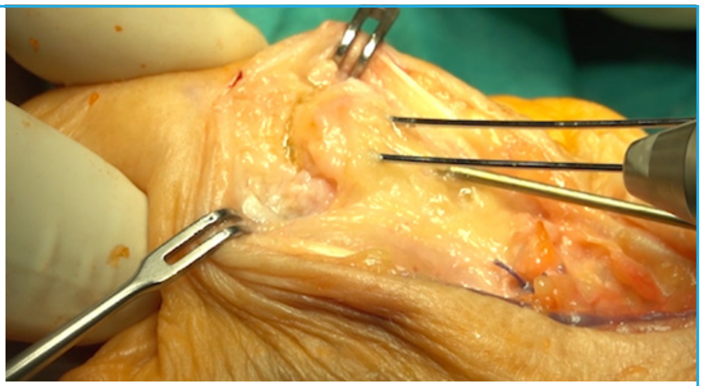




Step 7:
1. The former joint surfaces of the thumb MCP joint are compressed, and the K-wire is drilled from proximal across the joint into the shaft of the proximal phalanx.
2. Fluoroscopic control is used to confirm positioning.

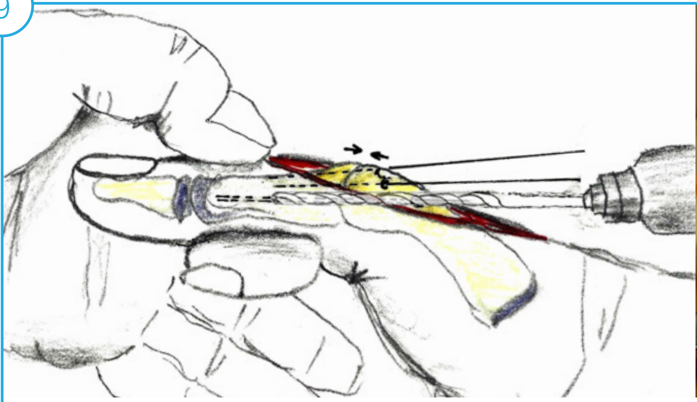
8





Step 8:
To prevent any displacement during drilling and tapping, two temporary 1.0 mm or 1.1 mm K-wires are placed to stabilize the thumb MCP joint. These K-wires are inserted as far ulnar and radial as possible to avoid interfering with the drilling path.

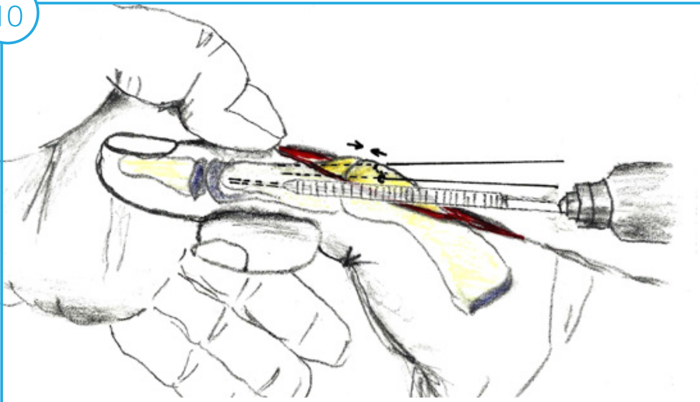
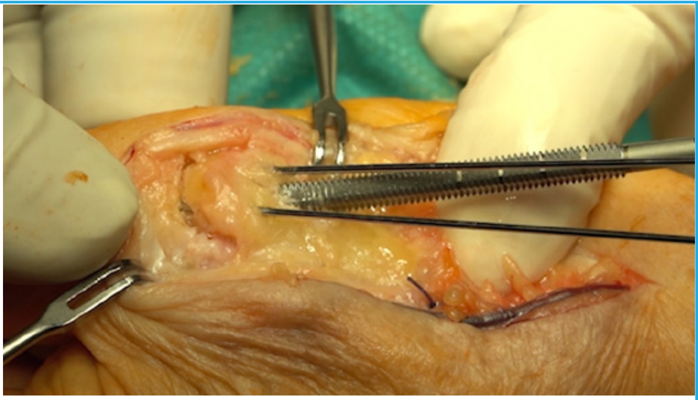
9




Step 9:

The thick 1.6 mm K-wire is now exchanged for a 1.1 mm K-wire, over which stepwise drilling is performed until the desired diameter is reached. Drilling begins with the smallest (blue) drill bit. Depending on the size of the bone, the appropriate diameter of the Shark Screw® cut is selected. The goal is always to use the largest possible graft diameter in order to bridge the arthrodesis site with the maximum amount of bone material.

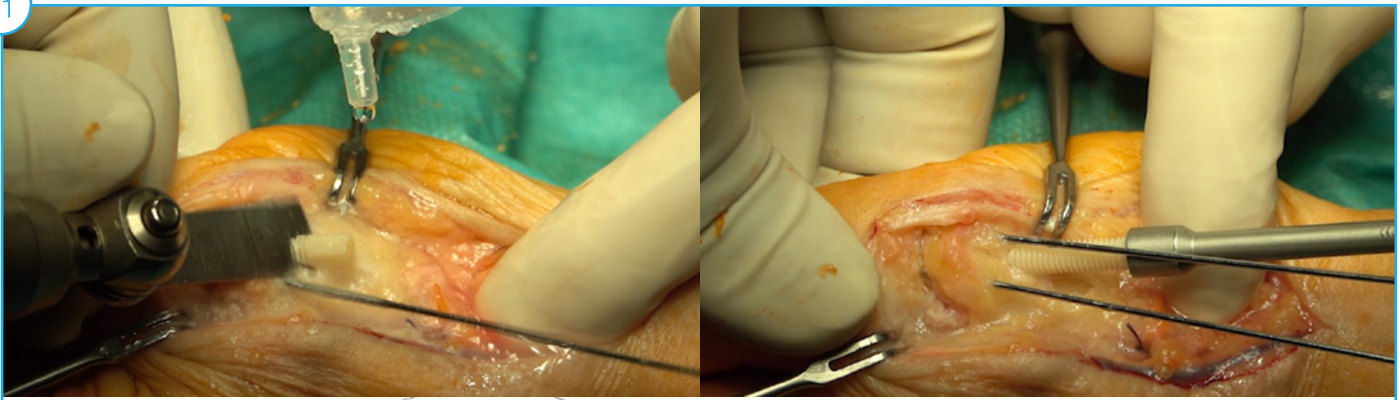
10

Step 10:

After the pilot hole is prepared, the canal is tapped over the K-wire and thoroughly flushed, as even small debris could obstruct insertion of the Shark Screw® cut.
To prevent thermal damage to the bone, tapping is performed slowly.
The depth of both the drill and the tap can be monitored using the laser markings on the instruments.

11

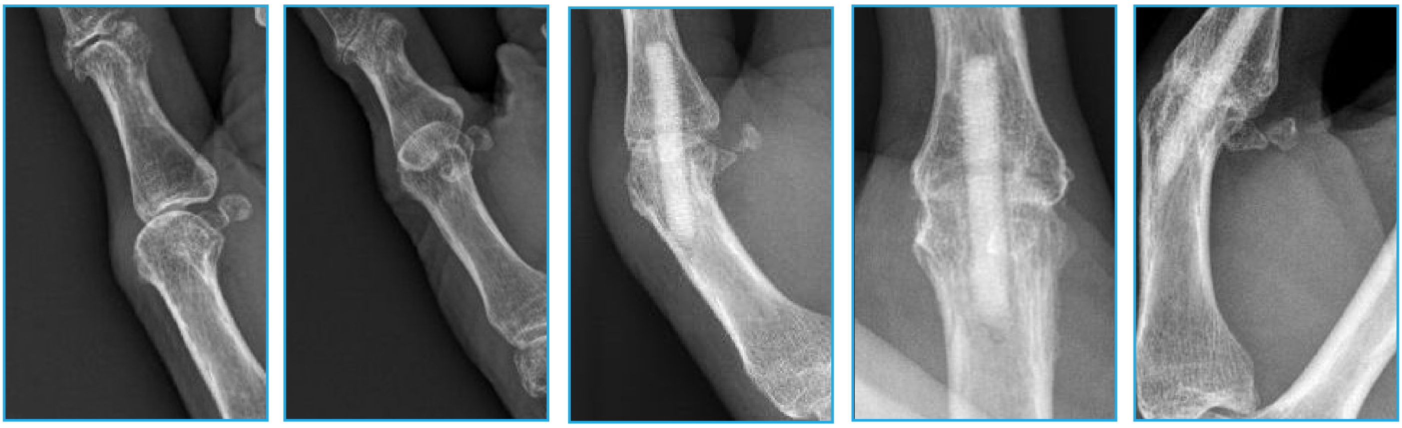
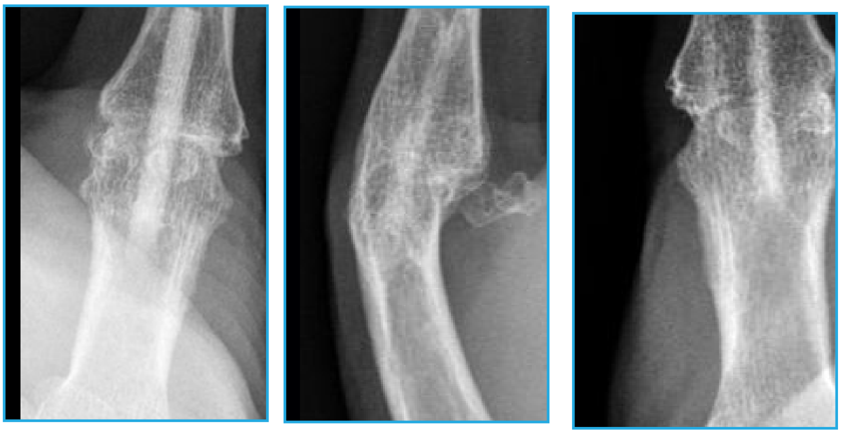


Step 11:
The Shark Screw® cut graft is inserted, and the protruding part of the screw is cut flush with the bone surface using an oscillating saw.
Only after this step are the temporary K-wires removed. The Shark Screw® cut provides rotationally stable arthrodesis. Compression is maintained by the screw graft itself.
The graft remains completely within the bone and does not protrude beyond the bone level at any point. Surrounding soft tissues, tendons, nerves, and vessels are preserved.

Postoperative Management

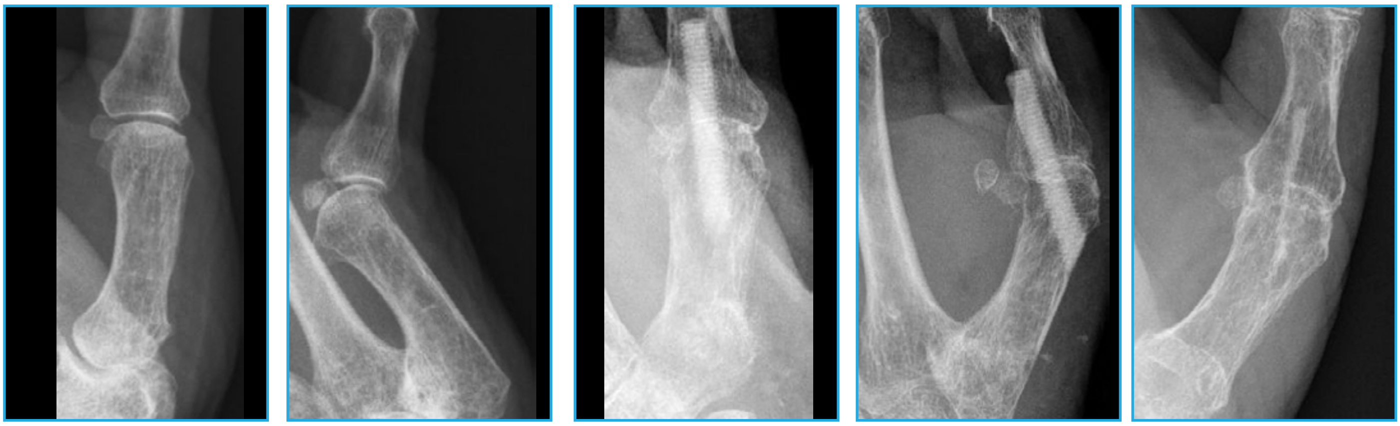
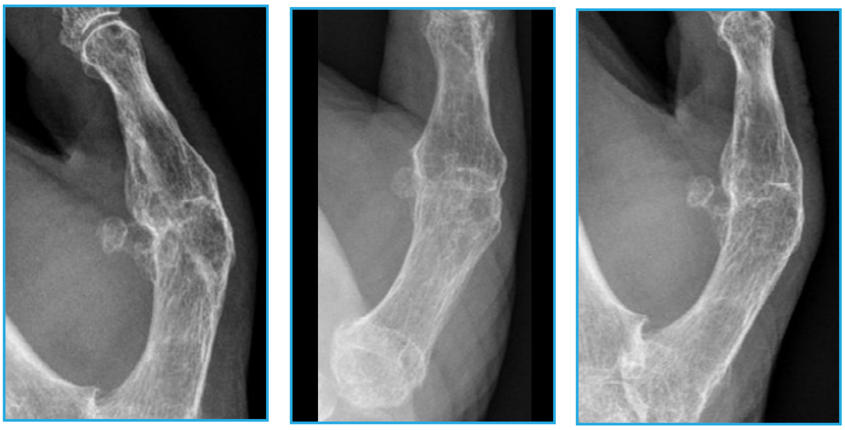
Postoperatively, a split thumb cast is applied for 6 weeks. Gradual loading of the arthrodesis is permitted after 8 weeks.

STREAM
SURGICAL
VIDEO

Radiographic follow-up of an MCP I joint arthrodesis

X-rays from left to right: preoperative lateral view | preoperative AP view | postoperative lateral view | postoperative AP view | 6 months postoperative lateral view | 6 months postoperative AP view | 2 years postoperative lateral view | 2 years postoperative AP view

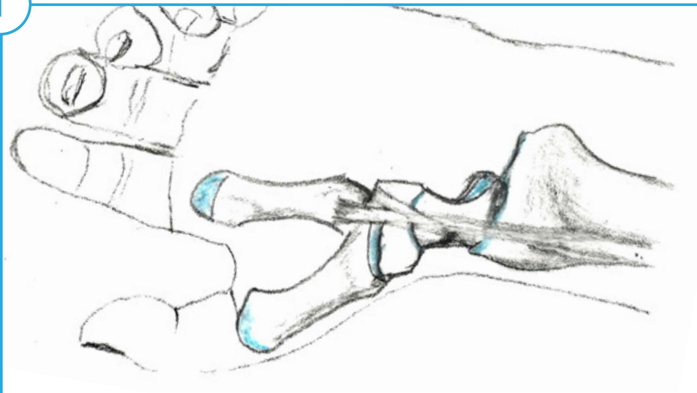
Radiographic follow-up of an MCP I joint

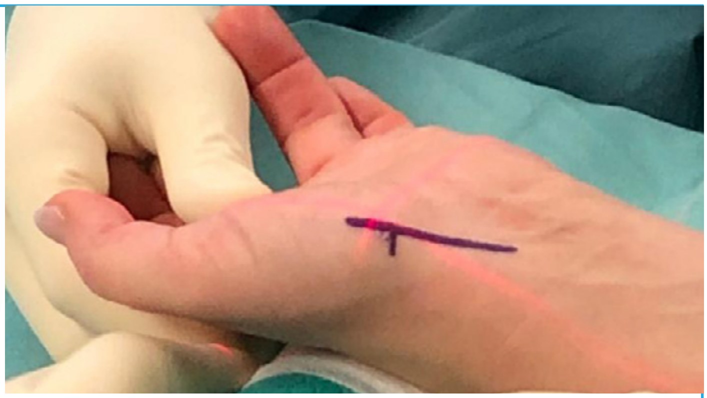
X-rays from left to right:
Preop AP (thumb MCP joint instability with severe rhizarthrosis) | Preop lateral | Postop AP (MCP I arthrodesis and resection-suspension arthroplasty of the thumb CMC joint) | Postop lateral | 6 months AP | 6 months lateral | 11 months postop | 11 months postop

Scaphoid Fracture / Non-Union

Surgical Technique: Palmar Approach

1



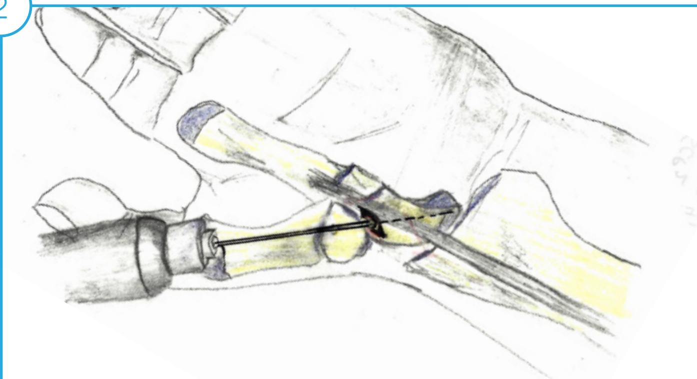


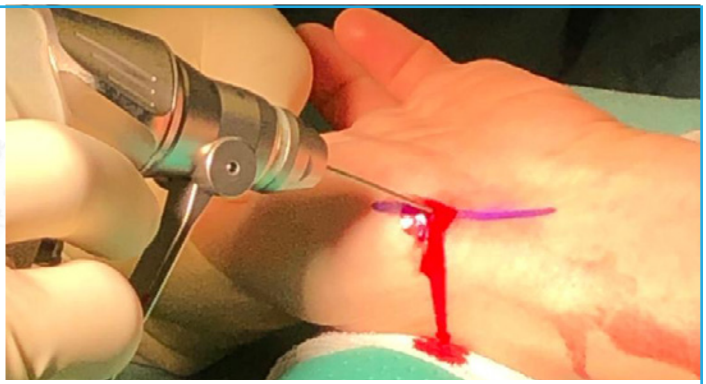
Step 1:

All surgical steps are performed under continuous fluoroscopic guidance.

A straight, longitudinal skin incision of approximately 0.5 cm is made over the scaphotrapeziotrapezoid (STT) joint at the radial border of the flexor carpi radialis (FCR) tendon, just distal to the wrist crease (Rascetta).
After the skin incision, blunt dissection and spreading are performed using scissors.

2



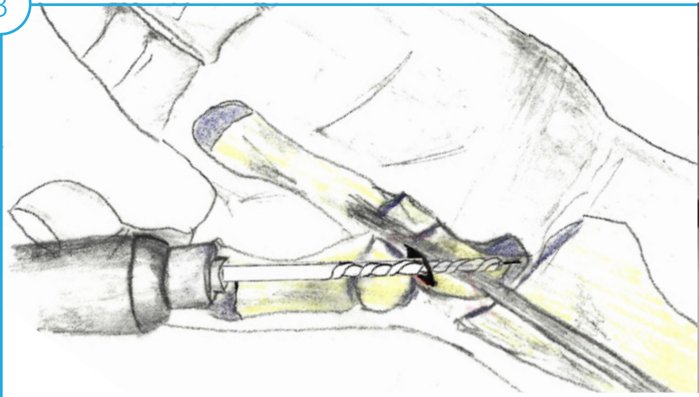


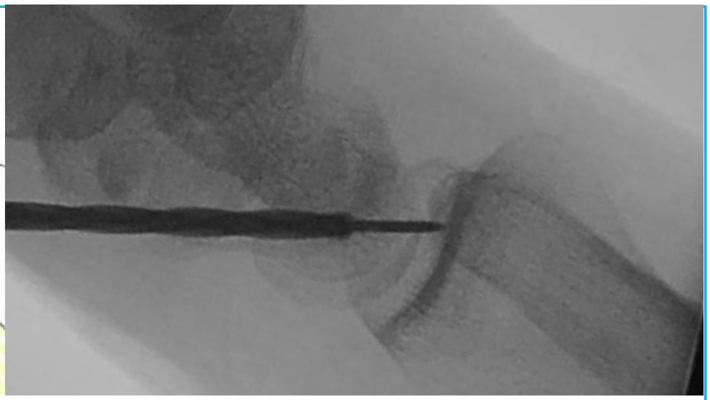
Step 2:

Under fluoroscopic guidance, the K-wire is inserted from the palmar-radial side through the scaphoid tubercle toward the proximal pole of the scaphoid.

Fluoroscopic control should include at least three projection planes (dorsopalmar, lateral, and Stecher views), as well as dynamic imaging during forearm rotation.

3

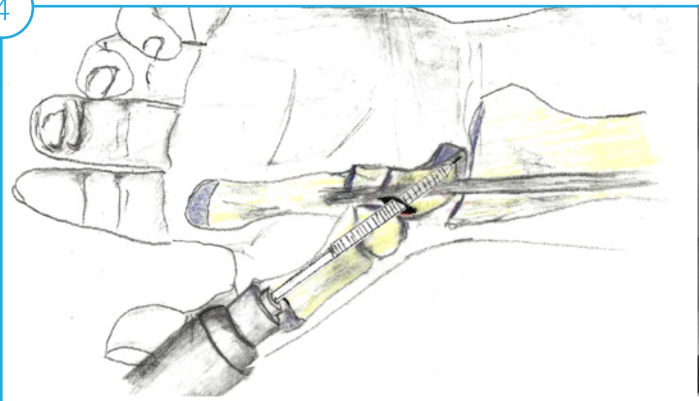


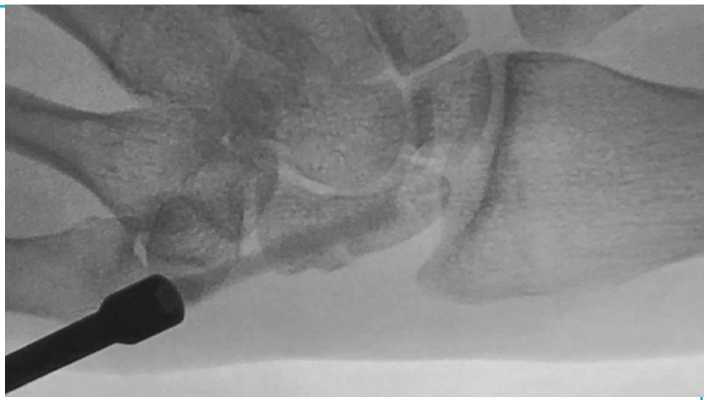


Step 3:
The pilot hole is now drilled over the K-wire.

Since a 3.5 mm Shark Screw® cut is used in nearly all cases of scaphoid osteosynthesis, the pilot hole is prepared using the blue drill bit.

4



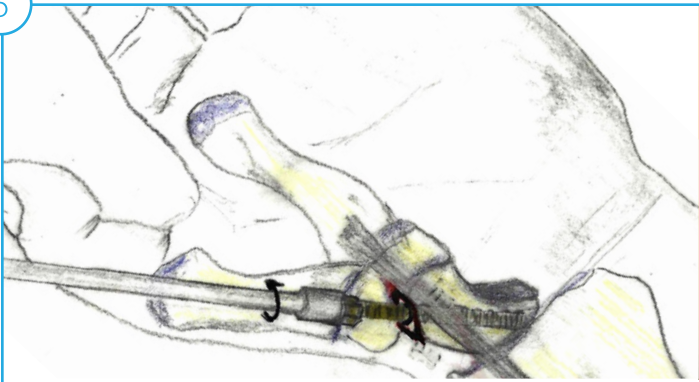


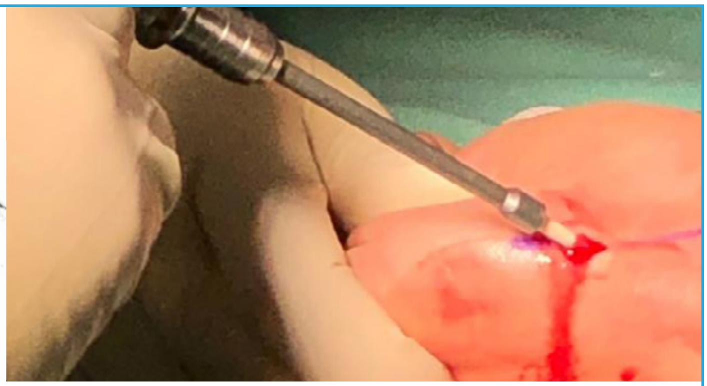
Step 4:
The thread for the 3.5 mm Shark Screw® cut is also tapped with the blue tap using the power drill. The final threads should be cut manually for better control. The desired drilling and tapping depth can be monitored using the lateral laser markings.

!

The prepared canal is flushed with sterile saline to prevent fine bone debris from obstructing the insertion of the Shark Screw® cut.

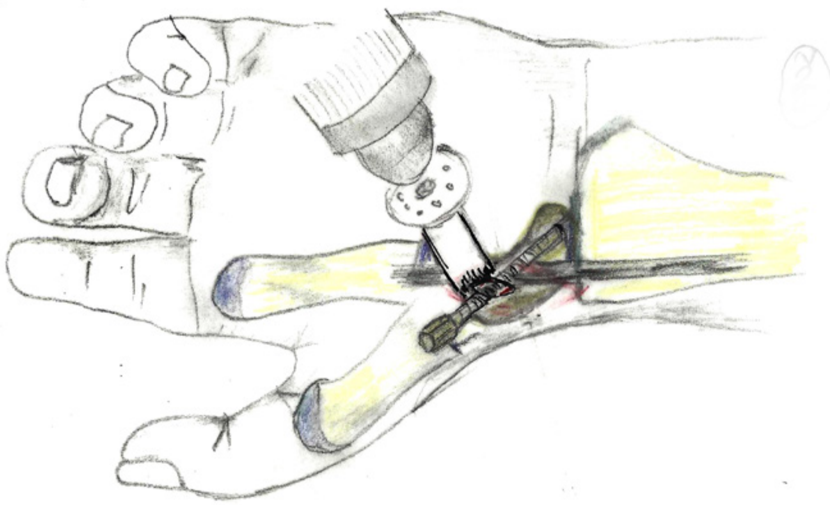
5





Step 5:
The Shark Screw® cut is then inserted smoothly using the hex screwdriver, also under fluoroscopic guidance.

6

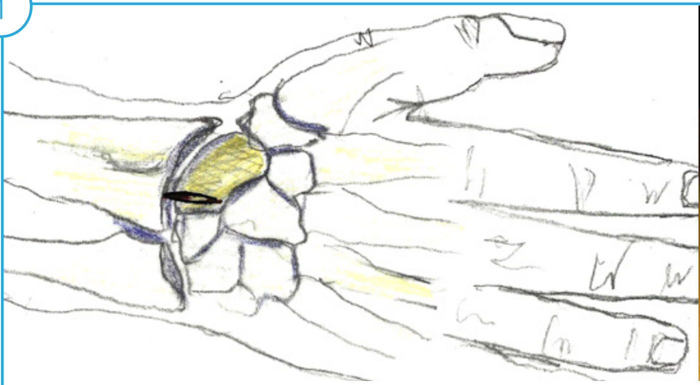


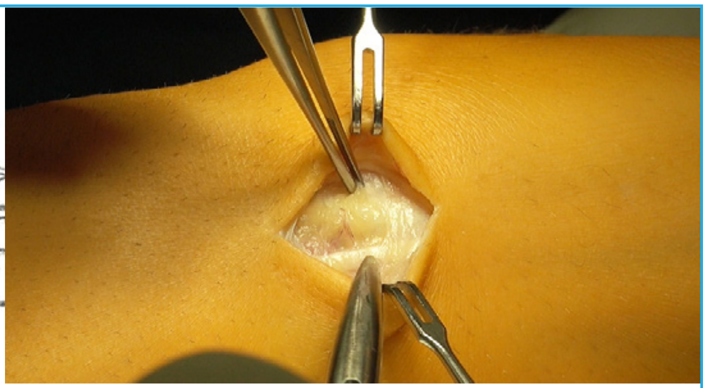
Step 6:
A narrow skin retractor is used to retract the incision proximally while the wrist is flexed, allowing the protruding part of the screw to be cut just above the bone surface with a very narrow oscillating saw.

Postoperative Management*

Whenever possible, patients are managed without fixation. Depending on the stability of the injury, immobilization in a cast for 2 weeks is sometimes applied, and in cases of non-union, up to 6 weeks.

1



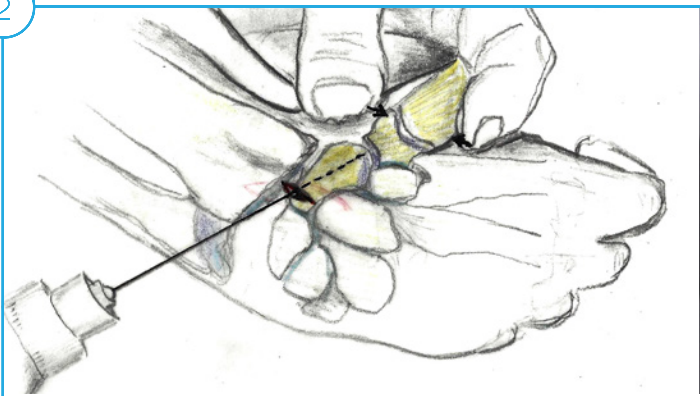


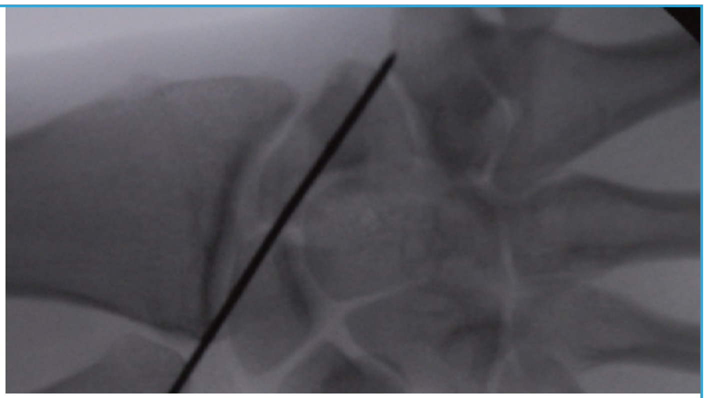
Step 1:

For the majority of fractures, especially nondisplaced ones, treatment can be performed through a small skin incision.

A longitudinal skin incision is made just ulnar to the dorsal tubercle of the radius (Lister's tubercle). The extensor retinaculum and the wrist capsule are then opened while carefully preserving the scapholunate ligament.

2

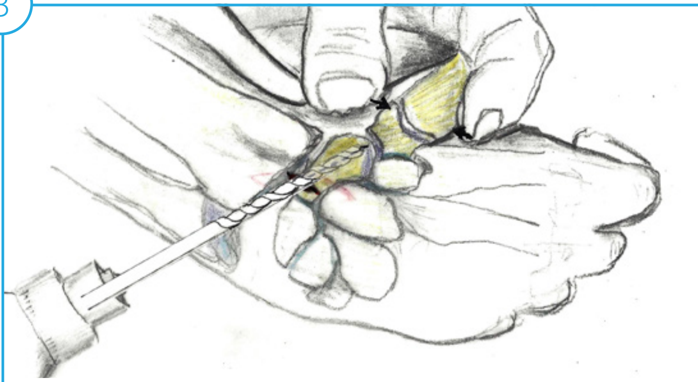


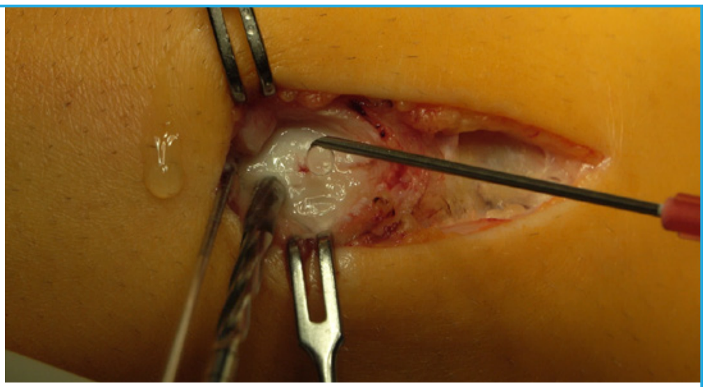


Step 2:

1. The surgeon's thumb and index finger grasp the thumb carpometacarpal (CMC) joint.
2. The wrist is flexed, and a 1.1 mm K-wire is drilled through the proximal pole of the scaphoid, aimed toward the center of the thumb CMC joint and the thumb ray.
3. Fluoroscopic control is then performed, including at least three projection planes (dorsopalmar, lateral, Stecher views) and dynamic imaging during forearm rotation.

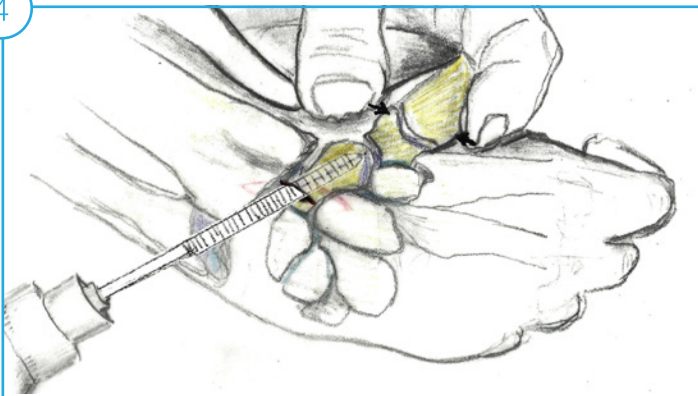
3

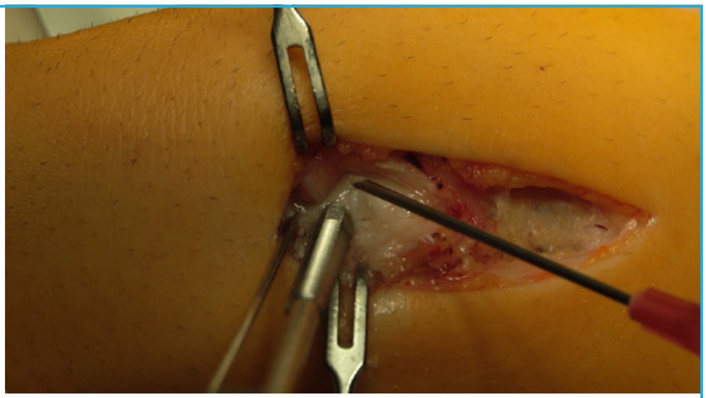




Step 3:
The pilot hole is now drilled over the K-wire.
Since a 3.5 mm Shark Screw® cut is used in nearly all cases of scaphoid osteosynthesis, the pilot hole is prepared using the blue drill bit.
The desired drilling and tapping depth can be monitored using the lateral laser markings.

4



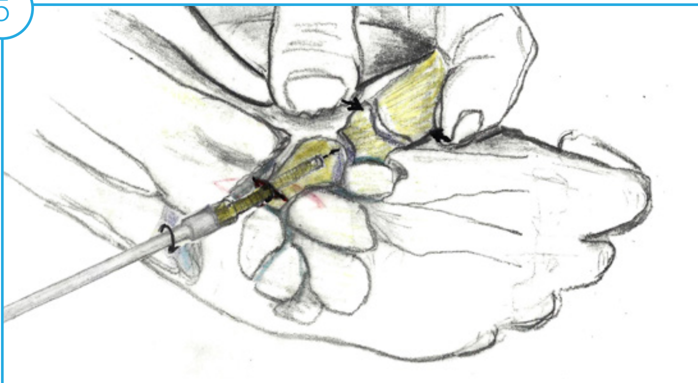


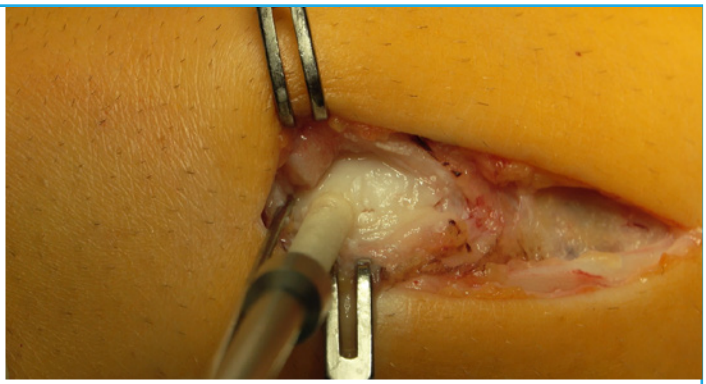
Step 4:
Tapping can be performed manually or using a power drill. The thread for the 3.5 mm Shark Screw® cut is also tapped with the blue tap.

!

The prepared canal is flushed with sterile saline to prevent fine bone debris from obstructing the insertion of the Shark Screw® cut.

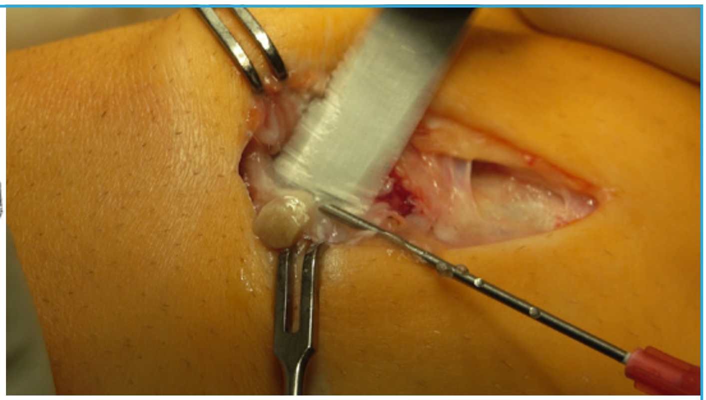
5





Step 5:
The Shark Screw® cut is then inserted smoothly using the hex screwdriver.

6

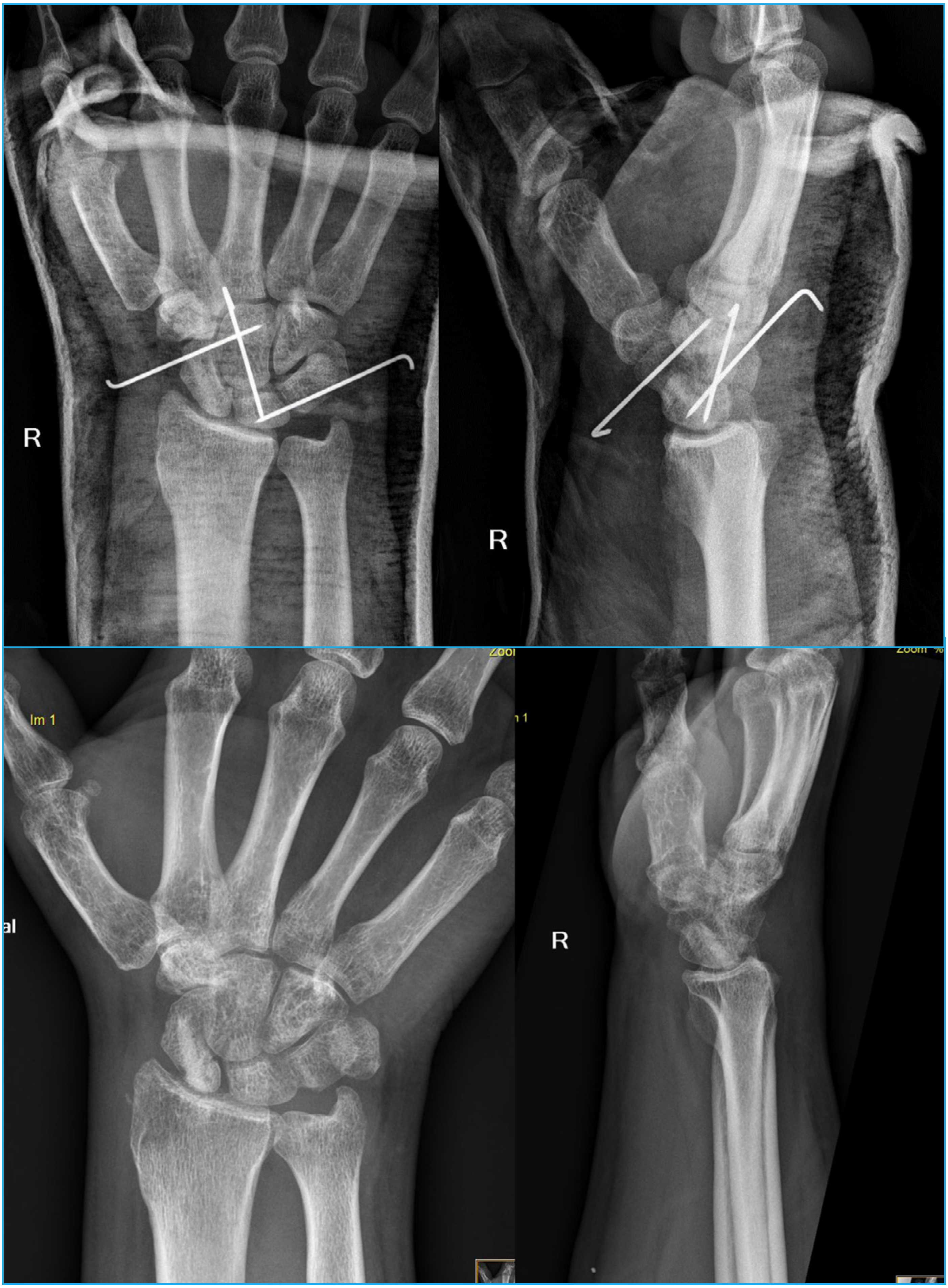


Step 6:
1. The protruding part of the screw is cut just above the bone surface using an oscillating saw.
2. The slightly protruding Shark Screw® cut is then contoured back to the level of the surrounding bone surface.
3. The subchondral lamella is engaged by the Shark Screw® cut at the entry site but must not extend beyond the cartilage surface.
4. If necessary, the Shark Screw® cut can be recessed below the cartilage surface using a small spherical burr.

Postoperative Management*

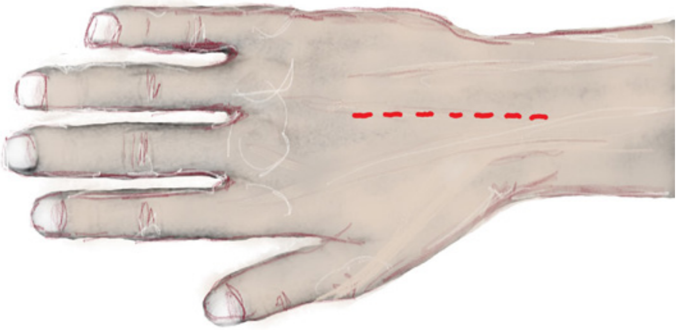
Whenever possible, patients are managed without fixation. Depending on the stability of the injury, immobilization in a cast for 2 weeks is sometimes applied, and up to 6 weeks in cases of nonunion.

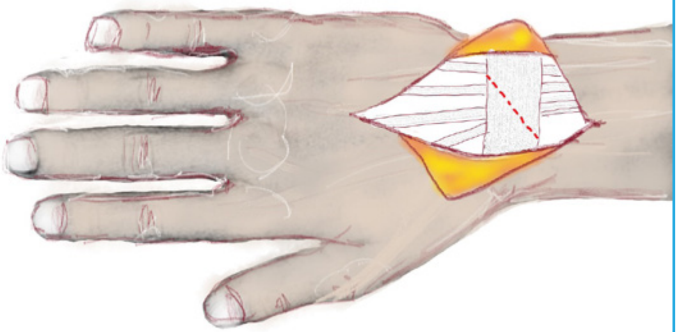
R
R
R
R



R
R
Im 1
R

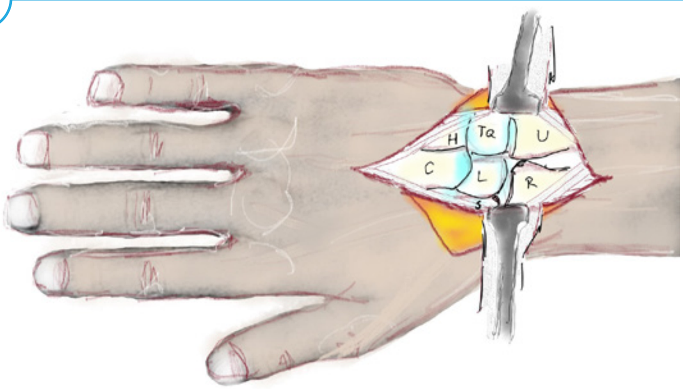
1





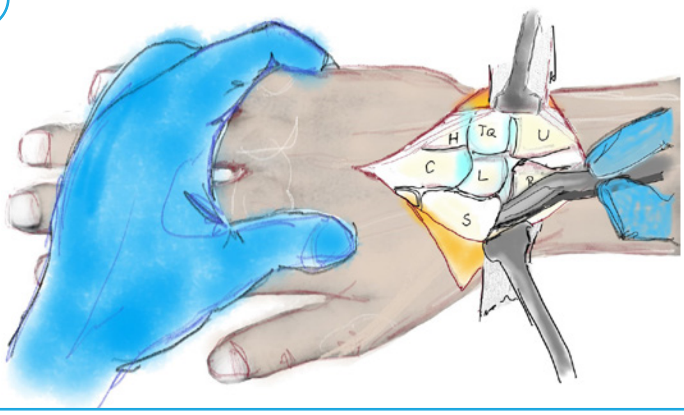
A central, straight skin incision is made over the wrist. The extensor retinaculum is obliquely incised over the 3rd, 4th, and 5th extensor compartments and elevated as ulnar and radial-based flaps. Beneath, the interosseous nerve with its accompanying artery and vein is identified and selectively denervated if indicated.

2



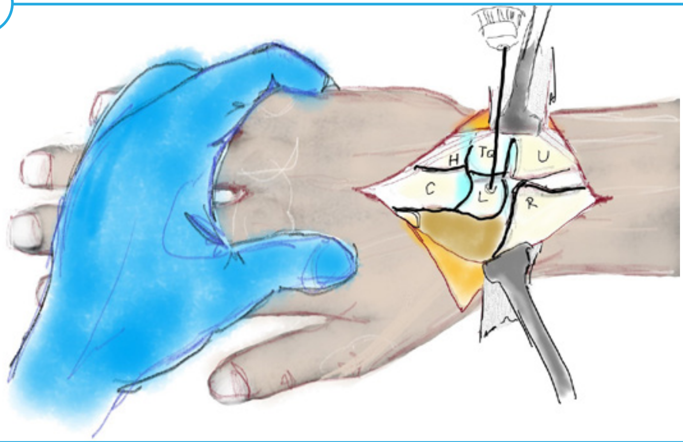
The wrist joint capsule is split longitudinally and carefully dissected off the underlying carpal bones using a scalpel. (H = Hamate, TQ = Triquetrum, U = Ulna, C = Capitate, L = Lunate, R = Radius, S = Scaphoid)

3



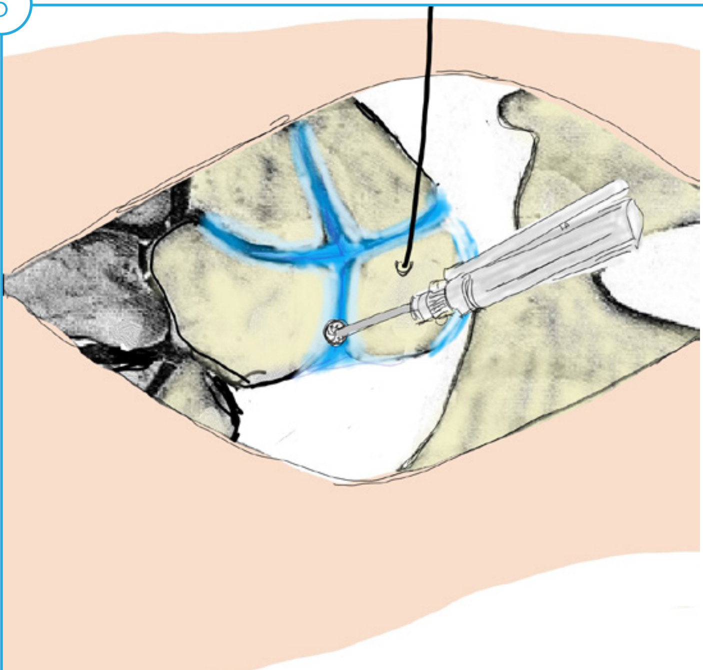
The scaphoid is exposed on the radial side. It is carefully resected en bloc using a McGlamery curette with gentle scraping and pressing motions, taking care not to damage the palmar ligaments. On the ulnar side, the joint capsule is detached up to the ulnar borders of the hamate and triquetrum.

4



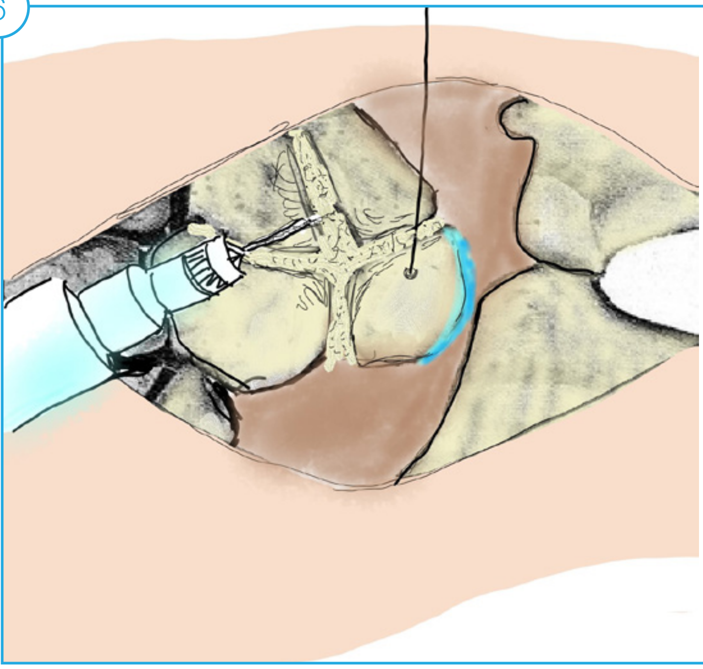
A 1.6 mm bicortical K-wire is placed through the lunate near its ulnar bone margin. The radial portion of the lunate is kept free to allow placement of the Shark Screw®. The 1.6 mm wire then functions as a joystick for repositioning and realigning the lunate.

5



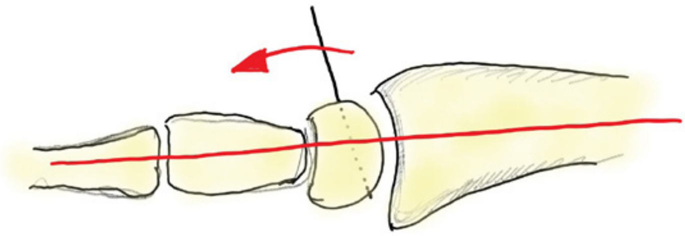
The remaining partially intact ligamentous connections between the carpal bones are now transected, and the joint spaces are distracted. The joint surfaces are carefully and completely debrided of cartilage using a sharp curette, chisel, or scraping motions with a running oscillating saw. All cartilage flakes must be removed down to the subchondral bone.

6



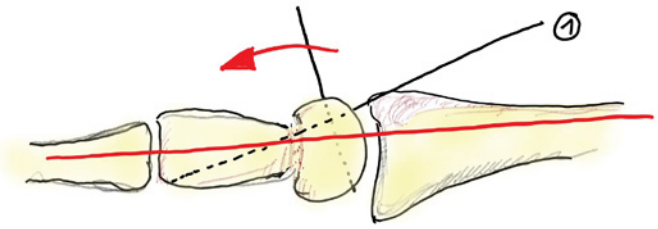
To promote better blood flow and faster remodeling, multiple small drill holes (1–1.5 mm drill bits) are made through the carefully debrided joint surfaces. The resulting bone debris is left in place locally to help fill small irregularities.

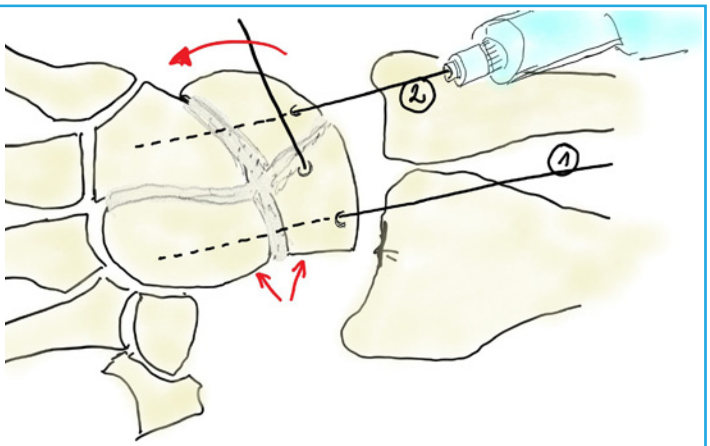
7



Using the joystick, the lunate is maximally rotated dorsally to achieve optimal realignment and repositioning. This ensures that sufficient wrist dorsiflexion is possible after arthrodesis. Additionally, care is taken to align the lunate properly relative to the proximal pole of the capitate (correct radio-ulnar orientation).

8

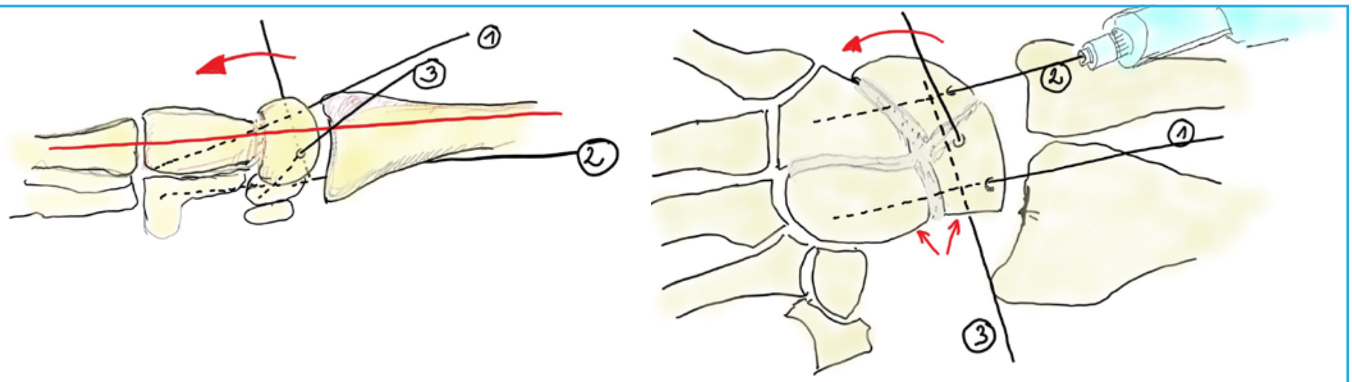




After complete realignment and repositioning of the lunate, three 1.6 mm K-wires are placed sequentially to define the future positions of the Shark Screw®. The 1.6 mm K-wire is used primarily because it does not bend during insertion (a 1.1 mm K-wire would bend and could be broken during subsequent drilling). The 1.6 mm K-wire must later be exchanged for a 1.1 mm K-wire prior to drilling and tapping.

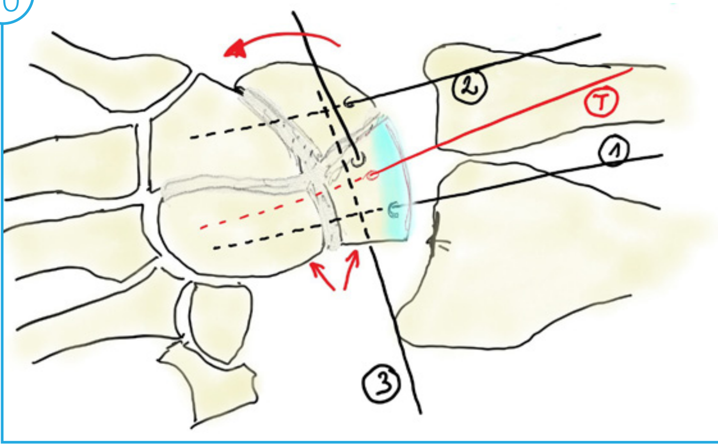
The first 1.6 mm K-wire (KW1) is inserted from proximal-dorsal into the lunate, exiting distally-palmar into the capitate. KW1 should be positioned in the radial portions of both carpal bones. The second K-wire (KW2) is inserted from proximal-dorsal into the triquetrum, exiting distally-palmar into the hamate. KW2 should be positioned in the ulnar portions of these carpal bones.

9



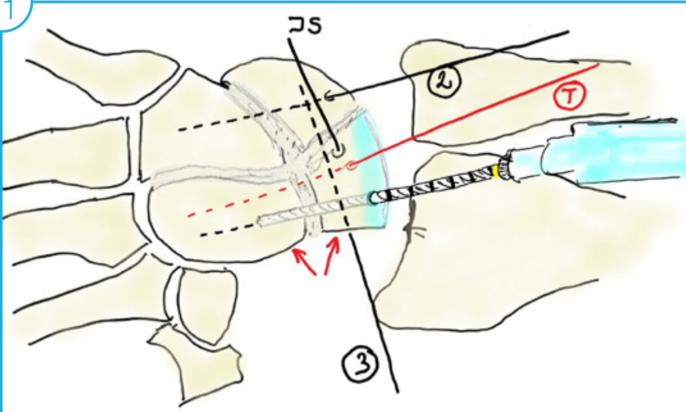
The third K-wire (KW3) is inserted from the radial side, positioned palmar within the lunate and triquetrum. KW3 also lies palmar to KW1 and KW2.
(Tip: By inserting and leaving thin needles in the respective joint spaces, landmarks can be well identified even without fluoroscopy. These needles act like goalposts positioned outside the bone, making K-wire placement easier and ensuring each wire is ideally placed intraosseously.)
Fluoroscopic control is performed in all planes, potentially including dynamic imaging.

10



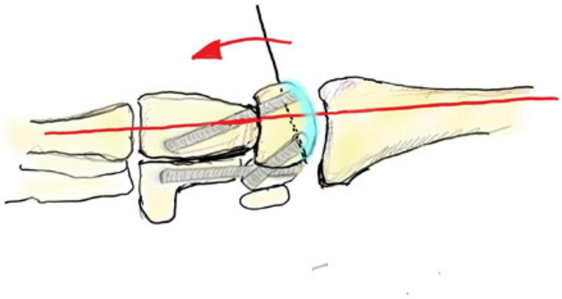
The individual carpal bones can now be placed under maximum compression. To prevent displacement of the carpal bones during drilling and tapping and to maintain compression, additional thin temporary K-wires (marked as T = red) are inserted. Care is taken to ensure these temporary K-wires are not placed too close to the other K-wires, as they could obstruct drilling.

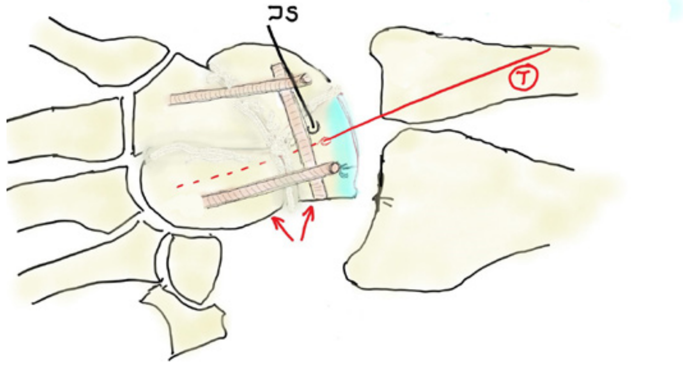
11



Each 1.6 mm K-wire is sequentially exchanged for a 1.1 mm K-wire and immediately overdrilled. The canal is then tapped, flushed, and the Shark Screw® is inserted to sufficient depth. Under no circumstances should the hexagonal screw head be recessed below the bone surface.
Insertion begins with the Shark Screw® between the lunate and capitate (usually 4.0 mm), followed by the other two 1.6 mm K-wires (usually 3.5 mm). Fluoroscopic control is used throughout the procedure.

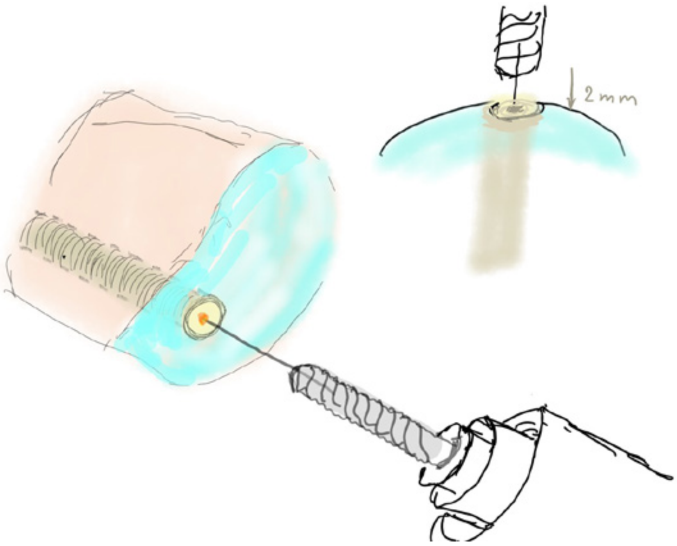
12





After all three Shark Screw® grafts are placed, the protruding parts (shaft and hexagonal head) are cut flush with the bone or cartilage surface.
If gaps or bone defects have formed, these are now filled with paste-like demineralized bone matrix (DBM).

13



The screw shaft, cut flush at the cartilage level in the lunate, usually lies within the cartilage surface. Therefore, the cortical bone of the Shark Screw® must be recessed: At the entry point of the Shark Screw® in the lunate, a 1.1 mm K-wire is inserted centrally into the shaft of the cut screw, advancing until secure fixation is achieved.

Over this K-wire, drilling is performed with the appropriate drill bit (e.g., blue, if a blue 3.5 mm Shark Screw® was previously used) approximately 2–3 mm below the cartilage level of the lunate to ensure no bone material of the Shark Screw® protrudes and irritates the joint.

After removing the temporary K-wires and the joystick, joint mobility is carefully tested. The wound is closed in layers.

Potoperative Management

Split forearm cast including the thumb for 2–3 days, followed by a full forearm cast including the thumb for a total of 8 weeks.

Radiographic follow-up of a Four Corner Fusion

A 72-year-old female patient presents with increasing pain in the radiocarpal joint. Preoperative X-rays reveal instability and a scapholunate diastasis, which has led to arthritis between the scaphoid and radius. After the four corner fusion, the patient is immobilized in a forearm cast including the thumb for 8 weeks. The involved carpal bones are stably fused, and the former joint spaces are bridged by bone formed around the Shark Screw® implants placed during surgery.

X-rays from left to right:
Row 1: preoperative AP view | preoperative radial deviation view | postoperative AP view | postoperative oblique view
Row 2: 3 months postoperative AP view | 3 months postoperative lateral view | 6 months postoperative AP view | 6 months postoperative oblique view

MC1 cyst, rhizarthrosis

Radiologic follow-up

The preoperative X-rays and CT scans reveal rhizarthrosis and a large cyst at the base of the first metacarpal bone.

The cyst was filled with paste-like demineralized bone matrix (DBM). To ensure stability of the flexor carpi radialis (FCR) tendon in the proximally located transosseous drill canal, it was fixed using a 3.5 mm Shark Screw® cut.



Radiographic follow-up of an MC1 cyst with rhizarthrosis

This clinical case presents radiographic follow-up of an MC1 cyst with rhizarthrosis.
X-rays from left to right: preoperative AP view | preoperative oblique view | MRI AP view




Radiographic follow-up of an MC1 cyst with rhizarthrosis

This clinical case shows radiographic follow-up of an MC1 cyst with rhizarthrosis.
X-rays from left to right: 4 weeks postoperative AP view | 4 weeks postoperative oblique view | 5 months postoperative AP view | 5 months postoperative oblique view

Radiographic follow-up of a Karpandji procedure

Clinical case of a 73-year-old female patient with arthritis of the distal radioulnar joint and corresponding pain. Preoperative arthritis is confirmed by CT. Subsequent X-rays demonstrate the postoperative bone healing progression.
Images from left to right: preoperative CT | postoperative AP view | postoperative oblique view | 5 months postoperative AP view | 5 months postoperative lateral view | 24 months postoperative AP view | 24 months postoperative lateral view

MCP2 arthrodesis in mutilating chronic polyarthritis

Radiologic follow-up

Radiologic follow-up of a 76-year-old patient with mutilating chronic polyarthritis. Preoperative X-rays show severe destruction of the MCP2 joint. The MCP joint is stiff but unstable. The patient declines joint replacement but desires surgical intervention due to pain.
A resection arthroplasty was considered insufficient for the stability required for his activities (carpentry, gardening, etc.), so an arthrodesis was performed as an exception. The procedure involved one 5.0 mm Shark Screw® diver, and the defects were additionally filled with paste-like demineralized bone matrix (DBM). With the arthrodesis, the patient regained functional load-bearing capacity of his second finger and is now pain-free.

Radiographic follow-up of an MCP II arthrodesis in mutilating chronic polyarthritis

X-rays from left to right: preoperative AP view | preoperative lateral view | 8 weeks postoperative AP view | 8 weeks postoperative lateral view | 25 months postoperative AP view | 25 months postoperative lateral view

The arthrodesis shows solid fusion, but remodeling of the Shark Screw® is notably slow. A large portion of the Shark Screw® is still visible.

Wedge osteotomy for lunate malacia IIIC

Radiologic follow-up

Radiologic follow-up of a 42-year-old female patient with lunate malacia stage IIIC. Wrist mobility is limited to slight wobbling movements, with constant day and night pain rated at VAS 8. Weight-bearing on the wrist is no longer possible (VAS 10).
As the patient strictly refuses arthrodesis or vascularized reconstruction, a Camembert osteotomy of the radius is performed as a salvage procedure to offload the lunate. Osteosynthesis is achieved using two 3.5 mm Shark Screw® cuts. Immediately postoperatively (while still in the cast), the patient reports complete pain relief.
At 6 months postoperative, the patient describes significant improvement, with only mild pain (VAS 2–3) during moderate loading, otherwise pain-free both day and night. Wrist range of motion is 30° dorsiflexion – 0° – 20° flexion. A retraining program is planned to shift the patient from physically demanding nursing work to office duties.
At 6 months post-op, the lunate malacia has consolidated without further fragmentation, and the osteotomy has healed without complications.

X-rays from left to right: preoperative oblique view | preoperative radial deviation view | postoperative AP view | postoperative lateral view | 6 months postoperative AP view | 6 months postoperative lateral view

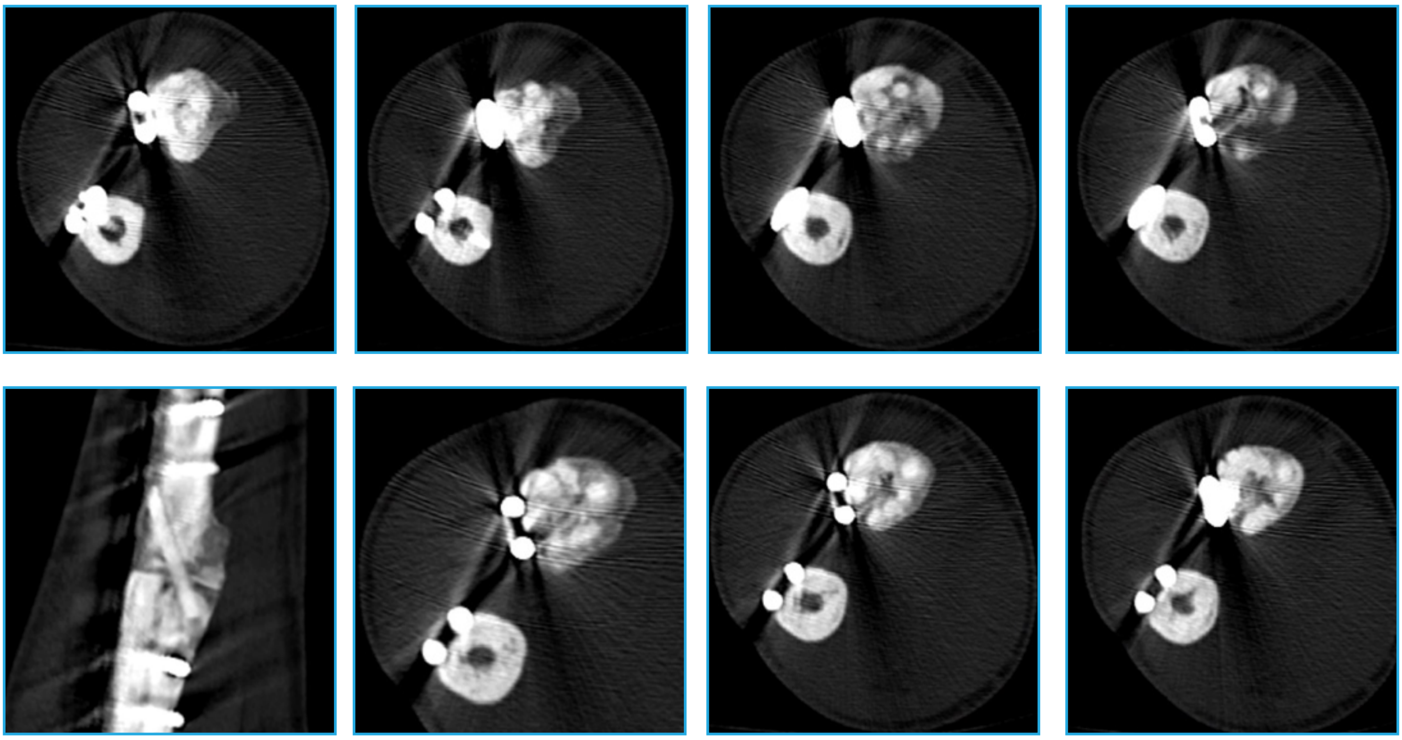
Nonunion following radius fracture

Radiologic follow-up

Radiologic follow-up of a 32-year-old patient who sustained a forearm fracture. Despite nonunion of the radius fracture, the patient has been placing disproportionate weight on the left forearm. On examination, nonunion is confirmed along with bending of the plate and the resulting significant shortening of the radius. The patient has experienced increasing pain for several weeks. (See preoperative X-rays, 3D reconstruction, and CT scans.)

During revision surgery, the bent plate is replaced with a straight one, and the radius is restored to the level of the ulna. The nonunion is additionally supported by two Shark Screw® placed “pillar-like” perpendicular to the nonunion site. These provide strong bone bridges to fill the defect and promote rapid healing.

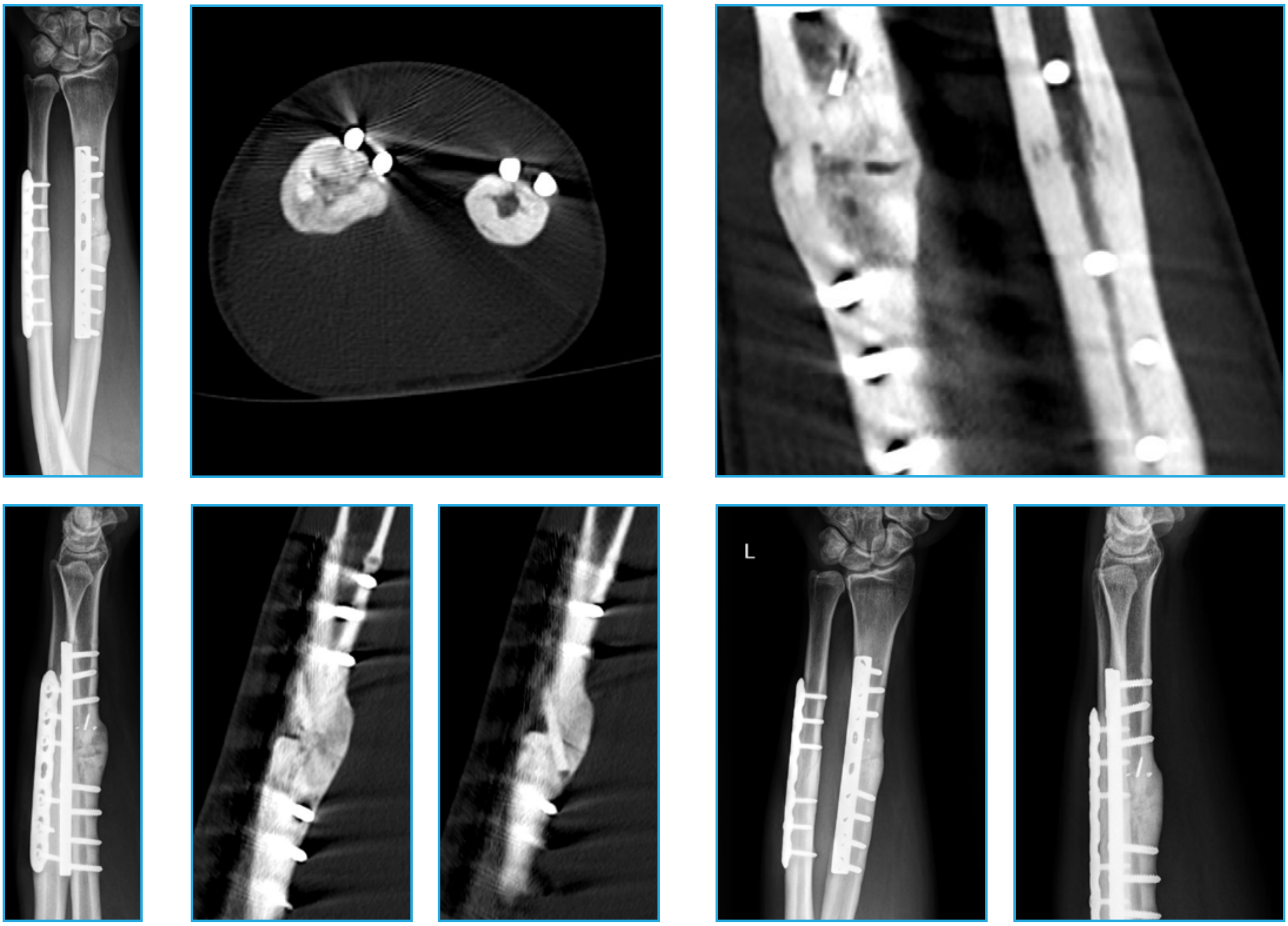
At 6 weeks postoperative, the coronal CT slices show cloudy areas of increased density around the implanted Shark Screw®, indicating high bone activity.



Nonunion following radius fracture

Radiologic follow-up

Further X-ray and CT images document bone healing at 5 and 12 months postoperatively. Metal removal is performed 12 months after surgery.
Images from left to right:
Row 1 (5 months postoperative): X-ray AP view | coronal CT slice | AP CT slice
Row 2 (12 months postoperative): lateral X-ray | lateral CT slices | 1-year AP view | 1-year lateral view



Reconstruction of a wrist with chronic polyarthritis bayonet deformity

Radiologic follow-up

A 57-year-old female patient with severe mutilating chronic polyarthritis. Preoperative X-rays, CT scans, and 3D reconstructions reveal a severe bayonet deformity of the wrist. Years earlier, synovectomy and resection of the ulnar head had been performed.

Functionally, the left hand is severely impaired. The fingers cannot be actively extended or flexed, and the wrist is fixed in a flexion contracture of approximately 50°.

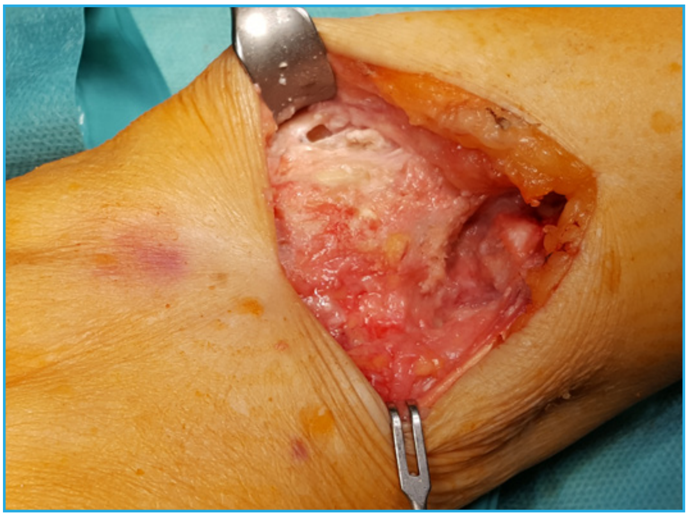
Radiographic follow-up of wrist reconstruction in chronic polyarthritis with bayonet deformity

Preoperative CT and X-ray images of the wrist in AP and lateral views.
The row below shows the preoperative 3D reconstruction of the wrist, which is used for surgical planning.

Reconstruction of a wrist with chronic polyarthritis bayonet deformity

Radiologic follow-up

The intraoperative images show the Shark Screws® in place at the end of the surgery, before the screw heads are cut flush with the bone surface. The image on the right shows the Shark Screw® heads cut and removed. This technique maximally preserves the overlying soft tissues, as no foreign material protrudes beyond the bone surface.



The radius was slightly refreshed on the ulnar side, and the remaining carpal complex was osteotomized to allow realignment and straightening of the carpus along the axis of the radius. Stabilization and bridging of the bone defects were achieved using two 4.5 mm Shark Screw® cuts, one 4.0 mm cut, and one 35 mm long, 5.0 mm thick Shark Screw® diver.
A forearm cast was applied for 8 weeks, while the fingers remained free for occupational therapy exercises.
X-rays:
postoperative AP view | lateral view

Wrist reconstruction in cerebral palsy with bayonet deformity

Radiologic follow-up

Further X-rays show the progression at 14 weeks and 8 months postoperatively.




Radiographic follow-up of wrist reconstruction in cerebral palsy with bayonet deformity

X-rays from left to right: 14 weeks AP view | 14 weeks lateral view | 8 months AP view | 8 months lateral view

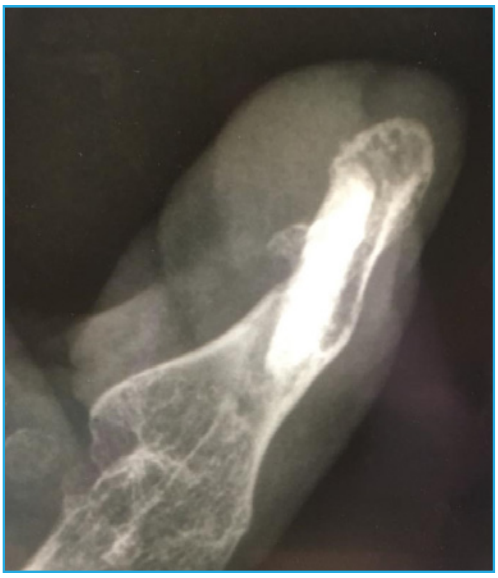
The clinical images were taken 1 year postoperatively and demonstrate that the hand can be used very functionally again, with biomechanical relationships restored as well as possible.


Reconstruction after nonunion in the thumb IP joint

Radiologic follow-up

A 32-year-old female patient with severe mutilating cerebral palsy. Following arthrodesis with two K-wires, no bone healing occurred, resulting in a very painful and non–weight-bearing nonunion. The K-wires migrated and caused large osteolytic defects in the distal and proximal phalanges. X-rays from left to right: preoperative oblique view | preoperative lateral view | intraoperative lateral view

Intraoperative image (top right): The K-wires are removed. The osteolytic defects have reached a very large extent, so that arthrodesis can only be stabilized with a 5 mm diameter Shark Screw®. The bone is paper-thin, which is why a finger cast splint is applied for 6 weeks. The intraoperative X-ray shows the relative mismatch between the delicate bone and the thickness of the Shark Screw®. A thick, solid bone bridge provides stable conditions for bone cell ingrowth and, consequently, bone healing.



The 1-year postoperative X-ray shows that the Shark Screw® has largely been transformed into the patient's own bone, and the bone remodeling has resulted in a stable, functionally excellent arthrodesis.

References

Selected Literature on Allografts

1. Kurth A., Lange U., Fachwissen Osteologie 1.5, Seiten 11-16
2. Bartl R., Tresckow E., Bartl Ch., Biphosphonatmanual Kapitel 1, Seiten 6-17
3. Buhl M., Dissertation Marburg 2001, Histologische Studie zum zeitlichen Heilungsablauf der subtrochantären Mehrfragmentfraktur des Schaffemurs mit Hilfe der polychromen Sequenzmarkierung.
4. Histologie: Lehrbuch der Zytologie, Histologie und mikroskopischen Anatomie Junqueira L.C., Carneiro J.
5. Smollich A., Sajonski H., Zelle und Gewebe. Eine Einführung für Mediziner und Naturwissenschafter. Kapitel 6 Seite 200
6. Tim Rolvien, Dissertation Hamburg 2015, Quantitative Experimentelle Untersuchung von Osteozyten bei Vitamin D Mangel und Immobilisation.
7. Primary Bone Healing RAHN, BERTON A.; GALLINARO, PAOLO; BALTENSPERGER, AUGUST; PERREN, STEPHAN M. The Journal of Bone & Joint Surgery: June 1971 - Volume 53 - Issue 4 - p 783-786
8. Axel Pruss, Arne Hansen, Moujahed Kao, Lutz Gu¨rtler, Georg Pauli, Frank Benedix. Comparision of the efficiacy of virus inactivation methods in allogeneic avital bone tissue transplants | Cell and Tissue Banking 2:201–215, 2001.
9. Klaus Pastl, Wolfgang Schimetta. The application of an allogeneic bone screw for osteosynthesis in hand and foot surgery: a case series | Archives of Orthopaedic and Trauma Surgery (2021)
10. I. Brcic, K. Pastl, H. Plank, J. Igrec, J. E. Schanda, E. Pastl, M. Werner. Incorporation of an Allogenic Cortical Bone Graft Following Arthrodesis of the First Metatarsophalangeal Joint in a Patient with Hallux Rigidus Life (2021)
11. Anika Grüneboom, Ibrahim Hawwari, Daniela Weidner, Stephan Culemann. A network of trans-cortical capillaries as mainstay for blood circulation in long bones | Nature Metabolism | VOL 236 1 | FEBRUARY 2019 | 236–250 |

IMPORTANT!

The descriptions of surgical techniques in this script represent application examples and serve as teaching aids to support clinical use of Shark Screw® grafts. The teaching material alone does not replace practical training.

The use of the grafts, the surgical procedure, and postoperative care depend on the patient and must be individually decided by the treating physician in each case. The physician must act in accordance with their training, experience, and the patient's overall health status, following careful review of the relevant medical literature.

IT IS
YOUR
SHARK
SCREW®
STORY...