stryker®

Osteosynthesis

T2 Kids
Pediatric Flexible Nail

Operative Technique

Contents

Introduction & Rationale

Introduction

In 1979, Professor Jean Prévot and his young team of surgeons - Dr Métaizeau, Dr Ligier and Dr Lascombes of the Centre Hospitalier Universitaire of Nancy, France, developed and introduced a technique for the treatment of long bone fractures in children using flexible IM nailing. The goal was to improve cumbersome surgical techniques that required long hospital stays and sometimes substantial scars that were badly perceived by both the children and their parents. At the same time, the system needed to provide adequate stability for the healing bone.

In 1994, Professor Prévot passed his torch of pediatric orthopaedic leadership of the University Hospital in Nancy to Professor Pierre Lascombes, who has continued to perfect and teach the flexible intramedullary nailing technique around the world.

In order to share the expertise acquired over more than 30 years in Nancy and with the intention to unite the culmination of experience of many renowned surgeons, Professor Lascombes published one of the most complete books about this flexible nail technique to date. The book, entitled *Embrochage centromédullaire élastique stable* [1] describes the technique for all bones and provides numerous illustrated tips and tricks. The illustrations found in this document are used with the permission of the publisher.[1]

Rationale

What is the concept behind flexible nailing which makes it not only biomechanically advantageous to more rigid fixations but also more demanding to learn as a technique?

The technique consists of bending nails of appropriate diameters in such a manner that, when inserted into a fractured bone, the nails may reduce the fracture, splint the cortices with optimal force at the fracture site and maintain the elastic energy to continually brace against rotational and angular forces of the muscles.

An effort is required of the surgeon to consider not only the choice of implant but also the manner in which the frame is to be constructed in his or her hands, according to the indication. It is the aim of Stryker to provide surgeons with the best possible materials and instruments to ease the task of reducing and stabilizing fractures in children. Much consulting has been done, drawings made and explained in detail, surgeries observed, laboratory studies and testing performed to determine the optimal materials, the dimensions and the shape of the nails as well as the effectiveness, ergonomics and necessity of each instrument. The operating room staff's needs have not been forgotten, as we have also considered the practicalities of the cleaning, storage and easy identification of our products.

It is our desire that the T2 Kids Pediatric Flexible Nail system helps each surgeon gain not only confidence but also joy in his or her ability to bring children back to good health.

Indications and Contraindications

Indications

The Stryker T2 Kids nail is intended for the fixation of fractures where flexibility of the implant is desired. This includes the following fractures:

- Lower extremity diaphyseal fractures of children and small-statured adults.
- Upper extremity diaphyseal fractures in both adults and children.
- Some metaphyseal fractures, such as radial neck, proximal humerus and supracondylar humerus fractures.

Contraindications

The physician's education, training and professional judgment must be relied upon to choose the most appropriate device and treatment.

Conditions presenting an increased risk of implant failure include:

- Open fractures Gustilo grade III.
- Comminuted fractures
- Epiphyseal fractures
- Obese patients with lower limb fractures
- Any active or suspected latent infection or marked local inflammation in or about the affected area.
- Bone stock compromised by disease, infection or prior implantation that can not provide adequate support and/or fixation of the devices.
- Material sensitivity documented or suspected.
- Malignant bone tumors.
- Implant utilization that would interfere with anatomical structures or physiological performance.
- Other medical or surgical conditions which would preclude the potential benefit of surgery.

Detailed information is included in the instructions for use being provided with each implant.

See package insert for a complete list of potential adverse effects and contraindications.

The surgeon must discuss all relevant risks, including the service life of the device, with the child's parents or guardian.

Features and Benefits

Nails

Materials

The T2 Kids nail is offered in two materials:[16-19]

Titanium: Grade 5 Ti6Al4V ELI conforming with ASTM F136, type II anodized with laser-etched rings for easy identification of nail diameter.

Stainless Steel: 1.4441 (316 LVM) conforming with DIN ISO 5832-1 with laser-etched rings for easy identification of nail diameters.

Diameters

Diameters: Ø1.5; Ø1.75; Ø2.0; Ø2.25mm with length 300mm.

Diameters: Ø2.5; Ø3.0; Ø3.5; Ø4.0mm with length 450mm.

We offer an extensive diameter range for optimal patient treatment.

Packaging

All nails are offered with 2 nails of the same diameter in sterile as well as in non sterile packaging, for the convenience of the hospital policies and practices.

Curved Tip

Curved nail tip with optimized length to allow maximal guidance without blocking in intramedullary canal.

IF the selected nail diameter (d) is 2/5 or 40% of the IM canal diameter (D) AND the nail tip height is a factor of 2.2d - THEN there remains a clearance between the IM canal and the nail tip.

Example: D=10mm

d =0.4x10=4mm

Nail tip height =8.8<10mm

Tapered Tips and Concave Side

Tapered tip and concave inner side for anchoring in metaphyseal bone and capturing fracture fragments.

Smooth Convex Side

Smooth and broad outer convex side improves gliding during insertion and helps to prevent second cortex penetration.

Pre-curved Shaft

The T2 Kids nail features an additional insertion bend to assure the maximum ease of insertion. This bend saves one step during the surgical procedure as such a curved shaft is added in most cases to ease insertion.

Note:

This pre-curved proximal shaft does not preclude the need for the surgeon to bend the nail to create the three point cortical contact.

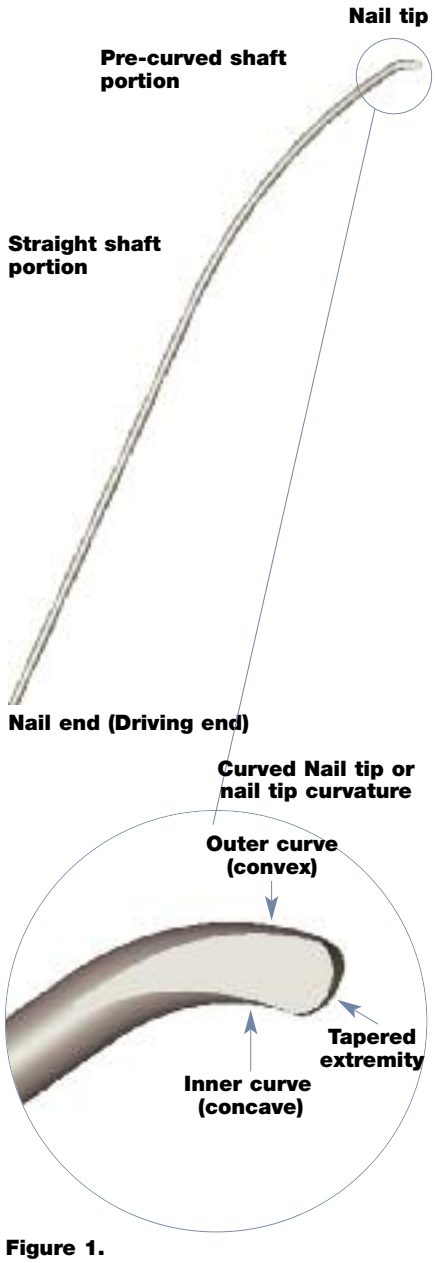


Figure 1.

Instruments

The Stryker T2 Kids instruments are based on the T2 IM Nailing instrument platform.

More than that, the T2 Kids system instruments are designed for best treatment outcome by distinguishing between small and large bone treatment characteristic to pediatric orthopaedics.

This optimizes the instrument-to-patient precision maneuvering while maintaining the Stryker signature ergonomic handles.

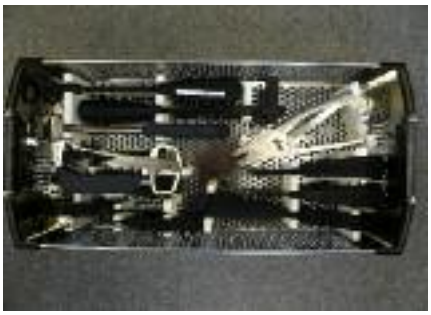


Image 1.

Trays

Tray Layout According to Operative Steps

1) Nail bending: Bending Instrument
2) Bone opening: Awl (Large and Small) and Tissue Protective Sleeve (opt.)
3) Nail Insertion and Tip Impaction: Inserter, Slotted Hammer
4) Nail Cutting: Cutters
5) Nail End Impaction: Final Impactors (Large and Small) and Slotted Hammer
6) Nail Removal: Forceps, Universal Rod (top tray insert) and Slotted Hammer

Features and Benefits

Material Advantages

All Stryker T2 implants are made of **Type II anodized titanium alloy (Ti6AL4V) for enhanced biomechanical performance[19].**

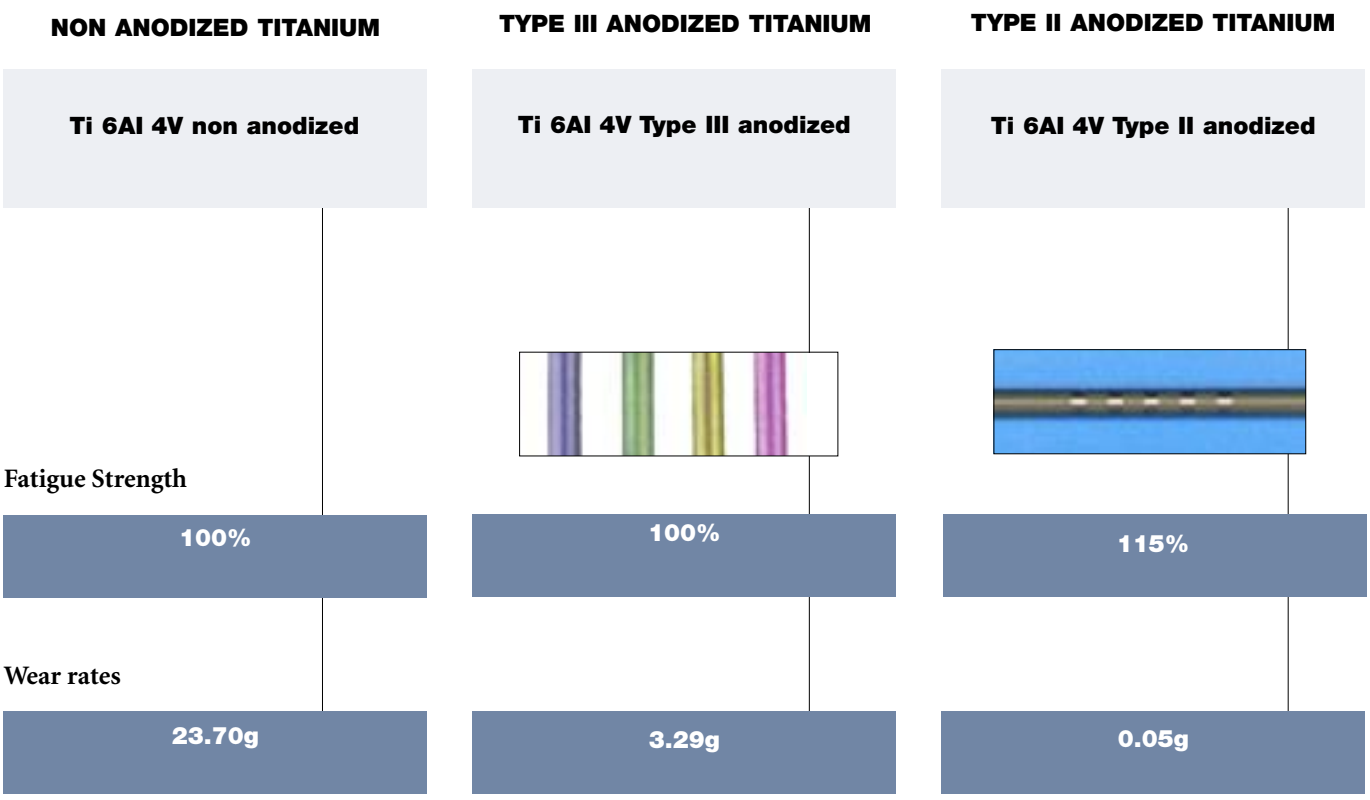


Diagram 1.

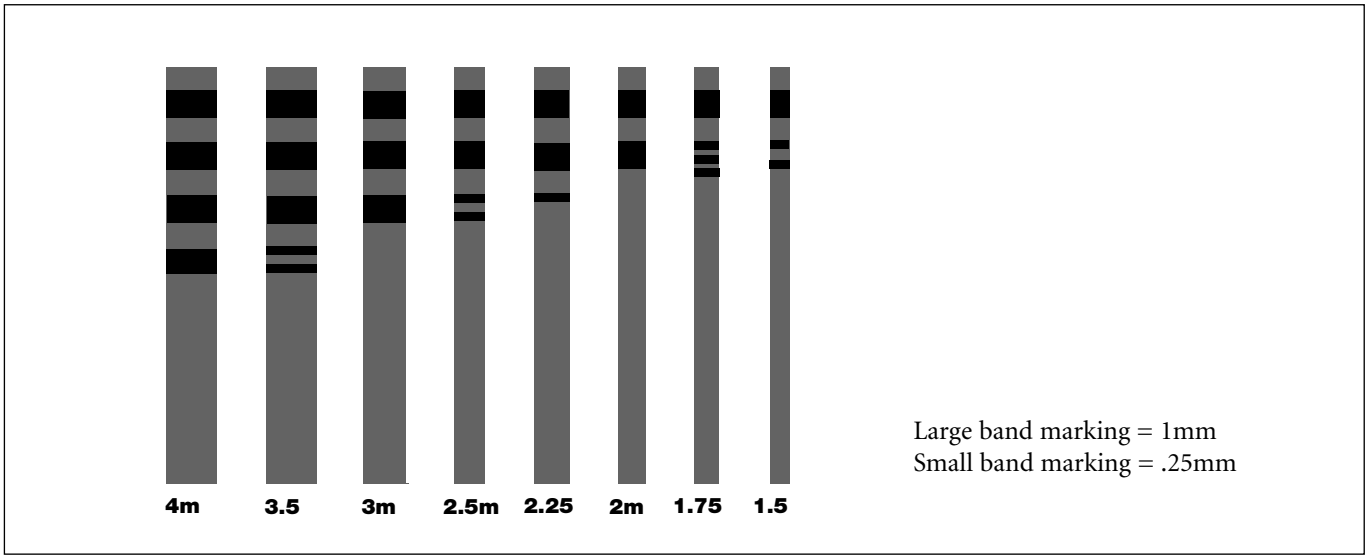


Diagram 2.

All Stryker T2 Kids nail ends are laser-marked with bands for easy diameter identification. Thick bands indicate 1mm diameter and thin bands indicate .25mm diameter. Verify the nail diameter by inserting the nail end into the designated hole in the tray insert.

All Fractures

Nail Selection

Instrument: X-Ray Ruler

The diameter of the implants should be about 40% of the diameter of the intramedullary canal measured on the X-ray.

The formula is therefore:

Ø nail = 0.4 x Ø IM canal.

Some individual adaptations are tolerated but experience has shown that when hesitating between two diameters, the greater diameter should always be preferred over the lesser diameter, which may lead to a deformation caused by a less stable construct.

In the majority of cases, the two nails should have matching diameters to prevent iatrogenic valgus or varus deformities. Verify the selected nail diameter in at least one of the four possible ways:

- Packaging information
- Laser band markings on the nail
- Measuring holes on the metal tray insert
- X-Ray Ruler

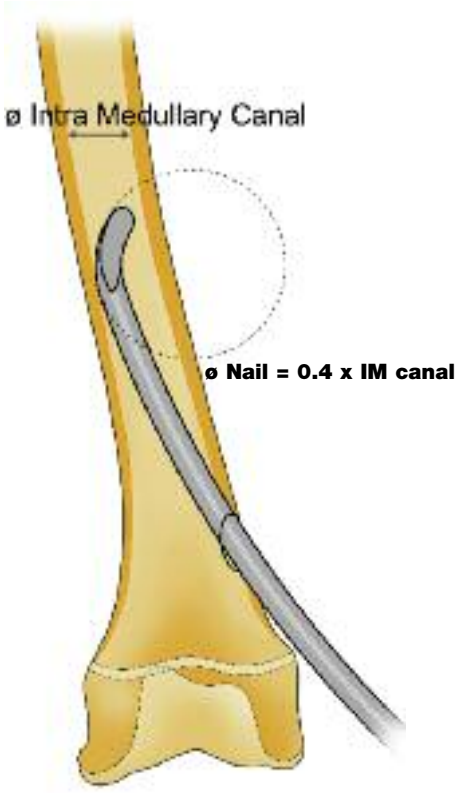


Figure 2.

Image 2.

Image 3.

Alternatively the nail diameter can be determined using the X-Ray Ruler. Place the X-Ray Ruler on the skin above the IM canal to be measured. Take a fluroscopic picture perpendicular to the X-Ray Ruler. Adjust the ruler now so that the IM canal outer line lies in between the cut out. The recommended nail diameter is displayed above the cut out.

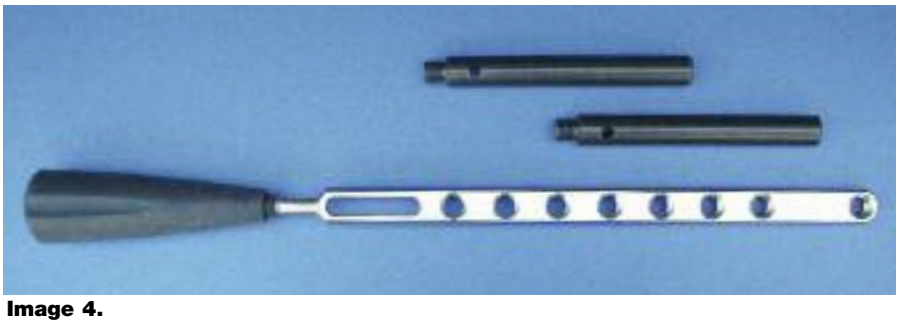


Image 4.

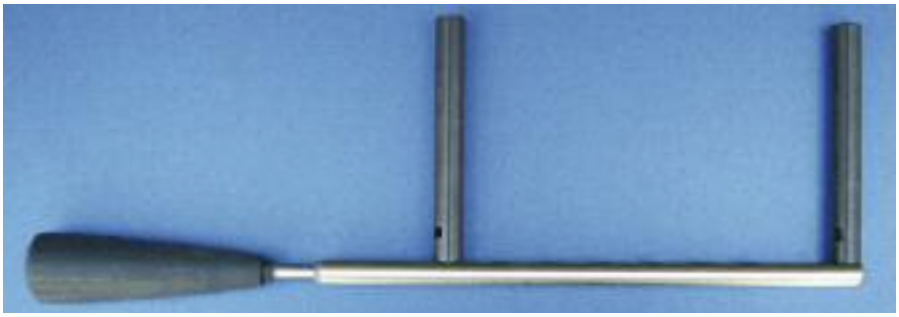


Image 5.

Fracture Reduction

Instrument: Reduction Instrument

Check if the fracture can be reduced in a closed manner prior to setting up the sterile field.

Assemble the Reduction Instrument by threading the two bars into the handle at the appropriate levels according to the limb to be treated and the patient's size. Slide the Reduction Instrument over the limb with a bar on each side and reduce the fracture by maneuvering the handle of the tool. Verify the reduction through bi-planar fluoroscopy over the radiolucent reduction bars.

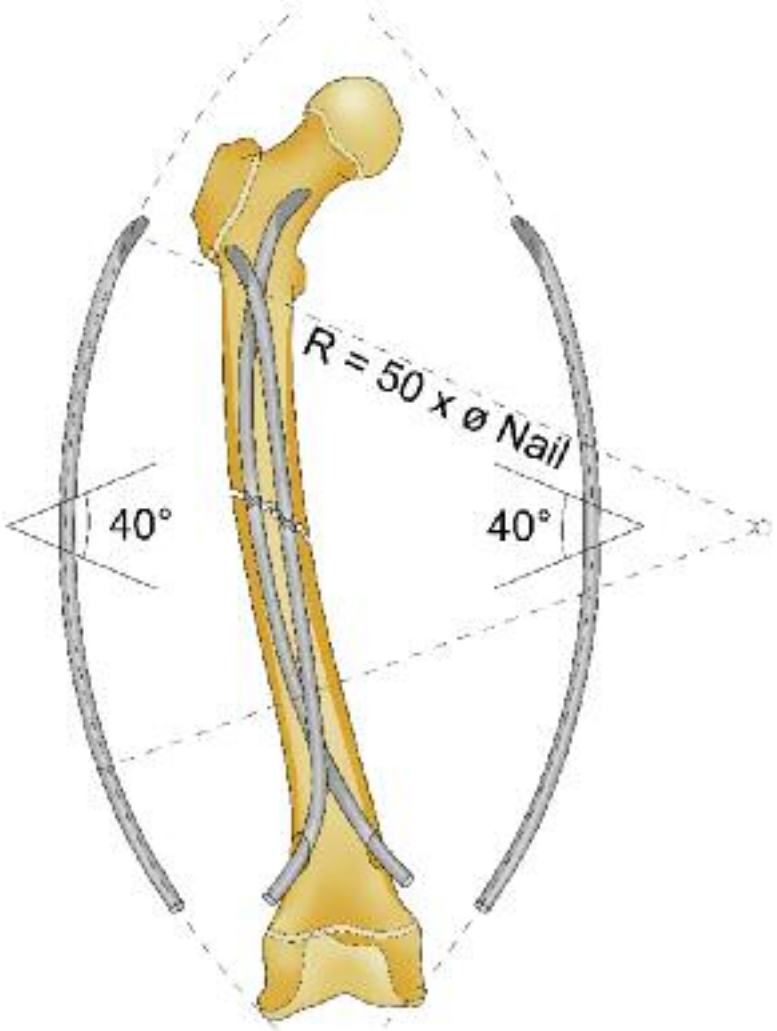


Figure 3.

Image 6. Creating the fracture bend using the slots

Image 7. Creating the fracture bend using the through-holes

Image 8. Decreasing the pre-curved shaft

Image 9. Increasing the pre-curved shaft

Nail Bending

Instrument: Bending Instrument

The Bending Instrument is a multi-purpose instrument with specifically designed bending slots and through-holes. The following possibilities are provided:

- creating identical fracture bends for two nails
- increasing or decreasing the radius of the pre-manufactured curved shaft

The fracture bend is created by the surgeon to ensure a continued correctional force within the intramedullary canal at the fracture level. This correctional force is a result of the characteristic memory of the metal (found in titanium and to a lesser degree in stainless steel). This metal memory, called elasticity, is a potential energy which causes the nail to strain against the cortex in an effort to regain the pre-operative bend which was produced by the surgeon and which afterwards is contained in an area too narrow to permit the bend to be physically expressed.

Engage the nail into the appropriate slot or through-holes.

Bend the nails according to the situation with the apex at the fracture level. Bending both nails identically permits an optimal stability of the frame by ensuring matching curves.

Caution: Avoid both over-bending the nail and creating any notches on the nail surface.

All Fractures

Determining the Incision and Insertion Points

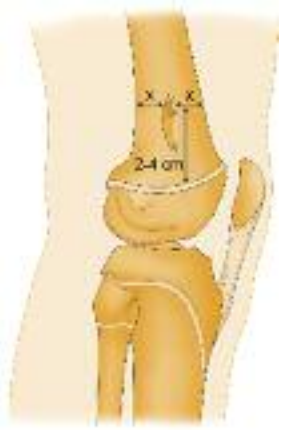
The insertion site can be determined by placing the Awl perpendicular to the bone and above the skin then taking a fluoroscopy image in the frontal view to confirm. The skin is incised where the cortex will be opened, allowing for extra space to permit maneuvering of the nail upon insertion without irritating the skin.

To fully benefit from the flexible intramedullary nailing technique, respect the following guidelines:

1) The apex of the (40°) bend is situated at the fracture level
2) The two nails are aligned face-to-face in the canal
3) The two nails cross each other above and below the fracture site.

See the diagrams on the following pages which depict the opening and final constructs for several procedures.

Femoral Retrograde



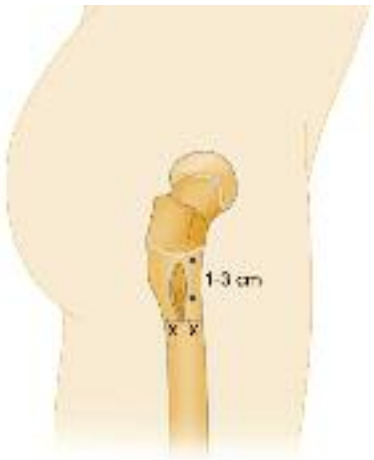
Opening

Construct

Warning: When opening the medial site, be careful not to let the Awl or Drill Bit slip posteriorly into the region of the femoral artery.

Figure 4.

Femoral Antegrade

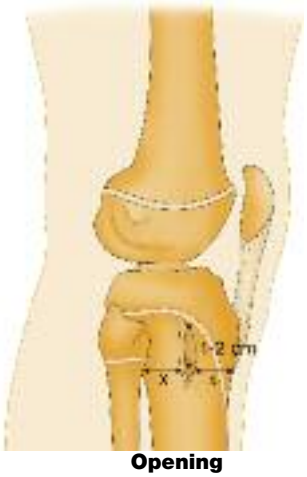


Opening

Construct

Figure 5.

Tibial/Fibial Antegrade



Opening

Construct

Construct

Figure 6.

All Fractures

Tibial Retrograde

Construct

Figure 7.

Proximal Humerus

Opening

Construct

Figure 8.

Humerus Midshaft

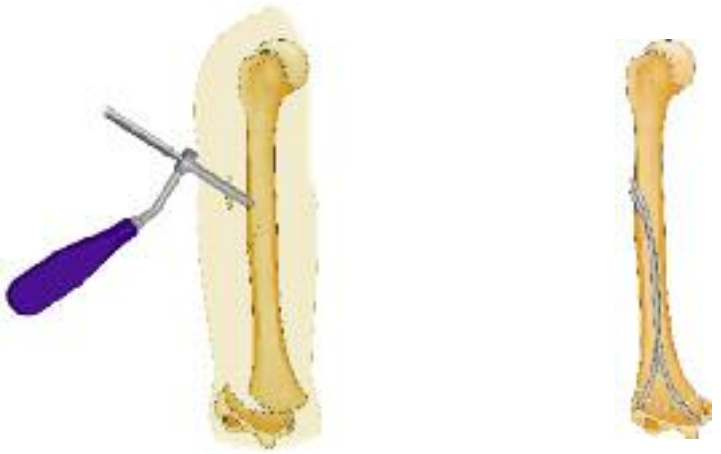
Opening

Construct

Warning: Avoid the radial nerve.

Figure 9.

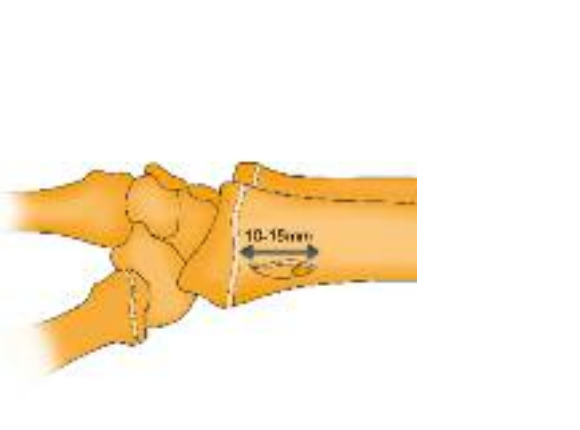
Humerus Supracondylar



Opening Construct

Figure 10.

Radial Neck



Opening **Construct**

Warning: Avoid the extensor tendons and superficial radial nerve.

Figure 11.

Forearm

Radial Opening **Ulnar Opening** **Construct**

Figure 12.

Femoral Mid-Shaft

1 - Cortical Opening

Instruments: Large ø5.0mm Awl or ø5.0mm Drill bit, Tissue Protection Sleeve

The Tissue Protection Sleeve accepts both the large ø5.0mm and small ø3.2mm drill bit as well as the Large ø5.0mm Awl. The front is serrated for a better grip on bone.

The length of the Tissue Protection Sleeve limits the functional length of the Drill Bits and the Large Awl to 20mm. This avoids penetration of the far cortex by the Drill Bit or Awl as well as protecting the adjacent soft tissues.

The Large ø5.0mm Awl or large ø5.0mm Drill Bit is reccommended when nails of the following diameters are used:

ø2.5mm; ø3.0mm; ø3.5mm and ø4.0mm.

The cortical insertion hole is made with the Awl or Drill Bit which is first applied at a 90° angle (perpendicular) to the cortex. Once the first cortex is penetrated, the instrument-to-bone angle is lowered to shape an oblique opening in the direction of the fracture.

Optional Curved Awls are available to further enlarge the insertion hole.

Warning:

Do not use the Curved Awl for the initial opening of the bone as a sharp curved instrument is difficult to prevent from damaging soft tissues.

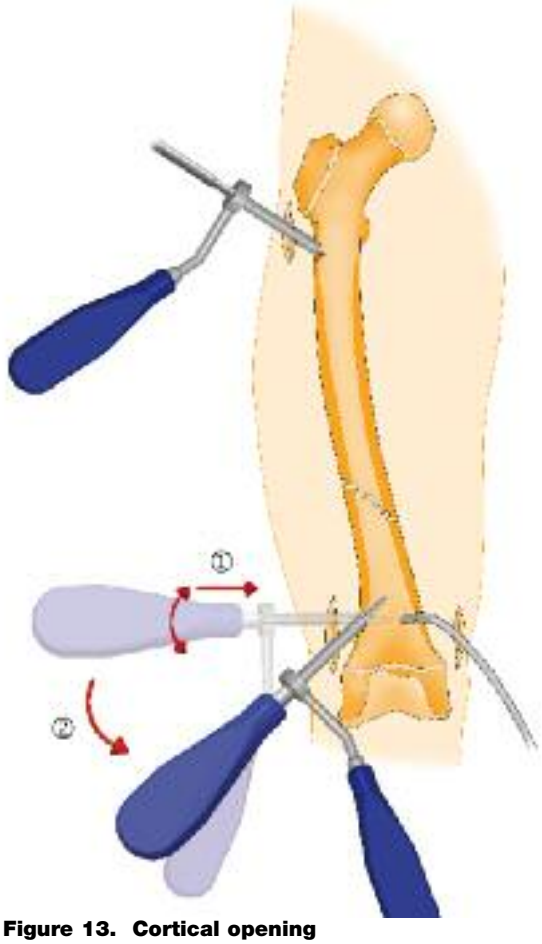


Figure 13. Cortical opening

2 - First Nail Insertion and Progression

Instrument: Inserter

Engage the selected nail with the Inserter by sliding its end into the front through the designated opening. For orientation of the curved nail tip align the nail tip with the handle of the Inserter.

Squeeze and hold the handle of the Inserter to firmly grip the nail.

Introduce the nail into the bone opening with the hook facing away from the fracture. When the opposite cortex is felt, rotate the nail 180° so that the hook now faces the fracture and is ready to be glided progressively through the intramedullary canal.

The nail is pushed forward in the canal using slight rotational movements to avoid blockage in the intramedullary canal.

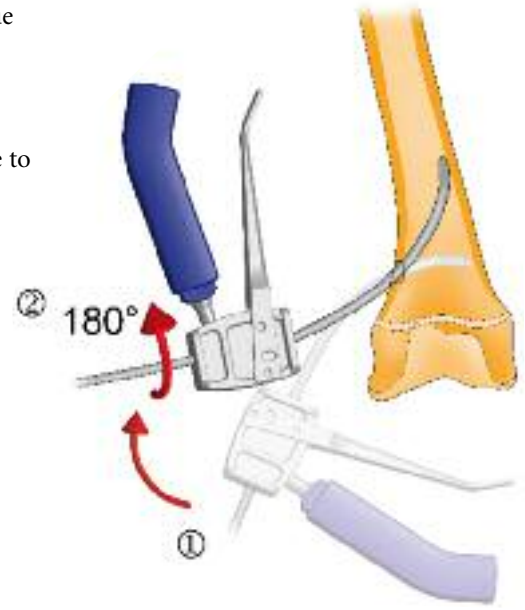


Figure 14. Nail insertion

Femoral Mid-Shaft

3 - Crossing the Fracture Site with the First Nail

Instruments: Inserter, Slotted Hammer

The Slotted Hammer is designed to fit over the nail and slide along it to tap with controlled blows on the Inserter and drive the nail forward in the intramedullary canal. Make sure to only tap on the strike surface on the front and backside of the Inserter for an insertion force in line with the nail.

Check the progression of the nail with fluroscopy to ensure that the tip is advancing with each blow.

When the fracture site is reached, the nail tip must be rotated 180° so that it is oriented just below the opposite fragment in both frontal and lateral fluoroscopic views. The fracture is reduced and reduction is checked using fluoroscopy once again. Drive the nail across the fracture site using the Slotted Hammer.

How far up the fragment should the first nail be inserted?

Option 1: Verify the reduction and nail position with frontal and lateral fluoroscopy. Advance the nail a few centimeters further in the far fragment.

By advancing the first nail just slightly into the second fragment there is less stability but more reduction potential, given that the communication between the two fragments is with only one unanchored nail. This also facilitates passage of the second nail.

Option 2: If the first nail is advanced much further up the canal, there is a heightened stability of the primary reduction but the passage of the second nail is not as simple, as the space in the intramedullary canal has been reduced. In this case, more space can be gained by rotating the nail.

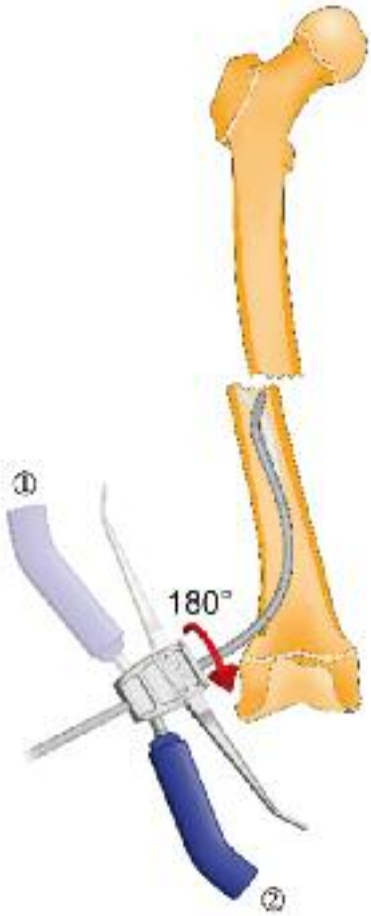


Figure 15. Crossing the fracture site

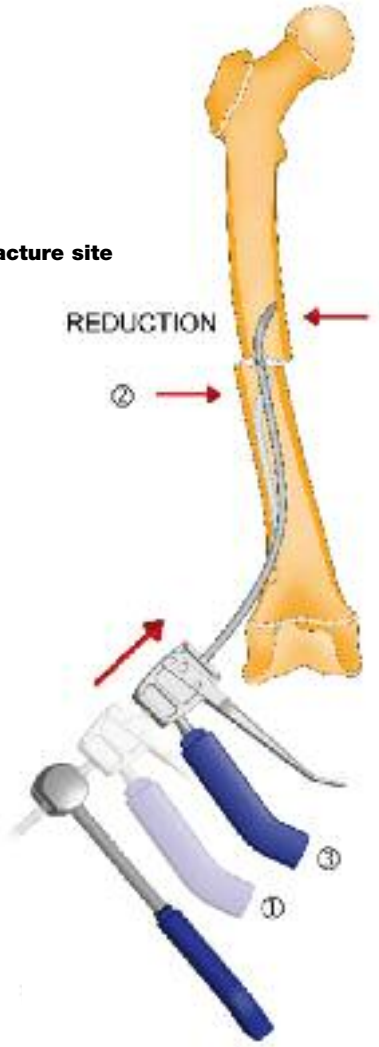


Figure 16. Crossing the fracture site

Femoral Mid-Shaft

4 - Crossing the Fracture Site with the Second Nail

Instruments: Inserter, Slotted Hammer

Prepare the insertion site in the bone for the second nail as described before. Place the second nail into the Inserter and repeat the steps described. Insert the second nail just up to the fracture site.

Warning:

When opening the medial side, be careful not to let the Awl or Drill Bit slip posteriorly into the region of the femoral artery.

Crossing of the fracture site can be performed immediately after the first nail has crossed (Option 1) or when the first nail is well engaged in the fragment (Option 2), as already described in the previous step.

Cross the fracture site with the second nail in the same manner as that of the first: advance to the fracture site, orient the curved tip to enter the IM canal of the further fragment and advance the second nail through the fracture site into the further fragment.

Both nails are advanced until they reach the metaphysis.

The nails may be rotated to achieve perfect reduction of the fracture.

Orient the curved tips (and thus the bow of the nail) in the direction dictated by the situation:

Varus/valgus angulation caused by a transverse fracture can be addressed by directing the nail tips medially or laterally as appropriate to counter the angulation forces. A varus angulation can be corrected by directing the nail tip laterally whereas a valgus angulation can be corrected by directing the nail tip medially.

Similarly, in the sagittal plane, a recurvatum angulation can be corrected by directing the nail tips posteriorly and a flexion angulation by directing the nail tips so that the concave sides face anteriorly.

There are of course possibilities of combined deformities as well as biomechanical factors to be considered. The surgeon must choose the optimal position of the nails in the intramedullary canal to provide a stable frame in spite of the constraints.

During all moments of fracture reduction, great vigilance must be taken to avoid a rotational malunion, as the remodeling is limited in this axis.

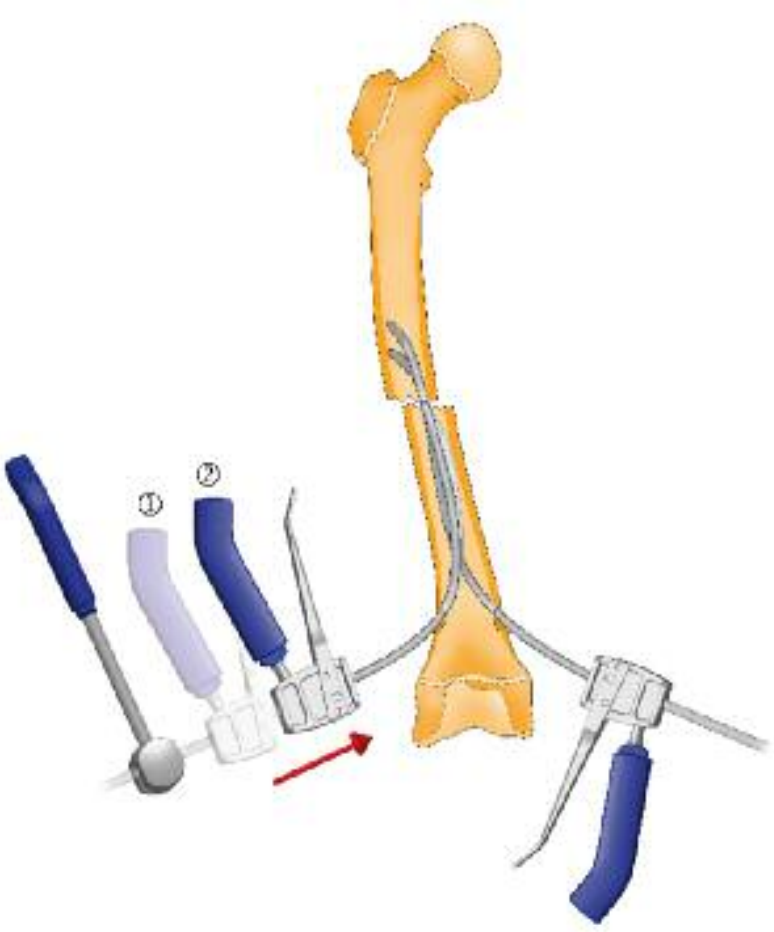


Figure 17. Second nail crossing the fracture site

Femoral Mid-Shaft

5 - Impacting the Nail Tips

Instruments: Inserter,
Slotted Hammer

Once the position and orientation of both nails are satisfactory, they are impacted into the cancellous bone of the metaphysis while maintaining reduction. Use the Large Slotted Hammer on the Inserter to impact the nails.

Attention should be paid to the horizontal plane at all times during this reduction step so as to prevent rotational malunion.

Impaction of the fracture plays an important role in final reduction. All transverse fractures must be impacted to minimize the potential for later leg length discrepancy. In oblique and spiral fractures and even fractures with a third fragment, impaction provides stabilization of the fracture site at the expense of slight shortening (5 to 10 mm) which is readily compensated for by postoperative overgrowth.

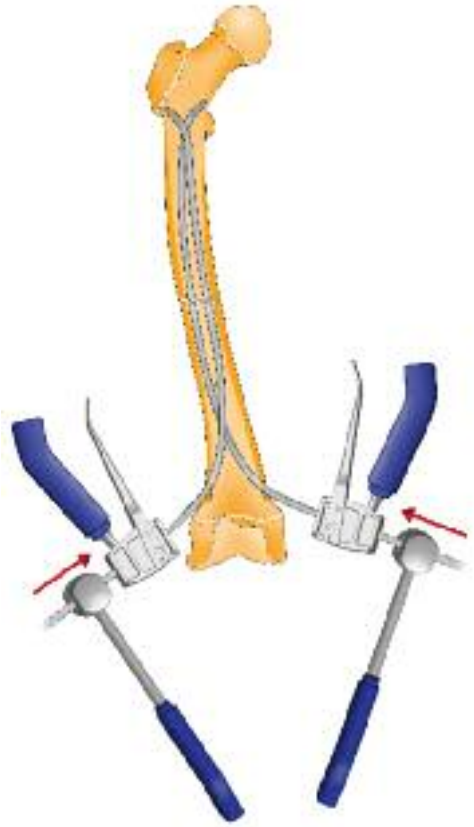


Figure 18. Impacting the nail tips

6 - Bending the Nails Prior to Cutting

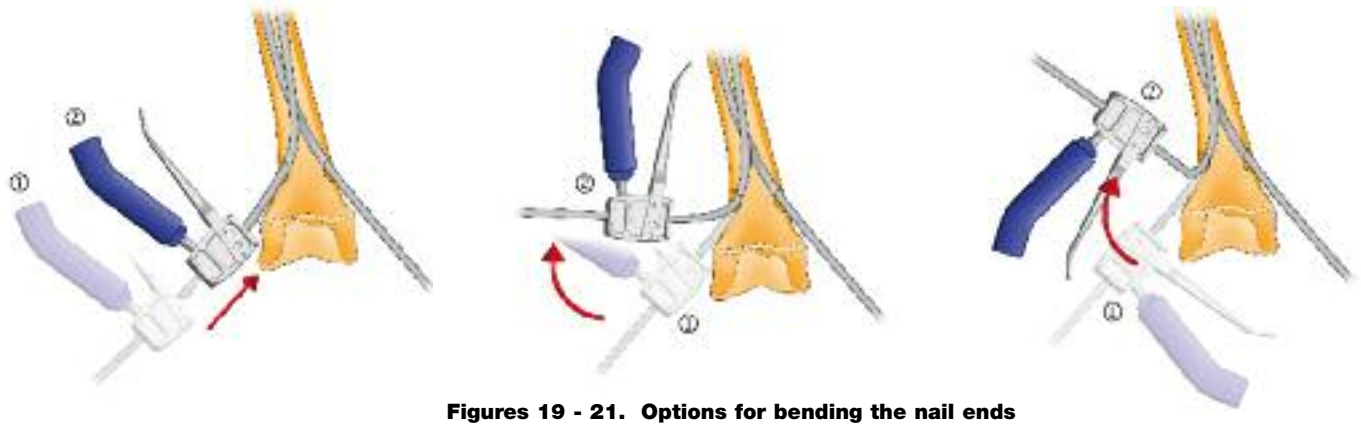
Instrument: Inserter

At this point, the Inserter is still on the nail. There are three options for bending the trailing ends prior to cutting off the excess material:

Option 1) In some cases, the trailing ends are not bent at all; they are simply left to lie against the cortical wall after trimming.

Option 2) For ease of future removal, the nail ends may be bent away from the cortex at an angle of approximately 30-60°, according to the limb involved and the surrounding soft-tissue coverage.

Option3) The third option is to sharply bend the trailing ends (>90°) with the intention to fully recess them into the bone later in the procedure. Be aware that removal of a sunken nail is more difficult than a protruding nail.



Figures 19 - 21. Options for bending the nail ends

Femoral Mid-Shaft

7 - Cutting the Nail Ends

Instrument: Large Cutter

Remove the Inserter from the nail. Make sure the Large Cutter is assembled as shown and the inner sleeve is rotated to the mid position where the cutting holes are open to slide the assembly over the nail, matching the nail diameter with the dedicated hole in the assembly. Push the Cutter down over the nail to the desired cutoff point. Be aware that the cutoff point is 3mm off the frontal plane of the Cutter. After you have positioned the Cutter at the correct position, slide the handle piece over the key on the top of the assembly. You can attach the handle to the key top on either the right or left side. The optimal position to engage the handle with the assembly is when both handle pieces are at an angle of about 60°.

Cut the nail by moving the handles smoothly towards each other. The cutoff portion of the nail is captured within the cutter.

If access to the cutoff point is difficult, you may also mark the nail at the cutoff point with a pen or clamp. Retract the nail far enough to access the cutoff point. The cut nail end is pushed back into the intramedullary canal using the Final Impactor as described next.

Image 10. Large Cutter

8 - Impacting the Cut Nail Ends

Instruments: Final Impactor, Slotted Hammer, Large Forceps

The Large Final Impactor will leave from 7 to 12mm of nail length protruding from the outer cortex, according to the position in which it is placed on the bone. For the femur, it is recommended to leave 12mm of nail protruding from the bone but less is better tolerated if the child is small or slender.

Turn the Impactor so that the desired length of protruding nail is indicated on the side which is closest to and faces the cortex (the opposite length will be facing the surgeon). Impact the nails into the metaphyseal bone whilst firmly maintaining the reduction. If the nail has been over inserted use the Large Forceps to retract the nail.

Final fluroscopic verification in both frontal and lateral planes is made prior to wound closure.

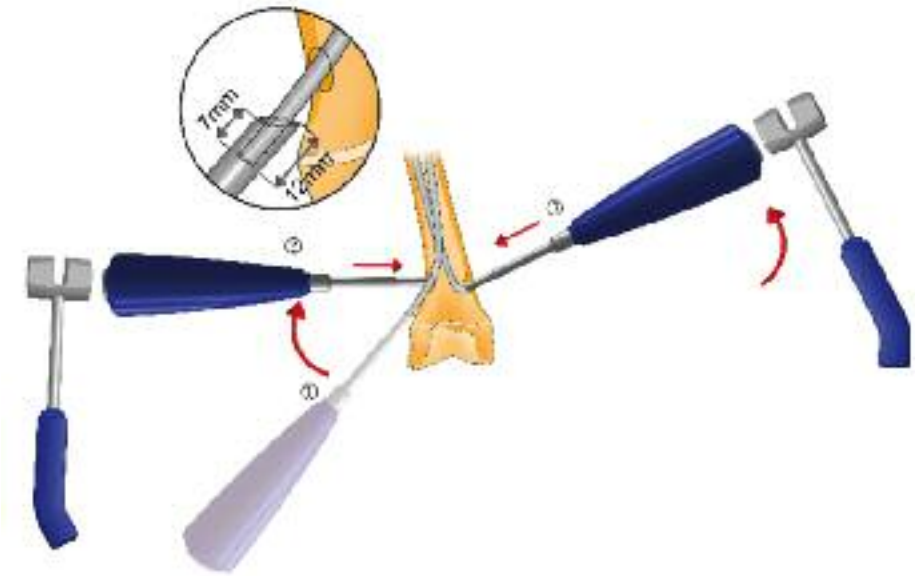


Figure 22. Impacting the nail ends

Figures 23 - 25. Options for nail impaction

Forearm Mid-Shaft

1 - Incision and Insertion Points for Radial Shaft Fracture

Instruments: Small Awl

The cortical insertion hole is made with the Awl which is first applied at a 90° angle (perpendicular) to the cortex. Once the first cortex is penetrated, the awl-to-bone angle is lowered to shape an oblique opening in the direction of the fracture.

The Small ø3.2mm Awl or Small ø3.2mm Drill Bit is recommended when nails of the following diameters are used:

ø1.5mm; ø1.75mm; ø2.0mm and ø2.25mm.

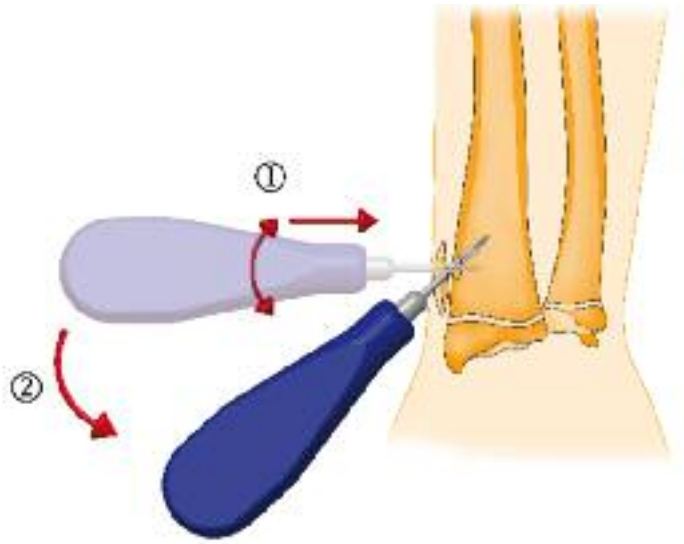


Figure 26. Cortical opening

2 - Radial Nail Insertion

Instrument: Universal Chuck with T-Handle

Engage the selected nail with the Universal Chuck by sliding its end into the center of the opening. Locking the grip on the nail can be achieved by turning the Chuck clockwise. For optimal grip make sure that the nail is captured in the center of the Chuck as it can happen that the nail is clamped with a slight offset.

Introduce the nail into the bone opening with the hook facing away from the fracture. When the opposite cortex is felt, rotate the nail 180° so that the hook now faces the fracture and is ready to be glided progressively through the intramedullary canal.

Warning:

Do not grip the T-Handle with your palm over the center of the strike plate, as the nail end will protrude from there.

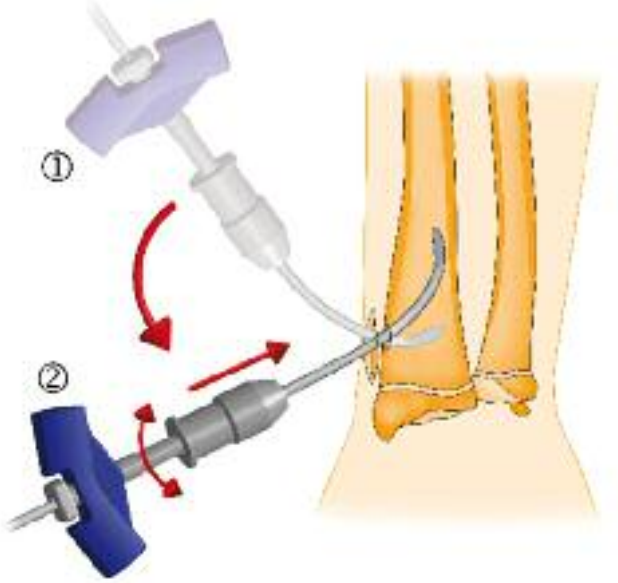
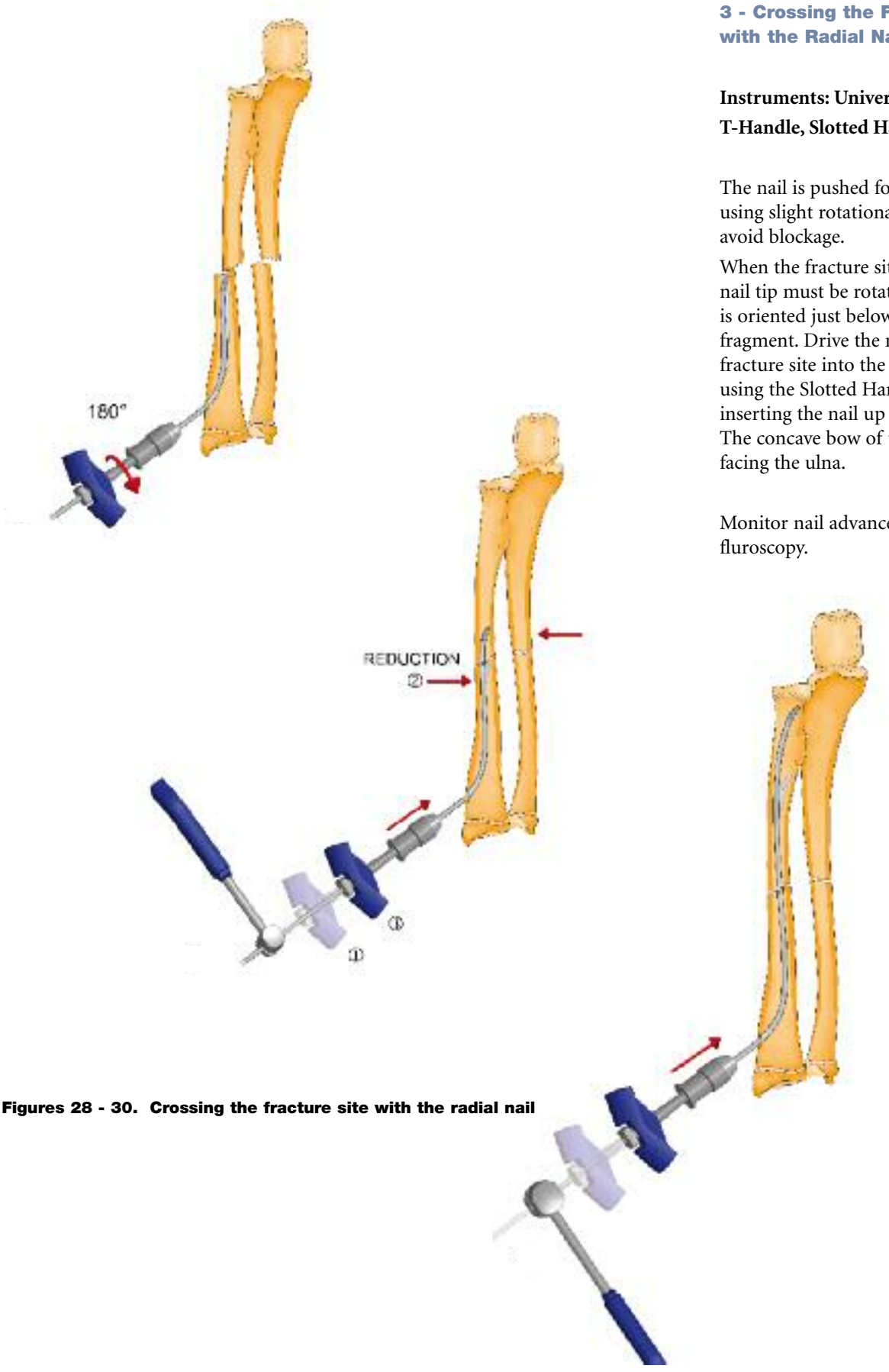


Figure 27. Radial nail insertion

Forearm Mid-Shaft



Figures 28 - 30. Crossing the fracture site with the radial nail

3 - Crossing the Fracture Site with the Radial Nail

Instruments: Universal Chuck with T-Handle, Slotted Hammer

The nail is pushed forward in the canal using slight rotational movements to avoid blockage.

When the fracture site is reached, the nail tip must be rotated 180° so that it is oriented just below the opposite fragment. Drive the nail through the fracture site into the second fragment, using the Slotted Hammer. Continue inserting the nail up to the metaphysis. The concave bow of the nail must be facing the ulna.

Monitor nail advancement with fluroscopy.

Forearm Mid-Shaft

4 - Cortical opening for the Ulnar Nail

Instrument: Small Awl

Perform the skin incision for the ulnar nail. Prepare the insertion site in the ulnar bone for the second nail. The ulnar entry site is on the posterolateral aspect of the olecranon so that the end of the nail will be buried in the short elbow extensor muscle (anconeus) and permit leaning the elbow on the table. The medial approach is to be avoided as there is a risk of damaging the ulnar nerve.

The Small ø3.2mm Awl or Small ø3.2mm Drill Bit is reccommended when nails of the following diameters are used:

ø1.5mm; ø1.75mm; ø2.0mm and ø2.25mm.

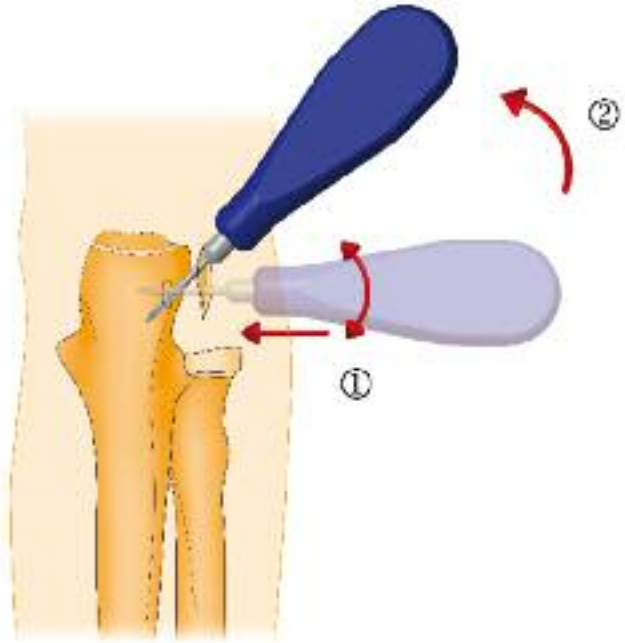


Figure 31. Cortical opening for the ulnar nail

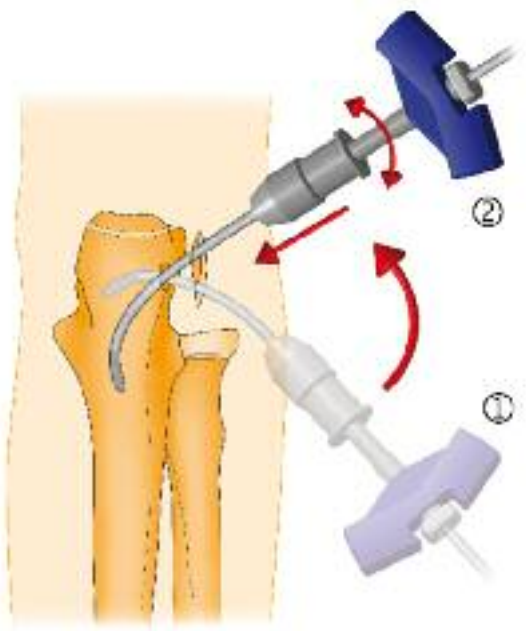


Figure 32. Cortical opening for the ulnar nail

5 - Insertion of Ulnar Nail

Instrument: Universal Chuck with T-Handle

Place the ulnar nail into the Universal Chuck by sliding its end over the center of the opening. Locking the grip on the nail is achieved by turning the Chuck clockwise. For optimal grip make sure that the nail is captured in the center of the Chuck as it can happen that the nail is clamped with a slight offset.

Advance the nail just down to the fracture site.

Forearm Mid-Shaft

6 - Crossing the Fracture Site with the Ulnar Nail

Instruments: Universal Chuck with T-Handle, Slotted Hammer

Cross the ulnar fracture site with the second nail in the same manner as that of the radial nail: Advance to the fracture site, orient the curved tip to enter the IM canal of the further fragment and hammer the second nail through the fracture site into the further fragment.

Continue inserting the ulnar nail down to the distal ulnar metaphysis and orient the concave bow of the nail towards the radius.

Ascertain that the nails are oriented correctly: the curved tip of the radial nail must be oriented towards the medial aspect whereas the curved tip of the ulnar nail must be oriented towards the lateral aspect. Thus the two concave aspects of the nails are face to face and the construct is further stabilized by the spreading of the intraosseous membrane.

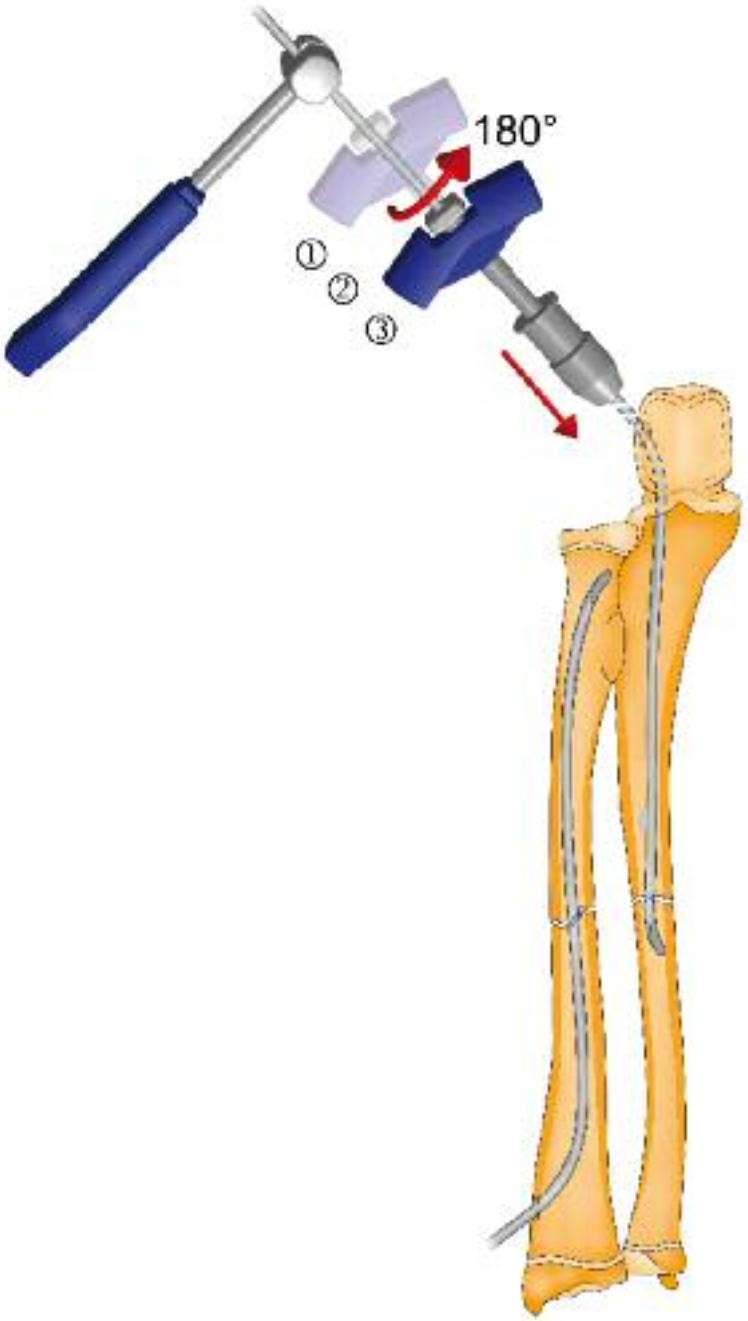


Figure 33. Crossing the fracture site with the ulnar nail

Forearm Mid-Shaft

7 - Impacting the Nail Tips

Instruments: Universal Chuck with T-Handle, Slotted Hammer

Use the Slotted Hammer to impact the nails into their respective metaphyses for the final reduction.

Once the position and orientation of both nails are satisfactory, they are impacted into the cancellous bone of the metaphysis while maintaining reduction. Use the Slotted Hammer on the Universal Chuck with T-Handle to impact the nails. Make sure to only tap on the strike plate of the T-Handle for an insertion force in line with the nail.

Attention should be paid to the horizontal plane at all times during this reduction step to prevent rotational malunion.

Figure 34. Impacting the nail tips

8 - Bending the Nail Ends Prior to Cutting

Instrument: Universal Chuck with T-Handle

At this point, the Universal Chuck is still on the nail. There are two options for bending the trailing ends prior to cutting off the excess material:

Option 1) In some cases, the trailing ends are not bent at all; they are simply left to lie against the cortical wall after trimming.

Option 2) For ease of future removal, the nail ends may be bent away from the cortex at an angle of approximately 30-60°, according to the limb involved and the surrounding soft-tissue coverage.

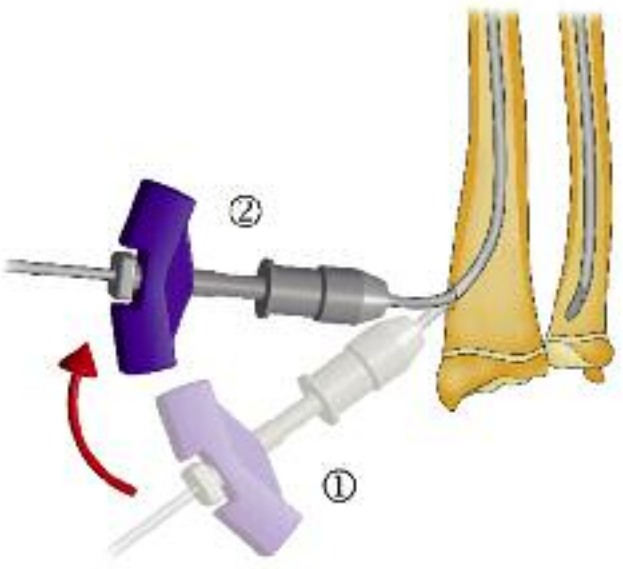


Figure 35. Bending the nail ends prior to cutting

Forearm Mid-Shaft

9 - Cutting the Nail Ends

Instrument: Cutter

Remove the Universal Chuck from the nail.

Cut the end of the nail with the Cutter, facing the golden cutting blades towards the cortex. The black rubber jaws are facing the operator and are holding the clipped nail end preventing it from flying off when the nail end is cut.

Figure 36. Cutting the nail ends

Cut the nail end as close as possible to the cortex leaving at least 3mm of the nail end protruding from the cortex.

Warning: Although there is a rubber grip designed to keep the clipped nail end from flying out of the Cutter, use of eye protection is advised.

If access to the cutoff point is difficult, you may also mark the nail at the cutoff point with a pen or clamp. Retract the nail far enough to access the cutoff point. The cut nail end is pushed back into the intramedullary canal using the Final Impactor as described next.

10 - Impacting the Nail Ends

Instruments: Small Final Impactor, Slotted Hammer

The Small Final Impactor will leave from 3 to 5mm of the nail length protruding from the outer cortex, according to the position in which it is placed on the bone.

Turn the Impactor so that the desired length of protruding nail is indicated on the side which is closest to and faces the cortex (the opposite length will be facing the surgeon). Impact the nails into the metaphyseal bone while firmly maintaining the reduction.

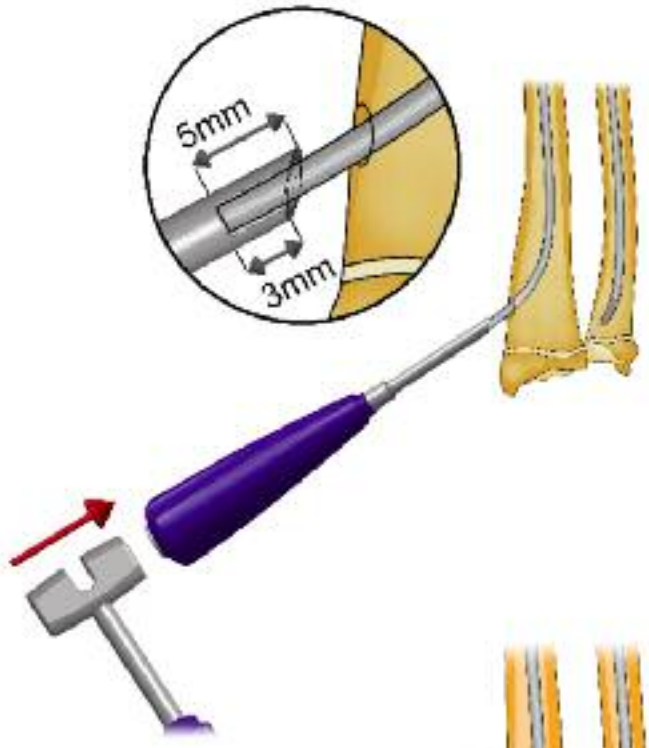


Figure 37. Impacting the nail ends

It is fundamental to completely pronate and supinate the forearm to ascertain full range of motion.

Final fluoroscopic verification in both frontal and lateral planes is made prior to wound closure.

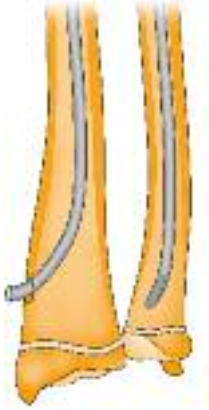


Figure 38. Impacting the nail ends

Removing the Nails

Instruments: Forceps,
Slotted Hammer, Universal Rod

Engage the Forceps to the exposed nail end. The Forceps require only a few millimeters of the nail end for removal in most cases. Engage the Forceps in line with the nail either straight on or from the side in a perpendicular manner.

Adjust the Forceps jaw width by turning the adjustment knob at the handle end. Squeeze the handles forcefully. If you have adjusted the jaw width correctly you will feel a distinct lock. Adjust the width of the jaws if the handles do not lock or can not be squeezed to lock.

Drive the nail out of the bone using the Slotted Hammer against the Universal Rod which can be threaded into the end or the side of the Forceps. If you have engaged the Forceps perpendicularly you are advised to thread the Universal Rod into the side of the Forceps in order to apply the extraction force inline with the nail in the IM canal.

Hold the handle firmly with one hand to prevent the handles from springing open when hammering on the assembly.

Removal with forceps only **Difficult removal**

Figure 39. Options for nail removal

Care and Maintenance

After each use, all instruments should be cleaned. Instruments with removable parts should be disassembled prior to cleaning. Steel brushes should not be used to clean the instruments.

Cannulated instruments should be thoroughly cleaned and opened prior to washing and disinfection. Standard proprietory detergents and disinfectants can be used in accordance with the manufacturer's recommendations.

Prior to autoclaving, instruments should be checked for cleanliness. Instruments with moving parts must be lubricated with autoclavable oil.

Universal Chuck with T-Handle

Clean the Universal Chuck with T-Handle after every use. Use a soft brush and neutral pH detergent to wash the debris from the Chuck and cannulation. It is essential to lubricate the Universal Chuck with T-Handle periodically with autoclaveable oil to maintain smooth operation of the chuck. After cleaning, apply a single drop of oil to each Chuck jaw and rear bushing.

Open and close the Chuck several times and wipe away the excess oil with a dry towel. Wash and sterilize the Inserter before use.

Large Cutter

The Cutter has movable parts. To disassemble the Cutter, unscrew the stop nut and remove the cutting inner sleeve from the handle piece.

Following the cleaning, and before autoclaving, lubricate the cutting sleeve with autoclavable oil. The cutting sleeve must be adequately lubricated to ensure smooth cutting.

Reassemble the Cutter by inserting the cutting sleeve into the handle piece and secure the sleeve with the stop nut. Move the cutting sleeve from one stop side to the other and wipe off the excess oil with a towel. Wash and sterilize the Cutter before use.

For more information see "Instructions for Cleaning and Sterilization" L24002000.

Ordering information - Implants

FLEXIBLE NAIL

Stainless Steel REF	Diameter mm	Total Length mm	Titanium REF
0197-1500 S	1.50	300	0196-1500 S
0197-1750 S	1.75	300	0196-1750 S
0197-2000 S	2.00	300	0196-2000 S
0197-2250 S	2.25	300	0196-2250 S
0197-2500 S	2.50	450	0196-2500 S
0197-3000 S	3.00	450	0196-3000 S
0197-3500 S	3.50	450	0196-3500 S
0197-4000 S	4.00	450	0196-4000 S

For non sterile implants, please remove 'S' from the reference number

Ordering information - Instruments

	REF	Description
Basic Instruments		
	0193-2400	Bending Instrument
	0193-1200	Awl, Straight, ø3.2mm
	0193-1000	Awl, Straight, ø5.0mm
	0193-3000	Inserter (space for 2 in Basic)
	1806-0170	Slotted Hammer
	702951	Cutter
	0193-1600	Final Impactor, ø2.5mm
	0193-1400	Final Impactor, ø4.0mm
	0193-3600	Forceps, Large
	1806-0110	Universal Rod
	0193-1800	Cutter, Large

	REF	Description
Optional Instruments		
	0193-2200	X-Ray Ruler
	0193-3200	Reduction Instrument
	0193-2600	Tissue Protection Sleeve
	0193-1100	Awl Curved, ø3.2mm
	0193-1300	Awl, Curved, ø5.0mm
	0193-4350(S)	Drill Bit, ø3.2x180mm
	0193-4500(S)	Drill Bit, ø5.0x180mm
	0193-2800	Universal Chuck with T-Handle
	6983-5000	Slotted Hammer, Small
	1806-0113	Universal Rod, Short
	0193-3400	Forceps, Small

Basic Metal Tray		
	0193-9100	Basic Set (complete incl. Instruments)
	0193-9110	Instrument Tray, Basic
	0193-9150	Insert, Basic
	0193-9190	Silicone Mat
	1806-9700	Universal Tray Lid

Optional Metal Tray		
	0193-9200	Optional Set (complete incl. Instr.)
	0193-9215	Instrument Tray, Optional
	1806-9700	Universal Tray Lid

Please note that these pictures are an indication only and are not to scale.

Ordering information - Instruments

	REF	Description
		Extraction Instruments
	0193-3800	Chisel
	700664	Hohmann Retractor, 6mm
	700666	Periosteal and Freer Elevator
	1806-6102	Teardrop Handle, AO coupling
	0193-4100	Crown Drill, Ø2 mm
	1806-6165	Crown Drill, Ø3 mm
	1806-6166	Crown Drill, Ø4 mm
	0193-4200	Conical Extractor, female, left hand, ø2 mm
	1806-6183	Conical Extractor, female, left hand, ø3 mm
	1806-6184	Conical Extractor, female, left hand, ø4 mm

Extraction Metal Tray

0193-9300	Extraction Set (complete incl. Instr.)
0193-9315	Instrument Tray, Extraction

Other available Instruments

702900	Table Plate Bender
702900-23	Bending Sleeve Universal (PEEK)
702951-1	Replacement Components for Cutter

Please note that these pictures are an indication only and are not to scale.

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19. Axel Baumann, Dipl.-Ing.*, Nils Zander, Dipl.-Ing.§, * DOT GmbH, Charles-Darwin-Ring 1a, 18059 Rostock, Germany.§ Stryker Trauma GmbH, Prof.-Küntscher-Str. 1-5, 24232 Schönkirchen/Kiel, Germany **Ti6Al4V with Anodization Type II: Biological Behavior and Biomechanical Effects.** March 2005.

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