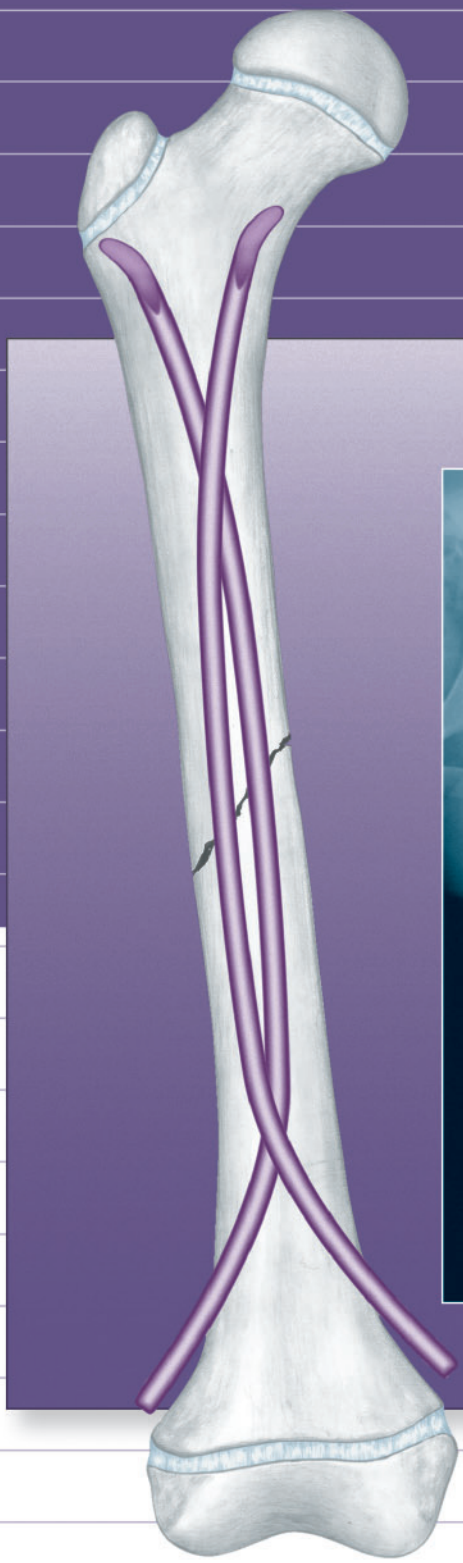
The Titanium Elastic Nail System

TECHNIQUE GUIDE



SYNTHES®

Original Instruments and Implants of the Association for the Study of Internal Fixation — AO ASIF

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Indications

The Synthes Titanium Elastic Nail (TEN) for Elastic Stable Intramedullary Nailing (ESIN) is intended for fixation of diaphyseal fractures of long bones where the medullary canal is narrow or flexibility of the implant is paramount. This includes:

- lower extremity fractures in pediatric patients,
- lower extremity fractures in small-statured patients, and
- upper extremity fractures in all patients.

In pediatric applications, the flexibility of the Titanium Elastic Nail allows it to be inserted at a point which avoids disruption of the bone growth plate.

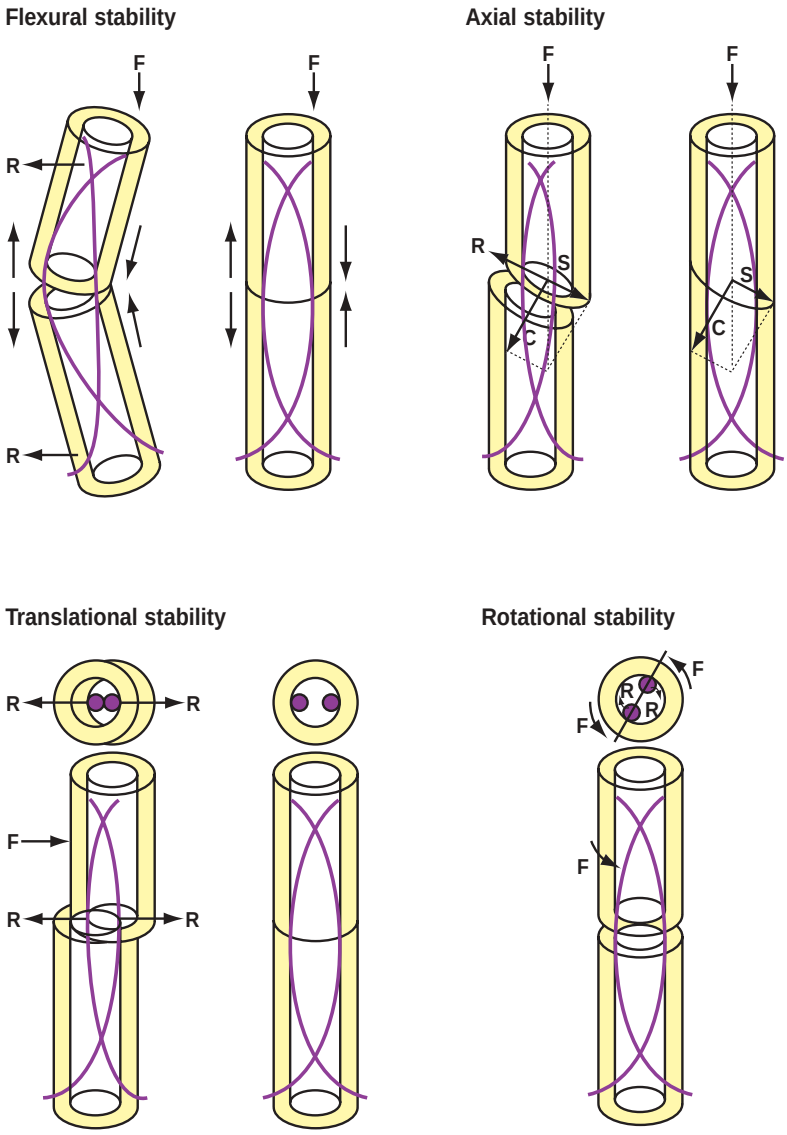
The Synthes Titanium Elastic Nail is not indicated for unstable fractures, such as long, oblique spiral fractures and multifragmentary fractures.

Features

The aim of this biological, minimally invasive fracture treatment is to achieve a level of reduction and stablization that is appropriate to the age of the child.

The biomechanical principal of the Titanium Elastic Nail is based on the symmetrical bracing action of two elastic nails inserted into the metaphysis, each of which bears against the inner bone at three points. This produces the following four properties: flexural stability, axial stability, translational stability and rotational stability. All four are essential for achieving optimal results.[1]

F = force acting on the bone
R = restoring force of the nail
S = shear force
C = compressive force



[1] Dietz, H.G. et al., *Intramedulläre Osteosynthese im Wachstumsalter*. Urban and Schwarzenberg; München 1997.

Case Examples

CASE 1 Pediatric femur—Standard technique

Preoperative

Postoperative

Follow up

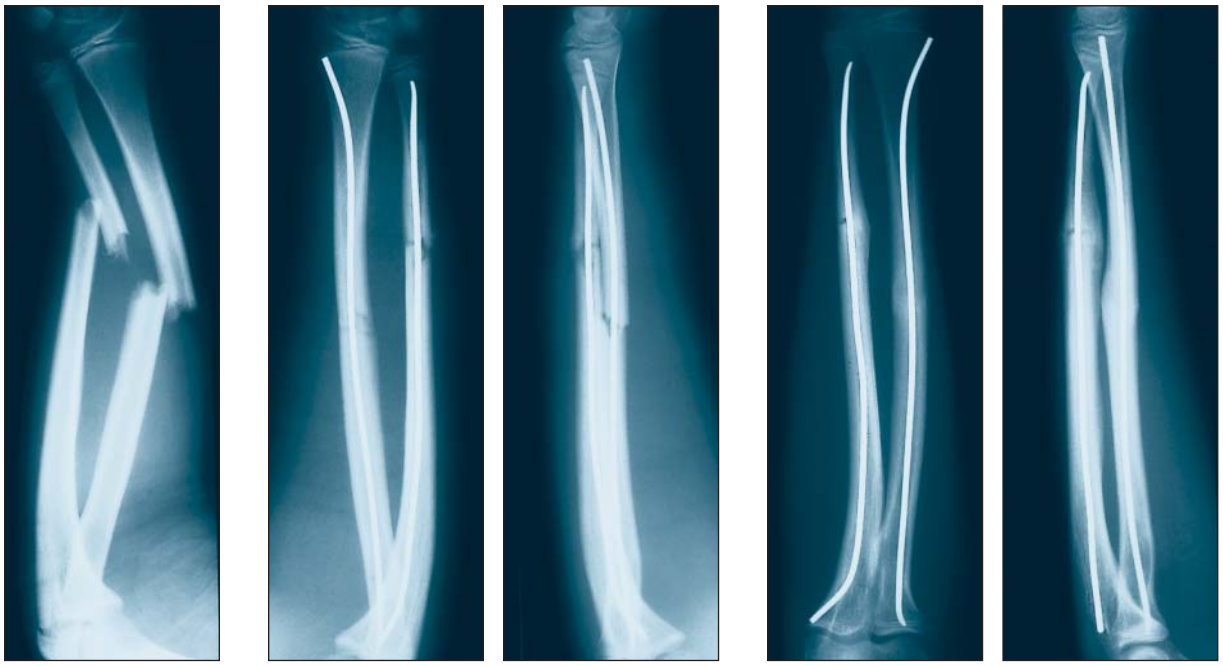
CASE 2 Pediatric femur—Descending technique

Preoperative

Postoperative

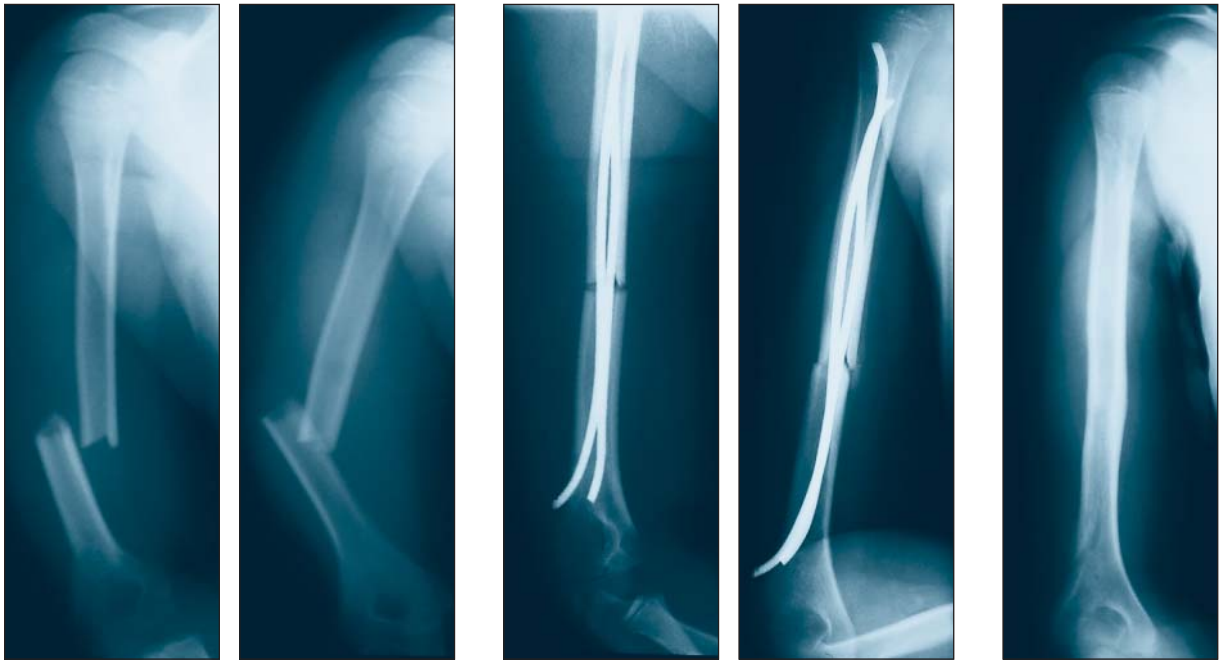
Case Examples (continued)

CASE 3 Pediatric radius and ulna



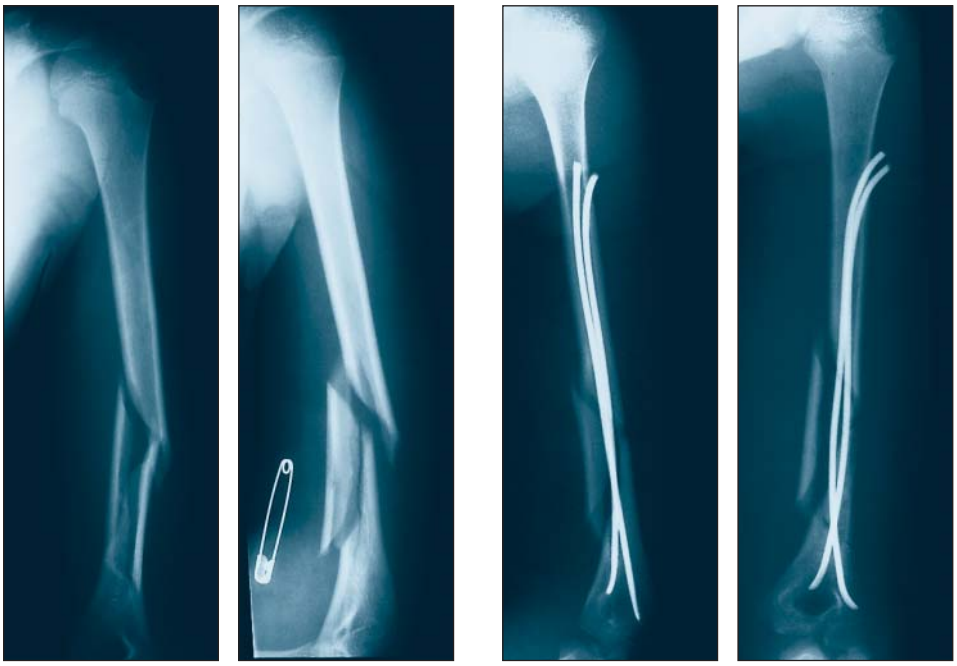
Preoperative *Postoperative* *Follow up*

CASE 4 Pediatric humerus—Ascending technique



Preoperative *Postoperative* *Follow up*

CASE 5 Pediatric humerus—Descending technique

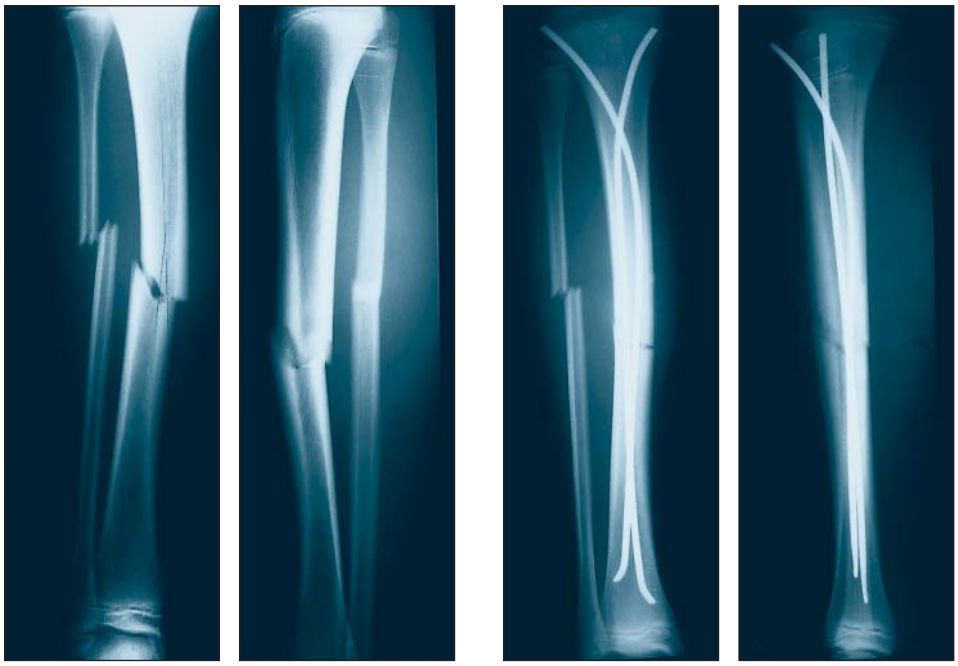


Preoperative *Postoperative*

Follow up

Case Examples (continued)

CASE 5 Pediatric tibia

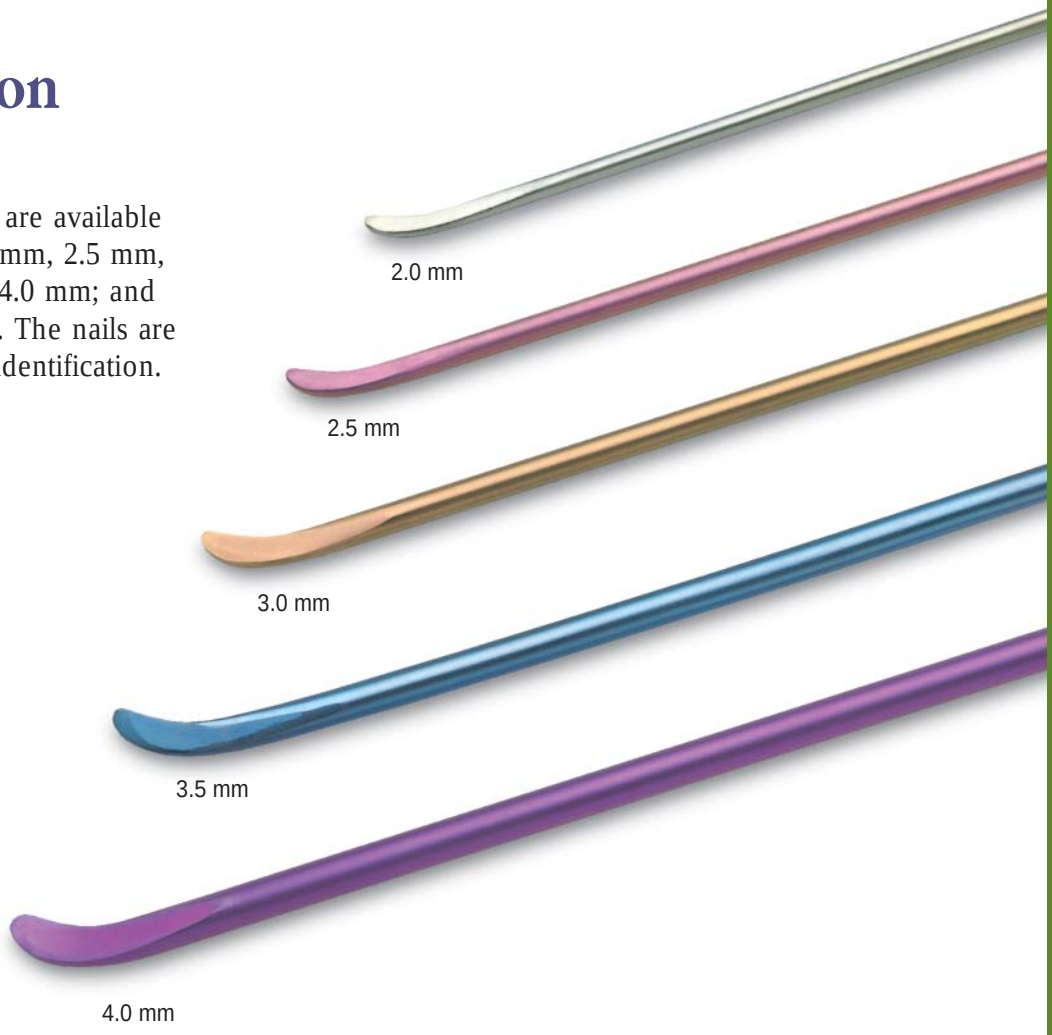


Preoperative *Postoperative*

Follow up

Nail Selection

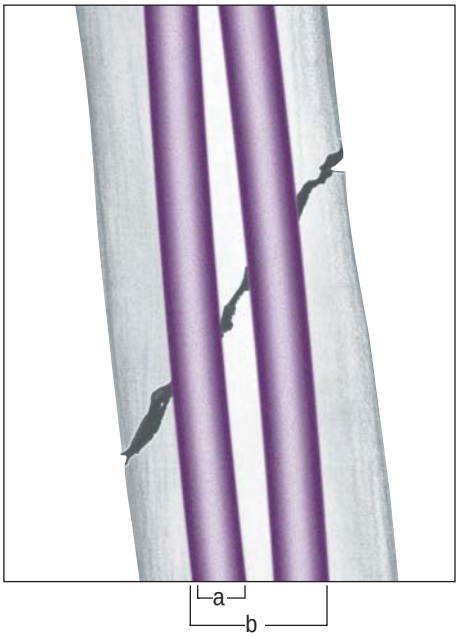
Titanium Elastic Nails are available in five diameters: 2.0 mm, 2.5 mm, 3.0 mm, 3.5 mm and 4.0 mm; and are 440 mm in length. The nails are color-coded for easy identification.



Measure the narrowest diameter of the medullary canal with a ruler. The proper nail diameter is no more than forty percent of the width of the canal. The following sizes are typically used for children of average stature:

6–8 years old	3.0 mm nails
9–11 years old	3.5 mm nails
12–14 years old	4.0 mm nails

Select two nails of the same diameter so the opposing bending forces are equal, avoiding malalignment.



Nail diameter (a) should be no more than 40% of the width of the medullary canal at the narrowest point (b).

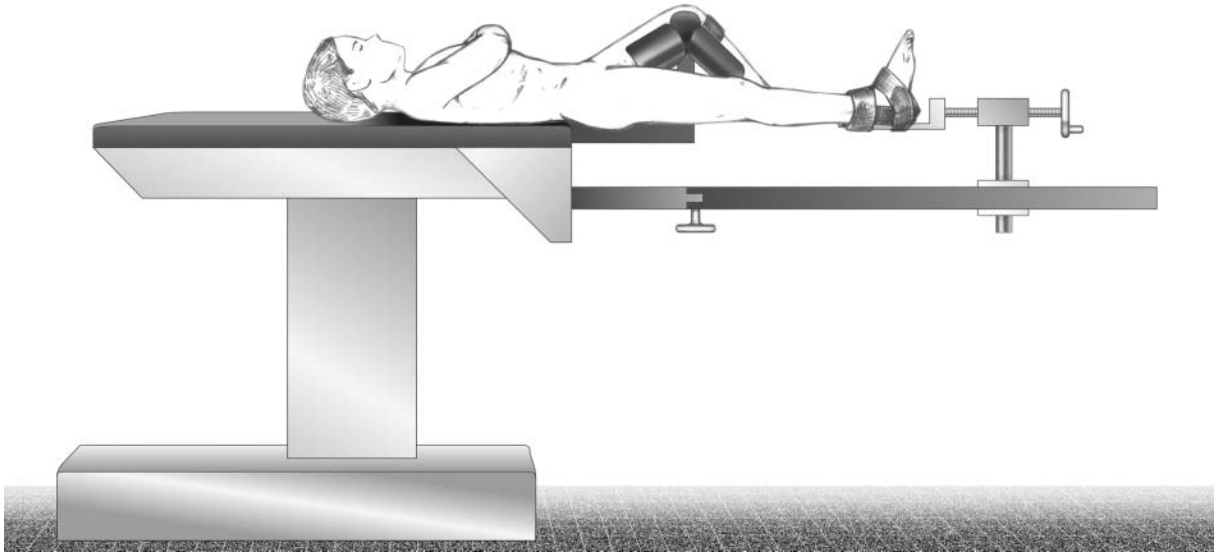
Pediatric Femoral Nail Insertion

Femoral fractures in children are typically stabilized with two nails inserted in a retrograde manner from medial and lateral entry points above the distal physis. Antegrade nailing, with a lateral entry point, is normally reserved for very distal femoral fractures.

This technique guide describes the more common retrograde technique in detail. For femoral fractures in average-statured children, use of 3.0 mm, 3.5 mm or 4.0 mm diameter nails is recommended according to the child's age.

Positioning the patient

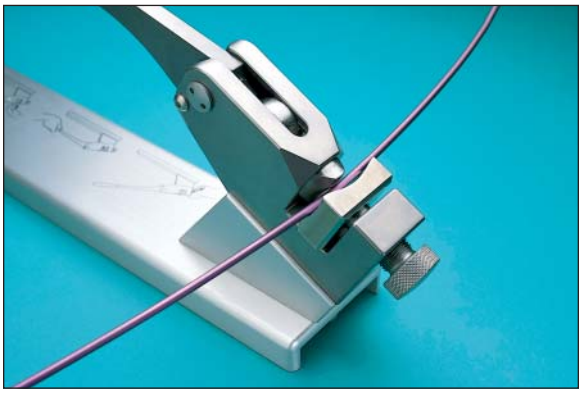
Position the patient supine in a free position or on a fracture table with a traction boot. If fracture reduction can be accomplished with manual reduction (usually only in small patients), a standard table may be used. Position the image intensifier on the lateral side of the affected femur for AP and lateral views of the leg from knee to hip. The setup must allow the surgeon access to both the lateral and medial aspects of the distal femur. Reduce the fracture and confirm alignment with fluoroscopy in both the AP and lateral views. Prep and drape the leg from hip to knee for reduction and intraoperative imaging.



Contouring the Nail

Contour both nails into a bow shape with the nail tip pointing to the concave side of the bowed nail. The etched line on the nail will provide a reference for the nail tip during insertion and should follow the same plane as the bow. Contouring may be done by hand or with the tabletop Plate-Bending Press [329.30]*. The apex of the bow should be at the level of the fracture. This shape allows the nail to generate optimal resistance to malaligning forces. The bow in each nail should be similar for a balanced effect.

Caution: Avoid creating a sharp bend which may reduce the effectiveness of the nail.



Contouring may be done by hand or with the table-top Plate-Bending Press [329.30].*

**Additionally available item*

Instruments for Opening the Femur

Power Drive*
[530.100]

Battery Casing*
[530.280]

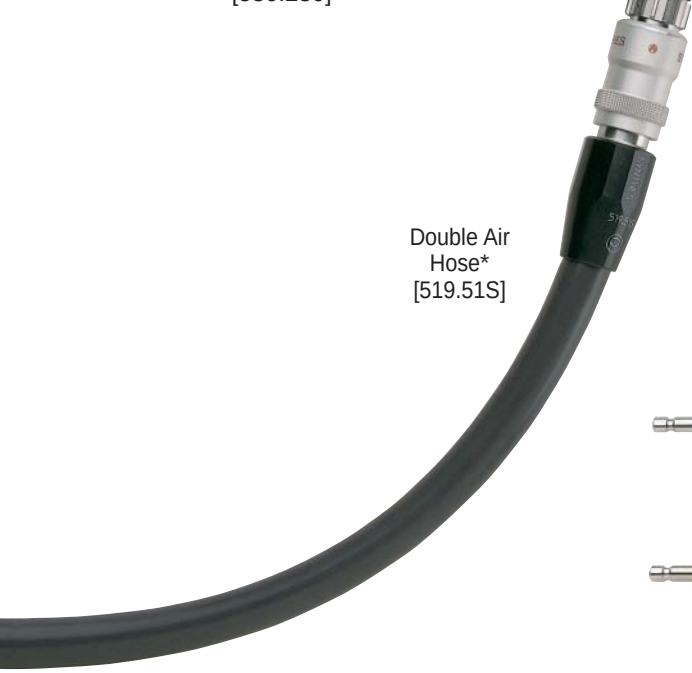
Small Battery
Drive*
[532.010]

Battery Casing*
[532.002]

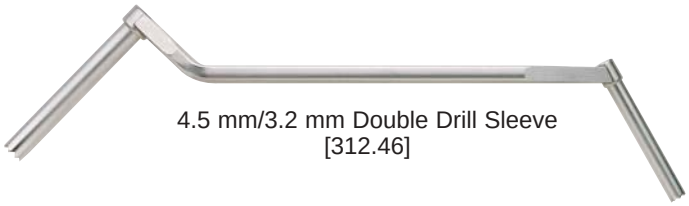
ComPact
Air Drive II*
[511.701]

Quick Coupling*
for drill bits
[511.75]

Quick Coupling*
for drill bits
[532.013]



Double Air
Hose*
[519.51S]



4.5 mm/3.2 mm Double Drill Sleeve
[312.46]

4.5 mm Three-Fluted Drill Bit
195 mm**, quick coupling [315.48]

3.2 mm Three-Fluted Drill Bit
195 mm**, quick coupling [315.29]

2.7 mm Three-Fluted Drill Bit
125 mm**, quick coupling [315.28]

Awl* [359.213]

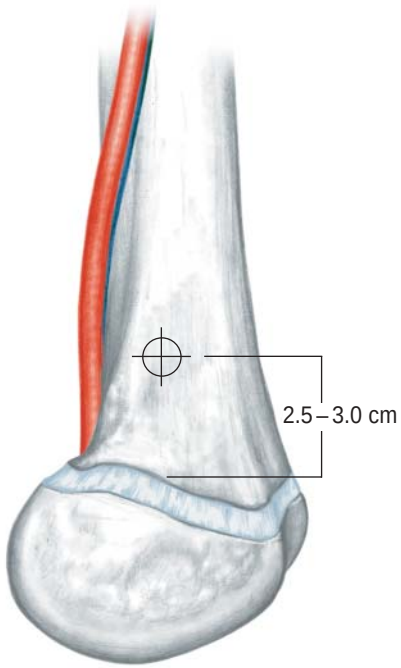
** Additionally available item*
***Total length*

Opening the femur

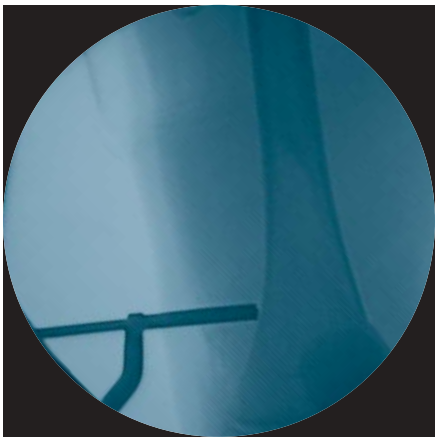
Creating the nail entry point

Make an incision on the lateral or medial aspect of the distal femur, starting 3 cm above the physis and extending distally for 2.5 cm. The entry point for the nail should be 2.5 cm–3.0 cm proximal to the physis.

Caution: When opening the medial side, be careful not to let the drill bit slip posteriorly in the region of the femoral artery.



Select the next largest drill bit relative to the diameter of the nail. (Drill bit sizes are 2.7 mm, 3.2 mm and 4.5 mm.) Use the 4.5 mm/3.2 mm Double Drill Sleeve [312.46] to protect the soft tissues. Start the drill bit perpendicular to the bone surface, 2.5 cm–3.0 cm proximal to the physis. Check the drill bit position with fluoroscopy.



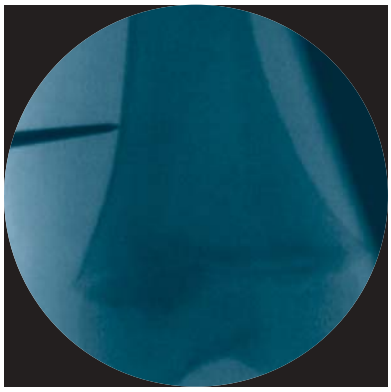
Opening the femur (continued)

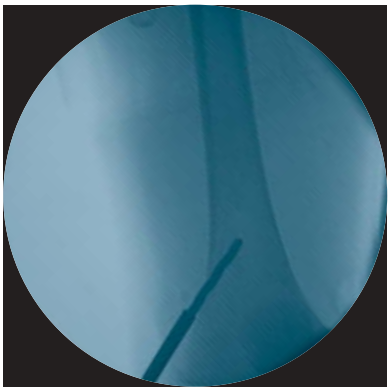
Creating the nail entry point (continued)

Penetrate the near cortex with the drill bit. With the drill bit rotating, but not advancing, slowly lower the drill to a 45° angle relative to the shaft axis. Now advance the drill bit at this angle until it reaches the medullary canal.

Caution: The drill must be running when angling the drill bit or drill bit breakage may result.

Technique Tip: *Finding the drilled entry hole can be difficult in pediatric patients since the periosteum may close over it. Have the contoured nail ready to introduce before removing the drill bit.*





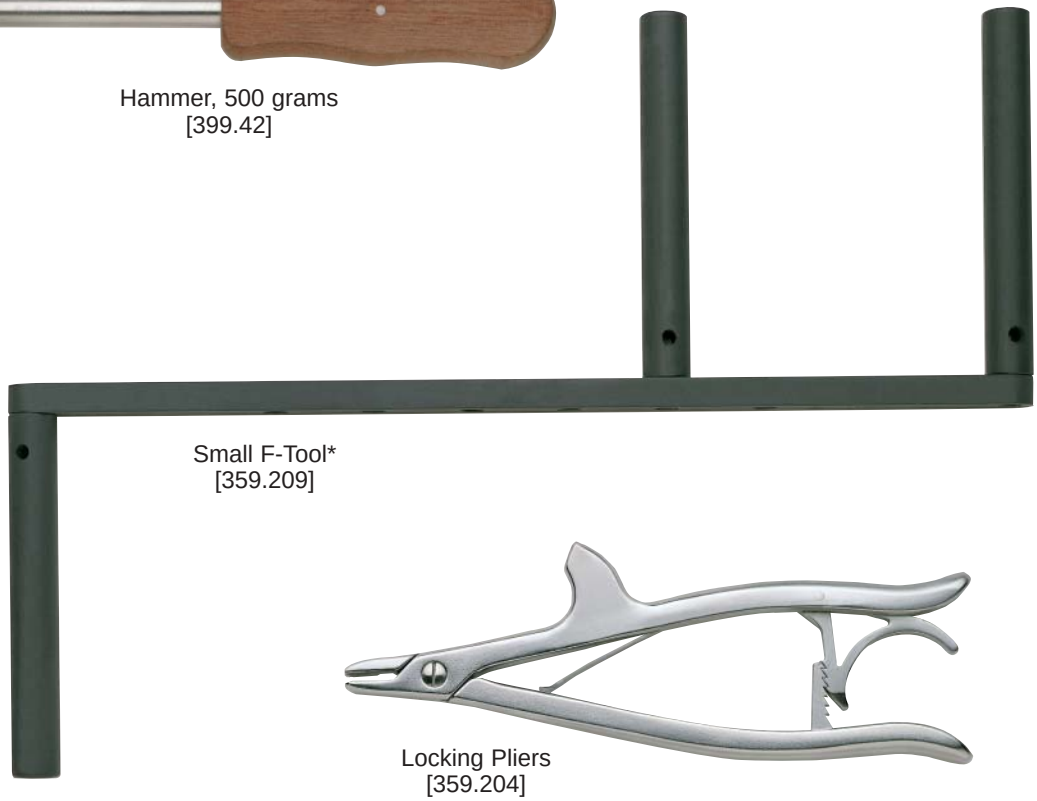
Alternatively, the Awl [359.213] can be used to penetrate the near cortex. Vertically insert the Awl down to the bone. With rotating motion, lower the Awl to a 45° angle relative to the shaft axis and continue to penetrate the cortical bone at an upward angle.

Instruments for Inserting/Removing the Nail

Inserter with Universal Chuck†
[359.201]

Detachable Slide Hammer, 580 grams
[357.026]

Hammer, 500 grams
[399.42]



Small F-Tool*
[359.209]

Locking Pliers
[359.204]

**Small F-Tool [359.209] consists of one Bar [359.207] and three Threaded Rods [359.208]. Replacement components for the Small F-Tool may be ordered individually.*

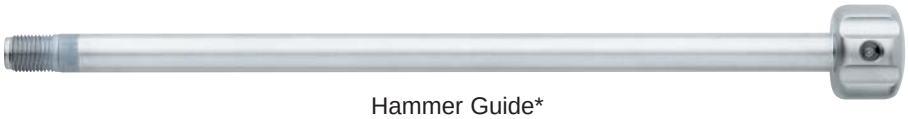
† *U.S. Patent Number: 5,913,860*

Instruments for Inserting/Removing the Nail (continued)

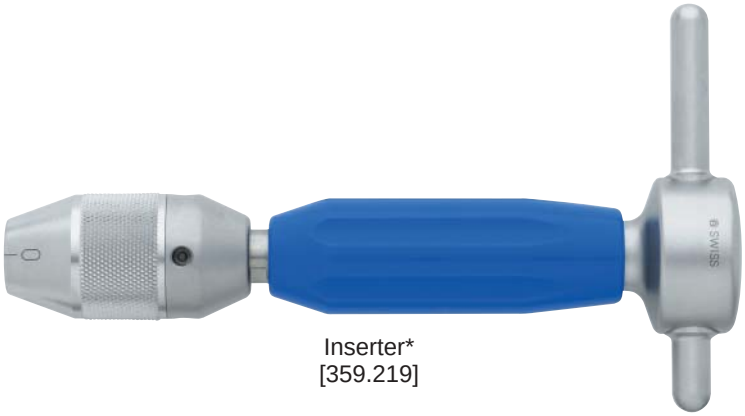
Spanner Wrench
321.25

Beveled Tamp
[359.206]

Standard Tamp
[359.205]



Hammer Guide*
[359.218]

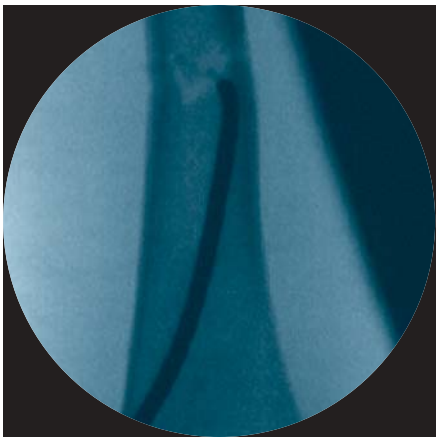


Inserter*
[359.219]

**Additionally available item*

Inserting the Nail

Locate and maintain the entry hole with a fingertip while withdrawing the drill bit and introducing the nail. Using fluoroscopy, align the nail tip so the convex side will glance off the far cortex. Advance the nail through the drilled entry hole by hand as far as possible.



Attach the Inserter with Universal Chuck [359.201] onto the nail with a length of about 150 mm of nail between the inserter and entry point. The longer this distance, the more difficult hammering will be since the nail will dampen the impact force. Tighten the inserter using the Spanner Wrench [321.25].

Inserting the Nail (continued)

Attach the Slide Hammer [357.026] to the shaft of the inserter. Use controlled blows to drive the nail up the medullary canal.

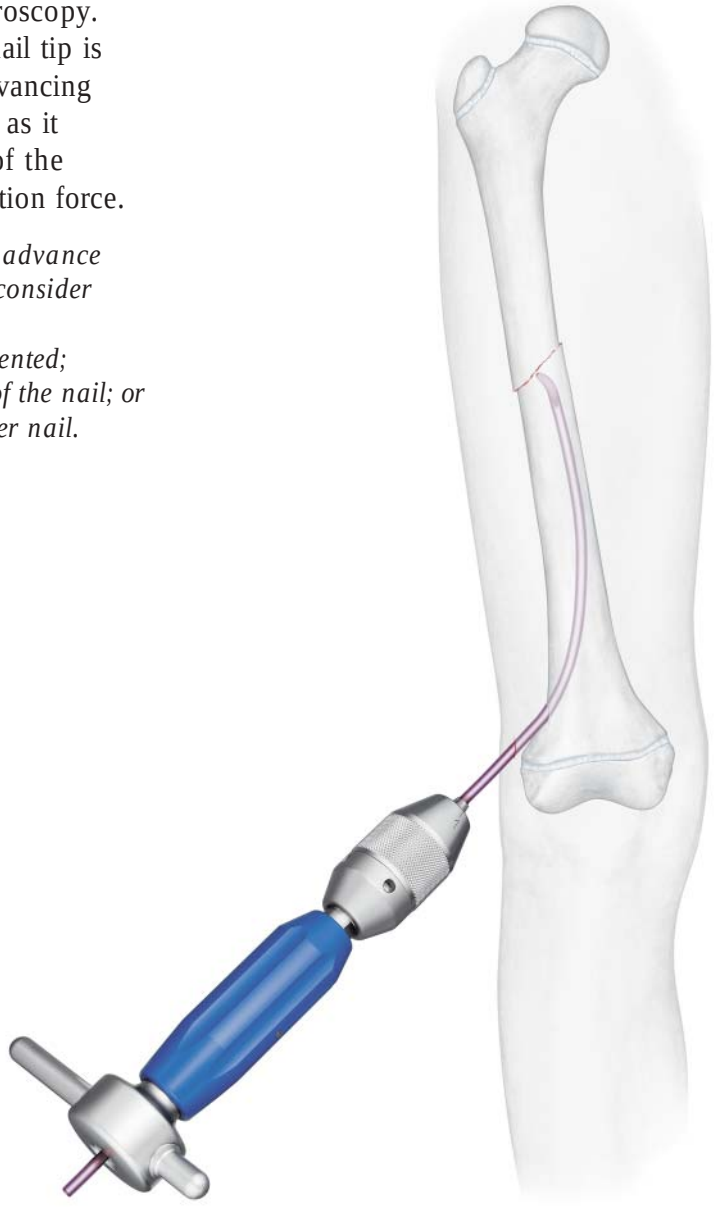
Caution: Do not use a standard hammer to drive the Inserter with Universal Chuck.

Alternatively, the Hammer Guide [359.218]* and Inserter [359.219]* can be used for nail insertion. The alternative instruments are used in the same manner described for the Inserter with Universal Chuck [359.201].

Monitor nail advancement with fluoroscopy. Ensure that the convex side of the nail tip is glancing off the far cortex and is advancing with each blow. The nail will bend as it progresses up the canal. This part of the procedure requires the greatest insertion force.

Technique Tip: *If it is very difficult to advance the nail with repeated hammer blows, consider the following options:*

1) ensure that the nail is properly oriented;
2) increase the contour near the tip of the nail; or
3) change to the next-smaller diameter nail.



**Additionally available item*

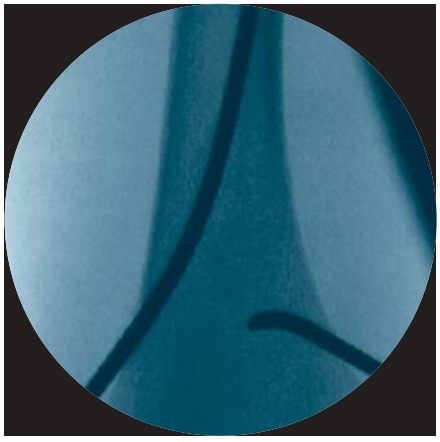
Reducing the Fracture

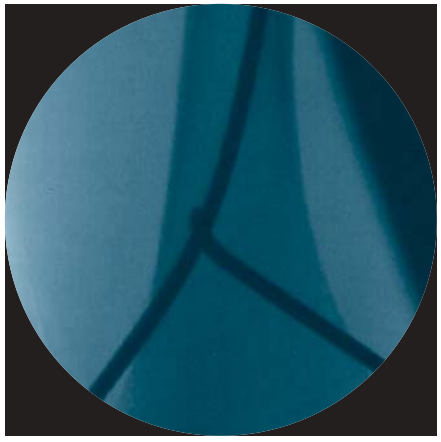
Use the Small F-Tool to provide reduction forces on either side of the fracture gap. To assemble the tool:

1. Thread one Threaded Rod [359.208] at the end of the Bar [359.207].
2. Thread the second rod into the bar so the rods just fit across the leg.
3. Thread the third rod into the opposite end of the bar.

The Small F-Tool is placed on the leg at the level of the fracture so that both rods provide force on the opposing fragments to aid reduction.

Drive the first nail to the level of the fracture. In a similar manner to that previously described, open the femur on the opposite side and insert the second nail up to the level of the fracture.





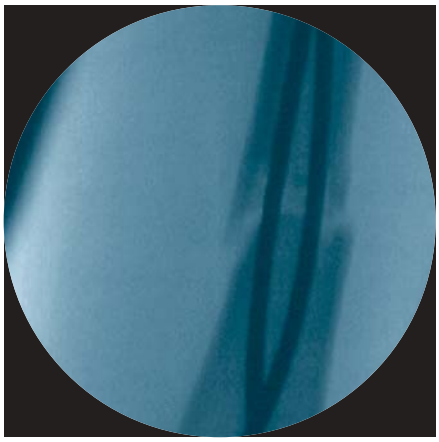
Inserting the Nail (continued)

Crossing the fracture

Visualize the fracture with fluoroscopy. Determine which nail will be easier to pass across the fracture. Advance that nail which will most effectively pull the proximal fragment into alignment. Using the Inserter with Universal Chuck [359.201] and Detachable Slide Hammer [357.026], drive the nail across the fracture, monitoring nail position with fluoroscopy. Alternatively, the Hammer Guide [359.218]* and Inserter [359.219]* may be used with the Detachable Slide Hammer to drive the nail.

The nail can be rotated to manipulate the curved tip across the fracture. Rotation is easiest while the nail is being advanced or retracted.

Care should be taken not to twist the nails more than 90°. Otherwise, a "corkscrew phenomenon" may be created and stability will be lost. Rotating the nail while it is stationary may loosen the Inserter.



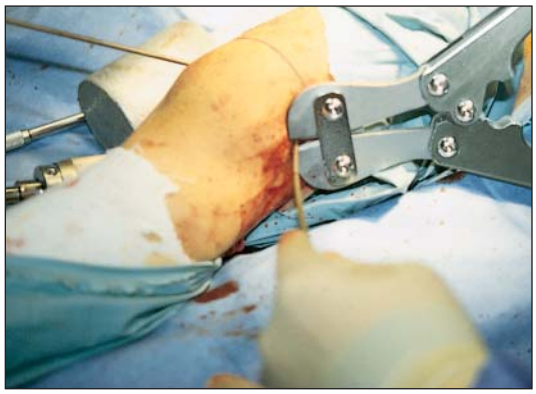
Technique Tip: *The Slide Hammer is essential at this stage since it is often necessary to advance and retract the nail repeatedly when attempting to cross the fracture. The Slide Hammer allows the Inserter and nail to be retracted easily and then advanced again.*

Advance the nail into the proximal fragment only enough to ensure reduction will be maintained. Further advancement may cause displacement of the proximal fragment making it more difficult to pass the second nail. Confirm nail position in both the AP and lateral views.

Using the Inserter and Slide Hammer, drive the second nail across the fracture and into the proximal fragment. Continue advancing this nail until it is just distal to the proximal physis. Advance the other nail to the same level. The two nails should diverge in opposite directions, both medial and lateral, for optimal rotational stability. If the fracture is distracted, release traction and impact the patient's heel.

Cutting the nail to length

Prior to cutting the nails to length, verify the position of the nails in relation to the rotation of the leg. Once the nail is inserted to its final position, mark the nail with a pen or clamp at the planned cutoff point. (The cutoff point should be 10–20 mm outside of the cortex.) Retract the nail far enough to access the cutoff point from outside the incision (usually 25–50 mm).



Bend the nail end away from the bone to deform it slightly (approximately 10–15° of permanent deflection). This will allow the protruding nail end to sit slightly off the cortex for easy removal while remaining low-profile to minimize soft tissue irritation.

Cut the nail with the Rod Cutter [388.72]* to the appropriate length. Reinsert the nail with either the Standard Tamp [359.205] or Beveled Tamp [359.206] and Hammer [399.42]. The Standard Tamp captures 2 mm of nail tip.

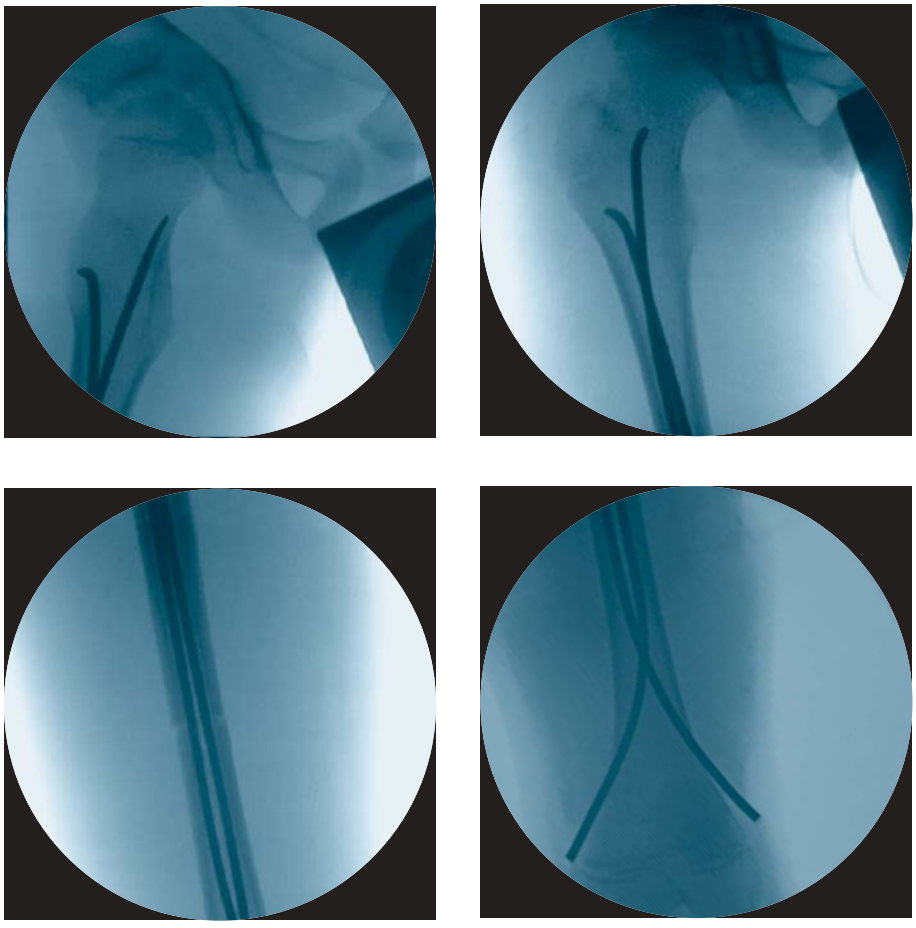
The Beveled Tamp captures 6 mm of nail tip and will leave approximately 10 mm of nail protruding from the cortex when the tamp is driven flush to the periosteum. Keep the etched line aligned with the long axis of the bone to keep the beveled surface in proper orientation. In order to prevent distraction of the fracture, a slight blow on the knee is recommended.

**Additionally available item*

Inserting the Nail (continued)

Cutting the nail to length (continued)

Confirm final nail position and fracture reduction with fluoroscopy. In its final position, the end of the nail should protrude 10–20 mm outside the cortex at an angle approximately 10–15° above the bone. If the nail has been overinserted, use the Locking Pliers [359.204] to grip and retract the nail.



Postoperative Care

A full-leg knee immobilizer may be used for patient comfort. Weight-bearing will depend upon the fracture pattern and stability, patient compliance and any other associated injuries. Progression of weight-bearing should be at the discretion of the surgeon.

Nail Removal

Palpate over the nail end, make an incision in the skin and bluntly dissect to expose the nail. Fluoroscopy may be needed to find the nail end. Once the nail end is exposed, attach the Locking Pliers [359.204]. The pliers require only a few millimeters of engagement with the nail for removal in most cases.

If capturing the nail is difficult, the lower jaw of the Locking Pliers can be driven under the nail end with light mallet blows. Use care to protect the physis from damage.

To remove the nail, use the Hammer [399.42] to strike the Locking Pliers on its "horn." Once the nail is retracted a few millimeters, removal can usually be completed by hand. If the nail is still difficult to remove, the Inserter and Slide Hammer can be used to complete removal.

Forearm

Forearm fractures in children typically require a single nail inserted in each bone. Nails may be used either antegrade or retrograde, depending on fracture location and surgeon preference. It is recommended that the nail be placed in the radius from a distal approach and the nail be placed in the ulna from a proximal approach. The nail diameters are normally between 2.0 mm and 3.0 mm, depending upon patient anatomy.

In forearm indications where hammering is not required for nail insertion, the lighter weight Universal Chuck with T-handle [393.10]* may be used in place of the inserter for more delicate control.

Position the patient supine with the affected arm placed on a radiolucent arm table. The image intensifier is positioned perpendicular to the arm, entering from the foot of the table.

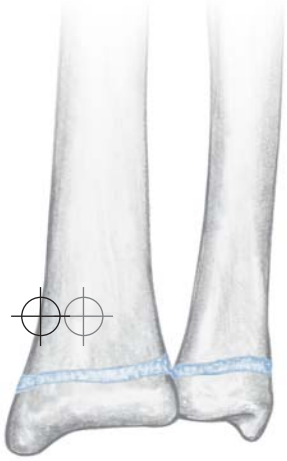
Follow up

**Additionally available item*

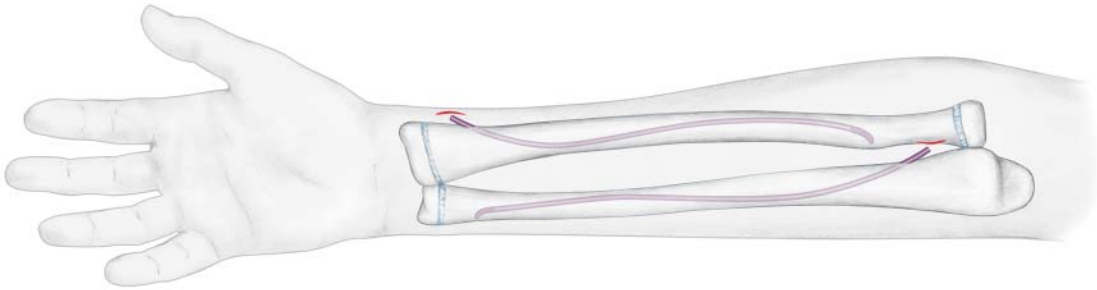
For diaphyseal fractures the entry point in the radius is either just proximal to the radial styloid or through Lister's tubercle.

For radial head fractures the nail is inserted retrograde, allowing the nail tip to capture the proximal fragment. Using a percutaneous probe, partial reduction can be obtained. Reduction can be completed using rotation of the curved tip of the nail.

Caution: Be aware of the extensor tendons and superficial radial nerve.



The antegrade entry point in the ulna can be either at the posterior aspect of the olecranon or a lateral approach through the proximal metaphysis. The retrograde entry point in the ulna is through the distal metaphysis.



Humerus

Humeral fractures in both children and adults typically require two nails inserted with a retrograde technique from a posterior insertion site. The nail diameters are normally between 2.5 mm and 3.5 mm, depending upon patient anatomy.

The entry point for each nail is posterolateral off the lateral supracondylar ridge, one hole above the other, angled upwards.

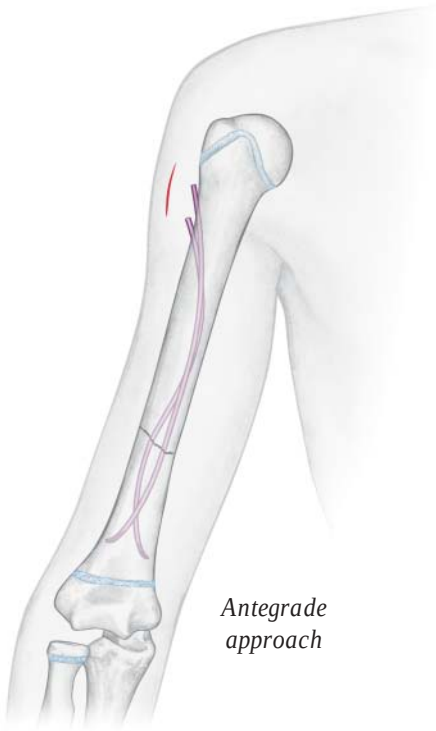
Alternatively, two nails can be inserted with an antegrade technique. The entry point for antegrade technique is located on the lateral humerus, level with the attachment point of the deltoid muscle.

Position the patient supine without a tourniquet. The arm may be placed on a radiolucent arm table or suspended vertically in traction. Prep and drape the arm from elbow to shoulder.

Caution: Be aware of the position of the radial nerve in relation to the fracture.

Follow up

Retrograde approach



Antegrade approach

Tibia

Tibial fractures in children typically require two nails inserted with an antegrade technique from medial and lateral entry points. The nail diameters are normally between 2.5 mm and 4.0 mm, depending upon patient anatomy.

Position the patient supine on a standard or fracture table. Prep and drape the entire lower leg.

The entry points are a few centimeters distal to the physis at anterolateral and anteromedial locations, to minimize soft tissue irritation.

Before fully inserting the nails into the distal metaphysis, verify rotational and angular limb alignment. Alignment can be adjusted by rotating the nails or modifying their curvature. Once alignment is satisfactory, the nails can be fully inserted to achieve the best anchorage in the metaphysis. Before cutting the nails to length, release traction and impact the heel, if necessary.

Follow up

Lateral view

Product Information

Care and Maintenance of Inserter with Universal Chuck [359.201]

Clean the Inserter after every use. Use a soft brush and neutral pH detergent to wash debris from the Inserter chuck and 6 mm cannulation.

It is essential to lubricate the Inserter periodically with Autoclavable Oil [519.97],* to maintain smooth operation of the chuck. After cleaning, apply a single drop of oil to the three chuck jaws and rear chuck bushing.

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

**Additionally available item*

Nail Specifications

Material
Titanium–6% aluminum–7% niobium alloy

Diameters/Colors:
2.0 mm—green

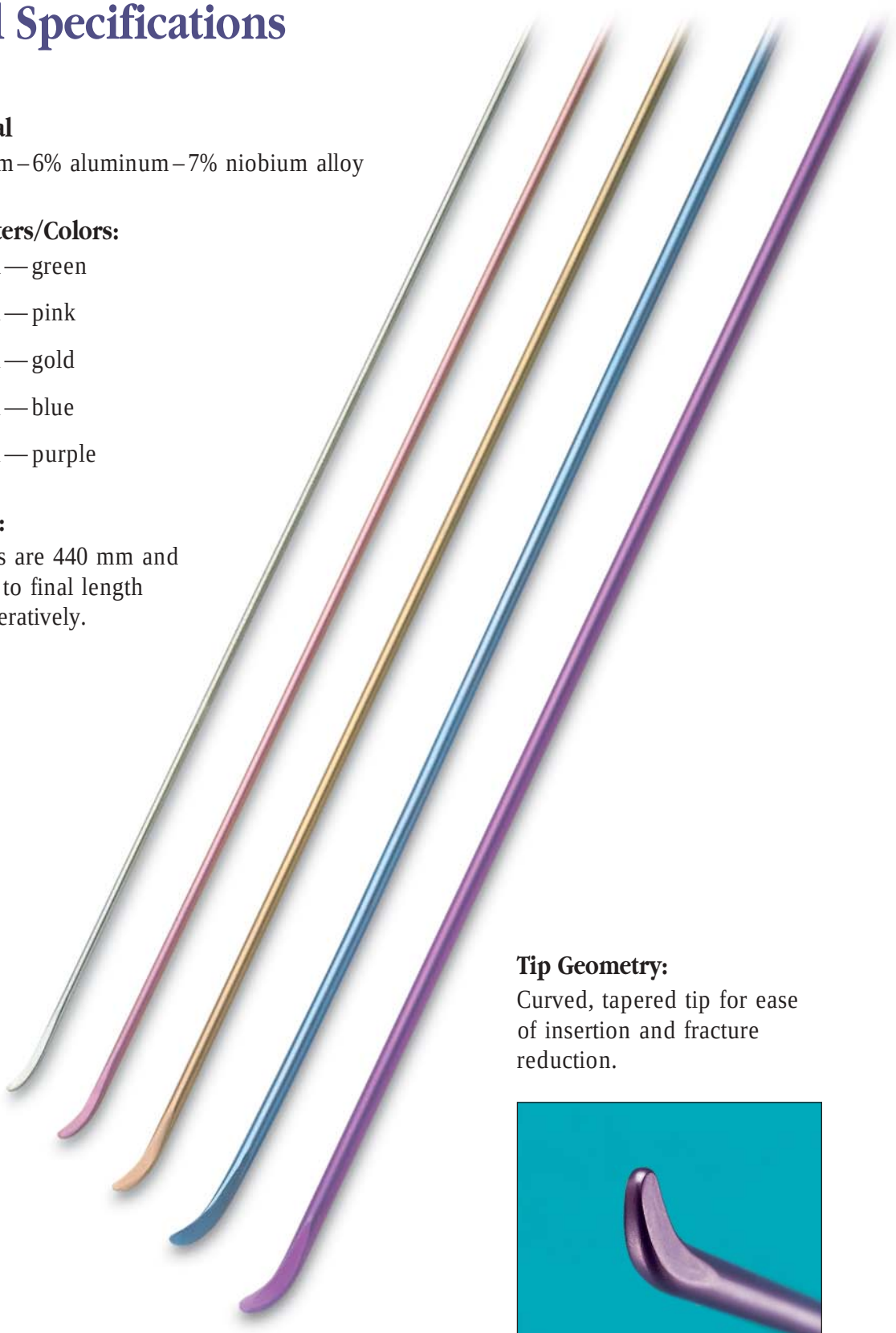
2.5 mm—pink

3.0 mm—gold

3.5 mm—blue

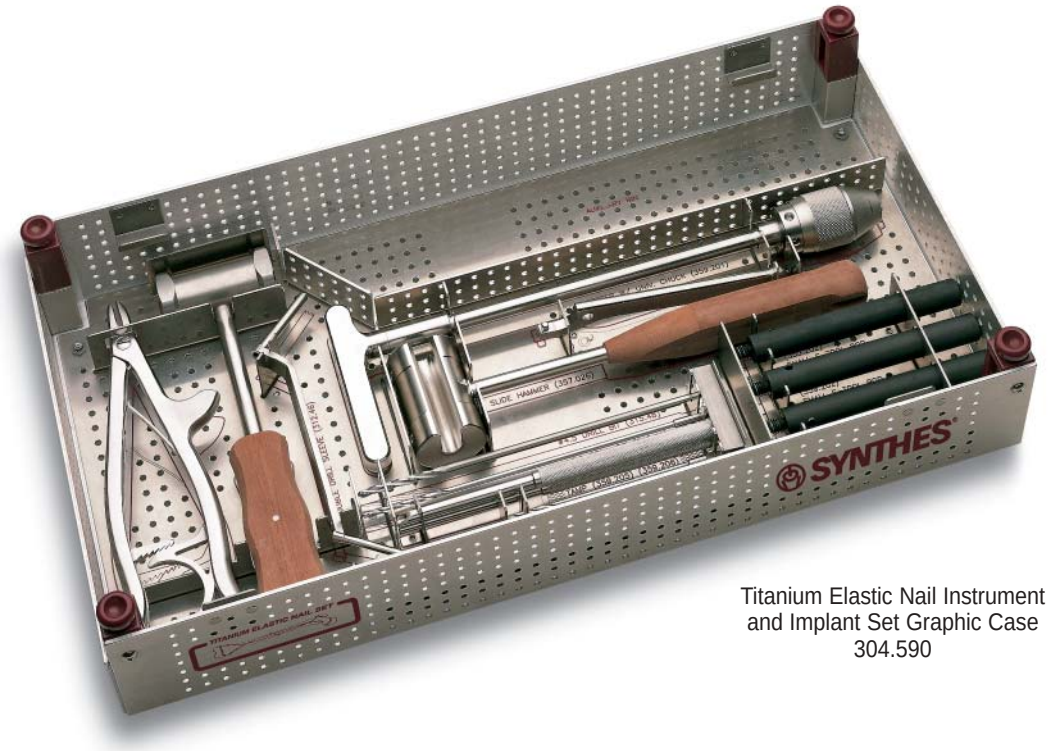
4.0 mm—purple

Length:
All nails are 440 mm and are cut to final length intraoperatively.



Tip Geometry:
Curved, tapered tip for ease of insertion and fracture reduction.

Titanium Elastic Nail Instrument and Implant Set [105.71]



Titanium Elastic Nail Instrument
and Implant Set Graphic Case
304.590

Titanium Elastic Nail Instrument and Implant Set [105.71] (continued)

Instruments

359.201	Inserter with Universal Chuck
359.204	Locking Pliers
359.205	Standard Tamp
359.206	Beveled Tamp
359.207†	Bar, for Small F-Tool
359.208†	Threaded Rod, for Small F-Tool, 3 each
312.46	4.5 mm/3.2 mm Double Drill Sleeve
	Three-Fluted Drill Bits, quick coupling
315.28	2.7 mm, 125 mm*
315.29	3.2 mm, 195 mm*
315.48	4.5 mm, 195 mm*
321.25	Spanner Wrench
357.026	Detachable Slide Hammer, 580 grams
399.42	Hammer, 500 grams

Implants◊

Titanium Elastic Nails, 6 each

	DIAMETER	LENGTH
475.920	2.0 mm	440 mm
475.925	2.5 mm	440 mm
475.930	3.0 mm	440 mm
475.935	3.5 mm	440 mm
475.940	4.0 mm	440 mm

Also Available

105.954H	Small Battery Drive with 14.4 V Battery Pack Set with Hudson Reduction Drive Unit
105.957	Power Drive Set
150.16	ComPact Air Drive II Set
329.30	Plate-Bending Press
388.72	Rod Cutter
393.10	Universal Chuck with T-Handle
519.97	Autoclavable Oil
359.213	Awl, for use with Titanium Elastic Nails
359.218	Hammer Guide, for Titanium Elastic Nails
359.219	Inserter, for use with Titanium Elastic Nails

† *Additionally available Small F-Tool [359.209] consists of Bar [359.207] and three Threaded Rods [359.208].*

* *Total length*

◊ *Implants available nonsterile or sterile-packed. Add "S" to catalog number to order sterile product.*

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