Antegrade Femoral Nail (AFN)

Surgical Technique

DePuy Synthes
PART OF THE Johnson&Johnson FAMILY OF COMPANIES

Image intensifier control

This description alone does not provide sufficient background for direct use of DePuy Synthes products. Instruction by a surgeon experienced in handling these products is highly recommended.

Processing, Reprocessing, Care and Maintenance
For general guidelines, function control and dismantling of multi-part instruments, as well as processing guidelines for implants, please contact your local sales representative or refer to:
http://emea.depuysynthes.com/hcp/reprocessing-care-maintenance
For general information about reprocessing, care and maintenance of Synthes reusable devices, instrument trays and cases, as well as processing of Synthes non-sterile implants, please consult the Important Information leaflet (SE_023827) or refer to:
http://emea.depuysynthes.com/hcp/reprocessing-care-maintenance

Contents

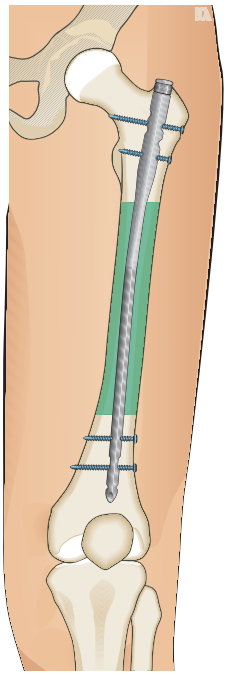
Indications/Contraindications

Indications

AFN Standard locking

Standard Locking Indications:

– The Antegrade Femoral Nail with standard locking is indicated for fractures in the femoral shaft:
– 32-A/B/C (except subtrochanteric fractures 32-A [1–3].1, 32-B [1–3].1, and 32-C [1–3].1)



AFN Reconstruction locking

Recon Locking Indications:

– The Antegrade Femoral Nail with recon locking is indicated for fractures in the femoral shaft in case of combination with femoral neck fractures:
  32-A/B/C combined with 31-B (double ipsilateral fractures)
– Additionally the Antegrade Femoral Nail is indicated for fractures in the subtrochanteric section:
  32-A [1–3].1, 32-B [1–3].1, and 32-C [1–3].1

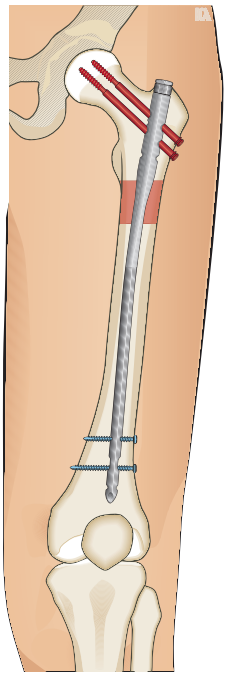


Fig. 1

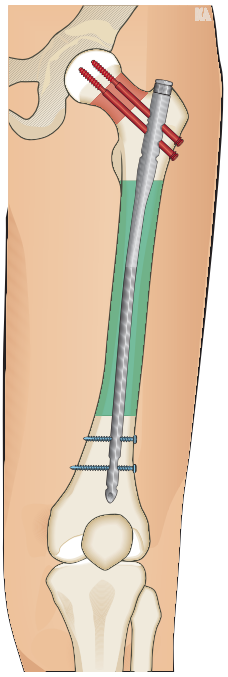


Fig. 2

Contraindications

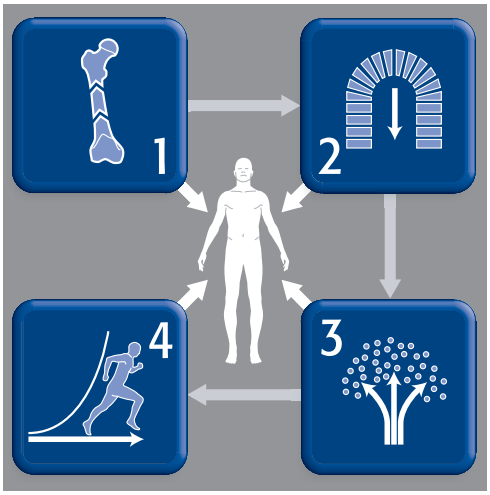
– Isolated femoral neck fractures
– Supracondylar fractures (localisation 32)
– Intertrochanteric fractures
– Pertrochanteric fractures

AO Principles

In 1958, the AO formulated four basic principles, which have become the guidelines for internal fixation[1,2].

Anatomic reduction
Fracture reduction and fixation to restore anatomical relationships.

Early, active mobilization
Early and safe mobilization and rehabilitation of the injured part and the patient as a whole.



Stable fixation
Fracture fixation providing absolute or relative stability, as required by the patient, the injury, and the personality of the fracture.

Preservation of blood supply
Preservation of the blood supply to soft tissues and bone by gentle reduction techniques and careful handling.

[1] Müller ME, Allgöwer M, Schneider R, Willenegger H. Manual of Internal Fixation. 3rd ed. Berlin, Heidelberg, New York: Springer. 1991.
[2] Rüedi TP, Buckley RE, Moran CG. AO Principles of Fracture Management. 2nd ed. Stuttgart, New York: Thieme. 2007.

AFN implants

The Antegrade Femoral Nail is available in diameters of 9, 10, 11, 12, 13, and 14 mm.

Due to the nail's anatomical design, nails are required for the left and the right femur.

Standard locking implants

End Cap (0–20 mm extension; diameters 9/10, 11/12, 13/14 mm)

Proximal diameters: 13–17 mm

4.9 mm Locking Bolt
Lengths 26–100 mm (in 2 mm increments)

Anatomical 6° ML angle

1500 mm bending radius

Cannulated for reamed/unreamed insertion
Lengths 300–480 mm (in 20 mm increments)

The Antegrade Femoral Nail (AFN) is available in titanium alloy TAN (Ti-6Al-7Nb)

Longitudinal grooves starting from 11 mm diameter for optimal insertion

A choice of static or dynamic interlocking

Bevelled distal nail end minimizes stress concentration

Reconstruction locking implants

End cap (0–20 mm extension in 5 mm increments for diameters of 9/10, 11/12, 13, and 14 mm)

Proximal diameters: 13, 15, and 17 mm

6.5 mm Hip Screw
Lengths 60–130 mm (in 5 mm increments) featuring insertion safety stop

Anatomical 6° ML angle

1500 mm bending radius

Cannulated for reamed/unreamed insertion
Lengths 300–480 mm (in 20 mm increments)

The Antegrade Femoral Nail (AFN) is available in titanium alloy TAN (Ti-6Al-7Nb)

Longitudinal grooves starting from 11 mm diameter for optimal insertion

A choice of static or dynamic interlocking

Bevelled distal nail end minimizes stress concentration

Preparation

Patient positioning
Position the patient supine on a fracture or radiolucent operating table. Place the contralateral leg on a leg support, and orient it intraoperatively.
Position the C-arm of the image intensifier in such a way that true AP and lateral views of the proximal femur are possible, and check it pre-operatively.

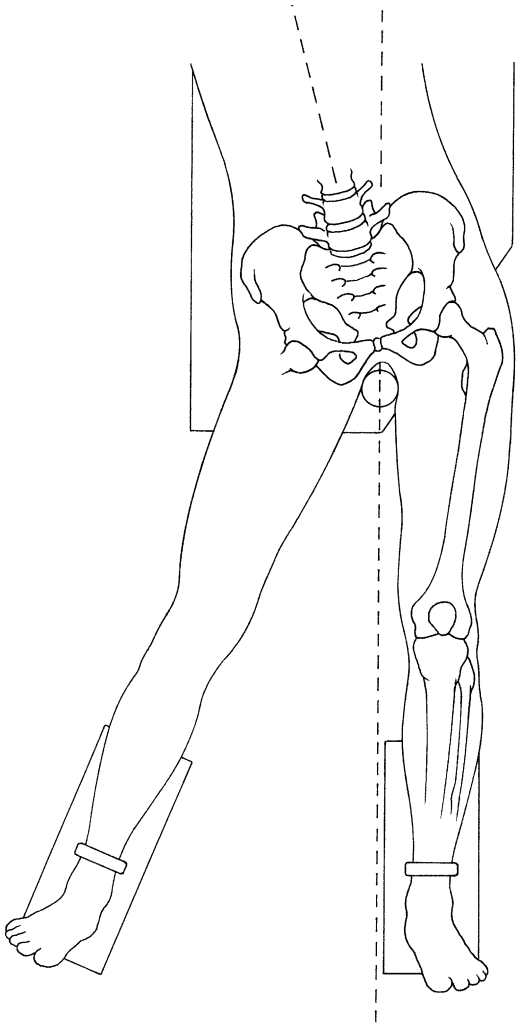
To ensure unimpeded access to the medullary cavity, abduct the upper body approximately 10–15° to the contralateral side (or abduct the affected leg by 10–15°).

When selecting the nail size, consider canal diameter, fracture pattern, patient anatomy and post-operative protocol.

Note: There are different positioning types:

- Supine + normal operating table
- Supine + normal operating table and distractor
- Supine + fracture table

- Lateral position + normal operating table
- Lateral position + normal operating table and distractor
- Lateral position + fracture table



Fracture reduction on the fracture table
If possible, carry out a closed preoperative reduction of the fracture under image intensifier control. Exact reduction and secure fixation of the patient to the operating table are essential for easy handling and a good surgical result.

Use of the large distractor is also possible.

Use of the distractor
The application of the distractor can be helpful in many types of frac-tures, for old injuries, or when the assistants are inexperienced. Using standard techniques for applying the distractor, insert the distal Schanz screw laterally without image intensification at the level of the upper margin of the patella. The middle of the femur is easy to find with the drill bit. Insert the proximal Schanz screw under image intensification into the femur to allow the AFN to enter the medullary canal on the lateral side of the screw.

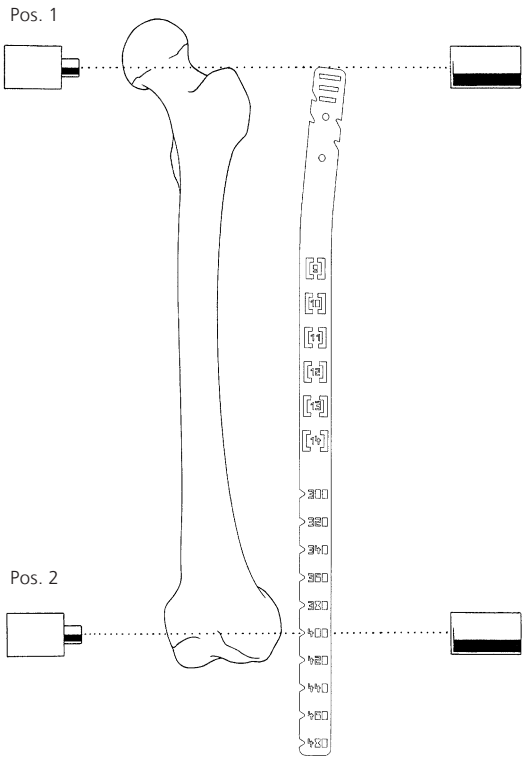
After mounting the connecting rods, distract the main fragments and achieve approximate reduction and length correction. An alternative procedure involves inserting the proximal Schanz screw for the distraction from the lateral side. Place the distractor so that the nail can pass it easily during insertion.

Determine nail length

A. Measure with the measuring device under image intensification

Position the image intensifier for an AP view of the proximal femur (position 1). Use long forceps to hold the Measuring Device (319.021) alongside the lateral aspect of the thigh parallel to and at the same level as the femur.
Adjust the C-arm of the image intensifier so that the beam is centred between the femur and the measuring device; this will prevent magnifi-cation errors. Adjust the measuring device until its proximal end is level with the tip of the greater trochanter.
Mark the skin at the top of the measuring device.

Move the image intensifier to the distal femur end (position 2), replace the proximal end of the measuring device at the skin mark and take an AP image of the distal femur. Verify the fracture reduction.
Read the nail length directly from the image of the measuring device, selecting the measurement at or just proximal to the epiphyseal scar, or at the chosen insertion depth.



B. Measure the contralateral femur

Measure the contralateral femur from the tip of the greater trochanter to the lateral femoral condyle. Subtract 20 mm from the measured length and select the next smaller nail length.

Example:

400 mm	→	380 mm → 360 mm	(40 mm smaller)
399 mm	→	379 mm → 360 mm	(39 mm smaller)
398 mm	→	378 mm → 360 mm	(38 mm smaller)

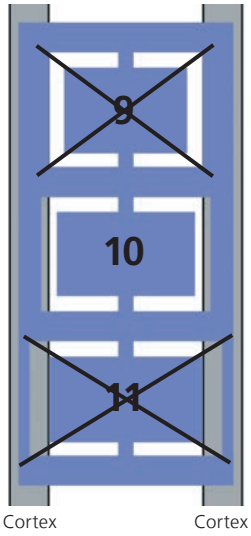
381 mm	→	361 mm → 360 mm	(21 mm smaller)
380 mm	→	360 mm → 340 mm	(40 mm smaller)
379 mm	→	359 mm → 340 mm	(39 mm smaller)

Determine nail diameter

Determine the distal nail diameter by placing the AO/ASIF planning template on an AP image over the isthmus.

Alternative:

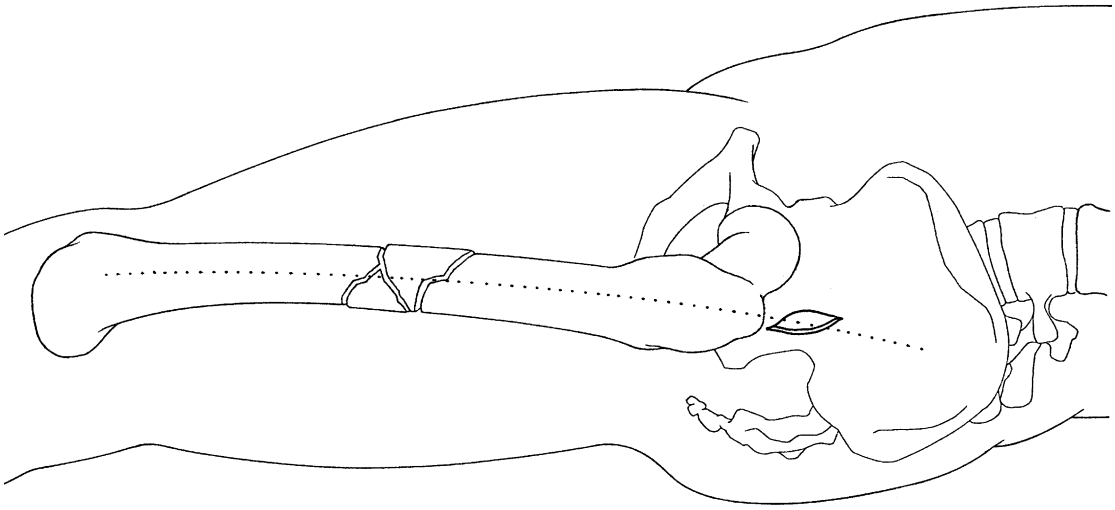
Under image intensifier control, place the Measuring Device (319.021) on the femur, and position the square marking over the isthmus. The corresponding nail diameter may be used if the transition to the cortex is still visible both on the left and the right side of the marking.



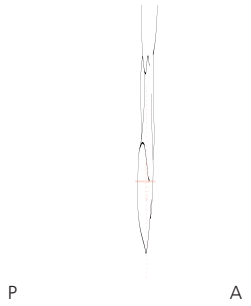
Surgical approach

Palpate the *greater trochanter*.

Make a 5cm incision approximately 5 to 10 cm proximal of the tip of the *greater trochanter*. Make a parallel incision in the fascia of the *gluteus medius* and split the gluteus medius in line with the fibres.



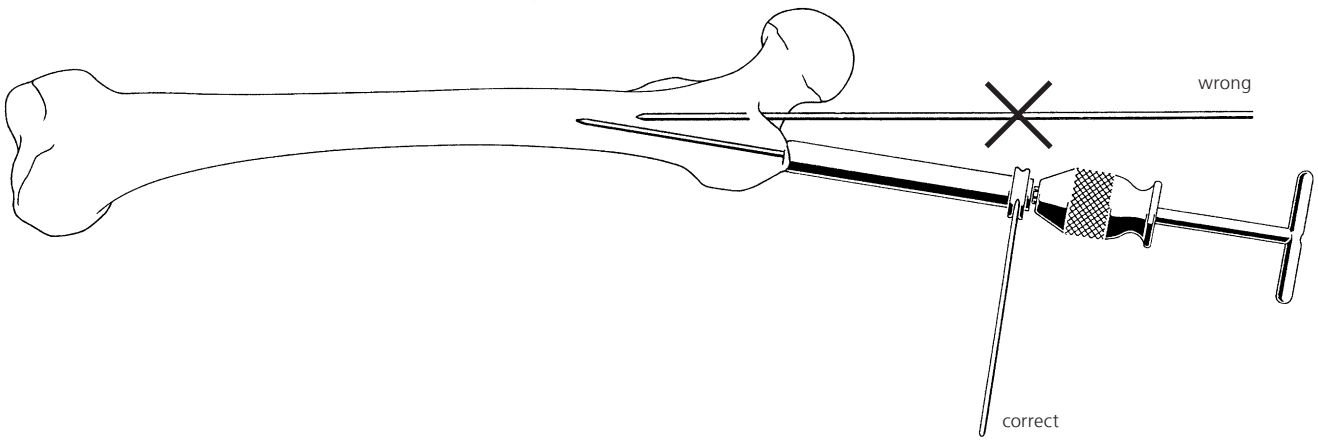
Determine nail insertion point and insert guide wire
In the AP view, the nail insertion point is normally found on the tip or slightly lateral to the tip of the greater trochanter in the curved extension of the medullary cavity.



The mediolateral angle of the implant is 6°. This means that the 2.8 mm Guide Wire (357.039) must be inserted laterally at an angle of 6° to the shaft. The guide wire can be inserted either manually with the Universal Chuck with T-Handle (393.100) or with the COMPACT™ AIR DRIVE and the quick coupling for Kirschner wires.

In lateral view, insert the guide wire in the centre of the medullary cavity to a depth of about 15 cm.

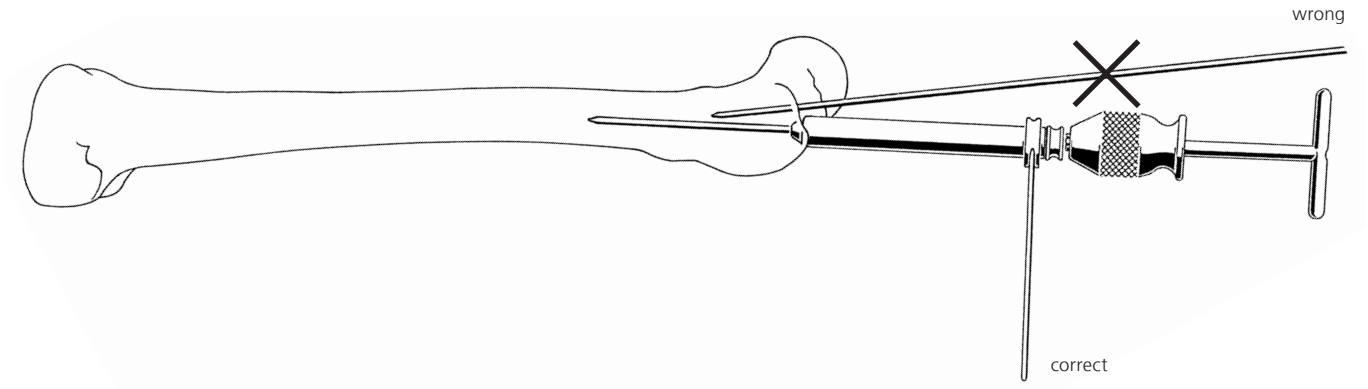
Precaution: The correct entry point and angle are essential for a successful result. To ensure the correct position of the guide wire, hold a sterile Antegrade Femoral Nail onto the femur and check radiographically.



Insert the Protection Sleeve 20.0/17.0 (357.001) with the Drill Sleeve 17.0/2.8 (357.002) and the 2.8 mm trocar. Remove the trocar.

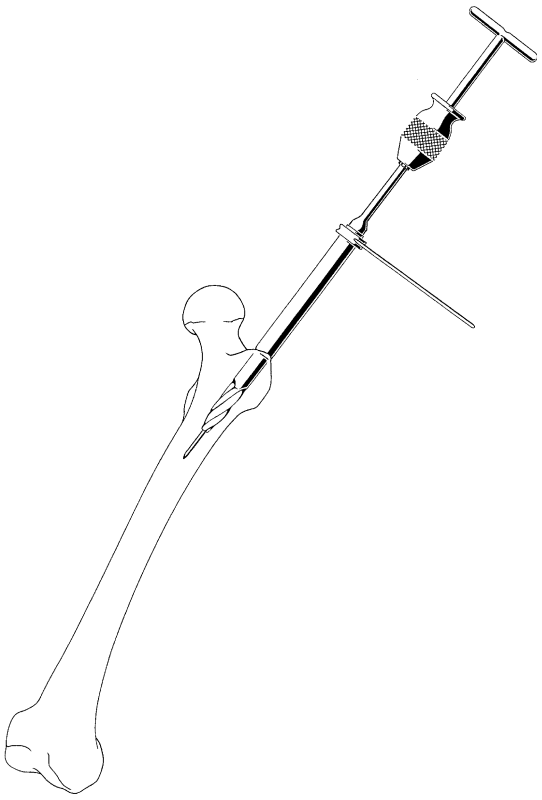
Percutaneous technique:
insert the guide wire through the Protection Sleeve 20.0/17.0 (357.001) and the Drill Sleeve 17.0/2.8 (357.002). Then remove the drill sleeve 17.0/2.8.

Precaution: After opening the proximal femur, dispose of the guide wire. Do not reuse.



Open the femur

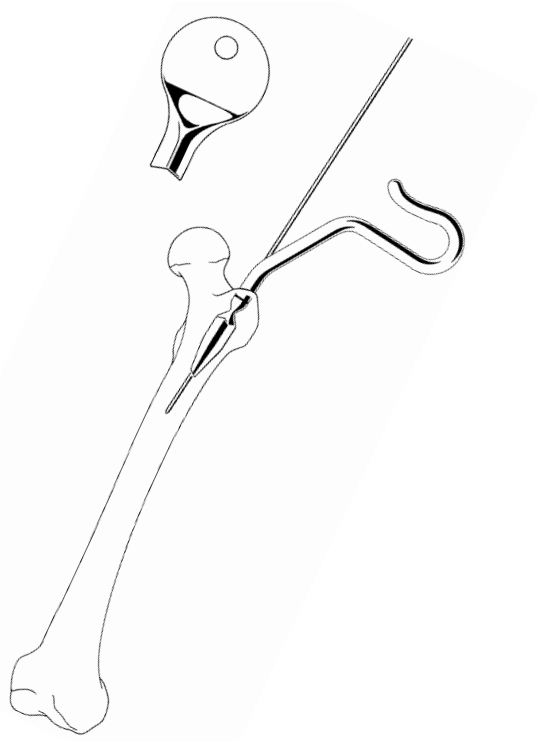
Depending on the selected nail diameter, guide the appropriate cannulated 14 mm, 16 mm, 18 mm Drill Bit (356.703, 356.704, 357.005) (see table below) through the Protection Sleeve 20.0/17.0 (357.001) over the guide wire, and ream manually with the Universal Chuck with T-Handle (393.100) to the stop on the protection sleeve. Remove both protection sleeve and guide wire. Do not reuse the guide wires, but dispose of them.



AFN		Drill bit	
Distal dia.	Proximal dia.	Dia.	Item no.
9 mm	13 mm	14 mm	356.703
10 mm	13 mm	14 mm	356.703
11 mm	15 mm	16 mm	356.704
12 mm	15 mm	16 mm	356.704
13 mm	17 mm	17 mm	357.005
14 mm	17 mm	17 mm	357.005

Alternative using the reverse awl

Open the femur or enlarge the entry point with the cannulated 14 mm, 16 mm, 18 mm Reverse Awl (356.710, 356.711, 357.008) (see table below). Use the Tissue Protector (351.050) to spare soft tissues. Drive the awl over the guide wire into the femur until the marking on the awl's shaft is level with the trochanter tip.



AFN		Reverse awl	
Distal dia.	Proximal dia.	Dia.	Item no.
9 mm	13 mm	14 mm	356.710
10 mm	13 mm	14 mm	356.710
11 mm	15 mm	16 mm	356.711
12 mm	15 mm	16 mm	356.711
13 mm	17 mm	19 mm	357.008
14 mm	17 mm	19 mm	357.008

Ream shaft
Alternative

In some cases, reaming of the shaft may be necessary.
Open the femur and insert the reaming rod. Pass the fracture zone and position the reaming rod in the centre of medullary cavity end (Fig. 1). Start reaming with a 8.5 mm medullary reamer.
Continue reaming using progressive size reamers in 0.5 mm increments. The diameter of the last reamer used should be 1–2 mm larger than that of the nail.

Note: For the detailed reaming procedure, please consult SynReam Surgical Technique.

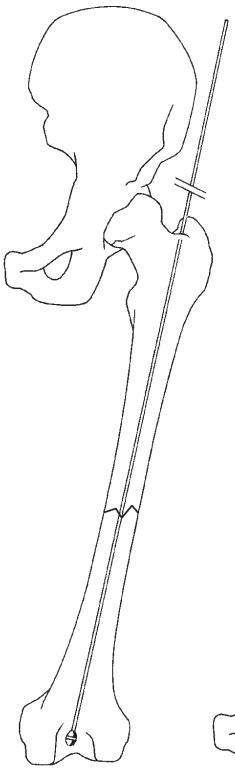


Fig. 1

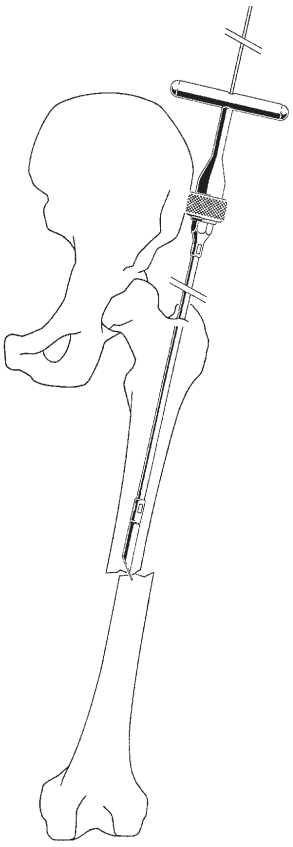


Fig. 2

Assemble instruments
Guide the Connecting Screw (398.335) through the Insertion Handle (357.521) and secure the nail tightly to the insertion handle using the Hexagonal Screwdriver (357.515) (Fig. 1). Diameter and length of the nail have already been determined during surgical preparation.

Ensure that the connection is tight (retighten, if necessary) to avoid deviations when inserting the screws through the insertion handle. Do not attach the aiming arm yet.

Note: The anatomical design of the Antegrade Femoral Nail requires left and right version nails. The nails are therefore labeled left or right on the proximal anterior end.

Precaution: Check that the connecting screw is correctly tightened. Do not overtighten.

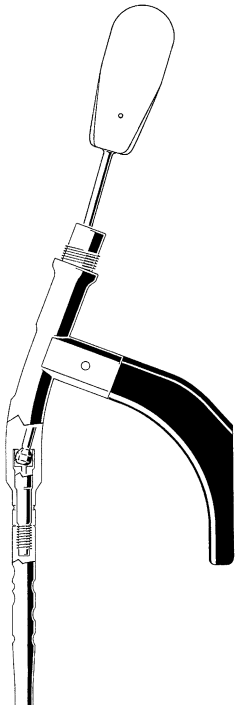


Fig. 1

Couple the insertion handle to the nail so that the handle is oriented laterally (the convex side of the nail bow marked „ANTERIOR" faces anteriorly) (Fig. 2).

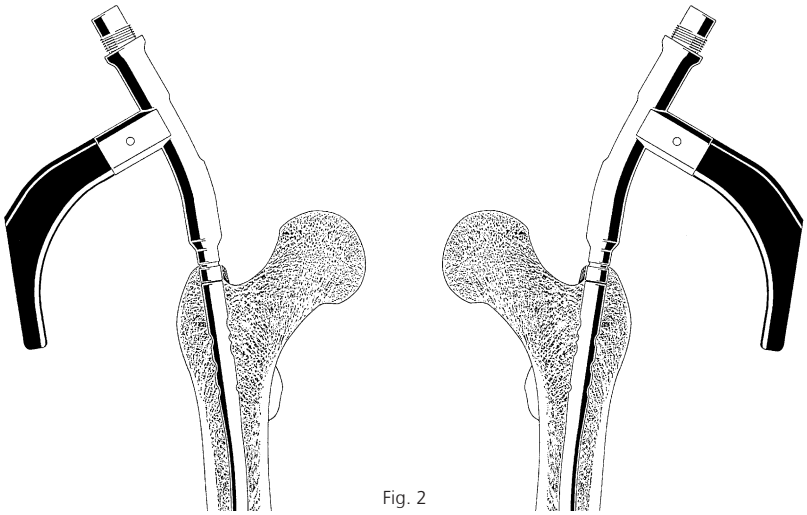


Fig. 2

Thread the Driving Cap (357.180) onto the insertion handle and tighten it. Slide the Slide Hammer (357.250) onto the Hammer Guide (357.220/ 221) and turn the handle to lock it in place. Slide this assembly onto the proximal end of the driving cap and finger-tighten the assembly (Fig. 3).

Mount the Slide Hammer (357.250) onto the Hammer Guide (357.220/ 221) (Fig. 4).

Note: The surgeon may also use the 700 g Hammer (399.430) instead of the ram with handle and the Hammer guide, and strike directly on the proximal end of the driving cap.

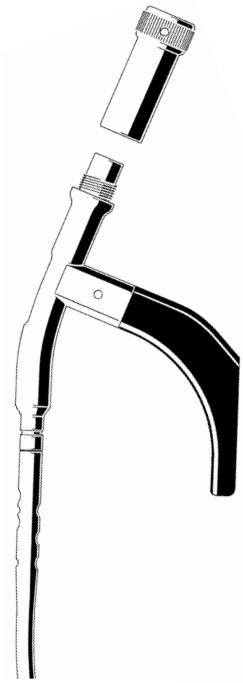


Fig. 3

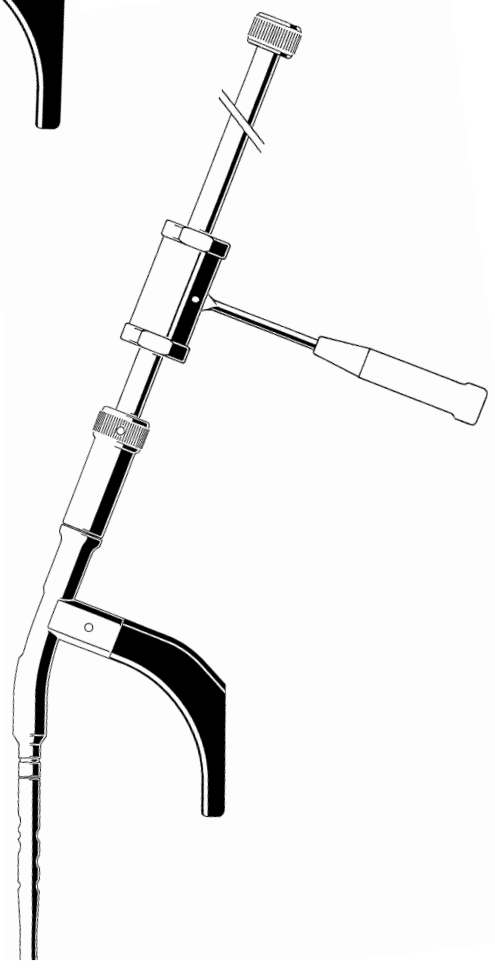


Fig. 4

Quick coupling connection
The insertion instrument set is also available with quick coupling connection making the assembly much easier.

Note: Direct Hammering with the 700 g Hammer (399.430) instead of the ram with handle and the Hammer guide is possible, but only with the Protective Cap for quick coupling connection (357.601) (Fig. 5).

Precaution: Do not hammer directly onto the insertion handle. Retighten and confirm that the nail is securely connected to the insertion handle.

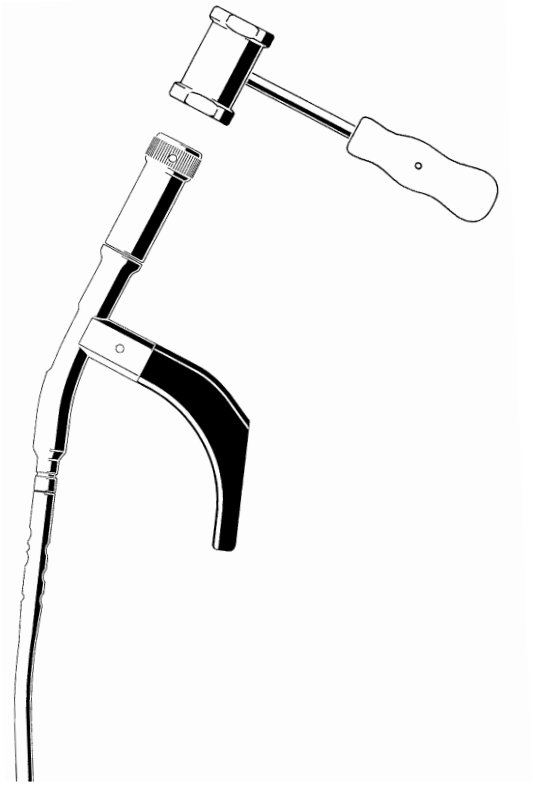


Fig. 5

Reamed technique

Once the guide wire rests securely in the distal main fragment, use slight rotational movements to insert the implant manually into the femur opening while the insertion handle points anteriorly (fig. 1). Continue the manual insertion of the implant; both the insertion handle and the nail will turn laterally (fig. 2). After a 90° rotation, the final position of the insertion handle will be in the LM plane (fig. 3). Use image intensification to verify the passage of the nail across the fracture zone.

Fig. 1

Fig. 2

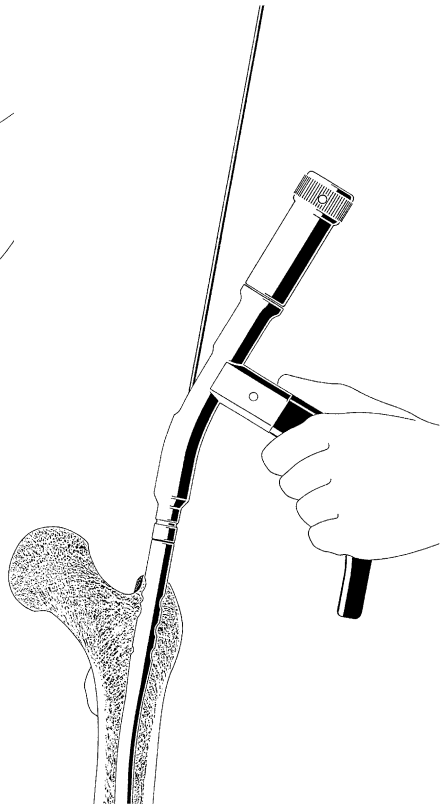


Fig. 3

Insert the nail
Unreamed technique
Use slight rotational movements to insert the nail manually into the femur opening while the insertion handle points anteriorly. Push the implant manually to the fracture; both the insertion handle and the nail will turn laterally (compare illustrations 1–3, page 18). Insert the guide wire. Reduce the fracture using the nail and the insertion handle, and guide the guide wire across the fracture line.

Verify the position of the guide wire in the distal fragment and correct it, if necessary. Advance the nail to the desired position.

Precaution: If nail insertion is difficult, choose a smaller diameter nail or ream the intramedullary canal to a larger diameter.

Use light Hammer blows to seat the nail into the metaphysis, leaving the proximal nail end at or just below the level of the tip of the greater trochanter. To avoid locking inaccuracies, recheck whether the connecting screw is secured tightly to the nail.

If nail over-insertion into the medullary cavity is required to ensure optimal positioning of the locking implants, the surgeon may extend the nail length with an end cap (see page 34, insert the end cap).

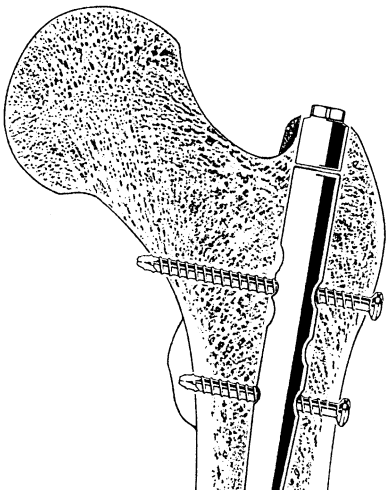
Remove the guide wire.

Note: During insertion of a cannulated nail, the cannulated Coupling Shaft (357.516) may be used to retighten the connecting screw over the guide wire.

Proximal locking

Standard locking
The Antegrade Femoral Nail AFN allows standard static locking for the fixation of femoral shaft fractures

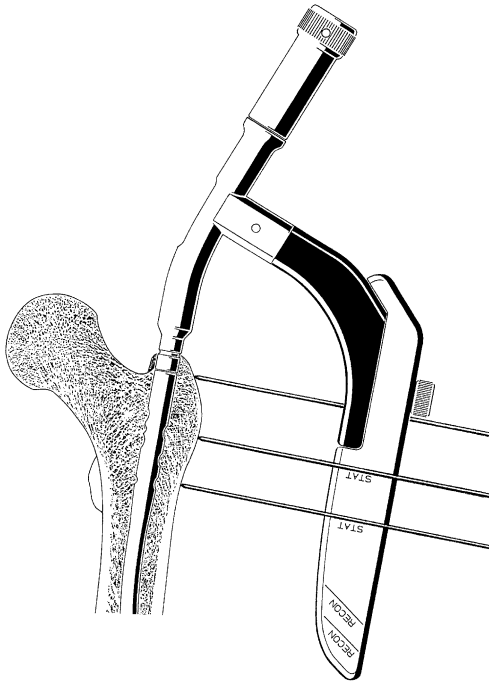
Indications
Indications/contraindications, see page 2.



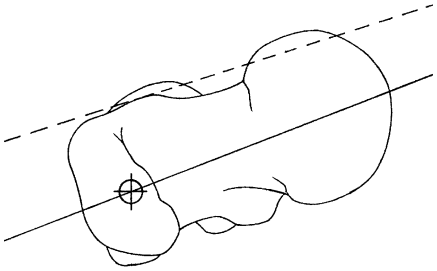
Mount the AFN Aiming Arm (357.522) onto the insertion handle.
Insert two 4.9 mm locking bolts for static, transverse locking.

Note: Check the position of the proximal nail end by inserting a guide wire through the insertion handle. The position of the locking bolt can be verified by placing guide wires on the surface of the insertion handle.
To ensure the correct anteversion of the implant, insert an additional guide wire into the femoral head along the ventral cortex of the femoral neck.

Precautions:
- Do not mount the aiming arm until the nail has been completely inserted.
- Adjusting for the correct anteversion before making a skin incision is crucial to allow uncomplicated guide wire and screw insertion.



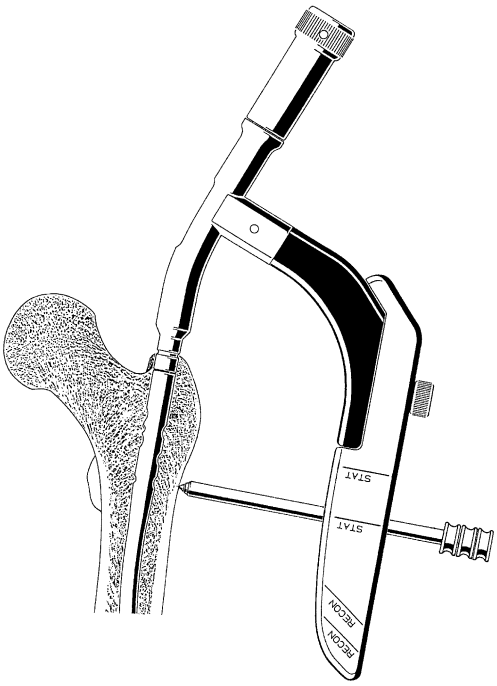
Use the image intensifier for AP and axial control.



Make a stab incision and insert the drill sleeve assembly consisting of Protection Sleeve 11.0/8.0 (357.760), Drill Sleeve 8.0/4.0 (357.710) and 4.0 mm Trocar (357.750), into the distal hole of the insertion handle (marked stat.) and advance it to the bone.

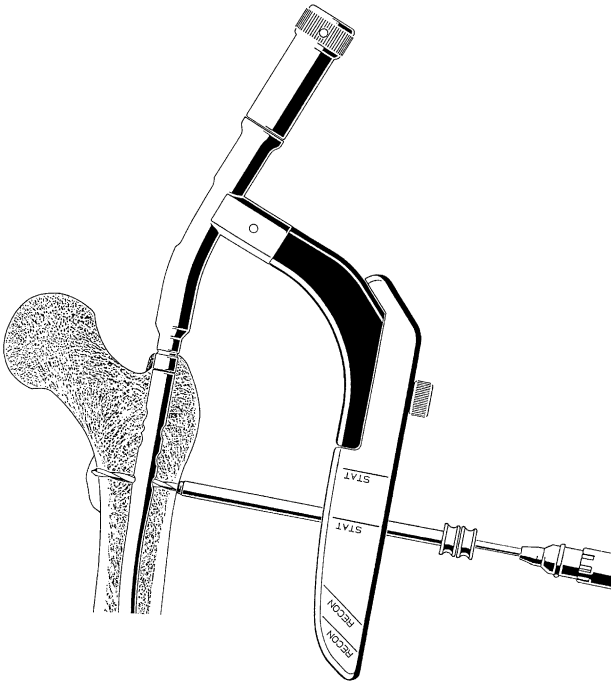
Remove the trocar.

Precaution: Do not exert forces on the aiming arm, protection sleeve, drill sleeves or drill bits. Such force may prevent accurate targeting through the proximal locking holes and damage the drill bits.

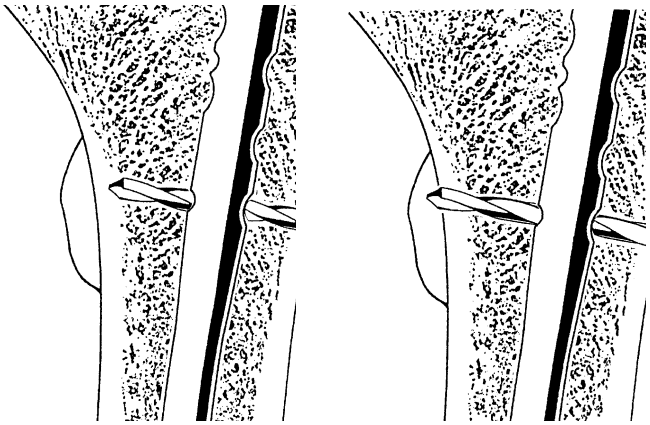


Drill through both cortices with the calibrated 4.0 mm Drill Bit (356.980), stopping the drill immediately after penetrating the far cortex. Confirm the drill bit position using the image intensifier.

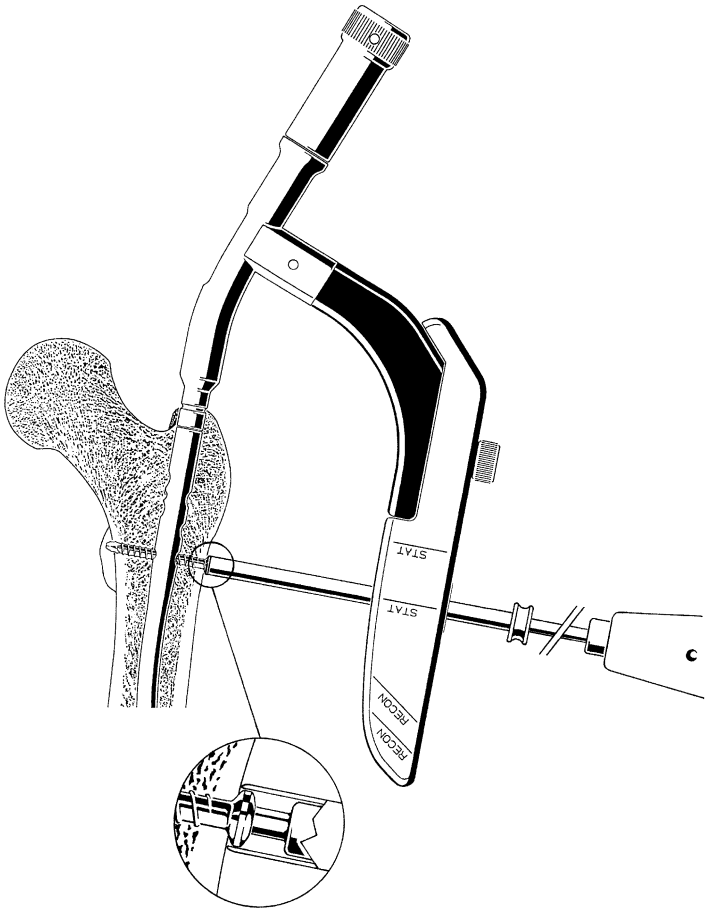
Make sure that the drill sleeve is pressed firmly to the cortex, and read the length of the locking bolt directly from the calibrated drill bit protruding at the back of the drill sleeve.



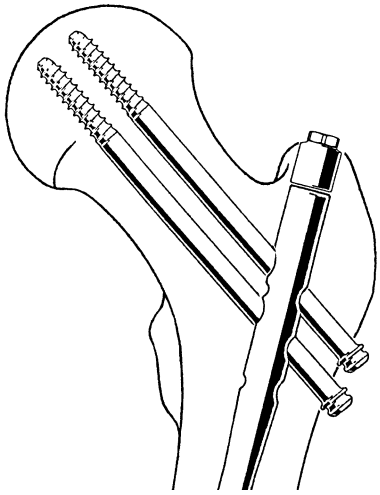
Note: There is no need to calculate the length of the bolt as the calibrated drill bit provides direct measurement. However, since the drill bit position directly represents the locking bolt position in the bone, the locking bolt will be too long if the drill bit is over-inserted, or if the drill sleeve is not pressed to the lateral cortex.
To prevent measuring errors, use the „pause and consider" method: temporarily stop the drill when the bit hits the far cortex.
Press the drill sleeve to the lateral cortex; continue drilling until the tip of the drill bit just penetrates the far cortex.
Read the locking-bolt length directly off the drill-sleeve back.



To use the Depth Gauge for Locking Bolts (357.790), remove the drill sleeve, measure through the protection sleeve using standard depth gauge technique, and add 2–4 mm to the reading to ensure thread engagement in the far cortex. Use the hexagonal screwdriver to insert the locking bolt through the protection sleeve.
Repeat this procedure to insert the second proximal locking bolt.



Reconstruction locking
The hip screw ensures secure fixation of the proximal fragment in subtrochanteric fractures with or without detached lesser trochanter, and in femoral neck fractures.



Indications
Indications/contraindications, see page 2.

Assemble instruments
See page 14.

Mount the AFN Aiming Arm (357.522) onto the insertion handle.
Reconstruction locking requires the insertion of two 6.5 mm hip screws.

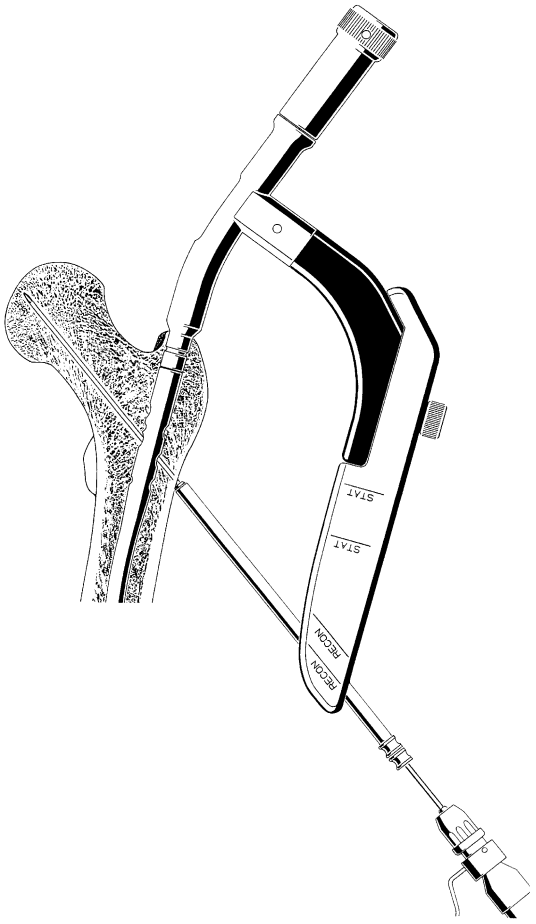
Note: The position of the nail can be verified by placing a guide wire onto the insertion handle. Check the position of the nail end by inserting a guide wire into the insertion handle.
To ensure correct anteversion of the implant, insert an additional guide wire into the femoral head on the ventral side of the femoral neck.

Insert both hip screws
Insert these screws using the pink drill sleeve assembly consisting of Protection Sleeve 11.5/9.0 (356.705), Drill Sleeve 9.0/2.8 (356.706) and 2.8 mm Trocar (356.707).

Insert guide wire for caudal hip screw
Make a stab incision and insert the drill sleeve assembly through the corresponding pink distal drill hole of the aiming arm to the bone. Mark the femur and remove the trocar.

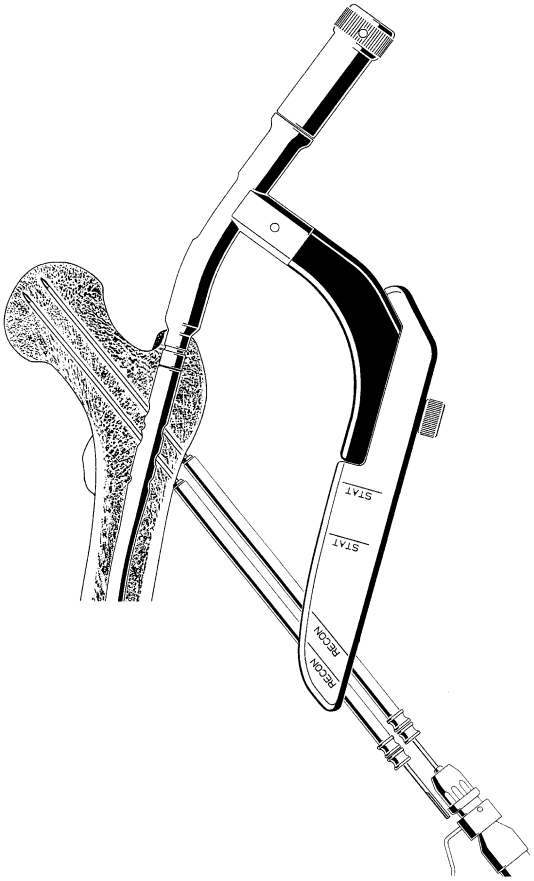
Insert a new 2.8 mm Guide Wire (357.039) through the drill sleeve into the bone, and check both direction and position under the image intensifier in AP and axial views. Select a position in the caudal area of the femoral head so that both proximal screws can be inserted. Insert the guide wire subchondrally or a maximum of 5 mm away into the femoral head. The final position of the guide wire should be in the centre of the lower half of the femoral neck. In lateral view, the wire should be positioned in the centre of the femoral neck.

Note: If the nail has to be repositioned, remove the guide wire, protection sleeve and drill sleeve. The nail can now be repositioned by rotation, deeper insertion or partial retraction.
Reinsert the drill sleeve assembly and the guide wire.

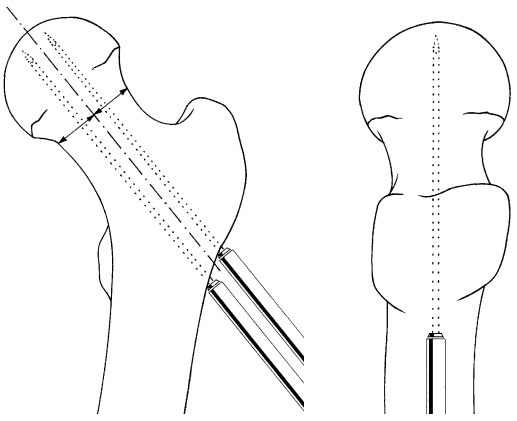


Insert guide wire for cranial hip screw
Make a stab incision and insert the second drill sleeve assembly through the proximal pink drill hole of the aiming arm to the bone. Mark the femur and remove the trocar.

Insert a second, new 2.8 mm Guide Wire (357.039) subchondrally through the drill sleeve into the femoral head.



Verify direction and position in AP and lateral views of the image intensifier.



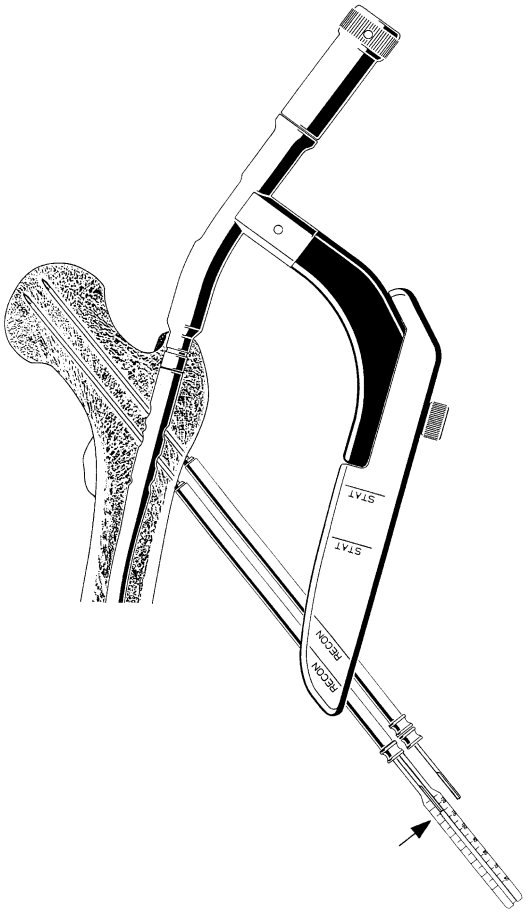
Measure length of caudal hip screw

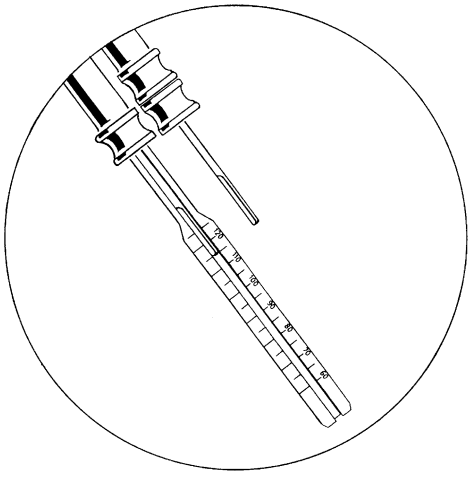
It is recommended to start with the insertion of the caudal hip screw.

Remove the Drill Sleeve 9.0/2.8 (356.706) and insert the Direct Measuring Device (357.042) over the Guide Wire (357.039) through the Protection Sleeve (356.705) to the bone, and determine the length of the required hip screw. Read the length of the hip screw directly off the measuring device.

Note: As the screw head is included in the total length of the screw, we recommend to round up and take the next larger hip screw.

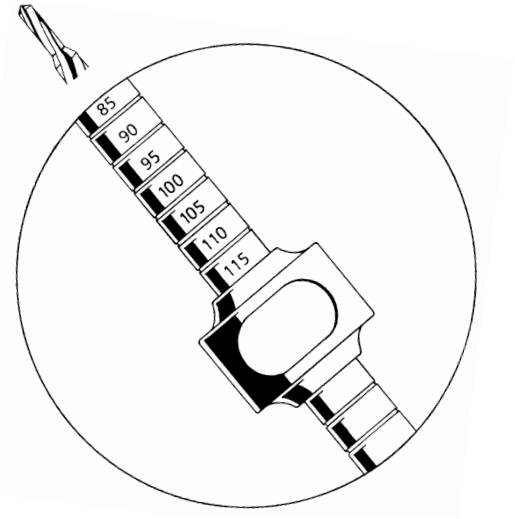
Precaution: Drill bit location with respect to the far cortex is critical for measuring the appropriate locking screw length.





Set reamer for caudal hip screw
Now set the measured length on the reamer by securing the fixation sleeve in the appropriate position. The correct length is indicated on the side of the fixation sleeve facing the reamer tip.

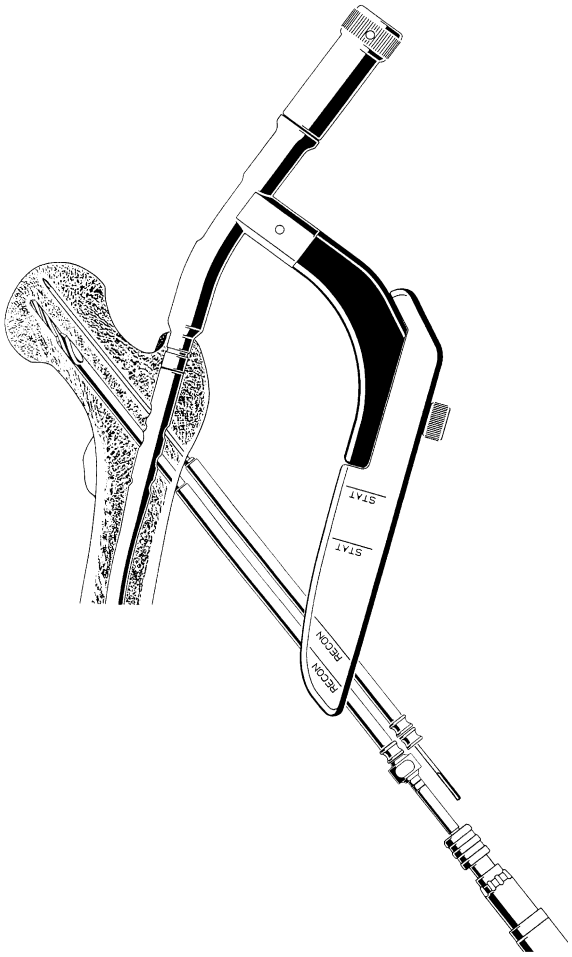
Remove the caudal guide wire.



Drill hole for caudal hip screw
Use the 6.5/4.5 mm Reamer (356.702) to drill to the stop. The secured Fixation Sleeve (356.701) prevents further drilling.

Verify direction and position in AP and lateral views of the image intensifier.

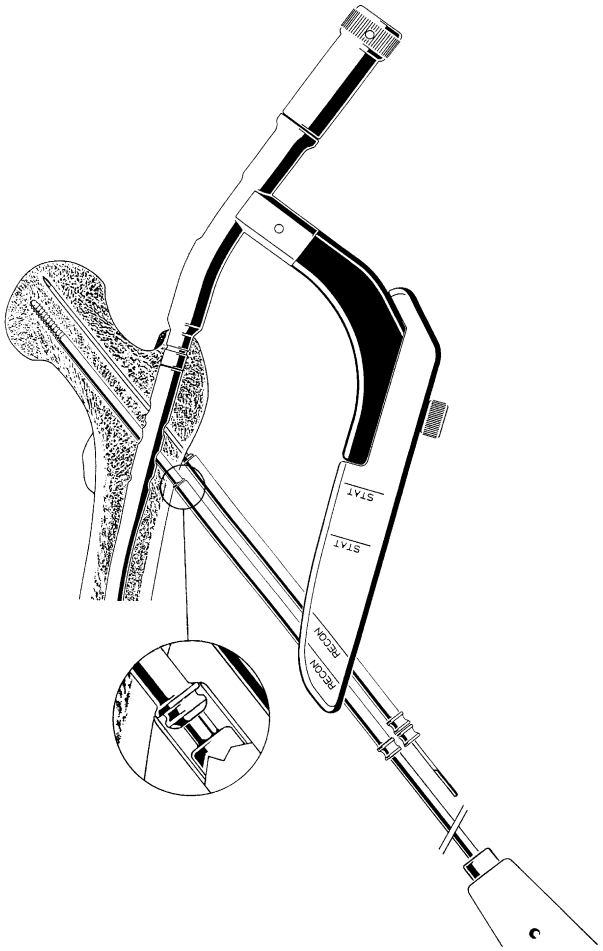
Tapping is not required due to the self-tapping tip of the hip screw.



Insert caudal hip screw
Use the Hexagonal Screwdriver (356.708) to insert the selected hip screw to the lateral cortex.

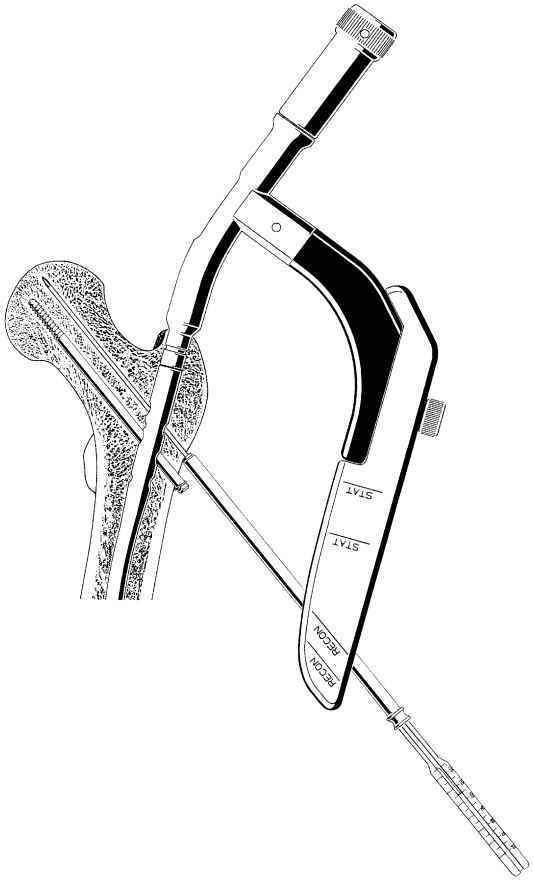
Verify direction and position in AP and axial views of the image intensifier.

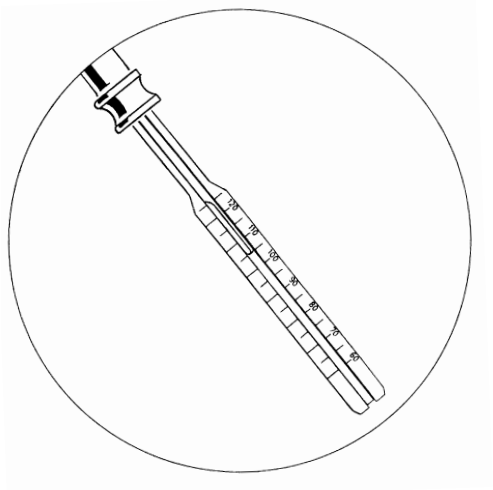
Remove the protection sleeve.



Measure length of cranial hip screw
After the insertion of the caudal hip screw, measure the length of the cranial hip screw.
Remove the Drill Sleeve 9.0/2.8 (356.706) and guide the Direct Measuring Device (357.042) over the Guide Wire (357.039) through the Protection Sleeve (356.705) until it touches bone, and determine the length of the required proximal hip screw. Read the length of the hip screw directly from the measuring device.

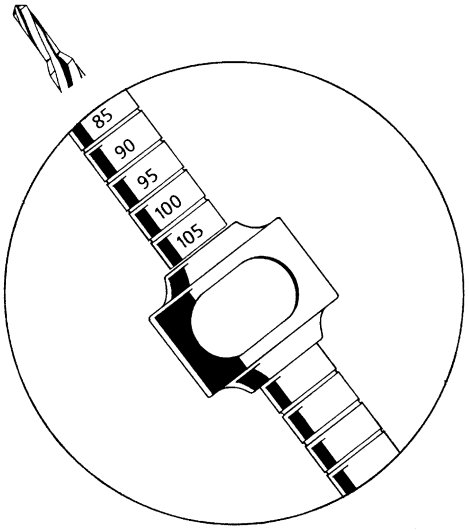
Note: As the screw head is included in the total length of the screw, we recommend to round up and take the next larger hip screw.





Set reamer for cranial hip screw
Now set the measured length on the reamer by securing the fixation sleeve in the appropriate position. The correct length is indicated on the side of the fixation sleeve facing the reamer tip.

Remove the cranial guide wire.



Drill hole for cranial hip screw
Use the 6.5/4.5 mm Reamer (356.702) to drill to the stop. The secured Fixation Sleeve (356.701) prevents further drilling.

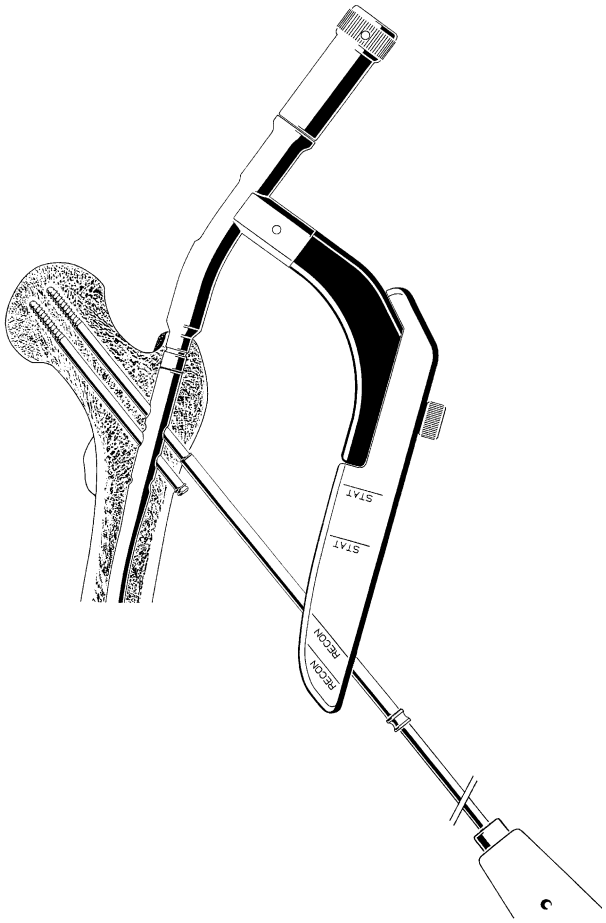
Verify direction and position in AP and axial views of the image intensifier.

Tapping is not required due to the self-tapping tip of the hip screw.

Insert cranial hip screw
Use the Hexagonal Screwdriver (356.708) to insert the selected hip screw to the lateral cortex.

Verify direction and position in AP and axial views of the image intensifier.

Remove the protection sleeve.



Compression
Fracture compression can be achieved by alternately tightening both hip screws. This should be done under image intensification to control compression. Be careful not to overtighten the screws to prevent stripping of the thread.

In osteoporotic bone, use a Washer (419.911) to prevent even the larger screw head from penetrating the lateral cortices.

Distal locking

Static locking

Distal locking is usually performed using two locking bolts. There are two static interlocking possibilities. Position the locking bolt at the proximal end of the locking slot. Depending on the fracture line, it is then possible to occupy the caudal (Fig. 1) or the cranial (Fig. 2) hole.

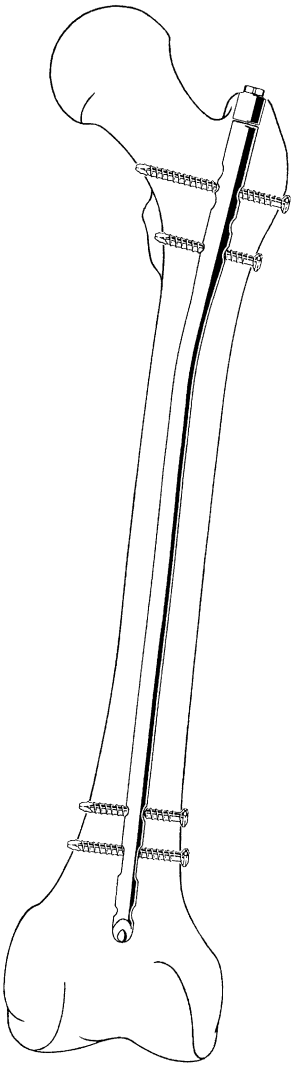


Fig. 1

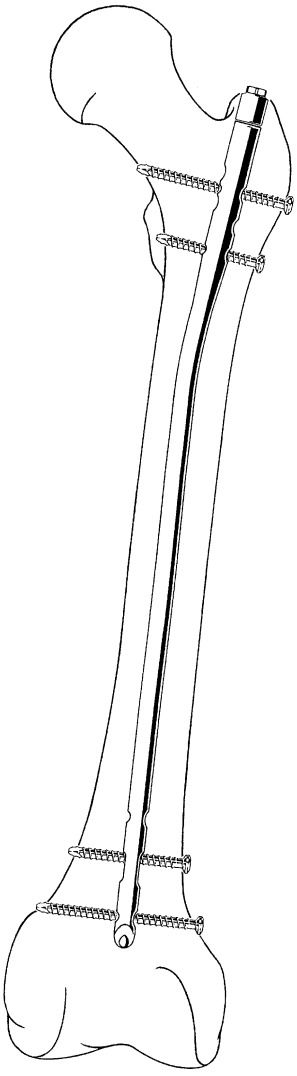


Fig. 2

Dynamic locking

If immediate dynamisation is required, use only the caudal locking slot distally. For secondary dynamisation, insert both locking bolts as described above, and remove the static bolt later. Reconfirm reduction of the distal fragment.

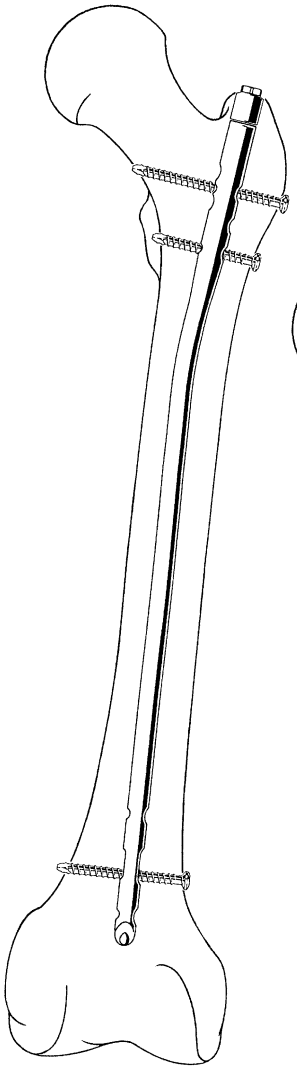


Fig. 3

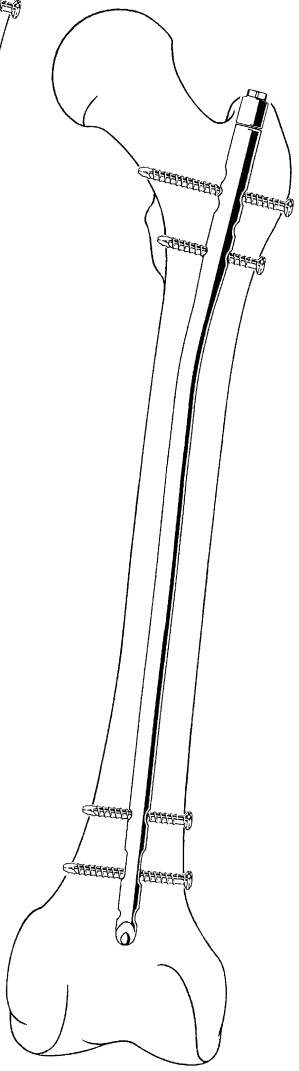


Fig. 4

Fig. 5

Note: In dynamisation, there is a risk of the nail penetrating the knee, due to the somewhat deeper position of the nail in reconstruction locking.

Use the Radiolucent Drive Mark II: align the image intensifier with the nail hole to be drilled until a perfect circle is visible in the centre of the screen. Make a stab incision at the incision point.

Use image intensifier control to insert the tip of the Drill Bit (356.980) into the incision, and hold the drill bit oblique to the X-ray beam until the tip is centred in the locking slot. Tilt the drive until the drill bit is in line with the beam and appears as a radio-opaque, solid circle in the centre of the outer ring. The drill bit will nearly fill the locking-hole image. Hold the drill bit in this position and drill through both cortices. Measure the required locking bolt length using the Depth Gauge for Locking Bolts (357.790) adding 2–4 mm to the reading to ensure locking bolt engagement in the far cortex.

Use the large Hexagonal Screwdriver (356.708) to insert the bolt.
Repeat the procedure for the second distal locking bolt. For static interlocking, position the caudal bolt at the proximal end of the locking slot, for dynamic interlocking at the distal end of the locking slot to allow dynamisation.

Verify direction and position in AP and axial views of the image intensifier.

Note: If the Radiolucent Drive MARK II is not available, perform distal locking in standard freehand technique using the Drill Bit (356.980).

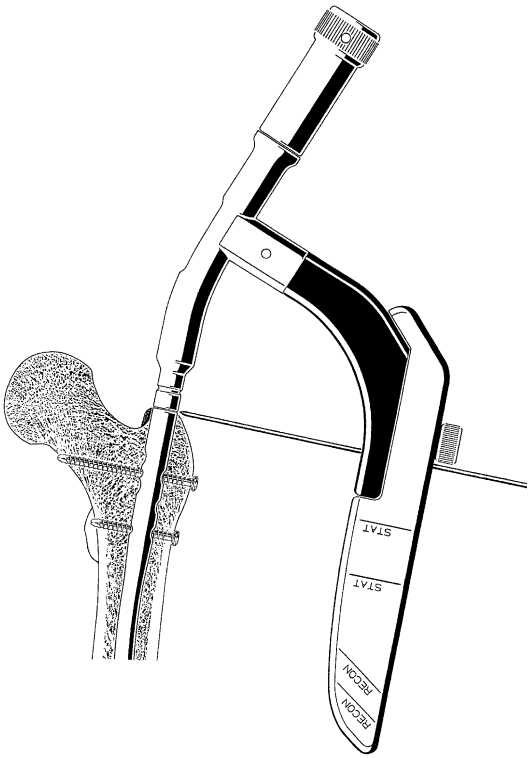
Insert the end caps
With the insertion handle in place, take an AP image intensification view of the position of the proximal nail end.
The nail end should be visible due to the difference in nail and insertion handle diameters.

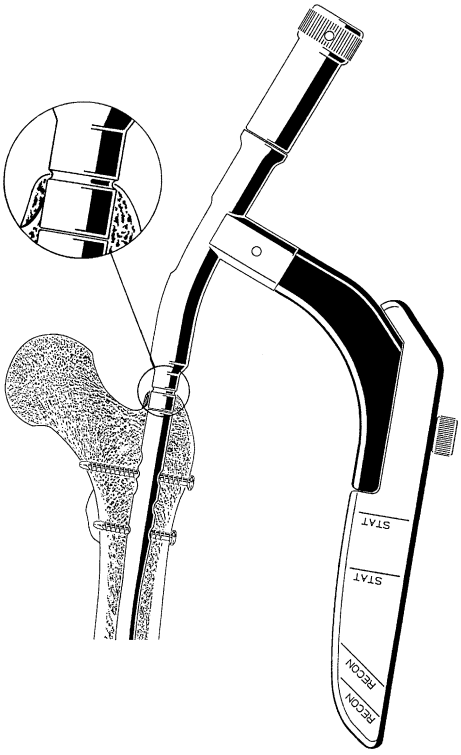
If the nail end is level with the tip of the greater trochanter, select the green end cap with 0 mm extension.

If the proximal nail end is distal to the tip of the greater trochanter, determine the appropriate length of the end cap with the help of the indented notches. Nail extensions of 5, 10, 15 and 20 mm are possible.

The following points apply:
– If the indented ring is at the upper rim of the greater trochanter, use the end cap with 10 mm extension
– If the base of the cone is level with the upper rim of the greater trochanter, use the end cap with 20 mm extension
– End caps with 5 and 15 mm extensions are available for finer increments

For additional orientation, insert a 3.2 mm guide wire through the appropriate hole of the insertion handle, and verify the guide wire position radiographically.





Loosen the connecting screw and remove the insertion handle.

Insert the hook of the Guide Wire with Hook (356.717) through the selected end cap. Now guide the 11/11 mm Cannulated Hexagonal Socket (356.715) over the guide wire to the end cap. The end cap is automatically secured as soon as this connection is made.

Guide the cannulated end cap to the proximal end of the nail. Tighten the end cap using the 11 mm Ratchet Wrench (321.200). Fully insert the end cap into the nail.

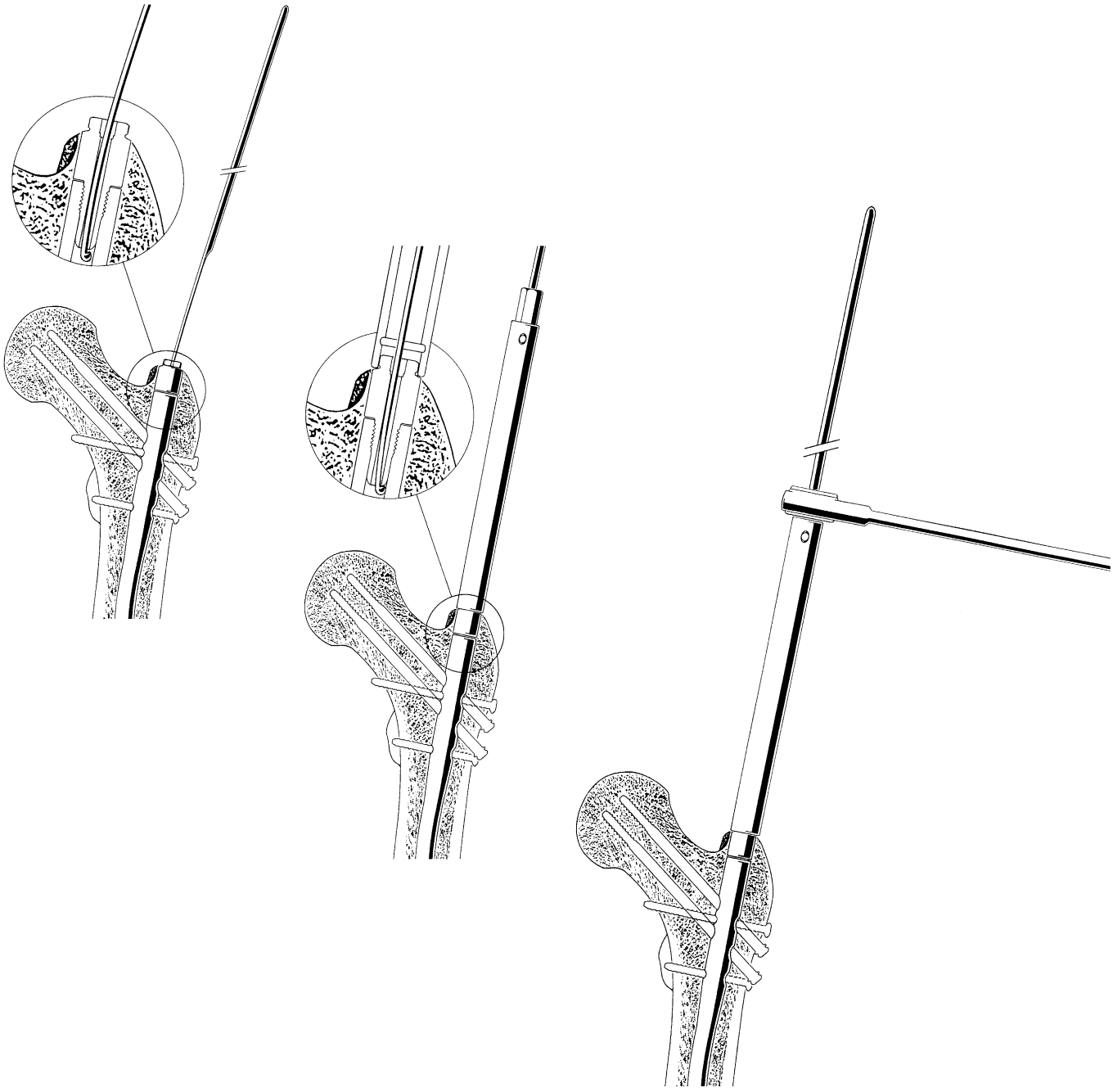
As the final threads of the end cap turn into the nail, you will feel increased resistance. Continue turning until the shoulder of the end cap contacts the proximal nail end. This prevents backout.

Notes:
- If the indented ring is level with the upper rim of the greater trochanter, use the end cap with 10 mm extension
- If the base of the cone is level with the upper rim of the greater trochanter, use the end cap with 20 mm extension

Remove the hexagonal socket, the ratchet wrench and the guide wire.

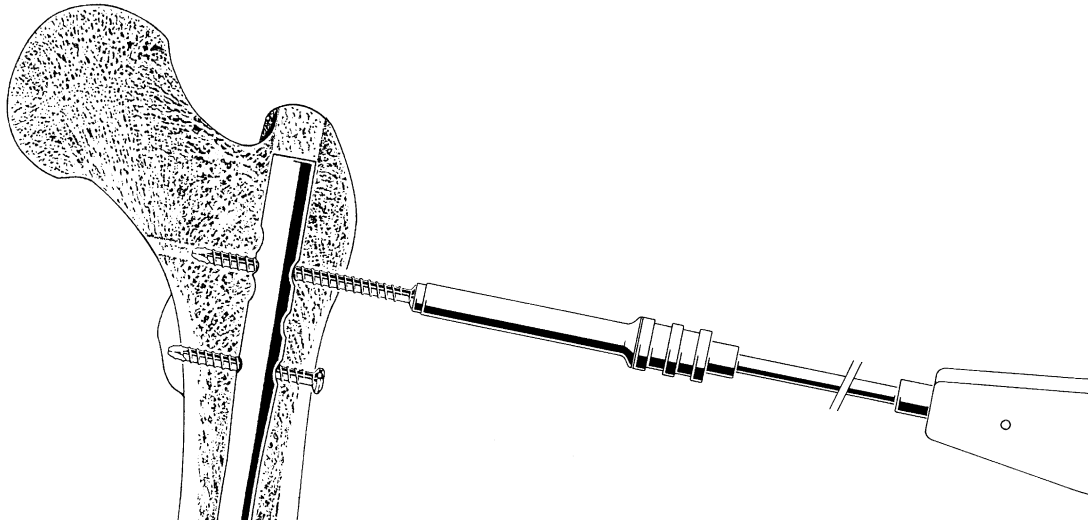
Remove end cap

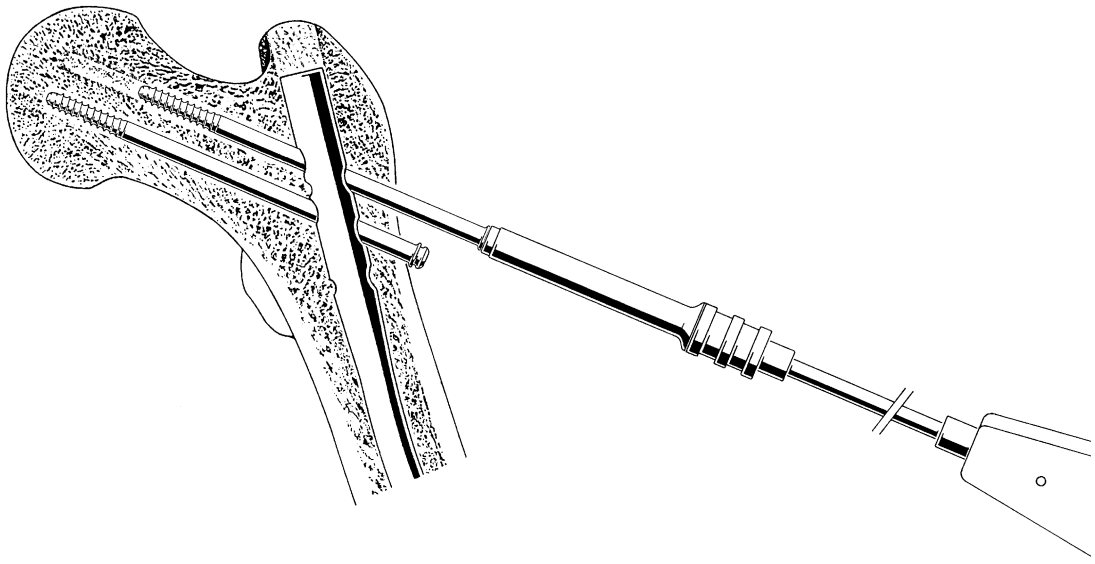
Remove bone particles from the end cap. Push the 2.8 mm Guide Wire with Hook (356.717) hook first through the end cap and take hold. Verify the hold of the guide wire. Use the 11/11 mm Cannulated Hexagonal Socket (356.715) and the Ratchet Wrench (321.200) for this procedure.



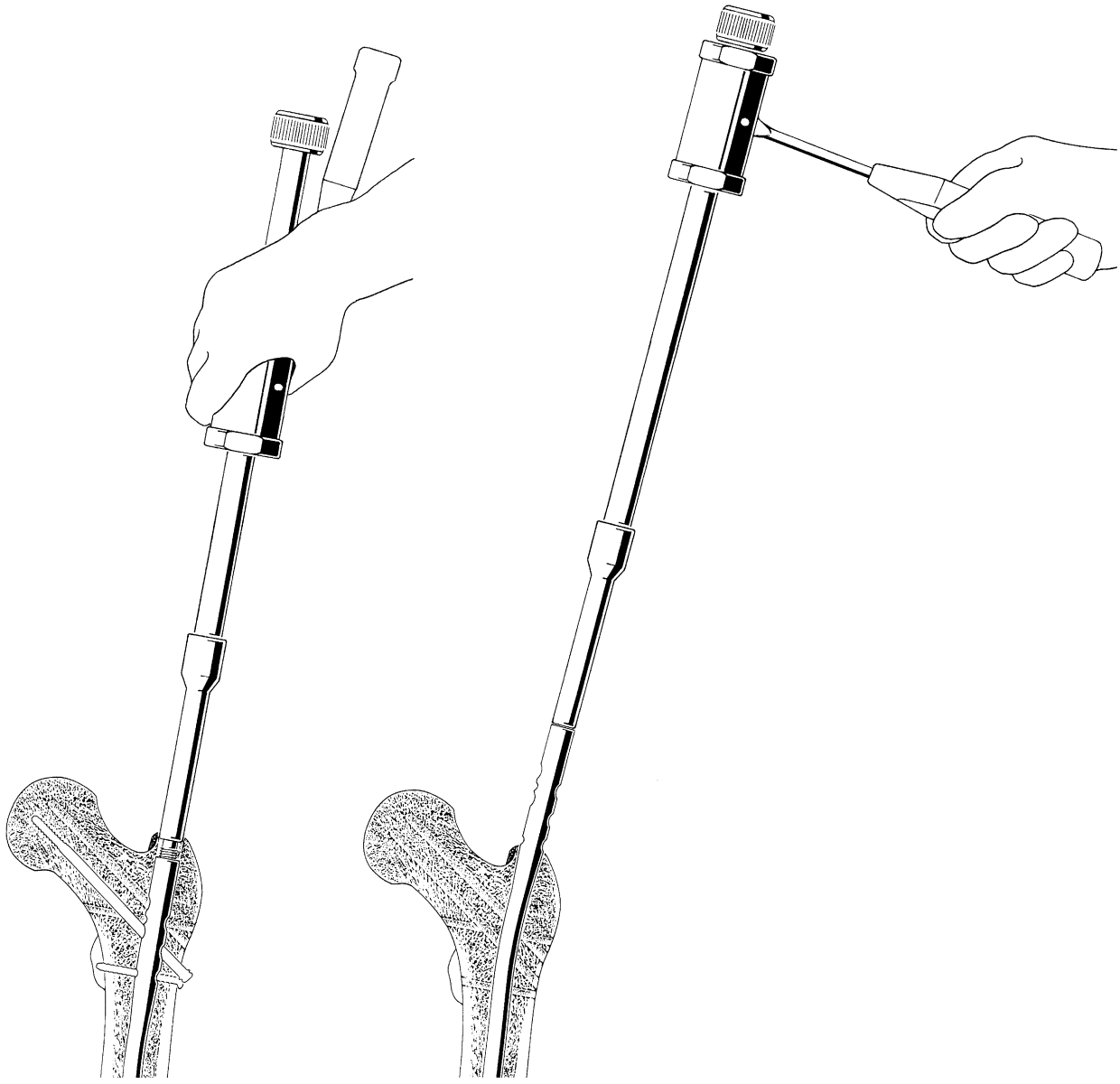
Remove locking bolts and hip screws
Remove the locking bolts or hip screws using the hexagonal 3.5 mm Screwdriver for AFN (356.708) and the appropriate Holding Sleeve (314.280).

Note: Before removing the last locking bolt or hip screw, thread the Extraction Screw (356.722) into the proximal nail end. This prevents the nail from rotating in the medullary canal.





Remove nail
Thread the Hammer Guide (357.220) and the Slide Hammer (357.250) into the extraction screw. Thread the extraction screw into the proximal nail end, through the incision made for end cap removal. Finger-tighten the assembly. Remove the remaining locking bolts and extract the nail.

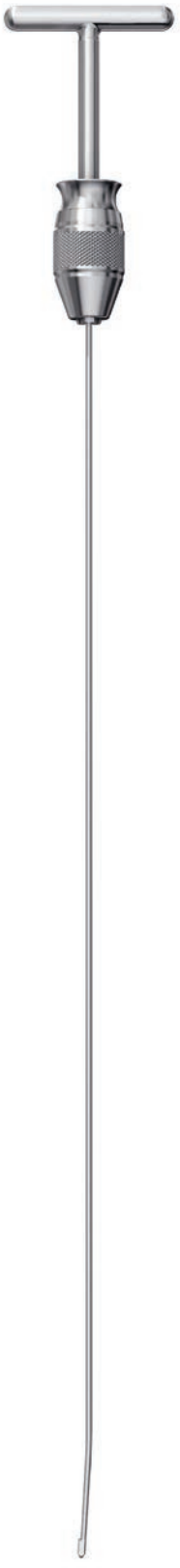


Alternative Technique – Extraction Hook

For removal of broken nail

Instruments	
355.399	Extraction Hook ∅ 3.7 mm, for Cannulated Nails
393.100	Universal Chuck with T-Handle
or	
393.105	Universal Chuck, small, with T-Handle

Begin with Steps 1 and 2 of Implant Removal, then remove the extraction screw from the nail.



Option 1

1

Assemble extraction hook and universal chuck

Insert the extraction hook into the universal chuck with T-handle. The hook should be parallel with the T-handle. This facilitates visualization of the hook position in the bone.

2

Insert extraction hook through nail

Pass the extraction hook through the cannula of the nail, including the distant fragment.

Precaution: Under image intensification, verify that the hook has passed through and engaged the distant end of the nail.

3

Extract nail

Extract both nail fragments.

Note: Keep the patient's limb restrained to increase the efficiency of the extraction force.

Option 2

1
Remove near nail fragment

Attach the appropriate extraction bolt or extraction screw to the nail. Remove the near nail fragment using the extraction bolt or extraction screw.

Note: The extraction hook can be used as an alternative to extraction instrumentation.

2
Ream canal

Ream the medullary canal 1 mm larger than the nail diameter to clear a path for the distant nail fragment.

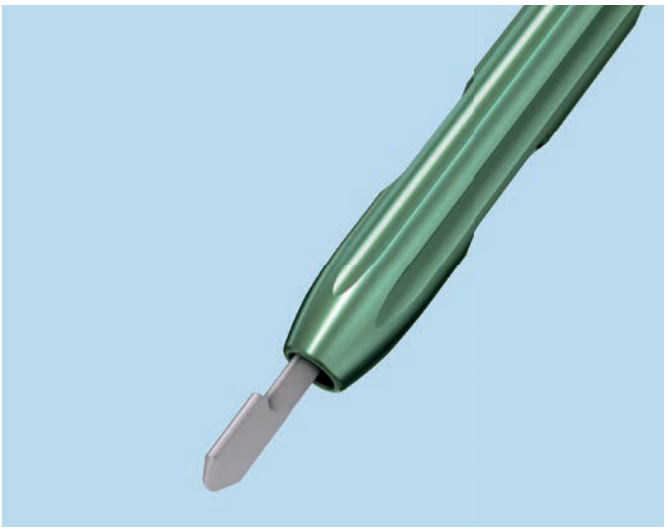
3
Align extraction hook

Insert the extraction hook and explanted near nail fragment into the medullary canal. The near nail fragment aligns the extraction hook with the cannulation of the distant nail fragment.

4
Engage distant fragment

Pass the extraction hook through the cannula of the distant nail fragment.

Precaution: Under image intensification, verify that the hook has passed through and engaged the distant end of the nail.



5
Extract nail

Extract both nail fragments.

Note: Keep the patient's limb restrained to increase the efficiency of the extraction force.

Cleaning

Intra-operative and postoperative cleaning
Use the 2.8 mm Stylet (319.460) to clean the cannulations of the instruments intraoperatively.

Subject to alterations.

Implants

Hip Screws

418.260	418.260S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 60 mm, Titanium Alloy (TAN)
418.265	418.265S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 65 mm, Titanium Alloy (TAN)
418.270	418.270S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 70 mm, Titanium Alloy (TAN)
418.275	418.275S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 75 mm, Titanium Alloy (TAN)
418.280	418.280S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 80 mm, Titanium Alloy (TAN)
418.285	418.285S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 85 mm, Titanium Alloy (TAN)
418.290	418.290S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 90 mm, Titanium Alloy (TAN)
418.295	418.295S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 95 mm, Titanium Alloy (TAN)
418.300	418.300S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 100 mm, Titanium Alloy (TAN)
418.305	418.305S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 105 mm, Titanium Alloy (TAN)
418.310	418.310S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 110 mm, Titanium Alloy (TAN)
418.315	418.315S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 115 mm, Titanium Alloy (TAN)
418.320	418.320S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 120 mm, Titanium Alloy (TAN)
418.325	418.325S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 125 mm, Titanium Alloy (TAN)
418.330	418.330S	Hip Screw ∅ 6.5 mm for AFN, self-tapping, length 130 mm, Titanium Alloy (TAN)

Washer

419.911	419.911S	Washer ∅ 12.5/6.5 mm, thickness 2.5 mm, Titanium Alloy (TAN)

End Caps

418.360	418.360S	End Cap for AFN ∅ 9.0–10.0 mm, cannulated, extension 0 mm
418.361	418.361S	End Cap for AFN ∅ 9.0–10.0 mm, cannulated, extension 5 mm
418.362	418.362S	End Cap for AFN ∅ 9.0–10.0 mm, cannulated, extension 10 mm
418.363	418.363S	End Cap for AFN ∅ 9.0–10.0 mm, cannulated, extension 15 mm
418.364	418.364S	End Cap for AFN ∅ 9.0–10.0 mm, cannulated, extension 20 mm
418.370	418.370S	End Cap for AFN ∅ 11.0–12.0 mm, cannulated, extension 0 mm
418.371	418.371S	End Cap for AFN ∅ 11.0–12.0 mm, cannulated, extension 5 mm, sterile
418.372	418.372S	End Cap for AFN ∅ 11.0–12.0 mm, cannulated, extension 10 mm, sterile
418.373	418.373S	End Cap for AFN ∅ 11.0–12.0 mm, cannulated, extension 15 mm
418.374	418.374S	End Cap for AFN ∅ 11.0–12.0 mm, cannulated, extension 20 mm
418.380	418.380S	End Cap for AFN ∅ 13.0–14.0 mm, cannulated, extension 0 mm
418.381	418.381S	End Cap for AFN ∅ 13.0–14.0 mm, cannulated, extension 5 mm
418.382	418.382S	End Cap for AFN ∅ 13.0–14.0 mm, cannulated, extension 10 mm
418.383	418.383S	End Cap for AFN ∅ 13.0–14.0 mm, cannulated, extension 15 mm
418.384	418.384S	End Cap for AFN ∅ 13.0–14.0 mm, cannulated, extension 20 mm

AFN – Antegrade Femoral Nails, Titanium Alloy (TAN) (add S for sterile)

		Diameter [mm]					
Right/Left	Length (mm)	9	10	11	12	13	14
Right	300	477.100	477.120	477.140	477.160	477.180	477.200
Left	300	477.101	477.121	477.141	477.161	477.181	477.201
Right	320	477.102	477.122	477.142	477.162	477.182	477.202
Left	320	477.103	477.123	477.143	477.163	477.183	477.203
Right	340	477.104	477.124	477.144	477.164	477.184	477.204
Left	340	477.105	477.125	477.145	477.165	477.185	477.205
Right	360	477.106	477.126	477.146	477.166	477.186	477.206
Left	360	477.107	477.127	477.147	477.167	477.187	477.207
Right	380	477.108	477.128	477.148	477.168	477.188	477.208
Left	380	477.109	477.129	477.149	477.169	477.189	477.209
Right	400	477.110	477.130	477.150	477.170	477.190	477.210
Left	400	477.111	477.131	477.151	477.171	477.191	477.211
Right	420	477.112	477.132	477.152	477.172	477.192	477.212
Left	420	477.113	477.133	477.153	477.173	477.193	477.213
Right	440	477.114	477.134	477.154	477.174	477.194	477.214
Left	440	477.115	477.135	477.155	477.175	477.195	477.215
Right	460	477.116	477.136	477.156	477.176	477.196	477.216
Left	460	477.117	477.137	477.157	477.177	477.197	477.217
Right	480	477.118	477.138	477.158	477.178	477.198	477.218
Left	480	477.119	477.139	477.159	477.179	477.199	477.219

Instruments

175.500	SynReam Instrument Set in SynCase
314.280	Holding Sleeve, large, for Nos. 314.190, 314.240, 314.260, 314.270 and 314.750
319.021	Measuring Device for AFN
319.460	Cleaning Stylet ∅ 2.8 mm, for Cannulated Instruments
321.200	Ratchet Wrench for Nut, hexagonal, 11.0 mm
351.050	Tissue Protector
355.399	Extraction Hook ∅ 3.7 mm, for Cannulated Nails
356.700	Reamer for Hip Screw ∅ 6.5/4.5 mm, for AFN
356.701	Fixation Sleeve, for Reamer No. 356.700
356.702	Reamer for Hip Screw ∅ 6.5/4.5 mm, complete, for AFN
356.703	Drill Bit ∅ 14.0 mm, cannulated, length 312 mm, for AFN
356.704	Drill Bit ∅ 16.0 mm, cannulated, length 312 mm, for AFN
356.705	Protection Sleeve 11.5/9.0, length 178 mm, for AFN
356.706	Drill Sleeve 9.0/2.8, length 191 mm, for AFN
356.707	Trocar ∅ 2.8 mm, for AFN
356.708	Screwdriver, hexagonal, ∅ 3.5 mm, for AFN
356.710	Reverse Awl ∅ 14.0 mm, for AFN ∅ 9.0 to 10.0 mm
356.711	Reverse Awl ∅ 16.0 mm, for AFN ∅ 11.0 to 12.0 mm
356.715	Socket, hexagonal, ∅ 11.0/11.0 mm, cannulated, for AFN
356.717	Guide Wire ∅ 2.8 mm, length 460 mm, with Hook

356.722	Extraction Screw for AFN/UFN/CFN and Spiral Blade, with Quick Coupling Connection
356.980	Drill Bit ∅ 4.0 mm, calibrated, length 270/245 mm, 3-flute, for Quick Coupling
357.001	Protection Sleeve 20.0/17.0, for No. 357.005
357.002	Drill Sleeve 17.0/2.8, for No. 357.001
357.005	Drill Bit ∅ 17.0 mm, cannulated, length 312 mm, for PFN
357.008	Reverse Awl for PFN
357.039	Guide Wire ∅ 2.8 mm with threaded tip with trocar, length 350 mm
357.601	Protective Cap for Quick Coupling Connection
357.180	Driving Cap for UFN/CFN
357.220	Hammer Guide, for No. 357.250
357.221	Hammer Guide with Quick Coupling, for No. 357.250
357.250	Slide Hammer, for Nos. 357.220 and 357.221
357.515	Screwdriver, hexagonal, with spherical head ∅ 8.0 mm
357.516	Coupling Shaft, cannulated, ∅ 8.0 mm, for No. 398.335
357.521	Insertion Handle for UFN/CFN
357.042	Direct Measuring Device for Guide Wire ∅ 2.8 mm, for No. 357.039
357.522	Aiming Arm for AFN
357.710	Drill Sleeve 8.0/4.0, for No. 357.760, green
357.750	Trocar ∅ 4.0 mm, for No. 357.710, green
357.760	Protection Sleeve 11.0/8.0, for UFN/CFN, green
357.790	Depth Gauge for Locking Bolts, measuring range from 26 to 100 mm

393.100	Universal Chuck with T-Handle
393.105	Universal Chuck, small, with T-Handle
398.335	Connecting Screw for CFN/AFN for SynReam
399.430	Hammer 700 g

Literature

Rüedi T.P., Murphy W.M. (2000) AO Principles of Fracture Management. Stuttgart, New York: Thieme Publisher's.

C. Krettek, P. Schandelmaier, and H. Tscherne. Stabilisierung von Femurschaftfrakturen mit dem Unaufgebohrten Femur Nagel (UFN) [Stabilization of femoral shaft fractures using the Unreamed Femoral Nail (UFN)]. Part 1: Standardverriegelung [Standard locking]. Operat. Orthop. Traumatol. 10 (4): 183–197, 1998.

O P. A. Karpos, M. A. McFerran, and K.D. Johnson. Intramedullary nailing of acute femoral shaft fractures using manual traction without a fracture table. J. Orthop. Trauma 9 (1): 57–62, 1995.

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MRI Information

Torque, Displacement and Image Artifacts according to ASTM F 2213-06, ASTM F 2052-06e1 and ASTM F 2119-07

Non-clinical testing of worst case scenario in a 3 T MRI system did not reveal any relevant torque or displacement of the construct for an experimentally measured local spatial gradient of the magnetic field of 3.69 T/m. The largest image artifact extended approximately 169 mm from the construct when scanned using the Gradient Echo (GE). Testing was conducted on a 3 T MRI system.

Radio-Frequency-(RF-)induced heating according to ASTM F 2182-11a

Non-clinical electromagnetic and thermal testing of worst case scenario lead to peak temperature rise of 9.5 °C with an average temperature rise of 6.6 °C (1.5 T) and a peak temperature rise of 5.9 °C (3 T) under MRI Conditions using RF Coils (whole body averaged specific absorption rate [SAR] of 2 W/kg for 6 minutes [1.5 T] and for 15 minutes [3 T]).

Precautions: The above mentioned test relies on non-clinical testing. The actual temperature rise in the patient will depend on a variety of factors beyond the SAR and time of RF application. Thus, it is recommended to pay particular attention to the following points:

- It is recommended to thoroughly monitor patients undergoing MR scanning for perceived temperature and/or pain sensations.
- Patients with impaired thermoregulation or temperature sensation should be excluded from MR scanning procedures.
- Generally, it is recommended to use a MR system with low field strength in the presence of conductive implants. The employed specific absorption rate (SAR) should be reduced as far as possible.
- Using the ventilation system may further contribute to reduce temperature increase in the body.

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