DePuy Synthes

PART OF THE Johnson&Johnson FAMILY OF COMPANIES

THE UNIVERSAL NAIL SYSTEM

Instruments and implants approved by the AO Foundation.
This publication is not intended for distribution in the USA.

SURGICAL TECHNIQUE


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

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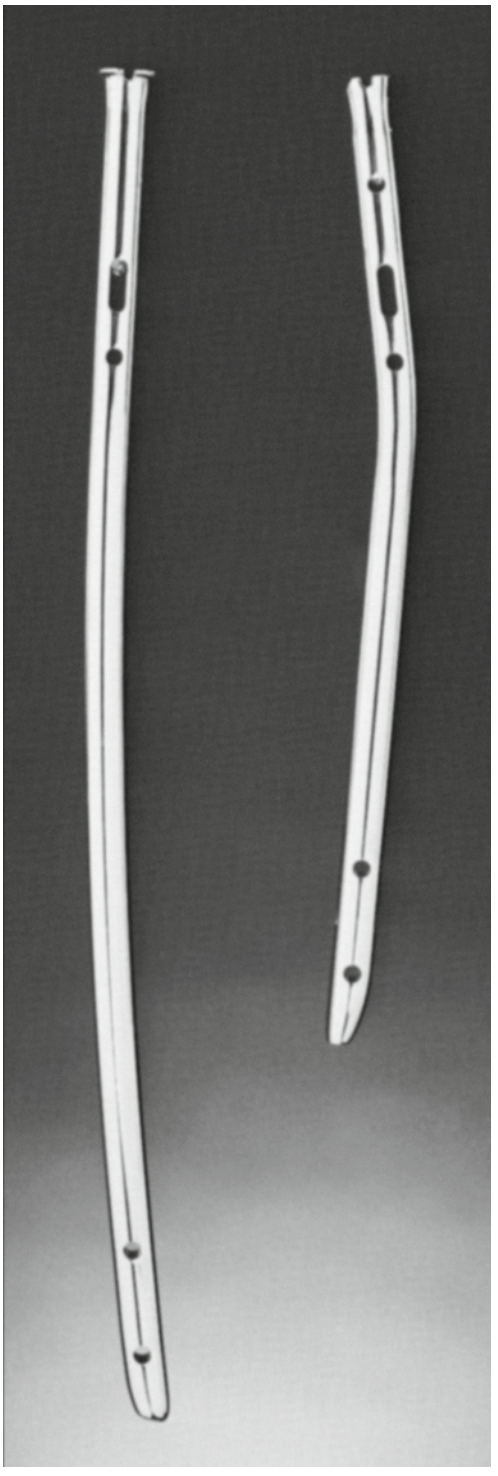
THE UNIVERSAL NAILS

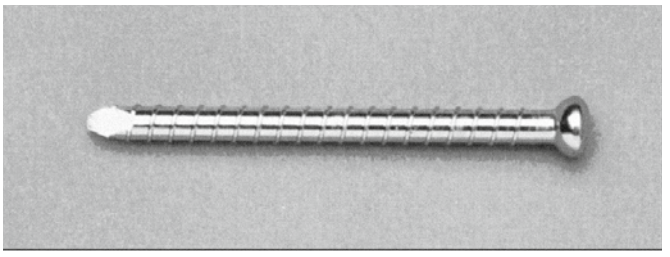
Universal Tibial and Femoral Nails feature:
- Anatomic design facilitates insertion and improved fit
- Transverse locking holes to allow use of one nail in either left or right extremity
- Conical threads for secure connection to insertion/extraction instruments
- Patented keystone* slot to prevent spreading of proximal end when connected to instruments
- Full length slot for flexibility
- 1.3 mm wall thickness of 316L stainless steel for strength with flexibility
- Cloverleaf cross section facilitates interference fit in the medullary canal
- Multiple locking options

Universal Tibial Nail features:
- Tapered distal tip to prevent penetration of posterior cortex during insertion, and to glide easily through medullary canal
- One dynamic and two static transverse locking holes proximally
- Two transverse locking holes and additional AP locking hole distally
- Anatomically correct 11° bend[1] and longer, flat proximal bend for correct insertion fit
- Beveled proximal end to prevent soft tissue irritation
- Wide range of available sizes: 10 mm–14 mm diameters and 255 mm–420 mm lengths



1 Heini PF. Untersuchung der Tibia-Innenform in Zusammenhang mit der Marknagelung. Dissertation. University of Bern, Switzerland; 1987.
* Keystone slot is covered under U.S. patent 4,628,920 and other patents.

Universal Femoral Nail features:
- Static and dynamic transverse locking holes proximally
- Two static transverse locking holes distally
- 1.5 m radius of curvature to approximate the average anatomic curve of the femur[2]
- A wide range of available sizes: 10 mm–19 mm diameters and 300 mm–480 mm lengths

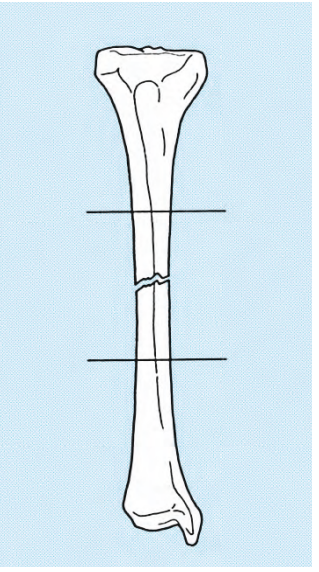


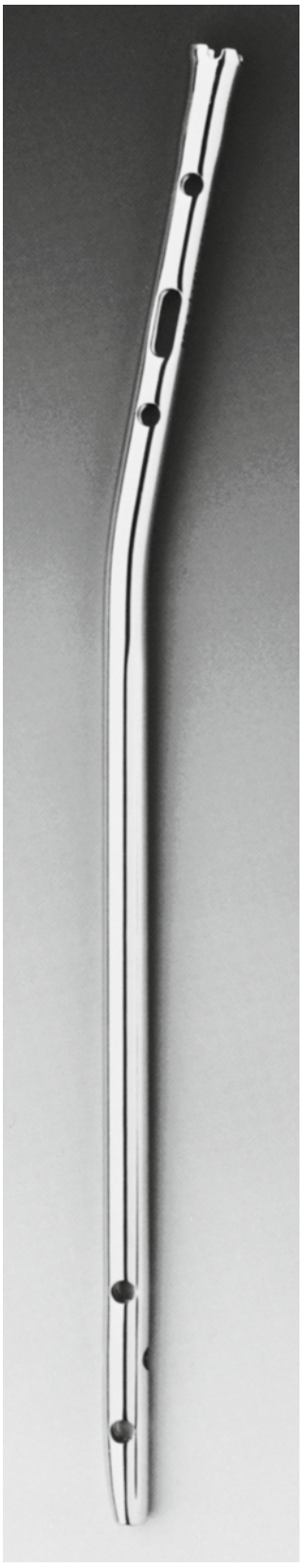
4.9 mm Locking Bolt features:
- One diameter bolt for all applications using universal nails
- 4.9 mm thread diameter, engages bone and nail for superior holding capacity
- Fully-threaded shaft for easier insertion and extraction
- 4.3 mm core diameter for greater strength
- Low head profile for areas with minimal soft tissue coverage
- Self-cutting trocar tip to eliminate tapping

2 Zuber K, Eulenberger J, Schneider E, Perren SM. "Anatomical curvature of the femoral canal for intramedullary roddings." In: Biomechanics and Applied Research: Selected Proceedings of the 5th Meeting of the European Society of Biomechanics. 423–428. Berlin: Springer; 1987.

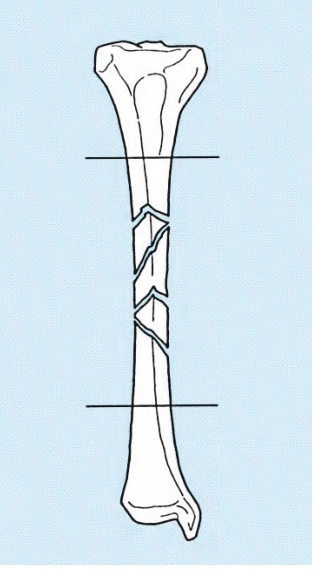
INDICATIONS AND CONTRAINDICATIONS

Indications:
- Tibia fractures with bony support (stable fracture in the middle third of the tibia, with or without locking):
- transverse fractures
- short oblique fractures
- pseudarthroses





Indications for Locking Technique Tibia fractures without bony support (unstable fractures in 60% of the tibial length):
- fractures near the metaphysis
- long torsional fractures
- segmental fractures
- comminuted fractures
- fractures with bone defects



Contraindications
- No specific contraindications

PREOPERATIVE CONSIDERATIONS

NAIL SELECTION

Although definitive nail length and diameter are determined intraoperatively, nail selection should be part of the preoperative plan.

An approximate nail length is determined by measuring the patient from the knee joint to the ankle joint and subtracting 2 cm.

An approximate nail diameter is determined by measuring the isthmus of the affected medullary canal from an X-ray. If the isthmus is obliterated by the fracture pattern, a measurement is made from the contralateral side.

The Universal Tibial Nail Ruler, found in the Preoperative Planning Kit, may also be used to determine approximate nail size. The ruler depicts the nails 15 % larger than actual size, to compensate for the magnification which occurs when taking an X-ray at the standard tube-to-film distance of one meter. Placing the ruler directly over the preoperative X-ray of the uninjured leg provides an estimation of nail length and diameter.

Based on these measurements, a minimum of three diameters of nails in three lengths should be made available for surgery.

PATIENT POSITIONING

The fracture may be reduced using open or closed technique. Closed reduction is the preferred method, with the patient in the supine position on a fracture table or radiolucent operating table. An image intensifier is needed.

Correction of rotation and reduction should be carried out before sterile draping, because it may be difficult to achieve reduction intraoperatively.

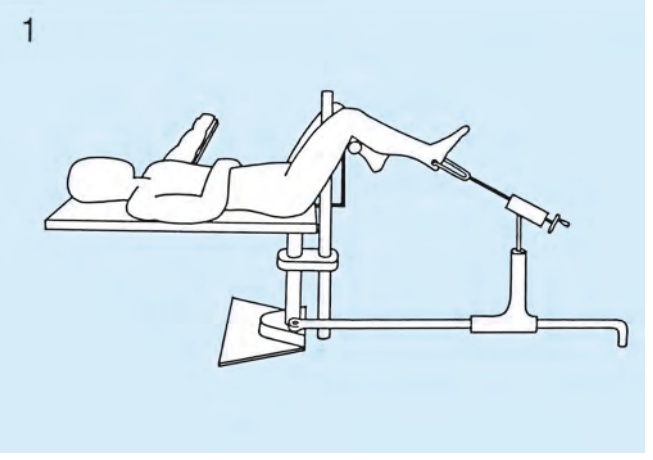
1

Positioning on a Fracture Table

The patient is placed in the supine position, with the injured leg flexed 90° at the knee. The foot of the injured leg is placed in a cushioned boot, or supported by a calcaneal traction pin. For distal locking, the calcaneal traction pin must be used since the shoe extends too far proximally.

The uninjured leg is positioned to allow free movement of the image intensifier from the AP to the lateral plane. The leg may either be extended, or flexed and abducted. The foot is placed in a cushioned boot.

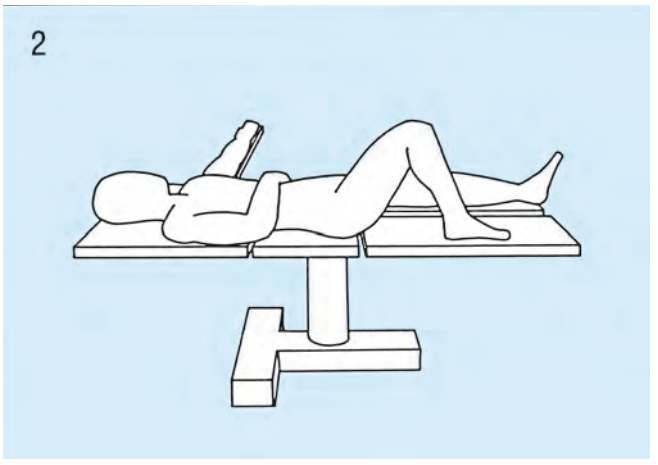
It is important that the popliteal fossa be well-cushioned; any pressure should act against the thigh.



2

Positioning on a Standard Table

The operating table must be radiolucent. The patient is placed in the supine position. The injured leg is positioned freely, with the knee flexed 90°. The uninjured leg is extended. The table should be adjusted to a comfortable operating height for the surgeon.

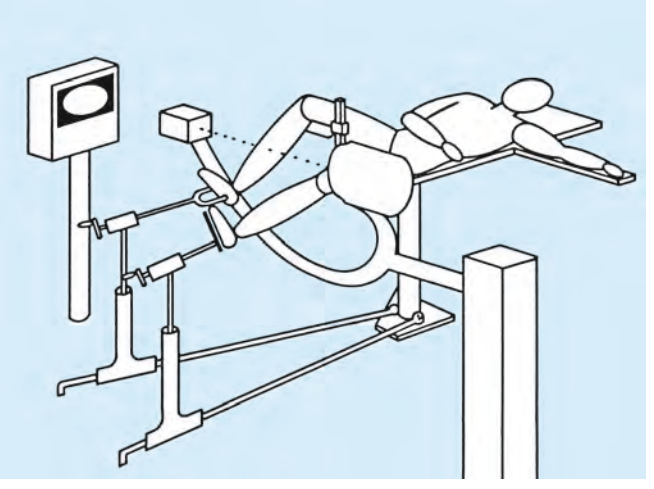


Use of the Image Intensifier

- An image intensifier is required for both closed reduction and distal locking techniques. The image intensifier allows controlled viewing of the fracture zone for insertion of the reaming rod, medullary reamer heads and universal nail.

- Proper positioning of the image intensifier is extremely important for locating the distal locking holes. With the patient in the supine position, the radiation source should be placed laterally to facilitate the aiming process, which is performed medially.

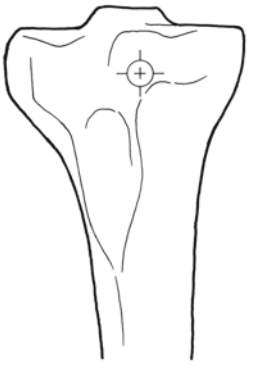
Note: **The required working distance between the medial aspect of the tibia and the receiver is 47 cm.**

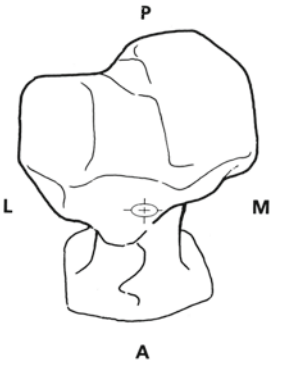


NAIL INSERTION

Entry Point

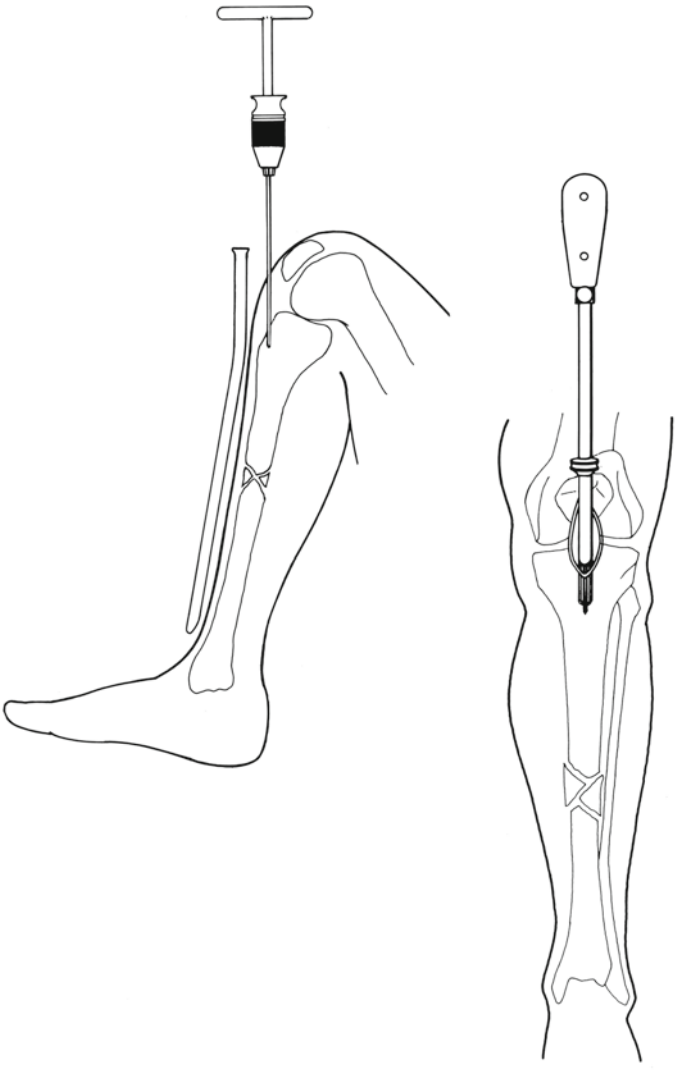
Selecting the proper entry point is important to prevent rotation of the nail during insertion (especially with proximal metaphyseal fractures). The entry point should be over the midline of the medullary canal (in most patients, slightly medial to the tibial tubercle) and as superior as possible without causing damage to the anterior edge of the tibial plateau.





Opening the Medullary Canal

Instruments	
393.100	Universal Chuck with T-Handle
351.060	Centering Pin ∅ 4.0 mm, length 400 mm, for No. 351.240
351.240	Cutter for UTN/CTN and for Universal Medullary Nail, ∅ 11.0 mm, length 350 mm
351.260	Protection Sleeve, for No. 351.240

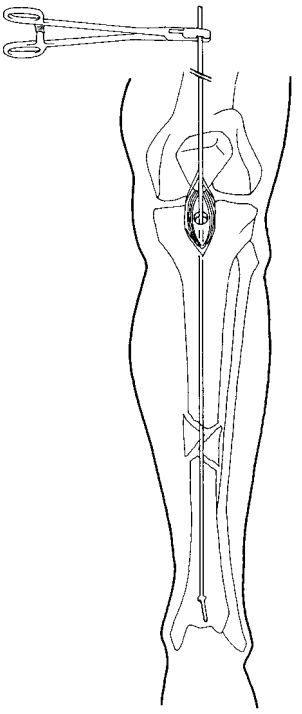


Make a longitudinal incision over the patellar tendon, and retract the tendon laterally. (In some patients, a patellar tendon-splitting technique may be used to access the entry point.) Using the Universal Chuck with T-Handle, insert a 4.0 mm Centering Pin into the entry point. Pass it distally, angled 15° in the sagittal plane to the axis of the tibial shaft, into the proximal aspect of the medullary canal. A sterile nail may be placed against the anterior aspect of the tibial crest to act as a guide to the correct angle of insertion of the centering pin. Verify placement with the image intensifier. Pass the 11 mm Cannulated Cutter and Protection Sleeve over the pin. With the Protection Sleeve pressed against the bone, manually rotate the cutter to carve the opening into the medullary canal. Tighten the setscrew at the base of the cutter handle onto the pin, and remove the cannulated cutter, sleeve and centering pin.

Note: **For pseudarthroses or hypertrophic nonunions, use the hand reamers sequentially to open the canal.**

Inserting the Reaming Rod

Under image intensification, insert the 2.5 mm Reaming Rod into the canal, across the fracture site, and into the distal metaphysis. The Universal Chuck with T-Handle may be used to facilitate insertion. The Holding Forceps is used to control the reaming rod.



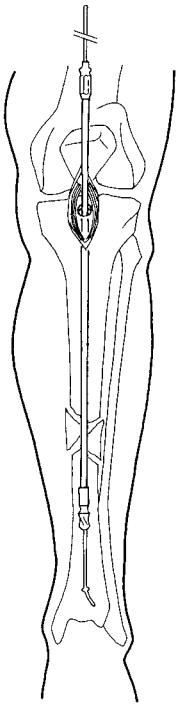
Reaming the Medullary Canal

Use the SynReam Flexible Shaft with the front-cutting 8.5 mm Medullary Reamer Head to begin reaming. To protect the soft tissue, place the Tissue Protector posterior to the flexible shaft.

Reaming progresses in 0.5 mm increments using the interchangeable Medullary Reamer Heads.

The diameter of the nail to be used will match the diameter of the last reamer head used. Overreaming the medullary canal is not absolutely necessary.

Refer to the SynReam surgical technique DSEM/TRM/0614/0103 for further information.

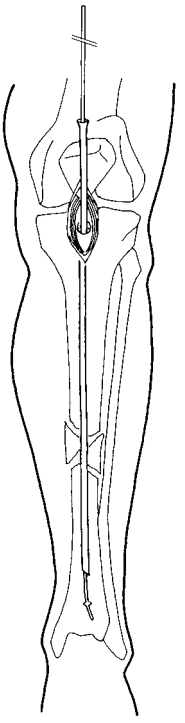


Measuring for the Nail
One of two methods can be used to measure for nail length:

a Determine the appropriate nail length by subtracting the exposed length of the reaming rod from its overall length of 950 mm. If using a calibrated reaming rod, read the appropriate nail length directly from the rod at the tibial entry point. If the measurement falls between two calibrated lengths, choose the shorter length nail.

Use the Radiographic Ruler after reduction or on the
C contralateral leg. Position the image intensifier for an AP view of the distal tibia. Holding the ruler with a long forceps, place it against the tibia with the distal tip at the level of the physeal scar, or at the desired nail depth; mark the skin at this point. Move the C-arm proximally to the level of the tibial plateau. Reposition the ruler against the tibia with the distal tip at the mark. Under image intensification, read the nail length directly from the ruler, choosing the nail length that is at or just below the level of the entry point.

Confirm the diameter of the selected nail with the Measuring Gauge.

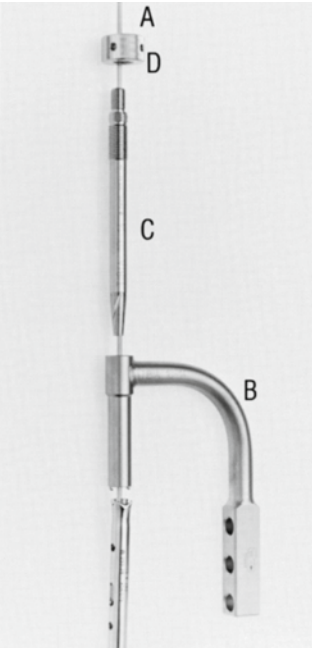


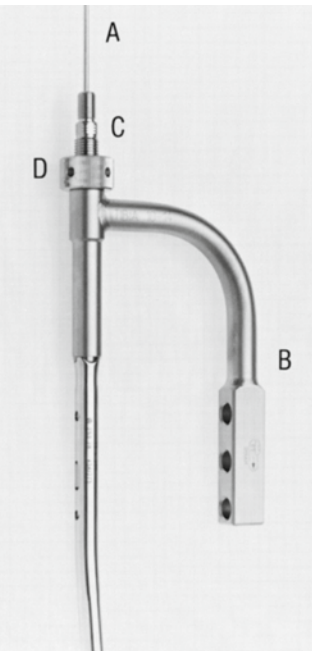
Assembling the Insertion Instrumentation

The Insertion Handle

Instruments	
355.470	Nut, knurled, for Tibial Medullary Nails ∅ 10.0 to 14.0 mm
355.440	Threaded Bolt, conical, for Tibial Medullary Nails ∅ 10.0 to 14.0 mm
355.410	Insertion Handle, for Tibial Medullary Nails ∅ 9.0 to 14.0 mm

The Insertion Handle guides the nail and controls rotation during insertion. Although the Insertion Handle is usually oriented medially throughout the procedure, it may be rotated laterally (180°) for easier insertion. If the nail is to be locked, the Insertion Handle must be oriented medially; it is then used as an aiming device for inserting the medial-to-laterally placed proximal locking bolts.





Standard Insertion Assembly

Instruments	
355.180	Driving Head
355.160	Driving Piece, curved

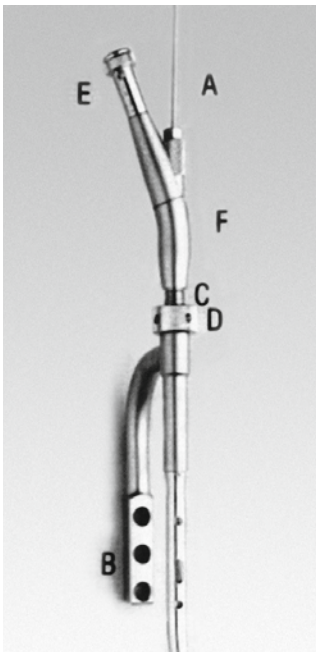
1
Slide the tibial nail over the 2.5 mm Reaming Rod (A). Manually insert the nail into the medullary canal as far as possible.

2
Orient the Insertion Handle (B) medially on the nail. The tabs of the Insertion Handle must engage the positioning notches of the nail.

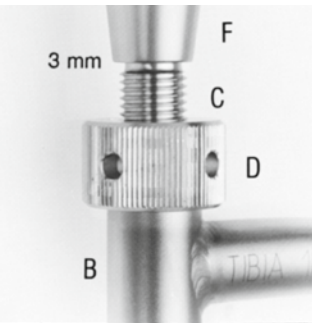
3
Pass the Threaded Conical Bolt (C) through the Insertion Handle, and screw into the proximal end of the nail.

Note: **Unlike the Universal Femoral Nail instrumentation, the conical bolt cannot be threaded into the Universal Tibial Nail before the Insertion Handle is in position. The conical bolt must be placed through the Insertion Handle first.**

4
Tighten the conical bolt with the Combination Wrench or Cannulated Socket Wrench. Do not overtighten. Mount the Locking Nut (D) onto the conical bolt, and tighten the nut with the 4.5 mm Pin Wrench.



Standard Insertion Assembly



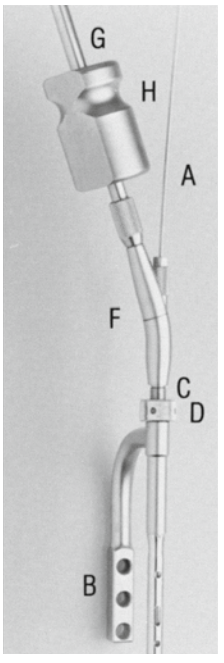
5

Mount the Driving Head (E) onto the Curved Driving Piece (F). Unscrew the knurled threaded sleeve until a thread end is visible. This will allow the driving piece to be positioned over the hex head of the conical bolt. The Curved Driving Piece must be positioned so it allows the driving force to be transmitted parallel to the long axis of the tibia, (i.e., parallel to the distal portion of the nail). Screw in the knurled threaded sleeve to secure the conical bolt in the driving piece.

Note: When tightening the Curved Driving Piece, leave 3 mm of clearance between the Curved Driving Piece and the first thread of the conical bolt. This will eliminate the chance of damaging the proximal threads of the conical bolt during nail insertion.

Alternate Insertion Assembly

The Ram Guide (G) and Ram (H) may also be used to insert the Universal Tibial Nail. Follow steps 1–4 (on the previous page), then screw the Curved Driving Piece with the Ram Guide onto the Threaded Conical Bolt. Slide the Ram over the Ram Guide, and screw the Grip (not shown) onto the upper end of the Ram Guide.



Alternate Insertion Assembly

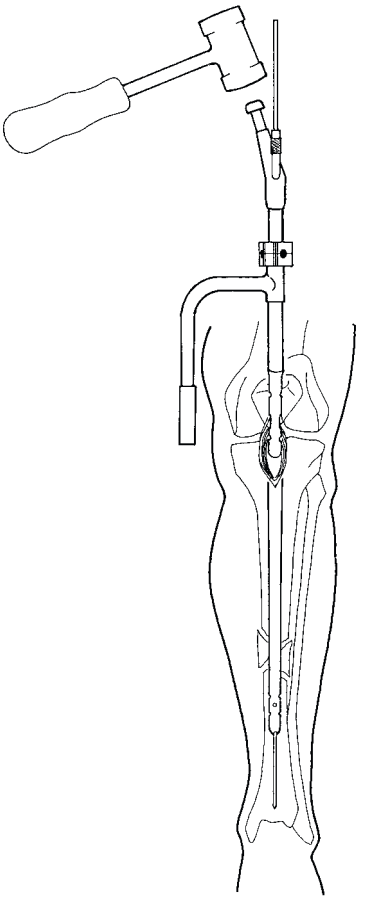
Inserting the Nail

Using the 700 g Hammer (or Ram assembly), drive the nail into the canal with measured blows. The image intensifier should be used to monitor the passage of the nail across the fracture site. Control rotation of the nail using the Insertion Handle.

Note: **If the nail is rotating, the Insertion Handle may be placed laterally for increased guidance and control. Loosen the Locking Nut, and disengage the Insertion Handle from the positioning notches of the nail. Rotate the Insertion Handle 180°, taking care to re-engage the Insertion Handle's tabs with the nail's positioning notches. Tighten down the Locking Nut with the pin wrench and retighten as necessary during nail insertion.**

The nail should advance into the medullary canal with each blow of the Hammer. If resistance is encountered, remove the nail and ream the canal an additional 0.5 mm. Reinsert the nail.

As the bend in the nail passes the insertion point, the surgeon will feel a release of tension. Insert the proximal nail end below the bone surface. When the nail is fully seated, remove the Curved Driving Piece and Driving Head (or Ram assembly) and reaming rod.



Removing the Threaded Conical Bolt

Instruments	
355.470	Nut, knurled, for Tibial Medullary Nails ∅ 10.0 to 14.0 mm
355.440	Threaded Bolt, conical, for Tibial Medullary Nails ∅ 10.0 to 14.0 mm
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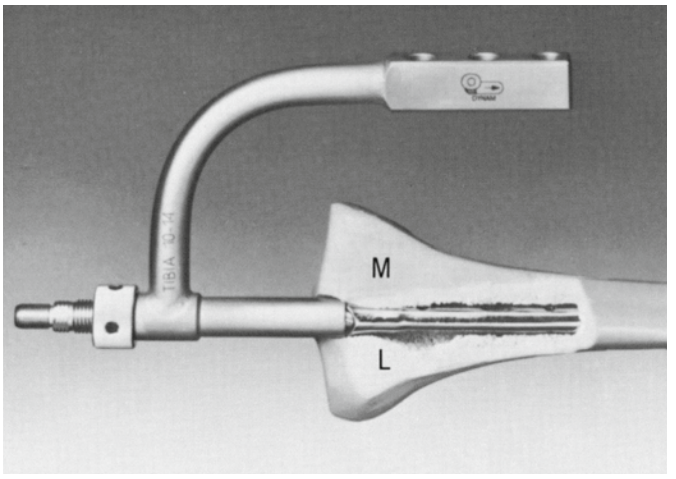


If the nail will not be locked proximally, remove the Insertion Handle assembly. Use the pin wrench to loosen the Locking Nut one-half turn. While holding the Insertion Handle firmly, remove the conical bolt with the Combination Wrench or the Cannulated Socket Wrench.

Note: **These instructions must be followed to prevent cross-threading of the conical bolt in the nail. See "Special Techniques," page 46, for more information.**

If the nail will be locked, the Insertion Handle, Threaded Conical Bolt and Locking Nut remain on the nail. The Insertion Handle must be oriented medially to place the proximal locking bolts, and should be reoriented to that position if necessary.

DISTAL LOCKING

Several distal locking technique options are available to the surgeon. The Radiolucent Drive provides a convenient technique for targeting and drilling the distal locking holes. The Radiolucent Drive reduces the working distance from the incision, offers less restricted positioning when using the image intensifier, and reduces operative time.

Alternatively, the locking technique with the Distal Aiming Device requires a minimum working distance of 47 cm between the receiver and the patient's leg; see page 39. If less working distance is available, see the alternative drilling technique ("Drilling in Two Steps") on page 44. As a further option, the 4.0 mm/4.5 mm Drill Bit (355.900) may be used to drill for distal locking in the standard freehand fashion.

The distal holes are locked first to maintain limb length and control rotation of the distal fragment.

The Universal Tibial Nail has three distal locking holes. Two holes are oriented mediolaterally (ML), and one hole is oriented anteroposteriorly (AP). Usually, locking is accomplished with two bolts, inserted medial to lateral. The chart below offers other locking options for special circumstances.

Distal Locking Combination Options

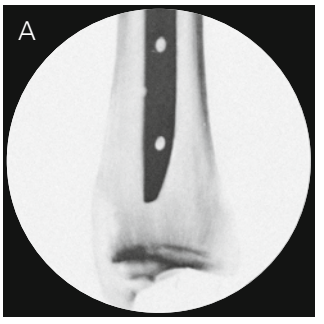
Special Circumstances	Proximal ML Hole	AP Hole	Distal ML Hole
Insufficient soft tissue coverage of most distal locking bolt head	X	X	
Distal fractures		X	X
Insufficient soft tissue coverage of both medial locking bolt heads (comminuted midshaft fractures only)		X	

Distal Locking with the Radiolucent Drive

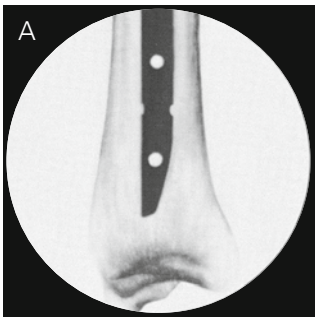
The Radiolucent Drive works with the image intensifier to target and drill the distal locking holes.

1

Align the image intensifier with the most distal hole in the nail. Adjust until a perfect circle is visible (Fig. A).



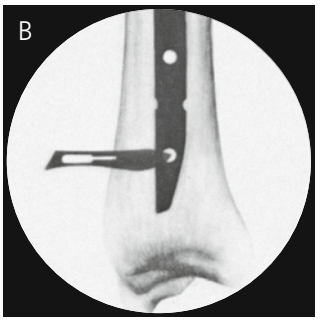
Incorrect position



Correct position

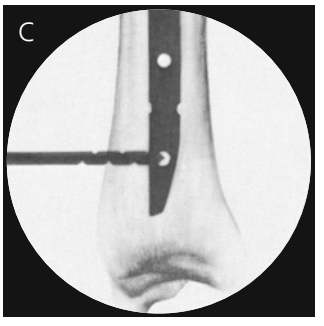
2

Under image intensification, place a scalpel on the skin with the tip of the blade over the center of the hole to determine the stab incision point. Make a stab incision (Fig. B).



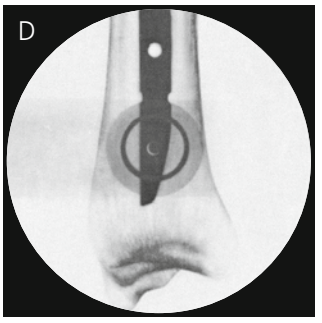
3

Insert the special 4.0 mm Three-Fluted Drill Bit (511.417) into the Radiolucent Drive. Under image intensification, place the tip of the drill bit oblique to the X-ray beam, into the stab incision and onto the tibia, until the tip of the drill bit is centered in the locking hole image (Fig. C).



4

Tilt the drive until the drill bit is in line with the X-ray beam and appears as a radiopaque solid circle in the center of the outer ring. The drill bit will nearly fill in the locking hole image. Hold the drill firmly in this position and drill through both cortices. Use image intensification to keep the drill bit centered in the outer ring throughout the drilling process (Fig. D).



5

Measure the hole with the Depth Gauge for locking bolts. Add 2 mm to this reading to ensure that the locking bolt will engage the far cortex. Insert the locking bolt and tighten with the hexagonal screwdriver.

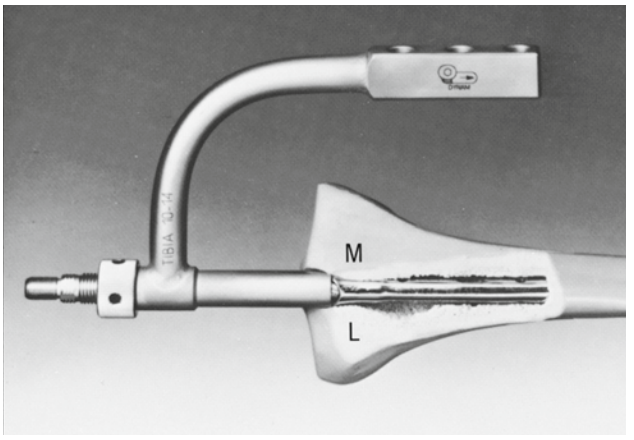
6

Reposition the image intensifier to align with the second selected hole (the second ML hole or the AP hole). Repeat steps 1 through 5 to insert a second distal locking bolt.

PROXIMAL LOCKING

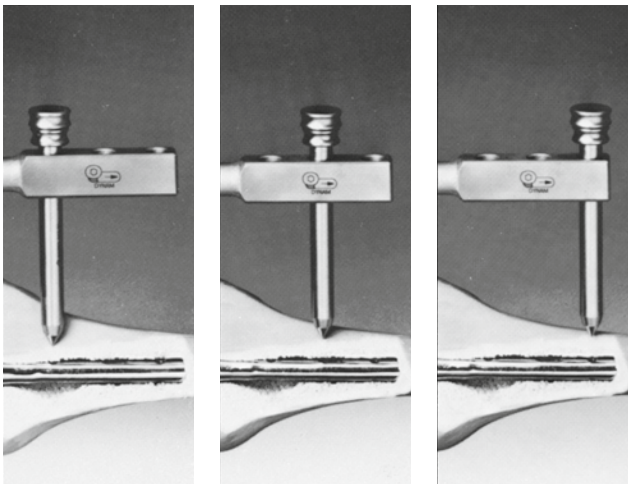
The Insertion Handle is used to locate the holes for the proximal locking bolts. The Insertion Handle must be placed medially for this procedure.

The dynamic and/or static locking bolts are placed through the holes of the Insertion Handle without image intensification. The hole for dynamic locking is marked "DYNAM." The nature of the fracture will dictate whether a dynamic and/or static locking bolt is placed.



1

Instruments	
355.750	Trocar ∅ 8.0 mm
355.700	Protection Sleeve 11.0/8.0

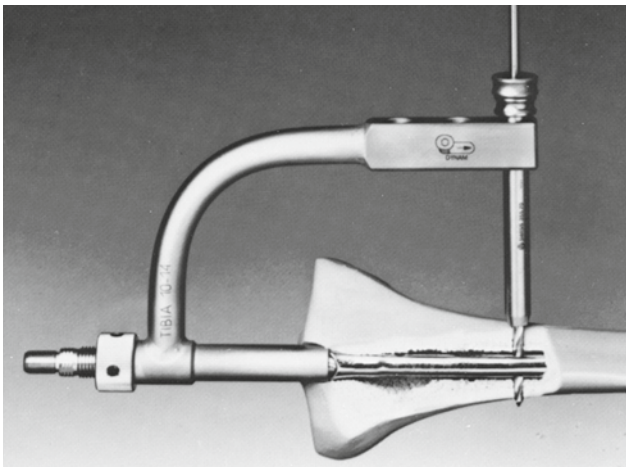


Insert the 11.0 mm/8.0 mm Protection Sleeve, with 8.0 mm Trocar inserted, through the appropriate drill hole in the Insertion Handle. Make a stab incision through the skin at the point where the trocar touches the skin. Pass the protection sleeve with trocar through the incision and onto the bone.

Remove the trocar. The protection sleeve remains in place until the locking bolt is completely inserted.

2

Instrument	
355.900	Drill Bit ∅ 4.0/4.5 mm, length 225/200 mm, 2-flute, for Quick Coupling



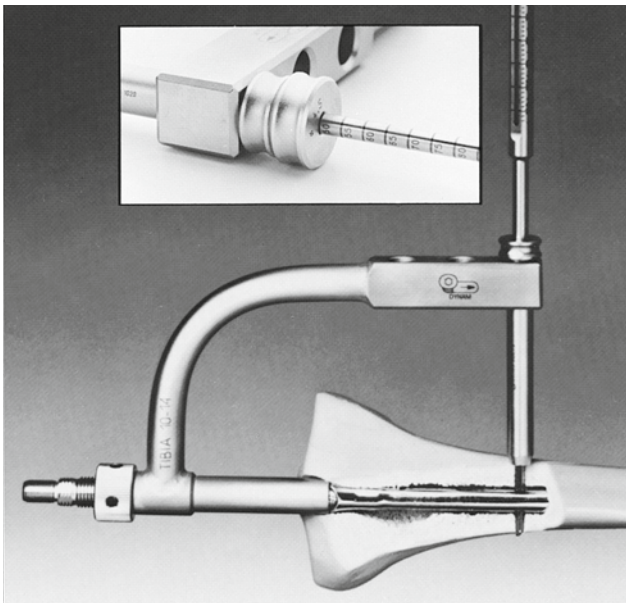
Insert the 8.0 mm/4.5 mm Drill Sleeve. Drill through both cortices using the 4.0 mm/ 4.5 mm Drill Bit.

3

Instrument	
355.790	Depth Gauge for Locking Bolts, measuring range up to 90 mm

Remove the drill sleeve. Using the Depth Gauge for locking bolts, measure for the proper length 4.9 mm Locking Bolt. Add 2 mm to the measurement to ensure engagement of the far cortex.

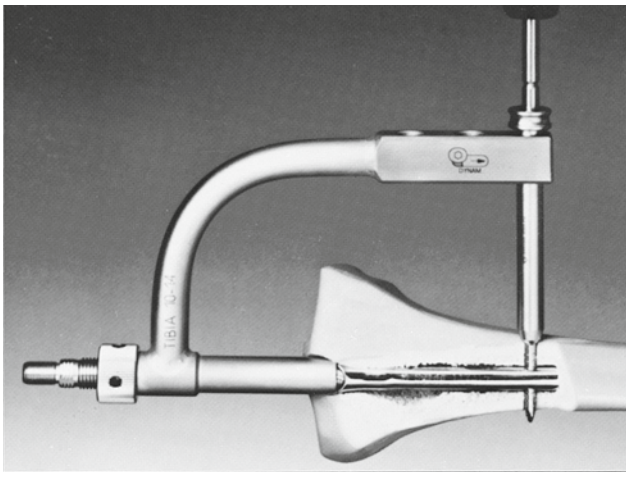
Note: **If using a calibrated drill bit, stop the drill after drilling through the far cortex. If necessary, use the image intensifier to confirm the position of the drill bit. Press the drill and protection sleeves firmly against the bone and read the correct bolt length on the calibrated drill bit at the end of the 8.0 mm/4.5 mm Drill Sleeve (see inset). Remove the drill sleeve.**



4

Insert the locking bolt through the 11.0 mm/8.0 mm Protection Sleeve.

If an additional proximal locking bolt is to be placed, repeat steps 1 through 4.



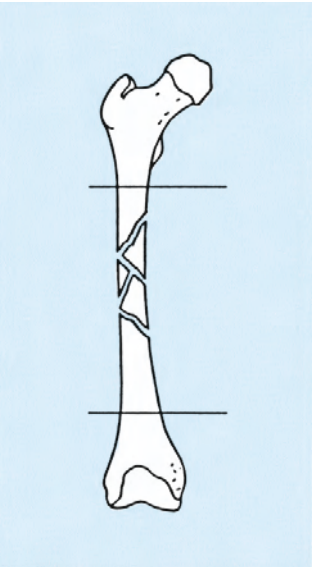
Removing the Insertion Instruments

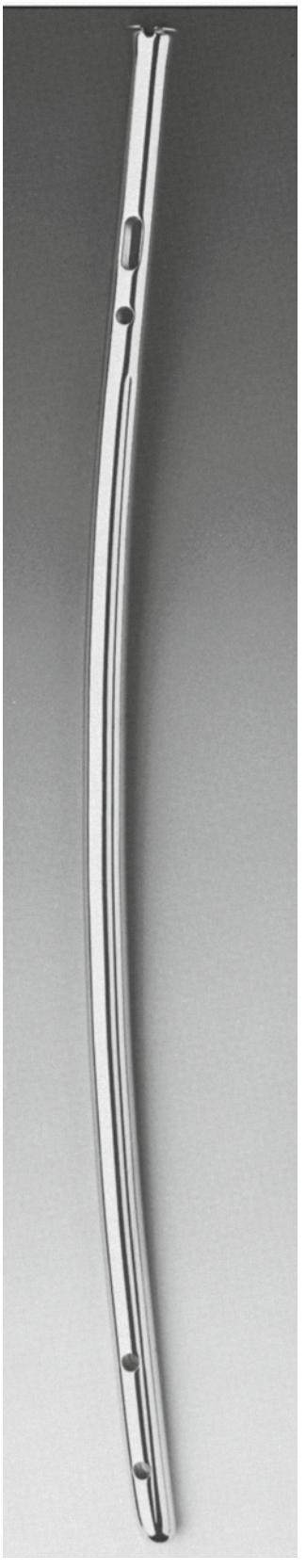
Remove the Insertion Handle assembly. Use the pin wrench to loosen the Locking Nut one-half turn. While holding the Insertion Handle firmly, remove the conical bolt with the Combination Wrench or the Cannulated Socket Wrench.

Note: **The conical bolt must be removed properly to prevent cross-threading and jamming of the conical bolt in the nail. See "Special Techniques," page 46, for more information.**

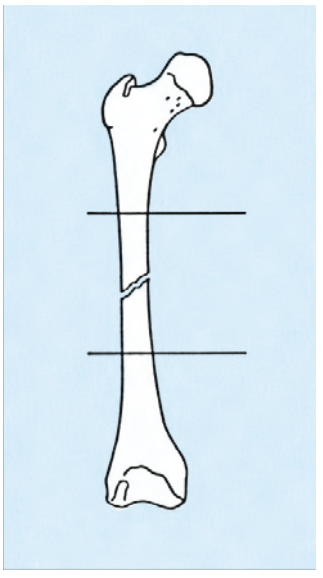
INDICATIONS

Femur fractures with bony support (stable fracture in the middle third of the femur, with or without locking):
- transverse fractures
- short oblique fractures
- pseudarthroses





Indications for Locking Technique Femur fractures without bony support (unstable fracture in 60% of the femoral length):
- fractures near the metaphysis
- long torsional fractures
- segmental fractures
- comminuted fractures
- fractures with bone defects



NAIL SELECTION

Although definitive nail length and diameter are determined intraoperatively, nail selection should be part of the preoperative plan.

An approximate nail length is determined by measuring the patient from the tip of the greater trochanter to the knee joint space and subtracting 2 cm.

An approximate nail diameter is determined by measuring the isthmus of the affected medullary canal from an X-ray. If the isthmus is obliterated by the fracture pattern, a measurement is made from the contralateral side.

The Universal Femoral Nail Ruler, found in the Preoperative Planning Kit, may also be used to determine approximate nail size. The ruler depicts the nails 15 % larger than actual size, to compensate for the magnification which occurs when taking an X-ray at the standard tube-to-film distance of one meter. Placing the ruler directly over the preoperative X-ray of the uninjured leg provides an estimation of nail length and diameter.

Based on these measurements, a minimum of three diameters of nails in three lengths should be available for surgery.

PATIENT POSITIONING

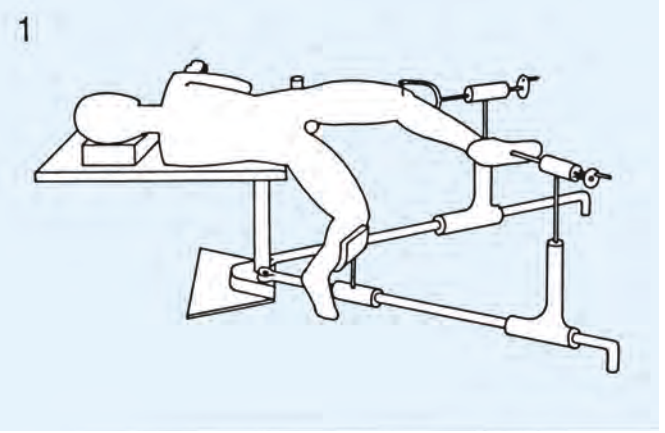
The fracture may be reduced using open or closed technique. Closed reduction is the preferred method, with the patient positioned on a fracture table or radiolucent operating table; an image intensifier is needed. Correction of rotation and reduction should be carried out before sterile draping, because it is difficult to achieve reduction intraoperatively.

1

Lateral Positioning on a Fracture Table

A fracture table with long cantilevers is used. The patient is placed in a lateral decubitus position. The pelvis is held vertical with the supports on each side of the table. The patient is slid downwards on the table until the perineum rests on a well-cushioned perineal post.

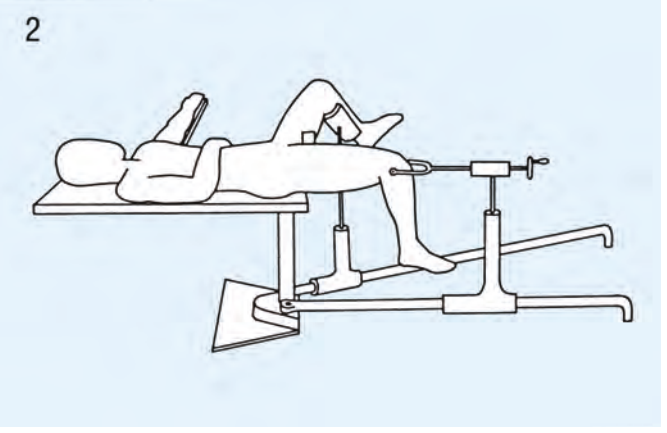
A traction pin is placed in the intercondylar area of the injured leg to apply traction and aid reduction. The foot of the injured leg is placed in a boot. The uninjured leg is flexed at the hip and knee, and supported by a brace. The uninjured leg should be externally rotated to allow the image intensifier to be adjusted freely.



2

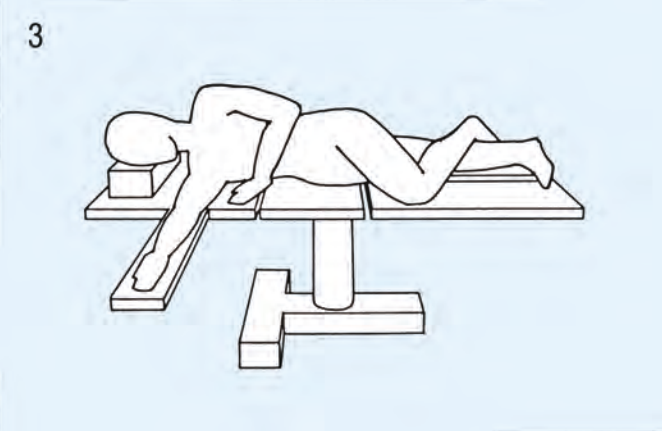
Supine Positioning on a Fracture Table

With the patient in the supine position, the leg of the injured femur is allowed to hang with the knee flexed 90°. The patient's pelvis should be positioned flat, providing correct rotational alignment of the femur. To allow access to the proximal femur, either adduct the injured leg, or shift the torso to the uninjured side, while keeping the pelvis flat. The uninjured leg is placed in a support.



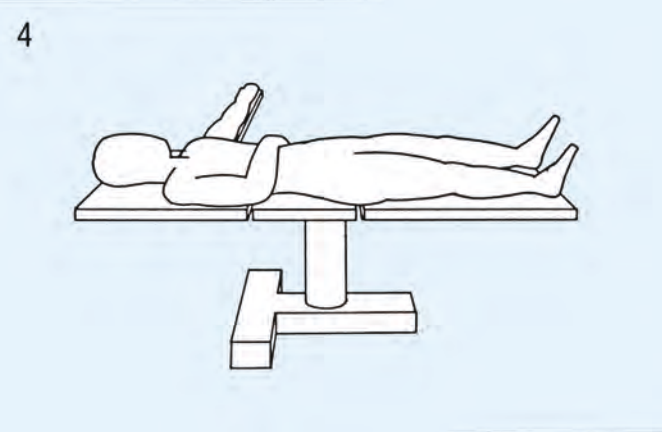
3
Lateral Positioning on a Standard Table

The operating table must be radiolucent. The patient is placed in a lateral position (a vacuum mattress may be helpful for this purpose). The injured leg is flexed forward 45°, and with the knee bent 90°, is placed over the uninjured leg. The Large Distractor is used to aid reduction and correct rotational alignment.



4
Supine Positioning on a Standard Table

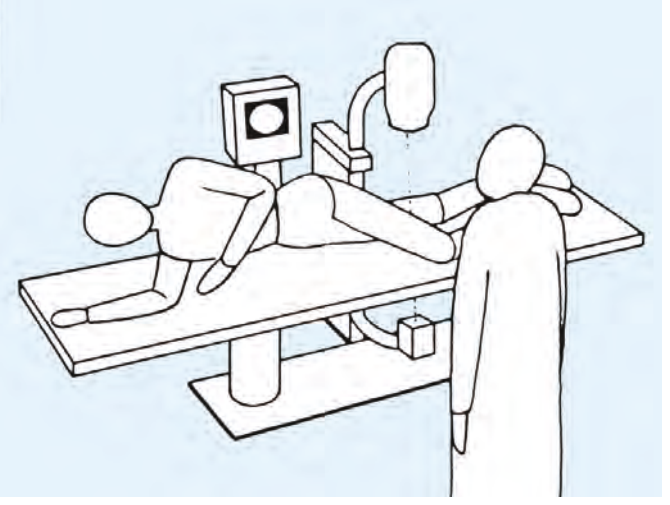
The operating table must be radiolucent. The patient is placed in a supine position. To allow access to the proximal femur, the uninjured leg is abducted as far as possible, and the injured leg is adducted. The Large Distractor is used to aid reduction and correct rotational alignment.



Use of the Image Intensifier

- An image intensifier is required for both closed reduction and distal locking techniques. The image intensifier allows controlled viewing of the fracture zone for insertion of the reaming rod, medullary reamer heads, and universal nail.

- Proper positioning of the image intensifier is extremely important for locating the distal locking holes. With the patient in the lateral decubitus or supine position, the radiation source should be placed on the medial aspect of the femur. This will facilitate the aiming process, which is performed laterally.

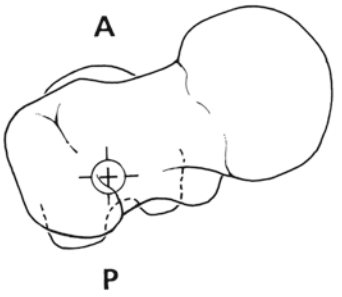


Note: **The minimum required working distance between the lateral aspect of the femur and the receiver is 47 cm.**

NAIL INSERTION

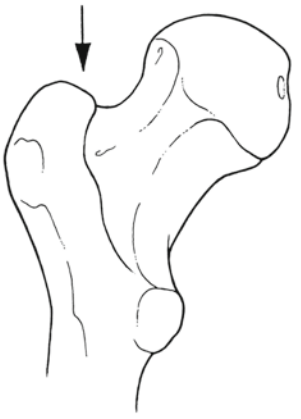
Entry Point

Selecting the proper entry point is important to prevent complications during nail insertion. This entry point differs from that of the original AO ASIF nail. Because the universal nail is slightly stiffer and more curved than the original nail, the insertion point must be in line with the medullary canal. Studies of the geometry of the medullary canal show that the ideal entry point is immediately in or just posterolateral to the piriformis fossa.



Opening the Medullary Canal

Instruments	
393.100	Universal Chuck with T-Handle
351.240	Cutter for UTN/CTN and for Universal Medullary Nail, ∅ 11.0 mm, length 350 mm
351.260	Protection Sleeve, for No. 351.240



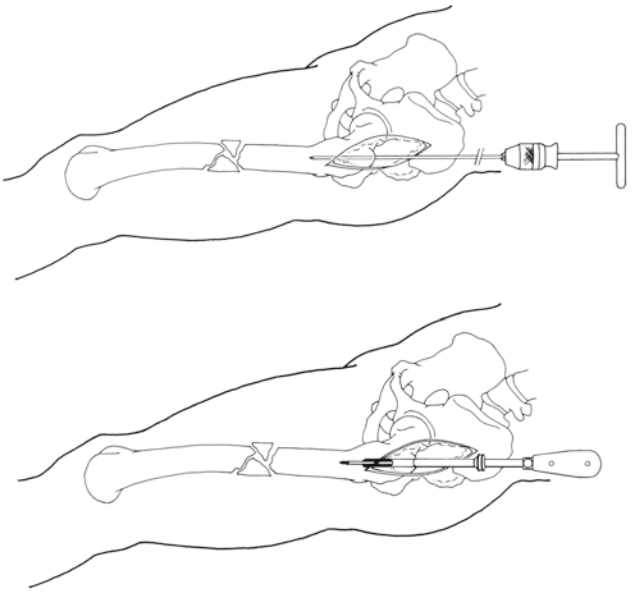
Make a longitudinal incision proximal to the greater trochanter. Either the 11.0 mm Cannulated Cutter or the awl can be used to open the medullary canal.

If the 11 mm Cannulated Cutter is used, assemble the 4 mm Centering Pin in the Universal Chuck with T-Handle. Place the tip of the pin at the correct entry point. Rotate the centering pin to penetrate the medullary canal. Verify placement with image intensification. Remove the universal chuck.

Pass the 11 mm Cannulated Cutter and Protection Sleeve over the centering pin. Rotate the cannulated cutter and open the medullary canal to a minimum depth of 5 cm. (Image intensification may be required.) When the canal is penetrated, fix the centering pin in the cannulated cutter by tightening the setscrew at the base of the handle. Remove the cannulated cutter/centering pin assembly.

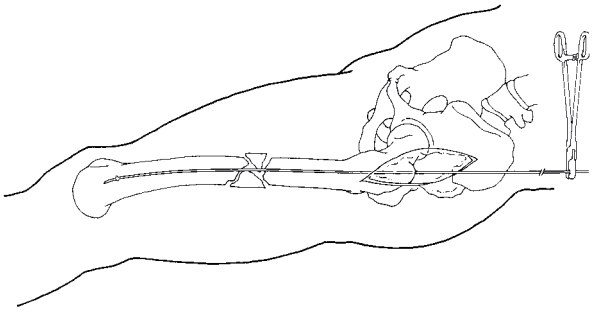
If the awl is used, place its tip at the correct entry point, and turn it to open the medullary canal.

Note: **For pseudarthroses or hypertrophic non-unions, use hand reamers sequentially to open the canal.**



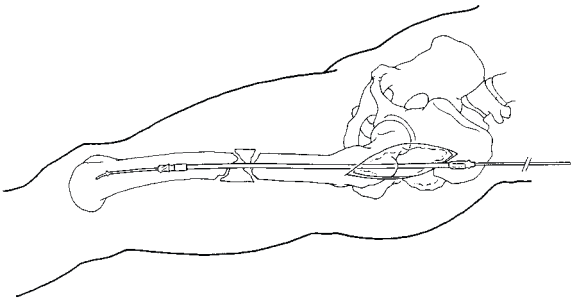
Inserting the Reaming Rod

Under image intensification, insert the 2.5 mm Reaming Rod into the canal, across the fracture site, and into the distal metaphysis. The Universal Chuck with T-Handle may be used to facilitate insertion. The Holding Forceps is used to control the reaming rod.



Reaming the Medullary Canal

Use the SynReam Flexible Shaft with the front-cutting 8.5 mm Medullary Reamer Head to begin reaming. To protect the soft tissue, place the Tissue Protector medial to the flexible shaft.



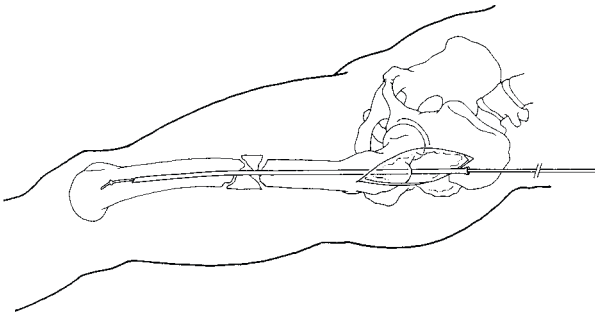
Reaming progresses in 0.5 mm increments using the interchangeable Medullary Reamer Heads.

The diameter of the nail to be used will match the diameter of the last reamer used. Overreaming the medullary canal by 0.5 mm–1.0 mm facilitates nail insertion but is not absolutely necessary.

Refer to the SynReam surgical technique DSEM/TRM/0614/0103 for further information.

Measuring for the Nail

Determine the appropriate nail length by subtracting the exposed length of the reaming rod from its overall length of 950 mm. Confirm the diameter of the selected nail with the Measuring Gauge. If using a calibrated reaming rod, read the appropriate nail length directly from the rod at the femoral entry point. If the measurement falls between two calibrated lengths, choose the shorter length nail.



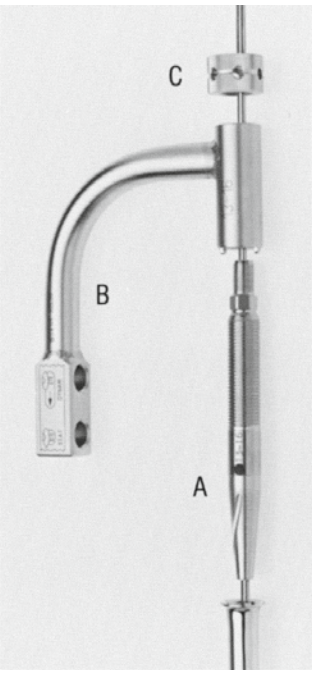
Assembling the Insertion Instrumentation

Instruments	
355.490	Insertion Handle, for Femoral Medullary Nails ∅ 9.0 to 12.0 mm
355.500	Insertion Handle, for Femoral Medullary Nails ∅ 13.0 to 16.0 mm
355.510	Insertion Handle, for Femoral Medullary Nails ∅ 17.0 to 19.0 mm
355.570	Nut, knurled, for Femoral Medullary Nails ∅ 9.0 to 12.0 mm
355.580	Nut, knurled, for Femoral Medullary Nails ∅ 13.0 to 16.0 mm
or	
355.590	Nut, knurled, for Femoral Medullary Nails ∅ 17.0 to 19.0 mm
355.530	Threaded Bolt, conical, for Femoral Medullary Nails ∅ 9.0 to 12.0 mm
355.540	Threaded Bolt, conical, for Femoral Medullary Nails ∅ 13.0 to 16.0 mm
355.500	Insertion Handle, for Femoral Medullary Nails ∅ 13.0 to 16.0 mm

The Insertion Handle
The Insertion Handle guides the nail and controls rotation during insertion. If the nail is locked, the Insertion Handle is also used as an aiming device for inserting the proximal locking bolts.

Standard Insertion Assembly

Instruments	
355.280	Handle, for No. 355.220
355.220	Hammer Guide, cannulated, for Universal Medullary Nails
355.250	Ram



1

Slide the femoral nail over the 2.5 mm Reaming Rod. Manually insert the nail into the medullary canal as far as possible.

2

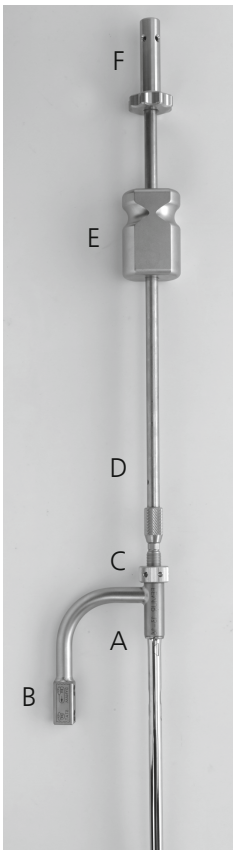
Screw the Threaded Conical Bolt (A) into the proximal end of the nail. Pass the Insertion Handle (B) over the bolt. Be sure to use the conical bolt and Insertion Handle that correspond to the diameter of the nail to be inserted. The Insertion Handle should be oriented laterally, and its tabs must engage the positioning notches of the nail.

3

Using the Insertion Handle to control nail rotation, tighten the conical bolt with the Combination Wrench or Cannulated Socket Wrench. Mount the appropriate Locking Nut (C) onto the conical bolt, and tighten with the 4.5 mm Pin Wrench.

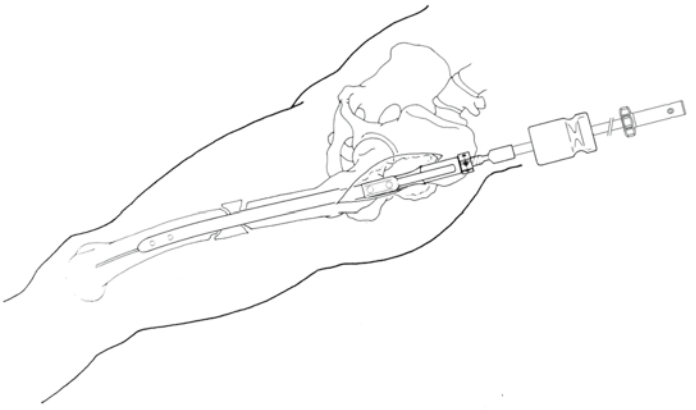
4

Pass the Ram Guide (D) over the guide rod, and screw it onto the proximal end of the conical bolt. Slip the Ram (E) over the Ram Guide and screw the Grip (F) onto the upper end of the Ram Guide.



Inserting the Nail

With controlled blows of the Ram, insert the nail into the canal. To prevent the guide rod from backing out, the Guide Rod Retainer may be inserted into the Ram Guide. Image intensification should be used to monitor the passage of the nail across the fracture. Control rotation of the nail using the Insertion Handle.

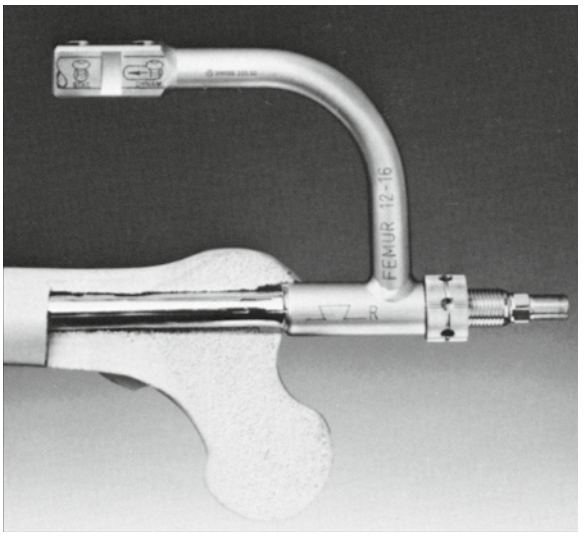


The nail should advance in the medullary canal with each blow of the Ram. If resistance is encountered, remove the nail and ream the canal an additional 0.5 mm to 1 mm.

When the nail is fully seated, remove the Ram Guide Assembly and guide rod.

Removing the Threaded Conical Bolt

If the nail will not be locked, remove the Insertion Handle assembly. Use the pin wrench to loosen the Locking Nut one-half turn. While holding the Insertion Handle firmly, remove the conical bolt with the Combination Wrench or the Cannulated Socket Wrench.



Note: **These instructions must be followed to prevent cross-threading of the conical bolt in the nail. See "Special Techniques," page 46, for more information.**

If the nail will be locked, the Insertion Handle, Threaded Conical Bolt and Locking Nut remain on the nail.

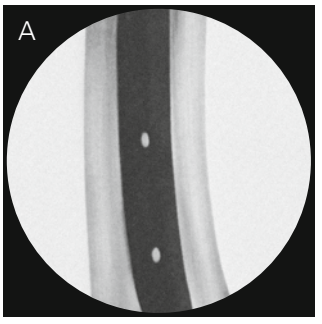
DISTAL LOCKING

Distal Locking with the Radiolucent Drive

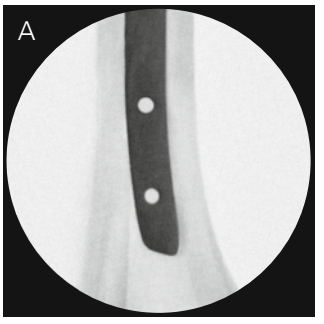
The Radiolucent Drive works with the image intensifier to target and drill the distal locking holes.

1

Align the image intensifier with the most distal hole in the nail. Adjust until a perfect circle is visible (Fig. A).



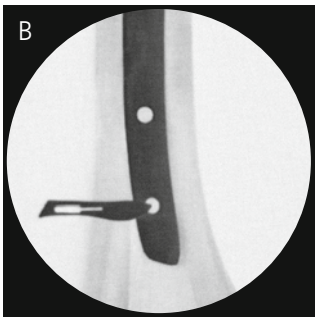
Incorrect position



Correct position

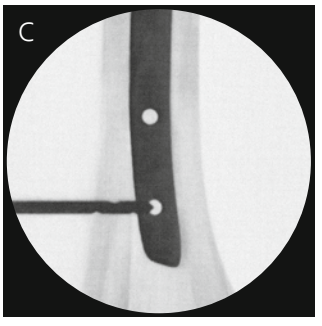
2

Under image intensification, place a scalpel on the skin with the tip of the blade over the center of the hole to determine the stab incision point. Make a stab incision (Fig. B).



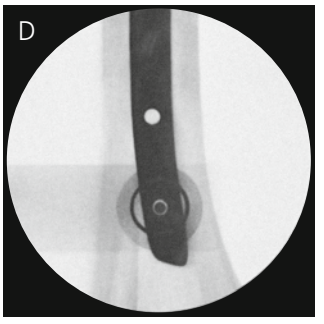
3

Insert the special 4 mm Three-Fluted Drill Bit (511.417) into the Radiolucent Drive. Under image intensification, place the tip of the drill bit oblique to the X-ray beam, into the stab incision and onto the femur, until the tip of the drill bit is centered in the locking hole (Fig. C).



4

Tilt the drive until the drill bit is in line with the X-ray beam and appears as a radiopaque solid circle in the center of the outer ring. The drill bit will nearly fill in the locking hole. Hold the drill firmly in this position and drill through both cortices. Use image intensification to keep the drill bit centered in the outer ring throughout the drilling process (Fig. D).



5

Measure the hole with the Depth Gauge for locking bolts. Add 2 mm to this reading to ensure that the locking bolt will engage the far cortex. Insert the locking bolt and tighten with the hexagonal screwdriver.

6

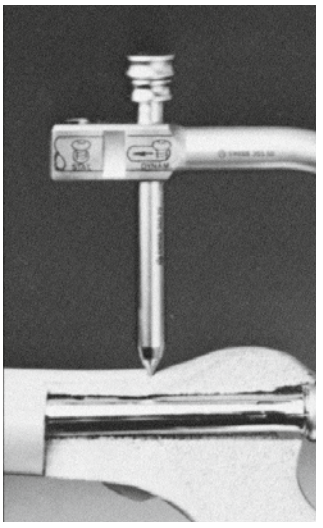
Reposition the image intensifier to align with the second distal hole, and repeat steps 1 through 5.

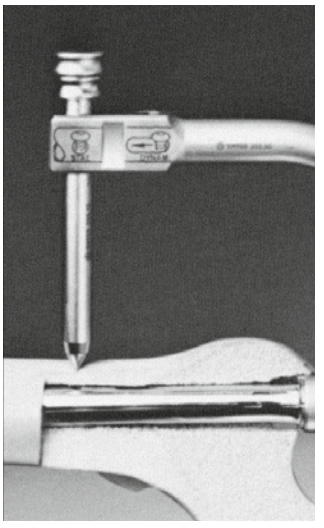
Alternative Distal Locking Techniques

Several alternative techniques are available to the surgeon for distal locking if the Radiolucent Drive is not available. The Distal Aiming Device requires a minimum working distance of 47 cm between the receiver and the patient's leg; see page 39. If less distance is available, see "Drilling in Two Steps" on page 44, or use a 4 mm/ 4.5 mm Drill Bit (355.900) for standard freehand technique.

PROXIMAL LOCKING

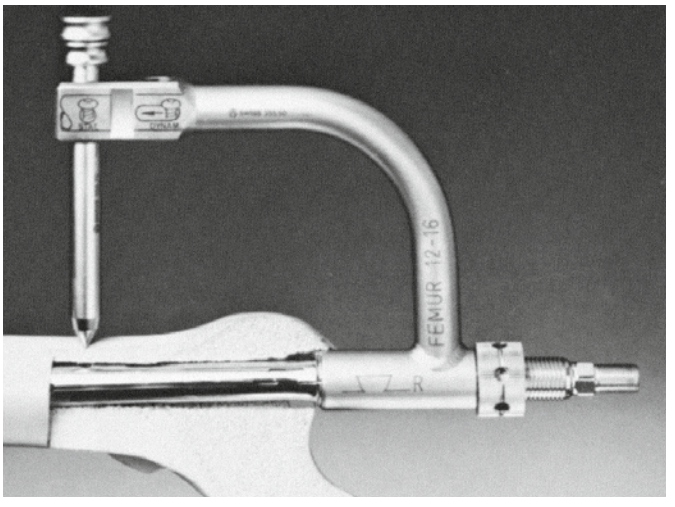
The Insertion Handle is used to locate the holes for the proximal locking bolts. The dynamic and/or static locking bolts are placed through the holes of the Insertion Handle without image intensification. The holes are marked "DYNAM" for dynamic locking, and "STAT" for static locking. The nature of the fracture will dictate whether a dynamic and/or static locking bolt is placed.





1

Instruments	
355.750	Trocar ∅ 8.0 mm
355.700	Protection Sleeve 11.0/8.0



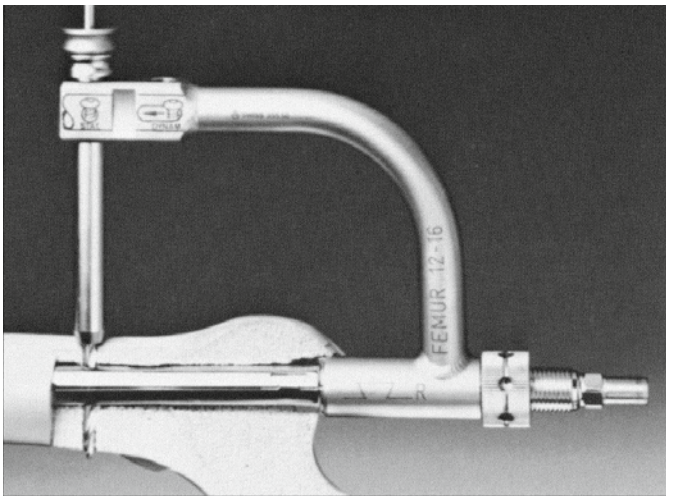
Insert the 11 mm/8 mm Protection Sleeve, with 8 mm Trocar inserted, through the appropriate drill hole in the Insertion Handle. Make a stab incision through the skin at the point where the trocar touches the skin. Pass the protection sleeve with trocar through the incision and onto the bone.

Remove the trocar. The protection sleeve remains in place until the locking bolt is completely inserted.

2

Instruments	
355.900	Drill Bit ∅ 4.0/4.5 mm, length 225/200 mm, 2-flute, for Quick Coupling
355.710	Drill Sleeve 8.0/4.5

Insert the 8 mm/4.5 mm Drill Sleeve. Drill through both cortices using the 4 mm/4.5 mm Drill Bit.

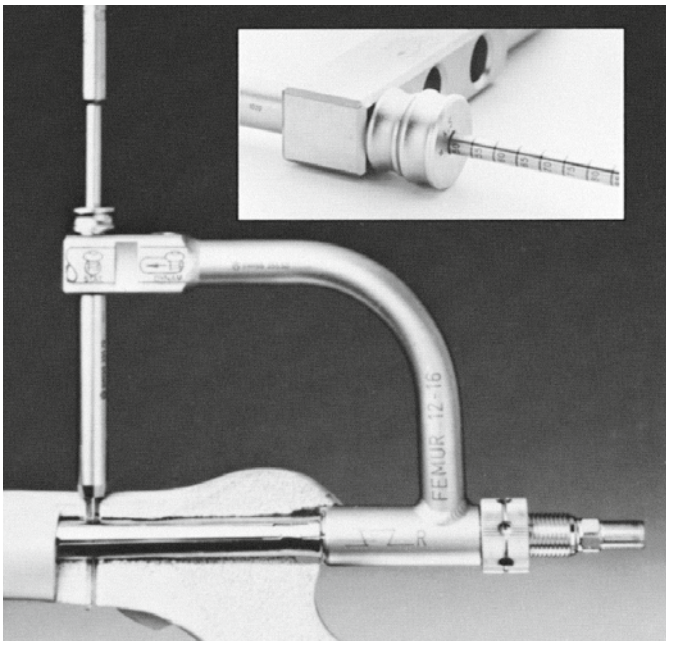


3

Instrument	
355.790	Depth Gauge for Locking Bolts, measuring range up to 90 mm

Remove the drill sleeve. Using the Depth Gauge for locking bolts, measure for the proper length 4.9 mm Locking Bolt. Add 2 mm to the measurement to ensure engagement of the far cortex.

Note: If using a calibrated drill bit, stop the drill after drilling through the far cortex. If necessary, use the image intensifier to confirm the position of the drill bit. Press the drill and protection sleeves firmly against the bone and read the correct bolt length on the calibrated drill bit at the end of the 8.0 mm/4.5 mm Drill Sleeve (see inset). Remove the drill sleeve.



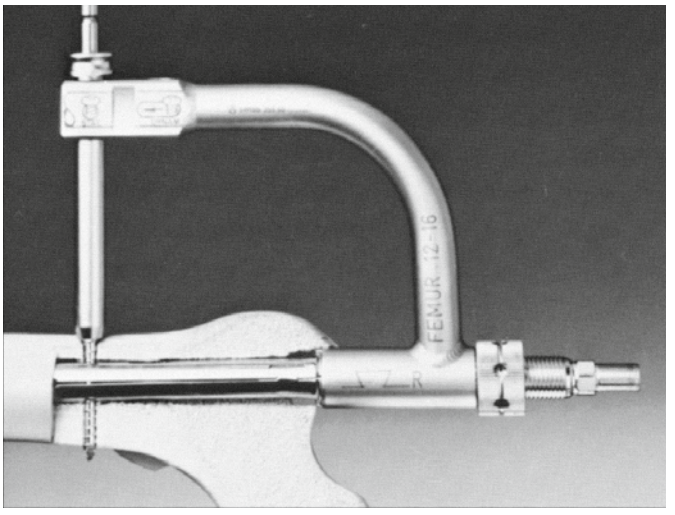
4

Insert the locking bolt through the 11 mm/8 mm Protection Sleeve.

If an additional proximal locking bolt is to be placed, repeat steps 1 through 4.

Remove the remaining insertion instruments.

Note: **The conical bolt must be removed properly to avoid jamming. See "Special Techniques," page 46 for more information.**



SPECIAL TECHNIQUES

- Distal Locking with the Distal Aiming Device
- Drilling in Two Steps
- Removing the Threaded Conical Bolt
- Extracting the Nail

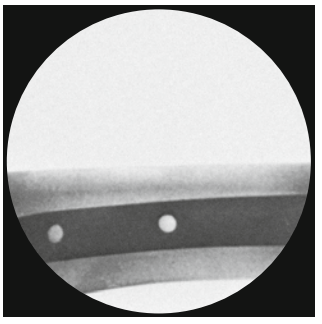
DISTAL LOCKING WITH THE DISTAL AIMING DEVICE

The Distal Aiming Device is used when a Radiolucent Drive is unavailable. The standard technique, used when locking the two transverse distal holes in the Universal Tibial and Femoral Nails, is shown here in use with the Femoral Nail. It can be varied in the tibial nail by locking the distal AP hole.

1

- Position the image intensifier so that both transverse distal holes appear on the monitor, and the X-ray beam is aligned with the axis of the most proximal of the distal locking holes (unless this hole is too near the fracture).

  The locking hole will appear completely round on the screen. To facilitate viewing of the Distal Aiming Device, the image should appear in the lower middle half of the screen.



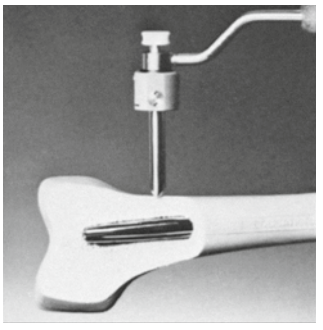
- Lock the image intensifier in this position until drilling is complete.

- Using image intensification to verify the location of the incision, make a stab incision over the hole, down to the bone.

2

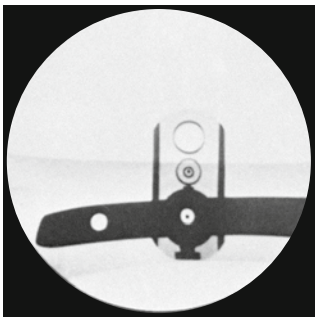
Instruments	
355.640	Aiming Trocar
355.600	Distal Aiming Device

Insert the Aiming Trocar into the Distal Aiming Device, and pass the trocar through the incision and onto the bone. The Aiming Trocar is used to center the aiming device over the hole in the nail.



3

Instrument	
355.620	Direction Finder



Under image intensification, tilt the aiming device so that the dot is in the center of the circle of the Direction Finder.

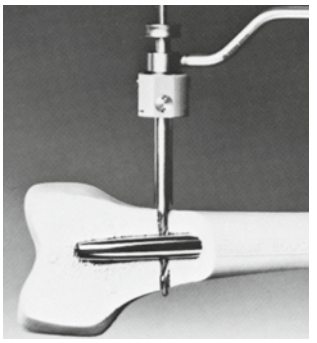
Shift the aiming device over the bone until the dot of the Aiming Trocar is in the center of the locking hole. Keep the Direction Finder dot centered in the circle to ensure alignment in the X-ray beam.

4

Push the Distal Aiming Device firmly against the bone surface. Remove the Aiming Trocar and replace it with the 8.0 mm/4.5 mm Drill Sleeve. Confirm the positioning with the Direction Finder. If the aiming device is correctly aligned, the locking hole in the nail appears round through the drill sleeve, and the dot is in the center of the Direction Finder.

5

Instruments	
355.900	Drill Bit ∅ 4.0/4.5 mm, length 225/200 mm, 2-flute, for Quick Coupling
355.790	Depth Gauge for Locking Bolts, measuring range up to 90 mm



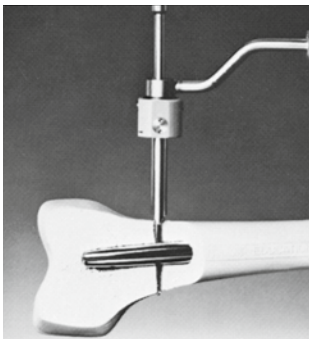
- Under image intensification, drill through both cortices with the 4.0 mm/4.5 mm Drill Bit. Use the Direction Finder to confirm and adjust drilling direction. The Oscillating Attachment with the 4.0 mm/4.5 mm Three-Fluted Drill Bit is recommended to prevent spooling of the soft tissue around the bit.

- **Note:** **If the image intensifier position does not allow sufficient clearance for drilling, use the two-step drilling procedure described on page 44.**

  Remove the drill sleeve. Measure for the proper length of the 4.9 mm Locking Bolt through the aiming device. Select a locking bolt 2 mm longer than the measured length, to compensate for the tapered trocar tip and ensure full engagement of the far cortex. Set this locking bolt aside.

6

Instuments	
355.660	Fixation Bolt for Femur
314.270	Screwdriver, hexagonal, large, ∅ 3.5 mm, with Groove, length 245 mm

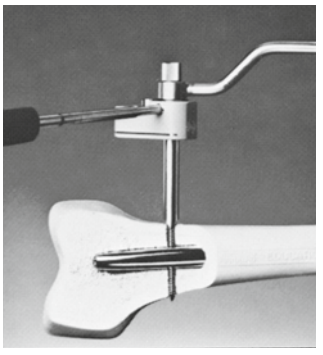


Insert the self-cutting fixation bolt (tibial or femoral, as appropriate), and tighten it down with the Hexagonal Screwdriver. This anchors the Distal Aiming Device to the bone.

If necessary, reposition the image intensifier so that both (transverse) distal holes appear on the screen. The most distal hole will not appear round because the beam direction is in the axis of the more proximal hole. Correct drilling direction will be ensured by the fixation bolt.

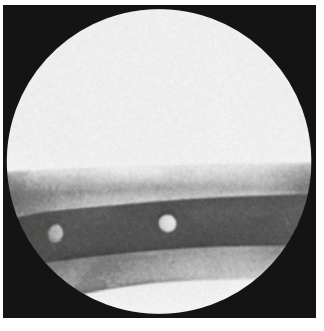
7

Insert the screwdriver into one of the two hexagonal setscrews on the side of the Direction Finder. Loosen the setscrew by turning it counterclockwise, so that the Direction Finder will turn freely around the 11.0 mm/ 8.0 mm Protection Sleeve.



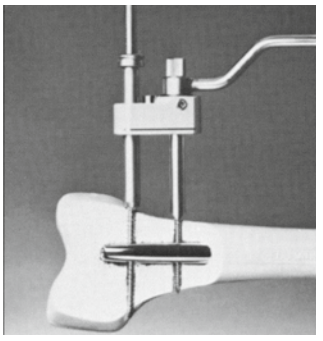
8

Under image intensification, use the Large Hexagonal Screwdriver to swing the Direction Finder so that the two metal guide markers are parallel to the nail. Lock the Direction Finder in place by tightening the setscrew.



9

Instruments	
355.900	Drill Bit ∅ 4.0/4.5 mm, length 225/200 mm, 2-flute, for Quick Coupling
355.710	Drill Sleeve 8.0/4.5



Make a stab incision over the distal hole. Insert the 11 mm/8 mm Protection Sleeve and 8.0 mm Trocar through the Direction Finder and stab incision onto the bone.

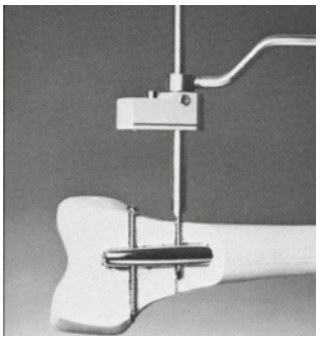
Replace the trocar with the 8.0 mm/4.5 mm Drill Sleeve. Drill through both cortices using the 4.0 mm/4.5 mm Drill Bit.

Remove the drill sleeve. Measure for the proper length locking bolt. Add 2 mm to the measurement to ensure full engagement of the far cortex.

Insert the locking bolt through the 11 mm/8 mm Protection Sleeve.

10

Remove the protection sleeve and fixation bolt. Insert the previously selected locking bolt. Remove the Distal Aiming Device.



Note: **If an AP bolt is used in the tibia, rotate the image intensifer 90° and repeat steps 1 through 6. Immediately insert the locking bolt.**

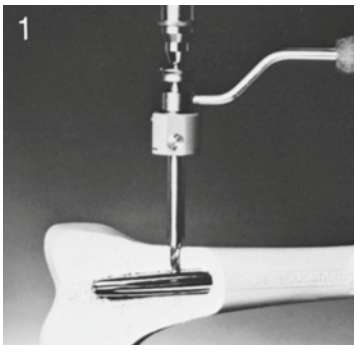
DRILLING IN TWO STEPS

This is an alternate technique to drilling with the 4 mm/4.5 mm Drill Bit in distal locking procedures. It is used only when there is insufficient space (less than 47 cm) between the receiver of the image intensifier and the bone, and a Radiolucent Drive is not available. The technique entails drilling in two steps: first with the 4.5 mm Drill Bit, and then with the 3.2 mm Drill Bit.

The following procedure replaces step 5 for the distal locking technique with the Distal Aiming Device (page 41).

1

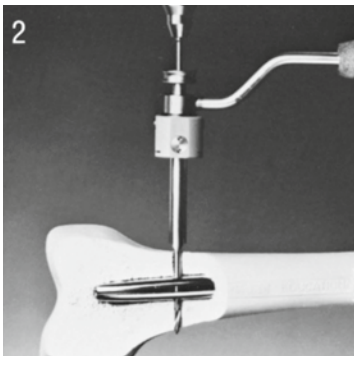
Instruments	
355.710	Drill Sleeve 8.0/4.5
310.440	Drill Bit ∅ 4.5 mm, length 145/120 mm, 2-flute, for Quick Coupling
355.600	Distal Aiming Device



Under image intensification, drill with the 4.5 mm Drill Bit through the near cortex. While drilling, verify alignment with the Direction Finder.

2

Instruments	
310.020	Drill Bit ∅ 3.2 mm, length 225/200 mm, 2-flute, for Quick Coupling
355.730	Drill Sleeve Insert 3.2



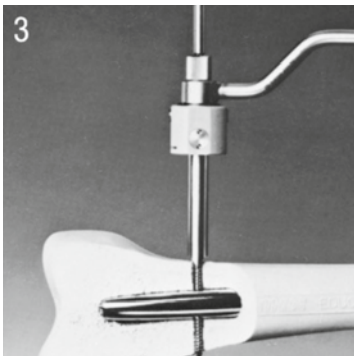
Replace the 8 mm/4.5 mm Drill Sleeve with the 4.5 mm/3.2 mm Insert Drill Sleeve. Pass the drill sleeve completely through the nail, so that it rests on the opposite cortex.

Drill the far cortex with the 3.2 mm Drill Bit.

3

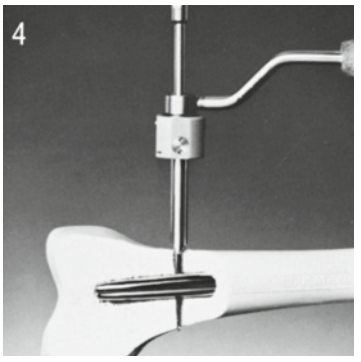
Instrument	
355.790	Depth Gauge for Locking Bolts, measuring range up to 90 mm

Remove the insert drill sleeve. Using the Depth Gauge for locking bolts, measure for the bolt. Select a locking bolt 2 mm longer than the measured length to compensate for the tapered trocar tip and ensure full engagement of the far cortex.



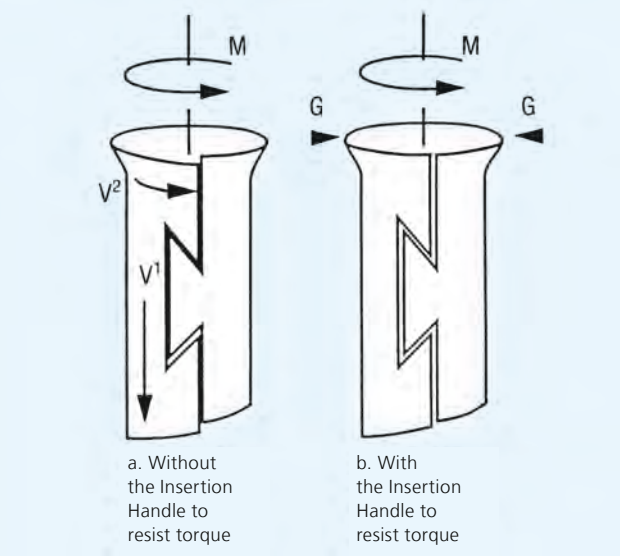
4

Resume with step 6 for distal locking technique with the Distal Aiming Device (page 42).



REMOVING THE THREADED CONICAL BOLT

To prevent cross-threading of the conical bolt in the nail, the Threaded Conical Bolt must be removed properly. This entails using the Insertion Handle to resist the torque present upon removal of the conical bolt. Because the tabs of the Insertion Handle engage the positioning notches of the proximal nail end, distortion of the nail is prevented, and the conical bolt is easily removed.



Legend:
M = Removal movement of the conical bolt
$V^{1,}V^{2}$ = Change of the nail geometry during removal of the conical bolt without resistance from the Insertion Handle
G = Resisting moment from the Insertion Handle

Removal Technique

1

Use the 4.5 mm Pin Wrench to loosen the Locking Nut one-half turn.

2

Instruments	
321.160	Combination Wrench ∅ 11.0 mm
391.880	Vice Grip, length 180 mm

While holding the Insertion Handle firmly, remove the conical bolt with the Combination Wrench or the Cannulated Socket Wrench.

Should jamming occur, loosen the conical bolt with the Combination Wrench and Locking Pliers.

Jammed Threaded Conical Bolt

Jamming can occur if the short conical bolt contained in the original AO ASIF Nailing Instrument Set is used, because the Insertion Handle cannot be used over the original conical bolts. Removal of the old-style bolts can be very difficult.

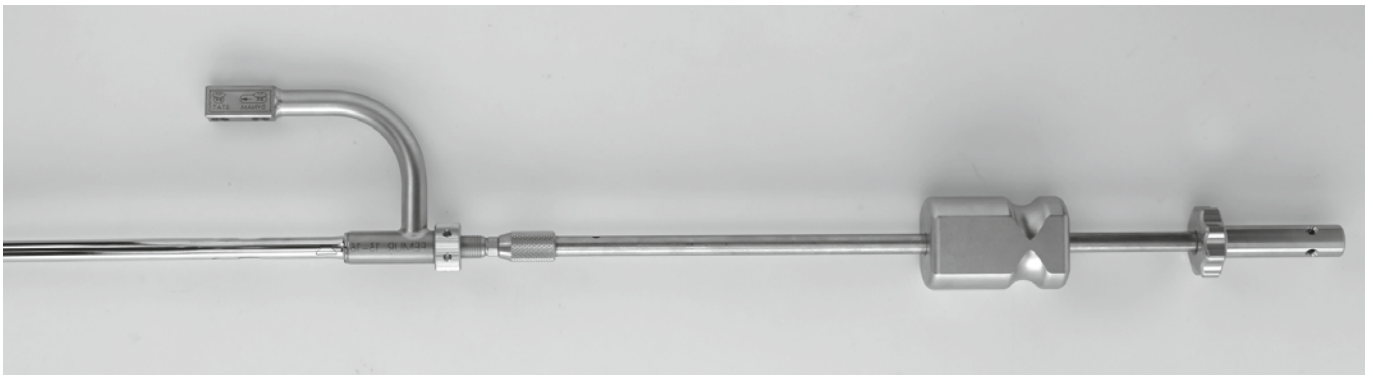
If this situation occurs, withdraw the nail approximately 5 cm. Hold the proximal nail end with the Locking Pliers and the bolt with the Combination Wrench. Use the Locking Pliers as a torque resistor while loosening the bolt. This method should be used in emergencies only.

EXTRACTING THE NAIL

Nail Extraction
The Universal Tibial and Femoral Nails' threaded proximal ends greatly simplify extraction. The thread provides a secure connection with the conical bolt for smooth and accurate transmission of forces during nail extraction.

Selection of the appropriate conical bolt is critical to avoid complications or damage to the nail during extraction. The Universal Tibial Nail uses one conical bolt for all nail diameters, simplifying removal. For Universal Femoral Nail extractions, it may be necessary to review X-rays to determine the nail diameter, and thus, the appropriate conical bolt.

Locking bolts must be removed prior to nail extraction. Make a short incision over the heads of the locking bolts. Use a curette and sharp hook to remove tissue ingrowth in the hex recess. Using the Large Hexagonal Screwdriver with Holding Sleeve, insert the screwdriver into the hexagonal recess of the locking bolt. Push the Holding Sleeve forward to engage the bolt head. Remove the locking bolt.



Nail Extraction Assembly: Threaded Conical Bolt, Ram Guide, Ram, Grip

When all locking bolts have been removed, proceed with nail extraction.

1
Make an incision at the nail entry point (for the tibia, see page 8; femur, page 27).

2
Expose the nail end and remove all tissue ingrowth from the threads, using a curette and sharp hook.

3
Using the socket wrench, tightly screw the appropriate conical bolt into the proximal end of the nail.

4
Slide the Ram over the Ram Guide, keeping the weighted end proximal. Attach the Grip onto the proximal end of the Ram Guide. Screw this assembly onto the conical bolt.

5
With controlled blows of the Ram against the Grip, extract the nail. It is often necessary to retighten the conical bolt with the Combination Wrench. This compensates for any loosening of the threaded connections due to residual tissue ingrowth or nail deformation, and will prevent stripping of the threads.

IMPLANTS

Universal Tibial Nails*

Art. Nr.	∅	length
250.240	10.0 mm	240 mm
250.250	10.0 mm	255 mm
250.270	10.0 mm	270 mm
250.280	10.0 mm	285 mm
250.300	10.0 mm	300 mm
250.310	10.0 mm	315 mm
250.330	10.0 mm	330 mm
250.340	10.0 mm	345 mm
250.360	10.0 mm	360 mm
250.380	10.0 mm	380 mm
250.400	10.0 mm	400 mm
250.420	10.0 mm	420 mm
251.280	11.0 mm	285 mm
251.300	11.0 mm	300 mm
251.310	11.0 mm	315 mm
251.330	11.0 mm	330 mm
251.340	11.0 mm	345 mm
251.360	11.0 mm	360 mm
251.380	11.0 mm	380 mm
251.400	11.0 mm	400 mm
251.420	11.0 mm	420 mm

* Available non-sterile or sterile packed ∅ 10 and 11 mm.
Add "S" to the catalogue number to order sterile products.

Art. Nr.	∅	length
252.280	12.0 mm	285 mm
252.300	12.0 mm	300 mm
252.310	12.0 mm	315 mm
252.330	12.0 mm	330 mm
252.340	12.0 mm	345 mm
252.360	12.0 mm	360 mm
252.380	12.0 mm	380 mm
252.400	12.0 mm	400 mm
252.420	12.0 mm	420 mm
253.280	13.0 mm	285 mm
253.300	13.0 mm	300 mm
253.310	13.0 mm	315 mm
253.330	13.0 mm	330 mm
253.340	13.0 mm	345 mm
253.360	13.0 mm	360 mm
253.380	13.0 mm	380 mm
253.400	13.0 mm	400 mm
253.420	13.0 mm	420 mm

UNIVERSAL FEMORAL NAILS

Part No.	Article Name
274.000	Universal Femoral Nail ∅ 10.0 mm, length 340 mm, Stainless Steel
274.000S	Universal Femoral Nail ∅ 10.0 mm, length 340 mm, Stainless Steel, sterile
274.010	Universal Femoral Nail ∅ 10.0 mm, length 360 mm, Stainless Steel
274.010S	Universal Femoral Nail ∅ 10.0 mm, length 360 mm, Stainless Steel, sterile
274.020	Universal Femoral Nail ∅ 10.0 mm, length 380 mm, Stainless Steel
274.020S	Universal Femoral Nail ∅ 10.0 mm, length 380 mm, Stainless Steel, sterile
274.030	Universal Femoral Nail ∅ 10.0 mm, length 400 mm, Stainless Steel
274.030S	Universal Femoral Nail ∅ 10.0 mm, length 400 mm, Stainless Steel, sterile
274.040	Universal Femoral Nail ∅ 10.0 mm, length 420 mm, Stainless Steel
274.040S	Universal Femoral Nail ∅ 10.0 mm, length 420 mm, Stainless Steel, sterile
274.050	Universal Femoral Nail ∅ 10.0 mm, length 440 mm, Stainless Steel
274.050S	Universal Femoral Nail ∅ 10.0 mm, length 440 mm, Stainless Steel, sterile
274.060	Universal Femoral Nail ∅ 10.0 mm, length 460 mm, Stainless Steel
274.060S	Universal Femoral Nail ∅ 10.0 mm, length 460 mm, Stainless Steel, sterile
274.070	Universal Femoral Nail ∅ 10.0 mm, length 480 mm, Stainless Steel
274.070S	Universal Femoral Nail ∅ 10.0 mm, length 480 mm, Stainless Steel, sterile
274.080	Universal Femoral Nail ∅ 10.0 mm, length 300 mm, Stainless Steel
274.080S	Universal Femoral Nail ∅ 10.0 mm, length 300 mm, Stainless Steel, sterile
274.090	Universal Femoral Nail ∅ 10.0 mm, length 320 mm, Stainless Steel
274.090S	Universal Femoral Nail ∅ 10.0 mm, length 320 mm, Stainless Steel, sterile
274.100	Universal Femoral Nail ∅ 11.0 mm, length 340 mm, Stainless Steel
274.100S	Universal Femoral Nail ∅ 11.0 mm, length 340 mm, Stainless Steel, sterile
274.110	Universal Femoral Nail ∅ 11.0 mm, length 360 mm, Stainless Steel
274.110S	Universal Femoral Nail ∅ 11.0 mm, length 360 mm, Stainless Steel, sterile
274.120	Universal Femoral Nail ∅ 11.0 mm, length 380 mm, Stainless Steel
274.120S	Universal Femoral Nail ∅ 11.0 mm, length 380 mm, Stainless Steel, sterile
274.130	Universal Femoral Nail ∅ 11.0 mm, length 400 mm, Stainless Steel
274.130S	Universal Femoral Nail ∅ 11.0 mm, length 400 mm, Stainless Steel, sterile
274.140	Universal Femoral Nail ∅ 11.0 mm, length 420 mm, Stainless Steel
274.140S	Universal Femoral Nail ∅ 11.0 mm, length 420 mm, Stainless Steel, sterile
274.150	Universal Femoral Nail ∅ 11.0 mm, length 440 mm, Stainless Steel
274.150S	Universal Femoral Nail ∅ 11.0 mm, length 440 mm, Stainless Steel, sterile
274.160	Universal Femoral Nail ∅ 11.0 mm, length 460 mm, Stainless Steel
274.160S	Universal Femoral Nail ∅ 11.0 mm, length 460 mm, Stainless Steel, sterile
274.170	Universal Femoral Nail ∅ 11.0 mm, length 480 mm, Stainless Steel
274.170S	Universal Femoral Nail ∅ 11.0 mm, length 480 mm, Stainless Steel, sterile
274.180	Universal Femoral Nail ∅ 11.0 mm, length 300 mm, Stainless Steel
274.180S	Universal Femoral Nail ∅ 11.0 mm, length 300 mm, Stainless Steel, sterile
274.190	Universal Femoral Nail ∅ 11.0 mm, length 320 mm, Stainless Steel
274.190S	Universal Femoral Nail ∅ 11.0 mm, length 320 mm, Stainless Steel, sterile

274.200	Universal Femoral Nail ∅ 12.0 mm, length 340 mm, Stainless Steel
274.200S	Universal Femoral Nail ∅ 12.0 mm, length 340 mm, Stainless Steel, sterile
274.210	Universal Femoral Nail ∅ 12.0 mm, length 360 mm, Stainless Steel
274.210S	Universal Femoral Nail ∅ 12.0 mm, length 360 mm, Stainless Steel, sterile
274.220	Universal Femoral Nail ∅ 12.0 mm, length 380 mm, Stainless Steel
274.220S	Universal Femoral Nail ∅ 12.0 mm, length 380 mm, Stainless Steel, sterile
274.230	Universal Femoral Nail ∅ 12.0 mm, length 400 mm, Stainless Steel
274.230S	Universal Femoral Nail ∅ 12.0 mm, length 400 mm, Stainless Steel, sterile
274.240	Universal Femoral Nail ∅ 12.0 mm, length 420 mm, Stainless Steel
274.240S	Universal Femoral Nail ∅ 12.0 mm, length 420 mm, Stainless Steel, sterile
274.250	Universal Femoral Nail ∅ 12.0 mm, length 440 mm, Stainless Steel
274.250S	Universal Femoral Nail ∅ 12.0 mm, length 440 mm, Stainless Steel, sterile
274.260	Universal Femoral Nail ∅ 12.0 mm, length 460 mm, Stainless Steel
274.260S	Universal Femoral Nail ∅ 12.0 mm, length 460 mm, Stainless Steel, sterile
274.270	Universal Femoral Nail ∅ 12.0 mm, length 480 mm, Stainless Steel
274.270S	Universal Femoral Nail ∅ 12.0 mm, length 480 mm, Stainless Steel, sterile
274.280	Universal Femoral Nail ∅ 12.0 mm, length 300 mm, Stainless Steel
274.280S	Universal Femoral Nail ∅ 12.0 mm, length 300 mm, Stainless Steel, sterile
274.290	Universal Femoral Nail ∅ 12.0 mm, length 320 mm, Stainless Steel
274.290S	Universal Femoral Nail ∅ 12.0 mm, length 320 mm, Stainless Steel, sterile

274.300	Universal Femoral Nail ∅ 13.0 mm, length 340 mm, Stainless Steel
274.300S	Universal Femoral Nail ∅ 13.0 mm, length 340 mm, Stainless Steel, sterile
274.310	Universal Femoral Nail ∅ 13.0 mm, length 360 mm, Stainless Steel
274.310S	Universal Femoral Nail ∅ 13.0 mm, length 360 mm, Stainless Steel, sterile
274.320	Universal Femoral Nail ∅ 13.0 mm, length 380 mm, Stainless Steel
274.320S	Universal Femoral Nail ∅ 13.0 mm, length 380 mm, Stainless Steel, sterile
274.330	Universal Femoral Nail ∅ 13.0 mm, length 400 mm, Stainless Steel
274.330S	Universal Femoral Nail ∅ 13.0 mm, length 400 mm, Stainless Steel, sterile
274.340	Universal Femoral Nail ∅ 13.0 mm, length 420 mm, Stainless Steel
274.340S	Universal Femoral Nail ∅ 13.0 mm, length 420 mm, Stainless Steel, sterile
274.350	Universal Femoral Nail ∅ 13.0 mm, length 440 mm, Stainless Steel
274.350S	Universal Femoral Nail ∅ 13.0 mm, length 440 mm, Stainless Steel, sterile
274.360	Universal Femoral Nail ∅ 13.0 mm, length 460 mm, Stainless Steel
274.360S	Universal Femoral Nail ∅ 13.0 mm, length 460 mm, Stainless Steel, sterile
274.370	Universal Femoral Nail ∅ 13.0 mm, length 480 mm, Stainless Steel
274.370S	Universal Femoral Nail ∅ 13.0 mm, length 480 mm, Stainless Steel, sterile
274.380	Universal Femoral Nail ∅ 13.0 mm, length 300 mm, Stainless Steel
274.380S	Universal Femoral Nail ∅ 13.0 mm, length 300 mm, Stainless Steel, sterile
274.390	Universal Femoral Nail ∅ 13.0 mm, length 320 mm, Stainless Steel
274.390S	Universal Femoral Nail ∅ 13.0 mm, length 320 mm, Stainless Steel, sterile

274.400	Universal Femoral Nail ∅ 14.0 mm, length 340 mm, Stainless Steel
274.400S	Universal Femoral Nail ∅ 14.0 mm, length 340 mm, Stainless Steel, sterile
274.410	Universal Femoral Nail ∅ 14.0 mm, length 360 mm, Stainless Steel
274.410S	Universal Femoral Nail ∅ 14.0 mm, length 360 mm, Stainless Steel, sterile
274.420	Universal Femoral Nail ∅ 14.0 mm, length 380 mm, Stainless Steel
274.420S	Universal Femoral Nail ∅ 14.0 mm, length 380 mm, Stainless Steel, sterile
274.430	Universal Femoral Nail ∅ 14.0 mm, length 400 mm, Stainless Steel
274.430S	Universal Femoral Nail ∅ 14.0 mm, length 400 mm, Stainless Steel, sterile
274.440	Universal Femoral Nail ∅ 14.0 mm, length 420 mm, Stainless Steel
274.440S	Universal Femoral Nail ∅ 14.0 mm, length 420 mm, Stainless Steel, sterile
274.450	Universal Femoral Nail ∅ 14.0 mm, length 440 mm, Stainless Steel
274.450S	Universal Femoral Nail ∅ 14.0 mm, length 440 mm, Stainless Steel, sterile
274.460	Universal Femoral Nail ∅ 14.0 mm, length 460 mm, Stainless Steel
274.460S	Universal Femoral Nail ∅ 14.0 mm, length 460 mm, Stainless Steel, sterile
274.470	Universal Femoral Nail ∅ 14.0 mm, length 480 mm, Stainless Steel
274.470S	Universal Femoral Nail ∅ 14.0 mm, length 480 mm, Stainless Steel, sterile
274.480	Universal Femoral Nail ∅ 14.0 mm, length 300 mm, Stainless Steel
274.480S	Universal Femoral Nail ∅ 14.0 mm, length 300 mm, Stainless Steel, sterile
274.490	Universal Femoral Nail ∅ 14.0 mm, length 320 mm, Stainless Steel
274.490S	Universal Femoral Nail ∅ 14.0 mm, length 320 mm, Stainless Steel, sterile

274.500	Universal Femoral Nail ∅ 15.0 mm, length 340 mm, Stainless Steel
274.500S	Universal Femoral Nail ∅ 15.0 mm, length 340 mm, Stainless Steel, sterile
274.510	Universal Femoral Nail ∅ 15.0 mm, length 360 mm, Stainless Steel
274.510S	Universal Femoral Nail ∅ 15.0 mm, length 360 mm, Stainless Steel, sterile
274.520	Universal Femoral Nail ∅ 15.0 mm, length 380 mm, Stainless Steel
274.520S	Universal Femoral Nail ∅ 15.0 mm, length 380 mm, Stainless Steel, sterile
274.530	Universal Femoral Nail ∅ 15.0 mm, length 400 mm, Stainless Steel
274.530S	Universal Femoral Nail ∅ 15.0 mm, length 400 mm, Stainless Steel, sterile
274.540	Universal Femoral Nail ∅ 15.0 mm, length 420 mm, Stainless Steel
274.540S	Universal Femoral Nail ∅ 15.0 mm, length 420 mm, Stainless Steel, sterile
274.550	Universal Femoral Nail ∅ 15.0 mm, length 440 mm, Stainless Steel
274.550S	Universal Femoral Nail ∅ 15.0 mm, length 440 mm, Stainless Steel, sterile
274.560	Universal Femoral Nail ∅ 15.0 mm, length 460 mm, Stainless Steel
274.560S	Universal Femoral Nail ∅ 15.0 mm, length 460 mm, Stainless Steel, sterile
274.570	Universal Femoral Nail ∅ 15.0 mm, length 480 mm, Stainless Steel
274.570S	Universal Femoral Nail ∅ 15.0 mm, length 480 mm, Stainless Steel, sterile
274.580	Universal Femoral Nail ∅ 15.0 mm, length 300 mm, Stainless Steel
274.580S	Universal Femoral Nail ∅ 15.0 mm, length 300 mm, Stainless Steel, sterile
274.590	Universal Femoral Nail ∅ 15.0 mm, length 320 mm, Stainless Steel
274.590S	Universal Femoral Nail ∅ 15.0 mm, length 320 mm, Stainless Steel, sterile

274.600	Universal Femoral Nail ∅ 16.0 mm, length 340 mm, Stainless Steel
274.600S	Universal Femoral Nail ∅ 16.0 mm, length 340 mm, Stainless Steel, sterile
274.610	Universal Femoral Nail ∅ 16.0 mm, length 360 mm, Stainless Steel
274.610S	Universal Femoral Nail ∅ 16.0 mm, length 360 mm, Stainless Steel, sterile
274.620	Universal Femoral Nail ∅ 16.0 mm, length 380 mm, Stainless Steel
274.620S	Universal Femoral Nail ∅ 16.0 mm, length 380 mm, Stainless Steel, sterile
274.630	Universal Femoral Nail ∅ 16.0 mm, length 400 mm, Stainless Steel
274.630S	Universal Femoral Nail ∅ 16.0 mm, length 400 mm, Stainless Steel, sterile
274.640	Universal Femoral Nail ∅ 16.0 mm, length 420 mm, Stainless Steel
274.640S	Universal Femoral Nail ∅ 16.0 mm, length 420 mm, Stainless Steel, sterile
274.650	Universal Femoral Nail ∅ 16.0 mm, length 440 mm, Stainless Steel
274.650S	Universal Femoral Nail ∅ 16.0 mm, length 440 mm, Stainless Steel, sterile
274.660	Universal Femoral Nail ∅ 16.0 mm, length 460 mm, Stainless Steel
274.660S	Universal Femoral Nail ∅ 16.0 mm, length 460 mm, Stainless Steel, sterile
274.670	Universal Femoral Nail ∅ 16.0 mm, length 480 mm, Stainless Steel
274.670S	Universal Femoral Nail ∅ 16.0 mm, length 480 mm, Stainless Steel, sterile
274.680	Universal Femoral Nail ∅ 16.0 mm, length 300 mm, Stainless Steel
274.680S	Universal Femoral Nail ∅ 16.0 mm, length 300 mm, Stainless Steel, sterile
274.690	Universal Femoral Nail ∅ 16.0 mm, length 320 mm, Stainless Steel
274.690S	Universal Femoral Nail ∅ 16.0 mm, length 320 mm, Stainless Steel, sterile

274.700	Universal Femoral Nail ∅ 17.0 mm, length 340 mm, Stainless Steel
274.700S	Universal Femoral Nail ∅ 17.0 mm, length 340 mm, Stainless Steel, sterile
274.710	Universal Femoral Nail ∅ 17.0 mm, length 360 mm, Stainless Steel
274.710S	Universal Femoral Nail ∅ 17.0 mm, length 360 mm, Stainless Steel, sterile
274.720	Universal Femoral Nail ∅ 17.0 mm, length 380 mm, Stainless Steel
274.720S	Universal Femoral Nail ∅ 17.0 mm, length 380 mm, Stainless Steel, sterile
274.730	Universal Femoral Nail ∅ 17.0 mm, length 400 mm, Stainless Steel
274.730S	Universal Femoral Nail ∅ 17.0 mm, length 400 mm, Stainless Steel, sterile
274.740	Universal Femoral Nail ∅ 17.0 mm, length 420 mm, Stainless Steel
274.740S	Universal Femoral Nail ∅ 17.0 mm, length 420 mm, Stainless Steel, sterile
274.750	Universal Femoral Nail ∅ 17.0 mm, length 440 mm, Stainless Steel
274.750S	Universal Femoral Nail ∅ 17.0 mm, length 440 mm, Stainless Steel, sterile
274.760	Universal Femoral Nail ∅ 17.0 mm, length 460 mm, Stainless Steel
274.760S	Universal Femoral Nail ∅ 17.0 mm, length 460 mm, Stainless Steel, sterile
274.770	Universal Femoral Nail ∅ 17.0 mm, length 480 mm, Stainless Steel
274.770S	Universal Femoral Nail ∅ 17.0 mm, length 480 mm, Stainless Steel, sterile
274.780	Universal Femoral Nail ∅ 17.0 mm, length 300 mm, Stainless Steel
274.780S	Universal Femoral Nail ∅ 17.0 mm, length 300 mm, Stainless Steel, sterile
274.790	Universal Femoral Nail ∅ 17.0 mm, length 320 mm, Stainless Steel
274.790S	Universal Femoral Nail ∅ 17.0 mm, length 320 mm, Stainless Steel, sterile

274.800	Universal Femoral Nail ∅ 18.0 mm, length 340 mm, Stainless Steel
274.810	Universal Femoral Nail ∅ 18.0 mm, length 360 mm, Stainless Steel
274.810S	Universal Femoral Nail ∅ 18.0 mm, length 360 mm, Stainless Steel, sterile
274.820	Universal Femoral Nail ∅ 18.0 mm, length 380 mm, Stainless Steel
274.820S	Universal Femoral Nail ∅ 18.0 mm, length 380 mm, Stainless Steel, sterile
274.830	Universal Femoral Nail ∅ 18.0 mm, length 400 mm, Stainless Steel
274.830S	Universal Femoral Nail ∅ 18.0 mm, length 400 mm, Stainless Steel, sterile
274.840	Universal Femoral Nail ∅ 18.0 mm, length 420 mm, Stainless Steel
274.840S	Universal Femoral Nail ∅ 18.0 mm, length 420 mm, Stainless Steel, sterile
274.850	Universal Femoral Nail ∅ 18.0 mm, length 440 mm, Stainless Steel
274.850S	Universal Femoral Nail ∅ 18.0 mm, length 440 mm, Stainless Steel, sterile
274.860	Universal Femoral Nail ∅ 18.0 mm, length 460 mm, Stainless Steel
274.860S	Universal Femoral Nail ∅ 18.0 mm, length 460 mm, Stainless Steel, sterile
274.870	Universal Femoral Nail ∅ 18.0 mm, length 480 mm, Stainless Steel
274.870S	Universal Femoral Nail ∅ 18.0 mm, length 480 mm, Stainless Steel, sterile
274.880	Universal Femoral Nail ∅ 18.0 mm, length 300 mm, Stainless Steel
274.880S	Universal Femoral Nail ∅ 18.0 mm, length 300 mm, Stainless Steel, sterile
274.890	Universal Femoral Nail ∅ 18.0 mm, length 320 mm, Stainless Steel
274.890S	Universal Femoral Nail ∅ 18.0 mm, length 320 mm, Stainless Steel, sterile
274.920	Universal Femoral Nail ∅ 19.0 mm, length 380 mm, Stainless Steel
274.920S	Universal Femoral Nail ∅ 19.0 mm, length 380 mm, Stainless Steel, sterile
274.930	Universal Femoral Nail ∅ 19.0 mm, length 400 mm, Stainless Steel
274.930S	Universal Femoral Nail ∅ 19.0 mm, length 400 mm, Stainless Steel, sterile
274.940	Universal Femoral Nail ∅ 19.0 mm, length 420 mm, Stainless Steel
274.940S	Universal Femoral Nail ∅ 19.0 mm, length 420 mm, Stainless Steel, sterile
274.950	Universal Femoral Nail ∅ 19.0 mm, length 440 mm, Stainless Steel
274.950S	Universal Femoral Nail ∅ 19.0 mm, length 440 mm, Stainless Steel, sterile
274.960	Universal Femoral Nail ∅ 19.0 mm, length 460 mm, Stainless Steel
274.960S	Universal Femoral Nail ∅ 19.0 mm, length 460 mm, Stainless Steel, sterile
274.970	Universal Femoral Nail ∅ 19.0 mm, length 480 mm, Stainless Steel
274.970S	Universal Femoral Nail ∅ 19.0 mm, length 480 mm, Stainless Steel, sterile

INSTRUMENTS

393.100	Universal Chuck with T-Handle
351.060	Centering Pin ∅ 4.0 mm, length 400 mm, for No. 351.240
351.240	Cutter for UTN/CTN and for Universal Medullary Nail, ∅ 11.0 mm, length 350 mm
351.260	Protection Sleeve, for No. 351.240
355.470	Nut, knurled, for Tibial Medullary Nails ∅ 10.0 to 14.0 mm
355.440	Threaded Bolt, conical, for Tibial Medullary Nails ∅ 10.0 to 14.0 mm
355.410	Insertion Handle, for Tibial Medullary Nails ∅ 9.0 to 14.0 mm
355.180	Driving Head
355.160	Driving Piece, curved
355.750	Trocar ∅ 8.0 mm
355.700	Protection Sleeve 11.0/8.0

355.900	Drill Bit ∅ 4.0/4.5 mm, length 225/200 mm, 2-flute, for Quick Coupling
355.490	Insertion Handle, for Femoral Medullary Nails ∅ 9.0 to 12.0 mm
355.500	Insertion Handle, for Femoral Medullary Nails ∅ 13.0 to 16.0 mm
355.510	Insertion Handle, for Femoral Medullary Nails ∅ 17.0 to 19.0 mm
355.570	Nut, knurled, for Femoral Medullary Nails ∅ 9.0 to 12.0 mm
355.580	Nut, knurled, for Femoral Medullary Nails ∅ 13.0 to 16.0 mm
355.590	Nut, knurled, for Femoral Medullary Nails ∅ 17.0 to 19.0 mm
355.530	Threaded Bolt, conical, for Femoral Medullary Nails ∅ 9.0 to 12.0 mm
355.540	Threaded Bolt, conical, for Femoral Medullary Nails ∅ 13.0 to 16.0 mm
355.500	Insertion Handle, for Femoral Medullary Nails ∅ 13.0 to 16.0 mm

355.280	Handle, for No. 355.220
355.220	Hammer Guide, cannulated, for Universal Medullary Nails
355.250	Ram
355.710	Drill Sleeve 8.0/4.5
355.790	Depth Gauge for Locking Bolts, measuring range up to 90 mm
321.160	Combination Wrench ∅ 11.0 mm
355.640	Aiming Trocar
355.600	Distal Aiming Device
355.620	Direction Finder
355.660	Fixation Bolt for Femur

314.270	Screwdriver, hexagonal, large, ∅ 3.5 mm, with Groove, length 245 mm
310.020	Drill Bit ∅ 3.2 mm, length 225/200 mm, 2-flute, for Quick Coupling
355.730	Drill Sleeve Insert 3.2
391.880	Vice Grip, length 180 mm

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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 036.001.300 DSEM/TRM/0116/0590(1) 09/16