The Universal Nail System.
Warning
This description alone does not provide sufficient background for direct use of the product. Instruction by a surgeon experienced in handling this product is highly recommended.

Reprocessing, Care and Maintenance of Synthes Instruments
For general guidelines, function control and dismantling of multi-part instruments, please refer to: www.synthes.com/reprocessing
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The Universal Nails

Universal Tibial and Femoral Nails feature:

- Anatomic design for easier 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 for the best 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° bend1 and longer, flat proximal bend for easier insertion, better 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


*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
- 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

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Tibial Nailing Technique

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
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.
Preoperative Considerations (continued)

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
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 036.000.808 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.
Nail Insertion  (continued)

Measuring for the Nail  (continued)

b. Use the Radiographic Ruler after reduction or on the 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

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

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.

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.
Nail Insertion (continued)

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.

Note: Take care not to trap fingers during hammering.

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

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 35, 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 31. If less working distance is available, see the alternative drilling technique (“Drilling in Two Steps”) on page 34. 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**

<table>
<thead>
<tr>
<th>Special Circumstances</th>
<th>Proximal ML Hole</th>
<th>AP Hole</th>
<th>Distal ML Hole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient soft tissue coverage of most distal locking bolt head</td>
<td>[ ]</td>
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<tr>
<td>Distal fractures</td>
<td>[ ]</td>
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<tr>
<td>Insufficient soft tissue coverage of both medial locking bolt heads (comminuted midshaft fractures only)</td>
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</table>
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).

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.

The C-arm symbol indicates that image intensification is required for this step.
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. 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. 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 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 35, for more information.
Femoral Nailing Technique

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
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 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.
Preoperative Considerations (continued)

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
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 nonunions, 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 036.000.808 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.
Nail Insertion (continued)

Assembling the Insertion Instrumentation

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

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.

**Note:** Take care not to trap fingers during hammering.

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 35, 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).

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).

The C-arm symbol indicates that image intensification is required for this step.
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 31. If less distance is available, see “Drilling in Two Steps” on page 34, 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 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 Insert the 8 mm/4.5 mm Drill Sleeve. Drill through both cortices using the 4 mm/4.5 mm Drill Bit.
3 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.

\textit{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.

\textit{Note:} The conical bolt must be removed properly to avoid jamming. See “Special Techniques,” page 35 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. 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. 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.

The C-arm symbol indicates that image intensification is required for this step.
Distal Locking with the Distal Aiming Device
(continued)

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. 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 34.

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. 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.

The C-arm symbol indicates that image intensification is required for this step.
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 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 intensifier 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 32).

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

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. 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 32).
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.

Removal Technique

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

2. 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.

Legend:

- **M** = Removal movement of the conical bolt
- **V** = Change of the nail geometry during removal of the conical bolt without resistance from the Insertion Handle
- **G** = Resisting moment from the Insertion Handle
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 22).

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 weight-ed 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.

*Note:* Take care not to trap fingers during hammering.