Technique Manual of SIGN IM Nail & Interlocking Screw System Insertion & Extraction Guide

www.signfracturecare.org

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Dear SIGN Fracture Care International Partner:

This technique manual has been revised periodically for 11 years. These revisions often occur during the flight home from visiting SIGN programs. These observations are a combination of ideas from 5,000 SIGN surgeons. We anticipate further revisions as SIGN designs new implants and instruments. Please make notes in this manual as you make observations and forward them to SIGN staff for discussion.

The SIGN nail first designed in 1999 has not changed since we began manufacture of the nail. The instruments are progressively being improved.

Features the SIGN IM nail includes:

- Adaptability—The same nail is used for tibia, retrograde and antegrade approach to femur and humerus. No left or right side nails.
- No radiation exposure—C-arm is not needed to accomplish interlock.
- Solid—stronger, less surface for biofilm.
- Slots—allow for compression and distraction of fracture fragments may accelerate healing.
- No arc of radius-allows three point fixation.
- 9° proximal bend-rotational stability.
- 1.5° bend distally for easier insertion.

The SIGN surgical database was implemented in August 2003 to evaluate SIGN system and indications. 50,000 SIGN surgeries have been reported. These reports have stimulated innovation and evaluation of indications. Our 29% follow-up rate, which continues to rise, has enabled us to evaluate our results as well as study new techniques and new products. Questions or comments can be entered in the comment section, or by email, and we will respond.

Sincerely,

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Patient Preparation

Patient must have no infected areas or injuries that preclude surgery. Patient should be told about risks, benefits of surgery, and agree to insertion of the SIGN IM Nail. Please check the patient’s skin the night before surgery. If possible, washing the patient’s leg should be done the night before as well as the morning of surgery. The cast may be removed for washing and operative site covered with sterile towel.

- General medical condition suitable for surgery?
- Laboratory work?
- Inspect skin for wounds. It may be necessary to remove a cast.
- Range of motion of the knee?
- Template x-rays for implant sizes?
- X-rays available for the operating room?
- Wash fractured leg as noted above.
These materials, which are not part of the SIGN set, should be present in the operating room: drill; chuck key; mallet; bone holding forceps; knife; forceps; clamps; cautery; suction; towel clips; needle holders; sutures; retractors, curved awl and periosteal elevator.

All personnel must wear masks, hats, and cover as much skin as possible. Bacteria spread to the wound on skin cells from people in the operating room. Traffic in the OR should be minimal.

**SIGN Equipment Necessary for Use of SIGN Nail:**

- L-handle
- Locking Bolt - (2) one is extra
- Target Arm (Long Proximal Target Arm, Distal Target Arm)
- Short Target Arm (for use with nails shorter than 280mm)
- Distal Cap Screws - (4) two are extra
- Shoulder Cap Screws - (2) one is extra
- Combination Hex Wrench - (2) one end fits the Shoulder Cap Screw, Distal Cap Screw and the other end fits the interlocking screws
- Cannula
- Alignment Pin - (2) One is extra
- Drill Guides - (2) one small for pilot hole, one large for Step Drill
- Drill Bits
  - Large (2) (6.3mm)
  - Small (2) (3.5mm) for both near & far cortex
- Screw Caddy and SIGN Interlocking screw assortment – filled with SIGN screws
- SIGN IM nails in probable sizes should be available
- Hex Screw Driver (3.5mm)
- Extractor/Compressor Set
  - Extractor Rod Connector
  - Extractor-Compressor Rod
- Slap Hammer Weight
- Slot Finders: Cannulated, Solid, and Curved, one of each
- 11mm Wrench
- Tissue Protector - (2) one is extra (these are reusable)
- Depth Gauge
- Step Drill
- Screw Hole Broach

*Note: For more information see Chapter 12*
Open Fractures

Open fractures should be debrided, irrigated and evaluated for wound closure as soon as possible after injury. Antibiotics should be started as soon as possible. After debridement, close dead space in the wound. A basic consideration of open fractures is whether the wound can be closed without risk of infection. If so, a nail can be inserted.

Treatment by External Fixation

Fractures treated by external fixation may have conversion to SIGN nail immediately upon removal of external fixation, if pin tracks are clean and dry. If pin tracks look infected, over-drill pin hole and place another pin in a different location. Wait until the pin track is clean and dry before conversion.

Reduction

- **Closed reduction** can often be accomplished if the fracture is less than 10 days old. If closed reduction is attempted, check stability in all planes prior to reduction so you can compare the stability after the reamer or nail has been inserted.

- **Open reduction** is usually necessary after 7-10 days. Gently dissect the soft tissue and early callus from the main fracture fragments. Ream the canals of each fragment to the metaphysis. Overream the bone canals at the fracture site if bone has grown in. Reamers must be rotated in *clockwise* direction during reaming and during removal of reamers. Save the bone from the flutes of the reamer and the fluid from the reaming in a bone cup. Place them at the fracture site just before closing.

Transverse fractures can be reduced after both ends have been freed from soft tissue. Figure 1 demonstrates one method. Allow the tissues to slowly elongate during reduction.

Figure 2 demonstrates reduction of oblique fractures and those with minimal telescoping.

Alignment and rotation are accomplished using the linea aspera. Stabilize the reduction securely with a Loman clamp during reaming from bone entrance, nail insertion and interlocking.

If the fracture has telescoped long enough to become fixed, the SIGN distractor or AO distractor can be used to bring these fragments out to length.
Technique for Use of SIGN Distractor

- Free up both ends of the fracture fragments completely, then ream as described. The fracture fragments should be parallel when the bone holders are applied.

- Once bone holders are applied, place the distractor over clamps and stabilize connection. (Figure 3)

- There is one movable side of the distractor and one that is immobile. The immobile side of course would be placed on the fracture fragment that is immobile such as the proximal fragment of a fractured femur.

- Begin ratcheting to distract the fragment. Go slowly as the quadriceps will be very tight. Stop periodically to allow the tissues to stretch. (Figure 4)

- Once the distraction has reached 4 inches, remove the distractor and replace the clamps so that they are close together. This will put less stress on the ratchet arm.

- Begin the distraction again. If there is a tight band in the quadriceps, release it. Be sure rotation is aligned as you distract the fragments and they will soon fit together anatomically. (Figure 5)

*Note: It is important to go slowly so that the tissues can stretch.*
Reaming from the Bony Entrance

- Use the curved awl to make the initial bony entrance.
- Reamers of increasing sizes are introduced to connect the bony entrance to the diaphysis.
- Use tissue protector to keep the reamers from touching the skin.
- If the reamer does not advance, pull back and redirect the reamer.
- Apply counterpressure to leg as needed.
- Ream until chatter and select the nail diameter 2 mm smaller.
- The length of the nail in the tibia is determined by pushing the blunt reamer to subchondral bone and measuring the distance on the reamer (Figure 6). In the femur the length must be determined by template using the normal femur x-ray or using the marks on the reamer and laying alongside the femur without touching the skin. The reamers have marks on the shaft.
- Overream another 2 mm for 4 cm distal to the entrance hole to accommodate the bend in the nail.
- Save the bone and fluid that comes out when the reamer is withdrawn and place in a bone cup.
- If you are uncertain the reamer is in the canal, push it and if no resistance occurs, the reamer is not in the canal.
- Blocking screws can be used to guide the nail and prevent deformity in the proximal and distal femur and tibia.

Fig. 6
CHAPTER 3: SIGN TECHNIQUES FOR ALL FRACTURES

Attaching Nail to the Target Arm

1. Attach nail to L-Handle
   - Insert the locking bolt through the hollow stem of the L-handle. (Figure 7)
   - Align the tabs in the nail to the corresponding notches on the stem tube of the L-handle. (Figure 8)
   - Be sure the L-handle protrudes on the side for proper interlock.
   - Tighten the locking bolt into the nail. (Figure 8)

   If the locking bolt is not progressing easily through the L-handle and into the nail, unscrew the locking bolt, and reorient the locking bolt. Do not cross-thread.

2. Attach Target Arm
   - Attach the assembled L-handle and nail to the proximal target arm using the shoulder cap screw. (Figure 9)
   - If the shoulder cap screw does not turn easily, adjust the junction between the L-handle and the target arm.
   - Use the combination hex wrench to secure the target arm to the L-handle.
Attaching Nail to the Target Arm (cont.)

3. Attach Distal Target Arm to Proximal Target Arm

- Place the tongue of the distal target arm in the groove of the proximal target arm.
- Place the alignment pin into distal nail slot. (Figure 10)
- Align the holes in the distal and proximal target arms.
- Be sure the two sides of target arm are approximated before screwing in cap screws, which are placed two holes apart.
- Tighten each cap screw a bit and then tighten the other while the alignment pin is held above the slot in the nail.
- Final tightening of the cap screws is done with the combination hex wrench.
- Remove the target arm. (Figure 11)
Nail Insertion

- Use the tissue protector to prevent the nail from touching the skin. Push the nail into the canal as far as possible. Many surgeons do not use a mallet to insert the nail. If you decide to use a mallet, use small taps and rotate the nail 10° as it proceeds down the canal. (Figure 12)

- Apply counter pressure to the leg to allow nail to advance. If the nail does not advance with the small taps, consider using a smaller diameter nail or reaming more. Hitting the nail forcibly will bend the nail and make interlock more difficult. Check the reduction periodically.

- Leave the proximal 3mm of the nail above the cortical bone to provide additional stability. Remember the ring on the stem tube is 3mm above the nail. (Figure 13)
**Distal Interlock**

The distal interlock is done before the proximal interlock so the nail can be rotated to find the slot in the nail.

- Reattach the target arm to the L-handle (Figure 14). Be sure the locking bolt is tight.
- Decide whether you will use 1 or 2 interlocking screws. If one interlocking screw is sufficient, place the screw in the hole nearest the fracture.
- Use the alignment pin to mark the location for the skin incision. Be sure the skin incision is large enough to place the cannula and your finger on the bone. This finger is used to identify the location of the cannula on the bone and stabilize the cannula during the drilling of the holes.
- Incise the fascia. Use the periosteal elevator to spread the muscle down to the bone.
- If the cannula is directed by the target arm so it does not hit the bone, loosen the cap screws and adjust the target arm so the cannula will direct the hole into the canal. You will find the slot in nail by rotation of the nail.
- Place the cannula on the bone. (Figure 15)
- Use a curved clamp to remove soft tissue between the cannula and the bone. Be sure no fascial bands are pushing the cannula.
Distal Interlock (cont.)

Drilling hole in near cortex

- Insert the small drill guide into the cannula and use small drill bit to drill a hole in the near cortex. Avoid hitting the nail with the drill bit. (Figure 16)
- Remove small drill guide and place large drill guide.
- Insert the step drill to enlarge the pilot hole.
- Stop rotating the step drill when it stops suddenly after engaging in the slot of the nail. Further twisting will break the step drill. (Figure 17)
- In hard bone the screw hole broach inserted through the cannula may be used to enlarge the hole to allow the slot finders to enter the canal. If the slot finder does not rotate, use the screw hole broach to enlarge the hole and remove the ring of bone at the bottom of the hole. See Figure 18 for comparison of screw hole broach and step drill.
CHAPTER 3: SIGN TECHNIQUES FOR ALL FRACTURES

Distal Interlock (cont.)

Slot Finder

- Insert the solid slot finder through the hole in the near cortex.
- Line the flats of the slot finder handle with the target arm.
- Apply pressure to the solid slot finder with the flats in the plane of the target arm. Rotation is not used to place the slot finder. Push the slot finder in. If the slot finder engages the slot in the nail, 10° to 15° of rotation with a sharp stop to the rotation will occur. This is the “SIGN feel.” (Figure 19)

- If the slot finder rotates 360°, it is not in the slot or stuck in the hole in the cortex.

- If the solid slot finder enters the slot and the “SIGN feel” is felt, place the cannulated slot finder. Test again for “SIGN feel.” (Figure 20)

- Place the small drill bit through the cannulated slot finder and drill a hole in far cortex.

- Remove the cannulated slot finder and measure the length of screw. (See page 18, Figure 27)

Note: Refer to Chapter 12, page 44 & 45 for slot finder part numbers and detailed pictures.
Distal Interlock (cont.)

- The slot finder may miss the slot (Figure 21). Often the surgeon feels the slot finder hitting the nail but it does not enter the slot.

- **Remove the target arm** and use the curved slot finder. Do not keep trying to put solid slot finder into slot.

- Find the nail with the curved slot finder. It may be necessary to change the direction of the curved slot finder. (Figure 22-23)

- Once the curved slot finder partially enters the slot (Figure 23), rotate the nail to allow complete entry into the slot. (Figure 24)

- Once the curved slot finder enters the slot. Change to solid slot finder and then cannulated slot finder. Leave the target arm off.
Distal Interlock (cont.)

Drill hole in far cortex

- Once the cannulated slot finder enters the slot, drill for hole in far cortex. (Figure 25)
- Place the depth gauge through the cannulated slot finder into the far cortex. (Figure 26)
- Leaving the depth gauge in the hole, remove the cannulated slot finder and place the cannula over the depth gauge to measure for the screw. (Figure 27)
CHAPTER 3: SIGN TECHNIQUES FOR ALL FRACTURES

Distal Interlock (cont.)

- Do not bend the Depth Gauge. If the depth gauge is bent it will not pass through the cannulated slot finder into the hole in distal cortex. (Figure 28)

- Use your finger tip tactile sense to determine when the tip is caught on edge of the hole. Rotate depth gauge to measure in two sides of hole.

- Add 5mm to the measurement so two threads can be inserted through the far hole and the head of the screw is 3mm prominent on the near cortex. This will make screw removal much easier should it be necessary.

- Place the screw through the holes in the cortex and slot of the nail. Raise the cannula during screw insertion so the screw head can be visualized in order not to insert the screw too deeply. (Figure 30)

- Rotate the L-handle to be sure the screw is in the slot after the screw has been inserted.

- Compress the fracture as needed after the first interlocking screw has been placed (see extractor compression section).
CHAPTER 3: SIGN TECHNIQUES FOR ALL FRACTURES

Placement of the Second Distal Interlocking Screw

Place Screw

- The second distal interlocking screw is used for additional stability.

- Place the alignment pin in the hex of the head of the screw which has been inserted. (Figure 31)

- An assistant should be assigned to be sure this alignment pin remains in the hex. Rotate the L-handle and leave it in the center of the rotation.

- The initial incision should be large enough to insert the second interlocking screw. Use the same procedure as the first distal interlocking screw.
Proximal Interlocking Screw Fixation

- Remove the alignment pin resting in the screw head of a distal interlocking screw. This is not necessary for the proximal interlocking.

- Finding the slot and hole in the proximal nail does not require slot finder.

- The cannula and small drill guide are placed through the target arm and the hole is drilled through both near and far cortex. (Figure 33)

- The hole is enlarged, by the step drill, in the near cortex (Figure 34). The depth gauge is used to measure the length of the screw using the cannula and the proximal interlocking screws are placed.

- Remember the proximal apertures in the nail are a slot and a hole. (Figure 32).

- Manipulation of the knee should be done after nail and screw insertion in all SIGN surgery.
CHAPTER 3: SIGN TECHNIQUES FOR ALL FRACTURES

Tips for Interlocking

- After placing the target arm on the L-handle, sometimes the cannula directs the small drill guide so it is not in contact with the bone cortex. If this occurs, loosen the distal cap screws and adjust the target arm so the pilot hole is directed through the cortex. In the femur this occurs in the anterior plane and in the tibia the posterior plane. Proceed with enlarging the hole in the near cortex and use the curved slot finder to find the slot in the nail. Sometimes it is necessary to chamfer the hole toward the nail slot with the screw hole broach to allow cannulated slot finder to enter slot in nail. Rotate the nail by rotating L-handle to position slot parallel with hole in near cortex.

- If either slot finder will not rotate after being placed into the hole in the near cortex, enlarge the hole with the screw hole broach. Often bone will remain in the hole even though the step drill enters the slot in the nail.

- If the slot finder does not enter the slot in the nail, remove the target arm and use the curved slot finder. Place the curved slot finder through the hole in the near cortex and find the nail by tapping on it. Rotate the nail so the slot in the nail is parallel with the hole in the cortex. If the curved slot finder partially enters the slot, rotate the nail to allow it to fully enter the slot. Confirm location of the slot by using the solid slot finder and then the cannulated slot finder. Once the cannulated slot finder has been placed and confirmed by the “SIGN feel,” drill the hole in the far cortex. Measure and place the screw.

- If the curved slot finder does not enter the slot, check the longitudinal orientation. Be sure the reduction has not slipped. This will misalign the longitudinal orientation of the hole in the cortex and slot of the nail. Correct this misalignment and place the slot finder. Check to be sure the nail has not migrated proximally or distally, which will also misalign the hole and slot in the longitudinal plane.

- Check to be sure the locking bolt is tight, before attempting interlock.

- After insertion the location of the end of the nail depends on
  1. Amount of anterior bow in the femur
  2. Force required to drive the nail through the canal
  3. Diameter of the nail
  4. Length of the nail

    Please contemplate this. The end of the nail will reside more posteriorly the greater the anterior bow, the greater the amount of force to drive the nail in, the smaller and longer the nail.

- If the nail is struck by mallet to progress down the canal, the nail will be bent in the isthmus and this bend will cause nail to progress posteriorty. The target arm will be anterior so adjust the target arm.
The fracture may need compression after the nail and the first interlocking screw has been placed.

1. First, make sure the locking bolt is connected tightly to the nail through the L-handle. (Figure 35)

2. Place the connector on the locking bolt by sliding the head of the bolt into the base of the connector. (Figure 36)

3. Place the slap hammer weight on the connector rod. (Figure 37)

4. Attach the connector rod to the connector. The extractor-compressor can now be used to extract the nail or compress the fracture. (Figure 38)
Position of Patient for Proximal Tibia Fractures

Proximal tibia fractures may be reduced in the Figure 4 position. (Figure 39) This allows the assistant to flex the proximal fragment during reaming and nail insertion.

Skin Incision

Flex the knee to feel the patella tendon. Make the skin incision in the midportion of the tendon from the patella to the tibial tubercle, (Figure 40) or incise medial to the patellar tendon.

Bone Entrance

Do not enter the fat pad. A curved awl is used to make the bone entrance. The more proximal the fracture, the more posterior the entrance hole should be. Direct the awl anteriorly to shape the entrance hole anteriorly especially in proximal fractures. (Figure 41)
Reaming and Placement of the Nail

Push the proximal fragment into flexion to reduce the fracture as the curved awl makes the bone entrance. (Figure 41)

Continue pressure during reaming insertion of the nail. The blocking screw may be used if this is unsuccessful. The blocking screw can be any cortical or cancellous screw or even a K wire. (Figure 42)

We use fewer blocking screws because flexion of the proximal fragment reduces the fracture, in most surgeries. The proximal bend of the nail should be placed apex posteriorly.

- If you use a bump, avoid pressure in the popliteal space. (Figure 43-44)
- If open reduction is necessary, perform this prior to the incision for the bone entrance of the nail.
Mid and Distal Tibia Fractures (cont.)

**NOTE:** See technique used in all approaches in Chapter 3.

**NOTE:** Distal and Proximal Interlock described in previous section.

The awl is used to make the entrance hole. Use the reamers to extend the hole into the diaphysis. (Figure 45)

Ream until chatter and then select diameter 2mm smaller. If you are unsure that the nail is in the canal of the distal fragment, push the reamer until resistance is encountered. If there is no resistance, the nail is not in the canal.

The length of the nail is determined by placing a blunt reamer down to subchondral bone and measuring this length. (Figure 46)

The new reamers are marked at 280mm and 320mm to help determine the length of the nail.
NOTE: See technique used in all approaches in Chapter 3.

Indications Distal Femur
Fractures in the distal femur should be treated with retrograde approach unless there are wounds around knee or leg.

Position of the Patient
Supine position with a sterile bump or triangle under the knee. 60° of knee flexion is desirable. Moving the knee into extension and flexion allows better visualization of the femoral notch. If 60° flexion is impossible, manipulate knee to gain flexion or remove 4mm longitudinal section of patellar tendon & leave attached distally (similar to ACL patellar tendon graft).

Reduction of the Closed Fracture
Closed reduction can be done without C-arm in fresh fractures. Open reduction is accomplished by the mini incision technique. After identifying the fracture, incise the skin & tensor fasciae latae. Use periosteal elevator to distract muscle fibers. Dissect posterior to vastus lateralis.

Skin Incision
A medial parapatellar incision or incision through the patellar tendon may be used. This is done by flexing the knee so the patellar tendon can be palpated, incising the patellar tendon and removing a window in the fat pad to see the medial aspect of the femoral notch.

Bone Entrance
Use curved awl to make entrance hole in the medial aspect of the femoral notch above the posterior cruciate ligament at junction of articular surface. (Figure 47) Give counter traction by holding fracture reduction.

If the entrance is placed too far posteriorly, the posterior cruciate blood supply will be compromised. The patella does not articulate with the articular surface in the area of the entrance hole. Stabilize the distal femoral fragment as the bony entrance and reaming take place. Look at the fracture site to see the direction of the awl and subsequent reamers.
**Reaming**

Introduce the reamers after the bone entrance has been made using the awl. The reamers are rotated 360° in a clockwise manner. Reduction of the fracture will provide counterpressure for reaming. Look at the distal femur fragment if the fracture site is exposed to direct the reamer. Save the bone from the flutes of the reamer in a bone cup for use as a bone graft. Diameter of the nail is determined by noting the size of the reamer that creates chatter in the isthmus of the femoral canal. Use a nail whose diameter is 2mm smaller than the reamer that created the chatter.

**Nail Insertion**

The bend of the nail is angled apex **anteriorly**. The nail should not be within 6cm below the lesser trochanter. (Figure 48)

Stop advancing the nail when the ring touches the articular cartilage on the medial femoral condyle. (Figure 49)

Check the tightness of the locking bolt to the nail. The nail should be inserted so the ring rests on the articular surface of the medial femoral condyle. The nail will then be just below the articular surface. (Figure 49)
**Distal Interlock**

*NOTE: See page 22 for location of end of nail.*

The final location of the slots in the distal nail depends on the curve of the femur and the force necessary to insert the nail. SIGN nail is a straight nail. If it is inserted into the canal without force, it will end up in the anterior portion of the femur. (Figure 50)

The longer the nail, the more anterior the distal tip will be (Figure 50). Adjust the target arm if the cannula rests too far anteriorly off the bone.

If the nail is exerted with force it will bend and be more centrally or posteriorly located in the canal. If the slots are in a narrow part of the femur, they will be more central in the canal. (Figure 51)

Figures 52 and 53 illustrate the effect rotation has on the orientation of the slots. Rotation of the nail will place the slots in parallel with the hole in the near cortex. This is especially important with a curved slot finder.

Insert the solid slot finder. Keep the flat of the handle in line with the nail. Push it in the slot.

The second “SIGN feel” is rotating the slot finder 10° when it is in the slot. If it does not rotate, it may be stuck in the bone hole or obliquely in the slot. Use the screw hole approach.

If either slot finder cannot be placed, remove the target arm and use the curved slot finder, page 17. Be sure the fracture has not shifted or the hole will not be in longitudinal orientation to the slot. Rotate the nail to orient the slot to the hole. Practice this using the nail when not in the bone or use a sawbones.
Compression of Fracture in Retrograde Approach

NOTE: If you wish to compress the fracture site, place one interlocking screw in the nail hole nearest the knee. The locking bolt is struck to move the distal fracture fragment toward the proximal fragment. (Figure 54) Different from the antegrade approach.

After Compression of Fracture Site

Some rotation is still possible if the proximal interlocking screw has been placed to impact the fracture, (Figure 54). Use the usual technique for finding the distal slot in the nail. If more rotation is needed, the proximal screw closest to the knee may be removed to allow rotation. After the distal interlock has been accomplished, place the proximal interlock.

NOTE: Distal and proximal refers to the nail rather than the bone. (Figure 55)

NOTE: See technique used in all approaches in Chapter 3.
Position of Patient

Supine or Lateral: Lateral is best for open reductions. Technique for lateral position will be described. Patient must be stabilized in the lateral position to prevent shifting during surgery.

Reduction

If open reduction is indicated, perform this prior to skin incision for nail insertion. Incision should be as short as possible. Identify the proximal fragment by abducting the leg. Incise the skin and fascia over the end of this fragment. Use your finger to identify the fracture site. If the bone has penetrated the muscle, use that tract to expose the fracture site. If not, approach in the posterior portion of the vastus lateralis. Use periosteal elevator to spread the muscle fibers. Free up each of the main fragments by removing soft tissue attachments. Save the callus for bone graft. Ream each fragment from the fracture site. Do not penetrate the metaphysis at either end of the bone. Save the bone from the flutes of the reamer for bone graft. Secure the reduction with clamps.

Skin Incision For the Entrance

Extend from the superior greater trochanter posteriorly in the direction of the gluteus maximus fibers. Dissect down to the greater trochanter in the region between the posterior and middle one third junction. Dissect through muscle fibers with finger or periosteal elevator. Incise the fascia for the insertion hole.

Bone Entrance

Entrance should be placed in a junction between the posterior and middle one third of the greater trochanter. (Figure 56)

We do not recommend placing the entrance through the piriformis fossa. Hoop stresses are generated when the bend passes through the piriformis fossa. If you doubt this, place a nail into a sawbones and note the hoop stresses. The SIGN nail has a 9° bend in the proximal end to accommodate the proximal curve of the femur. Use a curved awl to make the entrance. If possible visualize the fracture site to determine the direction of the awl. Sink the awl to the hilt.

Reaming

Start with the smaller reamers and increase reamer sizes until chatter is heard. Be sure you can feel the reamer rotating through a 360° arc to know the reamer is in the canal. Once chatter is felt for 4-6cm, over ream the proximal femur to allow room for the bend of the nail. Be aware of the reduction during reaming. Nail diameter is 2-3mm smaller than the reamer which caused chatter.
Preparation of the Nail

NOTE: See technique used in all approaches in Chapter 3.

Insertion of the Nail

Use tissue protector to keep the nail off the skin. Push the nail in as far as it will go. If the nail stops, tap the locking bolt with small taps. Rotate the nail 10° after 4 taps. (Figure 57)

The 1-1/2° bend at the end of the nail helps keep the nail from being caught in the canal. If the nail does not advance with light taps, it is not in the canal or it is too large. Never hit the nail with heavy blows. This will cause the nail to bend and make interlocking difficult. Never hit the L-handle or you will ruin the L-handle for interlocking. Check reduction as the nail advances.

Allow the nail to rotate freely as the bend in the nail slides into the canal, never force rotation. Leave nail 3mm prominent above bone cortex. (Figures 58 and 59)

Note the difference in orientation of slots. (Figures 58 and 59)

Both directions allow stable interlock.
Insertion of the Nail (cont.)

Proximal interlock can be done through lateral to medial (Figure 60) or anterior to posterior direction. (Figure 61) They are equally stable.

The proximal end of the nail should be 3mm higher than the cortex of the greater trochanter. (Figure 60) This adds to the stability of the nail and makes removal easier.

Distal Interlock

After insertion the location of the end of the nail depends on

- Amount of anterior bow in the femur
- Force required to drive the nail through the canal
- Diameter of the nail
- Length of the nail

If the nail is inserted without force, the end will be anterior in the canal. (Figure 62)

The end of the nail will reside more posteriorly the greater the anterior bow, the greater the amount of force to drive the nail in, the smaller and longer the nail. (Figure 63)
Compression of Fracture

After the first distal interlocking screw is placed, the fracture site may be impacted. (Figure 64)

Proximal Interlock

This may be directed from lateral to medial or anterior to posterior.

Manipulate the knee to full flexion.
Position of Patient

The patient is placed in beach chair position on the operating table. (Figure 65)

All prominences must be padded especially the radial nerve.

Reduction

If open reduction is done first, avoid damage to the radial nerve.

Skin Incision

Palpate the bicipital groove and make the incision posterior to the groove (Figure 66) in the greater tuberosity.

Use periosteal elevator to dissect through the fibers of the deltoid muscle. Split the rotator cuff so it can be repaired. Repair is very important.
Bony Entrance

The hole should be placed in the greater tuberosity at the junction of the articular surface. Use the curved awl. (Figure 67)

Reaming

Be sure the fracture site is not distracted during reaming. (Figure 68)

Nail Insertion

The diameter of the nail is 1mm less than the largest reamer that achieved chatter. Be sure the fracture site is not distracted during placement of the nail. Rotate the nail so the distal interlocking screws will not be in the vicinity of the radial nerve. The nail should be flush with the entrance hole. Place bone wax over the end of the nail after the L-handle is removed.

Interlocking

Interlocking is done as described in the technique used in all approaches. The difference in the proximal interlock is that the screw must not penetrate the joint space. Make the pilot hole and enlarge using the step drill.
**Description**

The SIGN intramedullary Fin Nail is designed so the Fin Nail takes the place of the distal interlocking screw. (Figure 69)

Proper technique especially reaming for Fin Nail will optimize the fixation.

Please note the femoral canal is oval so on one view of the post-op x-ray the Fin Nail appears to be surrounded by bone and the other x-ray reveals a gap between canal and Fin Nail on one side.

![Fig. 69 Cross section of fins seated in bony canal](image)

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<tr>
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<th>Size 8mm</th>
<th>Size 9mm</th>
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</table>

**NOTE:** The Fin Nail length refers to the distance between the nail notch (at the proximal end of nail) and the end of the flutes as shown above. (Figure 70)

The marks show the reaming depth of the **LAST** reamer used for the corresponding nail.
CHAPTER 9: FIN NAIL

**Technique**

Open or closed reduction can be used. The technique used in standard SIGN Nail is the same except for the reaming.

**Triple Ream**

**First Ream**
- Ream until chatter is felt for 4 to 6cm of the canal. The size of the fin will be 1mm larger than this reamer.

**Second Ream**
- Ream with the next larger size reamer but stop at the mark pertaining to the length of the Fin Nail selected. (Figure 71)

**Third ream**
- Ream using the next 2 larger sizes to accommodate for the bend of the nail. This reamer should only penetrate 4cm.

**Proximal Interlocking**

This procedure is similar to proximal interlocking of the standard SIGN Nail. The proximal portion of the standard target arm, short target arm, or hip and pediatric target arm may be used.

**Instruments**

The standard or short target arm is used for the proximal interlocking. (Figure 72)
1. It is important to leave the proximal end of the nail and the screws prominent. Many times we see that the nail has been placed inside the bone and we are concerned about removal later on. It is much easier to find the interlocking screws and nail if they are left prominent.

2. Leave one screw present until the nail can be adequately secured and pulled out. Sometimes after the distal interlocking screws have been removed a screw driver or other instrument can be left in the slots of the nail so it does not slide down. We were also able to push the nail up using this method.

3. Try to use the same distal holes for interlocking in the replacement nail if the broken nail is SIGN. Use the same length of nail, but a wider width. Four holes in the femur provide a stress concentrator which may result in a fracture at the distal interlocking area. If the broken nail is not SIGN try to line up at least one hole to SIGN slot.

4. The advantage of using stainless steel nails over titanium becomes manifest because the bone does not grow into stainless steel as it does into titanium.
SIGN Standard IM Nails and Fin Nails

Description: SIGN Intramedullary Nails (IM Nails), Fin Nails and Screws are designed to provide fixation of tibial, femoral, and humeral fractures while they heal.

Information for Use: The surgeon must select the type and size nail that best meets the patient’s need.

Indications:
The SIGN IM Nail is indicated for internal fixation of diaphyseal tibial fractures, distal femur fractures including transverse fractures, oblique and spiral fractures, comminuted fractures, fractures with bone loss, open fractures, corrective osteotomies, pathologic fractures, pseudoarthrosis of the tibial shaft, non-unions, mal-unions and fractures of the proximal femur.

The SIGN Fin Nail is indicated for internal fixation of stable fractures in the femur and humerus.

Contraindications: Active or latent infection, Osteoporosis, insufficient quantity or quality of bone/soft tissue and/or material sensitivity is suspected, or patients who are unwilling or incapable of following postoperative care instructions.

Warnings: For safe and effective use of this implant, the surgeon must be thoroughly familiar with the implant, the method of application, instruments, and the recommended surgical technique for this device. Device breakage or damage can occur when the implant is subjected to increased loading associated with delayed union, non-union, or incomplete healing. Improper insertion of the device during implantation can increase the possibility of loosening and migration. The patient must be cautioned, preferably in writing, about the use, limitations, and possible adverse effects of this implant including the possibility of the device failing as a result of loose fixation and/or loosening, stress, excessive activity, or weight bearing or load bearing, particularly if the implant experiences increased loads due to delayed union, non-union, or incomplete healing. The patient must be warned that failure to follow postoperative care instructions can cause the implant and/or treatment to fail.

Precautions: An implant shall never be reused. Previous stresses may have created imperfections, which can lead to device failure. Instruments shall be inspected for wear or damage prior to usage. Protect implant appliances from scratching and nicking. Such stress concentrations can lead to failure.

Adverse Effects: Fracture of the implant due to excessive activity, prolonged loading upon the device, incomplete healing, or excessive force exerted on the implant during insertion. Implant migration and/or loosening. Metal sensitivity or histological or allergic reaction resulting from implantation of a foreign material. Pain, discomfort, or abnormal sensations due to the presence of an implant. Nerve damage resulting from surgical trauma. Necrosis of bone or bone resorption. Necrosis of tissue or inadequate healing may occur with any fracture.
Sterility: All Implants and Instruments are provided non-sterile. Sterilization must be performed prior to surgery, using one of the following methods. For a gravity displacement autoclave, set at 250°F (121°C) for 30 min., allow drying time of 45 min. For a pre-vacuum autoclave, set at 270°F (132°C) for 4 min., allow drying time of 30 min. or at 273°F to 279°F (134°C to 137°C) for 3 min., allow drying time of 16 min.

Please consider your equipment manufacturer’s written instructions for the specific sterilizer and load configuration being used and current Association of periOperative Registered Nurses (AORN) standards and recommended practices.

NOTE: These parameters are for full loads using wrapped sets, rigid containers and/or peel pouches.

Storage Instructions: Store in a cool dry place, and keep away from direct sunlight. Prior to use, inspect product package for signs of tampering, damage, or water contamination. Use oldest lot first.
SIGN Instruments: SIGN instruments are reusable; however, they have a limited life span. Prior to and after each use, the instruments must be inspected where applicable for sharpness, wear, damage, proper cleaning, corrosion and integrity of the connecting mechanisms. Notify SIGN (info@signfracturecare.org) if they should be replaced. Instrument breakage or damage can occur when an instrument is subjected to excessive loads, speeds, or dense bone. Striking the cutting surfaces with other metal will cause these surfaces to become dull.

Cleaning: SIGN instruments and accessories must be thoroughly cleaned before reuse. Decontamination of reusable instruments should occur immediately after completion of the surgical procedure. Excess blood or debris should be wiped off to prevent it from drying onto the surface. Use an enzymatic-cleaning product such as Enzol.

NOTE: Even surgical instruments manufactured from high-grade stainless steel must be dried thoroughly to prevent rust formation. All devices must be inspected for cleanliness of surface and joints, proper function, and wear and tear prior to sterilization.

Sharpening: The drill bits and reamers become dull if they are dinged by hitting the nail or other metal. They should be protected during surgery, cleaning, and sterilization. They are also dulled by pushing drill bits into bone when they are not advancing. The drill bit heats up and becomes dull. Pulse the drill to help reduce heat.
CHAPTER 12: SIGN INSTRUMENTS AND IMPLANTS

IMPLANTS

Part numbers are in BOLD

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### SHORT IM NAILS

* used with the Target Arm parts 433, 434, 435 on page 43

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# CHAPTER 12: SIGN INSTRUMENTS AND IMPLANTS

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REFERENCES

Cafafi LA, Antkowiak T, Curtiss S, Neu CP, Moehring D. A biomechanical comparison of the Surgical Implant Generation Network (SIGN) tibial nail with the stand hollow nail. Injury 2010;41:753-757
