

M/DN[™]
RETROGRADE NAIL
INTRAMEDULLARY
FIXATION

Surgical
Technique



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SURGICAL TECHNIQUES FOR FIXATION OF FRACTURES WITH AN M/DN™ (METAPHYSEAL/ DIAPHYSEAL NAIL)

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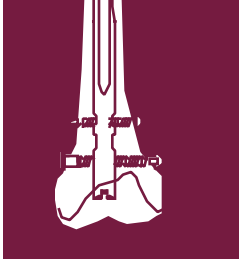
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SURGICAL TECHNIQUE FOR M/DN RETROGRADE FEMORAL NAIL FIXATION

INTRODUCTION

Retrograde femoral nailing is an alternate technique for the treatment of femoral fractures utilizing an intramedullary nail that is similar to but modified from a standard antegrade femoral nail. The *M/DN* Retrograde Femoral Nail is designed for optimal distal fixation and anterior to posterior proximal fixation. The nail is available in six diameters ranging from 9mm to 14mm and lengths from 14cm to 48cm in 2cm increments. The distal end of the retrograde femoral nail is 12mm in diameter for nail sizes 9-12mm.

INDICATIONS

- A. Fractures w/o Extensive Comminution
- B. Fractures Involving the Femoral Condyles
- C. Intertrochanteric Femoral Shaft Fractures
- D. Femoral Shaft Fractures with Attendant Femoral Neck Fractures
- E. Floating Knee Fractures
- F. Distal Fractures Involving Osteoporotic Bone
- G. Closed Supracondylar Fractures
- H. Nonunions or Pseudoarthroses
- I. Malunions
- J. Pathological Fractures
- K. T-condylar Fractures

PREOPERATIVE PLANNING

Proper preoperative planning is essential to successful retrograde nailing of the femur. To determine the appropriate nail size, an Ossimeter, roentgenogram templates, and an x-ray film of the unaffected extremity are necessary for determining canal size at the isthmus and for measuring the length of the femur to aid in determining nail length.

Harris/Galante Bulb-tipped Guide Wires (Sounds), available in diameters from 10mm to 17mm, can be used as an alternate technique to determine nail diameter and length.

X-rays taken at a 36-inch distance from the x-ray source result in 10-15 percent magnification of bone. The Ossimeter has both an actual size scale and one that takes into account this magnification. It should be used routinely to determine nail diameter and length.

The proper length of the nail should extend from 5mm-7mm above the intercondylar notch to 2cm-4cm above the superior border of the lesser trochanter. The diameter of the femoral nail should match the isthmus in the lateral x-ray projection.

The surgeon should review the x-ray to assure that there are no unusual anatomic variations.

PATIENT POSITIONING AND RADIOGRAPHIC CONTROL

Place the patient in the supine position (Fig. 1) with the knee flexed approximately 30 degrees. Prep the hip to the iliac crest to ensure access to the lesser trochanter.

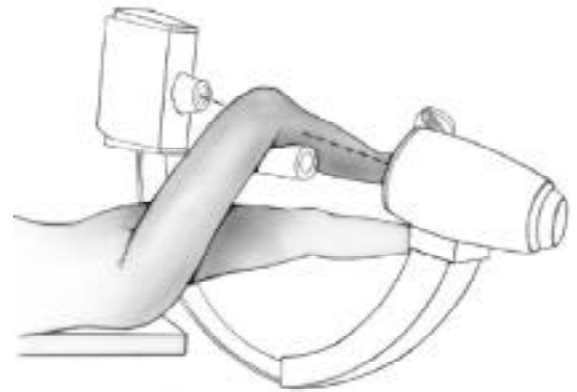


Fig. 1

The use of image intensification is required. The image intensifier should be sterile-draped and may be positioned from either the contralateral or ipsilateral side of the operating table. Positioning from the contralateral side will facilitate insertion of the proximal locking screws. This will also allow the limb to be externally rotated when obtaining a lateral view of the proximal femur for estimating the screw size. Confirm visualization of the hip as well as the shaft of the femur using image intensification before prepping and draping.

REDUCTION

It is important to reduce the fracture before beginning the surgical procedure.

INCISION AND EXPOSURE

Make a medial parapatellar incision in line with the femoral shaft (Fig 2). Dissect the soft tissue medial to the patellar ligament. It is not necessary to expose the femoral condyles as placement of the pin is determined under C-arm control.

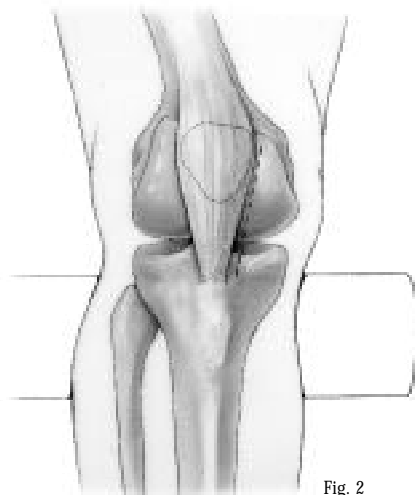


Fig. 2

CREATING THE ENTRY PORTAL

Locating the entry portal is extremely important to avoid anterior placement of the nail, involvement of the intercondylar notch, mediolateral mal-positioning, or posterior positioning involving the cruciate ligaments.

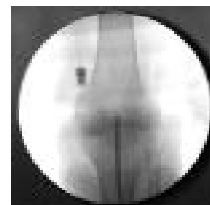
Place a smooth Steinmann pin through the fat pad and onto the femoral condyles (Fig. 3). Guide the pin to the notch region using gentle pressure to avoid any extraneous scoring of the articular cartilage. Take A/P and lateral views to check the proper position. The starting point should be in line with the femoral canal on the A/P view, and just anterior to where Blumensaat's line intersects the anterior intercondylar notch on the lateral view.



Steinmann Pin

Fig. 3

When the proper position is confirmed, apply firm pressure on the pin so the tip engages and maintains its position. Then adjust the angle of the pin so it is aligned with the femoral canal. Monitor the pin alignment with both A/P and lateral C-arm views as the pin is driven into the bone.



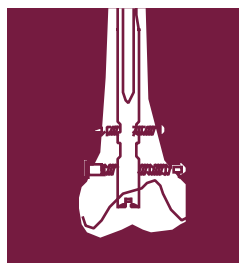
Advance the pin proximally until reduced resistance is felt as the pin exits the metaphyseal region. Make a final check with A/P and lateral views.

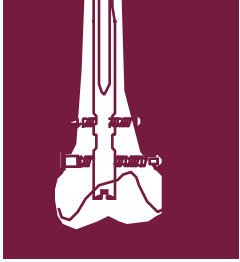
Insert the Trochanteric Reamer over the pin, and ream through the metaphyseal region (Fig. 4). Be sure to follow the path of the pin, allowing the reamer to advance through the metaphyseal bone without binding on the pin and pushing it up the femoral canal. Do not ream into the diaphyseal area. Stop reaming when reduced resistance is felt. Remove the reamer and Steinmann pin.



Trochanteric Reamer

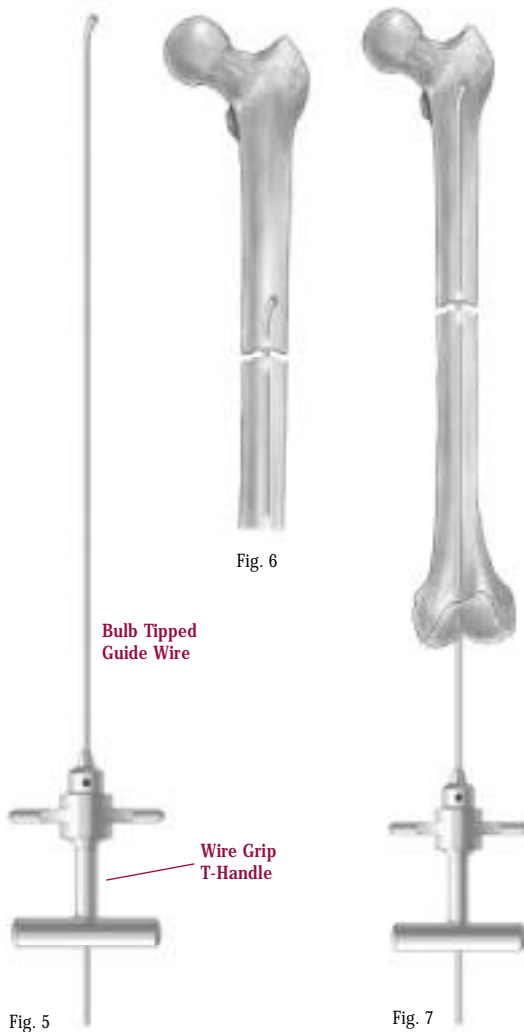
Fig. 4





GUIDE WIRE PLACEMENT AND REAMING

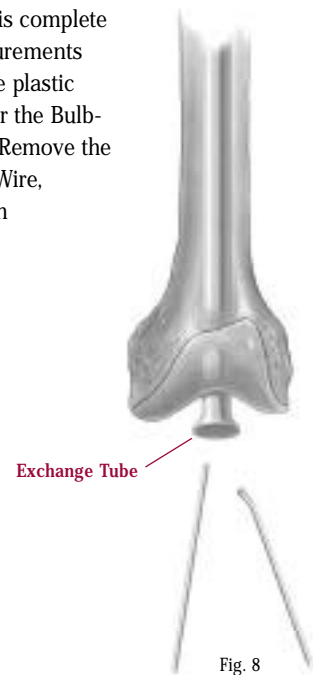
Attach the 3.0mm Bulb-tipped Guide Wire to the Wire-Grip T-Handle and tighten (Fig. 5). To aid in manipulation, bend the wire at a 10°-15° angle 2cm from the tip (or use a pre-bent wire). Insert the Guide Wire through the entry hole and manipulate it up the distal femur. At the fracture site, manipulate the Guide Wire under C-arm control (Fig. 6). Once in the proximal canal, pass the wire to its final position (Fig. 7).



Determine the proper nail length by placing a second Guide Wire of equal length at the intercondylar notch. The length of the wire that is not overlapping is the correct nail length. The 50cm Ruler or Ossimeter may be used for an accurate measurement.

Remove the Wire-Grip T-Handle, and place an intramedullary reamer over the Guide Wire. Ream the femoral canal in 1mm increments until contact is made with the cortical wall. Then continue to ream in .5mm increments up to 1mm greater than the selected nail diameter. **The distal end of the nail is enlarged on some sizes. Over ream as appropriate to create clearance for the nail. 9mm-11mm nails have a 12mm distal end.**

When the reaming is complete and the final measurements are made, insert the plastic Exchange Tube over the Bulb-tipped Guide Wire. Remove the Bulb-tipped Guide Wire, and insert a Smooth Guide Wire (Fig 8).



NAIL INSERTION

Place the selected nail over the Smooth Guide Wire and into the femur. Slide the adjustable arm of the Retrograde Distal Targeting Guide approximately to the middle of the targeting guide base and tighten the lock knob. Depending on the size of the patient, it may be necessary to adjust the position of the arm in or out.

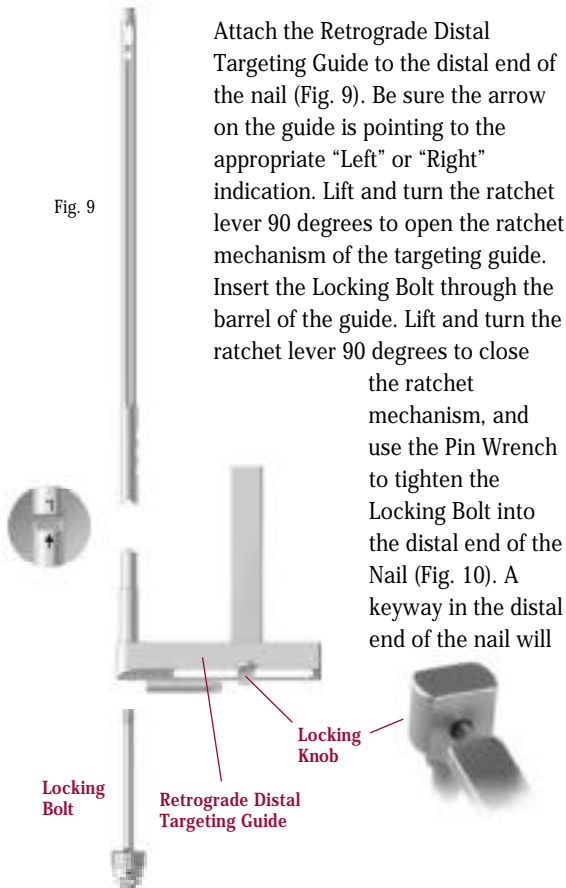


Fig. 9

Attach the Retrograde Distal Targeting Guide to the distal end of the nail (Fig. 9). Be sure the arrow on the guide is pointing to the appropriate “Left” or “Right” indication. Lift and turn the ratchet lever 90 degrees to open the ratchet mechanism of the targeting guide. Insert the Locking Bolt through the barrel of the guide. Lift and turn the ratchet lever 90 degrees to close the ratchet mechanism, and use the Pin Wrench to tighten the Locking Bolt into the distal end of the Nail (Fig. 10). A keyway in the distal end of the nail will

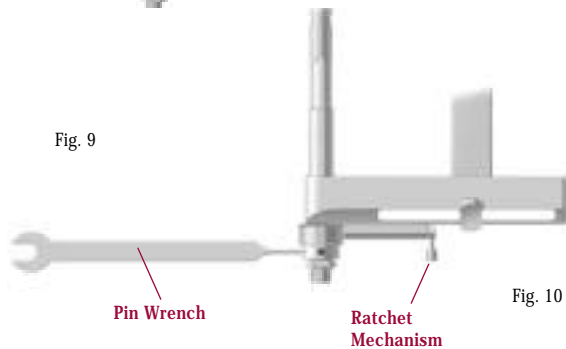


Fig. 9

Fig. 10

help ensure proper alignment. The ratchet mechanism will prevent the Locking Bolt from loosening during insertion of the nail (Fig. 11).

Note: If the ratchet mechanism of the Retrograde Distal Targeting Guide does not operate freely, it may be necessary to disassemble, clean, and reassemble the mechanism. If the ratchet mechanism becomes inoperative, it may be removed. The assembly will still function; however, the Locking Bolt may loosen during the procedure.

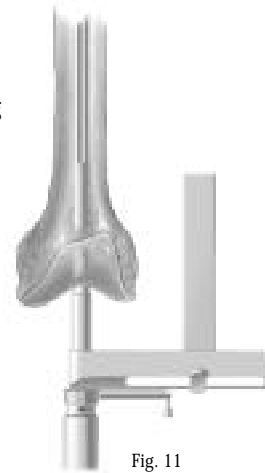


Fig. 11

Verify proper alignment by inserting the 4.5mm Femoral Drill Bushing into the 8.0mm Femoral Screw Bushing. All retrograde nail sizes use 5.5mm screws distally (Color Code: Green). Place the two guide bushings through one of the inferior holes in the Retrograde Distal Targeting Guide. Insert the 4.5 Femoral drill through the inner bushing. When the device is properly aligned, the drill will pass through the hole of the nail and will not contact the nail (Fig. 12). After ensuring proper alignment, remove the drill and bushings.

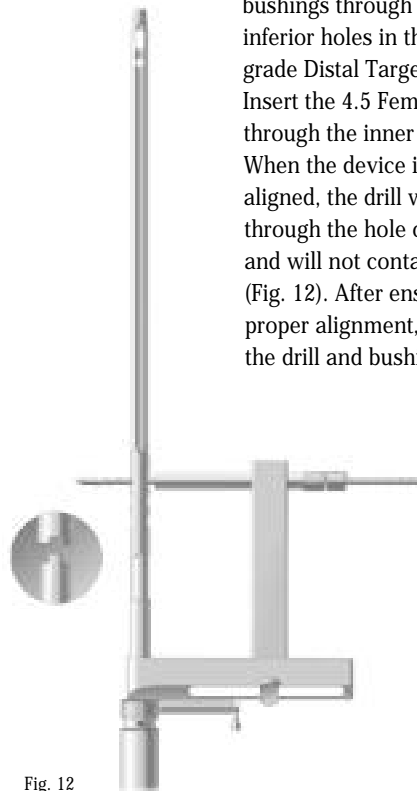
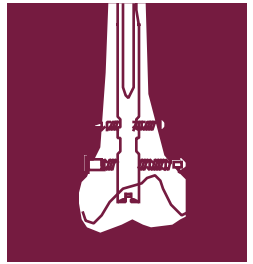
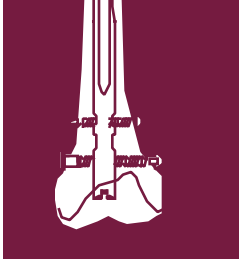


Fig. 12





Screw the Threaded Driver or Slaphammer onto the back end of the Locking Bolt. Begin seating the nail using gentle impaction. While impacting the nail, use the targeting guide to maintain the proper rotation. Take great care when crossing the fracture site. Visualize the fracture in two planes with image intensification to assure proper passage of the nail into the proximal fragment. Reduce the force of impaction as the distal end of the nail approaches the intercondylar notch.

If excessive resistance is encountered during nail driving, remove the nail and check the size of both the reamer and nail. Once proper sizing has been confirmed, the surgeon may choose to over ream the canal further or select a smaller size nail.

Continue to seat the nail. The targeting guide has a shoulder 15mm from the end of the nail (Fig. 13). Using this shoulder as a reference, countersink the nail approximately 5mm-7mm below the intercondylar notch. When the nail is fully seated, remove the Threaded Driver. Then **REMOVE THE GUIDE WIRE.**

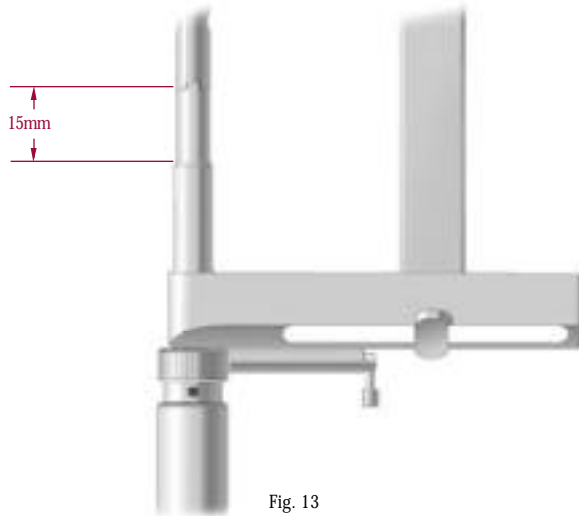


Fig. 13

DISTAL LOCKING

Slide the arm of the Retrograde Distal Targeting Guide toward the knee until it gently contacts the skin, and

tighten the Locking Knob with the pin Wrench. Insert the Femoral Screw Bushing through the Retrograde Distal Targeting Guide. Make a small incision at the point where the bushing contacts the skin. Then insert the 4.5mm Femoral Drill Bushing (Color Code: Green), into the Femoral Screw Bushing. Advance both bushings through the incision until they contact the

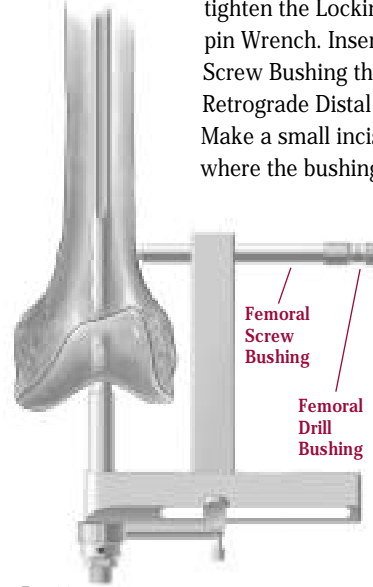


Fig. 14

bone (Fig. 14). Insert the 4.5mm Femoral Drill (Color Code: Green) and drill until the medial cortex is penetrated (Fig. 15). Remove the drill and Femoral Drill Bushing.

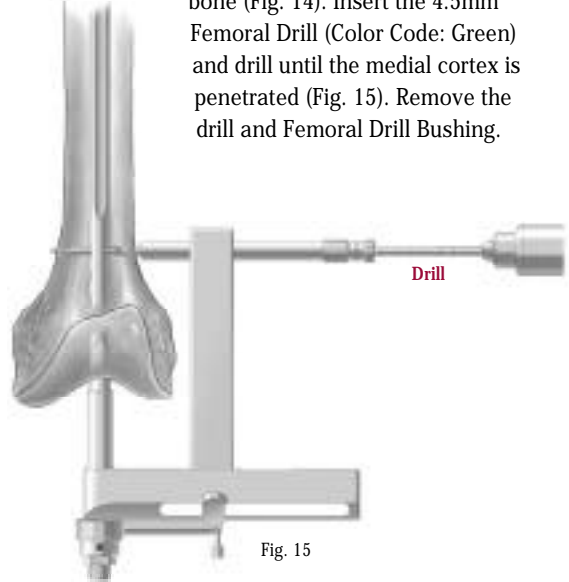


Fig. 15

IMPLANT/INSTRUMENTATION SPECIFICATIONS FOR RETROGRADE NAILS

Nail Dia. (mm)	9	10	11	12	13	14
Head Diameter (mm)	12	12	12	12	13	14
Guide Wire, Smooth (mm)	3.0	3.0	3.0	3.0	3.0	3.0
Proximal Screw Size (mm)	4.2 blue	4.2 blue	4.2 blue	5.5 green	5.5 green	5.5 green
Drill Bushing Size (mm)	3.2	3.2	3.2	3.2	3.2	3.2
Proximal Drill Size (mm)	3.2	3.2	3.2	3.2	3.2	3.2
Distal Screw Size (mm)	5.5 green	5.5 green	5.5 green	5.5 green	5.5 green	5.5 green
Trocar Dia. (mm)	3.2	3.2	3.2	3.2	3.2	3.2
Distal Drill Size (mm)	4.5	4.5	4.5	4.5	4.5	4.5

Use the Long Screw Depth Gauge to determine the screw length (Fig. 16). **Select an appropriate length screw to ensure adequate engagement of the outer cortex.** Then use the T-Handle Screwdriver to insert the appropriate size screw to the correct has mark (Fig. 17). All retrograde nails use 5.5mm screws distally. Repeat the procedure for the second and third distal screws. Note: Distal locking screws for all femoral nails are 5.5mm in diameter with lengths ranging from 20mm to 100mm in 5mm increments. These are inserted from lateral to medial. The proximal anterior to posterior locking screws for the 9mm through 11mm nails are 4.2mm in diameter with lengths ranging from 20mm to 90mm in 5mm increments. For the 12mm through 14mm diameter nails, the 5.5mm locking screw can be used at the proximal anterior to posterior locking screw positions.

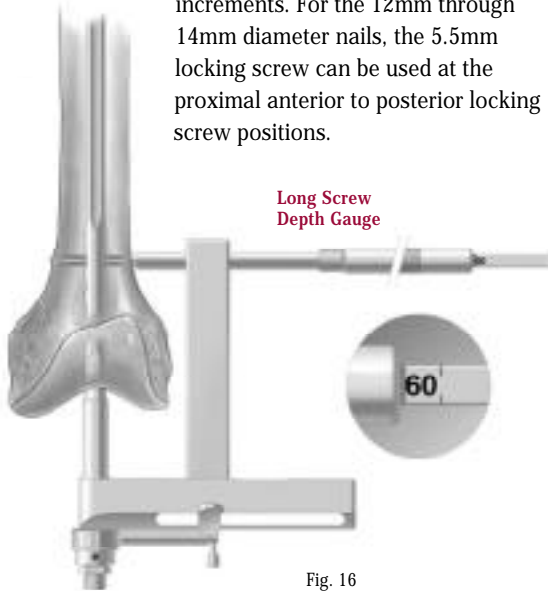


Fig. 16

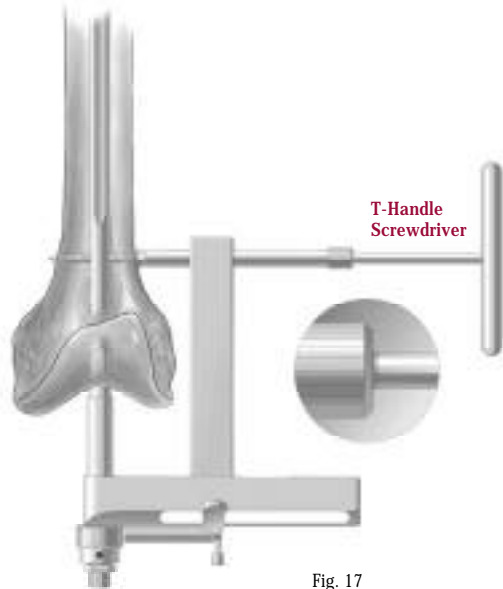


Fig. 17

If the bone is osteoporotic, a Cortical Nut and Washer are available to prevent the screw(s) from pulling out of the bone. After inserting the Femoral Screw Bushing, insert the 4.5mm Femoral Drill Bushing and the 3.2mm Femoral Pin/Drill Bushing. Then insert a 3.2mm Steinmann Pin into the Femoral Pin/Drill Bushing. Use the drill to drive the pin through both cortices (Fig. 18). Palpate the pin on the medial side of the knee, and make a small skin incision to expose the tip of the pin.

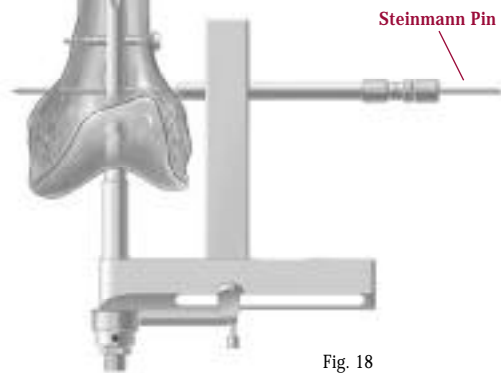


Fig. 18

Insert the Cortical Nut Counterbore over the pin and bore into the medial bone (Fig. 19). Remove the Steinmann Pin, and the Femoral Pin/Drill Bushing.

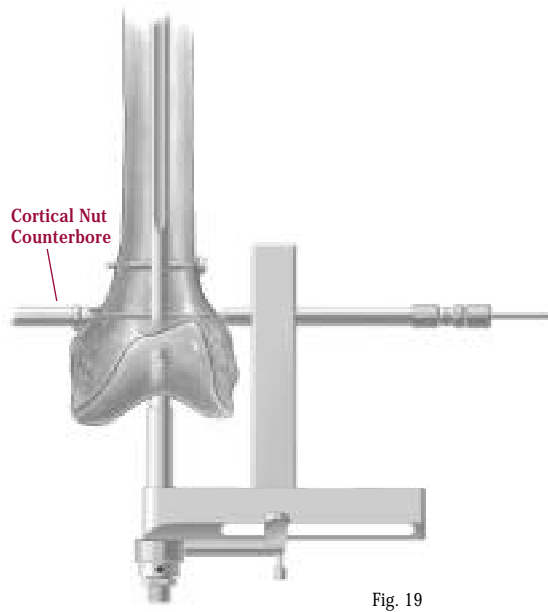
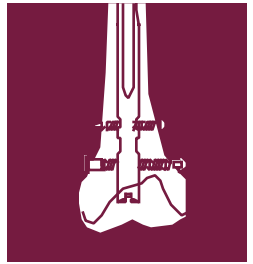
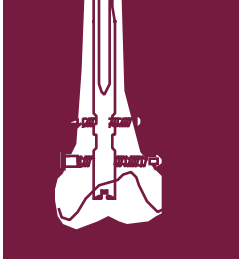


Fig. 19





Then use the drill to drill through both cortices (Fig. 20). Remove the Femoral Drill Bushing and use the Long Screw Depth Gauge to determine the screw length (Fig. 21). **Select an appropriate length screw to ensure adequate engagement of the far cortex.**

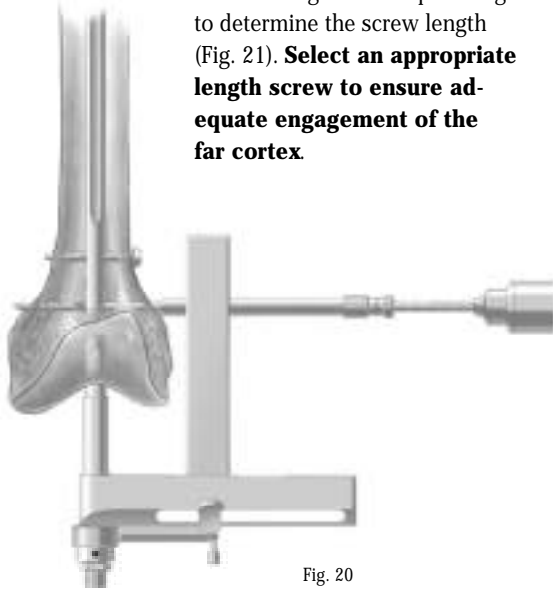


Fig. 20

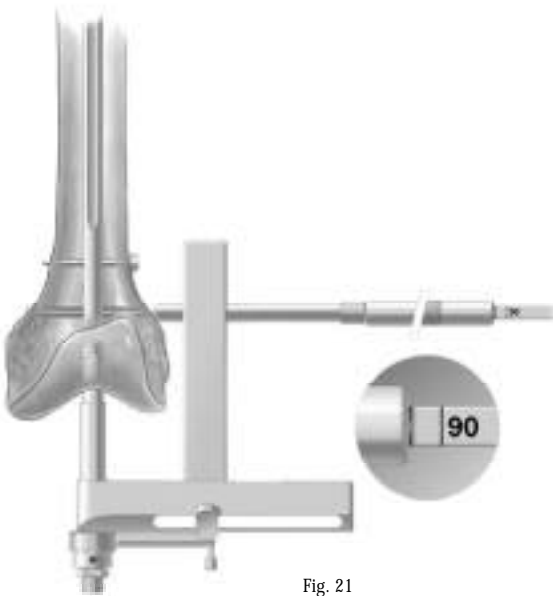


Fig. 21

Use the T-Handle Screwdriver to insert the appropriate size screw through the targeting guide. Before the screw enters the wound, insert a Washer onto the screw (Fig. 22). Then begin driving the screw into the bone and through the hole in the nail.

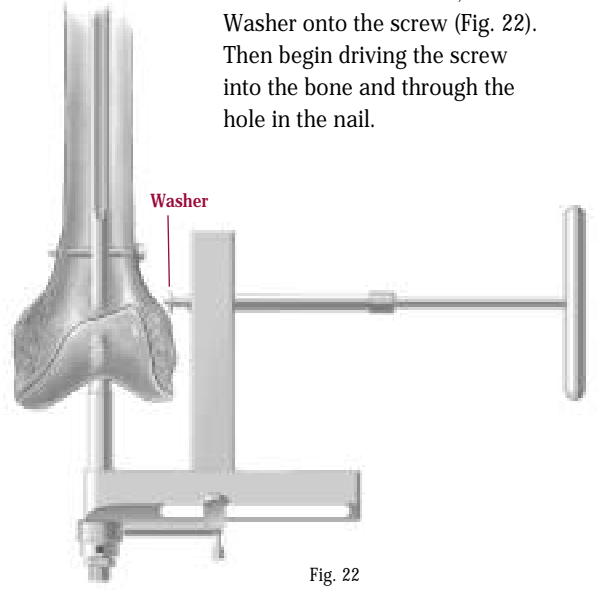


Fig. 22

As the screw penetrates the opposite cortex, observe the screw entering the cortical nut (Fig 23). Use an image intensifier to verify proper alignment. Continue to drive the screw until the Cortical Nut is tight. Be careful not to overtighten.

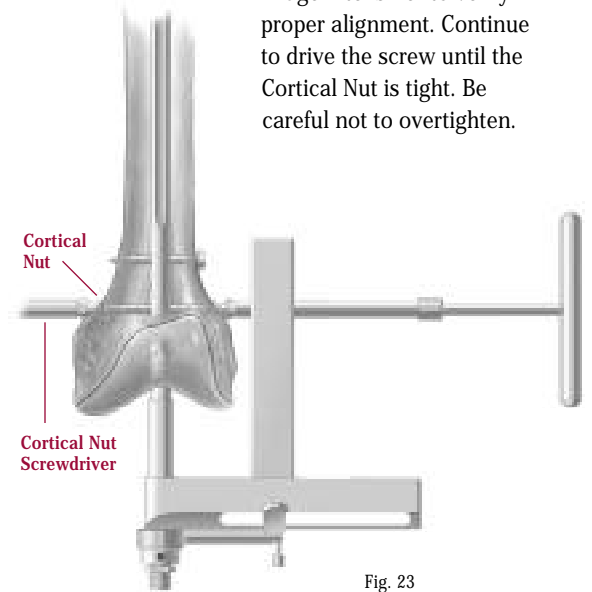


Fig. 23

*U.S. Patent 4,969,889

Remove the screwdriver and Femoral Screw Bushing. Take A/P and lateral C-arm views to check for correct positioning. Disengage the ratchet mechanism, then loosen and remove the Locking Bolt and the Retrograde Distal Targeting Guide.

To avoid nonunion and leg length discrepancy, take A/P and lateral C-arm views to be sure that the fracture is at the proper length and not distracted. If there appears to be distraction, lightly tap the nail in until the cortices are properly engaged.

PROXIMAL LOCKING

Technique for Using the Free-Hand Targeting Device

The proximal locking screws may be inserted with a freehand technique using the Free-Hand Targeting Device*. **Note: 9mm-11mm retrograde nails use 4.2mm screws proximally which require 3.2mm Drills or Trocars (Color Code: Blue). 12mm-14mm retrograde nails use 5.5mm screws proximally which require 4.5mm Drills or Trocars (Color Code: Green).** Insert an appropriate size Trocar (3.2mm for 4.2mm screw, 4.5mm for 5.5mm screw) into the Free-Hand Targeting Device and finger tighten.

Note: 14cm - 22cm length nails in all diameters have 1 lateral/medial proximal dynamic slot and 1 static locking hole. 24cm - 48cm length nails in all diameters have 1 anterior/posterior dynamic slot and 1 static locking hole.

Choose the appropriate locking hole based on the need for dynamization. The inferior locking hole on the *M/DN* Retrograde Nail is used for static locking. If static locking is preferred, but there is a potential need for later dynamization, insert screws in both locking holes. The locking screw in the static hole can then be removed to achieve later dynamization.

For success with this technique, proper placement of the A/P x-ray beam is critical. Position the C-arm so the locking hole of the nail appears perfectly round on the monitor or, if using the dynamic slot, the slot should reveal its greatest width (Fig. 24).



Fig. 24

When this is achieved, make an anterior stab wound opposite the appropriate locking hole. Bring the tip of the Trocar to the bone and center it over the locking hole using the C-arm (Fig. 25). Drive the Trocar into the bone and across the hole in the nail in line with the A/P x-ray beam, but do not penetrate the posterior cortex (Fig. 26).

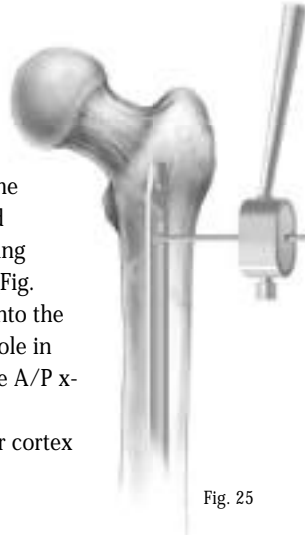


Fig. 25

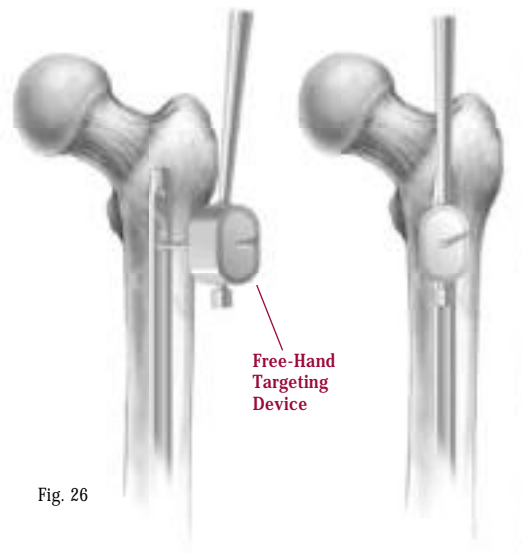
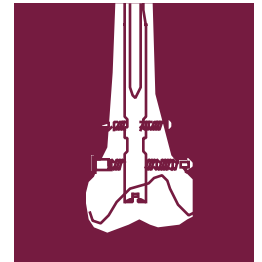
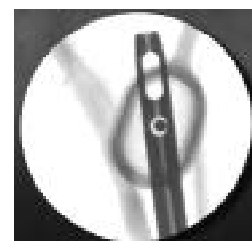
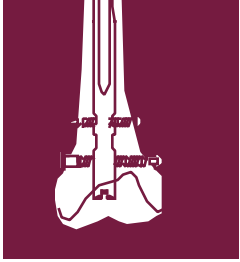


Fig. 26

Remove the Free-Hand Targeting Device. Verify Trocar placement in both the A/P and lateral planes. Proximal Bushings can be used with the Free-Hand Targeting Device. A separate radiolucent Bushing Insert is available to accommodate the bushings. Insert the 3.2 or 4.5mm Proximal Bushing and the 8.0mm Proximal Bushing into the targeting device, and place it over the Trocar (see chart on page 6 for correct size information). Advance the bushings to the bone and check their position with the C-arm.





After it has been correctly placed, remove the Trocar and the 4.5mm Proximal Bushing. The path of the

Trocar in the bone acts as a pilot hole for the appropriate size drill. Insert the Proximal Stop Drill into the 8.0mm Proximal Bushing. Before drilling through the anterior cortex, check the A/P and lateral C-arm image to assure that the drill is in the hole in the nail. Then drill both cortices. The step in the drill will prevent over-drilling (Fig. 27).

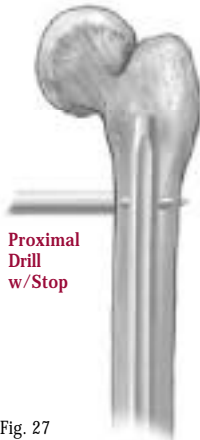


Fig. 27

Remove the drill and insert the Short Screw Depth Gauge (Fig. 28). The length of the screw is determined by reading it directly off the depth gauge. **Select an appropriate length screw to ensure adequate engagement of the far cortex.** Insert the appropriate size *M/DN* Screw using the appropriate screwdriver (Fig. 29).

Short
Screw
Depth
Gauge

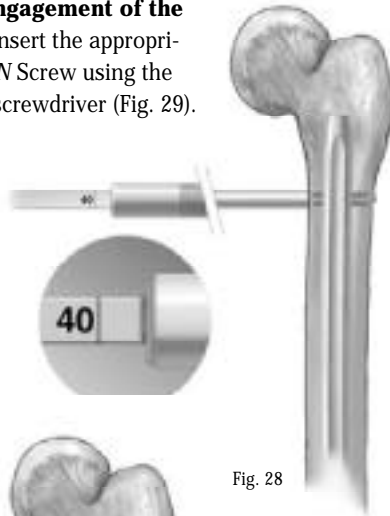


Fig. 28



Fig. 29

If desired, insert the second screw in the second locking hole of the nail in an identical manner (Fig. 30). Check the position of both screws with the C-arm in the A/P and lateral planes (Fig. 31).

END CAP PLACEMENT

If desired, insert an *M/DN* End Cap of the appropriate length (0mm, 5mm, 10mm or 15mm) in the distal nail.



Fig. 30



Fig. 31

CLOSURE AND POSTOPERATIVE CARE

Thoroughly irrigate the knee and close the distal wound. Apply a soft compression dressing.

Early range-of-motion exercises of the knee and ankle are encouraged. Allow partial weight bearing to progress to full weight bearing as fracture callus increases on the x-ray films, usually at eight to twelve weeks.

EXTRACTION

Should extraction of the nail become necessary, attach the Threaded Extraction Adaptor to the end of the nail and use a Slaphammer to extract the nail. If an End Cap had been used, be sure to remove before attempting to remove the nail.

Note: The cannulated Locking Bolt should not be used for nail removal. Extraction of the nail should be accomplished by using the Threaded Extraction Adaptor.

