OPERATIVE TECHNIQUE

# The Retrograde Femoral Nailing System

## For Supracondylar and Femoral Shaft Fractures and Osteotomies

By Prof. Dr. D. Pennig

ORTHOFIX®

# CONTENTS

## INDICATIONS

| SHORT RETROGRADE NAILS | LONG RETROGRADE NAILS |
|---|---|
| • Supracondylar fractures of the femur<br>• Femoral shaft or distal femoral fractures in the presence of proximal femoral implants or total hip joints<br>• Fractures above the femoral component of a total knee joint<br>• Non-union in distal femoral fractures after plate fixation or antegrade nailing<br>• Osteotomies | • Femoral shaft fractures in very obese patients<br>• Femoral shaft fractures in pregnant patients<br>• Femoral shaft fractures with concomitant femoral neck fractures<br>• Femoral shaft fractures in patients with osteoarthritis of the hip (where impaired hip movement makes antegrade nail insertion difficult)<br>• Floating knee with both femoral shaft and tibial shaft fractures (where insertion of both nails is possible through a short medial para-patellar approach)<br>• Femoral shaft fractures in polytrauma<br>• Bilateral femoral shaft fractures<br>• Femoral shaft fractures where a traction table or other reduction equipment is not available |

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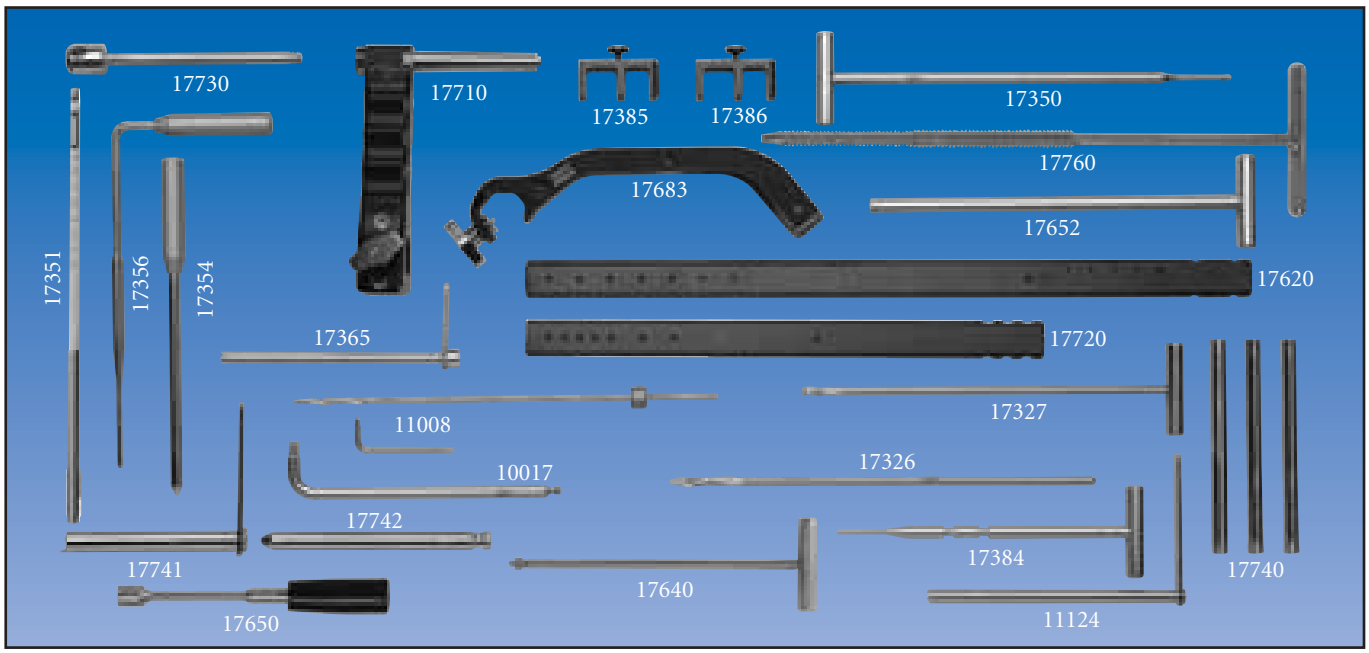
## PATIENT POSITIONING

Either general or regional anaesthesia is used. The patient is placed supine on a radiolucent table. The leg should be draped free and fluoroscopic control in both planes should be possible. The femur is positioned horizontally on the table with the knee flexed 50° to provide adequate access.

A rolled towel may be used at the distal end of the femur to prevent recurvatum of the distal fragment.

The opposite leg is placed in a gynaecological leg rest.

Where a nail less than 240 mm long is to be inserted, a tourniquet may be used which must not obstruct proximal locking.




## Retrograde Nailing Instrumentation

| | | |
|---|---|---|
| 1 | 10017 | 6 mm Polyhedral Allen Wrench |
| 1 | 11008 | Drill Bit Kit 4 mm, length 310 mm |
| **1** | **11124** | **Drill Guide 6 mm** |
| **1** | **17326** | **Drill Bit 6 mm, length 280 mm** |
| **1** | **17327** | **T-Handled Hand Reamer 6 mm** |
| 1 | 17350 | Screw T-wrench, hexagonal 3.5 mm |
| 1 | 17351 | Locking Screw Depth Gauge |
| 1 | 17354 | Straight Trocar 8 mm |
| 1 | 17356 | Graduated Angled Trocar 4/8 mm |
| 1 | 17365 | Drill Guide 4 mm |
| **1** | **17384** | **T-Handled Stabilizing Rod 6 mm** |
| **1** | **17385** | **Stabilizing Spacer 10 mm** |
| **1** | **17386** | **Stabilizing Spacer 11 mm** |
| **1** | **17620** | **Long Guide Bar, 240 – 360 mm nails** |
| 1 | 17640 | Countersink Hand Drill 8/4 mm |
| 1 | 17650 | Compression Nut Spanner |
| 1 | 17652 | T-Handled Locking Screw Extractor |
| **1** | **17683** | **Sliding Outrigger** |
| 1 | 17710 | Handle |
| 1 | 17720 | Short Guide Bar, 140 – 220 mm nails |
| 1 | 17730 | Locking Rod |
| 3 | 17740 | Smooth Screw Guide |
| 1 | 17741 | Reamer Guide Sleeve |
| 1 | 17742 | K-wire Insertion Centralizer |
| 1 | 17750 | K-wire 3 mm, length 400 mm (not illustrated) |
| 1 | 17760 | Cannulated Hand Reamer 12/10 mm |
| 1 | 17606 | Sterilisation Box for Instruments |
| 1 | 17607 | Sterilisation Box for Implants |

Instruments marked in bold are not required for the insertion of short nails up to 220 mm long.
Instruments can be supplied individually or as one of two kits:

| | |
|---|---|
| 17600 | Complete Retrograde Nailing Kit |
| 17700 | Supracondylar and Ankle Arthrodesis Nailing Kit |

## RETROGRADE NAILS

| TOTAL LENGTH (mm) | DIAMETER (mm) 10 | 11 | 12 |
|---|---|---|---|
| 140 | 77014 | | 77214 |
| 160 | 77016 | | 77216 |
| 180 | 77018 | 77118 | 77218 |
| 190 | 77019 | 77119 | 77219 |
| 200 | 77020 | 77120 | 77220 |
| 210 | 77021 | 77121 | 77221 |
| 220 | 77022 | 77122 | 77222 |
| 240 | 76024 | 76124 | |
| 260 | 76026 | 76126 | |
| 280 | 76028 | 76128 | |
| 300 | 76030 | 76130 | |
| 320 | 76032 | 76132 | |
| 340 | 76034 | 76134 | |
| 360 | | 76136 | |

| | |
|---|---|
| 77900 | Retrograde Nail End Cap |

*Note:* For the first 50 mm all nails are 12 mm in diameter; they then taper to the diameter stated.
Nails up to 220 mm long have three locking holes at each end. The longer nails have two at each end.

## STANDARD LOCKING SCREWS (6 mm thread diameter)

| TOTAL LENGTH (mm) | THREAD LENGTH (mm) 8 | 12 | 20 |
|---|---|---|---|
| 30 | 73930 | | |
| 35 | 73935 | | |
| 40 | 73940 | | |
| 45 | 73945 | | |
| 50 | | 73950 | |
| 55 | | 73955 | |
| 60 | | 73960 | |
| 65 | | 73965 | |
| 70 | | | 73970 |
| 75 | | | 73975 |
| 80 | | | 73980 |
| 85 | | | 73985 |
| 90 | | | 73990 |
| 95 | | | 73995 |
| 100 | | | 73900 |
| 105 | | | 73905 |
| 110 | | | 73910 |

## REVISION LOCKING SCREWS (8 mm thread diameter)

| TOTAL LENGTH (mm) | THREAD LENGTH (mm) 7 | 9 | 12 | 20 |
|---|---|---|---|---|
| 30 | 74530 | | | |
| 35 | 74535 | | | |
| 40 | 74540 | | | |
| 45 | 74545 | | | |
| 50 | | 74550 | | |
| 55 | | 74555 | | |
| 60 | | 74560 | | |
| 65 | | 74565 | | |
| 70 | | | 74570 | |
| 75 | | | 74575 | |
| 80 | | | 74580 | |
| 85 | | | 74585 | |
| 90 | | | 74590 | |
| 95 | | | | 74595 |
| 100 | | | | 74500 |
| 105 | | | | 74505 |
| 110 | | | | 74510 |

| | |
|---|---|
| 74405 | Pack of 4 washers |

Washers are usually used with Revision Screws or Compression Screws.

## COMPRESSION LOCKING SCREWS (8 mm thread diameter)

| TOTAL LENGTH (mm) | THREAD LENGTH (mm) 12 | 20 |
|---|---|---|
| 70 | 76570 | |
| 75 | 76575 | |
| 80 | 76580 | |
| 85 | 76585 | |
| 90 | 76590 | |
| 95 | | 76595 |
| 100 | | 76500 |
| 105 | | 76505 |
| 110 | | 76510 |

| | |
|---|---|
| 76900 | Compression nut with self-locking washer (pack of 4) |

Compression locking screws are used with a compression nut at the threaded end. They may also have a washer at the head end when the bone quality is poor.

## CLEANING OF EQUIPMENT

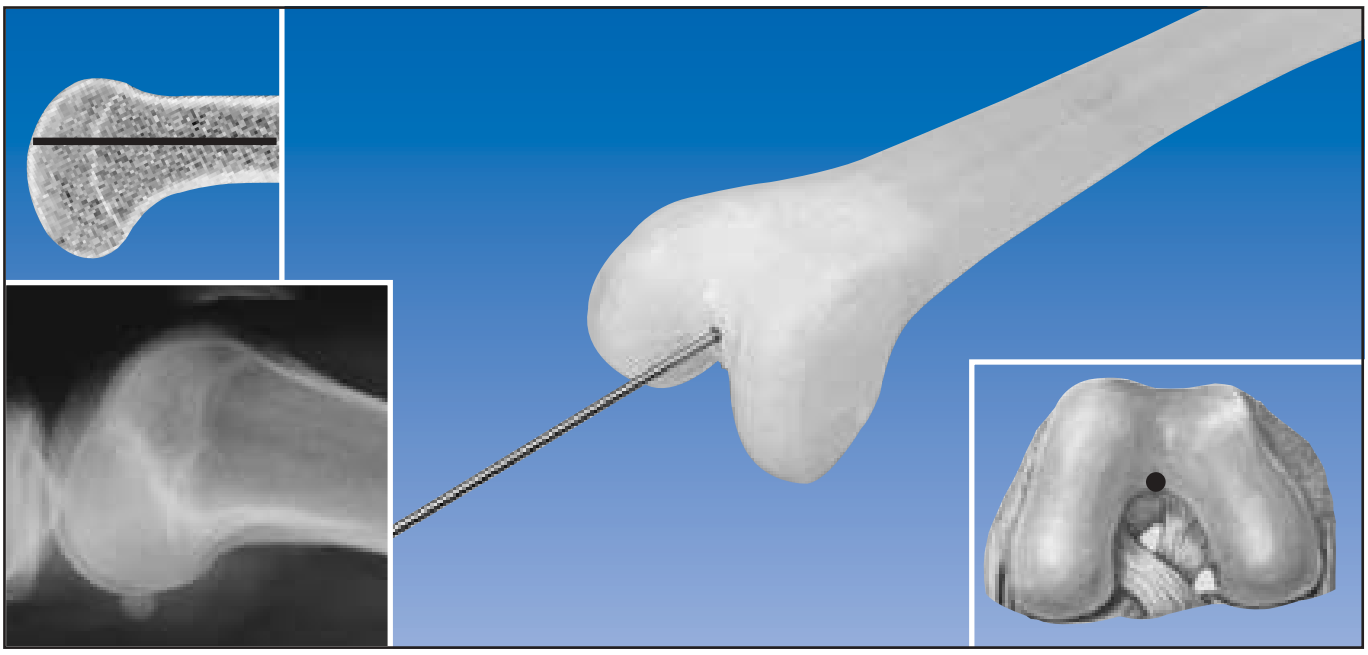
The implants and instrumentation should be removed from their packaging and cleaned thoroughly using medical grade alcohol 70% + distilled water 30% (Detergents with free fluoride, chloride, bromide, iodide or hydroxyl ions must not be used, as they will damage the black anodised coating on any Orthofix products). After cleaning, the devices should be rinsed with sterile distilled water and dried using clean non-woven fabric.

## STERILIZATION

Prior to surgical use, the products should be cleaned as described above and sterilized by steam autoclaving following a validated sterilization procedure, utilizing a prevacuum cycle (Orthofix recommends the following cycle: steam autoclave 132°-135°C [270°-275°F], minimum holding time 10 minutes).

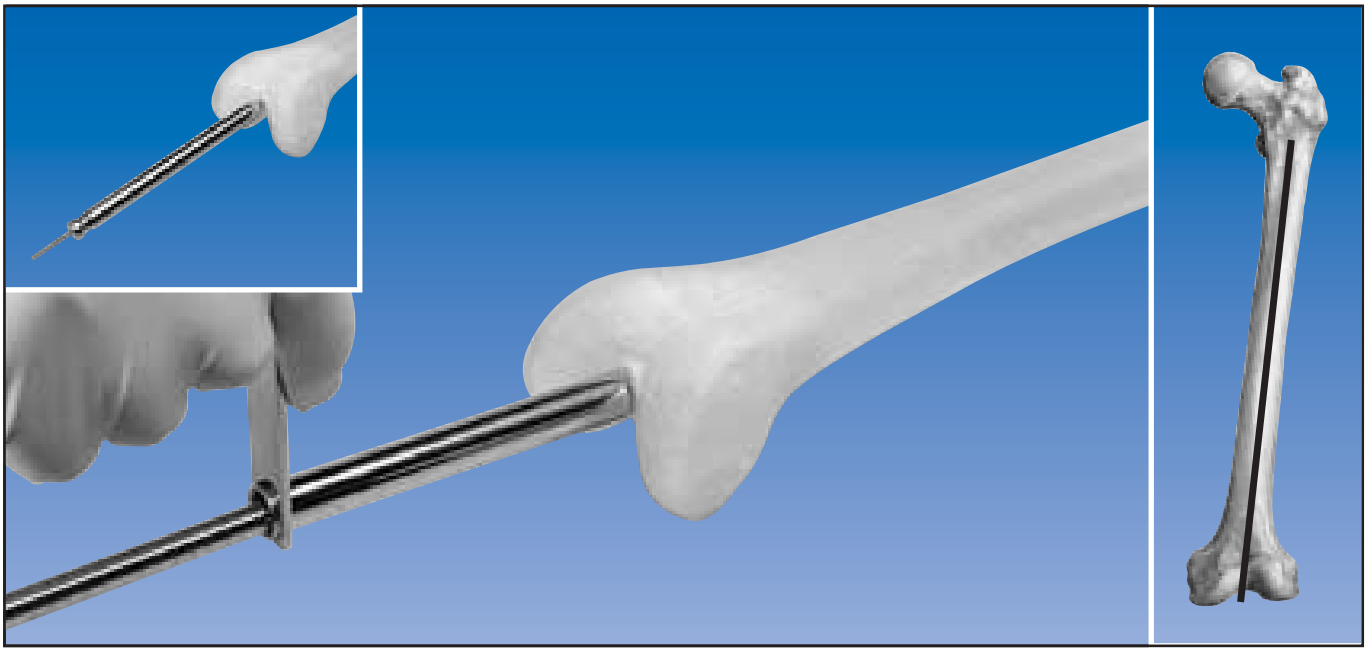
### THE NAILS, NAIL END CAPS AND LOCKING SCREWS MUST NEVER BE REUSED

These implants may look "as new" when removed, but will have been subjected to considerable stresses while in the patient. All Orthofix implants are for **single use only**



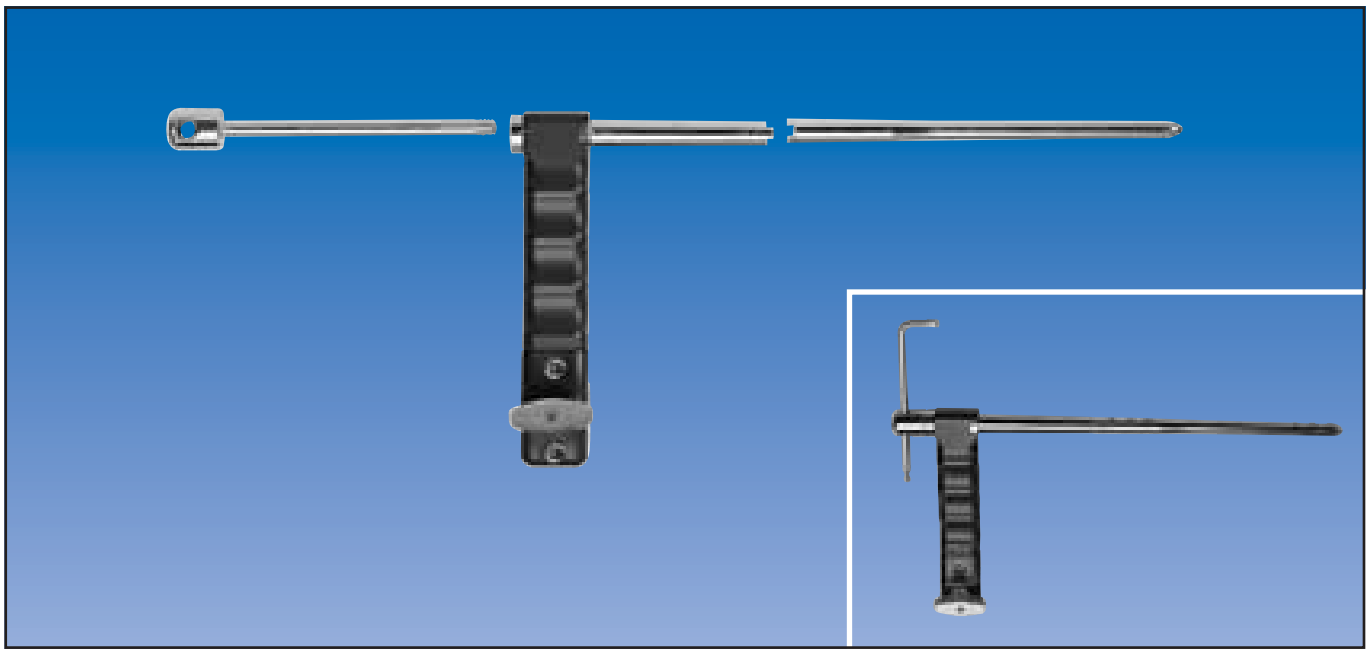
## NAIL INSERTION

A 4-6 cm medial para-patellar incision is made and the patellar tendon and fat pad retracted to the lateral side. In cases where the patellar tendon cannot be retracted laterally, a trans-patellar tendon approach is advisable. The entry point is made in the intercondylar notch. With fractures extending into the joint, the intra-articular fracture should be reduced anatomically and stabilized using posteriorly placed lag screws, prior to opening the intercondylar notch. Alternatively, the fracture position may be maintained with bone forceps, and compression locking screws used for fixation (see page 14). Entry into the intercondylar notch is made with a 3 mm Kirschner wire placed centrally, anterior to the insertion of the posterior cruciate ligament. The point of entry should be in line with the long axis of the femoral shaft in both the AP and coronal planes. Blumensaat's line is used for the identification of the point of entry in the lateral view.

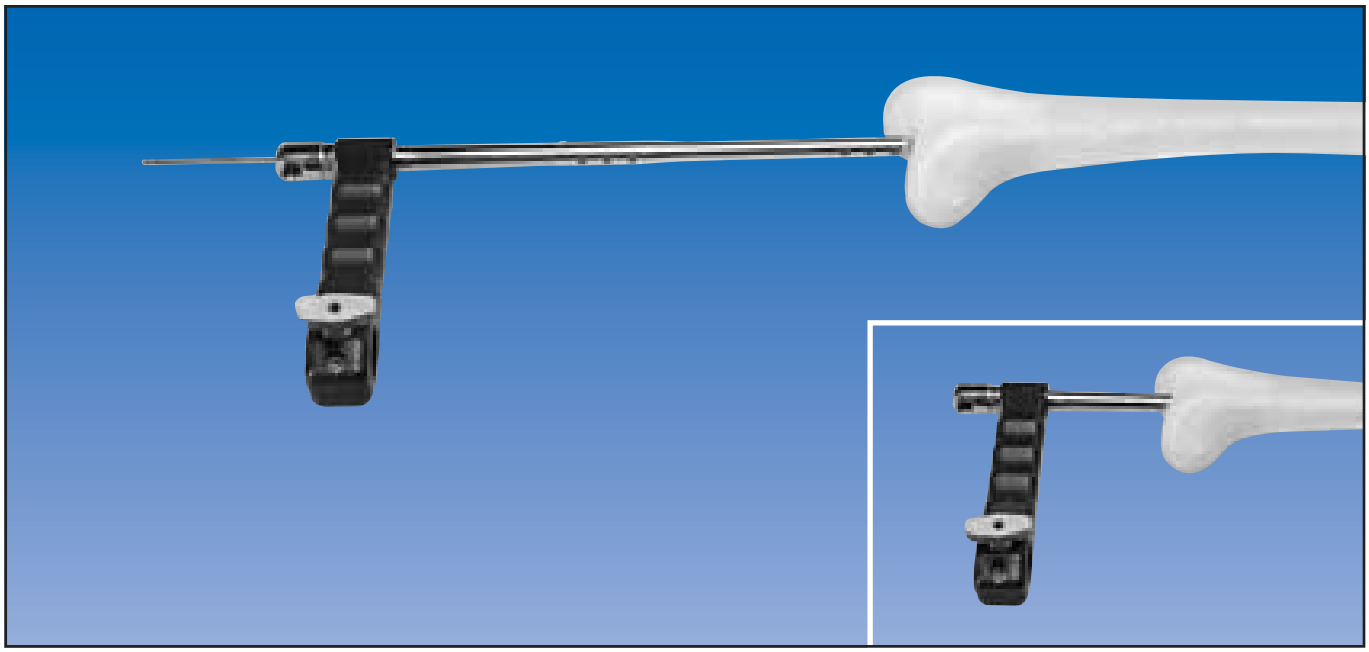


After a radiological check in both planes, the Insertion Centralizer is inserted over the Kirschner wire and the Reamer Guide Sleeve slid over the centralizer. The tooth of this guide sleeve protects the insertion of the posterior cruciate ligament and the handle must point anteriorly.

With the guide sleeve firmly engaged and the centralizer removed, the 12 / 10 mm diameter hand reamer is used to open the metaphyseal bone of the femoral condyles. For short nails and osteoporotic bone this will be sufficient, but for longer nails power reaming is required over a 3 mm guide wire with olive (80-100 cm long). Passage of the guide wire with olive through the bone must be confirmed prior to nail insertion. The 3 mm Kirschner wire is removed and replaced by the olive tipped guide wire. The guide wire is inserted into the proximal fragment, up to the level of the lesser trochanter and the femoral canal reamed to 1.0 mm more than the proposed nail diameter.

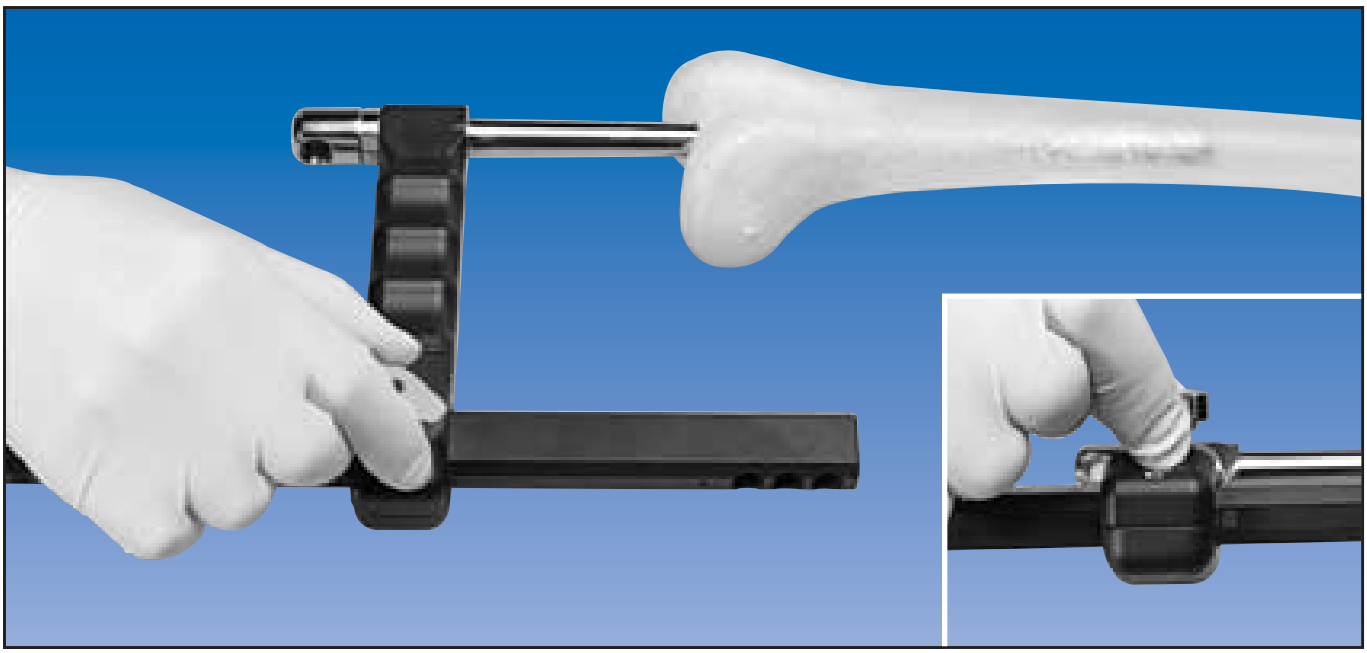


The correct length nail is inserted into the handle and locked into position with a 6 mm Allen wrench. Before the nail is inserted, it is important to check alignment of the distal and proximal holes in the nail and the guide bar. In order to do this, the guide bar is mounted on to the handle following the procedures described below under "Distal Locking" pages 7-8 and "Proximal Locking" pages 9-12. A screw guide and drill guide are inserted into the holes in the guide bar and alignment checked using the drill bit.
Before nail insertion, the olive tipped guide wire must be exchanged for a long 3 mm plain guide wire, using an exchanged tube if necessary.



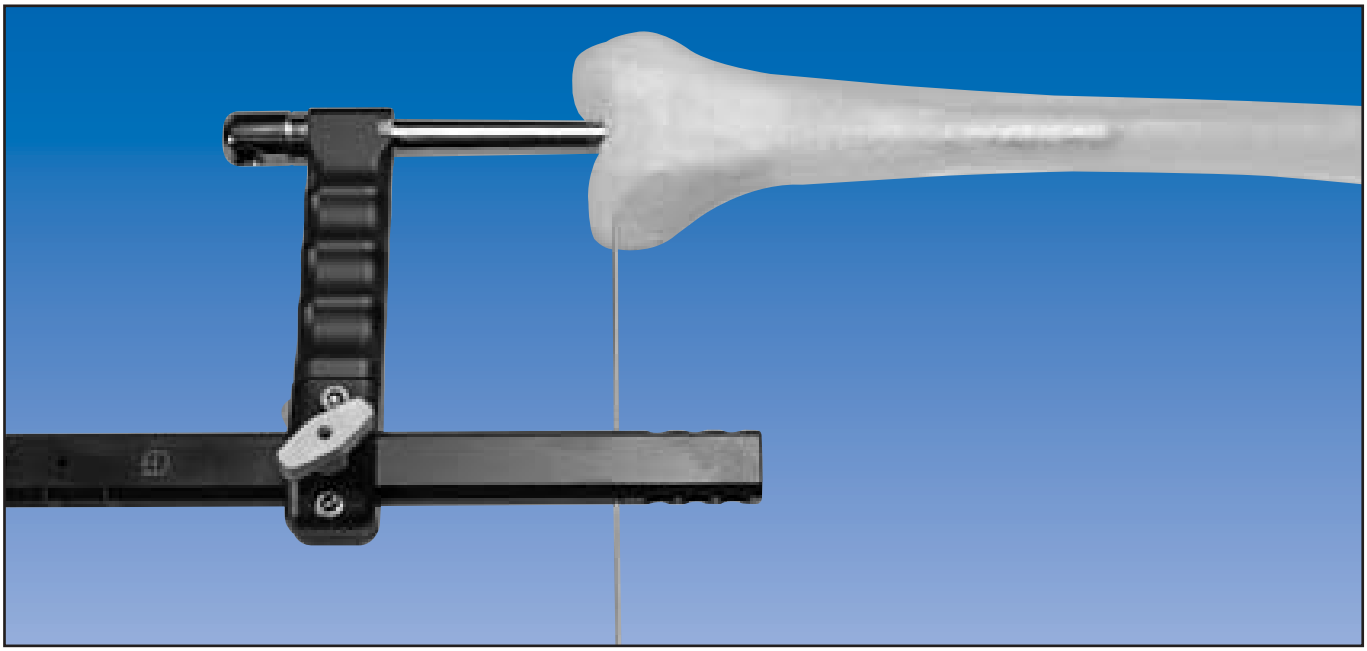
The guide sleeve is removed and the nail inserted over the guide wire, ensuring that the distal end of the nail is beneath the surface of the intercondylar notch, so that it will not protrude into the knee joint. It can be advanced further if required by the fracture pattern.

***Note:*** *For longer nails, the proximal end of the nail should be advanced no further than the level of the lesser trochanter.*
The guide wire is withdrawn and the knee rinsed with at least 500 ml of Ringer's solution.



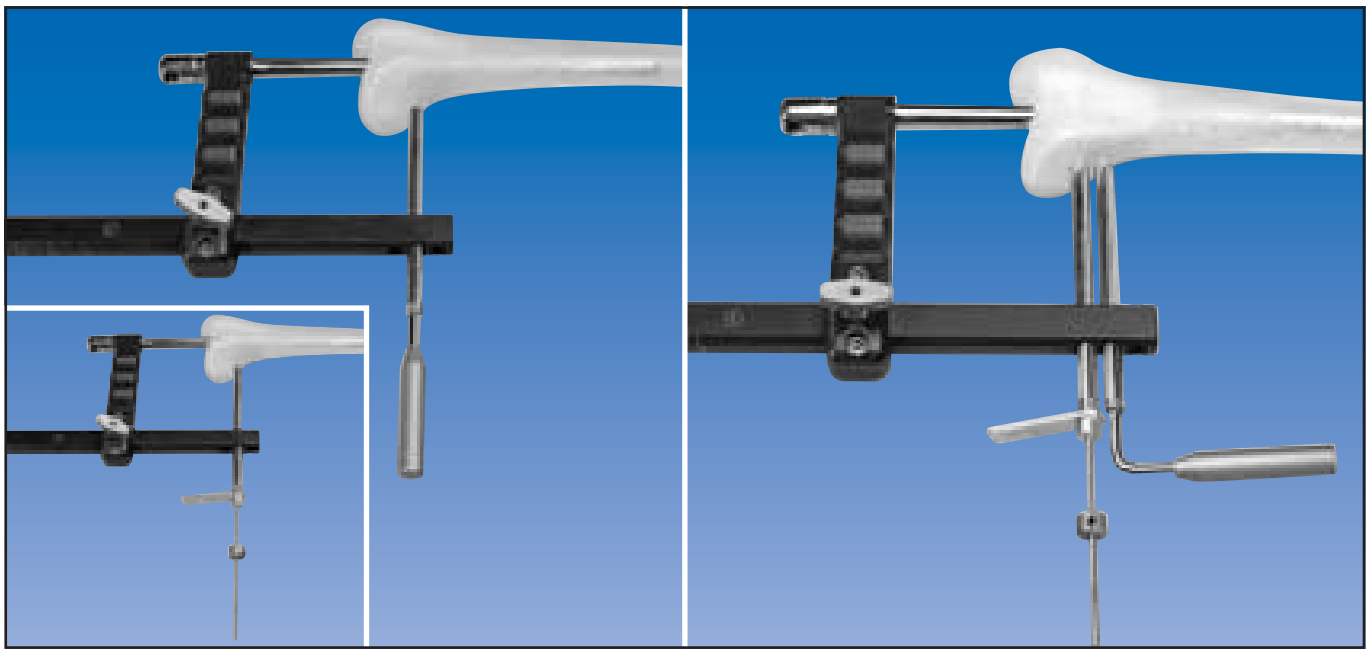
## DISTAL LOCKING

Distal locking is usually performed first from the lateral side. The guide bar is inserted into the handle until the D mark is level with the front surface of the handle and then locked firmly into position. Due to the straight design, the nail may be rotated and oblique insertion of the locking screws is possible, if desired by the surgeon. Medio-lateral insertion is also possible and may be advantageous in certain cases (see page 8).

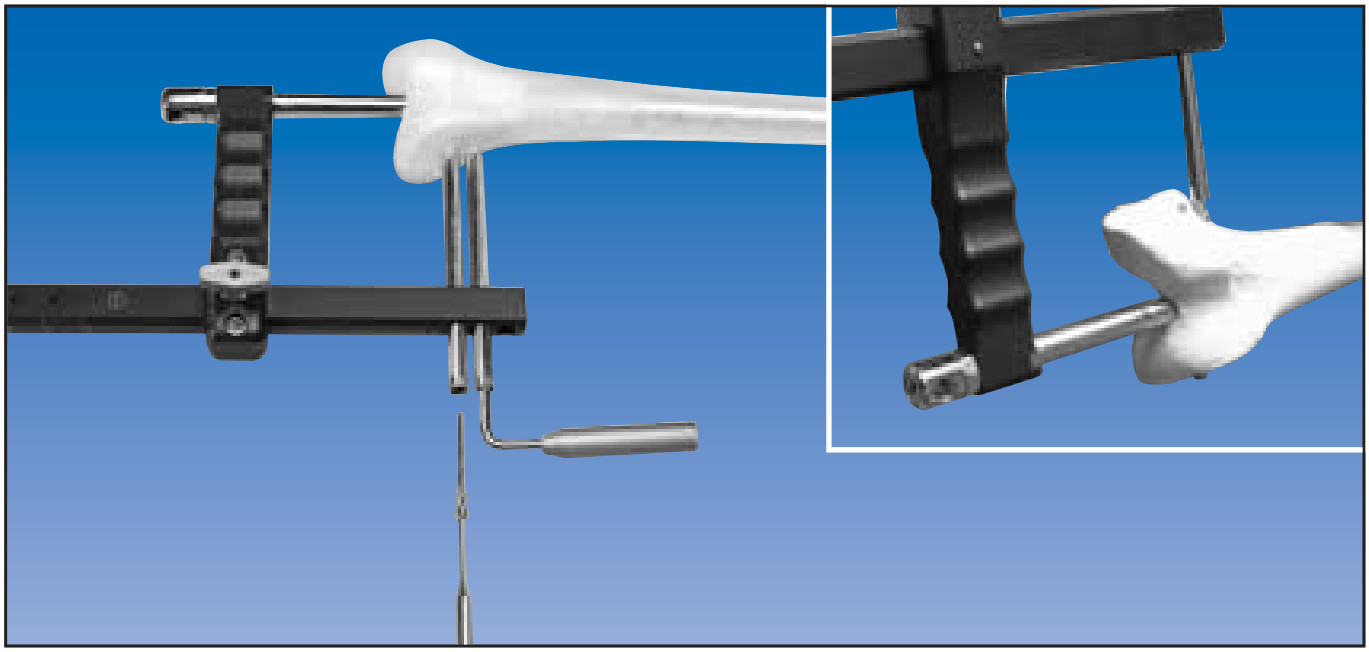


A 2 mm Kirschner wire is inserted into the appropriate hole in the guide bar to establish the position of the distal end of the nail. This must be proximal to the surface of the intercondylar notch, to prevent the nail end protruding into the knee joint. If permitted by the fracture level, distal locking is best performed at the metaphyseo-diaphyseal junction in diaphyseal fractures.

In supracondylar fractures, the locking level is determined by the fracture.

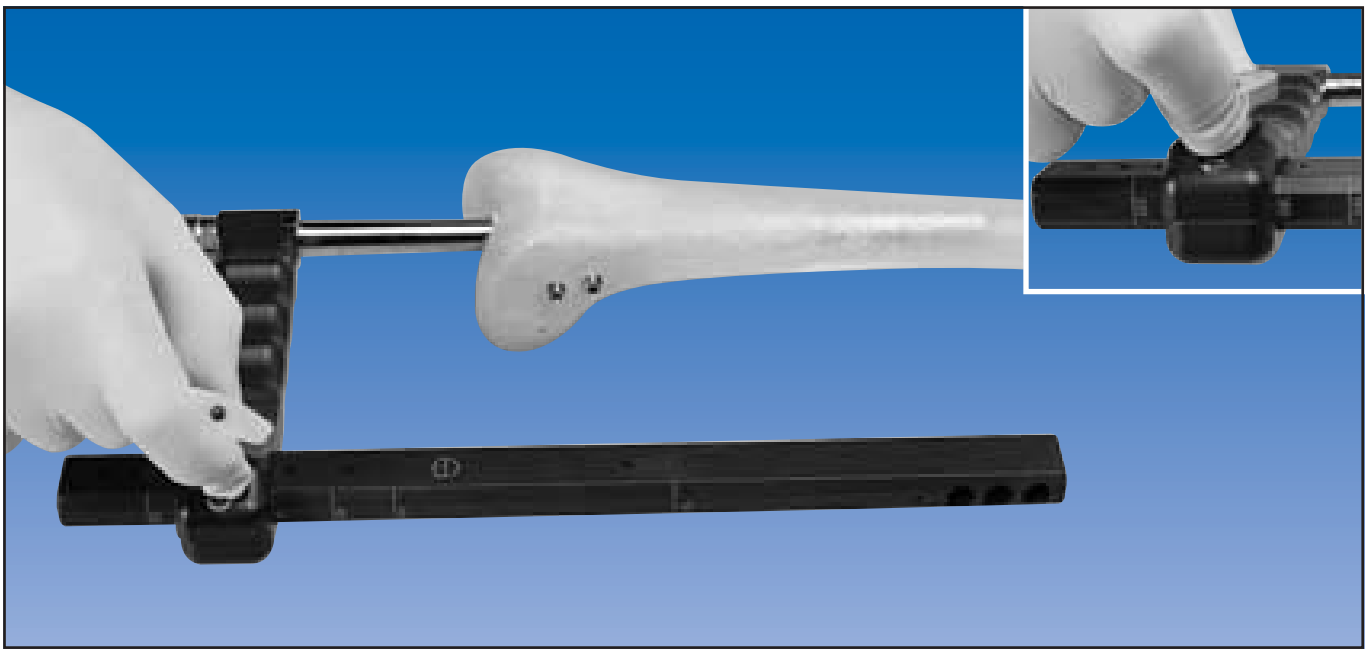


A screw guide is inserted into the most proximal of the distal holes in the guide bar. Note that in the short nails there are three proximal and distal locking holes, but only two in nails longer than 220 mm. A stab incision is made with blunt dissection down to the bone; the screw guide is then advanced down to the bone using the straight trocar. The straight trocar is removed, a 4 mm drill guide inserted into the screw guide and gently tapped into the bone. The bone is then drilled with the 4 mm drill bit.
The drill bit and drill guide are removed and the graduated angled trocar inserted into the screw guide, so that it passes through the nail and engages the far cortex. Correct placement may be verified by insertion of the guide wire into the nail until resistance is felt. A screw guide is now inserted into the remaining distal hole in the guide bar, down to the bone through a stab incision. A 4 mm drill guide is inserted into the screw guide and the bone drilled with the 4 mm drill bit.



The drill bit and drill guide are removed and a locking screw of correct length inserted. The graduated angled trocar is removed from the first screw guide and an appropriate length locking screw inserted. If possible, all three distal locking screws should be inserted. In soft osteoporotic bone, Revision Screws, with an 8 mm diameter thread, should be used. Screw heads should be countersunk when the soft tissues are thin (see page 14).

***Note:*** *In particular cases, depending upon the fracture pattern, one or more distal locking screws may be inserted from the medial side. If the first locking screw has been inserted from the lateral side, the locking rod is loosened but not completely unscrewed, and the handle rotated through 180°. The locking rod is then firmly tightened again, and a second locking screw inserted from the opposite side.*

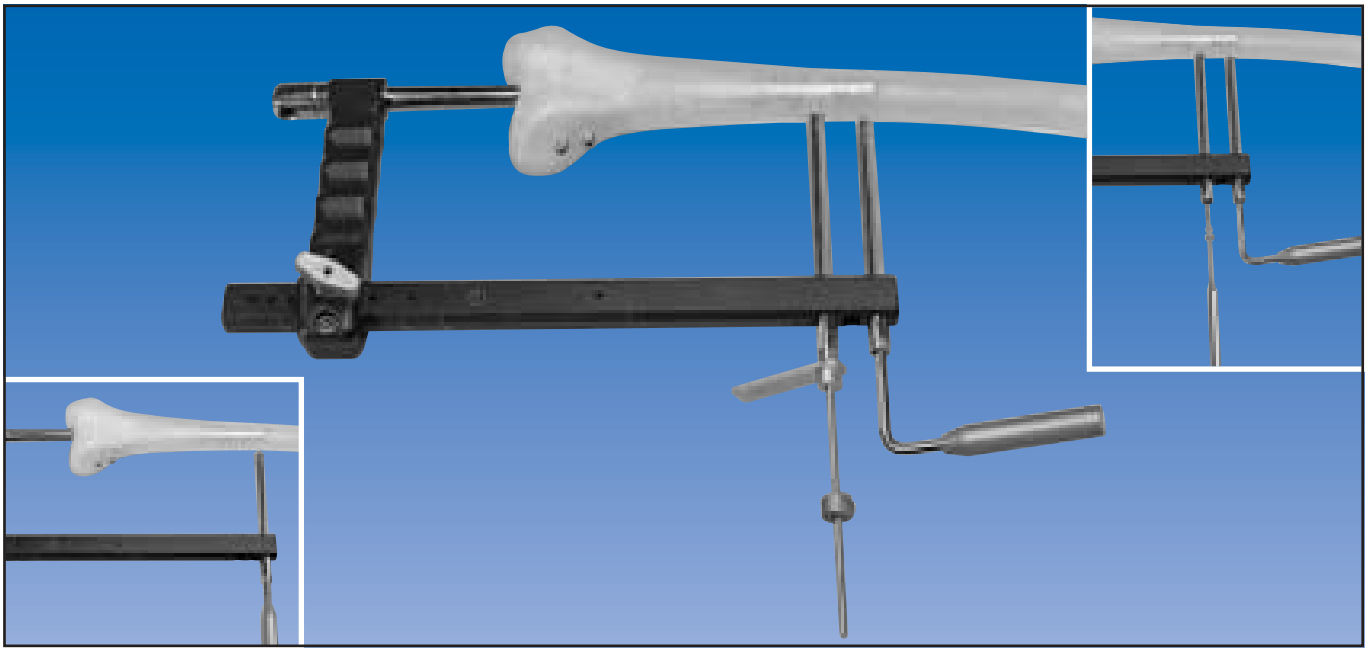


## PROXIMAL LOCKING

The handle must be positioned laterally for proximal locking; this is always performed from the lateral side even if some or all of the distal locking screws have been inserted from the medial side. The guide bar is advanced until the number corresponding to the selected nail length lines up with the front of the handle.

***Note:*** *For nails up to 220 mm long, the Short Guide Bar (17620) is used; for nails longer than 220 mm, the Long Guide Bar (17720) is used.*

The correct guide bar is then locked firmly into place. For nails longer than 220 mm, some mechanical assistance is necessary for reliable proximal locking. This is not necessary for nails up to 220 mm long. The technique of proximal locking is therefore slightly different according to nail length, and is now described.



### Proximal Locking for Supracondylar Nails (140 mm to 220 mm long)

A screw guide is inserted into one of the proximal holes of the Short Guide Bar and advanced down to the bone through a stab incision using the straight trocar.

The trocar is removed, a 4 mm drill guide inserted into the screw guide and the 4 mm drill bit used to drill both cortices. The drill bit and drill guide are removed and the graduated angled trocar inserted into the screw guide, so that it passes through the nail and engages the far cortex.

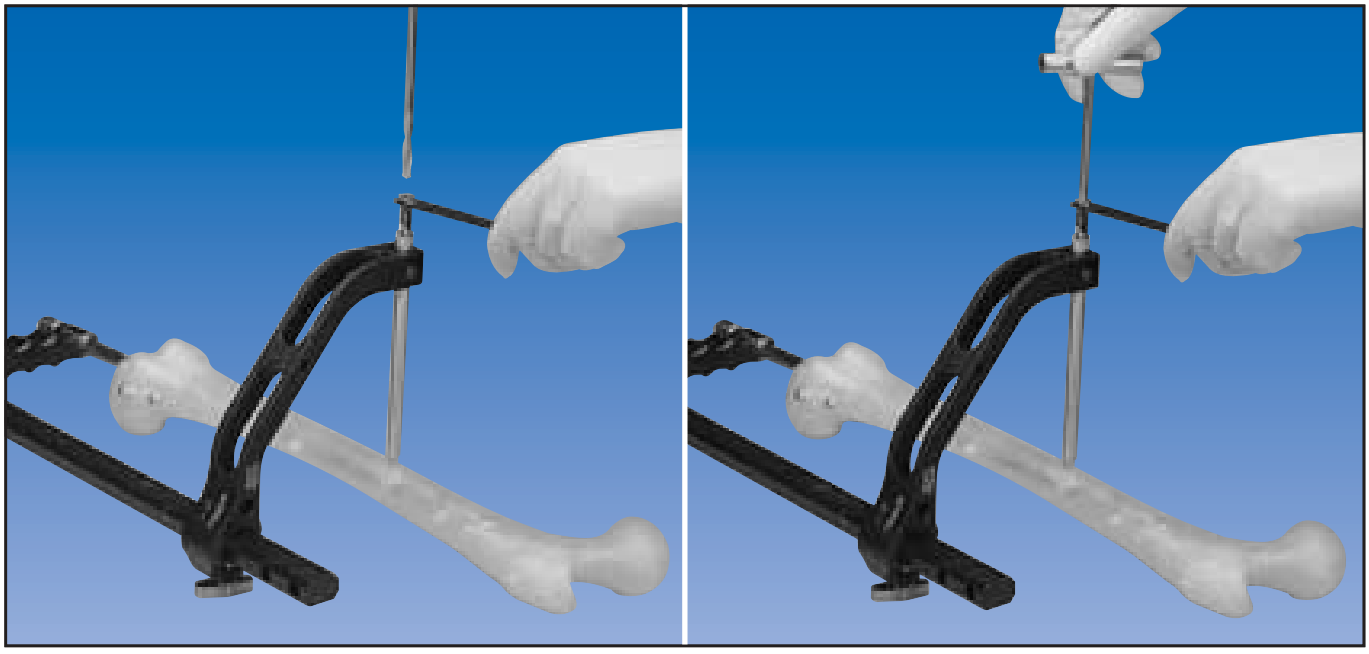
The second hole is then drilled in the same manner, and a locking screw inserted. The graduated trocar is removed and a locking screw inserted into this hole. In osteoporotic bone or heavy patients, the third hole should also be used. Locking screw positions are confirmed with the Image Intensifier.

## Proximal Locking for Long Retrograde Nails (240 mm to 360 mm long)

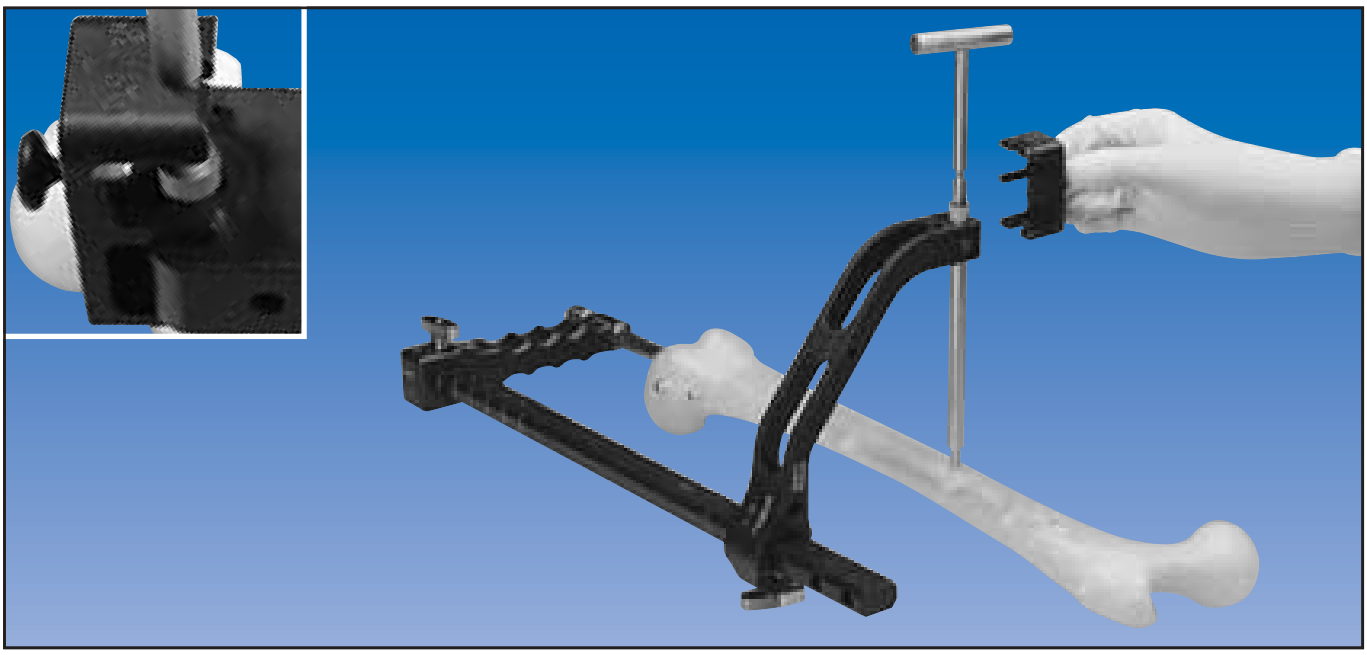
The Sliding Outrigger is mounted anteriorly to the Long Guide Bar and moved until it is just distal to the two proximal holes, where it is firmly locked into place. A screw guide is inserted through the hole in the outrigger down to the skin anteriorly, and by palpation, centered over the middle of the femur. The point of contact with the skin is noted. A 15 mm longitudinal incision is made at this point, down to the deep fascia. The muscle is then split longitudinally down to the bone.

***Note:*** *Careful blunt dissection is required to avoid injury to neurovascular structures.*

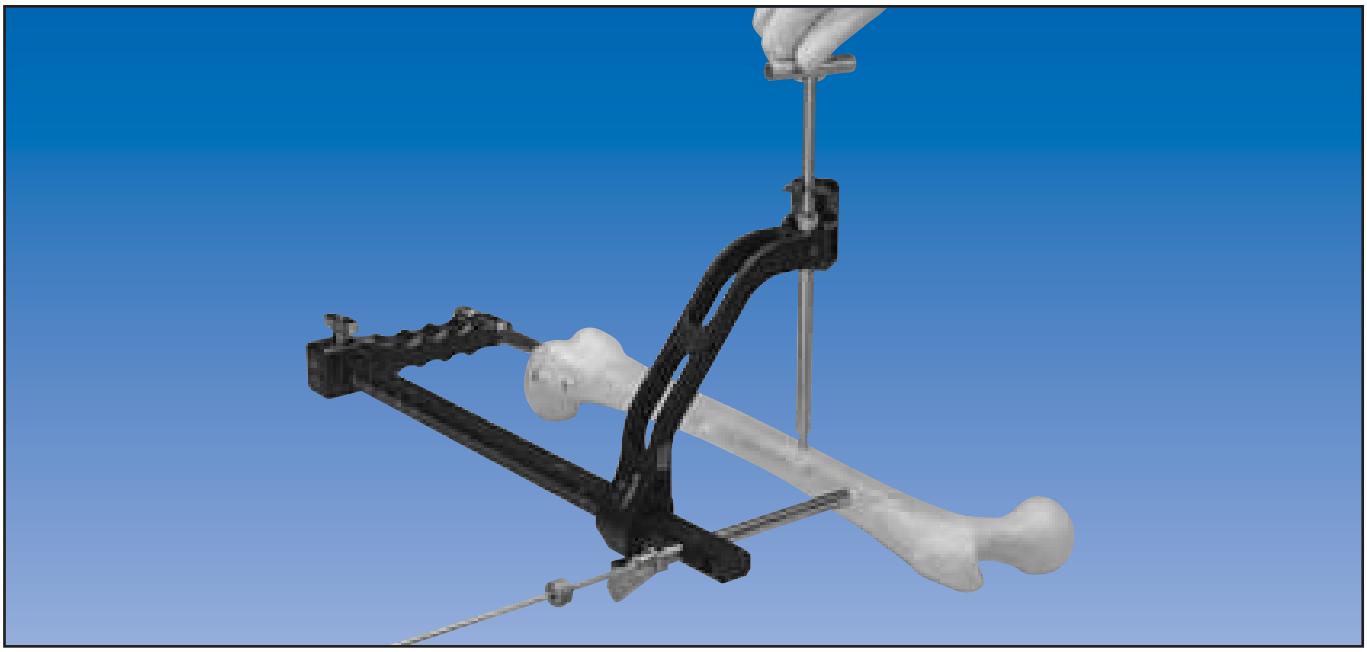
The straight trocar is now inserted into the screw guide, and the two pushed together down to the bone. Once in contact with the bone, the screw guide is centered over the middle of the femoral shaft, by palpation with the straight trocar, using gentle pressure on the guide bar in the frontal plane.



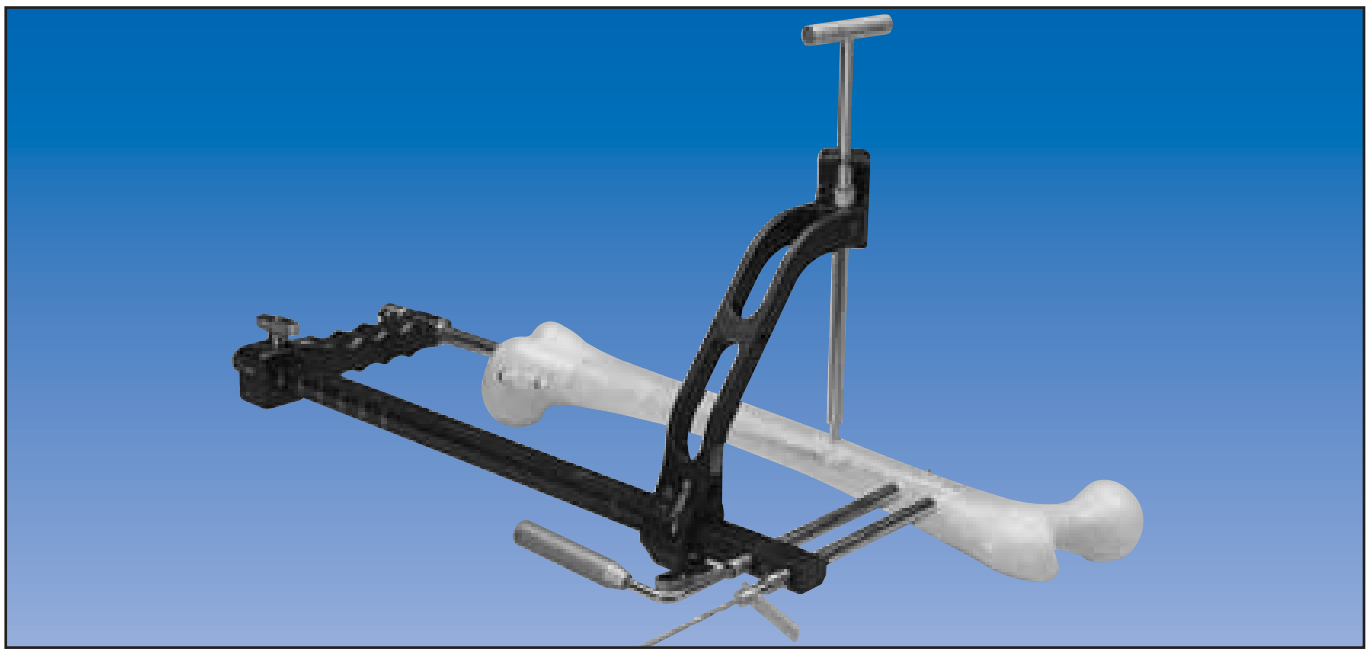
The straight trocar is now withdrawn and the 6 mm drill guide inserted.
The 6 mm drill bit is inserted down to the bone, using gentle pressure to keep the point in contact with the cortex. The anterior cortex only is then drilled.
The drill bit is removed and the 6 mm T-Handled Hand Reamer inserted. The hole in the bone is cleared by turning the hand reamer, until its tip can be heard and felt touching the nail. Tapping the nail to confirm contact may be helpful. The hand reamer is then removed, and the hole rinsed with saline to wash out bone chips.



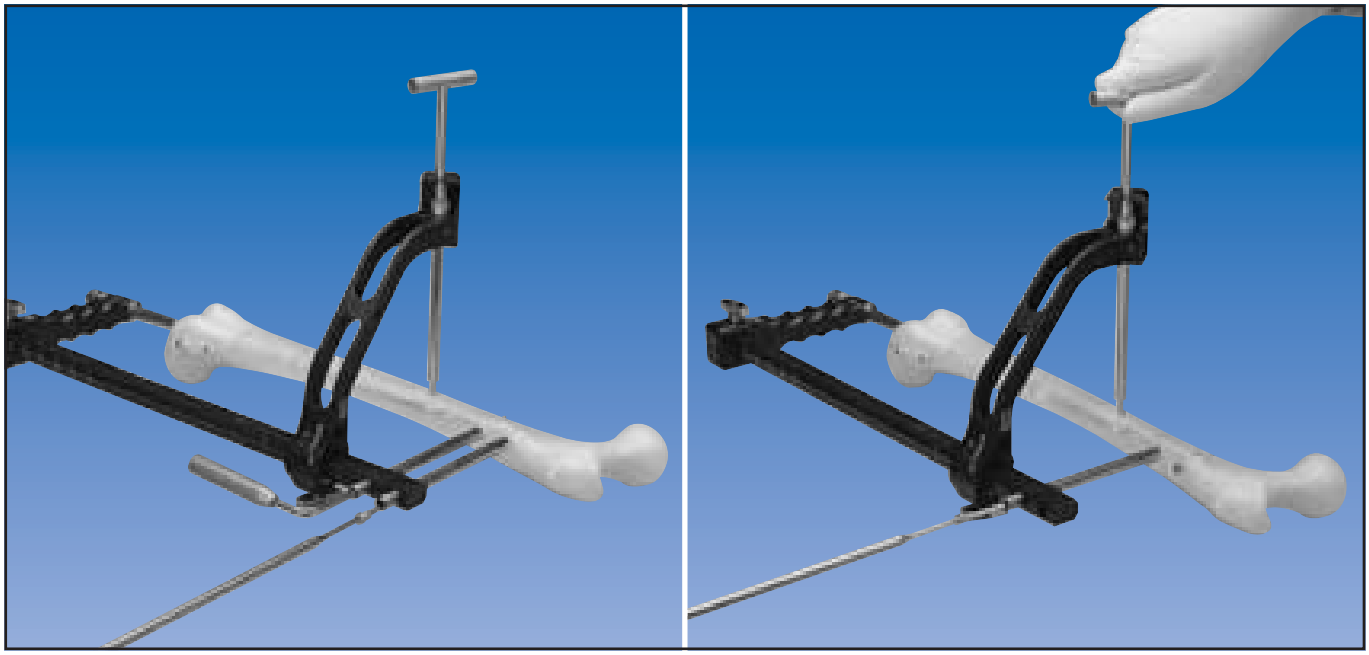
The T-Handled Stabilizing Rod is inserted through the screw guide and the hole in the anterior femoral cortex, down to the nail, contact being confirmed by tapping its tip on to the nail. The Stabilizing Spacer is now attached so that the upper, narrowest fork fits into the groove in the shaft of the stabilizing rod, a retaining ball holding it in place.
The number for the diameter of the nail (i.e. 10 or 11) should be on the outer surface of the spacer, facing the surgeon. The two other forks grip the screw guide and the outrigger.



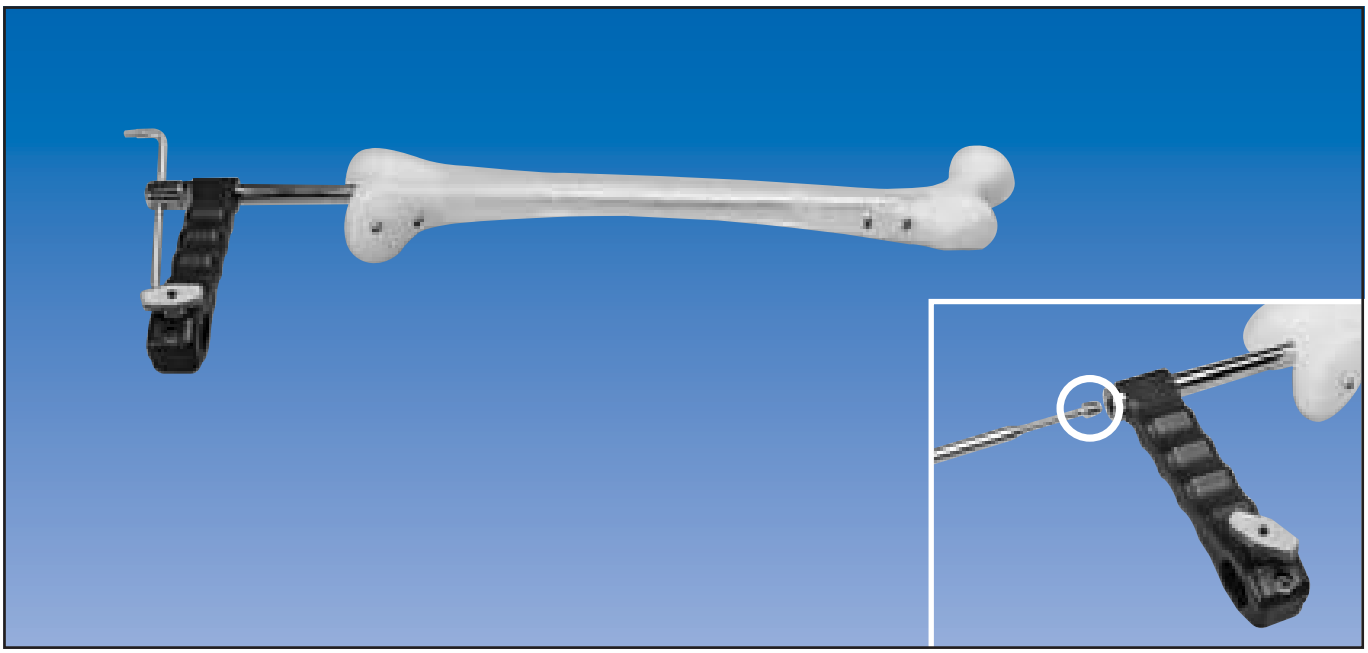
The handle of the stabilizing rod is now held so that its tip is in contact with the nail. The surgeon maintains this contact throughout. A screw guide is inserted through one of the holes in the guide bar and, through a stab incision, advanced down to the bone with the aid of the straight trocar. A 4 mm drill guide is now inserted into the screw guide, and tapped gently to engage its teeth in the bone. The surgeon grips the T-handle of the stabilizing rod, to keep its tip against the nail, and maintains this position throughout the drilling procedure. The 4 mm drill bit is used to drill both cortices.



The drill bit and drill guide are removed and the graduated angled trocar inserted into the screw guide, so that it passes through the nail, and engages the far cortex. This trocar stabilizes the position of the guide bar, and the second hole must not be drilled until it is in position. Screw guide alignment is now maintained, so the surgeon may release the handle of the stabilizing rod.
A second screw guide is inserted into the remaining hole in the guide bar and the second hole drilled in the same manner.



A locking screw of correct length is now inserted into the second hole. The screw guide is left in place over the screw head to stabilize the guide bar.
The graduated trocar is now removed. The surgeon again maintains the position of the stabilizing rod by gripping its handle and the second locking screw is inserted. Locking screw positions are confirmed with the Image Intensifier. The T-handled stabilizing rod, screw guide and outrigger are then removed.



## CLOSING PROCEDURES

The guide bar and locking rod are removed, but the handle kept in place so that the nail end cap (see circle) can be inserted through the nail support with the T-wrench. The nail end cap must be securely tightened. The knee is rinsed with at least 500 ml of Ringer's solution. The incisions are then closed with a suction drain in the knee joint (supracondylar notch). The drain is removed after 48 hours.

### Revision Locking Screws

These have an 8 mm diameter thread of the same length as the standard locking screws. It is recommended that they are used in place of the standard locking screws in osteoporotic bone, or when the thread from the standard locking screws has been inadvertently stripped from the bone. For additional compression, they can be used with a washer, which provides a positive key against the first cortex. The washer, 14 mm in diameter, must be screwed on to the revision locking screw before it is inserted. Insertion with a washer must be without the aid of a screw guide.

### Compression Locking Screws

These are similar to revision locking screws, but have in addition a 10 mm thread on the end, which takes a self-locking nut. This is designed to maintain the reduction of distal intercondylar femoral fractures. Reduction must be achieved initially, and maintained while the nail is passed. The locking screw length is estimated carefully, so that the tip of the screw will just penetrate the second cortex. A 14 mm washer is screwed on up to the screw head. The compression locking screw is then inserted just as a revision locking screw with a washer. If the length has been estimated correctly, a small amount of the threaded tip will penetrate the second cortex. A compression nut with integral washer is then applied and tightened, locking the nail and maintaining fracture reduction at the same time. The screw head must be fixed with the 3.5 mm hexagonal T-wrench while the compression nut is tightened with the tool provided.

### Countersink Hand Drill

This can be used when soft tissue cover is thin to recess a locking screw head into the bone, and will normally be needed for distal locking screws only. The instrument is inserted into the screw guide after drilling and turned until the mark is level with the top of the screw guide. At this point the surface of the screw head should be level with the surface of the bone.

A posterior splint is used for one week post-operatively, after which partial weightbearing (up to 15 Kg) in a walker frame is recommended if the knee joint incision has healed. A programme of gradually increasing weightbearing should be instituted, up to full weightbearing when there is radiographic evidence of callus formation. As for antegrade nails, the amount of weightbearing at any time must depend on the diameter of implant chosen, the weight of the patient, the progress of fracture healing, and the stability and degree of comminution of the fracture. If any fracture is comminuted to the extent of Winquist III or IV, or unstable for any other reason, we recommend toe touch weightbearing only up to a maximum of 30 Kg until there is good radiological evidence of callus formation.
With 10 mm diameter nails longer than 220 mm, we recommend partial weightbearing only up to a maximum of 50% body weight until there is good evidence of fracture healing.
Continuous passive motion is recommended to maintain knee flexion and extension.

Isometric muscle exercises for the whole limb should be encouraged from the outset. Normally, a good range of knee and hip movement is achieved spontaneously. Active physiotherapy for the knee is recommended only when the patient is mobile and pain free. Too vigorous a programme of physiotherapy in the early stages may be harmful.
Dynamization may be considered if union is delayed, by removal of the proximal locking screws, but is not recommended as part of the standard technique.

## INTERNAL FIXATION

PM IKD — Intramedullary Skeletal Kinetic Distractor: Tibial Surgical Technique

Intramedullary Skeletal Kinetic Distractor: Femoral Surgical Technique

PM IMT — The Orthofix Tibial Nailing System

PM IMF — The Orthofix Femoral Nailing System

PM AAN — The Ankle Arthrodesis Nail

PM RFN — The Retrograde Femoral Nailing System

PM PRD — PORD™ DEVICE
Posterior Reduction Device
for Hip and Femoral Fractures

PM PCP — THE GOTFRIED PC.C.P
for Percutaneous Compression Plating
of Pertrochanteric Hip Fractures

## EXTERNAL FIXATION

PM 01 — ORTHOFIX EXTERNAL FIXATION:
BASIC CONSIDERATIONS

PM 02 — GROWTH PLATE DISTRACTION
- Chondrodiatasis
- Hemichondrodiatasis

PM 03 — LIMB LENGTHENING
AND CORRECTION OF DEFORMITIES
BY CALLUS DISTRACTION
- Callotasis
- Hemicallotasis
- Tibial lengthening
  and angular correction with the
  OF-Garches limb lengthener

PM 04 — ARTHRODIATASIS
(Articulated Joint Distraction)
- Hip
- Ankle

PM 05 — ARTHRODESIS (Joint Fusion)
- Shoulder
- Hip
- Knee
- Ankle

PM 06 — DIAPHYSEAL FRACTURES
- Humerus
- Forearm
- Femur
- Tibia

PM 07 — DISTAL TIBIAL AND PILON FRACTURES

PM 08 — PELVIC APPLICATIONS

PM 09 — TREATMENT OF FRACTURES AND
DEFORMITIES IN SMALL BONES

PM 10 — THE PENNIG DYNAMIC WRIST FIXATOR

PM 11 — THE LIMB RECONSTRUCTION SYSTEM
- Part A: General Principles
- Part B: Correction of Deformities

PM 12 — THE RING FIXATION SYSTEM
- Part A: The Hybrid Fixator
- Part B: The Sheffield Ring Fixator -
  Standard Trauma Applications
- Part C: The Sheffield Ring Fixator -
  Limb Reconstruction
  and Complex Trauma

PM RLW — The RadioLucent Wrist Fixation System

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