Ankle Arthrodesis Nail

Surgical Technique

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BIOMET INC

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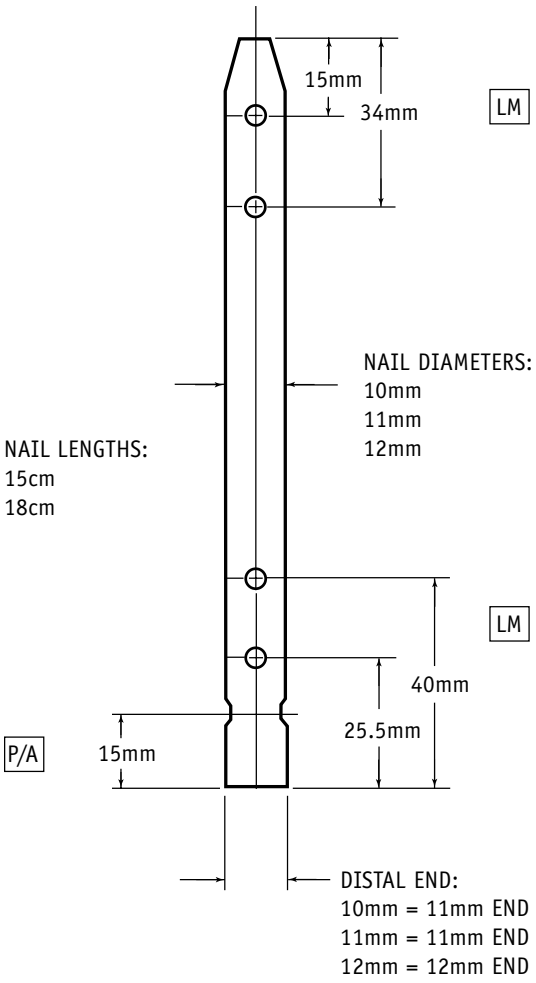
This Ankle Arthrodesis Nail brochure is presented to demonstrate the surgical technique utilized by George Quill, M.D. and Stuart Miller, M.D. Biomet, as the manufacturer of this device, does not practice medicine and does not recommend this or any other surgical technique for use on a specific patient. The surgeon who performs any procedure is responsible for determining and utilizing the appropriate technique for such procedure for each individual patient. Biomet is not responsible for selection of the appropriate surgical technique for an individual patient.

Ankle Arthrodesis Nail

Introduction

The goals of ankle arthrodesis are the relief of pain and deformity and the development of a solid fusion. Numerous techniques exist for isolated tibiotalar arthrodesis, a procedure that leaves some motion at the subtalar joint. A number of clinical situations warrant inclusion of the subtalar joint as well. Disabling arthritis, subluxation or deformity of not only the tibiotalar, but also the talocalcaneal joint, are some of the indications for fusing the subtalar joint along with the ankle. In patients with poor bone stock, such as severe osteoporosis, talar AVN, or prior failed ankle fusion, the surgeon often seeks the extra purchase of calcaneal bone in achieving a fusion. Intramedullary nailing has proved to be a solid method of fixation for achieving tibiotalocalcaneal arthrodesis. A nail inserted through the plantar aspect of the foot can afford excellent stability, position, and alignment. The process of tibiotalocalcaneal arthrodesis using an intramedullary nail, usually involves an ankle arthrotomy, preparation of the joint surfaces, and then placement of the nail through a plantar incision. Screws are placed proximally into the tibia in a standard fashion and, after compression, the nail can be locked distally with screws into the calcaneus and the talus.



Unique Compression Device
Optimal Patient Sizing

- The strength and biocompatibility of titanium alloy
- Lateral to medial transfixation locking screws
- A load sharing fixation device that affords torsional rigidity and better calcaneal purchase through the posterior to anterior transcalcaneal locking screws
- The option for compression with a nail-mounted compression device
- Fully cannulated, closed section nail design
- Optimal patient sizing 10, 11, 12mm nail diameters, nail lengths of 15 and 18cm
- Fully threaded 5.0mm diameter, titanium screws
- Precise, reproducible instrumentation

Indications

- Avascular Necrosis of the Talus
- Trauma (malunited tibial pilon fracture)
- Failed Total Ankle Replacement
- Severe deformity as a result of talipes equinovarus, cerebral vascular accident, paralysis or other neuromuscular disease
- Revision Ankle Arthrodesis
- Neuroarthropathy
- Rheumatoid Arthritis
- Osteoarthritis
- Pseudoarthrosis

The indications for tibiotalocalcaneal arthrodesis include avascular necrosis of the talus or failed total ankle arthroplasty with subtalar intrusion. Patients with a failed ankle fusion, as well as those patients with rheumatoid or osteoarthritic involvement of these joints, are excellent candidates for tibiotalocalcaneal fusion. Various deformities about the hind-foot and ankle, such as pseudoarthrosis, neuromuscular disease, or severe defects after tumor resection often present for tibiotalocalcaneal and, in certain instances, pantalar arthrodesis. With significant instability, subluxation, or arthritis involving not only the ankle and hind-foot, but also the transverse tarsal joints, coupling the mid-foot to the hind-foot by fusing the transverse tarsal joints often gains essential stability.

Contraindications

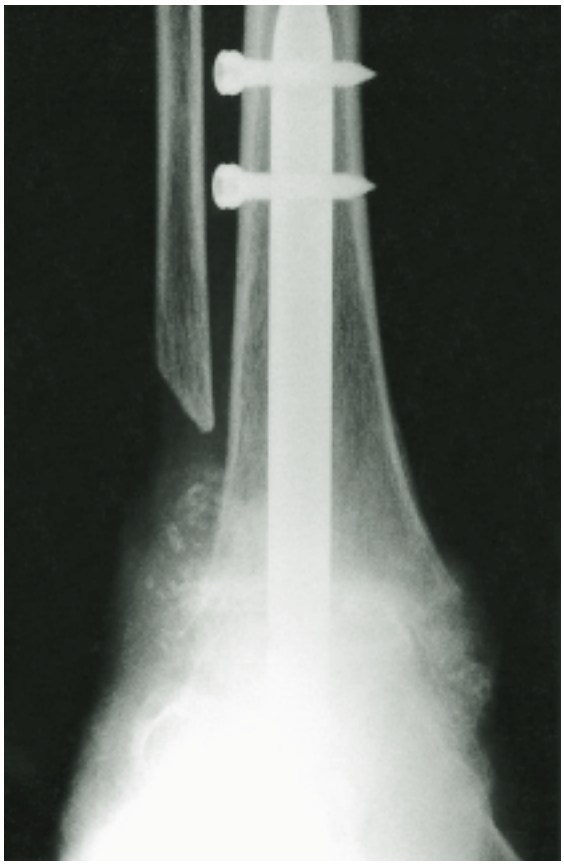
- Dysvascular Limb
- Active Infection
- Insufficient Plantar Pad
- Severe Longitudinal Deformity

Contraindications for tibiotalocalcaneal and pantalar arthrodesis with nail fixation include a dysvascular extremity or severe active infection. Patients lacking appropriate plantar skin or fat pad will most likely fail intramedullary fixation. Severe and fixed deformities of the ankle, hind-foot, and distal tibia may be relative contraindications for closed nailing and arthrodesis. Because of the difficulty in obtaining a collinear reduction of the tibia, talus, and calcaneus; a more open procedure may be necessary with fixation either by nail, plates and screws, or circular frame.

Implant Rationale

The Biomet Ankle Arthrodesis Nail is ideally suited for tibiotalocalcaneal fusion indications. This second-generation nail affords rigid, load sharing fixation that incorporates a simple nail-mounted, in-line method of compression across the arthrodesis sites. Available in 10, 11, and 12mm diameters and 15 and 18cm lengths, the nail offers reproducible targeting and accurate bicortical locking, from lateral to medial, with 5mm fully threaded screws. The Biomet nail is unique in that it affords even more torsional rigidity and better calcaneal purchase through its transcalcaneal locking screw that is inserted from posterior to anterior, using a nail-mounted targeting device. This calcaneal locking screw may also be inserted through the transverse tarsal joints to aid in fusing the hind-foot and ankle to the mid-foot. Laboratory bio-mechanical testing has demonstrated that the insertion of the posterior to anterior fixation screw provides 40% more torsional rigidity than other existing nails that incorporate only lateral to medial transverse calcaneal screws alone.[1]

1. Data on file.



53-year-old Rheumatoid Arthritis patient

Ankle Arthrodesis Nail

Surgical Technique

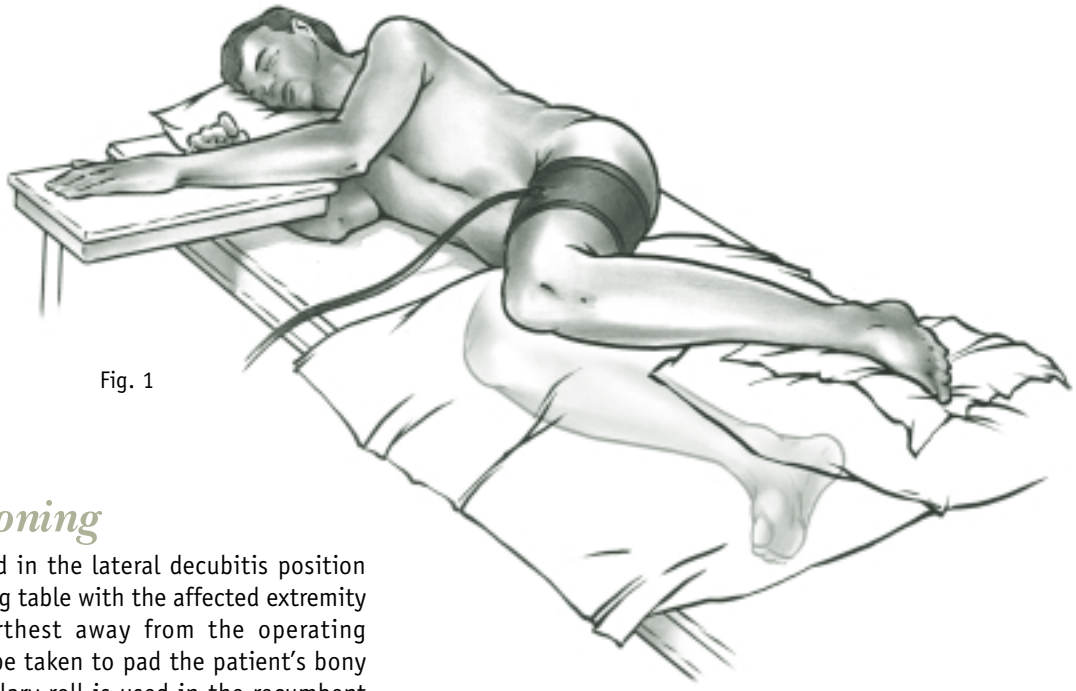


Fig. 1

Patient Positioning

The patient is positioned in the lateral decubitis position on a radiolucent operating table with the affected extremity to be operated up (farthest away from the operating table). Great care must be taken to pad the patient's bony prominences and an axillary roll is used in the recumbent axilla. The non-operated extremity is flexed at the hip and knee and placed very close to the anterior border of the operating table. In this fashion, intraoperative fluoroscopy can be used as indicated to image the operated extremity in all planes. General or spinal anesthesia is usually required and a thigh tourniquet facilitates the plantar dissection (Figure 1).

Fig. 2

Surgical Exposure

The transfibular approach affords excellent exposure for ankle fusion. A longitudinal incision is made over the posterior fibula then, curves distally along the peroneus tendon (Figure 2). Great care should be taken to note the course of the existing neurovascular structures and tendons (Figures 3a & 3b).

Fig. 3a

The distal 5cm of the fibula is resected in a beveled fashion at a level 2cm proximal to the tibiotalar joint line. The distal portion of the fibula may be morsellized for use as an autogenous bone graft (Figure 4). **Note: Some prefer to skeletonize the distal fibula and lift off the lateral cortex and harvest the cancellous bone, while others prefer to remove the distal fibula.** This local bone graft is utilized after nail placement.

Fig. 3b

The peroneal tendons should be preserved. Special care should be paid to the occasionally present lateral peroneal artery in the region of the syndesmosis, which may bleed excessively. (Occasionally further fibular resection is needed to expose and tie off this vessel.) The incision is extended distally to the sinus tarsi to allow subtalar joint visualization (Figure 5).

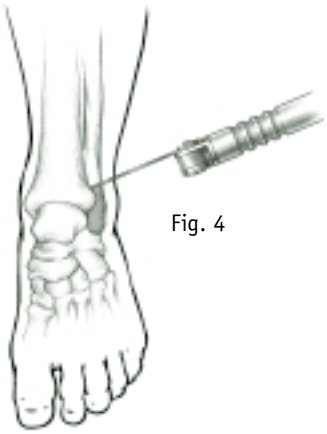


Fig. 4

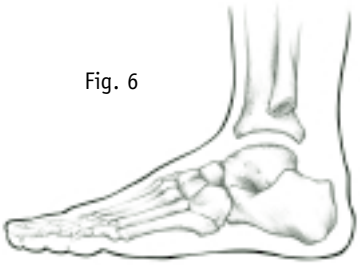
Fig. 5

Surgical Exposure, continued

The ankle joint preparation is crucial to successful fusion. Two techniques for preparation of the tibiotalar joint are described.

1) The tibiotalar joint is denuded of cartilage in a congruent fashion, removing anterior and posterior osteophytes with a chisel and rongeur. Diseased cartilage is removed down to bleeding subchondral cancellous bone preserving, if possible the natural concavity of the distal tibial articular surface and the dorsal concave surface of the talus. If necessary, when performing tibiotalocalcaneal arthrodesis, the tibiotalar joint may be provisionally fixed in place with thick, smooth K-wires, while both sides of the subtalar arthrodesis site are prepared with chisels, curettes, and rongeurs. An anterolateral ankle arthrotomy may be used and may be coupled with an anteromedial arthrotomy to correct deformity present across the ankle joint and to prepare the joint surface by removing what remains of the articular surface.
2) A transverse saw cut is made across the distal tibia. The ankle is then brought into neutral position and a matching talus cut is performed. The posterior and lateral talar surfaces should also be decorticated to allow greater fusion surface. The subtalar joint is prepared in a standard fashion with chisels or curettes (Figure 6).

Fig. 6



The best position of arthrodesis is in neutral dorsiflexion, three to five degrees of hind-foot valgus, and external rotation symmetric with the contralateral uninvolved extremity. Appropriate external rotation is achieved when the anteromedial crest of the tibia lies parallel with the second ray of the involved foot.

Nail Entry Site

Following the preparation of the bony surfaces, a 3cm longitudinal plantar incision is made anterior to the subcalcaneal fat pad slightly lateral to the midline, especially in the patient with significant preoperative valgus deformity. Blunt dissection is carried down to the plantar fascia, which is split longitudinally. The intrinsic muscles are swept medially or laterally and the neurovascular bundle on the sole of the foot is identified (Figure 7). The ideal position for the plantar calcaneal entry site is well anterior to the weight bearing surface of the calcaneal tuberosity and approximately 2cm posterior to the articulation of the calcaneus with the transverse tarsal joints. In the coronal plane, the entry site should lineup with the center of the tibial medullary canal (Figure 8).

A 3/32" x 9" Steinmann Pin is inserted through the calcaneus, talus, and into the tibia (Figure 9). Confirm the position of the guide wire on the image intensification. Using the 7.0mm diameter cannulated drill, ream the subtalar and tibiotalar articular surfaces over the 3/32" guide pin (Figure 10). It is helpful to have an assistant hold the foot in the appropriate alignment during the transmedullary reaming.

Fig. 7

Fig. 8

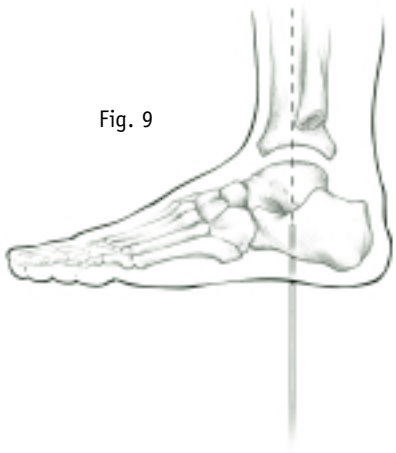


Fig. 9

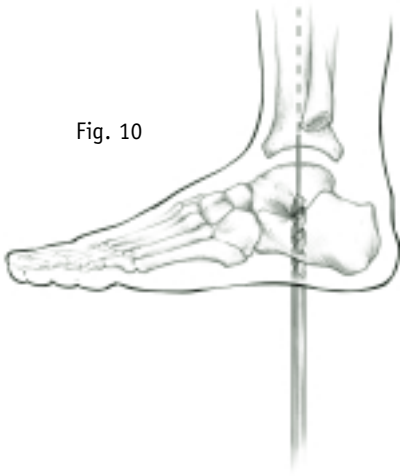
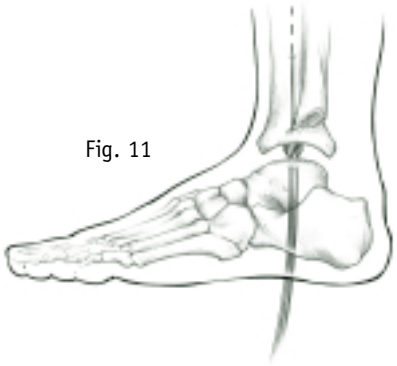


Fig. 10

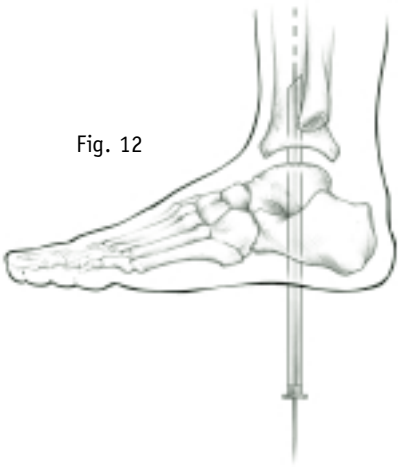
Guide Wire Placement and Canal Reaming

Fig. 11



Remove the 3/32" Steinmann Pin. A 3.2mm ball-tipped guide wire is inserted trans-calcaneally through the talus into the tibial medullary canal using image intensification. Progressive reaming is performed over the guide wire in 0.5mm increments using flexible reamers (Figure 11). It is recommended to ream to 0.5mm larger than the anticipated nail's outside diameter. It is necessary to ream to a depth of only 18–20cm in the tibial canal; do not ream beyond the distal third of the tibial shaft. When reaming is complete, remove the ball tip guide wire or exchange it for a plain tip Nail Driving Guide.

Fig. 12

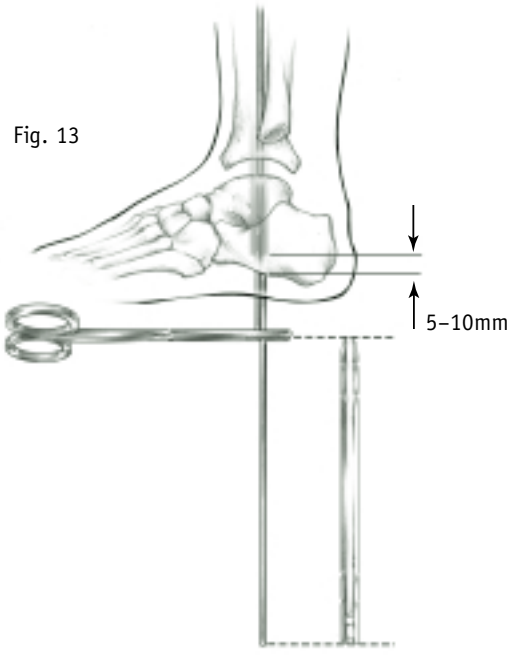


Note: The nail may be inserted over a Nail Driving Guide. Insert the 6.3mm Medullary Alignment Tube over the Ball Tip Guide and remove the Ball Tip Guide. Insert the 3.2mm x 48cm plain tip Nail Driving Guide through the Alignment Tube until it passes the fusion site (Figure 12). Confirm the position on the image intensification. It is important that the Nail Driving Guide be very close to the center of the tibial canal to alleviate any chance of driving the nail into the cortex of the tibia. Remove the Medullary Alignment Tube. The nail may now be inserted over the Nail Driving Guide.

Nail Length Determination

A second Nail Driving Guide of the same length is used to measure the length of nail to be used (Figure 13). An X-ray scale used under image intensification is an alternative to a second Nail Driving Guide.

Fig. 13



The Biomet Ankle Arthrodesis Nail is available in lengths of 15 and 18cm. In the most optimal setting, the proximal nail end should extend at least 1½ to 2 tibial diameters above any potential cortical stress risers, e.g. non-union sites, cortical holes existing after removal of old hardware, tibial fracture, or oteotomy sites. Ideally, the nail should be countersunk 5–10mm from the plantar calcaneal cortex. In some situations, where calcaneal purchase or transverse tarsal fixation requires, the nail may be countersunk more deeply. The nail-mounted compression device provides an easy technique for achieving compression across the ankle and subtalar arthrodesis sites (refer to technique for Compression on page 11). **Note: Patient matched implants of other lengths can be made, as special indications may arise.**

Outrigger Assembly

The compression nut (1) is turned onto the nail end of the driver bushing (2). The compression sleeve (3), with the flared end toward the nail, is then inserted over the nail end of the driver bushing, next to the compression nut (Figure 14). The driver bolt (4) is passed through the driver bushing (2) and attaches to the nail. The two tangs on the underside of the driver must engage with the two slots on the distal end of the nail. The target arm (5) engages the driver bushing. The driver bolt is then firmly tightened using the 3/8" hex socket T-wrench, locking the driver bushing to the nail (Figure 15). The threaded driver handle (6) locks the target arm to the driver bushing (Figure 16).

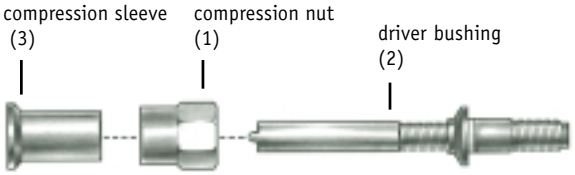


Fig. 14

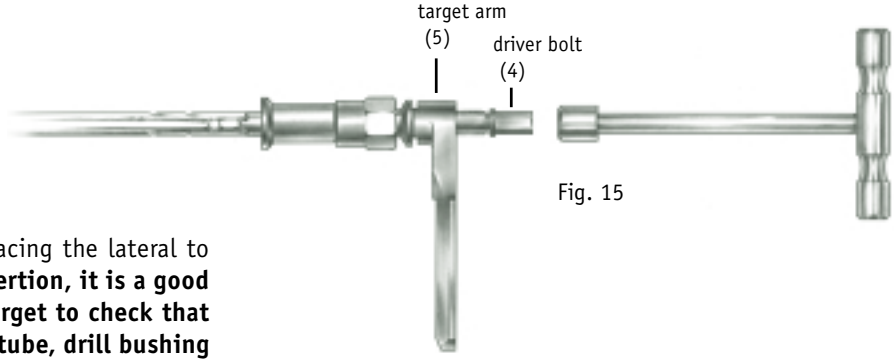


Fig. 15

Nail Insertion

The targeting arm is positioned for placing the lateral to medial locking screws. **Before nail insertion, it is a good idea to attach the proximal/distal target to check that the drill will pass through the guide tube, drill bushing and nail.** The nail is inserted internally rotated, so when the screws are inserted from lateral to medial (target arm on the lateral side), they will pass into the tibia, clearing the fibula. Countersink the nail approximately 5–10mm from the plantar surface of the os calcis to allow for compression across the arthrodesis, screw hole position, and to ensure it will not be unduly prominent later for weight bearing (Figure 17). **Note: If using a Nail Driving Guide, remove it before inserting the screws into the nail.**

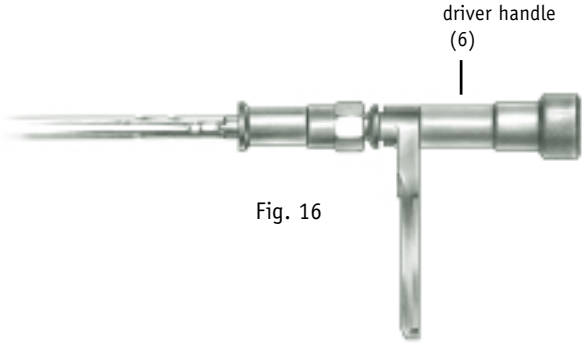


Fig. 16

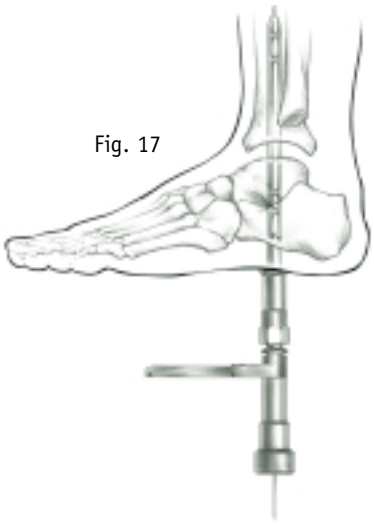


Fig. 17

Proximal Screw Insertion

The proximal/distal target should be tightened onto the target arm using the hex socket T-wrench (Figure 18). A 3/32 x 9" guide pin may be placed through the hole in the target to confirm the placement of the distal nail end. The drill bushings are placed into the guide tube and the assembly is placed into the proximal holes in the target. **Note: The guide tubes straddle the nail length number, either 15 or 18cm length.** Using fluoroscopic control, a small stab incision is made on the lateral side of the leg; the drill guides are placed down on the lateral cortex of the tibia. A 4.3mm calibrated drill bit is passed through the drill bushing, lateral cortex of the tibia, nail, and just through the medial cortex of the tibia (Figure 19). Having drilled one hole successfully, leave that drill in place and drill the second. With the guide tube held firmly against the lateral cortex, the appropriate length of the locking screw can be read directly off the calibrated drill (Figure 20). As an alternative, a depth gauge may be used to determine the appropriate screw length, after removing the drill bushing (Figure 21).

Remove the inner drill bushing and place the appropriate bicortical screw using the hex drive T-wrench (Figure 22). In a similar fashion, the second proximal tibial screw can be inserted from lateral to medial (Figure 23).

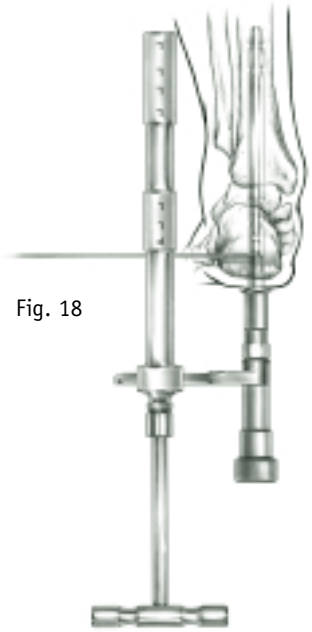


Fig. 18

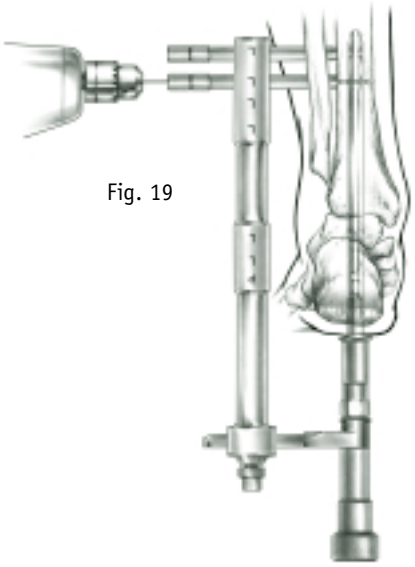


Fig. 19

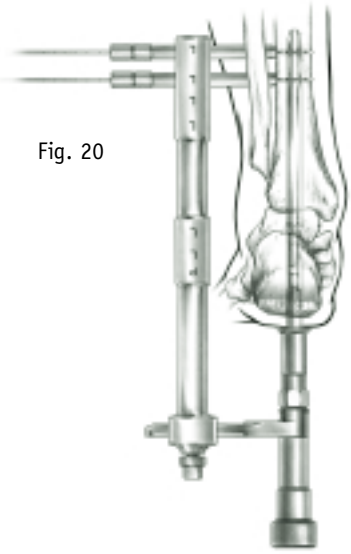


Fig. 20

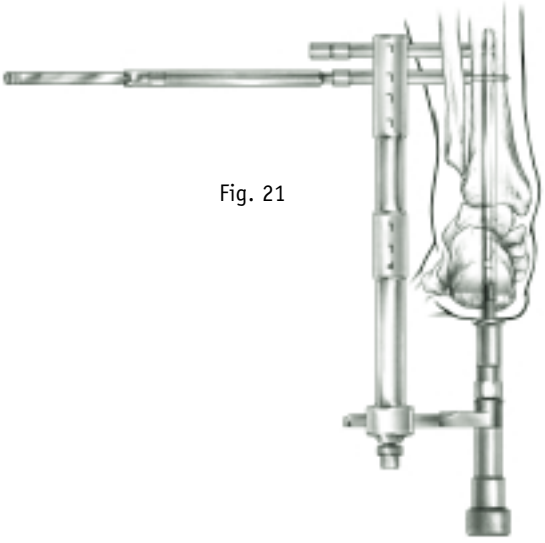


Fig. 21

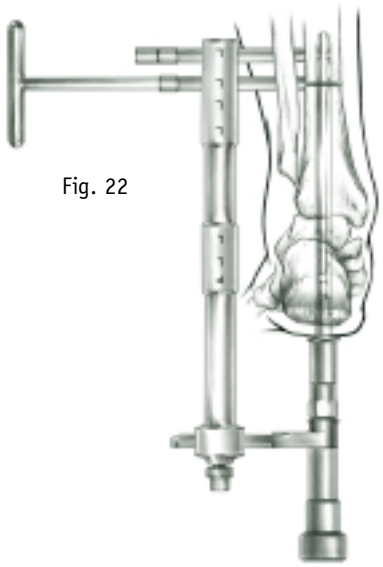


Fig. 22

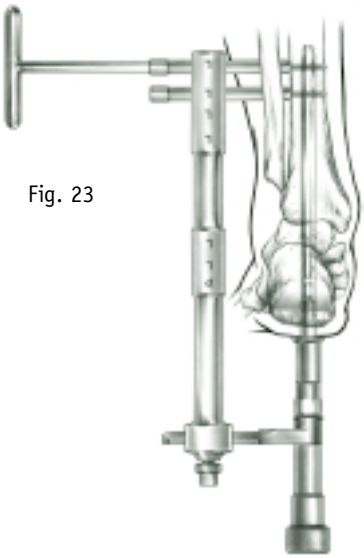


Fig. 23

Compression

The unique nail–mounted compression device provides an easy technique for achieving compression across the ankle and subtalar arthrodesis sites. The distal end of the nail must be countersunk, from the calcaneal plantar surface, to the expected amount of compression desired. The compression nut is turned clockwise with the 3/4" End Wrench until the desired amount of compression is achieved at the arthrodesis sites (Figure 24). A total of 15mm compression is possible, using the compression nut on the driver bushing. Take care not to tighten the compression nut so severely that the plantar cortex of the calcaneus is crushed or leave the plantar aspect of the nail prominent through the bottom of the calcaneus. Care must also be taken to avoid impinging soft tissues on the plantar aspect of the foot between the compression sleeve and the os calcis. Once the arthrodesis site is compressed the appropriate distance, it is then locked distally with 5mm screws.

Fig. 24

Distal Screw Insertion

Lateral to medial talar and calcaneal locking screws are placed using the same guide tube and drill bushing as for proximal locking (Figure 25). The most appropriate position for these screws is determined by each individual case, but most often one screw passes through the talus and one through the calcaneus (Figure 26).

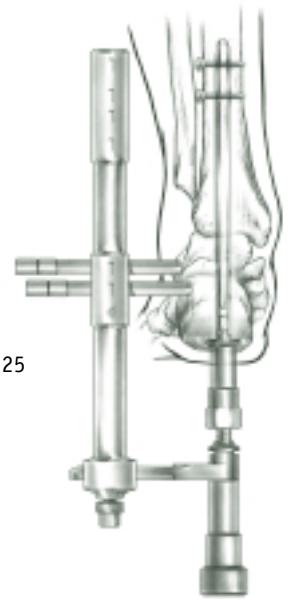


Fig. 25

To insert the posterior to anterior screw, the target arm with the proximal/distal target must be indexed 90°. To index the target arm, loosen the driver handle 3 turns, index and retighten in the PA position (Figure 27). The Guide Tube with the Drill Bushing is placed through the targeting hole. The appropriate position on the skin is noted and a small circle is usually made with the drill sleeve and then a longitudinal stab wound made. Blunt dissection affords ready passage of the drill sleeve down to bone on the posterior or posterolateral os calcis. Again the surgeon is careful to protect the neurovascular structures in this area.

Using fluoroscopic imaging, the calibrated drill bit is then passed through the calcaneus, through the nail into the subarticular surface of the anterior calcaneus. Determine the appropriate length of screw to be used by reading from the calibrated drill off the top of the drill bushing (Figure 28). **You may want to select a screw 5mm shorter than the calibrated drill reading if you are countersinking for the screw head.** Remove the inner drill bushing and use the T-handle countersink, so that the PA screw is not unduly prominent posteriorly on the subcutaneous border of the os calcis (Figure 29). A depth gauge may also be used to determine the appropriate screw length (Figure 30). Insert the appropriate 5.0mm screw through the guide bushing using the Hex Drive T-Wrench (Figure 31).

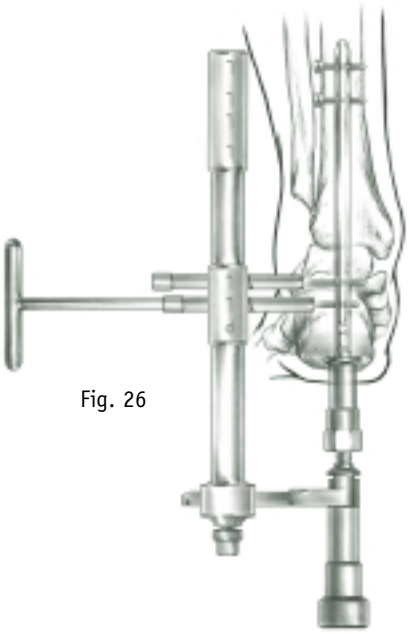


Fig. 26

Note: For the true pantalar arthrodesis, the drill and subsequent posterior to anterior screw may be passed across the transversetarsal joints into the cuboid or tarsonavicular as well (Figure 32).

Fig. 27

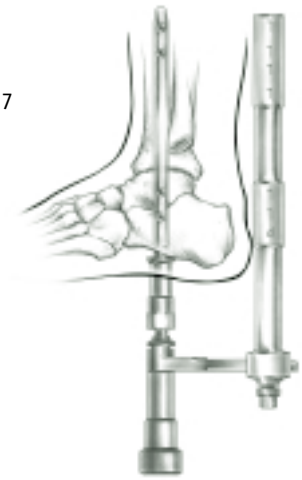


Fig. 28

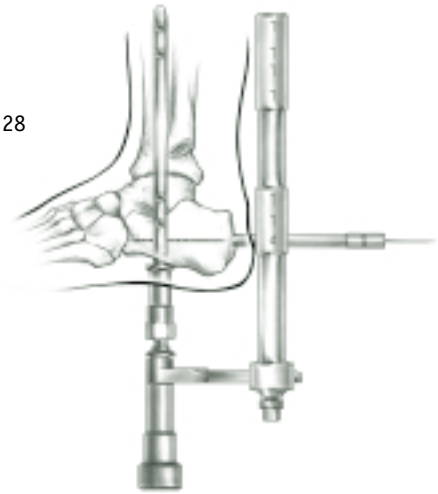


Fig. 29

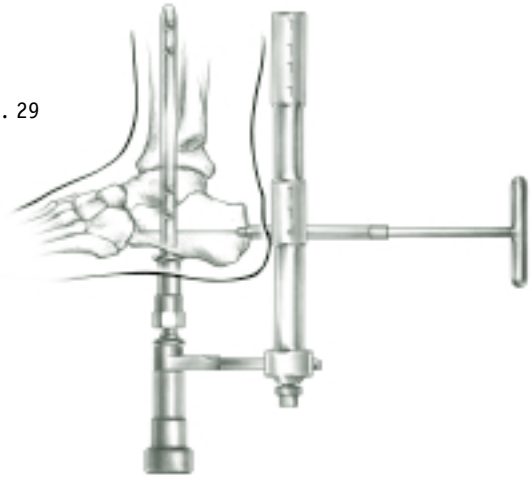


Fig. 30

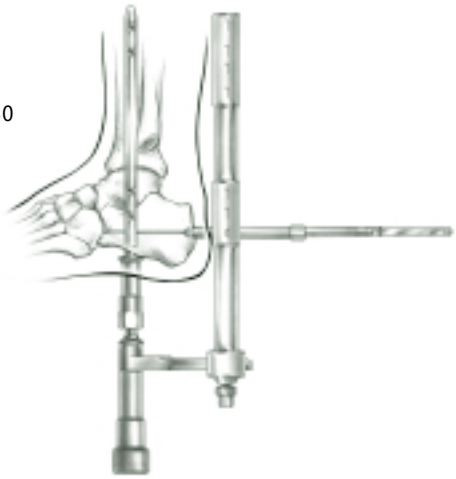


Fig. 31

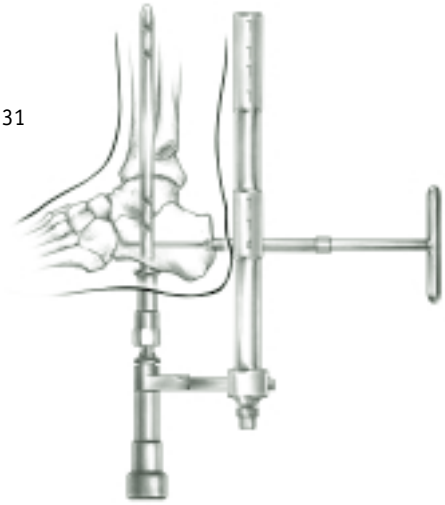
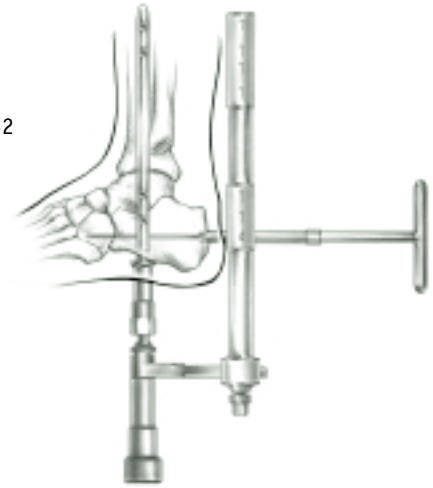


Fig. 32



End Cap Placement

The end cap may be threaded into the end of the nail to prevent fibrous ingrowth and restrict medullary blood flow from the distal end of the nail. While applying pressure to the driver bushing to keep it engaged on the nail, remove the driver bolt with the Hex Socket T-Wrench. The end cap is inserted through the driver bushing using the Hex Drive T-Wrench (Figure 33).

Fig. 33

Bone Graft Placement

The fibular bone graft may be placed anteriorly and especially posteriorly to facilitate fusion. The posterior tibia surface may be decorticated to provide further fusion surface.

Wound Closure

It is advisable at this point to obtain permanent AP and lateral X-rays before wound closure. Because of the large bleeding cancellous surfaces at the arthrodesis sites and the large amount of bone graft employed in this procedure, it is often advisable to place a closed suction drainage tube. The wound can be closed in layers and the patient protected in a noncircumferential plaster splint with bulky compressive dressing.

Fig. 34

Postoperative Care

It is advised that the patient be nonweight bearing on the operated extremity until clinical and radiographic union are apparent. Often a period of cast immobilization anywhere from 6–12 weeks is necessary to achieve this goal. Further protection with a walking boot or brace may help ease the transition to weight bearing.

Nail Removal

In most cases, the nail is not inserted with the intention of removal, however locking screw removal may be indicated after fusion if local irritation is experienced. When a nail is to be removed, the proximal locking screws should be left in place until the extractor adapter is attached to the nail. The end cap is removed and the nail extractor adapter is threaded into the distal end of the nail (Figure 34). The screws are removed with the Hex Drive T-Wrench. The slap hammer is threaded into the nail extractor adapter and the nail is removed.

Ordering Information

Biomet Ankle Arthrodesis Nail			
Length	Part Number		
	10mm Diameter	11mm Diameter	12mm Diameter
15cm 18cm	**345120** **345125**	**345140** **345145**	**345160** **345165**

Titanium End Cap
345220

Titanium Fixation Screws 5.0mm Diameter/Fully Threaded	
Part Number	**Length**
33-345418	20mm
33-345420	25mm
33-345422	30mm
33-345424	35mm
33-345426	40mm
33-345428	45mm
33-345430	50mm
33-345432	55mm
33-345434	60mm
33-345436	65mm
33-345438	70mm
33-345440	75mm
33-345442	80mm
33-345444	85mm
33-345446	90mm
33-345448	95mm
33-345450	100mm
33-345452	105mm
33-345454	110mm

Instrumentation

Driver Bushing

471691

Compression Nut

471692

Compression Sleeve

471693

Driver Bolt

471694

Proximal/Distal Target

471695

T-Handle Countersink

471696

Cannulated Drill 7mm

471697

Target Arm

471630

Driver Handle—Threaded

471535

Guide Tube (2 each)

471545

Trocar for Guide Tube

471546

Drill Bushing 4.3mm (2 each)

471650

Hex Drive T-Wrench 3.5mm

457118

Hex Drive Power Bit 3.5mm

457119

T-Wrench 3/8 Hex

449110

Calibrated Twist Drill
4.3mm x 254mm (sterile)

471656

Steinmann Pin Trocar Point
3/32 x 9"- Pkg. 5 (sterile)

25-361278

TI-End Wrench 3/4"

471758

Nail Driving Guide
3.2mm x 48cm

467212

Screw Depth Gauge

34-513644

Nail Extractor Adapter

471560

Nail Extractor w/Slide Hammer

471565

Instrument Case

595039

Ankle Arthrodesis Nail Template

471604

Suggested Additional Instrumentation

Modular Flexible Reamer System
(Requires 3.2mm **Ball Tip Guide)**

469060	98cm (Sterile)
469055	55cm (Sterile)

Standard	Head Only	Ti-Nitride
467734	8.0mm	**467634**
467736	8.5mm	**467636**
467738	9.0mm	**467638**
467740	9.5mm	**467640**
467742	10.0mm	**467642**
467744	10.5mm	**467644**
467746	11.0mm	**467646**
467748	11.5mm	**467648**
467750	12.0mm	**467650**
467752	12.5mm	**467652**
467754	13.0mm	**467654**
467756	13.5mm	**467656**
467758	14.0mm	**467658**
467760	14.5mm	**467660**
467762	15.0mm	**467662**
467764	15.5mm	**467664**
467766	16.0mm	**467666**
467768	16.5mm	**467668**
467770	17.0mm	**467670**
467772	17.5mm	**467672**
467774	18.0mm	**467674**
467776	18.5mm	**467676**
467778	19.0mm	**467678**
467780	19.5mm	**467680**
467782	20.0mm	**467682**

Shaft Only

467716	40cm
467718	52cm

Modular Reamer Sterilization Case

593243

X-Ray Scale

475920

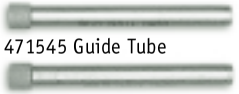
471691 Driver Bushing

471692
Compression Nut

471693
Compression Sleeve

471694 Driver Bolt

471546 Trocar for Guide Tube



471545 Guide Tube

471650 Drill Bushing 4.3mm

471758 TI-End Wrench 3/4"

25-361278 Steinmann Pin 3/32 x 9"

471656 Calibrated Twist Drill 4.3mm x 254mm

457119 3.5mm Hex Drive Power Bit

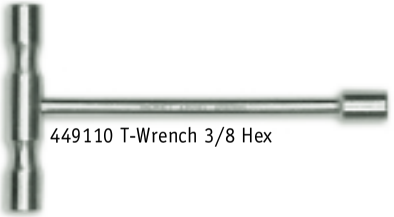
471695 Proximal/Distal Target

471535 Driver Handle

457118 3.5mm Hex Drive T-Wrench

471696 T-Handle Countersink

471630 Target Arm



449110 T-Wrench 3/8 Hex

471697 Cannulated Drill 7mm

34-513644 Screw Depth Gauge

471560
Nail Extractor Adaptor

471565 Nail Extractor w/Slide Hammer

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