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Late Reconstruction of Complex Ankle Fractures and Dislocations

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TRAUMATIC ARTHRITIS

The long-term complications of traumatic injury of the ankle joint are related to the degree of articular surface damage, the severity of the fracture, and the amount of actual disruption of the normal anatomy of the joint. Cartilage of the ankle joint will normally repair itself after certain impact loads, but exaggerated forces can kill cartilage cells at the microscopic level, leading to permanent joint damage.[50]

Fractures and ligamentous disruption alter the normal anatomic relationships, leading to stress overload of the joint surfaces. Ramsay and Hamilton found loss of normal articular congruity with 1 mm of lateral talar shift.[33] Macko and colleagues found significant experimental alteration in joint reaction forces with loss of a posterior malleolar fragment from simulated fracture.[21] Nepola investigated articular congruity with talar shift from fibular diastasis using pressure-sensitive film and did not identify the diminished joint surface contact suggested by Ramsay and Hamilton. Other factors, such as joint instability and altered joint mechanics, may be even more important in causing joint destruction.[29]

Numerous clinical reports have demonstrated that articular anatomy must be perfectly restored in order for a good result to be achieved. If that goal is not accomplished, traumatic arthrosis is the likely outcome.[44] The exact cause of degenerative arthritis at the microscopic level remains unclear, but structural changes are well recognized. There is a radiographic decrease in joint space and formation of sclerotic joint margins, peripheral osteophytes, and subchondral cysts.

A typical history includes morning stiffness or pain until the person has had a chance to "loosen up." Symptoms are aggravated by prolonged walking and standing. "Change of weather" aches are common.[23] Physical examination demonstrates localized joint line tenderness, and slight warmth may be detectable over the joint. There is pain at the extremes of range of motion, which becomes more restricted as time passes. Bony proliferation can be palpated and occasionally visualized along the malleoli.

Conservative Treatment

All patients should undergo conservative treatment initially, which should include anti-inflammatory medication and the judicious use of local corticosteroid injections. As stress overload and instability are the causes of progression, modification of activity should be encouraged. Overweight patients should be encouraged to lose weight, and those with jobs involving standing or walking should switch to more sedentary ones if possible.

Orthotic devices should be tried, including polypropylene ankle foot orthoses or double upright braces, with the axis fixed in the neutral position. Rocker-bottom shoes or SACH (solid-ankle, cushioned-heel) modifications reduce stress in the ankle.[22, 23]

Operative Management

Arthrodesis remains the treatment of choice for relief of pain and instability in patients with disabling tibiotalar arthritis. The vast majority of patients should wait at least 1 year before this operation is considered. Davis and Millis found the average time to fusion secondary to trauma was 12 months in 48 cases.[11] Morrey and Wiedeman similarly found that more than one-half of their post-traumatic arthrodesis patients required fusion within 12 months after injury.[27]

Certain post-traumatic injuries require very early or "primary" arthrodesis, but this should be considered only as a last resort. Such patients have bone loss, severe tissue injury, or comminution involving both the distal tibia articular surface and talus.[43]

Morrey and Wiedeman found a higher rate of complications in the post-traumatic arthrodesis group, including infection, nonunion, and malunion.[27] Davis and Millis noted an infection rate of 22 percent in their series, and 39 of 48 patients complained of persistent pain that originated in the subtalar joint.[11]

At least 30 different methods have been devised for ankle arthrodesis.[24] Because of the diversity of problems and evolving surgical techniques, future modifications are likely. However, any ankle arthrodesis should include the following components: (1) tibiotalar compression arthrodesis with internal or external fixation; (2) fibular osteotomy to shorten the relative length compared with the normal joint line and to narrow the distal fibula; (3) medial malleolar osteotomy to narrow the medial side of the ankle; (4) careful and appropriate surgical approach to avoid skin slough and damage to neurovascular structures; and (5) bone grafting to fill in defects in difficult situations. Whatever surgical technique is used, the optimum result depends on positioning the ankle arthrodesis in neutral to 5 degrees of plantar flexion and 5 to 10 degrees of external rotation. Slight heel valgus may be allowed, but varus and dorsiflexion should be meticulously avoided.[8, 22, 25–27, 36]

In traumatic cases, choice of surgical approach is multifactorial. Patients at high risk for complications are those with previous infection, severe soft tissue injury with tenuous skin or surgical scars, significant talar avascularity, spasticity, or neurotrophic joint. Any surgical technique should take the safest approach to limit the pseudarthrosis, infection, and reflex sympathetic dystrophy that can occur after these procedures. Total ankle arthroplasty has been investigated as an alternative to ankle arthrodesis, but most authors would recommend that this procedure be avoided in young healthy individuals with single joint involvement.[6, 47] Arthroscopic techniques for ankle arthrodesis have been attempted but remain experimental.

We recommend the following three basic techniques with possible modifications: (1) simple arthrodesis through an anterior approach with percutaneous three-screw internal fixation; (2) arthrodesis using medial and lateral incisions with medial and lateral malleolar osteotomy and internal fixation; (3) arthrodesis, using any of above methods, combined with external fixation; and (4) tibiocalcaneal arthrodesis, from an anterior or posterior approach, for salvage.

Anterior Arthrodesis

Anterior arthrodesis has become popular in recent years because of its limited exposure and the use of three screws directed from medial, lateral, and posterior. It is most appropriate in cases of limited soft tissue trauma and when there is no risk of potential skin slough from previous incisions. It may be contraindicated when previous screws and plates have been inserted or when fibular osteotomy may be required, because of shortening needed to compensate for joint loss. This approach should also be avoided in patients with suspected vascular damage to the posterior tibial artery or absent posterior pulse.[19]

Technique

The anterior approach described by Colonna is used (Fig. 26–1).[9, 15] After elevation of the tourniquet, the incision begins on the anterior aspect of the ankle and extends 6 cm proximal to and 5 cm below the joint line. Extreme caution should be used in identifying the superficial peroneal nerve branches. The deep fascia is divided in line with the skin incision. The approach is developed between the extensor hallucis longus and extensor digitorum longus. The anterior tibial artery and deep peroneal nerve are identified and protected medially. The capsule, synovium, and perios-

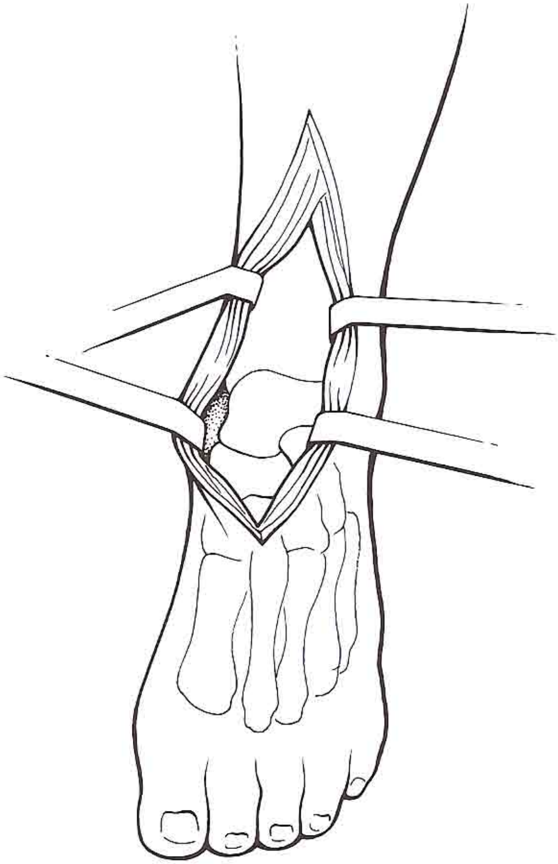

FIGURE 26–1. Anterior approach to the ankle joint. Extensor hallucis longus and anterior tibial tendons and neurovascular bundle are retracted medially. Extensor digitorum longus is retracted laterally. (Redrawn from Colonna PC, Ralston EL: Operative approaches to the ankle joint. Am J Surg 52:44, 1951.)

teum of the anterior ankle joint are exposed to gain full access to the articular surface exactly perpendicular to the long axis of the leg. A similar cut is made on the surface of the talus. Cartilage and subchondral bone are removed sparingly until viable cancellous bone is visualized; usually no more than 5 to 10 mm of shortening occurs. The abutting surfaces of the medial and lateral malleoli are removed, and adjustments are made until perfect apposition of articular surfaces is accomplished. At this point, foot position is assessed, seeking anatomic neutral or slight equinus angulation, neutral or slight valgus heel position, and 5 to 10 degrees of foot external rotation comparable to the contralateral normal side. The posterior screw is the most difficult to insert; a cannulated 6.5-mm cancellous lag screw and image intensification may be helpful. Another method is an indirect one in which a 4.5-mm hole is drilled from the joint surface proximally and posteriorly. A suction tip is inserted through the distal hole to serve as a guide for a 3.2-mm drill inserted percutaneously through the skin and into the talus. A 6.5-mm screw is inserted into the dense talar bone, and 6.5-mm cancellous screws are inserted obliquely through the medial and lateral malleoli into the talus. Rigid stability should be achieved, and screws must not enter the subtalar joint (Fig. 26–2). To facilitate screw insertion, a large smooth Steinmann pin may be placed through the sole of the foot into the distal tibia. This can be removed after screw insertion but can be left if rigid stability is not present. Intraoperative radiographs assess foot position and ensure that screws have not entered the subtalar joint. Bone chips are used to fill any defects at the fusion site. The wound is closed routinely over a drain, and a bulky dressing with posterior plaster splint is applied. A modification of the above technique involves use of an anterior AO spoon plate instead of three screws (Fig. 26–3).[28]

Postoperative Care and Rehabilitation

The patient is kept non–weight bearing for 6 weeks, and the initial splint is taken off at 10 to 14 days and the sutures are removed. A new short-leg cast is applied for 4 weeks, and a short-leg walking cast is used for an additional 6 weeks. Once clinical and radiologic union are ensured, the patient is allowed unprotected weight bearing and encouraged to resume normal activities. An appropriate heel lift and rocker-bottom sole are indicated for all patients to increase comfort. If radiographic union is likely, but the patient has persistent discomfort, a removable ankle-foot orthosis may be used for an additional 6 to 12 weeks. The presence of reflex sympathetic dystrophy should not be overlooked and should be treated aggressively at this point.

Transmalleolar Arthrodesis

This approach has been utilized in ankle arthrodesis by numerous authors and has an

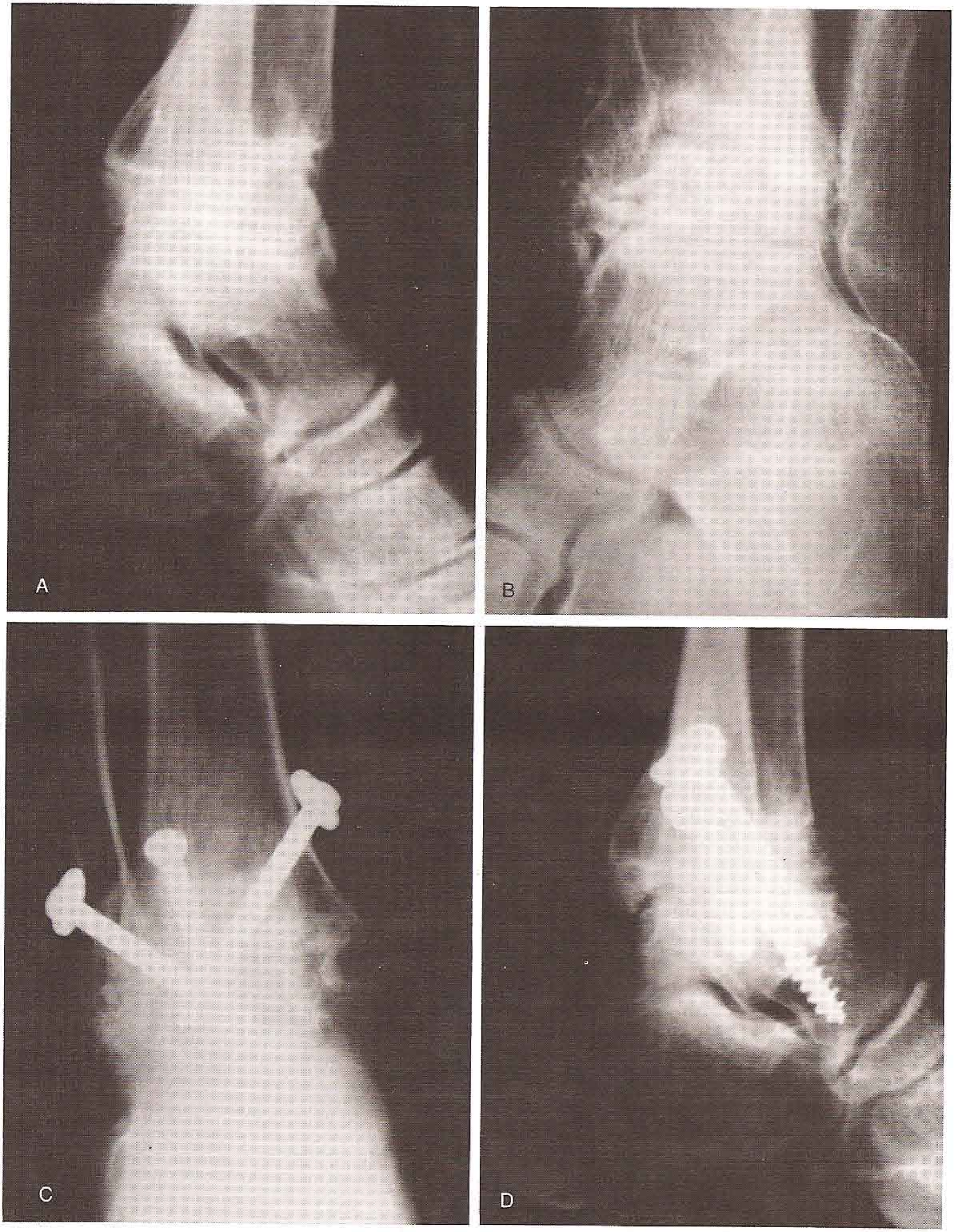

FIGURE 26–2. (*A* to *D*), Clinical example of the anterior approach for ankle arthrodesis using medial-, lateral-, and anterior-directed screws placed percutaneously for internal fixation.

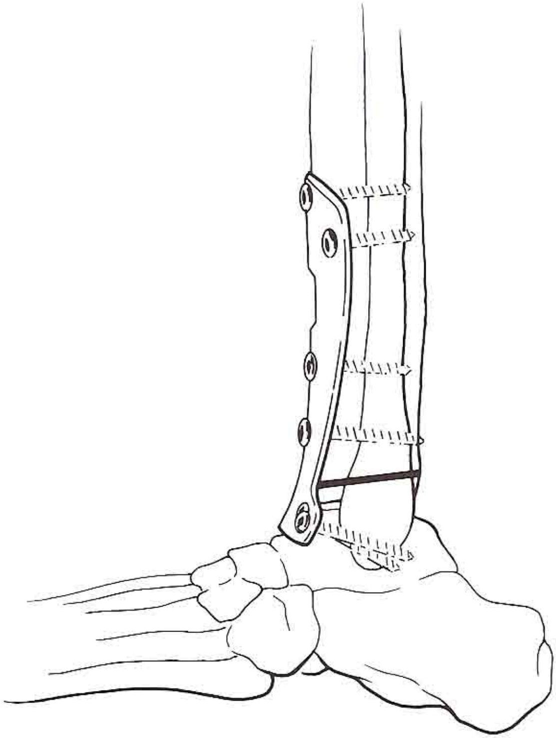

FIGURE 26–3. AO spoon plate for anterior internal fixation. (Redrawn from Müller ME, Allgöwer M, Schneider R, Willenegger H: Manual of Internal Fixation: Techniques Recommended by the AO Group. New York, Springer-Verlag, 1979.)

excellent rate of success.* The particular advantage in traumatic situations is the ability to use previous operative incisions and to gain access to previously placed hardware. Also, the foot can be narrowed by osteotomizing the medial malleolus and distal fibula. With greater articular loss, the fibula must be shortened to restore the normal relationship to the foot. If soft tissues are adequate, internal fixation is sufficient.[38] Otherwise, minimal internal fixation combined with external compression fixation is used (Fig. 26–4).

Several authors recommend excision of the distal fibula, but incorporating the fibula as a lateral bone plate may add strength to the fusion and allow for better peroneal tendon function.[34] Similarly, retaining the posterior beak of the medial malleolus may preserve the pulley for the posterior tibial tendon (Fig. 26–5).[39] The incision is anterolateral over the distal fibula and ankle joint, extending 8 cm from the tip of the lateral malleolus proximally. The distal tibiofibular joint is identified, and the syndesmotic ligaments are removed. Osteotomy of the fibula is done 3 to 4 cm above the joint line. A second cut is made if shortening of the fibula is needed to restore the anatomic relation to the lateral talus. The medial one-third of the distal fibula is removed, and the lateral distal tibia and talus are decorticated and contoured to match the fibular surface. The distal fibula thus becomes a lateral bone plate or strut (Figs. 26–6 and 26–7).[42, 49] A second incision is made medially, starting over the tip of the medial malleolus and extending proximally for 8 cm. The periosteum of the medial aspect of the tibia and the deltoid ligaments are reflected (Fig. 26–8), and the medial malleolus is resected in line with the medial shaft of the distal tibia. It is possible to save the posterior one-third of the medial malleolus to protect the neurovascular structures and posterior tibial tendon. At this point, the distal tibial surface can be resected in a plane perpendicular to the long axis of the tibia and the superior articular surface of the talus resected in a line parallel to the longitudinal axis of the foot. Adjustments are made for the ideal neutral position of the ankle and heel, and external rotation of the foot is accomplished. Temporary fixation is obtained using Kirschner wires inserted from the tibia distally into the talus. The fibula is fixed using a 6.5-mm cancellous screw into the distal tibia, and a second 6.5-mm screw into the talus, avoiding the subtalar joint. A small T-plate is then applied to the medial side, using a tensioning device to gain compression prior to final screw fixation (Fig. 26–9).[34] Temporary fixation is removed, and bone grafting is done as needed. Final radiographs should confirm the desired foot position. Closure over a drain is done in the usual fashion, and a bulky dressing, with posterior splint, is applied. Modifications include using a large Steinmann pin through the sole of the foot for stability and a second T-plate laterally with excision of the fibula.

*See references 1, 2, 13, 19, 24, 26, 42, 45, and 48.

External Fixation in Arthrodesis

The Charnley compression technique for ankle arthrodesis has been standard for many years. Biomechanical improvements have created more stable reconstructions, using pins in

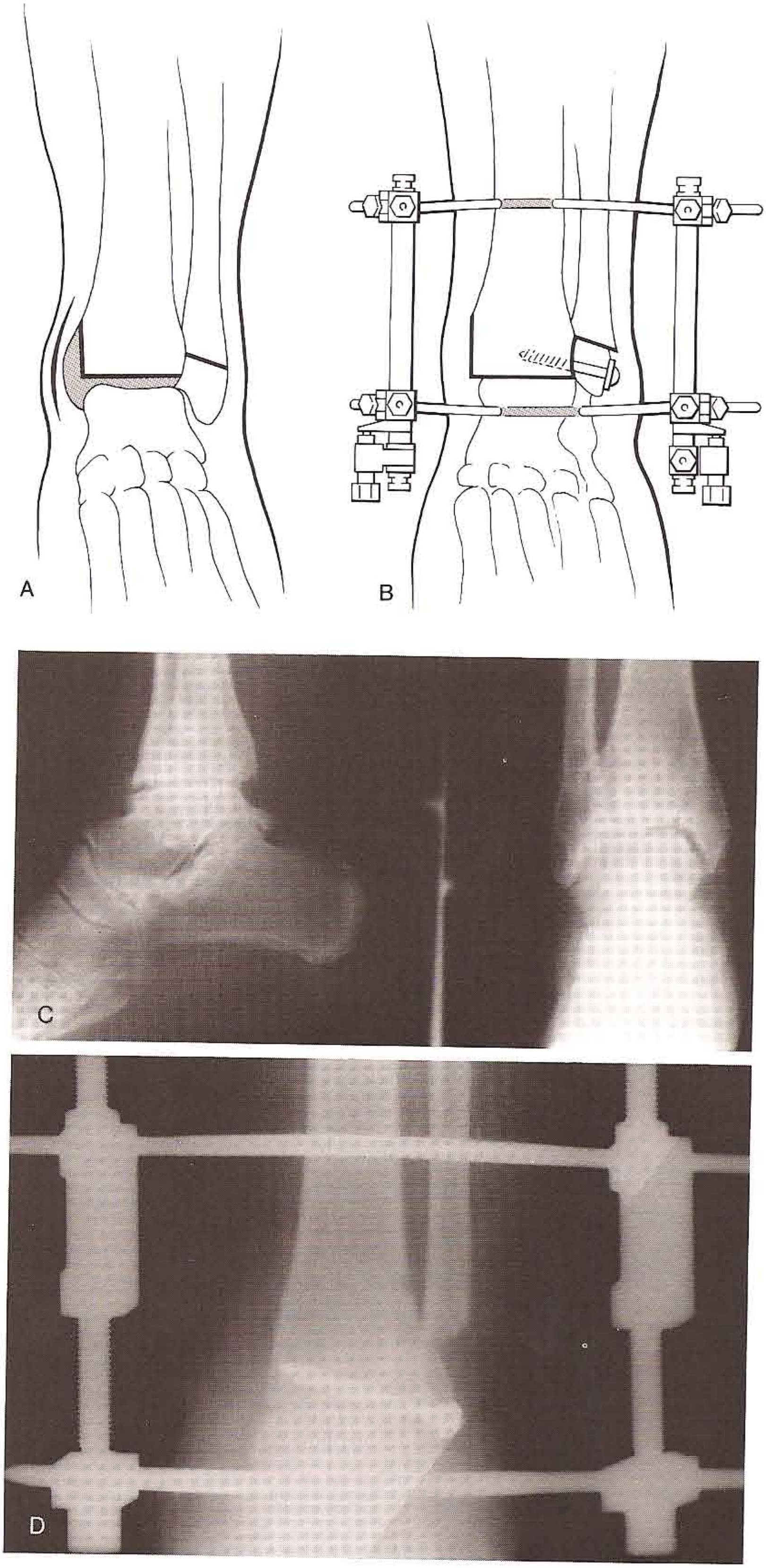

FIGURE 26–4. *(A)*, Technique of ankle arthrodesis using medial and lateral incisions, osteotomy of medial malleolus, and osteotomy of fibula with shortening. *(B)*, Minimal internal fixation of distal fibula and external fixation with AO external fixation clamps. *(C* to *F)*, Clinical example of satisfactory arthrodesis using this technique.

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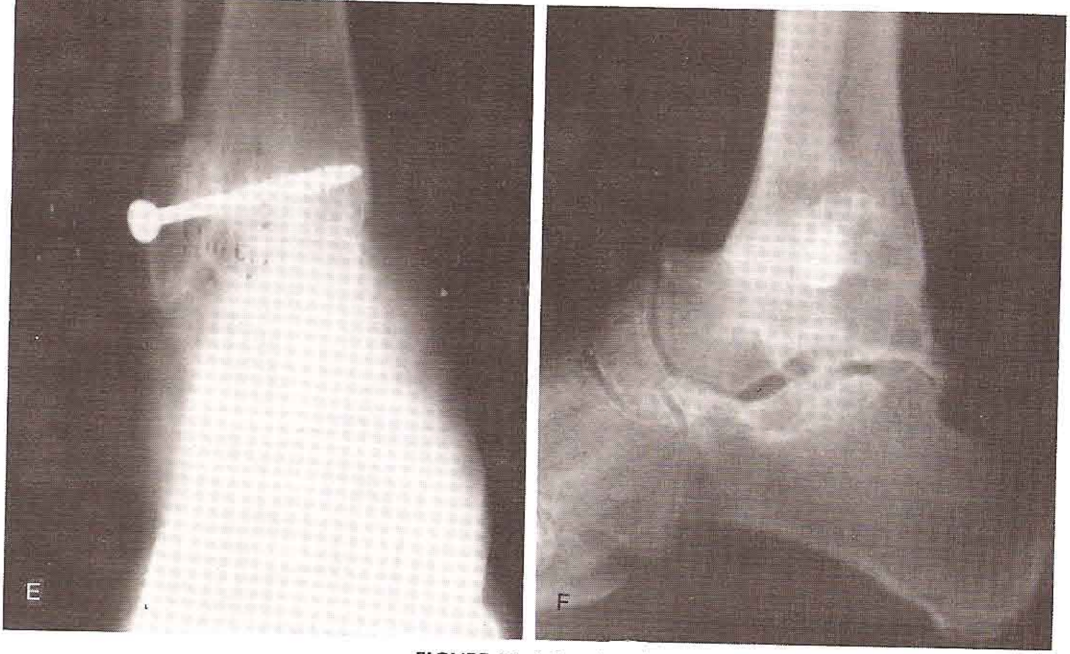


FIGURE 26–4 *Continued*

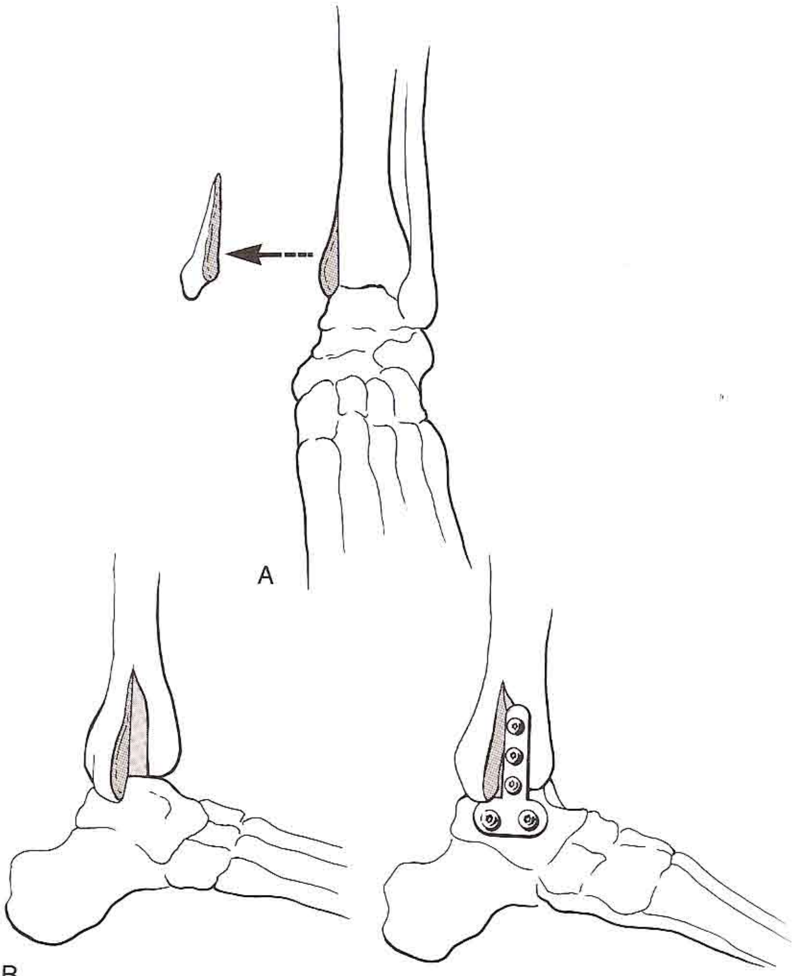


FIGURE 26–5. (*A* to C), Posterior beak of medial malleolus is maintained to protect posterior tibial tendon and neurovascular structures. Internal fixation with AO small fragment T-plate. (Redrawn from Scranton PE Jr: Use of internal compression in arthrodesis of the ankle. J Bone Joint Surg 67A:553, 1985.)

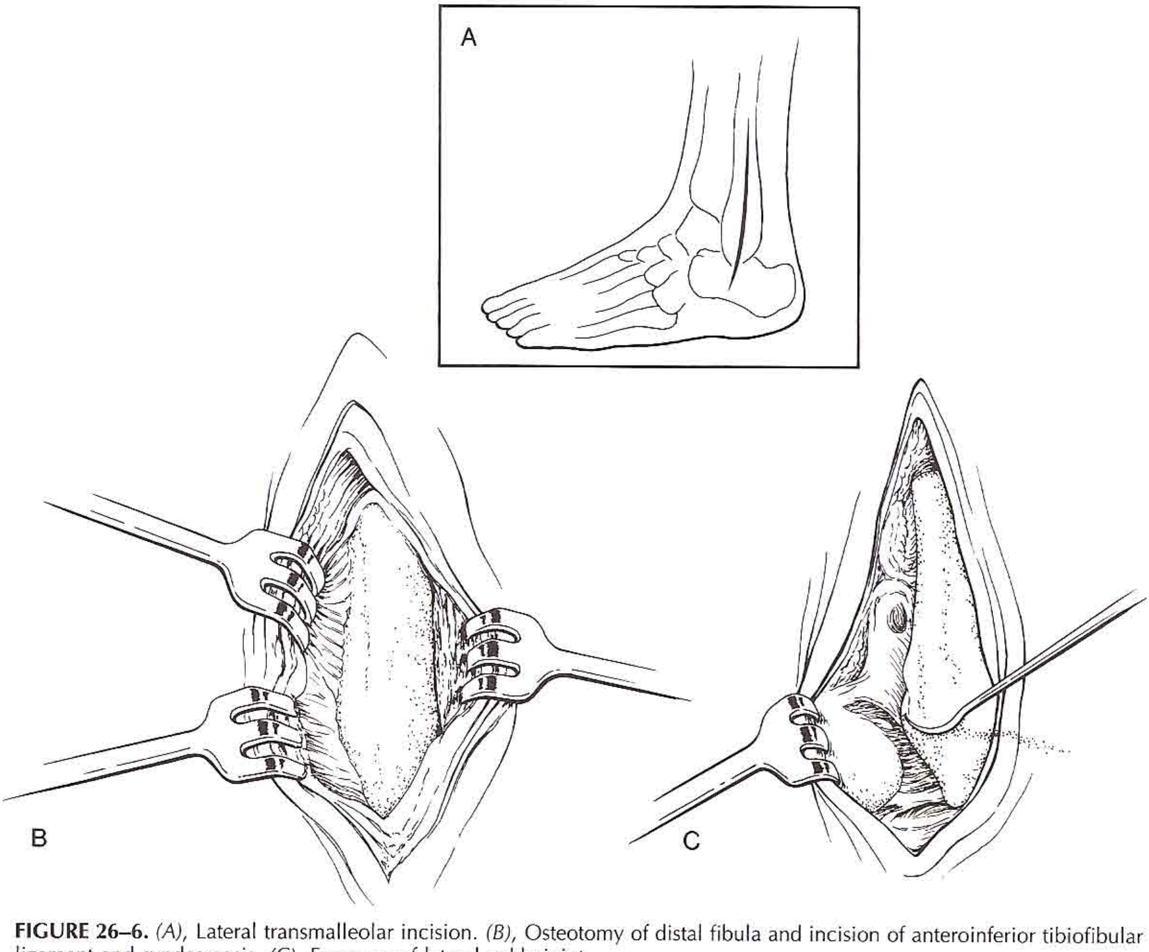


FIGURE 26–6. *(A)*, Lateral transmalleolar incision. *(B)*, Osteotomy of distal fibula and incision of anteroinferior tibiofibular ligament and syndesmosis. *(C)*, Exposure of lateral ankle joint.

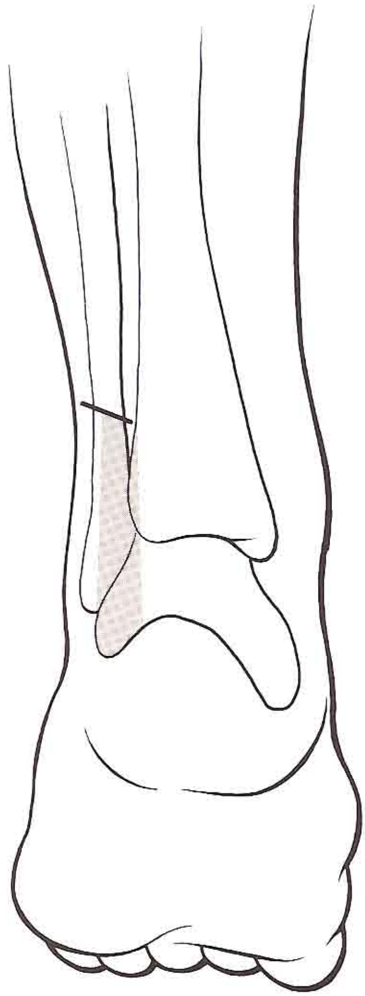


FIGURE 26–7. Removal of medial fibula and lateral distal tibia and lateral talus.

a triangular configuration (Figs. 26–10 and 26–11).[4, 14, 18, 28, 46] In addition to providing stability when internal fixation is inadequate, external frames are advantageous in certain traumatic cases. Previous sepsis, necrotic intra-articular fractures, and previous soft tissue trauma with resultant scarring are other indications for external fixation.

Severely comminuted fractures involving the distal tibia and talar dome may require fusion within the first 3 weeks of injury. The talar distal pin insertion is not possible in this situation, and a triangular frame is constructed using two pins through the calcaneus, away from the neurovascular bundle, with extension to the first metatarsal. Kenzora and associates advise using slight distraction to avoid damage to the subtalar joint.[18] These frames can be left in place for up to 3 months (Fig. 26–12).

Technique

External fixation utilizes percutaneous pin fixation through separate 1-cm stab incisions. The neurovascular structures must be meticulously avoided. Predrilling of all pin sites is mandatory, especially in dense cortical bone. Appropriate pin guides are used to avoid soft tissue damage, and pins are inserted by hand through the predrilled holes. Compression across the exposed bone surfaces can be done, once the frame is applied. Further skin release is done after final adjustment to avoid tenting. Ointments and salves are avoided, and pin tracts are cleansed daily with hydrogen peroxide.

Tibiocalcaneal Arthrodesis

This fusion is indicated in salvage situations that may result from complex fracture-dislo-

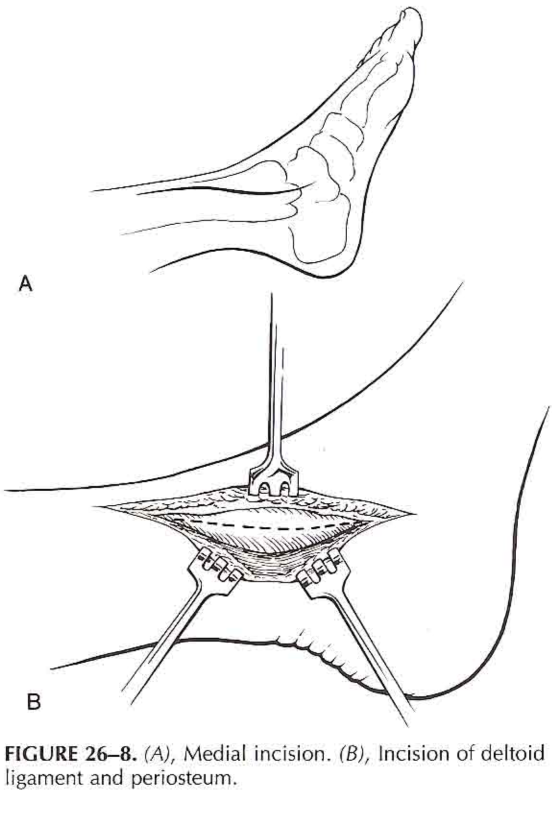
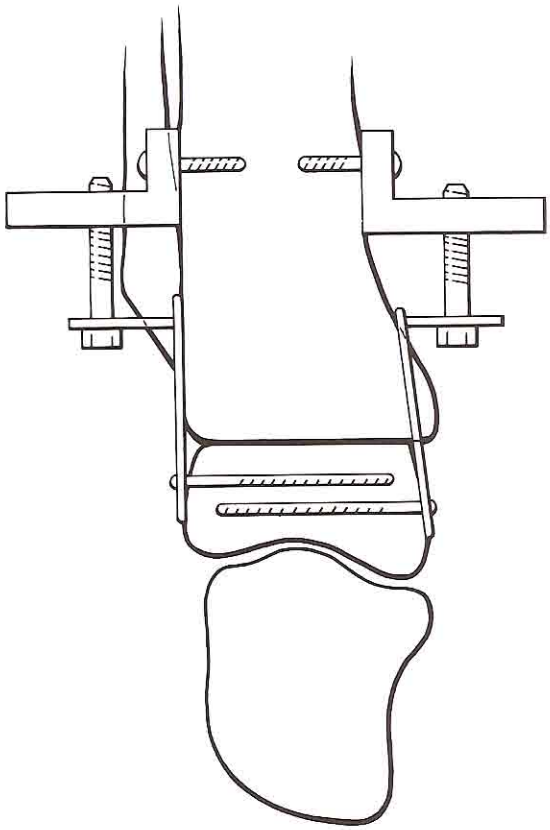


FIGURE 26–8. *(A)*, Medial incision. *(B)*, Incision of deltoid ligament and periosteum.

FIGURE 26–9. Medial and lateral tensioning device applied to small fragment T-plates. (Redrawn from Ross SK, Matta JM: Internal compression arthrodesis of the ankle. Clin Orthop 199:54, 1985.)



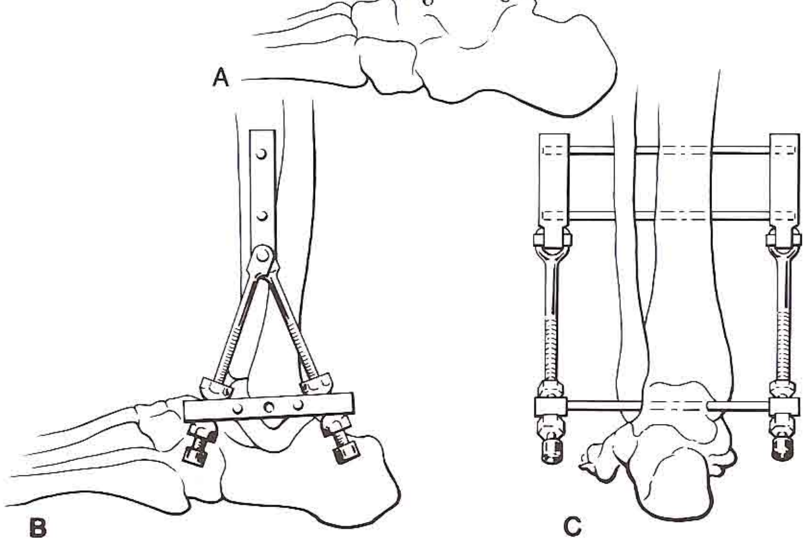


FIGURE 26–10. (*A* to *C*), Calandruccio frame demonstrates three-point fixation of the talus to the distal tibia.

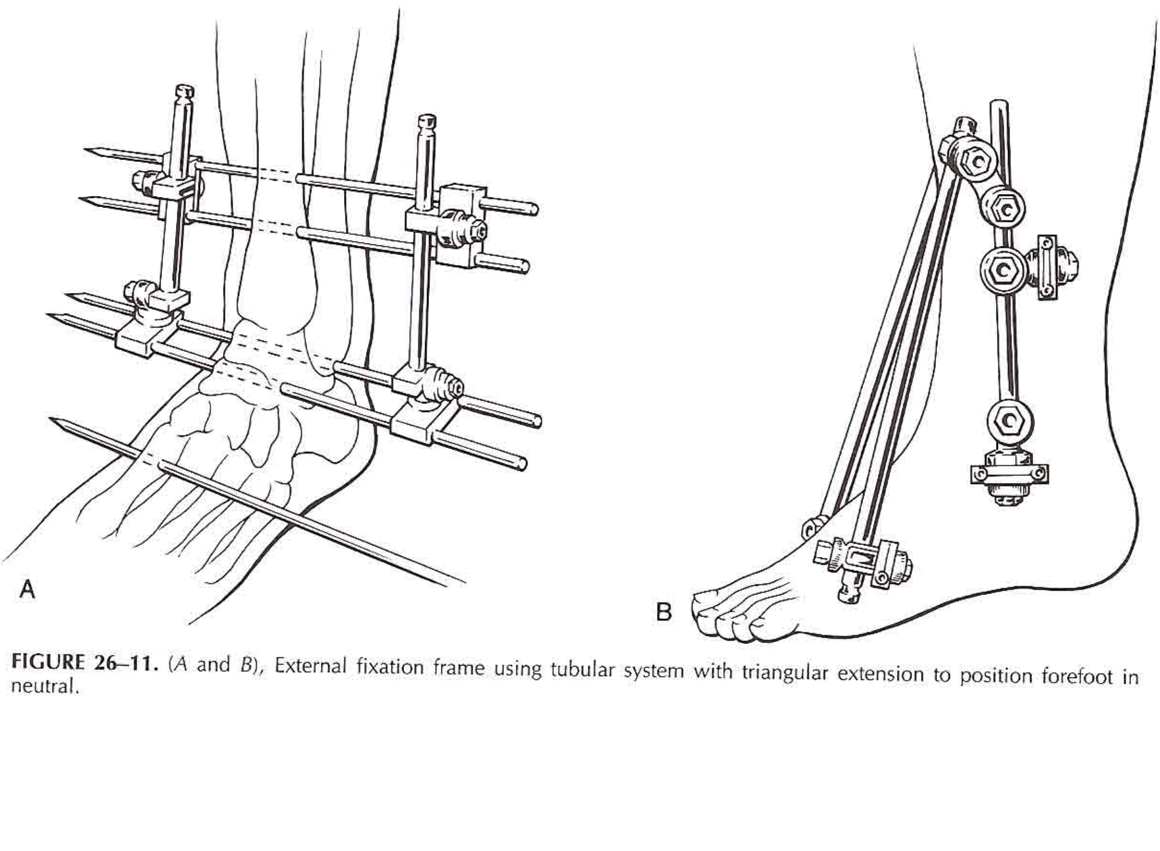


FIGURE 26–11. (*A* and *B*), External fixation frame using tubular system with triangular extension to position forefoot in neutral.

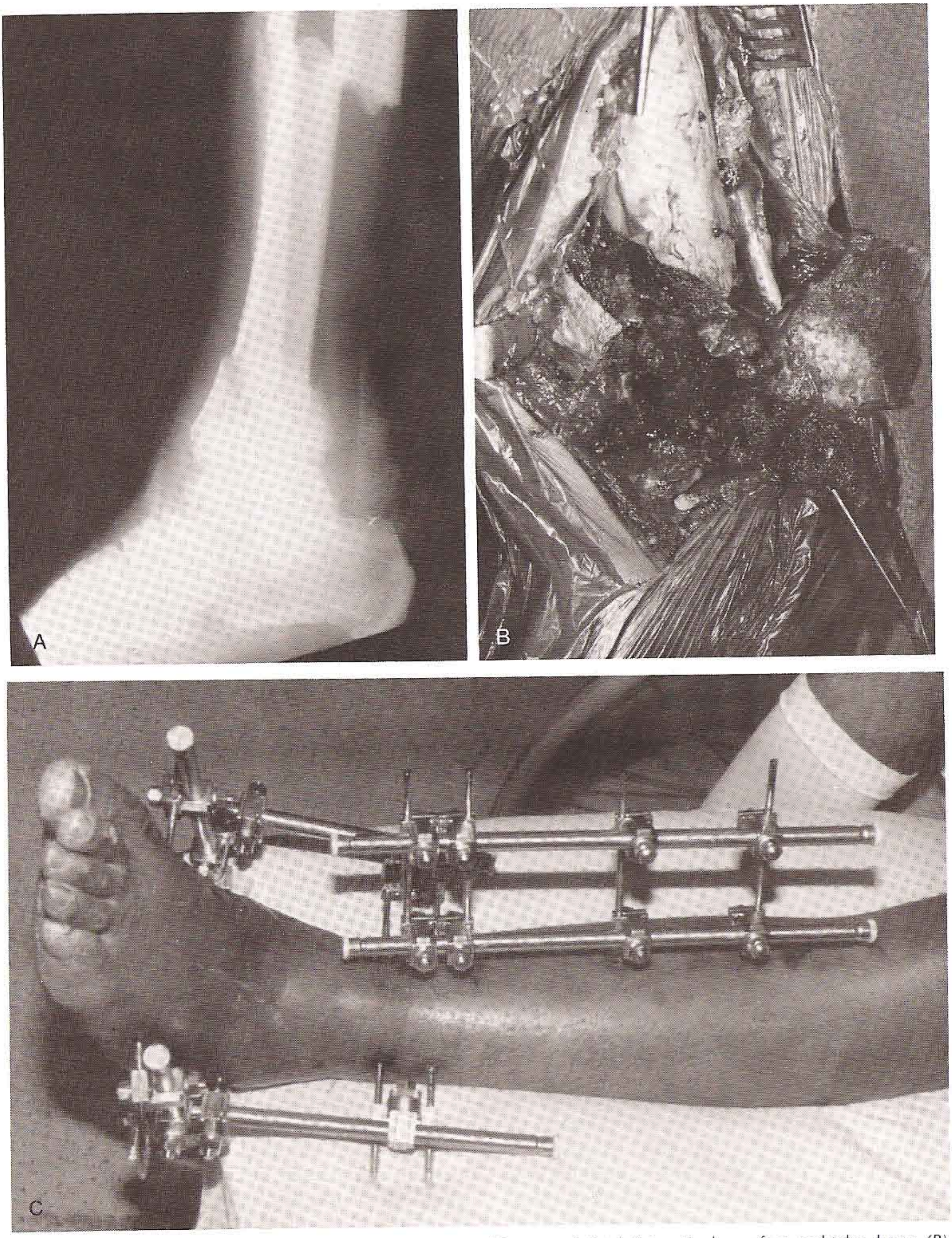


FIGURE 26–12. *(A)*, Lateral radiograpah of acute comminuted fracture of distal tibia articular surface and talar dome. *(B)*, Intraoperative photograph demonstrating complete articular destruction. *(C)*, Triangular frame engaging distal tibia, body of calcaneus, and first and fifth metatarsals.

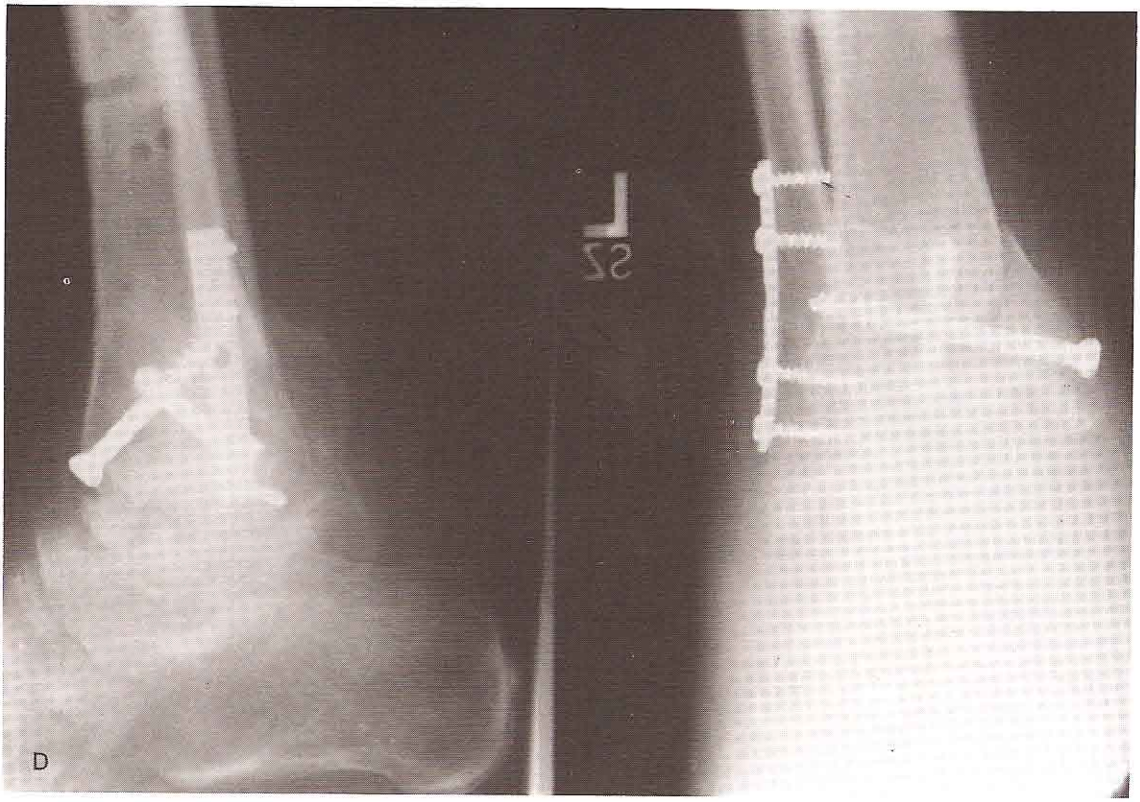


FIGURE 26–12 *Continued (D),* Six-month postoperative radiograph demonstrates solid ankle fusion and minimal internal fixation placed at initial procedure.

cations involving both the tibia and talus, avascular necrosis of the talus, and nonunion of a tibiotalar arthrodesis (Fig. 26–13).[5, 35] Avascularity of the body of the talus frequently leads to nonunion of ankle fusions. It is also possible to use this fusion in failed total ankle arthroplasty and neuropathic arthropathy. This operation is important primarily in cases in which both the ankle and the subtalar joints are involved, with severe deformity and degenerative arthritis. This procedure should be done only in those cases in which the only surgical option is tibiocalcaneal fusion. Either an anterior or a posterior approach can be used, depending on the need for hardware removal or status of the soft tissues. The posterior approach, described in the next section, offers the advantage of avoiding previous incisions and providing wide access to both joints of the hindfoot. External fixation is required and must be optimally placed for rigid fixation and compression of bone surfaces. Fixators can safely be left in place for 9 to 12 weeks.

Technique

The patient is placed in the prone position, and iliac crest bone graft is taken from the ipsilateral iliac crest. A 20-cm posterolateral incision is made along the lateral border of the Achilles tendon (Fig. 26–14). The Achilles tendon is longitudinally split in half in its distal third and the halves are transected, one proximally and one distally. The flexor hallucis tendon is retracted medially to protect the neurovascular structures. The tibiotalar and subtalar joint capsules are removed subperiosteally. A trough is cut from the tibia into the body of the calcaneus, and articular cartilage from the joint surfaces is removed through the trough. Adjustments are made to obtain apposition of bone surfaces. The foot is then placed in the neutral plantigrade position, with

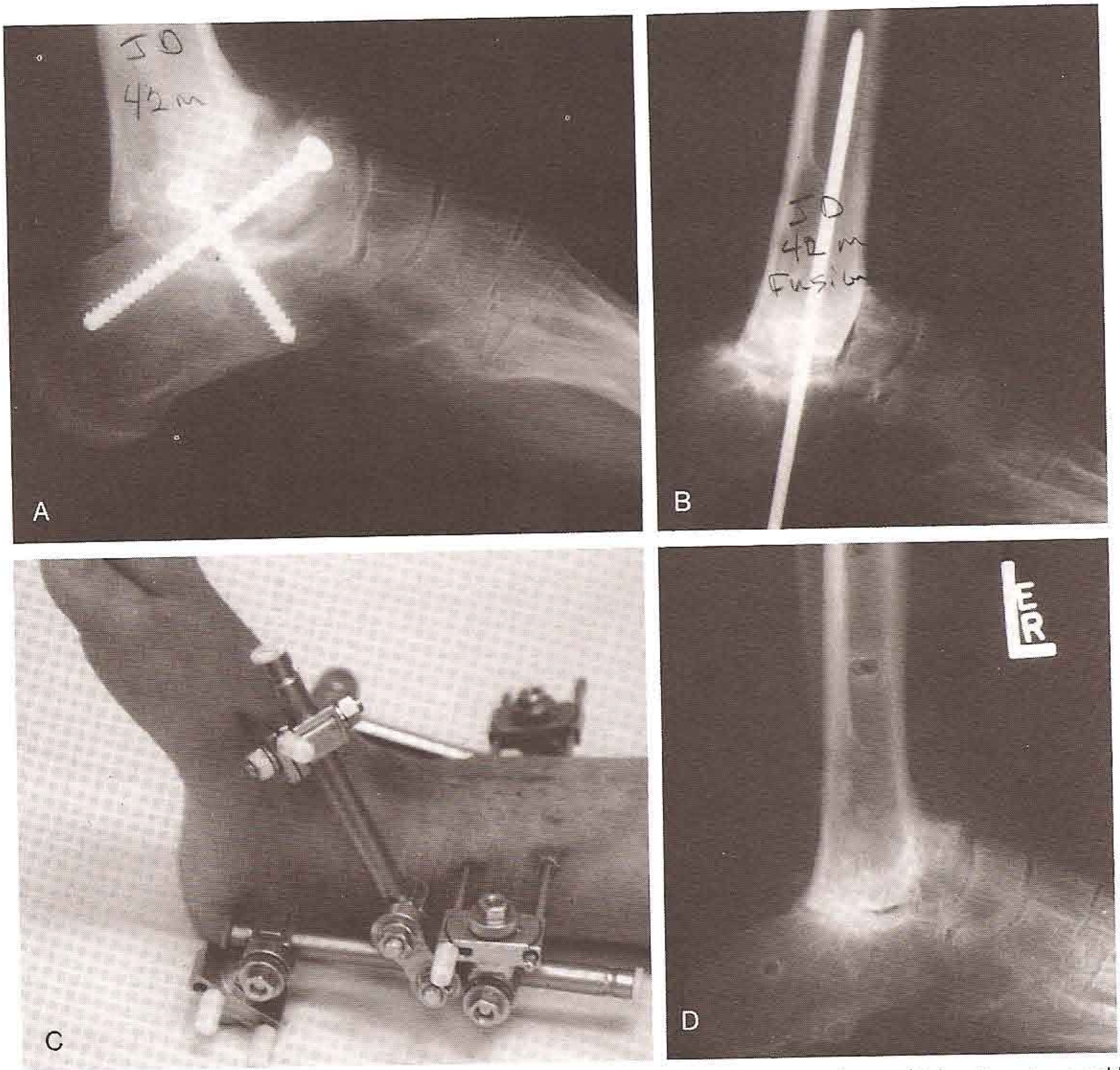


FIGURE 26–13. *(A)*, Tibiocalcaneal arthrodesis performed in a 30-year-old woman after multiple attempts at ankle arthrodesis for talar body dislocation. *(B)*, Anterior tibiocalcaneal fusion with intraoperative stabilization using a long Steinmann pin. *(C)*, Triangular external frame left in place for 12 weeks. *(D)*, Incomplete union at 8 months following attempted fusion.

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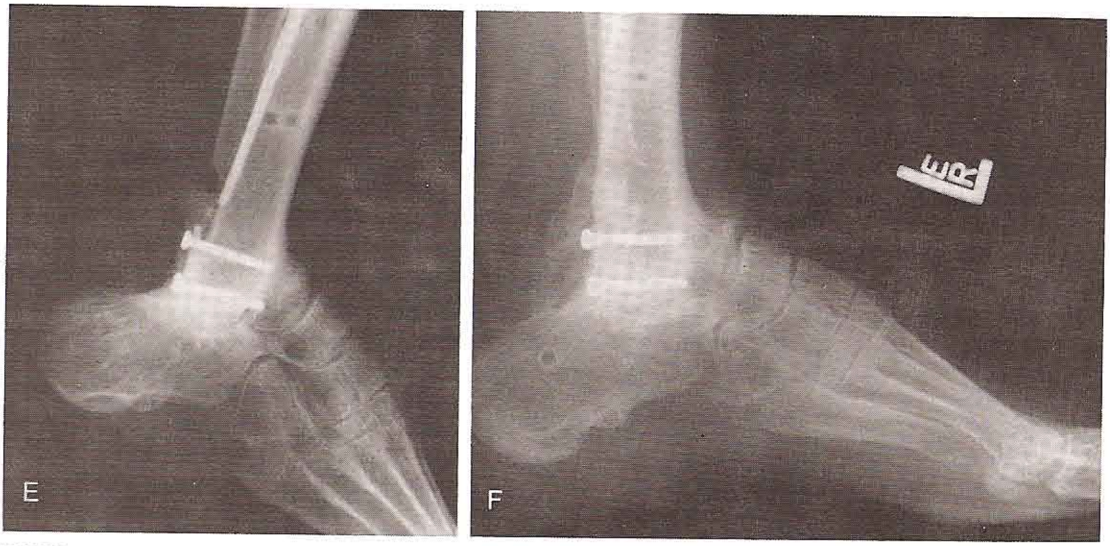

FIGURE 26–13 *Continued (E),* Refusion through the posterior approach using a sliding graft of posterior distal tibia. *(F),* Solid fusion after the second attempt of tibiocalcaneal fusion.

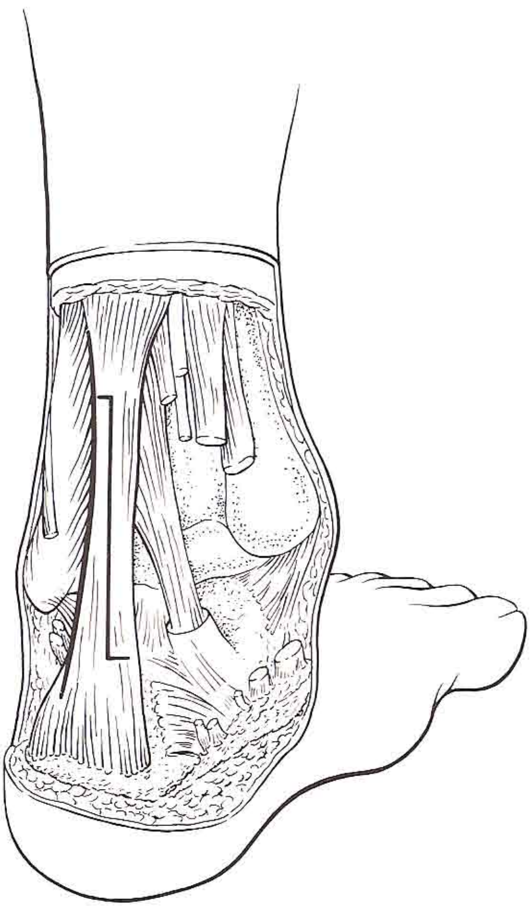

FIGURE 26–14. Tibiocalcaneal arthrodesis through posterolateral incision, splitting Achilles tendon longitudinally and transecting proximal and distal segments. Flexor hallicus longus muscle and tendon are retracted medially.

the heel in from neutral to 5 degrees of valgus. Approximately 5 degrees of external rotation of the foot are obtained, comparable to the opposite side. The external fixation device is applied, with the Steinmann pins placed posteriorly in the calcaneus to avoid the neurovascular structures. Cancellous bone graft is then inserted along the posterior trough to create an intra-articular and extra-articular arthrodesis. The flexor hallicus longus is returned to its normal position and sutured, and the Achilles tendon is resutured. The wound is closed over a drain, and a bulky compressive dressing is applied. Sutures are removed at 10 to 14 days, and pin care is explained. The frame is worn for 9 to 12 weeks, then a short-leg walking cast is applied for an additional 4 to 6 weeks.

FIBULAR MALUNION AND ANKLE DIASTASIS

Malunion after an ankle fracture most commonly results from inadequate reduction at the time of initial treatment. It is now understood that operative intervention is needed to restore the anatomic relations in most unstable ankle fractures, and this is particularly true if fibular fracture and diastasis of the syndesmosis are associated with disruption of either the deltoid ligament or the medial malleolus. Correction requires restoration of the short externally rotated fibula and reduction to its normal position in the fibular notch.[10, 12, 16, 30, 40, 48, 50]

Patients with this problem usually have a history of an ankle fracture that was treated by closed reduction and cast immobilization. If malunion has resulted, pain and swelling appear over the anterior aspect of the joint and are aggravated by strenuous physical activity. Younger active individuals develop symptoms much more quickly than older sedentary patients. Eventually, the symptoms become constant and are relieved only by cessation of weight bearing. Fibular malunion is best identified on the lateral radiograph, where displacement and posterior subluxation can be identified.

Radiographic Criteria

For preoperative planning and postoperative assessment, radiologic criteria of the normal joint are essential. The following criteria were derived from review of the literature (Fig. 26–15):

1. The talocrural angle is the superior medial angle of a line perpendicular to the distal tibial articular surface and a line joining the tips of both malleoli on the mortise view. The adult talocrural angle is 83 degrees ± 4 degrees and there is normally less than 2 degrees difference from the opposite side. Any difference over 5 degrees is abnormal.
2. The medial clear space is the distance from the lateral border of the medial malleolus to the medial border of the talus at the level of the talar dome on the mortise radiograph. A space of more than 4 mm is abnormal.
3. Talar tilt refers to any differences in the width of the joint spaces proximal to the medial and lateral talar ridges on the mortise radiograph. Two millimeters of difference is considered the upper limit of normal.
4. Syndesmosis A measures the tibiofibular clear space from the lateral border of the posterior tibial malleolus (point A) to the medial border of the fibula (point B) on the anteroposterior radiograph. This space is normally less than 5 mm and represents syndesmosis disruption if abnormal.
5. Syndesmosis B measures the tibiofibular overlap from the medial border of the fibula (point B) to the lateral border of the anterior tibial prominence (point C) on the anteroposterior radiograph. This is abnormal if less than 10 mm.
6. Talar subluxation is a subjective assessment of congruity of the tibial articular surface and talar dome on the anterior radiograph. Any incongruity is abnormal (see Fig. 26–15).[17, 31, 32, 37]

Conservative treatment, including anti-inflammatory medication, physical therapy, and rest, are of limited benefit but may be tried initially. Operative treatment is considered if the patient is young and intends to resume an active lifestyle. Contraindications include significant degenerative arthritis with joint space narrowing and osteophytes and osteochondral defects of the talus.

Yablon has had excellent results in 20 of 26 cases treated from 1 to 7 years after injury.[51] Weber had similar results in 17 of 23 cases and stated that the quality of reduction achieved, length of time to revision, and condition of the joint surface were the main factors determining

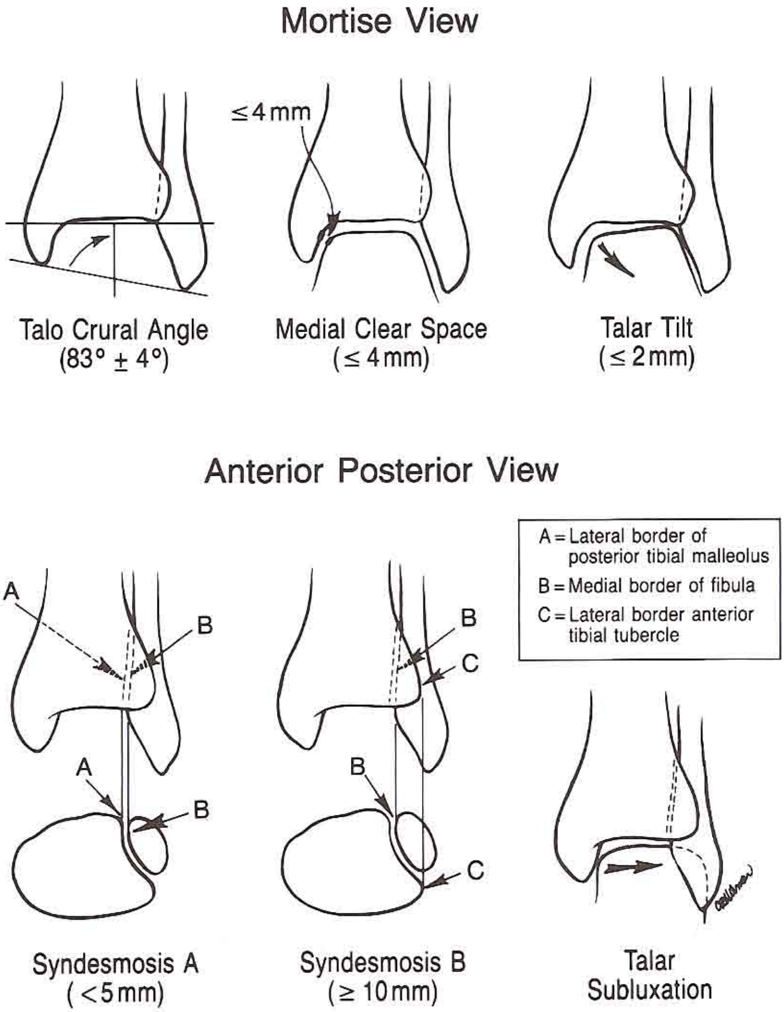

FIGURE 26–15. Syndesmotic radiographic criteria. (See text.)

outcome.[48] When arthritic changes are advanced, ankle arthrodesis is the primary treatment. Therapy must be individualized, although it is apparent from Yablon's studies that patients with occult fibular malunion with no talar subluxation are likely to have better results than those with gross fibular diastasis and talar subluxation.

Technique

The patient is placed supine with a sandbag under the ipsilateral hip. A 10-cm incision is made over the distal fibula, starting at the tip and extending proximally. The fibula is exposed, and the site of malunion is identified. Scar tissue must be removed from the fibular notch to allow for reduction. Failure of the talus to reduce anatomically must be corrected by a separate medial incision to resect soft tissue from the medial clear space. If medial malleolar malunion is noted, osteotomy and re-osteosynthesis of the medial malleolus may be needed.

An oblique osteotomy is made in the fibula through the previous malunion site. If this cannot be identified, a transverse osteotomy is made 7 cm proximal to the tip of the lateral malleolus. A five- or six-hole AO/ASIF small fragment semitubular plate is selected and contoured with internal rotation to allow for the anatomic bend and twist of the distal fibula. The plate is applied to the fibula distal to the osteotomy site using two 3.5-mm cortical screws. An AO compression-distraction device is applied proximal to the plate, and the fibula is distracted to the appropriate level, which is reached when the most proximal articular cartilage is at the level of the joint line. The fibula is reduced into the fibular notch by forcibly inverting and internally rotating the foot and by applying direct thumb pressure from a posterolateral direction so that the fibula does not remain subluxed posteriorly. A radiograph confirms restoration of fibular length and joint space as per the syndesmotic radiographic criterion (see Fig. 26–15). The remaining screws are inserted into the plate and a transverse position screw or syndesmosis screw is inserted 2 cm above the joint line to hold the anatomic position of the fibula. If this is placed through the plate, the foot should be held in maximal dorsiflexion at insertion. Special care must be taken in those cases in which there is a prior posterior malleolar fracture that remains unreduced, which will allow the fibula to sublux posteriorly. Bone graft is added to the osteotomy site from the distal tibial metaphysis. The syndesmosis and surrounding ligaments are not sutured. Final radiographs are made, and the wound is closed over a drain. A posterior splint is applied after wound closure (Fig. 26–16).

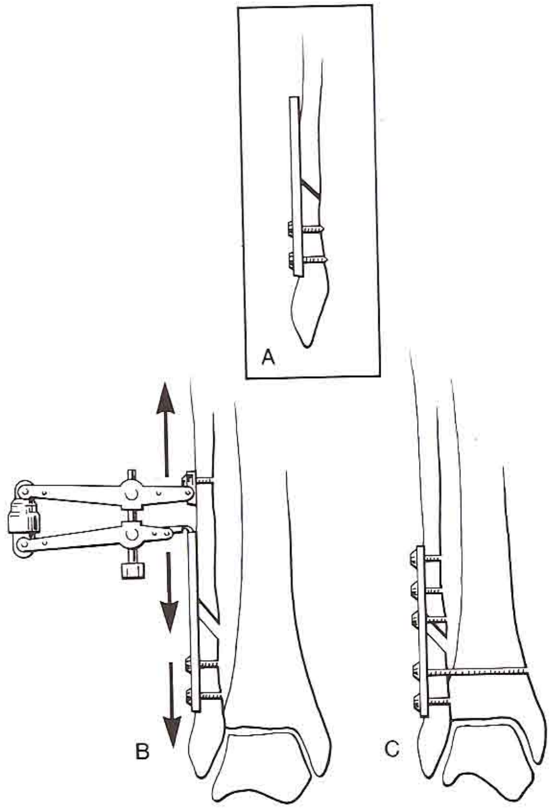

FIGURE 26–16. *(A)*, Fibular lengthening is accomplished by corrective osteotomy through an old fracture site, and the plate is secured distally. *(B)*, Tensioning device applied to proximal plate. *(C)*, The fibula is lengthened to the ideal position and a bone graft is applied. A syndesmotic screw may be added through the distal plate hole.

Postoperative Care

The posterior splint is changed at 10 days, and the sutures are removed at that time. A short-leg removable ankle-foot orthosis (AFO) is applied, and the patient is kept non–weight bearing for an additional 4 weeks. During this period, the AFO is removed two or three times daily to allow for active range-of-motion exercises. Six weeks following surgery, the patient is allowed full weight bearing, within the confines of the AFO, for an additional 6 weeks. Removal of the syndesmosis screw can be done under local anesthesia at 12 weeks prior to unprotected weight bearing.

Complications

The two reasons for failure of this operation are (1) attempting to reconstruct joints that show significant degenerative arthritis and (2) technical failure to meet the criteria for anatomic reconstruction of the ankle joint. Both problems can be avoided if careful attention is paid to radiographs. Ankle arthrodesis remains the salvage procedure for failed cases.

MEDIAL MALLEOLUS NONUNION

Failure of the medial malleolus to unite after fracture is occasionally seen, especially with displacement. Medial malleolar pseudarthrosis is interpreted as nonunion if not healed by 6 months. Treatment of these nonunions is difficult: Sneppen reported osseous union after surgical intervention in only 50 percent of cases.[41] However, Lindenbaum reported a case of traumatic loss of the medial malleolus that resulted in a stable ankle, with internal fixation of the lateral malleolus and simple reapproximation of the medial soft tissues.[3, 10, 20]

It is important to rule out other causes of pain, such as degenerative arthritis, before any attempt is made to treat these nonunions. Sneppen suggested that osteosynthesis should be attempted early, usually before 2 years. Surgical extirpation of a fragment may be done

FIGURE 26–17. *(A)*, Painful post-traumatic supramalleolar malunion or nonunion 1 year following injury in a 27-year-old woman. *(B)*, Lateral radiograph. *(C)*, Operative procedure consisted of hardware removal, osteotomy of the fibula, and application of Ilizarov device. *(D)*, Sequential lengthening and correction of malunion is accomplished, and the bone is stabilized until union occurs.

if the remaining portion of the medial malleolus is large enough to preserve ankle joint stability. In those painful cases in which osseous union is sought, the operation should include excision of fibrous tissue, restoration of fracture surfaces, internal fixation of the fragment, and application of bone graft.

Technique

The medial malleolus is exposed by a 7-cm incision over the medial aspect of the ankle. The bone is dissected subperiosteally and the nonunion site is exposed. All fibrous tissue is removed from the nonunion site, except at the depth of the hole adjacent to the articular surface. Sclerotic bone is removed until cancellous surfaces are identified. The fragments are reduced with a towel clip, and two Kirschner wires are used to stabilize the fragment, supplemented with a figure-eight tension band wire. Autologous bone graft, obtained from a separate window in the distal tibia, fills any remaining defect in the nonunion site. The wound is closed over a drain, and a short-leg cast is applied.

Postoperative Care

The cast is changed at 2 weeks, and the patient is kept non–weight bearing for an additional 2 weeks. At that point, a walking heel is added, and the patient may walk with full weight bearing for an additional month. If radiographic union is demonstrated, the cast can be eliminated.

SUPRAMALLEOLAR MALUNION

Malunion of the distal tibia above the articular surfaces of the ankle joint is the result of angulation that occurs with closed treatment. Even a minor degree of varus or valgus produces an abnormal weight-bearing alignment. If traumatic arthritis has not developed and the patient has a symptomatic deformity, corrective osteotomy is considered. A valgus deformity can be repaired by creating an opening wedge laterally with fibular osteotomy. Varus deformity carries the added risk of damage to the medial neurovascular structures if done in a single stage. This situation optimally requires the use of an external fixator, such as the Ilizarov device, that can be sequentially lengthened over a period of time and then compressed until union occurs (Fig. 26–17).[7]

Technique

For valgus malunion, a lateral incision is made over the distal fibula extending 7.5 cm. A long oblique osteotomy is made in the distal fibula, the lateral distal tibia is exposed, and a saw or osteotome is used to make a transverse osteotomy at the level of the malunion. Correction is made by manual osteoclasis. Iliac crest bone can be grafted to the osteotomy site. An external fixation device can be applied through the tibia and talus as described for ankle arthrodesis.

For varus malunion, a 5-cm medial incision is used for the distal tibia osteotomy and a lateral incision for the fibular osteotomy. An external fixation (Ilizarov) device is applied for staged distraction over a 2-week period. After correction has been achieved, the external fixation device can maintain compression for an additional 4 to 6 weeks. An alternative to this method is to use internal fixation with an AO/ASIF spoon plate on the distal tibia.

Postoperative Care

After the external fixation device is removed, a short-leg cast may be applied until the osteotomy has healed. Physical therapy is then initiated to restore normal function.

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