71 Ankle injury

71.1 Introduction & examination

Ankle injuries are common and if mismanaged serious outcomes are frequent. (71-16) Injuries include minor sprains, disabling tears of the collateral ligaments, usually the lateral ones, serious malleolar fracture-dislocations, compression fractures of the lower tibial end or the talus and ruptures of the Achilles tendon.

EXAMINING THE FOOT AND ANKLE
Is this an acute or recent injury or a chronic condition?

LOOK for:
(1) loss of normal alignment with the leg,
(2) internal or external rotation, eversion, inversion or swelling,
(3) abnormal prominence of one malleolus,
(4) backward displaced or broad, heel,
(5) open wounds

FEEL for:
(1) unstable, painful movements,
(2) impaired sensitivity,
(3) absent pulses
(4) intact Achilles tendon
(5) site of maximal tenderness
(6) crepitus & integrity of the tarsus, metatarsals (especially the 5th), calcaneus, and tibia.

MOVE.
How far is flexion, extension, inversion & eversion possible.
Grasp the heel with one hand and the lower tibia with the other, and test side-to-side movement.

N.B. For a chronic condition, watch the patient walking, and note any limp, whether the heel & toes strike the ground normally. Examine the wear on the shoes and compare both sides. Is there recurrent pain and swelling after long walks? Do other joints cause similar problems?

RADIOGRAPHS
Decide if you want images of the ankle or the foot.
(a) For the ankle, obtain an AP view in 20°-25° of internal rotation to compensate for the external rotation of a normal ankle, (this gives you a clear view into the ankle mortise) and a true lateral view.
(b) If you think the collateral ligaments, especially the lateral, are damaged, obtain forced inversion views (talar tilt test) and measure the angle between the talar and tibial joint surface lines. *Don't attempt this by twisting only on the foot* but twist the heel.
(c) For the foot, obtain an AP, lateral, and oblique views.
(d) For the calcaneus, obtain a lateral and special axial view..

STANDARD & FORCED ANKLE VIEWS

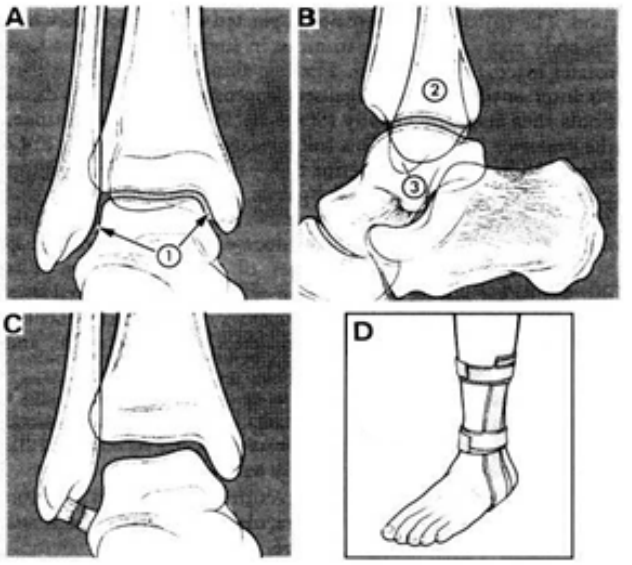


Fig. 71-1 STANDARD & FORCED INVERSION VIEWS. A, the joint space (1) between the talus and both malleoli should be simultaneously visible in the AP view, at 20° of internal rotation. B, the fibula (2) should lie just within the posterior border of the tibia (3) You should just be able to see the lower end of the fibula outlined against the talus. Note how smooth & congruous the normal joint surfaces are in a normal ankle. C a forced supination AP view with a talar tilt angle >20° indicating a total rupture of the lateral ligament complex. Get an oblique view if there is much pain & you haven't spotted a fracture. *Note the widening of the joint space.* D apply strapping to support a sprain. *Kindly contributed by John Stewart.*

71.2 Sprained & torn ankle ligaments

A sprain tears only some of the fibres of a collateral ligament, more commonly on the lateral side in an inversion injury and the medial side in an eversion injury.
A sprained ankle is swollen, and the corresponding collateral ligament is tender. Although walking is possible with difficulty, the ankle will eventually recover, even without treatment. But if the ligament complex is completely torn, the ankle will be unstable and will cause difficulties, especially when walking on rough ground.

This instability can produce a chronic chondropathy and finally an osteoarthrosis with impaired walking capacity, range of movements and chronic pain.

Ruptures of the lateral ligaments are often missed because the talus tilts over temporarily and then returns to its normal position, and ordinary AP and lateral radiographs look normal.

This is why you must test the stability of the ankle: a positive anterior drawer test (talar shift) compared with the normal side is sign of a rupture. If the diagnosis is seriously in doubt, or to determine the degree of rupture, obtain forced inversion (or eversion) views (71-1C).

N.B. Rupture of the medial (deltoid) ligament is usually combined with a fracture of the lateral malleolus.

TREATMENT
If there is only minor swelling & no instability (1°) apply adhesive strapping and encourage walking normally. This should heal in <1wk.

If the ligament is partially ruptured (2°) with <20° talar tilt) apply a below-knee walking cast with the ankle in neutral, provided there is little swelling. Encourage walking in the cast. Remove it after 3-4wks and apply adhesive strapping (or an ankle boot) for 3wks more.

If there is serious swelling apply a below knee plaster back slab elevate the leg and wait a few days until you can change the slab in a walking cast.

If the ligament is totally ruptured (3°) or **there is a luxation** (talar tilt >30° & talar shift >15mm), only contemplate repair in an active young person. Apply a below-knee walking cast as above, but leave it on for 6wks, and then strapping (or a boot). Encourage walking without a limp, which uses some muscles excessively and others not at all. The latter waste, and contribute to permanent instability, which then requires an Evans/Watson-Jones ligamentoplasty.

As a rule of thumb, **if a patient cannot weight-bear on the ankle**, a cast is needed.

A NEGLECTED TORN LIGAMENT MAY BE AS SERIOUS AS A FRACTURE

71.3 Malleolar fracture

Malleolar fractures are particularly common in young active and elderly people.
Displaced malleolar fractures are major injuries and emergency conditions. They are often not taken seriously enough. Incorrect treatment will result in a stiff, painful *equinus* ankle (71-11), and lifelong disability unless a difficult arthrodesis can provide a useful foot.

There are 3 types of malleolar fractures: unimalleolar (68%), bimalleolar (Pott's) (25%), & trimalleolar (7%).

These injuries arise when the foot remains fixed on the ground in an abnormal position, while the body continues moving forwards. The position of the foot and the movement of the body relative to it, determine how the ankle bones & ligaments will break. The movements of the foot are complex, and similar to those of the hand. Supination combines inward rotation of the forefoot with inversion of the hindfoot. Pronation combines outward rotation of the forefoot and eversion of the hindfoot.
There are four groups of fractures of various stages of severity within each group:

SUPINATION ANKLE FRACTURES

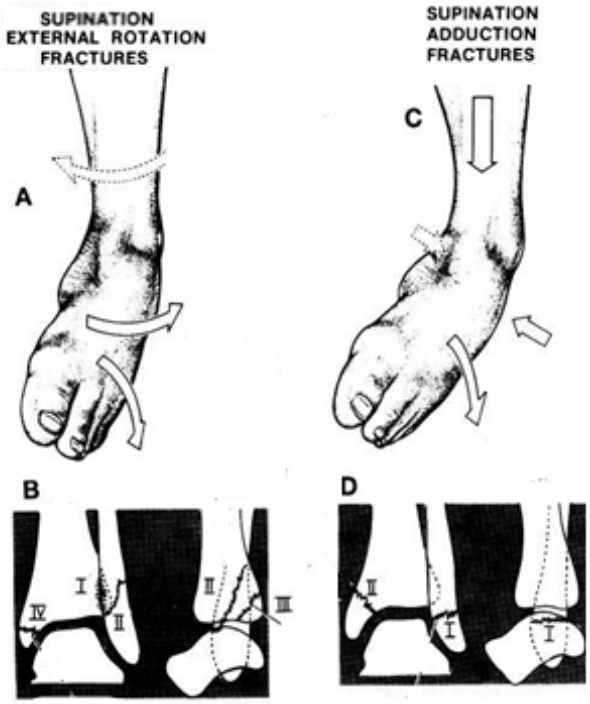


Fig. 71-2 SUPINATION FRACTURES. A, the leg rotates internally relative to the foot, the foot rotates externally to the leg, and supinates. B, stages I-IV of severity of fractures. C, the foot is forced medially into adduction by a downward force, and supinates. D, stages I-II of severity. *Adapted from Lauge-Hansen N. Fractures of the Ankle. Acta Orthopaedica Scandinavica. 1978: 51;181-192*

(a) Supination-external rotation fractures are the most common: the foot remains supinated on the ground, while the foot rotates externally on the leg.

Stage I: the anterior tibio-fibular syndesmosis ruptures,
Stage II: there is a spiral distal fibular (Weber B) fracture & talar displacement.
Stage III: the posterior tibia fractures, creating a posterior tibial fragment (Volkmann's triangle), with or without rupture of the posterior tibio-fibular ligament.
Stage IV: the deltoid ligament ruptures or there is a medial malleolus (Pott's) fracture (71-2B).
Stage V: the ankle dislocates.

The distinguishing feature of this group of fractures is the spiral fracture of the distal fibula.
Other varieties of this injury are a fibular fracture several cm above the ankle joint line, sometimes even as high as its neck.

(b) Supination-adduction fractures: the body moves laterally on the supinated foot.
Stage I: The lateral collateral ligaments rupture, or the fibula fractures transversely (Weber A).
Stage II: there is an additional medial malleolus fracture, usually vertical (71-2D).

(c) Pronation-abduction fractures &
(d) Pronation-external rotation: are less common.

One of the advantages of describing these fractures by the force that caused them is that you can use the opposite force to reduce them. In practice, recognition of the exact type of fracture is not important. The main principle is to recognize the incongruity between the talus and the tibia, to replace them exactly in contact with one another.
Then to immobilize the foot without weight bearing (except for undisplaced Weber A fractures) until the broken bones and torn ligaments have healed.

The mortise between the talus and the tibia is small, and transmits all the body weight, so *you must replace its joint surfaces exactly,* to enable normal weight bearing. Unfortunately, the ankle is not a joint which you can allow to mould itself by early active movements (70.4).

(e) '**Trimalleolar fractures'.** Ignore minor extra-articular fragments of the posterior edge of the distal tibia.

But intra-articular pieces >25-30% of the total tibial joint surface may dislocate proximally producing a step and a tendency to dislocate the talus posteriorly. These injuries are usually combined with lesions of the cartilage and damage to the joint surface, and so are serious.

SERIOUS MALLEOLAR FRACTURES

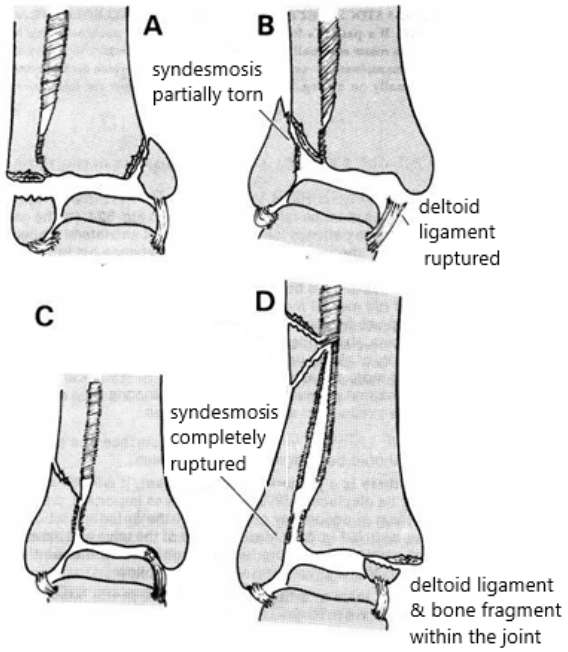


Fig. 71-3 SERIOUS MALLEOLAR FRACTURES. A, a supination-adduction Weber B fracture at the level of the joint. B, supination-external rotation fracture at the level of the syndesmosis, pulling the medial collateral (deltoid) ligament off the medial malleolus. C, a Weber C fracture above the syndesmosis, with a fragment of the deltoid ligament inside the joint prevents reduction. D, comminuted high Weber C fracture with a ruptured syndesmosis and interosseus membrane, with widened mortise (71.4)**.** *Adapted from Weber BG. Die Verletzungen des oberen Sprunggelenkes. Hans Huber,Bern 2nd ed. 1972.*

Danis-Weber Classification (Types A B C)
A: Fracture of the distal fibula below and up to the level of the syndesmosis (anterior and posterior tibio-fibular ligaments) but below the joint space. If there is only a minimal fragment of the tip of the fibula, this corresponds to a tear of the lateral ligaments. This fracture can be combined with a tear or rupture of the medial (deltoid ligament or a fracture of the medial malleolus. The syndesmosis always remains intact.
B: Fibula fractured at the level of the syndesmosis and slightly above the ankle joint space. The syndesmosis is usually partly or sub-totally ruptured. Medial side as in A.
C: Fibula fractured above the level of the syndesmosis. The syndesmosis is ruptured and tibio-fibular joint space is widened. This widening increases as the fibular fracture is more proximal, and means the interosseus membrane is also ruptured, usually to the level of the fibular fracture. So the attachment of the fibula to the tibia is lost all along the lower fibular fragment. You can diagnose this loosening by holding the foot tilted in pronation with your left hand and pressing the distal fibula against the tibia from behind at the joint level with your right hand. If a Weber C fibular fracture is high in the subcapital region, it is called Maisonneuve fracture (71.4)

ANKLE DISLOCATION REDUCTION
(GRADE 1.3)
Reduction is often difficult if the patient arrives long after the injury.
If the talus is dislocated (grossly out of place),
If the foot is in *equinus*, or
If there is no swelling yet but significant dislocation, *reduce the dislocation urgently*

CAUTION! Blood vessels, nerves, ligaments & tendons will be compressed or stretched. Later, the joint capsule and ligaments will tighten, and *reduction will be difficult or impossible*.
N.B. Wait for 2-7days if there is marked swelling.

Lift the leg by the heel. Frequently reduction occurs spontaneously with a snap. If it does not, ask an assistant to stabilize the leg with the knee slightly flexed, while you pull on the heel and foot in the axis of the leg, thus bringing the foot upwards.
You often don't need anaesthesia for this, but administer analgesia. Put a pillow or sandbag under the knee and heel and *accompany the patient* to the X-ray department, taking care that you maintain the reduction.

Compare the radiographs with your clinical findings and make a therapeutic plan. The majority of malleolar fractures can be treated by closed methods with good results.

If you fail to hold the reduction, use calcaneal traction 3-5kg for 1wk and try exact reduction once more leaving the Steinmann pin in place, fixing it in the below knee PoP.

STOCKINETTE (QUIGLEY) TRACTION
If you need to wait for swelling to reduce, or between trials of reduction, keep the ankle meanwhile in stockinette (Quigley) traction. Thread the leg through a tube of stockinette, and fix this to the thigh with several short pieces of zinc oxide strapping (71-4). *Don't put strapping around the thigh* because it may obstruct the circulation. Suspend the loose end of the stockinette from a drip stand, so that the foot rests c.20cm above the bed. Most fractures will reduce themselves automatically in 2 or 3 days, while the swelling subsides.
If you don't have stockinette, and the swelling is severe, reduce the fracture and temporarily hold the best position with a long horseshoe plaster splint which extends down one side of the leg, around the foot, and up the other side. Hold it with a crepe bandage.

STOCKINETTE (QUIGLEY) TRACTION

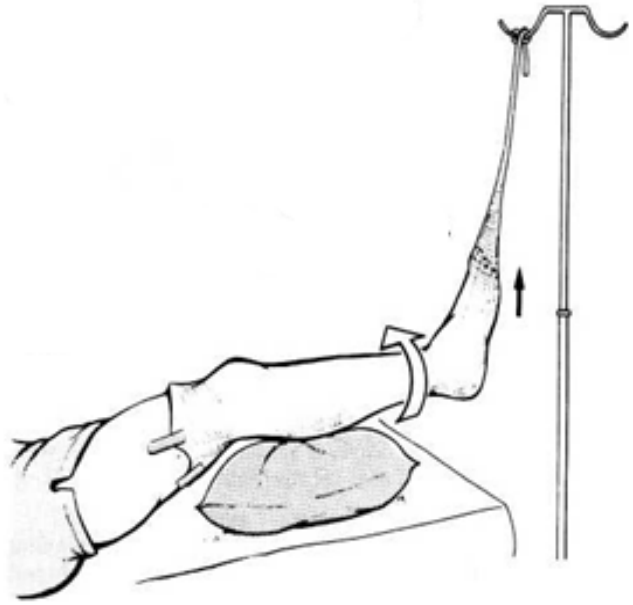


Fig. 71-4 STOCKINETTE TRACTION FOR A MALLEOLAR FRACTURE. Hold the leg like this with stockinette and it will tend to rotate externally relative to the foot, reducing the common supination-external rotation fracture in which the foot rotates externally on the leg. *Kindly contributed by Peter Bewes & John Stewart.*

Keep the patient in bed with the foot of the bed raised until the swelling has subsided. Tighten the crepe bandages as swelling subsides, and then apply a cast (71-9). If there are skin lesions (contusion marks or blistering, usually over the medial malleolus) make a window over the medial malleolus but keep the foot fixed. In this way, you can assess the swelling and treat the wound.
The purpose of reduction is to align the talus with the anterior part of the joint surface of the tibia. So look for congruity there.

Gross displacement or widening of the ankle mortise is easy to recognize, but minor degrees of non-congruity may be difficult to distinguish from a normal joint. When you reduce the fracture, take great care to obtain the highest possible degree of congruity. *A common error is to accept an unnecessary degree of non-congruity.*

A certain amount of deviation from normal anatomy is acceptable especially in unimalleolar and stage 1 & 2 fractures. *In general, however, the end results are commensurate with the accuracy of the reduction.*

POST-REDUCTION RADIOGRAPHS
Obtain AP views and in 20° of internal rotation (71-1)
(1) The gap between the talus and the medial and lateral malleoli should be about the same as the gap between the talus and the lower surface of the tibia.
(2) The saddle-shaped surfaces of the talus and the tibia should be congruous.
(3) Close reduction of the medial malleolus should show that there are no soft tissues between the fragments.
(4) The lateral malleolus should project more distally than the medial malleolus.

N.B. Inadequate correction of proximal displacement (shortening of fibula with luxation or subluxation in the tibio-fibular joint owing to a ruptured syndesmosis (Weber C fractures) or obvious incongruity, requires fixation, if possible.

If there is a posterior tibial fragment, it will almost certainly be displaced upwards. This is less important, provided the talus is accurately aligned with the anterior part of the tibia (71-5B). Misalignment of the talus and the shaft of the tibia (71-5C) produces a high point on the joint surface ensuring osteoarthritis will follow.

If the talus and tibia are misaligned, in the lateral view, remove the cast and try to improve reduction.

If a gap remains in the AP view between the medial malleolus and the talus, there is soft tissue in the joint.
This is especially likely to happen if the medial malleolus is intact, trapping the torn deltoid ligament in the ankle joint between the talus and the medial malleolus (71-3D).

Simple conservative methods are satisfactory in most stable Stage I & II or Weber A & B type fractures (without dislocation or widening of the ankle mortise). Other Weber C and a good number of displaced fractures are not easy to treat.

They need particular attention:
(1) 10-14days of in-patient care,
(2) Manipulation using 3-point fixation,
(3) Radiographic checks,
(4) Several well-applied casts,
(5) Proper follow up & re-manipulation if necessary.

CONGRUITY IN THE LATERAL ANKLE RADIOGRAPH

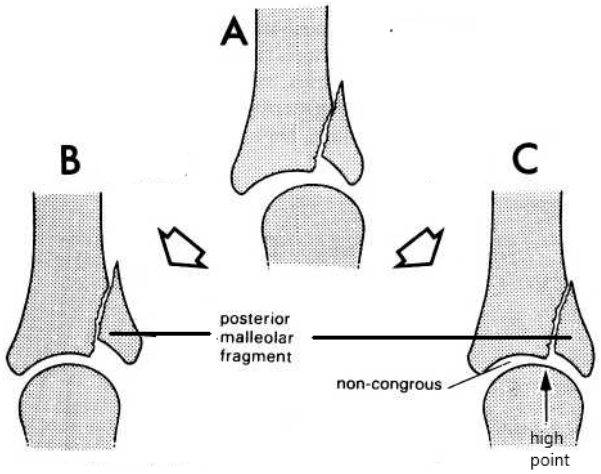


Fig. 71-5 CONGRUITY IN A LATERAL ANKLE RADIOGRAPH. A, if there is a large posterior tibial fragment, try to make the anterior part of the ankle joint congruous. B, it is congruous. C, there is a high point, which will lead to osteoarthritis later. *After Charnley J, The Closed Treatment of Common Fractures E&S Livingstone, Edinburgh 3rd ed. 1961*

If in a lateral view, >25-30% of the posterior lip of the tibia is fractured, the ankle will be unstable. The irreducible posterior fragment needs fixation.

Application of the casts is critical: this is your responsibility. Your main difficulty will be less in reducing the fracture, than in making sure it stays reduced.
In spite of the complexity of these fractures, in most of them there are really only 2 main fragments. The shafts of the tibia & fibula form one, while the foot and the malleoli form the other. The fragments attached to the foot move as 1 piece because they are all firmly joined by ligaments.
If you succeed in replacing the talus accurately under the tibia, the other fragments will usually follow suit. Align the foot on the leg by eye and by feel, and you will find you have reduced the fracture. You will be able to feel that the talus is back under the tibia more easily when there is no plaster on the foot. So explore the mobility of the foot before you apply it. Start by getting the feel of where the talus should be. Then apply plaster, fit the talus back in position, and hold it there until the plaster has set (71-9B).

The common supination-external rotation fracture (71-2A) needs moderate internal rotation of the foot to correct its position. Use one of your hands to support the heel and nudge the lateral malleolus medially, while your other hand presses the tibia laterally.

Meanwhile, ask your assistant to steady the knee, and so get help to apply 3-point fixation. *After reduction, the foot must not rotate on the leg*; if it does, reduction will certainly be lost. So, the cast must extend above the knee, and the knee must be gently flexed. There are no short cuts. Be sure to:

(1) apply the cast as described.

(2) X-ray the ankle again <2wks, so that another attempt at reduction is possible before it is too late.

N.B. Most reductions are lost during this period.

(3) Prevent walking on the cast too early.

N.B. This is a common error in unstable fractures.

TWO MAJOR FRAGMENTS IN ANKLE FRACTURES

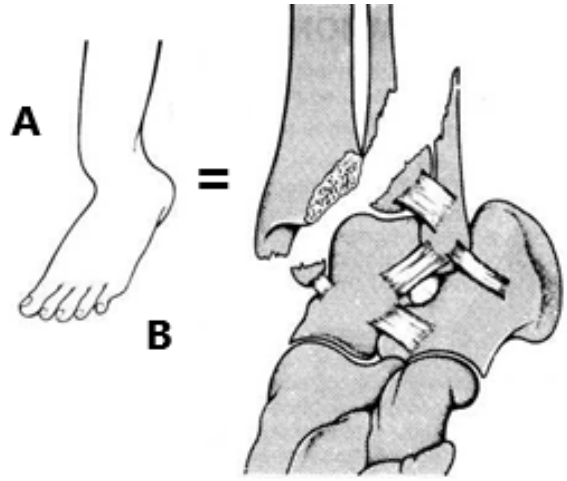


Fig. 71-6 MOST MALLEOLAR FRACTURES HAVE ONLY 2 PARTS. A, the leg. B, the foot. If you can put these together, you will have reduced the fracture. *After Charnley J, The Closed Treatment of Common Fractures. E&S Livingstone, Edinburgh 3rd ed. 1961*

If there Is more than a hairline crack, but no incongruity in the joint surfaces, apply a short leg walking cast (*not a malleolar cast*) for 2wks.

If there is any incongruity of the joint space, admit & treat by closed reduction.

If there is a large upwardly displaced posterior tibial fragment, expect difficulty, and try to reduce it by the special method described later.

SUCCESS DEPENDS ON GETTING THE DETAILS RIGHT

EXPLORING MOBILITY OF A MALLEOLAR FRACTURE

For Stage III or IV supination-external rotation trimalleolar fractures, in which the talus and the foot together are displaced posteriorly. In other fractures, and particularly for those in which the talus is displaced anteriorly, adjust your manipulation appropriately.

TESTING ANKLE MOBILITY

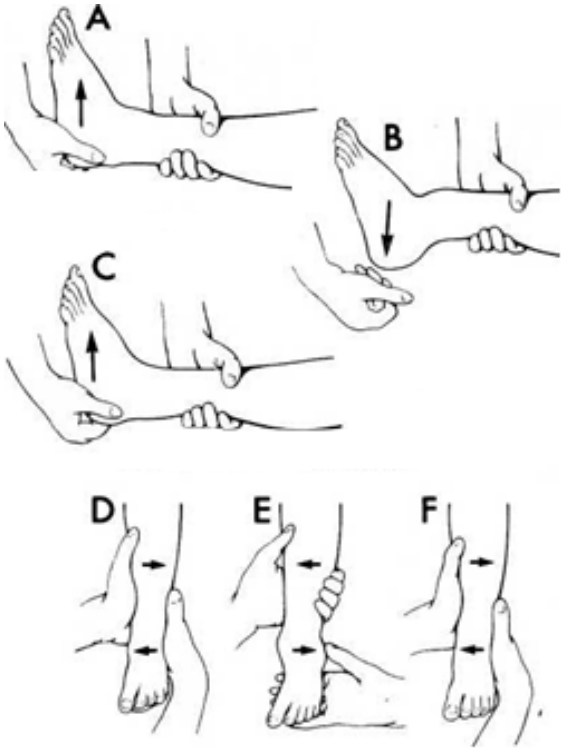


Fig. 71-7 EXPLORING THE MOBILITY OF A MALLEOLAR FRACTURE. A, hold the leg by the calf and the heel. B, the heel will fall when you remove your hand. Remember how far you have to lift the foot in order to replace it. D,E,F Similarly, remember how far you have to move it sideways. to reduce it. *After Charnley J, The Closed Treatment of Common Fractures. E&S Livingstone, Edinburgh 3rd ed. 1961*

Lie the patient with the legs over the end of the table. Find an assistant. Under ketamine, find the position of reduction. Explore the up & down and side-to-side mobility of the ankle joint (71-7A,B,D-F), while you try to find the best position of reduction.

If you hold the heel in the palm of your hand, with the leg horizontal and in slight external rotation (71-7C), the fracture will probably reduce itself.

If it is not reduced, rotate the foot internally a little, and fit the talus back into the lower end of the tibia. Align the patella carefully with the toes, so that it is the same on the fractured side as on the normal one. In this position the fracture should stay reduced.

Ask an assistant to hold the leg, and see if you can improve the position by applying 3-point fixation (71-8B).

Memorize the most stable position where you can most easily apply pressure to reduce the fracture. Remember carefully just how far forwards and how far medially you have to move the foot. You will need to return it to this same position while the plaster sets.

APPLYING THE FIRST MALLEOLAR CAST
Ask your assistant to hold the toes. Apply 1cm of cotton wool padding to the foot, ankle, and calf. Bind the wool on tightly and smooth it carefully. Use *cold* water to make the cast set slowly. Quickly wet and apply 3x 20cm plaster bandages lightly from the mp joints to just below the knee. A total of 3 bandages will make the cast thick enough to hold the foot reduced, without obscuring the feel of reduction. At this stage disregard the reduction of the fracture, and the position of the foot. As soon as the plaster is on, and *while it is still soft,* take the leg from your assistant. Massage the plaster thoroughly to remove air bubbles from between the layers of the bandage.

If the posterior tibial fragment is small (extraarticular or only minimally involving the joint surface), ignore it. Feel the fracture by moving the foot about inside the soft cast. Use the experience you have already gained to reduce it.

Apply 3-point fixation (71-8B). Ask your assistant to steady the knee.
(1) With one of your hands press the lower end of the tibia laterally
(2) With your other hand press the heel upwards and press the lateral malleolus medially
(3) While you rotate the foot internally a little (4). The lateral malleolus is attached to the foot. So, the pressure of the palm of your hand medially on the ankle will restore it to its correct position. Very little force is necessary, and if you have placed the foot correctly, gravity alone should be almost enough.

CAUTION!
(1) Keep the foot absolutely still until the cast has set. *Don't apply any finishing touches until it is hard.*
(2) *Don't apply the cast with the ankle inverted.*
(3) *As an additional check, make sure both the feet are similarly aligned in relation to the patellae.*
(4) *Avoid common errors* (71-9).

3-POINT PLASTER CAST FOR AN ANKLE FRACTURE-DISLOCATION

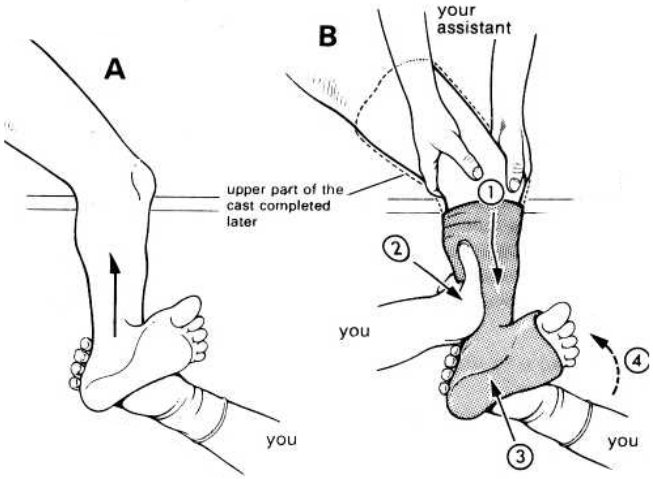


FIG. 71-8 3-POINT FIXATION FOR AN ANKLE FRACTURE DISLOCATION. A, hold the foot like this, and the fracture will probably reduce itself. B, if it is not reduced, rotate the foot internally a little, and fit the talus back into the lower end of the tibia. Align the patella carefully with the toes, so that it is the same on the fractured side as on the normal one. In this position the fracture should stay reduced. Ask an assistant to hold the leg, and (1) press the lower end of the tibia laterally, (2) with your other hand press the heel upwards and press the lateral malleolus medially. (3) While you rotate the foot internally a little (4), the pressure of the palm of your hand medially on the ankle will restore it to its correct position. When you have reduced the fracture, apply the cast below the knee. When this has set, extend it above the knee with the knee slightly flexed. *After Charnley J, The Closed Treatment of Common Fractures. E&S Livingstone, Edinburgh 3rd ed. 1961*

If the posterior fragment is large, is displaced upwards, & does not come down on the 1st manipulation, make use of the distal tibial origin of the *flexor hallucis longus* muscle. Strongly plantarflex the ankle into *equinus*. Dorsiflex the hallux sharply. Then, holding the toe dorsiflexed, bring the foot into the neutral position. Hold the foot in this position and apply a cast as described above.

If the posterior fragment is too large & does not reduce by this method as it is >⅓ the width of the tibia, proceed to fixation.

After the first coating of plaster has set, and there is no danger of the fracture slipping, complete the cast up to mid-thigh, with the knee flexed to 20°. Finish its top and bottom edges, and apply extra plaster bandages to strengthen it if necessary. *While it is still soft,* split the lower leg portion anteriorly down to the skin, *but don't spread it.*

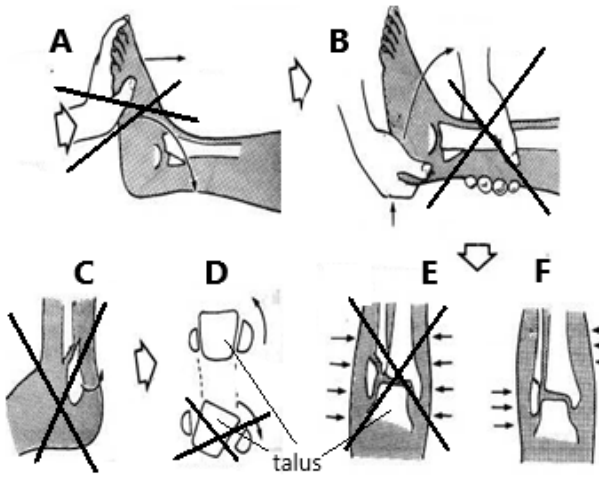
CHECK RADIOGRAPHS
Take an AP view in 20° of internal rotation and a lateral view immediately after reduction. If the talus is not in exactly its right place (71-5), remove the foot and ankle part of the cast, have another try, and complete the cast once more, making sure that the junction of the new & old parts don't press on the skin.

POST-REDUCTION CARE FOR AN ANKLE FRACTURE
Put the patient to bed, raise the leg to reduce swelling and observe the circulation of the toes carefully for 24h. If it is impaired, or if there is pain, spread or remove the cast and reduce the fracture again later. Ask the patient to move the leg and toes inside the cast as much as he can. Keep him in bed for 2 wks.

If the swelling has subsided, keep the patient in bed for a few days, and then get him up on crutches.
Check with a radiograph that the position has not been lost. If reduction is satisfactory, discharge him not weight bearing on crutches.

If reduction is not satisfactory, have another attempt at closed reduction. If this fails, proceed to fixation.

COMMON ERRORS IN ANKLE REDUCTION



71-9 COMMON ERRORS IN ANKLE REDUCTION. A, *don't flex the ankle to 90° by pressing on the toes* B, instead raise the heel, but *don't reduce the fibular displacement by squeezing the ankle from the lateral & medial sides.* C, *don't externally rotate the foot.* D, the lateral malleolus is already displaced posteriorly so further external rotation will separate the malleoli from their normal positions. E, *don't squeeze the ankle by pressing over both malleoli;* F, instead, exert pressure at different levels. *After Charnley J, The Closed Treatment of Common Fractures. E&S Livingstone, Edinburgh 3rd ed. 1961*

Check the position again after 2wks. **If reduction is not satisfactory,** have a final attempt at reduction. If this fails, proceed to fixation.

If reduction is impossible by 3-point fixation, & there are probably soft tissues between the fragments, or in the joint cavity (71-3C), proceed to fixation.

CAUTION!
If the fracture is unstable, make sure the patient understands that he must not bear weight on the ankle until 6wks after the injury.
Keep on with crutches. If the fracture is less severe, weight-bearing may start at 2-4wks if the injury does not involve the joint surface.

Remove the long leg cast and test for stability at 6wks, & obtain a check radiograph. If fracture healing seems to be progressing satisfactorily and the patient is cooperative, start mobilization with a protecting ankle shoe gradually increasing weight bearing. Encourage physiotherapy to build up muscle strength.

If you are not sure about the stability, change the malleolar cast for a short leg walking cast (70-4). Carefully mould its upper end by triangular compression (70-5) and fit it with a walking heel.
Allow continued walking on crutches with increasing weight bearing to tolerance for 3-4wks more.

REDUCE THE FRACTURE CAREFULLY
APPLY THE CAST PROPERLY
GET RADIOGRAPHS AT THE END OF THE 1ST, 2ND, & 6TH WKS
DON'T ALLOW WEIGHT BEARING BEFORE 6WKS !

OPERATIVE FIXATION (GRADE 3.2)
Indications:
(1) irreducible shortening of the fibula: Weber B,C and Maisonneuve fracture (71.4),
(2) syndesmotic disruption (tibio-fibular gap >6mm),
(3) impacted tibial roof comminuted tibial pilon fracture (71.5),
(4) irreducible posterior fragment >⅓ the width of the tibial roof,
(5) irreducible large fragment of the medial malleolus
(6) open fracture
(7) repeated failure in maintaining reduction,

N.B. Use closed, manipulative and minimally invasive methods for lower leg, ankle & foot injuries: they give acceptable functional results with far less risk in the majority of cases, and avoid disastrous complications of infection, and wound healing, even death!

Where you cannot satisfactorily reduce & hold a displaced fracture with the foot plantigrade, use fixation with Steinmann pins through the 1st & 5th metatarsals (71-10)

You can also use a Steinmann pin where there is serious posterior malleolar instability, by fixing the calcaneum, talus and tibial shaft (after you have relocated the talus under the tibia) and incorporate this in a below-knee cast.

PLANTIGRADE FIXATION BY PINS

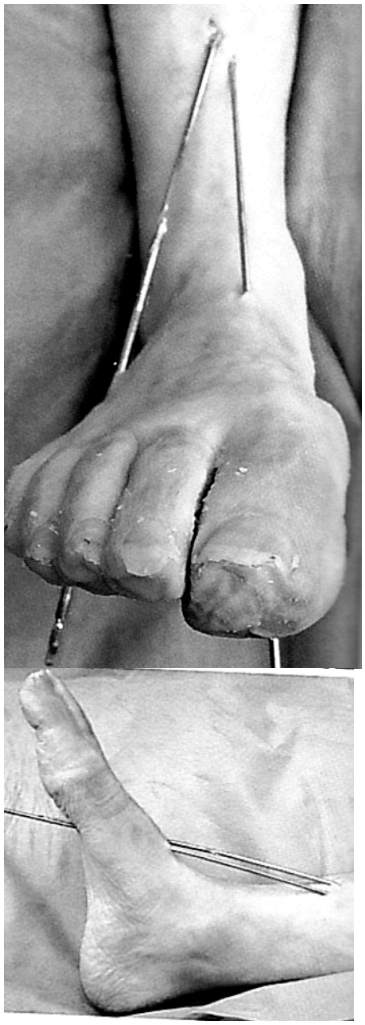


Fig. 71-10. PLANTIGRADE ANKLE FLEXION. This is useful to hold an unstable fracture or in burns to the dorsum of the ankle. Drill Steinmann pins through the 1st & 5th metatarsals at 45^0 to engage the tibia through small stab wounds. *After Gosselin RA, Spiegel DA, Foltz M. Global Orthopaedics. Springer 2nd ed 2019*

71.4 High spiral (Maisonneuve) fibular fracture

This rare injury is really a variety of a malleolar fracture in which the fibula, instead of breaking at the ankle, separates from the tibia at the ankle, twists, and breaks just below the knee.
The lower tibio-fibular ligamentous structure (syndesmosis) ruptures, as does the whole of the interosseous membrane from bottom to top. *You can easily miss this fracture unless you look for signs near the knee.*

The radiograph of the ankle may not reveal any bony injury in spite of the severe pain and swelling there. Even if you evoke only minimal pain laterally below the knee joint, suspect the Maisonneuve fracture.
The displacement can be minimal. Usually the fracture line is spiral or oblique. *Don't confuse it with the more common fracture of the shaft of the fibula* caused by direct trauma (not necessitating any treatment). Reduce the fracture as above, but apply a long leg cast.

If reconstruction of the ankle mortise is unsatisfactory owing to shortening and lateral displacement of the distal fibula fragment, this is a real indication for external fixation (71.6).

71.5 Explosion comminuted 'pilon' tibial fracture

Comminuted malleolar fractures don't fit in the Lauge-Hansen nor in the Weber system. Their injury mechanism is by severe axial compression: the talus is driven up into the tibia, which is often comminuted (71-4). In addition, one or both malleoli may fracture or one or both collateral ligaments of the ankle may be stretched or ruptured. Usually the foot is dislocated; frequently sharp fragments of the lower end of the tibia perforate the skin on its antero-medial aspect.

Apply calcaneal traction (initially 5-7kg to be reduced after 1wk to 4-5kg) elevate the lower bed end and obtain a check radiograph after 2-3 days. Combine traction with early active movements. After 4wks, if the alignment of the fragments and range of movements are acceptable, proceed with a long leg non-weight bearing cast keeping the Steinmann pin as a transfixation device in place. Remove it after 2-3 wks, leaving the cast for 4wks.

EXPLOSION ANKLE FRACTURE

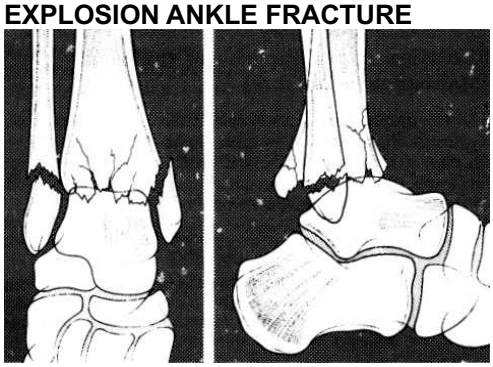


Fig. 71-11 AN EXPLOSION (Comminuted Pilon) ANKLE FRACTURE. This patient has little hope of a pain-free, moveable ankle. Make sure that what little movement he will have will be about the neutral position (the position of function). *A fixed equinus foot is a real disaster.*

Check stability & union clinically and decide whether a below knee cast would be sufficient, combined with starting weight bearing (10kg) to be increased by 10kg/wk. At 14-16wks, you should achieve full weight-bearing. An arthrodesis of the ankle joint will be necessary if severe osteoarthrosis supervenes.

71.6 Open ankle fracture

Any malleolar fracture-dislocations may have minor or major skin and soft tissue damage, even with a protruding bony fragment. Even if the exposed fractured bone has slipped back after emergency reduction, *the risk of bone and joint infection is high and you must treat the fracture as an open one*.

TREATMENT
Under ketamine in theatre, perform a *thorough* wound toilet (54.1), under strict antiseptic measures & with prophylactic antibiotic cover. Restore the position of the bones as best you can. *Make a special point of trying to align the talus with the malleoli and the tibial plateau*.

CAUTION! Don't close the wound!

After dressing the wound, immobilize the limb on a below knee PoP back slab in the neutral or best possible position and elevate the leg. Continue IV antibiotics for a minimum of 3 more days and change the antiseptic dressing (starting after the 2nd day without taking the leg out of PoP).

If no infection develops and the wound is healing, proceed as for a closed malleolar fracture depending on the fracture type. Check the radiograph and apply calcaneal traction with 3-5 kg.

N.B. Whenever you apply calcaneal traction for an unstable bi- or tri-malleolar fracture, reduction may initially be perfect, but there is a high risk of re-dislocation if the leg is mobile.

So apply a stable Braun's splint or similar device on which you can fix the injured leg using 2-3 stabilizing sandbags on both sides of the lower leg and strong large crepe bandages. Check the position regularly visually, by palpation and radiographically. You may need to re-position the sandbags. *Don't delegate this to auxiliary staff*.

EXTERNAL FIXATION (GRADE 3.2)
For unstable Weber B,C, pilon, open fractures, crush injuries, or badly infected wounds, and damage control, external fixation is indicated. The simplest type has ankle spanning fixed by an anterior tibial pin to a calcaneal pin.

Mark out the surface anatomy: the tibial tubercle and crest, the lateral & medial malleoli, and the line of the tibio-talar joint.

Place a pillow under the ipsilateral hip, and supports under the foot, so that the knee is slightly flexed, and the patella facing vertically.

Under LA or ketamine, it is best to insert 2 Schanz pins just lateral to the tibial crest c. 6-8cm superior to the fracture and wound site.

Start drilling at 30^0 to the tibia, so the drill bit does not slide off the bone surface, and when it has purchased, re-align the drill perpendicular to the leg (71-12). When you insert the pins, start them in the first direction, perpendicular to the bone, and then re-align them vertically, so the thread catches in the correct direction.

N.B. If the direction is wrong and you start screwing the pin in, you will not be able to get it right later.

DRILLING INTO THE ANTERIOR TIBIA

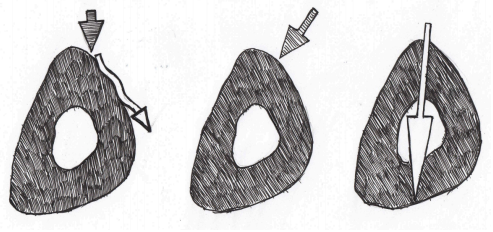


Fig. 71-12 DRILLING INTO THE ANTERIOR TIBIA. A, if you drill perpendicular to the leg, the drill will veer off the bone surface. B, so angle the drill *perpendicular to the bone.* C. the correct direction of the drill.

Check with a radiograph, if possible, that the pins have just crossed the opposite cortex.

ANATOMY OF THE HEEL

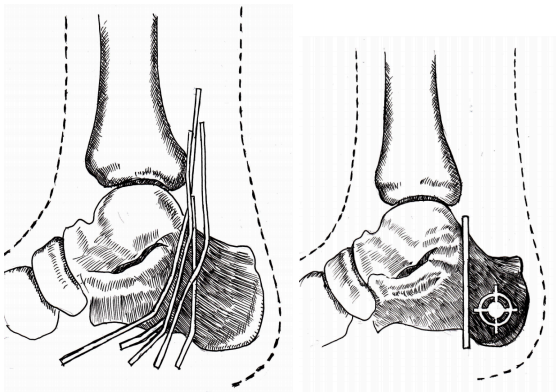


Fig. 71-13 AVOIDING THE NEUROVASCULAR BUNDLE. A, the variable position of arteries & nerves. B, place your pin well behind a line posterior to the tibio-talar joint.

Now place another pin across the calcaneum. *Make sure you place this posterior to a vertical line posterior to the subtalar joint*, in order to avoid the neurovascular bundle (71-13).

Link these pins preferably with a double X-fix bar (71-14). Depending on the instability of the fracture, you will be to hold a reduced position at least for the initial phase until the wounds have healed. *Make sure the rods are far enough from the skin surface to allow the leg to swell.*

SIMPLE ANKLE SPANNING FIXATION

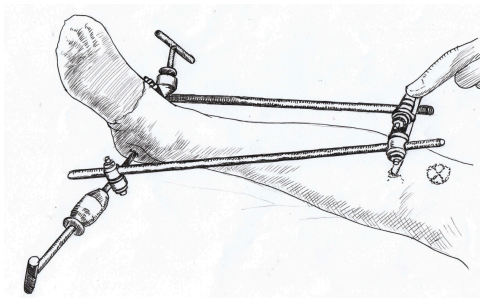


Fig. 71-14 SIMPLE ANKLE SPANNING FIXATION. You can achieve this with just 2 pins and two connecting bars

You can build a more stable bilateral triangle-shaped construction (71-15) if you add 4mm pins into the base of the 1st mt (palpate the anterior & posterior borders of the bone with the drill and then drill into the middle of the bone), and the base of the 5th mt (or cuboid).

N.B. Don't drill into the tip of the 5th mt!
The tibial pins should be parallel to each other, and the foot pins likewise.

MORE STABLE ANKLE SPANNING X-FIX

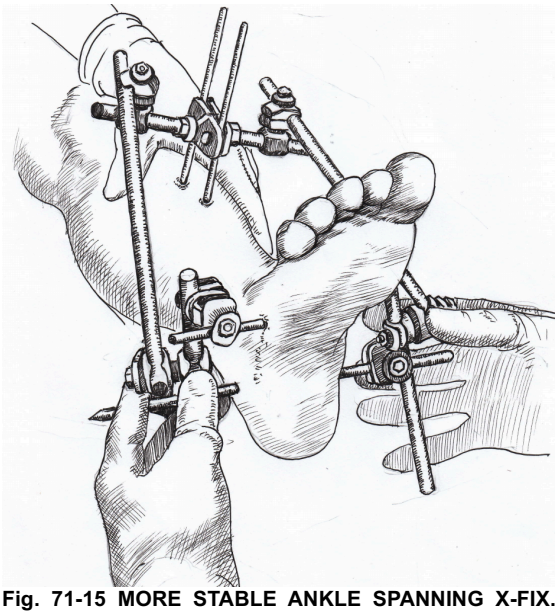


Fig. 71-15 MORE STABLE ANKLE SPANNING X-FIX. You can achieve a very versatile system by this frame. Turn the foot part of the fixator like a steering wheel.

Once you have reduced the fracture, tighten the links first by hand, and when you are satisfied by the position, with the wrenches. If possible, make a check radiograph, and if necessary re-position the fragments.
After 4-6wks, when the wounds have healed and the fractures have stabilized, remove the pins and apply a PoP, in order to reduce the risk of pin track infection and consequences of long immobilization.

If you have no X-fix or if you are not familiar with it, you can achieve useful temporary stabilization by inserting a long Steinmann-pin or strong K-wire through the middle part of the calcaneus and talus from inferiorly up into the tibial shaft.
Alternatively, introduce 4-pilon, 6 medium strong K-wires near the tips of the malleoli from both sides in oblique directions to fix the major fragments to the distal tibia through its metaphysis. Then fix the tips of the K-wires together in the cortex on the opposite sides of the tibia.

N.B. Make sure your pins are far from the wounds! You really need intra-operative radiology (or ultrasound) to do this properly.

71.7 Neglected ankle fracture

Not all untreated or badly managed ankle fractures turn out as bad as in 71-16. In remote rural areas native healers (bone setters) may achieve initial reduction and fixation with traditional techniques which might be helpful.
It is difficult to achieve a sufficient congruency of the ankle joint and re-dislocation after some days or wks is often inevitable.

Take an exact history and make a meticulous clinical examination including radiographs. You might find already united fractures in malunion or nonunion, or subluxed positions of the talus etc.
Some reconstruction or arthrodesis may be possible at a specialist centre. Both interventions are very tasking and have uncertain outcome. Otherwise an orthopedic shoe, intensive physiotherapy and analgesics are worth pursuing. All this should remind you of *the importance of taking malleolar fractures very seriously!*

A BADLY TREATED ANKLE INJURY

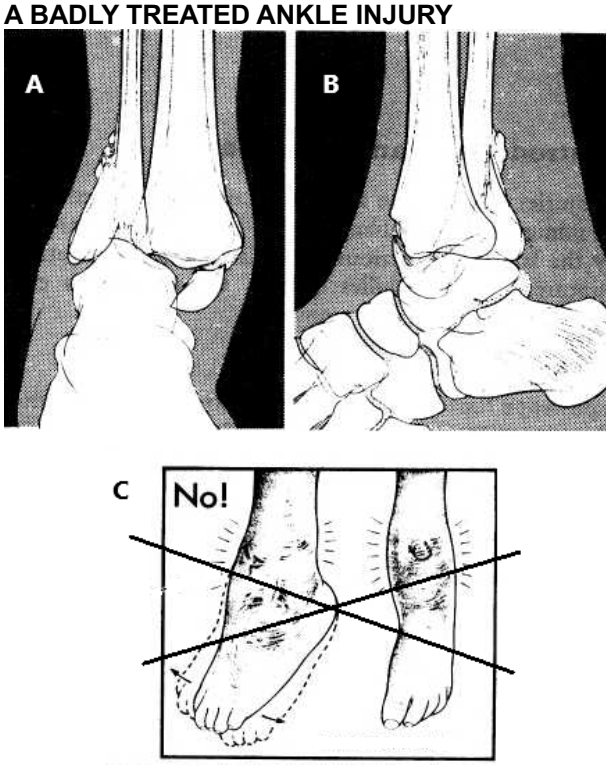


Fig. 71-16 A BADLY TREATED ANKLE INJURY. A, the foot is in *equinus*, and the little movement there is, is about this position. This makes walking impossible, except with a crutch, and is a very great disability. B, there is non-union & stiffness. *The fracture should have been reduced and put in a malleolar cast*; instead, she was given a backslab and not prevented from walking on it. C, there is permanent pain & disability.

71.8 Flexion ankle injury

Injuries of the flexor mechanism of the ankle are more common in males and arise typically between the ages of 20-50yrs.
They can be open, as when cut by a knife, or closed. Closed injuries are the result of spontaneous rupture of the flexor mechanism during violent or even moderate activity. They take 3 forms:

(a) Rupture of the *plantaris* tendon,
(b) Minor tear of the *gastrocnemius* muscle. These present with sudden pain in the calf muscle, often during only minor exertion, accompanied by exquisite tenderness in the middle of the calf. A raised shoe will ease symptoms. It resolves in 1wk.
(c) Achilles tendon rupture.
The Achilles tendon is the biggest tendon in the human body and, if it is not damaged by previous trauma or degenerative disease, is capable of withstanding the tension of 10x the body weight.

Risk factors for rupture are strenuous sports such as football, sprints, badminton, baseball as well as the use of quinolones, anabolic or cortisone steroids. Any movement producing a sudden maximum tension on the tendon can lead to a partial or total rupture. Usually there is a loud snap and immediate inability to rise on the ball of the foot or stand on the toes.

Grasping the calf (*gastrocnemius*) muscle fails to make the ankle plantarflex (71-13A). By palpating all along the Achilles tendon you may feel a gap which widens on dorsiflexion of the foot.
Usually you can clearly see the defect and measure its length by ultrasound scan.

If you can bring the ends of the ruptured tendon together by plantarflexion, apply a gravity *equinus* cast (this is the mount of *equinus* which gravity alone produces but no more, usually 30° of plantarflexion) for 2wks without weight bearing. Then build up the base and attach a walking heel (71-17B) and encourage weight bearing for 4wks more. Get a cobbler to prepare a heel raise of 2-3cm. Remove the cast at 6wks and protect the tendon for a further 4wks with the heel raised shoe.
Advise against running, or any violent exercise for 3 more months. Then arrange muscle strengthening exercises with physiotherapy.

ACHILLES TENDON INJURY

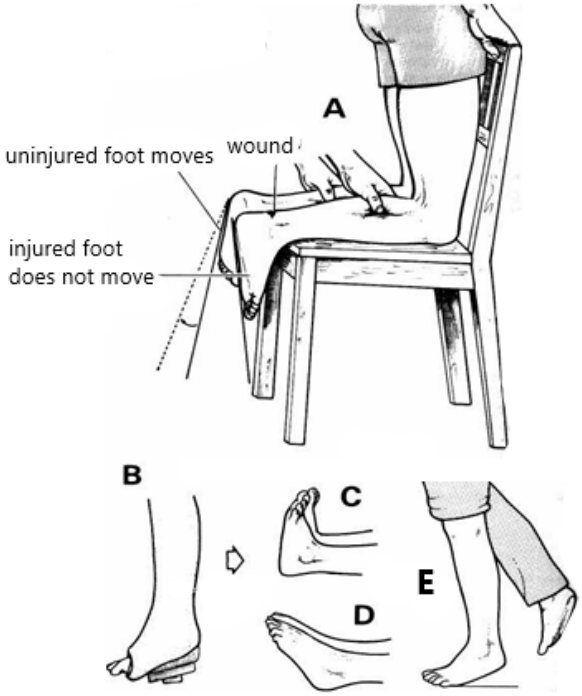


Fig. 71-17 ACHILLES TENDON INJURIES. A, squeeze the calf: if the foot does not plantarflex, the Achilles tendon mechanism is damaged. B, the walking *equinus* cast. C, D, E, after 6wks of active walking in the cast, there should be normal range of dorsiflexion & normal lift off.

ACHILLES TENDON REPAIR (GRADE 1.4)
Repair a rupture with a persistent gap of >2cm. In such cases a simple adapting tendon suture should be augmented by a ligament repair: pull a distally pedicled *soleus* flap (46.5) down, overlap the tendon suture and fix it laterally and distally to intact tendon with some single Z-sutures.

Repair an open injury, after a thorough toilet by standard figure-of-8 suture (47.1) keeping the foot in 30° of plantarflexion, and immobilize the ankle in an *equinus* cast.

If the wound is ragged or dirty, treat it in an *equinus* cast with a window, till you can perform a delayed primary suture.

ANKLE BRACE & BOOT

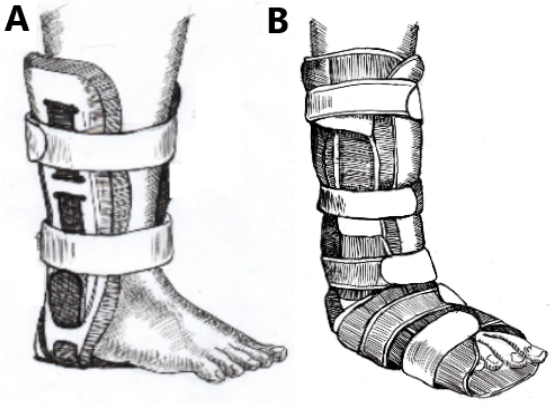


Fig. 71-18 ANKLE BRACE (A) & BOOT (B)