Malleolar fractures
Oswestry foot and ankle course

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This handout accompanies and expands Jim Barrie's lecture on malleolar fractures. It should be read in conjunction with the material (including illustrations) in the Foot and Ankle Hyperbook at www.foothyperbook.com/trauma/malleolarFx/ankleFxIntro.htm.

Pilon fractures are covered in another talk, so these are not included here, although the boundary between pilon fractures and complex fractures involving the posterior ± medial malleoli is not entirely distinct (see below).

The structure of this document is as follows:

1. Biomechanics
2. Assessment
3. Classification
4. Stable fractures
5. Unstable fractures
6. Complex fractures
7. Post-operative care
8. References

Fractures of the malleoli are common. Court-Brown (1997) calculated an incidence of 125/100000/year. They occur equally in both sexes, but are commoner in young men and older women. They are increasingly becoming an elderly person's osteoporotic fracture (Kannus 2002).

Most ankle fractures are low-energy twisting injuries sustained in falls, and only 1-2% are open injuries.

Biomechanics

The most important structure in the fractured ankle is the deep deltoid (or tibiotalar) ligament. This is a short, strong ligament which lies deep and rather posterior in the ankle and can be seen at arthroscopy. It should not be confused with the superficial deltoid ligament which lies more anteriorly and is seen during fixation of the medial malleolus, and which has little influence on ankle fracture stability (Michelson 1996). The deep deltoid acts as a check-rein which prevents abnormal movement of the talus, even if the lateral malleolus is displaced (Michelson 1996) or the syndesmosis is torn (Boden 1989). If the deep deltoid ligament (DDL) is intact, axial loading of the ankle results in the talus moving slightly laterally and becoming fully congruent with the plafond articular surface, which then acts as an additional stabiliser (Michelson 1990, 1996). Therefore, if the DDL is intact, weightbearing will make the ankle more stable, not less, and will not result in talar displacement.

However, if the DDL is torn or the medial malleolus is fractured, the talus is no longer strongly attached to the tibia and the talus can displace laterally. Yablon (1977) described how the talus "follows the fibula" in the unstable ankle. However, it is important to recognise that this only happens when the DDL is detached from the tibia. When the DDL is intact, fibular displacement does not cause talar displacement. In fact, Michelson (1992) and Harper (1995) showed that in stable ankle fractures with fibular displacement, the lateral malleolus is actually congruent with the talus while the proximal fibula rotates abnormally; the apparent external rotation is due to internal rotation of the proximal fragment by muscle action. In fact, as we will see later, even a partially torn DDL will usually restrict talar movement enough to provide stability for functional treatment.

The syndesmotic ligaments, especially the posterior tibiofibular ligament, are important secondary stabilisers. Even is the syndesmosis is torn, abnormal talar movement will not occur in the presence of an intact DDL. Although both main ankle fracture classifications (Lauge-Hansen and AO-Weber, see below) predict that supra-syndesmotic fractures always have a DDL rupture, this is not always the case in real fractures (Hermans 2011).

However, if both DDL and syndesmosis are torn (or medial and posterior malleolar fractures are present), the ankle mortise can become extremely unstable. Burns (1993) found that this combination produced a 39% reduction in tibiotalar contact area and a 42% increase on contact pressure. Syndesmotic injuries are usually accompanied by an interosseous membrane tear and a fracture of the fibula above the syndesmosis. However, the interosseous membrane tear may extend above the fibular fracture, so the injury complex may be more unstable than would be suggested by the level of the fibular fracture (Nielsen 2004).

Assessment

Based on the biomechanical model, we would want to be able to differentiate between stable and unstable fractures. All displaced fractures, by definition, are unstable, but there could be a group of undisplaced fractures which are unstable and might need more active treatment.

Among more severe injuries, we also want to identify dislocations, particularly those at risk of skin breakdown, patients with major damage to the soft tissue envelope as shown by severe swelling and blistering, and, of course, open fractures. As with all fractures, we need to identify nerve and vascular injuries and compartment syndrome, all of which are fortunately rare.

We need to identify relevant patient factors that might determine desired or achievable outcome: occupation, sports, previous mobility; and co-morbidities, especially those such as diabetes, vascular disease and skin problems, which increase treatment risks.

Most of these can be identified by a focused history and examination. The findings can then be applied to determine whether radiographs are indicated in a patient with an ankle injury. The Ottawa Ankle Rule (Stiell) has been shown in several studies to be reliable in preventing patients who need an Xray being missed, while reducing radiation exposure for those who do not. Patients who:

- have tenderness over
  - posterior half of medial or lateral malleolus
  - navicular tuberosity
  - 5th MT base
- cannot weightbear in the emergency department

should have mortise and lateral Xrays of the ankle (and foot where appropriate). An additional true AP of the ankle does not add to diagnostic accuracy (Vangsness 1997, Brage 1997). The mortise view is taken in internal rotation, so that the malleolar tips are in the same horizontal plane – the amount of rotation varies between patients but is usually 10-20deg. A true lateral is very valuable in assessing congruence and posterior malleolar fractures.

"Displacement" of an ankle fracture refers to the alignment of the talus in the mortise. This is normally identified according to the medial clear space. The medial clear space is normally no more than the superior clear space. However, at least 4mm and probably 5mm of medial clear space normally indicates an intact DDL and a stable ankle (Koval 2007). Minor degrees of fibular rotation are irrelevant if the mortise is congruent:

- they normally represent rotation of the proximal fragment while the lateral malleolus remains congruent with the talus (Michelson 1992, Harper 1995)
- the talus does not "follow the fibula" (Yablon 1977) unless the DDL is torn or the medial malleolus detached from the tibia (Michelson 1996)

Murphy (2012) measured medial and superior clear space in 73 patients without ankle injuries. 17% of male Xrays and 1% of female Xrays had a medial clear space >4mm, while 2% of males and no females had a medial clear space >5mm. 13% of radiographs had a medial clear space greater than superior clear space. Measurements were symmetrical, so the authors suggest the use of contralateral comparison radiographs to evaluate apparent medial widening.

Several papers (McConnell 2004, Egol 2004, Schock 2006) have suggested that external rotation stress Xrays can differentiate stable from unstable undisplaced fractures. Most of these used manual application of stress, but Schock used a "gravity stress view" with the patient in the lateral decubitus position, and reported this was less painful than manual stress but equally sensitive. These papers cast doubt on the accuracy of clinical signs in predicting instability – however, their main outcome measure was talar displacement under external rotation, with 4mm as the upper limit of normal. Schuberth (2004) showed this was a poor predictor of arthroscopically-diagnosed DDL tears. Nor has any paper shown that such translation mandates internal fixation.

If instability is defined as "abnormal movement under normal load", normal loading of the ankle is primarily axial rather than rotational. Weber (2010) reported the use of unprotected standing radiographs as stress tests, with 9% of 56 undisplaced fractures displacing under load. Akhtar (2009) reported 153 patients with clinical evidence of potential instability in which protected weightbearing views showed displacement in 2%.

Egol and Koval (2008) have moved on to investigate the significance of positive stress radiographs with MR imaging of the deep deltoid ligament. They found that 91% of patient with positive stress radiographs had only partial deltoid tears and were successfully treated in a walking boot.

Hoshino 16 reported a study of weightbearing radiography in 36 patients who had undisplaced malleolar fractures, medial tenderness, bruising or swelling and positive external rotation stress radiographs. Only three showed increased medial joint space on weightbearing radiography; the other 33 were successfully treated non-surgically. Tornetta (2012) treated 54 stress-positive fractures in cast after discussion with patients (60 chose surgery). All 54 healed without displacement as measured by weightbearing medial clear space. These studies support Weber's (2010) conclusion that stress radiographs greatly over-estimate instability and that most undisplaced ankle fractures can be treated non-surgically.

To summarise these findings:
- If it's displaced, it's unstable
- If it's undisplaced, it's probably stable
  - No medial tenderness, bruising or swelling >99%
  - Medial tenderness, bruising or swelling 90-98%
- Stress Xrays probably over-estimate true instability

Classification

The biomechanical model suggests that the most important axis of classification is stability rather than fracture morphology or displacement in themselves. This is supported by a meta-analysis of both biomechanical and clinical literature (Michelson 2007). Neither of the existing major fracture classification systems gives enough weight to stability, and both have additional problems.

These two classifications, which are somewhat related, are:
- Lauge-Hansen (1950)
- Weber, which was largely taken over by the AO group

Lauge-Hansen classified ankle fractures on the basis of
- The position of the foot at the time of injury. In a closed-chain environment, a pronated foot will result in tight medial and lax lateral ligamentous structures and a supinated foot will result in tight lateral and lax medial structures
- The direction of the force applied to the ankle: adduction, abduction or external rotation. Lauge-Hansen indicated that this force determined the order in which structures fail, and that structures fail in a predictable order.

Weber (and hence AO) classified fractures according to the relation of the fibular fracture to the syndesmosis:
- Type A below
- Type B at the level
- Type C above

In the AO version, there are two sub-layers of the classification, giving classifications such as B1 (lateral malleolus fracture at the level of the syndesmosis, medial structures intact) or B2 (lateral malleolus fracture at the level of the syndesmosis, medial structures failed).

It appears initially that the Lauge-Hansen classification is more what we are looking for. In particular, supination-external rotation injuries would be stable until the medial structures fail, detaching the DDL from the tibia, while pronation injuries would always be instable as the medial structures fail first. Instability is at the first, fundamental level of the classification while in the AO classification it is at the second level.

Unfortunately, there are a number of problems with Lauge-Hansen's classification:
- Several biomechanical studies have attempted to reproduce the work and classification of Lauge-Hansen. Unfortunately, the fractures they produced did not correspond with Lauge-Hansen's classification. (Michelson 1997, Haraguchi 2009). If anything, the fracture patterns produced by a given

force in modern experiments tend to be less severe than those described by Lauge-Hansen, and the relationship between forces exerted on the ankle and fracture patterns is not exact.

- Gardner (2006) and Hermans (2011) carried out MRI on a group of displaced ankle fractures, and Hermans compared the MRI with plain radiography. 10% could not be classified according to the Lauge-Hansen system. Over 50% did not have the patterns of ligament and bony injury predicted by their apparent Lauge-Hansen type.
- The AO classification is more reproducible. This may not be a very useful advantage, however, as this finding relates only to the first level of both classifications. If one compares the second level (the level at which stability is considered in the AO classification) the reproducibility of both is very poor.

Probably we need a new approach to classification which fits with the biomechanical, imaging and clinical evidence better, is focused on stability and is reproducible at a level that matters. It is one of the goals of this presentation to promote the need for such a more scientifically sound classification. In this presentation we group fractures according to stability. However, we also consider the existence of a group of fractures which are potentially unstable because they have a medial injury, but which are undisplaced at presentation.

Stable fractures

These fractures make up about 50-70% of all ankle fractures (Fox 2005, Koval 2007). They have a functioning deep deltoid ligament (Michelson 1996). Even patients with a partially torn deep deltoid ligament are usually stable enough to treat functionally (Koval 2007).

An RCT by Stuart (1989) compared cast with Aircast brace for the treatment of stable ankle fractures, and a further RCT by Port (1996) compared cast with bandage. In both these studies, patients treated without cast had less pain and stiffness initially, although by 6 months the casted fractures had caught up. A further trial by Egol (2000) showed no advantage of a walker boot over an Aircast brace. All fractures in these three trials healed in the normal time whether a cast was used or not, and none of them had any weightbearing restrictions. This confirms the biomechanical evidence that stable fractures do not displace under normal loading (Michelson 1995, 1996).

Thus stable fractures do not need a cast to achieve healing in a good position. If anything, patients treated in cast recover function and comfort more quickly. However, it is sometimes said that patients require a cast for pain control. Dalal (2010) reported that, given an informed choice, 82% of patients chose a brace, 17% RICE and 1% a cast.

There is no need to restrict weightbearing. Follow-up radiographs are not necessary (Michelson 1995) and given adequate initial assessment, fracture clinic attendance is not required (Martin 2004).

Unstable fractures

This group represents 25% of all fractures (Fox 2005). If the talus is displaced, the DDL must not be functioning, and the talus tends to “follow the fibula” (Yablon 1977). Tibiotalar incongruity results in marked reduction in joint contact area – 1mm of talar displacement reduces contact area by 40% (Ramsey 1977, Lloyd 2006) and displacement increases contact pressures by 42% (Burns 1993). These findings are only relevant in ankle fractures in which the DDL is torn – Ramsey and Lloyd both divided all the soft tissue restraints in their cadaver model before displacing the talus.

Incongruity, therefore, probably increases the risk of late osteoarthritis (although this is not inevitable). Displaced fractures need to be reduced and kept reduced while they heal.

Four RCTs have compared surgical fixation with closed reduction and casting (Bauer 1985, Phillips 1985, Rowley 1986, Makwana 2001). Makwana’s trial included only patients over the age of 55, and was the only trial to show any functional advantage at long-term follow-up for surgically treated patients. Bauer’s trial, which is the best methodologically, showed no difference at 6-8 years between patients treated surgically or by closed reduction and casting, but the surgical group recovered quicker. Rowley found that surgically treated patients took longer to recover normal movement and gait. Phillips’ paper is often quoted to show better outcomes in surgically treated patients, but in fact the clinical outcomes were the same – only the radiological outcomes were better after surgery.

These studies should not be taken to show that ORIF is unnecessary. For one thing, the post-operative management was restrictive (only Rowley et al allowed early weightbearing and none allowed early movement to surgically treated patients). Outcome measures were non-standardised and there was significant loss to follow-up in Phillips' and Makwana's series. In addition, there were patients in each series (10-30%) who could not be managed closed and required ORIF. Michelson (2007)'s meta-analysis showed that the risk of adverse events was 15% in the non-surgically treated groups and 10% in the surgical groups. On the other hand, redisplacement can be treated with surgery and conservatively treated fractures which remain undisplaced do as well as surgically treated fractures. It is reasonable for patients to choose after evidence-based counselling (Tornetta 2012). Further trials, using modern methods of post-operative care, may show additional advantages for surgery. Surgery would, of course, be mandated in open fractures and highly-unstable fractures, and strongly indicated in polytrauma and patients who will particularly gain from early mobilisation.

It is common to delay surgery until all swelling has resolved to minimise the risks of wound problems and infection. This can add to bed occupancy problems and recent series have shown that elevation at home is safe for most patients. In fact, Chou's (2009) review found that if anything the existing literature suggested that delay in surgery, especially beyond 4 days, resulted in increased wound problems (unlike pilon and calcaneal fractures). Although this evidence was all from case series it suggests that early surgery is reasonable unless there is severe soft tissue compromise.

The sequence of surgery is usually:

- Lateral malleolus: lag screw/neutralisation plate is possible although many fractures are only suitable for bridge plating, which can often be done with minimal periosteal disturbance (Siegel 2007)
- Medial malleolus: most can be fixed with lag screws although tension band or other wiring techniques are sometimes necessary. If the lateral malleolus is very fragmented it may be worth fixing the medial side first to re-attach the deep deltoid and regain some stability (Limbird 1987). Most medial malleolar fragments are attached to the deep deltoid ligament, but small fragments that contain only the anterior colliculus are not attached to the DDL so fixing them will not stabilise the ankle (Tournetta 2000). Also, medial malleolar fractures and DDL tears occasionally co-exist (Gardner 2006)
- Posterior malleolus: see comments below
- Syndesmosis stabilisation: see comments below

Complex fractures

These include

- Posterior malleolar fractures
- Adduction-type medial malleolar fractures
- Syndesmotic injuries
- Ankle fractures in diabetics
- Ankle fractures in osteoporotic bone

Posterior malleolar fractures

Most posterior malleolar fractures are posterolateral avulsions of the posterior tibiofibular ligament. However, Haraguchi et al (2006), using CT, found that 2/3 of posterior malleolar fractures were wedge-shaped and related to the posterior tibiofibular ligament, but 20% were transverse, extending in to the medial malleolus, and 15% were small posterior shell fragments.

A number of biomechanical studies suggest that tibiotalar instability occurs with a posterior fracture that separates 30-40% of the joint surface, in the posterolateral position, from the rest of the plafond. It is difficult to measure the proportion of separated joint surface from plain Xrays, as the fracture line is usually oblique. Clinical studies, however, have not shown a clear proportion of posterior separation that predicts a poor result. Both Harper (1988) and Jaskulka (1989) found that outcome was determined by the overall severity of the fracture and the adequacy of reduction, and Tejwani (2010) found that the presence of a posterior malleolar fracture of any size predicted poorer outcome for an ankle fracture, perhaps indicating a higher-energy injury. Mingo-Robinet (2011) found that results were poorer in patients with a posterior malleolar fragment greater than 25 on lateral Xrays, but the quality of reduction did not have a significant effect and they did not analyse the effect of different sizes of posterior fragment. At the moment we still recommend fixation of a large posterior malleolar fragment (over 25%), and if this requires open reduction we would now use the posterolateral approach in view of the experience in association with syndesmotic injuries.

Recent studies have explored the importance of the posterior malleolus in syndesmotic injuries. Gardner (2006) demonstrated in a cadaver model that posterior malleolar fixation resored 70% of syndesmosis stablity compared with 40% after syndesmotic screw insertion. Miller (2010) then demonstrated, in a small series, that open reduction and stabilisation of the syndesmosis produced equivalent clinical results to syndesmosis screw fixation. They recommended (Miller 2009a) direct visual confirmation of syndesmotic reduction and described the use of the posterolateral approach to achieve this (Miller 2009b). By using this method they reduced the rate of syndesmotic malreduction from 52% (Gardner 2006, Miller 2009) to 16% (Miller 2009). Amorosa (2010) reported a similar improvement in anatomical reduction from 27% with indirect reduction to 83% with direct open reduction.

Many smaller posterior malleolar fractures can probably be treated with indirect reduction but the posterolateral approach is a useful part of the ankle fracture surgeon's toolbox.

Adduction-type medial malleolar fractures

These vertical fractures are mainly associated with supination-adduction type injuries (type A in the AO/Weber classification). They are quite uncommon injuries: 1/6 of Herscovici's (2007) series and only 5% of McConnell's (2001).

The complex fractures in this group are those with not only a vertical shear element but also articular impaction. 8/19 vertical fractures in McConnell's series had some degree of impaction of the plafond adjacent to the main fracture line. This is a serious injury, which requires reduction of the plafond impaction and stable fixation. Bone grafting of the impacted area is usually recommended. Toolan (1984) found that the most stable form of fixation of adduction fractures was cancellous lag screws perpendicular to the fracture site. Anti-glide plates provided much less stability. Dumigan (2006) recommended the use of a neutralisation plate. Both of these studies were carried out on cadavers; there are no comparative clinical studies.

Another complex medial malleolar fracture pattern are those which extend posteriorly into the posterior margin of the plafond. In Haraguchi's (2006) study of posterior marginal fractures, 20% involved the medial malleolus. Weber (2004) drew attention to these fractures, and to the need for more extensive exposure to allow reduction and stabilisation, often with a small posterior plate. A posteromedial approach can be useful.

Syndesmotic injuries

Syndesmosis injuries are, generally, the most severe ankle fractures, with high risks of dislocation and joint surface injury. Egol (2009) found that the functional outcome of patients who required syndesmotic stabilisation was worse than those who needed only malleolar stabilisation.

Syndesmotic injury is usually associated with supra-syndesmotic fracture, but the level of the fracture does not predict the level of the tear of the interosseous membrane very accurately (Nielson 2004, Hermans 2011), so some fractures will be more unstable than the radiograph suggests. Indeed, Stark (2007) found that intra-operative stress testing identified syndesmotic injuries in 38% of trans-syndesmotic (AO type B) fractures, although their diagnostic criteria for a stable syndesmosis were quite stringent.

The syndesmosis presents a complex appearance on plain Xray. Three measurements have been studied, and were entitled "syndesmoses A-C" by Pettrone et al (1983):

- Syndesmosis A (also known as the tibio-fibular clear space) is measured on the AP radiograph between the lateral border of the posterior malleolus and the medial border of the fibula. There was a small but significant difference in the outcome scores between patients in Pettrone's series with a post-reduction value of 5mm or more and those less than 5mm, and so this was considered abnormal.
- Syndesmosis B (also known as the tibio-fibular overlap) is measured on the AP radiograph between the medial border of the fibula and the lateral border of the anterior tibial prominence. There was a small but significant difference in the outcome scores between patients with a post-reduction value of 10mm or more and those less than 10mm, and so this was considered abnormal.
- Syndesmosis C was the same measurement as syndesmosis B, but on the mortise radiograph. A value of 1mm or less was considered abnormal

- The medial clear space also gives indirect information about the integrity of the syndesmosis, and Nielson (2005) referred to this as "syndesmosis D". Pettrone considered a medial clear space of 3mm or greater on the AP view to be abnormal. As noted elsewhere, most studies have examined the mortise view, and current evidence suggests 4-5mm as the upper limit of normal.

Brage (1997) found that measurement of the tibiofibular clear space and mortise overlap had relatively poor reproducibility on a standardised set of Xrays, while the AP overlap was highly reproducible. Pneumaticos (2002) found that the tibiofibular clear space was constant irrespective of the rotation of the ankle, while the overlaps and medial clear space were highly rotation-dependent. However, Beumer (2004) found that measurements on cadavers were so position-sensitive that comparison of repeated measures was almost meaningless.

Biomechanical and clinical studies (Boden 1989, Solari 1991), clarified these injuries and suggested selective syndesmotic stabilisation. As with other ankle fractures, an intact deep deltoid ligament would protect against tibio-talar displacement even with severe syndesmotic tears – tears up to 15cm above the ankle have been studied in cadaver experiments. However, if the medial malleolus was fractured or the DDL torn, a low syndesmotic tear (existing data suggest <4.5cm from the ankle joint line) could still be stable if the fibula is anatomically reduced and fixed. Above this, a syndesmotic positioning screw is likely to be needed. van den Bekerom (2010) confirmed that Boden's criteria had a specificity of 0.96 but a sensitivity of only 0.39: they are good at ruling in the need for a syndesmosis screw but less good at ruling it out. In addition, fixation of the malleoli may be less stable than ideal, so it is best to stress test the syndesmosis after fixation of the malleoli. Therefore, it is probably best to stress test all ankle fractures after bony stabilisation. The syndesmosis should be stressed laterally, anteroposteriorly and in external rotation – Candal-Couto (2004) suggested the main direction of instability is anteroposterior rather than laterally, and Xenos (1995) found that AP radiography correlated less well with measured rotation in cadaver legs than lateral radiography. Radiographic screening is important, although direct palpation of the syndesmosis may also be useful.

Both Gardner (2006) and Vasarhelyi (2006) found that over 50% of ankle fractures with syndesmotic injuries showed some degree of malreduction on CT after apparently satisfactory ORIF. Although late reconstruction can give good results, it is better to ensure accurate reduction at primary surgery. Recent studies have explored the importance of the posterior malleolus in syndesmotic injuries. Gardner (2006) demonstrated in a cadaver model that posterior malleolar fixation resored 70% of syndesmosis stablity compared with 40% after syndesmotic screw insertion. Miller (2010) then demonstrated, in a small series, that open reduction and stabilisation of the syndesmosis produced equivalent clinical results to syndesmosis screw fixation. They recommended (Miller 2009a) direct visual confirmation of syndesmotic reduction and described the use of the posterolateral approach to achieve this (Miller 2009b). By using this method they reduced the rate of syndesmotic malreduction from 52% (Gardner 2006, Miller 2009) to 16% (Miller 2009).

Biomechanical studies suggest a single 3.5mm cortex screw, through 3 cortices, about 2cm above the ankle joint line, is adequate for stability. Additional, or larger, screws, do not normally reduce the risk of late displacement. It should be a neutral, not a lag screw. Occasionally, however, a second screw is required in a highly-unstable fracture or a very large patient.

The use of a fibre-wire is appealing, as it would potentially allow some natural movement of the syndesmosis. There has been some controversy as to whether the construct is strong enough, but recent cadaver series (Klitzman 2010), suggest syndesmotic movement is close to normal. Case series (Cottom 2009, de Groot 2011) have reported generally positive results, although with significant levels of local complications. One or more RCTs would be preferable to compare screw and fibre-wire fixation.

It is traditionally advised to keep patients with syndesmosis screws non-weightbearing until the screw is removed at 6-12 weeks, lest the screw should loosen or break, usually the former. Hamid (2009) found no difference in AOFAS ankle scores between patients who had retained syndesmosis screws, broken screws and retained screws. However, those with retained screws had slightly higher pain scores. Manjoo (2010) found better Olerud-Molander scores in patients who had screw removal or breakage, than in those with intact screws. The tibiofibular clear space was narrower with intact screws. Hsu (2011) also noted no difference in outcome between patients with broken screws and those with intact screws. Hsu also found that 15% of diastases recurred in patients whose syndesmosis screws were removed before 3 months, although this did not affect clinical outcome with the numbers of patients in their study.

Miller (2010) noted improvements in range of movement and ankle scores after implant removal in 25 patients who had syndesmotic screw and fibular plate removal. It appears that it is intact, rather than broken, screws that can cause difficulties. Manjoo recommended offering screw removal six months after ORIF to patients whose screws are intact at that stage, which seems consistent with current evidence. The evidence on syndesmotic screw removal is summarized in a systematic review by Schepers (2011).

Ankle fractures in diabetics

An excellent and comprehensive review of this topic was published by Wukich (2008).

The risks of treating ankle fractures in diabetics are higher than in non-diabetics whether surgical or closed methods are used (Flynn et al 2000). Infection and skin breakdown are the main problems, and peripheral vascular disease, neuropathy and swelling increase the risk. The risk of wound failure after ORIF has been reported at 30-50%. In open fractures the wound complication rate is 60% and the risk of amputation may be as high as 40% (White et al 2003). RCTs would be needed to accurately assess the risk/benefit ratio of ORIF in displaced fractures in diabetics, but it would be difficult to do such a trial because of the heterogeneity of the patients and fracture patterns.

Most authors recommend 12 weeks of casting in neuropathic patients whether surgical or non-surgical treatment is used, with 6-12 weeks NWB depending on the severity of the injury and the presence of adverse factors. There is no clear evidence to support this, but until clearer evidence emerges prolonged protection, even in relatively low-risk patients, is probably best.

In addition a fracture of the ankle may precipitate Charcot arthropathy in diabetics with peripheral neuropathy (Kristiansen 1980,Thompson 1993, Holmes 1994, Connolly et al 1998). In high-risk neuropathic fractures trans-articular fixation (Jani et al 2004) may give better stability than traditional osteosynthesis.

As in treating any foot and ankle problems in diabetics, it is extremely important to assess the severity and control of the diabetic condition and the presence of peripheral vascular disease, neuropathy, cardiac and renal failure. At the moment it seems reasonable to treat fractures in non-neuropathic patients on the same principles as the general population, but warning of increased risks, protecting for longer and monitoring for late displacement (Wukich 2008). In neuropathic patients we would consider treating displaced fractures with retrograde nails.

Ankle fractures in osteoporotic bone

Ankle fractures are increasingly an elderly osteoporotic injury (Kannus 2002). They are more likely to have a stable configuration, especially in women (Fox et al 2005), and undisplaced fractures can be treated in the same way as in younger patients.

Displaced fractures require reduction and stabilisation. Makwana et al (2001) showed a small advantage for ORIF over closed casting in the over-55 age group. However, bone stock in elderly patients may be poor and stable fixation difficult to achieve. Four techniques can be useful in very porotic bone:

- Malleolar contoured locking plates (Zahn 2011)
- Screws purchasing not only two fibular cortices but both tibial cortices in addition
- Trans-articular fixation with an external fixator, wires or a retrograde nail
- Fibular nailing (Rajeev 2011)

Relative stability may have to be accepted and protected with a BK cast post-operatively. Nevertheless, good results can be obtained (Srinivasan 2001, Shivarathre 2011).

As an alternative to plating the lateral malleolus, fibular nailing has been described (Gehl 2004, Rajeev 2011). Results were probably comparable with those of plating, possibly with fewer wound complications. An RCT comparing nailing and plating in the elderly would be useful.

Post-operative care

Several small RCTs have addressed post-operative care. Overall, these do not show any significant advantage for restriction of weightbearing. Thomas (2009) carried out a systematic review of early mobilisation after ankle fracture fixation, reviewing nine trials. Patients who had early movement had better range of movement, better Olerud-Molander scores and earlier return to work than patients treated in plaster. However, by 1 year the benefit had disappeared. The non-casted patients in these trials were protected by ankle bracing or NWB exercise, rather than being left completely free. In practice we find that most patients prefer the support of an ankle brace which fits a trainer and allows weightbearing and ankle movement. Lehtonen et al (2003) and Vioreanu (2007) reported a higher rate of wound problems in patients randomised to an Aircast brace instead of a cast, although Gul (2007) also found a similar rate of wound problems in patients who had unprotected mobilisation. Application of the brace after wound healing seems to avoid this problem.

Currently there seems no reason to restrict weightbearing or mobilisation unless there are specific reasons to do so. Such reasons might include poor bone quality with limited stability of fixation, or patient compliance issues. Our default practice is to splint the ankle in a backslab or BKW cast until the wound has healed and then to mobilise in an ankle brace with weightbearing as tolerated. However, many patients are not compliant and protection in a walking cast may be preferable.

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