Review Article

Understanding risks and complications in the management of ankle fractures

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Abstract

Ankle fracture (AF) is a common injury with potentially significant morbidity associated with it. The most common age groups affected are young active patients, sustaining high energy trauma and elderly patients with comorbidities. Both these groups pose unique challenges for appropriate management of these injuries. Young patients are at risk of developing posttraumatic osteoarthritis, with a significant impact on quality of life due to pain and impaired function. Elderly patients, especially with poorly controlled diabetes and osteoporosis are at increased risk of wound complications, infection and failure of fixation. In the most severe cases, this can lead to amputation and mortality. Therefore, individualized approach to the management of AF is vital. This article highlights commonly encountered complications and discusses the measures needed to minimize them when dealing with these injuries.

Key words: Ankle fractures, complications, diabetes, elderly, posttraumatic ankle osteoarthirits
MeSH terms: Ankle injuries, osteoarthritis, elderly, fractures, diabetes

Introduction

The annual incidence of ankle fractures (AF) is approximately 122-184/100,000 person years (1:800).[1-3] The two age groups most commonly affected are young active men with high-energy trauma, and older women with low energy trauma.[1-4] The earliest description of AF was given by Pott[5] and Dupuytren.[6] Although many classification systems are proposed, two most widely used ones are the Weber[7] and the Lauge-Hansen classification.[8-10] The former is based on the relationship of the level of the distal fibular fracture with the syndesmosis, in an attempt to quantify stability. The latter is based on a cadaveric study involving two aspects the position of the foot at the time of injury and the direction of the applied deforming force.

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Regardless of the method of the intervention, the primary intention is restoration of normal anatomy. Complications, associated with both nonoperative and operative management are an important consideration in decision making. For some fracture types, e.g. stable undisplaced injuries, nonoperative treatment is the most appropriate management as operative management of these types of injuries could expose these patients to the unnecessary risks of surgery and has been deemed as 'over treatment'.[11-13]

Patient selection is vitally important when deciding the type of management. It is well known that patients with conditions such as diabetes and peripheral vascular disease have an increased risk of complications and unsatisfactory outcome.[13] There is also controversy in the treatment of elderly patients with osteoporotic AF.[14]

Although the literature is replete with articles on AF,[2,11,15,16] a comprehensive review of complications encountered in the management of AF is lacking. This paper provides an up-to-date review of potential risks and complications in the management of this injury and discusses strategies for prevention and treatment.

Materials and Methods

We conducted a search for AF complications through databases: AMED (Ovid), BNI (Ovid), CINAHL (EBSCO), Embase (Ovid), HMIC: DH-Data and Kings Fund (Ovid), Medline (Ovid) and Psycinfo (Ovid) in English language only. The papers and systematic reviews were analyzed from this

search and also from the Cochrane Database of systematic reviews. A further search was made through DynaMed™. The search revealed over 1400 papers. The case reports, small case series and articles not directly related to AF were excluded. The review articles were cross referenced. We have included current best evidence available. We (SSM, LC, and JM) have included 73 papers discussing complications of AF and their prevention with a view to provide answers to some common issues faced by Orthopedic surgeon in dealing with such fractures in their day-to-day practice.

Soft tissue complications

Early complications associated with AF are related to the surrounding soft tissue envelope owing to anatomical reasons. Only subcutaneous tissue protects both malleoli. In cases of fracture dislocation of the ankle, potentially significant wound complications can precede any intervention. A prompt reduction of the dislocation in the emergency department reduces the risk of further damage. Hence, the recommendation is to reduce these fractures even before obtaining a primary radiograph[17,18] [Figure 1]. In cases of open fractures, adequate preoperative treatment, with sterile dressing and antibiotics within 3 h of injury is imperative.[19] The British Orthopedic Association (BOA) and British Association of Plastic Reconstructive and Aesthetic Surgeons (BAPRAS) have produced joint guidelines for the management of open fracture.[19] Although not specific to AF, given the potentially devastating complications, important principles from these guidelines apply. The care of soft tissues during manipulation and reduction in the emergency department is also important. If there is any concern regarding either of these aspects early Orthopedic involvement should be sought.

If a delay is contemplated in the definitive management due to excessive swelling, the fracture position should be closely monitored both clinically and radiologically. In cases of tri-malleolar or unstable bi-malleolar fractures where reduction cannot be maintained by the plaster, an external fixator should be applied, as loss of reduction will lead to further soft tissue complications.[20]

Figure 1: X-ray of ankle joint anteroposterior view showing fracture dislocation of ankle. It should be reduced promptly and postreduction radiographs should be obtained

Blisters

The incidence of fracture blisters in AF has been reported to be 6.6%.[21] Blisters have significant implication on both nonoperative as well as operative management. Fracture blisters are thought to be, as a result, of a cleavage injury at the junction of dermis and epidermis.[21] Anatomical areas, such as the ankle, with closely adhered skin without much muscle cover are especially prone.[21] There are two types of blisters: Hemorrhagic blisters and nonhemorrhagic blisters, with former representing a more severe injury.[21] Whilst some authors advocate letting the blisters resolve before a surgical intervention,[22] others are proponent of de-roofing these and applying antibiotic cream until reepithelialization occurs.[23] Although there is no clear consensus on how best to manage an AF in the presence of blisters, Uebbing *et al*. concluded that blisters are best left intact and allowed to heal prior to surgical intervention[21] [Figure 2].

Complications of nonoperative management

In a Cochrane review, which included three randomized and one quasi randomized trial with 292 patients, the complications of nonoperative treatment included malunion, nonunion, pain, loss of function, muscle atrophy, cartilage degeneration, stiff/swollen joint, deep vein thrombosis (DVT), and pulmonary embolism (PE).[1] The length of followup in the involved studies varied from 20 weeks to a mean of 7 years.[1]

Regular outpatient review with radiographs is an important part of nonoperative management, especially for the first fortnight. Secondary displacement, generally requiring surgery,[24] (4 out of 38 patients in the study) can occur once

Figure 2: Clinical photograph showing fracture blisters

the swelling subsides or if the fracture pattern is inherently unstable.

The treatment of the majority of Weber type A fracture is nonoperative and type C fracture is by open reduction and internal fixation (ORIF). Weber type B fractures, comprising the remaining 50%, are treated with either method.[1] The inherent flaw in this approach is that Weber classification is unable to assess the intrinsic stability of all AF, which is an important consideration when planning treatment.[1]

Complications of operative management

The primary outcome measures in determining the success of operative treatment include functional outcome, pain, and major adverse event.[25] Major adverse events are defined as those that require secondary intervention.[25] The other complications reported include insufficient primary osteosynthesis, soft tissue necrosis, infection, osteitis, DVT, delayed union, nonunion, secondary displacement, refracture, stiffness, muscular atrophy, tendinous insufficiency, sensory deficit, tarsal tunnel syndrome and complex regional pain syndrome type 1.[14,26,27] Prophylactic antibiotics at the time of induction of anesthesia, anatomical reduction and stable fixation, care of the soft tissue envelope with minimal stripping of the periosteum, risk assessment and appropriate treatment for venous thromboembolism (VTE) and early mobilization of the ankle joint can help minimize these complications. Anatomical reduction of the AF requires knowledge of the normal anatomy. Particular attention should be paid to the maintenance of length, alignment and rotation of fibula and restoration of syndesmosis. The per operative images should critically analyze the length of fibula by a tibiofibular line (radiographic line from distal fibular tubercle if drawn toward tibia should pass through tibial plafond on the mortise radiograph), circle sign (on the mortise radiograph there is an unbroken circle formed between lateral recess of fibula and lateral process of the talus).[28] There should be equal and parallel medial, superior and lateral clear space on the mortise radiograph formed by talus, medial malleolus, tibial plafond and lateral malleolus.[28] Circle sign and uniform clear space also indicate restoration of fibular rotation and syndesmotic alignment. Another sensitive measure of syndesmosis alignment is the tibiofibular clear space at level of syndesmosis on the anteroposterior radiograph. It is measured at 1 cm proximal to the ankle joint there should be <6 mm between the medial border of the fibula and the lateral border of the tibial incisura.[29] These radiological parameters can be equally utilized to assess the quality of reduction in nonoperative management of the AF as well.[28,29]

Trimalleolar fractures of the ankle

In a study of 57 patients with involvement of posterior malleolus, variability of the fracture types was noted. In 20 cases, the fracture extended in the medial malleolus. Knowledge of this pathoanatomy and careful scrutiny of the preoperative imaging is essential for approaching these fractures.[30]

Preoperatively computed tomography is warranted in these cases to delineate anatomy of the fracture, presence of comminution, impaction of the fragment and to plan the approach.[30,31] The fractures involving posterior malleolus have worse functional outcome up to 1 year but not significantly worse after 2 years when compared to those without involvement of posterior malleolus.[32]

It has been shown that when posterior malleolus is fractured, posterior syndesmotic ligaments are intact and are attached to the fragment.[33] In a biomechanical cadaveric study (n = 10), it was revealed that by internal fixation of the posterior malleolus up to 70% of the stiffness of syndesmosis could be restored as opposed to 40% restoration by stabilizing just the syndesmosis.[33] A study with long term followup (mean followup of 13 years and n = 45) has revealed that the outcome is not worse if the fragment size <25% of the posterior malleolus is not fixed.[34] It is important to ensure that posterior fragment is well reduced and there is no subluxation of the ankle joint once medial and/or lateral malleoli are stabilized.

Infection in ankle fractures

Infection is a recognized complication in the operative management of AF. The rate of deep infection in patients undergoing ORIF of AF ranges from 1% to 8%.[16,18,35,36] Predisposing factors include advanced age, high energy injuries, smoking, diabetes, open fractures, compromised soft tissue envelope and alcoholism.[16,18,35-39]

Prevention of infection is an important consideration in operative management.[16,18,35-39] In cases of operative management of AF antibiotic prophylaxis should be according to the local policy of the hospital and region. In the management of open fractures, we follow the policy advocated by the BOA and BAPRAS.[19] The aim should be to administer antibiotic within 3 h. It is worth noting that 3 h is the period that is considered from the time of injury and not since presentation to the hospital.

Infection in operated closed AF especially in compromised hosts can be limb threatening.[35] In cases of operated AF, which present with infection and presence of metalwork, debridement should be performed, and cultures obtained.[35] Metalwork is temporarily retained and culture specific antibiotic suppression provided if metalwork is stable and fracture has not healed (presentation within 10 weeks of index surgery). Final debridement and metalwork removal is performed once fracture heals.[35] In cases of infected mal-union or presentation

after 10 weeks of index surgery or unstable implant, metalwork is removed with initial debridement.[35] Antibiotics are continued for 6 weeks after final debridement.[35]

Ankle fractures and diabetes mellitus

Diabetes mellitus (DM) is a well recognized risk factor for infection.[35-44] Infection rates for diabetic patients undergoing ORIF of AF can be as high as 60%.[35] Failed treatment of infection in diabetics with AF can lead to amputation in 42% of the cases and mortality in 11%[45-47] [Figure 3a-f]. The most common organism (65%) reported is *Staphylococcus aureus*.[35] Given the high rates of infection and amputation, managing AF in patients with DM is particularly challenging.

Perioperative glycemic control is very important.[39] Fasting patients need to be on an insulin sliding scale to achieve this. DM, particularly when poorly controlled, predisposes patients to infection due to increased periods of hyperglycemia that causes nonenzymatic glycosylation yielding irreversible, advanced glycation end products (AGE).[39] AGE lead to disruption of soft tissues and impaired function.[39] Abnormal glucose metabolism results in vasculopathy, neuropathy, and inhibition of wound healing and impaired immune function thus creating conditions that predispose to infection.[35,39,40]

It is important to take care of the soft tissues perioperatively.[39] Delay in diagnosis or an inadequate immobilization has been shown to lead to an increase in Charcot arthropathy.[48] Enhanced fixation with multiple syndesmotic screws has been suggested in diabetics with displaced AF even in the absence of syndesmotic injury [38,49] [Figure 4]. Robust fixation has been recommended universally for operative management of AF in diabetic patients.[49,50]

Based on fair quality evidence deduced from level II or level III studies prolonged period of protection with

Figure 3: (a) X-ray of ankle joint anteroposterior view showing simple bi malleolar fracture in diabetic patient with peripheral neuropathy (b and c) X-ray of ankle joint anteroposterior and lateral view showing open reduction and internal fixation performed using standard technique. (d) X-ray of ankle joint anteroposterior view showing patient mobilized weight bearing at 6 weeks postoperative. This resulted in failure of fixation requiring removal of metal work and (e and f) X-ray of ankle joint anteroposterior and lateral views showing infected nonunion of the fracture

Figure 4: X-ray of ankle joint anteroposterior view showing multiple syndesmotic screws for internal fixation of ankle fracture in a diabetic patient

nonweight bearing followed by protected weight bearing has been recommended in diabetic patients with AF.[38,51] This period can be up to 6 months in cases of diabetic neuropathy.[38] It has been recommended that duration of immobilization should be until there are signs of fracture healing, which can be 2-3 times that of nondiabetic patient.[38,39]

Two specific predictors of poor outcome in diabetics are presence of peripheral neuropathy and lack of pedal pulses preoperatively.[40] Neuroarthropathy has been shown to be a significant risk factor for developing a wide range of complications.[42] Delayed complications may occur including loss of reduction, metalwork failure, nonunion, arthrosis and Charcot arthropathy.

Thromboembolic complications

The incidence of VTE in patients with a leg injury that had been immobilized in a plaster cast or brace for at least 1 week and who received no prophylaxis has been estimated to be 4.3-40%.[52] Although the precise incidence of DVT and PE is not known in foot and AF an analysis of a trauma database has estimated it to be 0.28% and 0.21%, respectively.[53] Another study (n = 100) have estimated the incidence of asymptomatic DVT of 5% in patients with AF who are treated with below knee casts.[54] In a randomized placebo-controlled trial for leg (including knee injuries) injuries, which also included soft tissue injuries, treated with above and below knee cast, the placebo group had a 4.3% incidence of DVT compared to 0% of those treated with low molecular weight heparin.[55] Results from Hospital Episode Statistics (admission database of English NHS Hospitals) have estimated the incidence of DVT and PE in operated AF to be 0.12% and 0.17%, respectively.[56] In a randomized, double-blind placebo-controlled trial of patients with AF who were treated surgically, the incidence of DVT in the placebo group was 28% versus 21% in the dalteparin group.[57] Most of these studies do not specify whether patients had a previous history of VTE.

Risk factors for VTE are previous history of DVT, immobilization, nonweight bearing, body mass index >30 kg/m^2, pregnancy, contraceptive pill, age >60 years, active cancer, recent hospital admission, above-knee plaster.[53,57,58]

Management and personal experience

Some studies have advocated that routine pharmacologic thromboprophylaxis is probably not justified in foot and ankle trauma patients.[53,56] In a recent telephone survey in the UK, it was shown that 84% (n = 47) hospitals do not routinely use thromboprophylaxis in patients with AF treated in plaster.[59] We feel that although routine thromboprohylaxis should not be used in AF, we agree with Shibuya *et al*. that an individualized risk assessment for each patient with these fractures should be carried out.[53]

Rehabilitation and its role in limiting morbidity

In a literature review of 31 randomized or quasi-randomized controlled trials concerning the rehabilitation of AF in adults, common complications elucidated included pain, stiffness, weakness and swelling.[26] All these are recognized as barriers to overcome for successful rehabilitation. Evidence is lacking regarding intervention following conservative management, with more evidence available on interventions following surgery.

A combination of early mobilization, early commencement of weight bearing and the use of a removable immobilization device, in conjunction with exercise showed a positive effect on ankle range of motion.[26] It is important to consider patient factors, particularly their ability to correctly apply and use a temporary immobilization device; their compliance with directed exercise regimes, as they can influence overall effectiveness of the intervention.[26]

Analysis of risk and benefit is equally important when considering the use of immobilization devices in patients following surgery. Although these devices may help reduce pain and encourage participation in the activity, they may also predispose to surgical site complications. A review of literature concluded that more research is required to answer the question of "the best rehabilitation" after AF treatment.[26]

The elderly patient with an ankle fracture

Operative treatment of AF in the elderly may pose a challenge. There is controversy in the management of AF in the elderly.[60]

The early results of ORIF in patients over the age of 70 carries risks of deep infection (1%), delayed wound healing (9%), mal-union (5%), and mortality (3%), preclusion of fixation of one malleolus due to comminution/soft bone (12%).[61] Factors leading to these complications include preexisting comorbidities and poor quality bone.

Various alternative methods of fixation have been proposed in osteoporotic AF. They include locking plates for the lateral malleolus[62,63] and tibio-talar-calcaneal nailing[64,65] in displaced comminuted unstable osteoporotic AF. The locking-plate fixation has been found to superior to the traditional semi-tubular plate fixation in cadaveric studies.[62,63] Currently a multicenter randomized controlled trial (ankle injury management) comparing Close Contact Cast versus ORIF is running in the UK to decide the optimum treatment for patients above 60 years of age.[66]

Posttraumatic osteoarthritis

Posttraumatic osteoarthritis (PTOA) is a major contributor to the morbidity associated with AF.

The incidence of PTOA has been reported as high as 70%; with rotational AF being the most common cause.[67] It occurs following a failure of restoration of normal anatomy due to mal/nonunion and is the most common indication for ankle arthrodesis.[67] When there is a significant displacement, anatomical reduction is more likely to be achieved through surgical means thus reducing long term risk of developing PTOA.[68] This is especially true in cases of the lateral talar displacement where 1 mm displacement has been shown to reduce the tibio-talar contact area by an average of 42% resulting in peak loads.[68] These peak loads lead to a secondary loss of cartilage and subsequent osteoarthritis.[68] One of the important factors in the development of PTOA is valgus deformity and fibular shortening, as a result of fibular mal-union.[69] It has been shown the latency time between injury and developing end-stage ankle OA is 20.9 years.[67] Another risk factor predisposing to PTOA is injury to ankle ligaments.[70] Athletes sustaining lateral ankle sprains are the most common group to sustain ligamentous PTOA.[70] Given the high incidence of AF in young patients, ankle arthrodesis in middle age patients is a very real consequence of PTOA. A patient's journey to arthrodesis involves chronic pain leading to functional impairment,[70] both of which significantly contribute to morbidity.

Removal of metal work

In AF with syndesmotic disruption, treatment involves the use of a syndesmotic fixation with the screw(s) or a Tightrope™. It is debatable whether this screw should be routinely removed.

Concern over patients with retained screws, suffering a worse outcome is considered a major factor responsible for the routine removal. In a retrospective review of 76 consecutive cases, 22.4% patients experienced complications, following routine removal of syndesmotic screw.[71] No difference in outcome has been shown regardless of retention or removal of the screw.[72] Schepers *et al*. advocated against routine removal of syndesmotic screws.[71,72]

Medico-legal implications in the management of ankle fractures

Between 2000 and 2006, there were 73 successful cases of litigation, related to trauma of the foot and ankle, in the UK.[73] Each received an average payment equivalent to $125,773.[73]

Conclusion

We have presented a review of commonly encountered complications in managing AF and methods of preventing them. The summary points outlined are: Annual incidence of AF is approximately 122/100,000 population (1:800). This injury most commonly affects two age groups: High-energy in young patients and low-energy in elderly patients. The most common cause of ankle joint arthritis is posttraumatic (PTOA) with estimated incidence to be in the region of 70%; rotational injuries being the commonest cause. The risk of VTE is reported to be low in patients with AF; DVT (0.12%) and PE (0.17%). Elderly and diabetic patients are at particular risk of complications. Routine removal of metalwork is not advised in the asymptomatic patients. There is controversy regarding routine removal of syndesmosis screw(s).

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