Fibula fractures management

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Abstract

Isolated distal fibula fractures represent the majority of ankle fractures. These fractures are often the result of a low-energy trauma with external rotation and supination mechanism. Diagnosis is based on clinical signs and radiographic exam. Stress X-rays have a role in detecting associated mortise instability. Management depends on fracture type, displacement and associated ankle instability. For simple, minimally displaced fractures without ankle instability, conservative treatment leads to excellent results. Conservative treatment must also be considered in overaged unhealthy patients, even in unstable fractures. Surgical treatment is indicated when fracture or ankle instability are present, with several techniques described. Outcome is excellent in most cases. Complications regarding wound healing are frequent, especially with plate fixation, whereas other complications are uncommon.

Key Words: Fibula fracture; Lateral malleolus; Distal fibula; Management; Treatment; Ankle

Core Tip: Isolated fibula fractures are very common injuries. Diagnostic exams must rule out ankle instability. Surgical treatment must be considered in the case of associated ankle instability. Risk factors for wound related complications must be considered when choosing the surgical technique.

INTRODUCTION

Ankle fractures are frequent injuries[1], increasing in elderly patients as a consequence of osteoporosis[2]. In most literature reports, distal fibula fractures represent the majority of ankle fractures[3]. These fractures are often the result of a low energy trauma with an external rotation and supination mechanism.

Many authors recommend conservative treatment for isolated fibula fractures without signs of ankle instability as good clinical results are obtained in most cases[1-3]. However, the trend in recent years is headed towards surgical treatment, with advantages in terms of anatomic restoration and earlier recovery[1-3].

Depending on fracture type, displacement and degree of instability, several surgical treatment techniques have been described. These include lateral *vs* posterolateral plating, nonlocking *vs* locking plate fixation, isolated screws and intramedullary fixation[4].

The aim of the present paper is to review the most recent literature about the epidemiology, mechanism of injury, diagnosis, classification, management and complications of isolated distal fibula fractures treatment.

EPIDEMIOLOGY

Ankle fractures are frequent injuries, accounting for about 9% of all fractures[1]. Moreover, there has been a sharp increase in osteoporosis related ankle fracture incidence in recent years. Isolated distal fibula fractures represent the most frequent ankle fracture type[3,4]. Elsoe *et al*[2] recently reported the epidemiology of 9767 ankle fractures, identifying distal fibula fractures as the most common fracture type, accounting for 55% of cases. Furthermore, according to the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification, type B is generally reported to be the more common distal fibula fracture type. Court-Brown *et al*[5] reported the following distal fibula fracture type distribution among 1500 ankle fractures: 52% type B trans-syndesmotic fractures, 38% type A infra-syndesmotic fractures and 10% type C supra-syndesmotic fractures[5]. Age and gender-related differences in ankle fracture epidemiology have been reported. Distal fibula fractures are more frequent in young active male patients. Werner *et al*[6] reported an incidence of isolated distal fibula fractures reaching 83% of cases among a population of National Football League athletes reporting ankle fractures. Conversely, Hasselman *et al*[7] found isolated fibular fracture to cover 57.6% of cases in elderly (> 65 years) women reporting ankle fractures.

MECHANISM OF LATERAL MALLEOLUS FRACTURE

Stability of the ankle mortise is determined by bony components (fibula, tibia and talus) and ligamentous structures (syndesmosis complex and lateral and medial collateral ligaments). Dynamic musculotendinous stabilizers, which exact function is less understood, also play a relevant role. There is on-going research on interactions between these structures and mechanisms that cause fracture.

Ankle sprains/torsion injuries, accidental falls and sports related accidents are the most frequently reported causes of distal fibula fracture, with different rates according to the different AO/OTA types. In type A fractures the main cause is represented by torsion (32%) followed by falls (23%) and sports related trauma (22%). In type B fractures the trend is similar, with reported rates of 27% for torsion, 37% for falls and 13% for sports related trauma. For type C the trend is slightly different because torsion represents only 3.7% of cases while falls and sports related trauma represent 28% and 21% of cases, respectively.

The most frequently described traumatic mechanism is supination-external rotation (SER). In this type of trauma, the talus rotates pushing the tibia and fibula apart, rupturing the anterior-inferior tibiofibular ligament and causing a simple ankle sprain.

Further progression of deforming force causes a simple oblique fibula fracture at the level of the syndesmosis, equivalent to the AO/OTA type B fracture. In the second most frequent mechanism, supination-adduction, adduction of the hindfoot causes either talofibular ligament rupture (ankle sprain) or an avulsion fracture of the distal fibula, equivalent to the AO/OTA type A fracture. As reported by Lauge-Hansen[8], lateral structures are damaged after the medial side when traumatic forces act in pronation.

Nonetheless, a recent *in vivo* study by Kwon *et al*[9] analyzing injury videos posted on YouTube and matching them to their corresponding X-rays, found that the Lauge-Hansen system was only 58% overall accurate in predicting fracture patterns from deforming injury mechanism.

DIAGNOSIS

Clinical examination
Clinical signs of an isolated fracture of the distal fibula are not specific and may not be distinguishable from a severe ankle sprain. These signs include swelling, bruising, pain, ecchymosis, tenderness and reduced range of motion (ROM). Swelling is the most common reported sign and was found to be a constant feature of all ankle fractures[10]. Because most isolated distal fibula fractures are stable, weight bearing is usually possible[11], thus patients might be ambulating at clinical presentation. There are no specific clinical tests for this fracture. Nonetheless, it is essential to evaluate medial ankle structures stability to choose the correct management. In C type fractures, the syndesmosis complex integrity must also be investigated. However, clinical examination alone is not diagnostic in most cases because pain, edema and muscle contracture can hinder correct evaluation[12,13].

Radiographic evaluation
Standard ankle X-rays are the mainstay of instrumental diagnosis for all ankle fractures. However, ankle sprains that might possibly cause a fracture might not deserve radiographic examination in all cases. In fact, due to the already described unspecific clinical presentation, other criteria should be considered to reduce the number of unnecessary exams and length of hospital stay[14,15]. The Ottawa Criteria were introduced for this purpose, despite some studies questioning their clinical validity[16].

When cases amenable for radiographic evaluation are selected, three radiographic views should always be obtained according to the American College of Radiology guidelines: antero-posterior (AP), lateral and mortise view[17].

The AP view is performed along the long axis of the foot. In isolated fibula fractures, this view is particularly useful to evaluate signs of associated ankle and/or syndesmotic instability through the analysis of talus coronal inclination, tibio-fibular overlap, tibio-fibular clear space and medial clear space (MCS)[18].

In the lateral view, the talar dome must be centered and congruent with the tibial plafond. This view is useful in isolated fibula fractures to demonstrate AP displacement and external rotation type fractures[19].

The mortise view is taken by placing the foot on the table with about 15° of internal rotation. This visualization is useful in isolated fibula fractures to detect signs of associated syndesmosis instability and to obtain a clear view of the lateral malleolus without other overlapping structures. It is especially useful in undisplaced and incomplete fractures[18,20].

Theoretically, these views are sufficient to identify an isolated distal fibula fracture in almost all cases. As demonstrated in several clinical and cadaveric studies[21-23] in standard radiographic evaluation, a MCS increase in isolated distal fibula fractures is a typical sign of rupture of the deltoid ligament with consequent talar lateral shift. These factors suggest a possible mortise instability, which is fundamental to define treatment modality. However, reliable radiographic determination of deltoid ligament rupture in such uncertain cases is difficult in clinical practice[24]. To adequately evaluate mortise stability, different modalities to obtain stress radiographs have been described.

The manual stress view has been considered the method of choice for years. However, being an operator dependent exam, reproducibility and radiation exposure to the physician are a concern. Moreover, it is not clear in the published data which MCS values are to be considered as a cut off to identify a clinically relevant deltoid ligament rupture.

Michelson *et al*[25] described for the first time in 2001 the gravity stress view to investigate ankle joint instability. The patient is placed in the lateral decubitus position with the distal half of the leg off the end of the table. Then a standard AP and mortise view is taken. Gravity stress views proved to be just as effective as manual stress views to detect deltoid ligament injury in association with an isolated distal fibula fracture[26-28]. Many advantages, such as no radiation exposure to the physician and less pain to the patient are described. Moreover, the constant force of gravity makes the exam reproducible[27].

Nonetheless, manual and gravity stress radiographs can overestimate the need for surgical fixation by showing MCS widening in partial deltoid ligament lesions that might uneventfully heal with conservative treatment[29-31]. For this reason, in the literature many authors described the weight bearing radiographs as an alternative method to identify ankle instability in isolated distal fibula fractures. As proposed by Weber *et al*[32], these radiographs should be performed with the patient standing on both legs as pain allows. An AP, lateral and mortise view is then taken with the weight ideally distributed equally on both ankles[32]. The disadvantage of this technique is the possible variability in weight distribution between healthy and injured side that could hide the degree of ankle instability in some cases.

Finally, magnetic resonance imaging is not indicated in the acute diagnosis of isolated distal fibula fractures. Its use in these lesions is very limited because traditional and stress radiographs proved to be equally effective in identifying the severity of associated deltoid ligament injury[33]. Conversely, magnetic resonance imaging might be useful to detect associated chondral injuries or to diagnose a fracture when conventional radiographs are inconclusive, and clinical suspicion is very high[34].

CLASSIFICATION

Although the fibula carries only 10% of the body weight (compared to 90% carried by the tibia)[35], its role is crucial in the stability of the ankle mortise. Based on this statement, to define an ankle with isolated fibula fracture as stable or unstable is crucial to guide proper treatment. Nonetheless, there is still debate in the literature on which are the most suitable clinical and radiological criteria to obtain this goal. The optimal management is based on an accurate knowledge of the fracture. For a comprehensive assessment of the fracture, a reproducible classification method is essential.

Different classifications have been proposed through the years. Lauge-Hansen and Danis-Weber classifications are the most used. They are based on standard AP, lateral and mortise radiographic views of the ankle. Their aim is to describe the mechanism of injury, predict soft tissue conditions and finally guide treatment.

The Lauge-Hansen classification, developed in 1954, is based on the position of the foot at the time of injury (supination or pronation) and on the deforming forces acting on the foot (abduction, adduction or external rotation)[36]. This results in a combination of four categories and thirteen patterns of ankle fracture. Isolated distal fibula fractures usually occur in the supination-external rotation type II and supination-adduction Lauge-Hansen types. In the other classes (pronation-abduction and pronation-external rotation) an isolated fibula fracture might occur above the level of the syndesmosis in association with a medial ligament injury. The main limitation of the Lauge-Hansen classification is the poor interobserver agreement that is instead very high in the Danis-Weber classification due to its simplicity.

The Danis-Weber classification (Figure 1) was first described by Robert Danis in 1949 and later modified by Bernhard Georg Weber in 1966. It was then adopted by the AO/OTA Group. It evaluates the location of the main fibular fracture in relation to the syndesmosis. Type A fractures are generally stable injuries occurring below the level of the syndesmosis. Type B fractures occur at the level of the syndesmosis and might be unstable in some cases. Type C fractures are usually unstable injuries occurring above the level of the syndesmosis[37].

However, differentiating fracture types in relation to the syndesmosis might lead the medial side of the ankle to be overlooked. Moreover, injury extent in the tibiofibular syndesmosis is often not predictable. These findings are crucial to detect tibio-talar instability and consequently to decide between surgical and nonsurgical management, especially for type B fractures[38]. Probably, as suggested by Lampridis *et al*[39], a combination of the two main systems is the correct approach. Nonetheless, the limits of these classification systems are reported by several studies in the literature, especially their poor prognostic and therapeutically predictive capabili-

Figure 1 Danis-Weber classification of distal fibula isolated fractures. A: Type A; B: Type B; C: Type C.

ties[40-42].

MANAGEMENT

Clinical and biomechanical data indicate that maintenance of talar reduction is the most important factor for the prognosis of ankle fractures[43,44]. A residual disloca-tion leads to a series of complications including impaired healing, early osteoarthritis and residual instability.

Shortening and external rotation of the fibula can cause talar lateral shift, reducing the tibio-talar contact area and increasing peak pressure in the articular cartila-ge[45,46]. Many authors believe that the deltoid ligament is the most important structure to maintain the position of the talus when the fibula is fractured[47-49].

An isolated distal fibula fracture is considered stable when less than 2 mm of displacement occurs, and no deltoid ligament rupture is detected (MCS < 4 mm)[50,51]. Several clinical studies have shown that in isolated fractures without concomitant medial injury, conservative treatment leads to excellent long-term results[52,53].

Conversely, many clinical studies have shown significantly better results in ankle fractures with mortise instability and talus displacement when an accurate fracture reduction is achieved[54]. However, unlike cases associated with gross instability, proper management of isolated fibula fractures that demonstrate instability only after stress radiographs is still a matter of debate in the literature[55]. In many authors' opinions, stress radiographs can overestimate the need for surgical fixation[29-31]. Hoshino *et al*[31] analyzed 36 patients with isolated distal fibula fracture demon-strating MCS widening at external rotation stress radiographs. All patients were treated with nonsurgical treatment initially. After 7 d, only one (3%) patient had an unstable ankle mortise on weight bearing radiographs, thus requiring operative treatment. All patients demonstrated good to excellent functional scores at 1 year follow-up[31].

NONOPERATIVE TREATMENT

Conservative treatment is indicated for isolated distal fibula fractures with a stable ankle mortise. As far as fracture displacement is concerned, Lesic *et al*[56] set 2 mm as the threshold between conservative and surgical treatment. However, there is no strong evidence in the literature advocating surgery for fracture displacement more than 2 mm[57]. Other studies suggest that radiographic displacement might not be reliable as it is mostly a rotational displacement[58-60].

Nonetheless, minor radiographic displacement seems not to affect clinical outcome[61]. Two studies have shown a high percentage of good results even when the fibula is posteriorly displaced up to 5 mm[41,62]. Hence, any isolated distal fibula fracture with a stable ankle can be treated conservatively (Figure 2).

Figure 2 Lateral, mortise and antero-posterior radiographic views of a Danis-Weber type B left distal fibula fracture. Conservative treatment is the correct choice for this case because minimal displacement of the fracture and absence of associated ankle instability are demonstrated.

Weber type A fractures can be considered equivalent to a ligamentous ankle injury. Likely, satisfactory results with nonoperative treatment can be achieved as in ligament ruptures[63].

In the literature, randomized and nonrandomized studies show satisfactory outcomes for conservative treatment in minimally displaced or nondisplaced Weber B type fractures[41,61,62,64]. Dobbe *et al*[65] reported that 13% of 108 conservatively treated infra-syndesmotic fractures had difficulties with work- and life-related activities. However, no relationship was identified between outcomes and the degree of articular displacement or fragment width[65]. These results might suggest the need to adapt treatment according to age and activity level. Sanders *et al*[54] suggested operative intervention in younger individuals, with the aim to reduce the risk of malalignment and improve outcomes. Conversely, a different management can be reserved for older and less active patients, which can be safely treated with cast immobilization even in unstable fracture patterns[54].

While there are several studies that describe conservative treatment for Weber type B fractures, a recent review comparing different managements for Weber type C fractures found only one study included conservative treatment. This demonstrates the widespread preference for surgical management in these cases[66]. Donken *et al*[67] compared the results of nonoperative and operative treatment for Weber type C fractures, with conservative treatment reserved to cases that demonstrated joint congruity, no signs of deltoid ligament injury and no medial malleolus fractures. Clinical results were comparable with most patients reaching high-level functional results[67].

Nonoperative treatment modality is chosen based on patients' symptoms, bone and skin quality, time lapse from injury to clinical presentation and risk factors for impaired healing (Table 1). Different conservative treatment modalities are described in the literature, ranging from cast immobilization without weight bearing to immediate full weight bearing without cast or brace. Historically, treatment in a plaster cast for several weeks was recommended. This strategy arises from the evidence that 6 wk are needed for any fracture to tolerate weight bearing[41,61,62,68]. Although a high rate of fracture union was demonstrated, a prolonged immobilization can result in ankle stiffness and higher risk of deep vein thrombosis[69-73]. To overcome these complications, Kortekangas *et al*[74] recently showed that a 3-wk period of immobilization is noninferior to 6 wk in the treatment of an isolated stable Weber B type fracture.

Alternative methods of immobilization with immediate weight bearing have been proposed through the years. In 1979, Stover *et al*[75] proposed a bivalve pneumatic air stirrup in the management of ankle fractures. Stuart *et al*[71] in 1989 showed the brace to improve patient comfort, post fracture swelling, range of ankle motion at union and time to full rehabilitation. Similar findings were reported by Brink *et al*[76], who advocated the use of a hinged short-leg boot with good results in pain relief, increased ROM and earlier return to ambulation. It has been suggested that an ordinary elastic bandage is equally safe and beneficial[52], and no difference in the amount of pain experienced has been found between early mobilization or plaster cast[77]. Ryd *et al*[52] described 49 patients treated only with elastic bandage for isolated distal fibula fractures displaced less than 2 mm and without medial tenderness. All of them had excellent clinical outcomes and were back to normal activity in about 4 mo[52].

Table 1 Summary of main criteria for conservative indication in isolated distal fibula fractures treatment

Nonoperative treatment	
Displacement	< 2 mm
Medial stability	MCS < 4 mm in AP/mortise view and/or in dynamic radiographs view
Poor bone and skin quality	
Long time lapse from injury	
Advanced age, low functional demand	
High risk of local and general complications	

AP: Antero-posterior; MCS: Medial clear space.

The functional treatment of stable ankle fractures is also supported by van der Berg *et al*[78], who showed better Visual Analogue Scale score and total ROM with a brace rather than with a cast after 6 wk, while no significant difference was found at 1 year.

SURGICAL TREATMENT

Open reduction and internal fixation is the most common treatment for unstable ankle fractures (Table 2). There are several fixation methods described for distal fibula fractures fixation, including one-third tubular plate (Figure 3), dynamic compression plate and locking plate with or without an independent lag screw[79-81]. The most used plates are angular stable metaphyseal or anatomic distal fibula plates (Figure 4) [82]. They can serve as bridging plates, compression plates, tension band plates or neutralization plates. Most studies comparing locking plates and conventional one third tubular plates show no differences in clinical and radiographic outcomes as well as in wound complications incidence[79,83-85]. However, these fixation techniques have a complication rate of up to 30% of cases, with wound complications being the most common[86-88]. This is attributed to the surgical trauma occurring in an already injured area with limited soft tissue cover. This range increases in smokers, in elderly patients and in patients with comorbidities such as diabetes and peripheral vascu-lopathy[87-90]. Minimally invasive plate osteosynthesis is a suggested alternative to prevent periosteal damage and major soft tissues dissection. This technique allows plate insertion through a small incision and better respects fracture biology[79]. However, anatomic restoration is more technically demanding for the surgeon, and the technique is suitable for only a small amount of fracture patterns.

Distal fibula fractures in elderly patients are often comminuted and present with impaired soft tissues coverage. Consequently, the correct management of ankle fractures in these patients must account for bone quality and the risk of soft tissue complications[80,86,89]. Locking plates provide a biomechanical advantage in cases of poor bone quality and are therefore recommended over nonlocking plates in osteoporotic patients when surgical management is chosen[86,80].

Fibular nailing is considered a valid alternative method of fixation for distal fibula fractures. The use of intramedullary fibula fixation was first introduced in the mid-1980s to reduce complications of the traditional plating techniques[91]. However, early attempts in intramedullary fibula fixation, such as using rush rods, Inyo nail, K. wires, *etc*., showed several complications and failures due to poor rotational and longitudinal stability, which led to loss of reduction, malunion and nail migration[92-94]. As a result, modern locking fibula nails have been developed to reduce such complica-tions[93]. Modern fibula nails are designed with proximal and distal locking fixation systems. The use of proximal and distal locking screws as well as of intersyndesmotic screws (Figure 5) if needed, allows optimal fracture stability with consequent advantages on early weight bearing[93,95]. The use of a modern fibula intramedullary nail should be considered especially in cases of suffering skin and/or patients with severe comorbidities[93-95]. Several authors compared the results of plating and nailing for internal fixation of the fibula in ankle fractures, and most of them show no differences in functional outcome[96,97]. Successful results with lower rates of wound breakdown and hardware prominence compared with standard open reduction and plating have been reported[93-96]. On the other hand, the main criticisms of this

Table 2 Summary of main criteria for surgical indication in isolated distal fibula fractures treatment

Surgical treatment	
Displacement	> 2-5 mm
Medial instability	MCS > 4 mm in AP/mortise view or in dynamic radiographs view
Type C	Any displacement

AP: Antero-posterior; MCS: Medial clear space.

Figure 3 Radiographic and clinical results at 3 mo from a one-third tubular plate fixation of a Danis-Weber type B left distal fibula fracture.

technique reside in the difficult management of rotational displacement, especially in type B fractures and in the absence of compression at the fracture site in simple oblique and spiral fracture patterns with a theoretical risk of delayed healing[93,95]. However, the minimally invasive approach that preserves fracture biology and periosteal blood supply might overcome this aspect[94,98].

COMPLICATIONS

Nonunion

Nonunion in ankle fractures is an extremely rare complication[99-103]. Distal fibula fractures usually heal uneventfully even with nonsurgical treatment. However, because most nonunions in this area are asymptomatic, the exact incidence of this complication is uncertain[99-103].

A higher incidence of fibular nonunion has been described when associated with medial instability. Sneppen *et al*[99] demonstrated a 0.7% incidence of fibular nonunion in ankle fractures involving the medial malleolus *vs* a 0.1% incidence in isolated fibular fractures. Complete nonunion was mostly seen in type A (Figure 6) and C fractures[100], whereas incomplete nonunion was described in Weber type B fractures[101].

Treatment is based on the type of nonunion, symptoms, initial fracture pattern, associated injuries and patient expectations. Asymptomatic nonunions are treated conservatively, with reports of spontaneous healing even several years after the initial injury[102]. For symptomatic nonunion, open reduction and internal fixation with or without bone grafting represents the best treatment choice resulting in successful outcomes in most cases[103].

Malunion

Angular malalignment occurs when the distal fibula heals in shortening or external rotation. This causes a lateral subluxation of the talus with ankle kinematics alteration leading to arthritis[44]. Most cases of angular malalignment occur after conservative treatment[104]. However, surgical treatment might be a cause of malunion if anatomic reduction is not achieved intraoperatively. Moreover, technical errors, suboptimal stability of fixation and unrecognized associated ligamentous instability might lead to loss of reduction and consequent malunion (Figure 7)[105]. Several radiographic parameters have been described to identify the correct length and rotation of the fibula

Figure 4 Clinical and radiographic results at 3 mo from surgical treatment of a Danis-Weber type B right distal fibula fracture with an anatomic angular stable plate.

in the ankle mortise: the Weber circle, the Shenton's line, the talocrural and bimalleolar angles[106]. These parameters can help the clinicians to more easily identify a malalignment that could cause continuous pain to the patient even after several months.

Surgical treatment is a demanding procedure, as anatomic reconstruction usually requires both fibula osteotomy and soft tissues release. Plate osteosynthesis is then required for fixation[107]. In several studies, the results of surgical treatment for malalignment were excellent. Yablon *et al*[108] reported good results over 7 years of follow up in 23 of 26 patients with fibular malalignment surgically treated 6 years after trauma. Ward *et al*[109] reported similar results in ankle fracture malunions treated with lengthening osteotomy of the fibula.

Wound dehiscence and infection
The distal fibula is subcutaneous and lacks a layer of overlying muscles. Thus, wound healing complications are the most common adverse events related to distal fibula fixation. Wound edge necrosis, wound dehiscence and superficial and deep infection have all been reported[110]. In the literature, the overall wound complication rate varies from 8.4% to 40.0% among studies[111-113] . The deep surgical infection rate is significantly lower, about 1.2% to 2.8% according to different reports[111,114,115].

The genesis is multifactorial as it depends on soft tissue compromise at admission, timing of surgery, fracture type and patient characteristics. Age, diabetes, steroid intake, smoking and peripheral vascular disease are associated with a greater risk of wound complications[88,112,116-118].The type of implant also might have a role. Schepers *et al*[119] reported in a retrospective study of 165 patients a higher wound complication rate with locking plates (17.5%) than with thinner one third tubular plates (5.5%). Conversely, Tsukada *et al*[84] in two different trials did not find any difference in complication rates between locking and nonlocking plates[84,115].

Figure 5 Clinical case of a Danis-Weber Type B left distal fibula fracture treated with locked nailing. A: Intraoperative image demonstrating fibula nail insertion with guided instrumentation; B: Detail of the clinical result of minimally invasive approach for fibular nail insertion; C: Antero-posterior X-rays demonstrating fracture fixation with fibular nail completed with two guided intersyndesmotic screws.

Figure 6 Lateral and antero-posterior view X-rays taken 4 mo after conservative treatment of a Danis-Weber type A distal fibula fracture. Despite the radiographic evidence of nonunion the patient is completely asymptomatic, and no further treatment is indicated.

The incidence of this complication can be minimized by treating the fracture as soon as reasonably possible[110] or postponing the surgery until the edema is resolved. The latter strategy has gained more and more popularity with the advent of damage control techniques. Whatever the timing, limiting the use of the tourniquet and closing the wound without tension is also advisable.

ROM limitation

Most patients after isolated distal fibula fractures recover with a completely functional ROM. When stiffness occurs, dorsiflexion deficit is more common. Lin *et al*[120] reported that in a population of 306 patients a 19% rate of plantar flexion limitation (only 2% > 10 degrees) occurred, while 41% of cases had restriction in dorsiflexion. In a review of 31 randomized trials about rehabilitation of ankle fractures, the authors found a positive effect on ankle ROM form early mobilization, early weight bearing and the use of a removable immobilization device. However, there is limited evidence supporting this strategy as patient compliance seems to play a significant role[120].

Figure 7 Clinical case of a Danis-Weber type C left distal fibula fracture treated with a one-third tubular plate. At post-op X-rays, malreduction with residual medial displacement is demonstrated. A dedicated adjustable tibio-fibular suture button fixation was added to obtain anatomic reduction and correction of associated ankle instability.

Early arthritis

Trauma is the most common cause of ankle osteoarthritis[121]. Arthritis results from a combination of direct cartilage damage and biomechanical alterations that affect joint kinematics[122]. It becomes evident 2 to 3 years after trauma and is often symptomatic. It is more frequent in higher grade fractures according to the Lauge-Hansen classification. Lübbeke *et al*[105], evaluating risk factors for development of ankle osteoarthritis, found a Weber type C or a fibula fracture with an associated fracture of the medial malleolus as the most important risk factors for the development of symptomatic radiographically advanced osteoarthritis. Surgical treatment seems to reduce the incidence of osteoarthritis by means of anatomic reduction and ankle stability restoration.

CONCLUSION

Isolated fibula fractures are very common injuries. Diagnostic exams must rule out ankle instability. Conservative treatment yields good results in stable fractures with stable ankle mortise. Open reduction internal fixation is indicated in case of associated ankle instability. Risk factors for wound related complications must be considered when choosing a surgical technique.

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