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Malunions and nonunions following tibial malleolar and tibial plafond fractures: current concepts

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Summary

Ankle fractures or fracture-dislocations account for about 4-5% of all body fractures, with approximately 120-180/100,000 affected persons/year. Tibial pilon fractures are relatively infrequent, accounting for 5-7% of all fractures of the tibia. This review aims to summarize the current evidence on malunions and nonunions following tibial malleolar and tibial plafond fractures and to give some tips to avoid such complications. Malunion and nonunion following tibial malleolar and plafond fractures are quite rare but dreadful complications. Accurate evaluation of comorbidities and optimization of the patient's health should be done before surgery. Multiple recent retrospective studies have shown that ankle/ tibial plafond fractures treated within 72 h of surgery have comparable outcomes to staged fixation, the two-stage protocol is the most commonly used approach for the treatment of high-energy intra-articular injuries of the distal tibia. Several surgical approaches have been described for the management of ankle and tibial plafond fractures. Each one of these approaches has its own advantages and disadvantages, hence, it is important to recognize that no one approach is right for all patients. Surgeons managing these complex fractures should be comfortable with the various approaches to the distal tibia and be prepared to use whichever approach is suitable for the individual soft tissues and fracture pattern. Finally, with improvements in surgical techniques and implants, complication rates following ankle and tibial plafond fractures have declined, and outcomes have improved.

Key words: distal tibia fractures, malunion, non-union, malleolar fracture, tibial plafond fracture

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Introduction

Ankle fractures or fracture-dislocations account for about 4-5% of all body fractures, with approximately 120-180/100,000 affected persons/year. The traumatic mechanism of injury generally consists of a torsional force applied to the joint, while the fracture pattern varies depending on the position of the foot (supination/pronation) and on the direction of the rotation (internal/external rotation) [1,2].
Tibial pilon fractures are relatively infrequent, accounting for 5-7% of all fractures of tibia [3]. The term "pilon", originally introduced by Destot in 1911, was stemmed from the French term "pilon" and, together with the term "plafond", it is currently employed in international literature [4]. Fractures of the tibial pilon are distal joint

fractures of the tibia, associated with the rupture of epiphyseal-diaphyseal continuity. They differ from fractures of the distal quarter, whether they be extra-articular or with a simple articular extension with little displacement, as well as from malleolar fractures that leave partial continuity with the diaphysis [4].

Tibial plafond fractures can be caused by very-high-energy traumas, i.e. motorcycle accidents, skiing accidents and falls from a height- or by low-energy trauma in osteoporotic patients [5].

Nonunion – defined by the US Food and Drugs Administration (FDA) as a fractured bone that has not completely healed within 9 months of injury and that has not shown progression towards healing over 3 consecutive months on serial radiographs [6] – and malunion – i.e. fracture healed in a position of deformity – are two dreadful complications that can be observed in specific types of patients and fracture patterns.

Diabetes, increased age, obesity, peripheral arterial disease, and non-ambulation are risk factors for nonunion [7]. Malunion, on the other hand, can be a frequent complication in supination-adduction injuries, with articular impaction of the tibial plafond, incorrectly managed at the time of surgery [8].

This review aims [1] to summarize the current evidence on malunions and nonunion following tibial malleolar and tibial plafond fractures [2] and to give some tips to avoid such complications.

Patient comorbidities

Comorbidities should be accurately assessed in patients with tibial malleolar and tibial plafond fractures, since they could severely compromise the fractur healing process. The main risk fractures for distal tibial non-unions include: diabetes, severe obesity, peripheral vascular diseases, osteoporosis, metabolic bone diseases, malnutrition and end-stage renal disease (ESRD).

Diabetes mellitus (DM) is a major public health problem worldwide [9]. According to the International Diabetes Federation (IDF), the global prevalence of DM in 2011 was 366 million, but it is estimated that in 2030 DM will affect 552 million of people [9,10]. Therefore, it is reported ankle/tibial plafond fractures and diabetes mellitus are both increasing in prevalence [7]. Patients with both diabetes and an ankle fracture have been shown to have an increased rate of complications which can be catastrophic [7].

It is reported that medical expenses for diabetic patients are over two times higher than nondiabetics and the total cost of DM management was about $ 245 billion dollars in 2012 in the USA [11].

Specifically, mean length of hospital stay and healthcare cost of ankle and tibial plafond fractures of patients with diabetes have been found to be significantly higher ($p < 0.01$) [12]. Furthermore, patients with complicated diabetes have longer hospital stays ($p < 0.01$) and are $ 6895 more costly than uncomplicated diabetic patients [7,12]. Therefore, these patients, being extremely complicated, present multifaceted challenges for surgeons [7].

It is remarkable that, while several papers discuss the perils of management of diabetic ankle fractures, there is little evidence on the optimal treatment for these injuries. Care should be taken, however, to ensure that these patients are optimized during the perioperative period [7].

According to Wukich et al. [13], unstable ankle fractures in diabetic patients without neuropathy or vasculopathy are best treated with open reduction and internal fixation with use of standard techniques. On the other hand, patients with neuropathy or vasculopathy are at increased risk for both soft-tissue and osseous complications, including delayed union and non-union. Careful soft-tissue management as well as stable, rigid internal fixation are mandatory to obtain a good outcome [13]. Prolonged non-weight-bearing and subsequently protected weight-bearing should be recommended following both operative and nonoperative management of ankle fractures in diabetic patients [13].

Timing of surgery

The optimal treatment for ankle and tibial plafond fractures is still controversial. Currently, the most commonly used approach for the treatment of high-energy intra-articular injuries of the distal tibia is a two-stage protocol that involves initial reduction and external fixation followed by delayed definitive reduction and internal fixation once the soft tissue swelling has subsided [14]. This two-stage approach typically requires up to a 2-week delay from injury to definitive treatment [14].

White et al., however, in a recent cohort study including 95 patients with AO/OTA type 43-C pilon fractures assessed the efficacy and safety of primary ORIF in the management of this injury [14]. Primary ORIF was performed within 24 hours in 70% of cases and within 48 hours in 88%. A nonunion rate of 6% was observed. These authors concluded most tibial pilon fractures can be stabilized by primary ORIF within a safe and effective operative window with relatively low rates of wound complications, a high quality of reduction, and functional outcomes that compare favorably with the published results for all other reported surgical treatments of these severe injuries [14].

Multiple recent studies have shown that ankle/tibial plafond fractures treated within 72 h of surgery have comparable outcomes to staged fixation [15,16]. However, these studies are all retrospective reviews and criteria for early fixation was often surgeon dependent [17]. Therefore, the timing of surgery and the need for staging should be assessed based on the quality of the soft tissue envelope, with the presence of soft tissue wrinkles as our primary determining factor [17].

Surgical approach

Historically, surgical management of pilon fractures has been

associated with high rates of complications, including wound complications, infections, nonunions, and even the need for amputation [17]. Nonetheless, recent studies have demonstrated a low percentage of wound complications in patients undergoing early definitive fixation [17].

Several surgical approaches have been described for the treatment of tibial plafond fractures. Careful analysis of radiographs and pre-operative CT scans are key when deciding which approach to perform. CT scans, moreover, are helpful in evaluating soft tissue structures that can become entrapped within the fracture, particularly the posteromedial structures, including the posterior tibial neurovascular bundle [18,19].

Several surgical approaches have been described for the management of tibial plafond fractures, including anterolateral, anteromedial, direct anterior, direct lateral, direct medial, posterolateral, and posteromedial approach. Each of these approaches has its own advantages and disadvantages, hence, it is important to recognize that no one approach is right for all patients. Surgeons managing these complex fractures should be comfortable with the various approaches to the distal tibia and be prepared to use whichever approach is suitable for the individual soft tissues and fracture pattern [17].

In ankle fractures, the presence of tibial posterior malleolus fracture, which occurs in about one-third of ankle injuries, correlates with poorer prognosis and worse clinical outcomes [2].

In recent years, the orthopaedic community is paying increasing attention to the correct analysis and classification of posterior malleolus fractures, but there is still a lack of consensus regarding the best surgical management of these injuries [2].

In the past, percutaneous anteroposterior fixation was generally used in the management posterior malleolus fractures [20]. Therefore, after the fixation of lateral and medial malleoli, with the patient in the supine position, the posterior malleolus was addressed by a 3.5/4.0 cannulated screw [21]. This minimally invasive technique aimed to reduce the malleolar fracture through ligamentotaxis.

However, this percutaneous technique was endowed with several disadvantages, including the limited effectiveness of ligamentotaxis, the impossibility to remove loose fragments eventually observed at the fracture site, and the potential for tibialis anterior nerve or artery damage. Furthermore, the anteroposterior partially threated screw may not provide enough interfragmentary compression when the thread of the lag screw partially crosses the fracture line [2,22].

Currently, the posterior approach is the preferred choice when percutaneous antero-posterior fixation is not indicated [21]. The main elements that should be assessed in the decision-making process are: the posterior malleolus fragment shape and size; the presence of loose bodies at the fracture site; the possibility to obtain anatomic fixation of the fracture; the presence of a posterior ankle subluxation; the eventual osteochondral impaction of the tibial plafond and mechanical stability of the joint [21].

Goals of surgical treatment

The main aims of surgical treatment are: 1) anatomical restoration of the joint surfaces with correct axial alignmen; 2) stable internal fixation to allow for early functional treatment; and 3) careful, atraumatic surgical technique to preserve blood supply to bone and soft tissue.

The four sequential principles for the correct management of tibial plafond fractures were described by Rüedi and Allgöwer, in 1979. These principles include: 1) restoration of fibular length; 2) anatomic reduction of the articular surface; 3) filling the residual bone defect with cancellous autograft; and 4) stabilization of the medial column [23]. Conceptually, these principles still hold true, but they have evolved over time. Furthermore, with improvements in surgical techniques and implants, complication rates following ankle and tibial plafond fractures have declined, and outcomes have improved.

Correct reduction of the fibula with restoration of length, rotation and axial alignment not only provides a reference for reconstruction of the distal tibia, but it may also facilitate partial reduction of the anterolateral and/or posterolateral fragments as a result of the usually intact syndesmotic ligaments (ligamentotaxis) [24]. Correct reduction of the fibula may help in preventing valgus malalignment of the distal tibia [24].

On the other hand, the need for accurate fibula fixation is controversial in cases where restoration of the length of a highly comminute tibia fracture may be impossible to achieve or when external fixation is used for definitive treatment of the fracture [24,25].

The posterolateral fragment is a “key fragment” for the reconstruction of the distal tibia articular surface. It may be reduced spontaneously by fixation of the fibula relying on ligamentotaxis, but in approximately 20% of cases, direct reduction is needed which may be achieved by different methods [24]. Reduction through a separate posterolateral or posteromedial approach may be the most accurate, but requires separate procedures and special patient positioning [24,26].

Axial displacement of the talus into the distal tibia causes impaction of the articular fragments and underlying cancellous bone that results in a bony defect after reduction of articular fragments. The use of bone substitutes, in association with locking plates, is recommended for filling these voids and supporting the articular fragments [24].

Completed the articular surface reconstruction, the joint block must now be reduced and fixed to the tibial shaft to restore length, rotation and axial alignment.

Conclusions

Malunion and nonunion following tibial malleolar and plafond fractures are quite rare but dreadful complications. An accurate comorbidity evaluation and optimization of health status should be performed before surgery.

Multiple recent retrospective studies have shown that ankle/tibial plafond fractures treated within 72 h of surgery have comparable outcomes to staged fixation, the two-stage protocol is the most commonly used approach for the treatment of high-energy intra-articular injuries of the distal tibia.

Several surgical approaches have been described for the management of ankle and tibial plafond fractures. Each of these approaches has its own advantages and disadvantages, hence, it is important to recognize that no single approach is right for all patients. Surgeons managing these complex fractures should be comfortable with the various approaches to the distal tibia and be prepared to use whichever approach is suitable for the individual soft tissues and fracture pattern.

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