Introduction

Intra-articular fractures of the tibial plafond are complex injuries which Continue to challenge orthopaedic surgeons in achieving anatomic reduction, while allowing early weight bearing and return to activity. Although a wide range of treatment options has been described for fixation of pilon fractures, the unique characteristic of each injury makes it difficult to advocate a general method of choice[(1)].

Comminuted fractures of the tibial plafond (pilon) are difficult to treat mainly due to associated severe soft-tissue injuries and high-energy fracture patterns [(2)].

The main mechanisms of injury of pilon fractures are two: (1) low-energy types, secondary to rotational forces (sporting accidents) and (2) high-energy types from axial loading of the distal articular surface against the talus causing multifragmental implosion of cartilage and bone (motor vehicle accidents, falls, work accidents). The plafond area in which the fracture develops depends on the position of the foot at the moment of trauma [(3)].

Rüedi and Allgöwer proposed a three stage classification in which the degree of comminution and articular incongruity play a fundamental role [4].

Fractures of the distal tibia have been treated in the past using various modalities. Rüedi and Allgöwer presented good results with open reduction and stable internal fixation using plates and screws [5].

With the increasing incidence of high-energy injuries, however, a rise in complications when using such treatment has been observed including soft tissue dehiscence, infection, osteomyelitis, delayed union or nonunions [6].

Minimally invasive techniques for reduction of the articular fragments combined with stable fixation through an external device have been employed in more recent years. Circular frames with tension wires, like the classic Ilizarov fixator, provide better stabilization especially in comminuted lesions and control the fracture in all three planes of the reduction [7].

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Discussion

Fractures of the distal tibia with extension into the ankle joint are relatively uncommon (less than 1% of fractures of the lower extremity). They were initially called “pilon fractures,” by Destot, in 1911, who likened the distal tibia to a pestle. Viewed from a different perspective, Bonin, in 1950, described these injuries as tibial “plafond fractures” because of the disruption of the roof of the ankle joint. High-energy pilon fractures are one of the most challenging orthopedic problems to successfully treat. [68]

As a result, a whole spectrum of treatment options have been advocated, often with barely satisfactory, if not discouraging, results. Most authors would agree the goal of treatment of any displaced intraarticular fracture should be an anatomic restoration of the articular surface, stable fixation of the joint to the shaft, and early restoration of motion, and hence, functional recovery. Unfortunately, the tenuous vascularity of the bone and soft tissues of the distal tibia often compromise the surgeon’s

ability to adequately restore and stabilize the complex fractures of the tibial pilon. [68]

Numerous studies have reported the results of different treatment modalities for pilon fractures; yet, few studies have specifically examined the complex subgroup of comminuted pilon fractures. These complex injuries, which are mainly due to high-energy trauma mechanisms, have been shown to have higher postoperative complication rates and a worse long-term outcome compared to lower energy fractures. There is currently no clear consensus regarding the optimal treatment strategy for comminuted pilon fractures.

It is now recognized that the key to avoiding complications with pilon fractures is meticulous attention to the soft tissue envelope. Some of the reportedly high complication rates may have been due to surgery performed through a compromised soft tissue envelope. Several recent reports used a staged protocol for the treatment of severe, high energy pilon fractures. In these studies patients underwent some type of initial temporizing

procedure, usually bridging external fixator with fibular stabilization followed by a delayed open reduction and internal fixation. [69]

Patterson and Cole reported 77% good results with no soft tissue complications and no infections. [70]

Sirkin et al. also reported a decreased complication rate with no fractures requiring coverage for soft tissue breakdown. [71]

Our relatively low rates of complications are likely a result respecting soft tissue injury with delayed definitive surgery.

The results of **Ruedi and Allgower** are the gold standard. the authors reported on 84 patients who had sustained low energy, closed tibial pilon fractures. They had a 74% rate of good and excellent results at four years. This cohort was followed and reported again at 9 years with outcomes continuing to be favorable. While many reports have shown excellent clinical and functional results with open reduction and internal fixation, high complication

rates with open reduction and stable internal fixation of these fractures has been reported. Most authors agree that operative treatment of low energy pilon fractures, yield good outcomes with open reduction and internal fixation. The controversy exists in the treatment of the complex higher-energy pilon fractures. [72]

Following the excellent results reported by Ruedi and Allgower in 1969, other authors have had difficulty reproducing the same outcomes. Following this initial report, the orthopaedic literature has been mixed with reports on outcomes and complication rates in operatively treated pilon fractures.

Etter and Ganz reported on long-term follow up of 41 patients with pilon fractures who were treated with ORIF; half of these patients had high energy fractures. they reported a high patient satisfaction for these fractures. Sixty-three percent of patients developed moderate to severe radiographic arthrosis. Of these, 14 were considered to have had a good

initial reduction. Their complications included five delayed unions, one non-union, and one infection. [73]

McFerran et al. reported an overall 54% complication rate. [74]

Teeny and Wiss reported a 70% complication rate and 26% fusion rate for 30 high energy pilon fractures treated with open reduction and internal fixation. Complications can be divided into early and late. Early complications include wound breakdown, infection and loss of reduction. Late complications include the development of arthritis, malunion or nonunion. The most common complication reported has been wound breakdown and infection. [75]

Chen et al. reported on 39 pilon fractures, of which 80% were lower energy. They reported very good clinical and functional results for the lower energy injuries, but all six of their high-energy fractures had fair or poor results. [76]

Our series differs from this report in that all of our fractures were high-energy type II and III fractures according to Ruedi and Allgower classification. in our study we have 20% complication rate in ORIF with one case of osteoarthritis, one case of malunion and one deep infection.

Sands et al. recently studied 64 patients who had sustained a pilon fracture and undergone open reduction and internal fixation. The authors found these patients to have lower scores than the general population. This finding had been found in other reports as well. [77]

Similarly, we found relatively low functional scores in both of our groups based on the AOFAS.

The use of external fixation with or without limited internal fixation theoretically diminishes the amount of surgical soft tissue injury in an effort to decrease the risk of postoperative soft tissue complications.

Marsh et al., reported on 35 patients with a minimum 5- year follow up who had been treated

with external fixator and limited internal fixation for a pilon fracture. These authors found that general health status was diminished and that patients were limited in their recreational activities. Overall, most had radiographic signs of arthritic change yet very few underwent secondary procedures. Patients continued to improve clinically even after 2 years following their injuries. [78]

But in our study we have 20% of our patients treated with external fixation with limited internal fixation had radiographic signs of osteoarthritis, one case of malunion and one superficial infection.

Few studies in the literature have directly compared pilon fractures treated with alternative methods.

Watson et al. compared the use of ORIF versus external ring fixation in all pilon fracture types. For comminuted fractures; the authors recommended the use of limited exposures and stabilization with external fixation, in order to decrease the rate of postoperative complications. [79]

Blauth et al. compared immediate ORIF, unilateral external fixation, and staged ORIF with percutaneous plating. They reported on a cohort which included all pilon fracture types and concluded that a staged ORIF resulted in lower complication rates, compared to the other treatment modalities. [80]

Pugh et al. compared the use of hybrid fixation with immediate ORIF on all pilon fracture types. they concluded that both treatment options are equally efficacious in terms of achieving union. However, external fixation resulted in a significantly increased rate of malunions. In view of the considerable soft tissue compromise associated with pilon fractures, other studies recommended a staged procedure with initial restoration of fibula length and external fixation and later conversion to ORIF after the soft tissue conditions have recovered. [81]

Wyrsch et al., found a higher complication rate in those patients treated with open reduction and internal fixation compared to those treated with external fixation. It should be noted, however, that in

the seven patients who developed major complications the average time from injury to surgery was 5 days. [72]

Pollak et al., found that at a mean 3.2 years following injury, patients treated with ORIF were compared to those treated with EF with or without limited internal fixation at two separate institutions. these patients overall were not functioning well. Analysis showed that patients treated with EF had poorer range of ankle motion and greater ambulatory dysfunction than those treated with open reduction and internal fixation. While our study was randomized; it was from a single surgeon at a single institution, using standard surgical algorithms which we believe strengthens our findings. [82]

In our study, the outcome of closed comminuted pilon fractures treated with external fixation was similar to that seen following formal open reduction and internal fixation. The only difference seen were the operation time and timing of weight bearing on the affected limb there were high significant difference between the study and control group.

Operation time was slightly higher in the ORIF group more than those treated with external fixation following their injuries. Timing of weight bearing was earlier in the external fixation group more than those treated with ORIF following their injuries. There were no differences in ankle range of motion, AOFAS score. There were also no differences in complication rates, and no association with worse outcomes, in those who experienced a complication in either group.

Furthermore, **Wyrsch et al**., found arthrosis to relate to the type of fracture, not the treatment received. Other authors have documented this fact as well. It appears that while the adequacy of articular reduction does play a major role in the late development of radiographic arthrosis, injury to the articular cartilage at the time of impact also plays a significant role. [72]

Marsh et al., found that a majority of patients had radiographic evidence arthritic changes at a minimum of 2 years. [78] In Our study radiographic

arthritic changes at our patients does not always correlate with clinical function.

Among the limitations of this study are fairly small sample sizes, short period of follow up, CT scans were not obtained postoperatively to assess the reduction as this was not the standard of care in our community. Reductions were assessed from plain radiographs by a single author who was obviously not blinded to the treatment methods and therefore may have biased the results. which would also have potentially biased the results. The fact that outcomes and complications were determined and graded by the surgeon causes an inherent bias. Finally, we do not report certain injury factors that may have had an impact upon outcome. This was not done at the time of injury and would have been impossible to ascertain in a retrospective manner.