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FRACTURES OF THE TIBIAL PILON - HORIZONTAL ARTICULAR SURFACE OF THE TIBIA

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SUMMARY

Introduction: *The distal tibia presents a quadrilateral cross-sectional shape and together with the fibula, ligaments and capsule, create the ankle mortise. The tibial pilon fractures thus to describe the high energy axial compressive force of the tibia when it acts as a mortar and is placed vertically on the talus.*
Objective: *to detail current information related to tibial pilon fractures, epidemiology, mechanism of action, clinical assessment, imaging assessment, classification, treatment, prognosis and complications.*
Methodology: *a total of 28 articles were analyzed in this review, including review and original articles, as well as clinical cases, of which 19 bibliographies were used because the other articles were not relevant to this study. The sources of information were PubMed, Google Scholar and Cochrane; the terms used to search for information in Spanish, Portuguese and English were: distal tibia fractures, horizontal articular surface of the tibia, tibial pylon, arthrodesis.*
Results: *tibial pilon fractures account for 7% to 10% of all tibial fractures, are more common in males aged 30 to 40 years and the vast majority are associated with high-energy trauma.*
Conclusions: *Individuals presenting with high-energy pylon fractures may also have multisystem trauma and other potentially life-threatening alterations. Imaging evaluation is important for good preoperative planning, as well as for scheduling a strategic reconstruction order. The prognosis of the fractured individual correlates with the type of fracture according to the Rüedi and Allgöwer classification which is based on the severity of comminution and displacement of the articular surface. Treatment is based on several factors, among which are the individual's age and functional*

status, the severity of the bone, cartilage and soft tissue injury, the degree of comminution and osteoporosis, as well as the surgeon's skill. Few authors recommend arthrodesis in acute fracture. Even when a precise reduction is achieved, good results are not always obtained. Without anatomic reduction, the results are not satisfactory. Clinical outcomes correlate with the severity of the fracture pattern as well as the quality of the reduction.

KEY WORDS: *fractures, tibial pylon, distal tibia, arthrodesis.*

INTRODUCTION

"Pilon," a word of French origin to describe a mortar, was first coined by Etienne Destot in 1911 to compare the mechanical activity of the distal tibia along with the talus. In other words, tibial pilon fractures are also referred to as such to describe the high energy axial compressive force of the tibia when acting as a mortar when placed vertically on the talus(1-3).

The distal portion of the tibia presents a quadrilateral cross-sectional shape that together with the fibula, ligaments and capsule, form the ankle mortise. The joint of the ankle is structurally complex, in ginglimo, conformed by the fibula, tibia, talus, as well as the ligamentous complexes. Primarily responsible for the stability of the ankle joint is the bony arrangement. The bony anatomy that confers stability is given by the distal section of the tibia and fibula, their articulation with the talus and with each other. The distal articular area of the tibia in union with the medial and lateral malleoli originate the cavity or mortise, this gives form to a compact articulation with the dome of the talus. The articular area of the leg is concave in the anteroposterior plane and convex in the lateral plane; it is also wider in the anterior section to maintain congruence with the talus, which provides intrinsic safety, primarily between loads(1,4-6).

METHODOLOGY

A total of 28 articles were analyzed in this review, including review and original articles, as well as cases and clinical trials, of which 19 bibliographies were used because the information collected was not important enough to be included in this study. The sources of information were Cochrane, PubMed and Google Scholar; the terms used to search for information in Spanish, Portuguese and English were: distal tibia fractures, horizontal articular surface of the tibia, tibial pylon, arthrodesis.

The choice of bibliography exposes elements related to tibial pilon fractures; in addition to this factor, epidemiology, clinical evaluation, classification, treatment, complications and prognosis of the disease are presented.

DEVELOPMENT

Epidemiology

Pilon fractures commonly occur in males with an incidence of approximately 57% to 65% versus the incidence in females. The distribution by age zones in pilon fractures maintains a bimodal pattern being more prevalent between 25 and 50 years of age, other bibliographies speak of presenting more frequency in men from 30 to 40 years of age.Tibial pilon fractures account for 7% to 10% of all tibial fractures and these fractures make up approximately 1% to 10% of fractures of the lower leg or tibia and are frequently associated with significant bony comminution and soft tissue disruption. In addition, pylon fractures may involve metaphyseal extension and may show associated fibular fractures. Most are caused by high-energy mechanisms; thus, associated injuries are frequent and need to be ruled out(5,7-9).

Mechanism of Injury

Pylon fractures are usually caused by high-energy mechanisms, such as motor vehicle accidents and falls from a height that result in direct axial compression and joint impaction of the tibial pylon. They can also occur due to low energy mechanisms, however they are less frequent. The mechanism and level of injury involved give the fracture pattern and treatment outlook for pilon fractures. The blow from an axial compression mechanism expands the articular surface proximally in the direction of the metaphysis, with related metaphyseal comminution. Association with fibula fractures is common(10-14).

- Axial compression or high energy: such as a fall from a height or traffic accidents. The force goes axially through the talus in the direction of the tibial pylon and generates impaction or subsidence of the articular area; it can be related to a large comminution. If the fibula remains intact, the ankle is shown to be forced in varus with medial pylon collapse. Plantar flexion or dorsiflexion of the ankle at the instant of injury results in a predominant injury to the posterior or anterior section of the pylon.
- Rotational or low energy force: as in a sports accident, it is usually caused by torsion combined with a varus or valgus force. Generates two or more large fragments with minimal comminution of the articular surface. Usually a fibula-related fracture occurs, typically transverse or short oblique.
- Mixed compression and shear injury: here the vector of these two forces gives rise to the fracture pattern. They are frequently associated with other fractures such as calcaneal, tibial plate, pelvic and vertebral fractures(7,15).

Clinical Assessment

Individuals presenting with high-energy pylon fractures may also show multisystem trauma, in addition to some life-threatening injuries; therefore, initial assessment and resuscitation should follow advanced trauma life support (ATLS) guidelines and start with the ABC sequence.

Subsequent to stabilization of the individual, a thorough history and secondary examination should be performed to evidence the mechanism of injury, as well as the possibility of other injuries. In the case of pilon fractures, meticulous inspection of the affected individual's lower limbs may give more information about the extent of the soft tissue injury. High-energy injuries may show with obvious deformities and open wounds; however, torsional injuries of less energetic impact may be complex to detect(1).

Most tibial pilon fractures are related to high-energy trauma; therefore, a comprehensive trauma evaluation is essential, as well as a secondary evaluation. Usually the individual is unable to walk and shows a different level of deformity in the distal portion of the involved leg. The examination should have insight into the neurovascular situation and any related injuries. As the tibia is almost subcutaneous in this part, displacement of the fracture or excessive pressure on the skin can change a closed fracture into an open fracture. Usually the swelling is massive and rapid, necessitating serial neurovascular scans, in addition to an evaluation of dermal integrity, the presence of necrosis and post-fracture phlyctenas. The essential importance of evaluation of soft tissue involvement should be emphasized.

The dissipation of the impact forces can result in a notable soft tissue injury in the periphery of the distal portion of the tibia, which can create an inadequate healing of the surgical incisions, evolving with necrosis of the margins and dehiscence of the wound if not adequately treated. Some bibliographies recommend waiting 7 to 10 days, until the soft tissues improve, before planning the definitive surgery(7,15).

Figure 1. Exposed tibial pilon fracture.

Source: The Authors.

Imaging Evaluation

Anteroposterior and lateral radiographs are suggested, in addition to the mortise projection. CT with coronal and sagittal reconstructions are frequently used to evaluate the fracture pattern and articular surface involvement. Proper preoperative planning is essential to create a strategically planned reconstruction order; contralateral radiographs may also serve as a template at the time of preoperative planning(1,7,15).

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Figure 2. Preoperative fluoroscopy of tibial pilon fracture.

Source: The Authors.

Classification

Rüedi and Allgöwer classification

It is based on the severity of the comminution, as well as on the displacement of the articular surface. This was the most widely used classification, however, at present its relevance is minimal. The prognosis is associated with the grade(7).

- ➢ Type 1: non-displaced fracture of the pylon.
- ➢ Type 2: displaced fracture with minimal subsidence or comminution. Displaced fracture with significant joint comminution.
- ➢ Type 3: metaphyseal subsidence.

There are other classifications such as that of the AO/OTA, however the one shown in the article is the most relevant at the moment. In the AO/OTA classification for long bone fractures, pylon fractures are divided into extra-articular (43A), partial articular (43B) and intra-articular (43C) and further subdivided according to the level of comminution. In addition to classifying the type of fracture, it is also important to take into consideration the extent of soft tissue damage using the Gustilo-Anderson classification for open fractures or the Tscherne classification for closed fractures(1).

Treatment

It is based on multiple factors, among which are:

- ➢ The individual's age and functional status.
- ➢ The severity of the bone, cartilage and soft tissue lesion.
- ➢ The degree of comminution and osteoporosis.
- ➢ The skill of the surgeon.

There are relatively few contraindications for surgical fixation of tibial pilon fractures(16).

Conservative Treatment

This may involve inguinopedic casting for 6 weeks followed by bracing and range-of-motion exercises, or early range-of-motion exercises. Conservative treatment is generally used in undisplaced fractures or in very debilitated individuals whose surgical intervention would be counterproductive. Manipulation of displaced fractures is unlikely to reduce intra-articular fragments. The detriment of reduction is common. Among the disadvantages are the inability to control the soft tissue status and the related inflammatory status(7,15).

Surgical Treatment

Displaced tibial pilon fractures are usually managed surgically. It is usually recommended to delay surgery for 7 to 14 days, thus optimizing soft tissue status, including reduction of swelling near the ankle, disappearance of phlyctenas, and sphacelation of disrupted soft tissues. High-impact energy disruptions can be managed with an external fixator that overlaps the injury and provides skeletal stability, maintains good length, and partially mitigates the fracture until definitive surgical treatment is done. Open reduction with internal fixation of related fibula fractures can also be performed at the time of external fixator placement(7,15).

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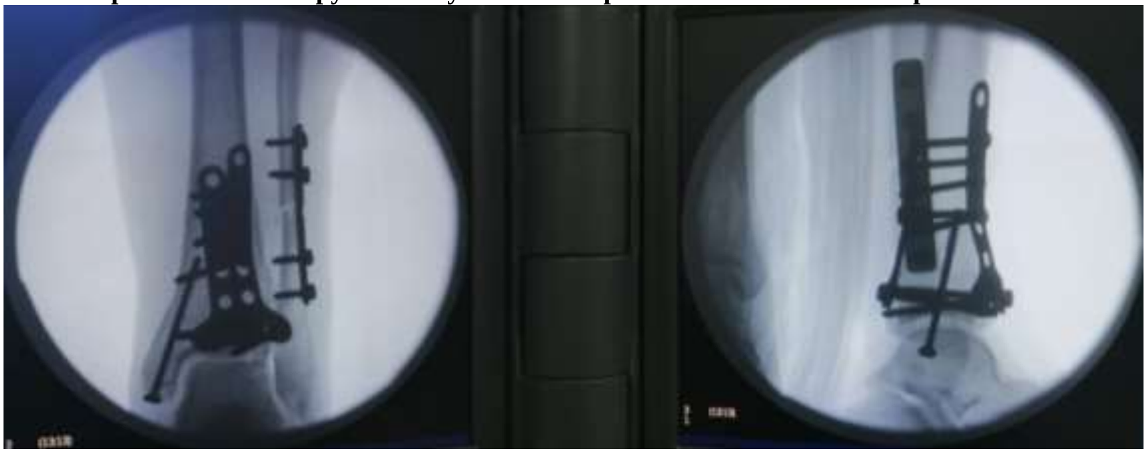
Figure 3.Postoperative fluoroscopy of osteosynthesis with plate and screws in a tibial pilon and fibula fracture.



Source: The Authors.

Objectives

- The main objectives of surgical fixation in these fractures are:
- Restoration of the articular area of the tibia.
- Bone grafting of the metaphyseal defects.
- Preservation of the length and stability of the fibula.
- Stabilization of the fracture of the distal part of the tibia(7).

Surgical Techniques

The reduction of the articular fragments can be done percutaneously or by means of limited minor incisions with support of multiple types of forceps, in addition to the radioscopic control to evaluate the reduction of the fracture. The metaphyseal fracture can be stabilized with plates or with an external fixator, which may or may not go beyond the ankle joint. In addition, grafting of the metaphyseal defects with some type of osteoconductive material is recommended(7).

Internal Fixation: the best way to obtain an accurate reduction of the joint area is through open reduction of the fracture and fixation with a plate. To reduce complications when using plates, the following is recommended:
Avoid incisions on the anteromedial aspect of the tibia.
Use small, precontoured, low-profile implants and mini fragment screws.
In fractures of high energetic impact, postpone surgery, while using an external fixator that overlaps the joint, and then perform definitive surgical treatment.
Use indirect reduction techniques to reduce soft tissue denudation.
Use percutaneous techniques to place the plates.

External fixator through the joint: can be used in individuals with extensive soft tissue involvement or open fractures. Reduction is continued by distraction and ligamentotaxis. When a correct reduction is obtained, the external fixator can be used as definitive treatment.

Articulated external fixator versus rigid external fixator: the rigid external fixator is the one commonly used, which theoretically disables the mobility of the ankle. With the articulated external fixators the movement can be made in the sagittal plane, avoiding varus deformity, in addition to shortening, its application is limited, however they help in the lubrication and nutrition of the cartilage, it could be used at the moment of presenting an integrity of the soft parts.

Hybrid external fixator: this does not go beyond the joint. The reduction of the fracture is simplified through fine needles, with or without olive, achieving the reestablishment of the circular surface and allowing bone stability. It is more useful when evaluating the fracture and there is a contraindication to internal fixation. It is related to deep wound infection in approximately 3% of cases(7,15).

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Figure 4. External fixation in tibial pilon fracture for damage control.

Source: The Authors.

Arthrodesis

In the literature, the recommendation of arthrodesis in acute fractures is infrequent. In a comminuted fracture, it is better to opt for intervention after healing and with the soft parts recovered. Usually, it is used as a rescue technique after other management that resulted in failure and the generation of post-traumatic osteoarthritis. Postoperative treatment.

Initially, the limb is immobilized in neutral dorsiflexion, carefully observing the soft tissues. When the soft tissues and fixation allow it, early mobility of the foot and ankle should be started. Weight bearing is not allowed for 12 to 16 weeks, and then gradually progress to full weight bearing after radiological evidence of fracture healing(7,15).

Complications

Good results are not always achieved, even when a good reduction is obtained; since there is no anatomical reduction, the results are not ideal. Over time, the high rates of complications and wound infections have been related to early open fixation by means of the affected soft tissue, which indicates the importance of a methodical assessment and manipulation of the soft tissue, especially in considerable pilon fractures(17).

Necrosis, bedsores and hematoma: these are related to the initial trauma together with inadequate treatment of the soft tissues. Efforts should be made to avoid excessive lifting of the soft tissues and to close the skin under tension. To obtain a correct closure, secondary closure, skin grafts or muscle flaps are usually used. These complications have decreased since the knowledge of the initial trauma of the soft parts and the development of instruments to reduce the effects such as the use of an external fixator that goes beyond the lesion, minimally invasive surgery, among others.

Pseudoarthrosis: it originated after a significant comminution with bone loss, reduction of arterial flow or infection. It presents an approximate incidence of 5%.

Consolidation in bad position: it is commonly found when after treatment, the reduction is not anatomical, as it does not neutralize forces that cross through the fracture and if a secondary paralysis is generated or an early loading is performed. It presents an approximate incidence of 25% when using an external fixator.

Infection: it is related to open injuries and soft tissue devitalization. The incidence is higher in early surgery with unfavorable soft tissues. Among the long-term alterations that these can cause are osteomyelitis, malposition consolidation and pseudoarthrosis.

Post-Traumatic Osteoarthritis: it is more common the greater the intra-articular comminution; evidencing the importance of restoring the anatomy of the articular area.

Tibial Shortening: generated by subsidence of the metaphysis, comminution of the fracture, or loss at first to restore length through fixation of the fibula.
Decreased Range of Motion of The Ankle: individuals usually show an average of 10° of dorsal flexion and 30° of plantar flexion(4,7).

Prognosis
Despite advances in radiographic imaging, surgical instrumentation and understanding of soft tissue management, pylon fractures are still complex to treat. Clinical outcomes correlate with the seriousness of the fracture pattern and the quality of reduction. Failed conservative treatment and persistent pain may necessitate ankle arthrodesis as a salvage intervention. Individual victims of pilon fractures should be adequately counseled about outcomes and possibilities following surgical fixation(11,14,18,19).

CONCLUSIONS
Individuals who present with high-energy pylon fractures may also have multisystem trauma and other life-threatening conditions. Imaging evaluation is important for good preoperative planning, as well as for scheduling a strategic reconstruction order. The prognosis of the fractured individual correlates with the type of fracture according to the Rüedi and Allgöwer classification which is based on the severity of comminution and displacement of the articular surface. Treatment is based on several factors, including the individual's age and functional status, the severity of the bone, cartilage and soft tissue injury, the degree of comminution and osteoporosis, and the skill of the surgeon. Few authors recommend arthrodesis in acute fracture. Even when a precise reduction is achieved, good results are not always obtained. Without anatomic reduction, the results are not satisfactory. Clinical outcomes correlate with the severity of the fracture pattern as well as the quality of the reduction.

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