

Tibial pilon fractures: functional results and evaluation of quality of life

Fraturas do pilão tibial: resultados funcionais e avaliação da qualidade de vida

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ABSTRACT

Objective: To evaluate the functional outcome and quality of life of patients with open tibial pilon fractures (AO - 43C3) undergoing surgical treatment with ligamentotaxis by means of external fixation for initial damage control, followed by open reduction and internal fixation at a later date.

Methods: An original study was conducted between September 2009 and July 2013. A total of 16 patients were examined during outpatient follow-up visits. Identification questionnaires and a specific foot and ankle evaluation (the Orthopaedic Foot and Ankle score, AOFAS) were completed, along with an SF-36 quality of life evaluation.

Results: Most patients showed a good range of motion (ROM), achieving a mean AOFAS score of 65 points (out of 100 possible points). The SF-36 questionnaire revealed low mean scores in the physical functioning, physical role functioning and bodily pain domains, with 60, 37 and 51 points, respectively. The average score in the general health domain was 84 points (out of a possible 100 points).

Conclusion: There was significant functional and quality of life impairment in patients affected by this type of fracture, even with the use of staged treatment.

Level of Evidence III; Retrospective Comparative Study.

Keywords: Fractures, open; Tibial fractures; Quality of life; Surveys and questionnaires.

RESUMO

Objetivo: Avaliar os resultados funcionais e qualidade de vida de pacientes com fraturas expostas do pilão tibial (AO - 43C3), submetidos a tratamento cirúrgico para contenção de danos em um primeiro momento, com o princípio da ligamentotaxia através de fixador externo e em segundo momento, com redução aberta e fixação interna.

Métodos: Foi realizado um estudo original, no período de setembro de 2009 a julho de 2013, no qual 16 pacientes foram examinados no retorno ambulatorial, posteriormente foram aplicados questionários de identificação e realizada a avaliação específica do pé e tornozelo, Orthopaedic Foot and Ankle Score (AOFAS) e avaliação de qualidade de vida SF-36.

Resultados: A maioria dos pacientes apresentou uma boa amplitude de movimento (ADM), revelando uma pontuação AOFAS média de 65 pontos (de 100 pontos possíveis). Pelo questionário SF-36, foram observadas médias baixas para os domínios capacidade funcional, limitação por aspectos físicos e dor, sendo 60, 37 e 51 pontos, respectivamente. Para o domínio estado geral de saúde, foram marcados 84 pontos (de 100 pontos possíveis).

Conclusão: Houve relevante comprometimento funcional e da qualidade de vida dos pacientes avaliados, acometidos por esse tipo de fratura, mesmo com a utilização do tratamento estagiado.

Nível de Evidência III; Estudo Retrospectivo Comparativo.

Descritores: Fraturas expostas; Fraturas da tíbia; Qualidade de vida; Inquéritos e questionários

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Study performed at the Hospital de Urgências de Goiânia - Hugo, Goiana, GO, Brazil.

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INTRODUCTION

Tibial pilon fractures involve the articular surface of the distal tibia and adjacent metaphysis or both regions, to varying degrees. They are relatively uncommon and represent 5% to 10% of tibial fractures and 1 to 5% of lower limb fractures⁽¹⁾.

These fractures commonly involve surrounding soft tissue injury, as the impact absorption threshold is exceeded at the distal tibia and there is a rapid transmission of destructive forces to the thin layer of adjacent soft tissue. The incidence of open fractures is high and comprises approximately 16% to 47% of all fractures in the distal third of the tibia⁽²⁾.

The name "pilon" comes from an analogy whereby the talus, acting as a hammer, hits the distal tibia load surface, causing a fracture as a result of an axial load on the tibia, with or without rotational forces^(3,4). Such fractures are generally associated with high-energy trauma, either due to car accidents or falls from great heights. They may also occur less frequently in low-energy trauma, in which rotational or shear forces predominate, resulting in less comminution of the articular surface and less soft tissue involvement, and therefore a better prognosis⁽³⁾.

The literature describes two classification systems commonly used for this type of fracture. The first is the Rüedi and Allgöwer classification system, which divides distal tibia fractures caused by axial loads into three types (type I, type II and type III) based on the degree of joint surface comminution^(5,6).

The other commonly used classification system is the AO/OTA. This system divides distal tibial fractures into three categories: type A, extra-articular fractures; type B, partial articular fractures; and type C, complete articular fractures. Each category is subdivided into three groups according to the degree of comminution. The partially comminuted articular fractures (type B3) and fracture types C1, C2 and C3 are considered to be tibial pilon fractures^(7,8).

Type C3 fractures, which include epiphyseal and metaphyseal comminution, often lead to serious soft tissue and bone injury and have a worse prognosis. The goal of surgical treatment is the anatomic reduction of fragments in order to restore congruence of the articular surface and promote bone union with minimal soft tissue injury⁽⁴⁾. These fractures can be treated with a transarticular external fixator fitted immediately after the injury in the initial surgical procedure, followed by a second planned intervention, days or even weeks thereafter⁽⁹⁾.

This study aimed to evaluate the functional outcomes and quality of life of patients with open tibial pilon fractures (AO - 43C3) who underwent initial damage control surgery using the principle of ligamentotaxis by means of an external fixator, and who then underwent open reduction and internal fixation in a second procedure.

METHODS

This study was approved by the Institutional Ethics Committee and registered on the Brazil Platform under number CAAE 14935713.4.0000.0033.

We evaluated a total of 30 patients with AO-43C3 open tibial pilon fractures (Figure 1) who underwent initial surgical treatment in the emergency room consisting of attachment of a uniplanar external fixator with a delta frame, and who were later treated by the Foot and Ankle Surgical Team of our teaching hospital between September 2009 and July 2013.



Figure 1. Preoperative X-ray. A. Anteroposterior. B. Lateral.
Source: Author's personal archive.

The following parameters were analysed: age, gender, affected side, type of accident, number of surgeries, interval between the first and second surgeries, healing time, mean follow-up, range of motion (ROM) and ankle axis. Data collection was performed during outpatient follow-up, at approximately 12 months after the final treatment. Data were collected using the AOFAS questionnaire for the ankle and hindfoot and the SF-36 questionnaire for quality of life. The collected data will be kept confidential and stored for five years and will then be incinerated as directed by the National Health Council (Conselho Nacional de Saúde - CNS) Resolution N° 196/96.

The specific foot and ankle evaluation was performed using the *Orthopaedic Foot and Ankle Score* (AOFAS) questionnaire. This questionnaire includes nine items across three categories: pain (40 points), function (50 points) and alignment (10 points), totalling 100 points. A score of 80-100 is considered excellent, scores of 60-80 are good, scores of 40-60 are satisfactory, and scores less than 40 are considered poor^(10,11).

The SF-36 is a multidimensional generic instrument comprising 36 items divided into eight domains that can be grouped into two major components: physical and mental. To analyse the results, the score for each question is converted onto a scale of 0 to 100, whereby zero corresponds to the worst state of health and 100 corresponds to the best. Each component is analysed separately^(12,13). The four domains relating to the physical component of the questionnaire (physical functioning, physical role functioning, bodily pain and general health) were analysed in this study.

The patients underwent a second surgical intervention after improvement of oedema and soft tissue injury. At that time, surgery was performed with side access for reduction and fixation of the fibular fracture using a semitubular plate or acetabular reconstruction and 3.5-mm screws to gain length. The anteromedial access route (Figure 2) was used for the reduction and fixation of the distal tibia fracture with acetabular reconstruction plates in the anterolateral and anteromedial position. In some cases, it was decided to fit a non-blocked distal tibia plate, depending on the type of fracture and the availability of synthesis material in the operating room (Figure 3). In fractures with greater comminution and bone loss, an autologous tricortical iliac graft was applied to replace the missing bone and act as a support for fixation of the plates.

Patients who had severe and/or incapacitating systemic or neurological diseases, severe CCT (craniocerebral trauma), chronic osteomyelitis or other associated fractures that would impede the intended evaluations were excluded, along with those who discontinued outpatient follow-up and those who refused to participate in the study.

All study participants signed terms of free and informed consent (TFIC).

RESULTS

Of the initial 30 patients, 16 were eligible for the study during the period of September 2009 to July 2013. The remaining 14 patients were excluded because they had seve-



Figure 2. Anteromedial access route.
Source: Author's personal archive.

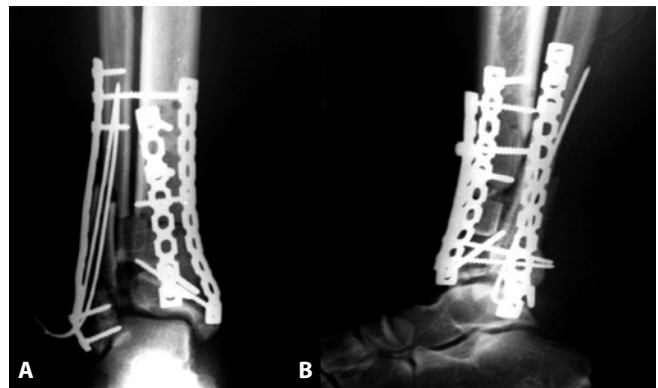


Figure 3. Postoperative X-ray. A. Anteroposterior. B. Lateral.
Source: Author's personal archive.

re and/or incapacitating systemic or neurological diseases, severe CCT (craniocerebral trauma), chronic osteomyelitis or other associated fractures that would impede the intended evaluations or because they discontinued outpatient follow-up or refused to participate in the study.

The mean age was 43.5 years (range 24-63 years). The prevalence of fractures was higher in women (10 patients, 63%).

Both sides were affected equally, with 50% of cases on the right side and 50% on the left. Thirteen fractures (81%) were the result of motorcycle accidents, two were due to falls (13%), and one was due to a car accident (6%). All fractures were of the open type AO - 43C3.

All fractures were initially treated in the emergency room with a delta-type transarticular external fixator. All 16 patients underwent a second surgery in which open reduction and internal fixation was performed with plates

and screws. Three surgeries required a bone graft, and the remaining 13 did not. Three patients required a third surgery, as the fracture did not heal, and bone graft placement was required. Two patients underwent revision with an Ilizarov-type dynamic external fixator due to failure of the internal osteosynthesis material and the lack of other types of plates in our service (Figures 4 and 5). In one patient, further reduction was performed with internal fixation due to reduction loss. In this latter case, a fourth surgery was required due to breakage of the material and the needs to exchange the osteosynthesis material for a more stable fixation and reset the iliac bone graft. In one case there was skin necrosis, with minimal exposure of the osteosynthesis material. This was resolved with bandages, without the need for a local rotation flap.

The mean time interval between the first and second surgeries was 17 days (range 8 to 26 days). The mean time to fracture healing was 5 months (31.25%). The mean follow-up time was 20 months (range 6 to 48 months). The questionnaire was administered to all eligible patients approximately twelve months after the final treatment.

Excellent range of motion was observed in 43.75% (7/16) of patients, with total ROM (dorsiflexion 10° + plantar flexion 30°) greater than or equal to 40° (Table 1). Overall, 93.75% (15/16) of patients had a normal axis, and one patient had slight varus upon clinical evaluation.

Results on the AOFAS questionnaire were classified as excellent for 31.25% (5/16) of patients, good for 31.25%

(5/16), satisfactory for 25% (4/16) and poor for 12.5% (2/16) (Figure 6).

With regards to quality of life as measured by the SF-36 questionnaire, 31.25% (5/16) of patients had a score close to 100 on the physical functioning domain, indicating the best possible result. For the physical role functioning domain, 50% (8/16) of patients had a score of zero, considered

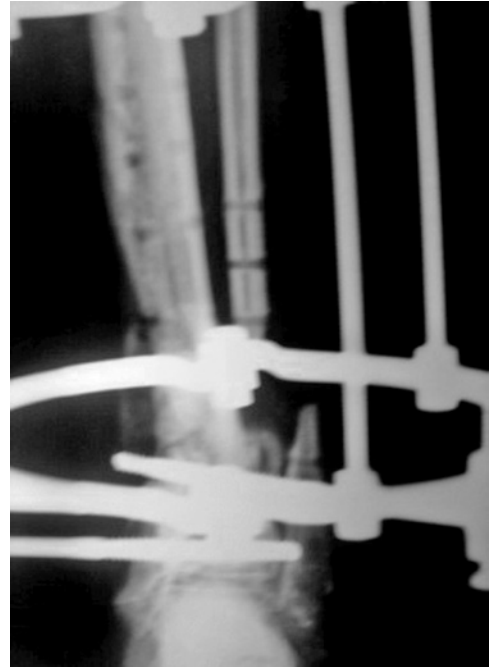


Figure 5. New fixation with an Ilizarov external fixator.

Source: Author's personal archive.



Figure 4. X-ray of ankle showing breakage of the synthesis material.

Source: Author's personal archive.

Table 1. Degrees of Range of Motion - Ankles

Patient	Dorsiflexion	Plantar flexion	Total rom
JLO	10°	25°	35°
ARA	15°	35°	50°
EMF	5°	35°	40°
LHCL	0°	35°	35°
VCR	0°	0°	0°
NWPO	15°	30°	45°
WRS	10°	45°	55°
MJSC	10°	45°	55°
MHR	0°	10°	10°
JDSF	10°	45°	55°
CPG	10°	40°	50°
EL	0°	30°	30°
JLS	15°	45°	60°
FHAS	0°	0°	0°
LLCS	0°	15°	15°
SESFB	5°	20°	25°

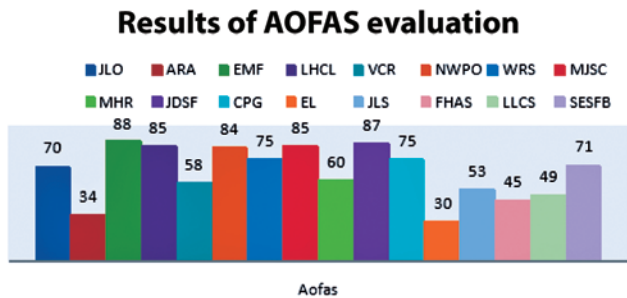


Figure 6. AOFAS questionnaire results by patient.

to be the worst result on the SF-36 questionnaire. For the bodily pain domain, 62.25% (10/16) of the patients achieved a score of greater than 50 on a scale from 0 to 100. In the general health domain, 50% (8/16) had a score close to 100. The mean scores were 60 for the physical functioning domain, 37 for physical role functioning, 51 for bodily pain, and 84 for general health (Table 2).

DISCUSSION

The choice of treatment for pilon fractures should take into account not only fracture stabilisation but also soft tissue injury, which is a frequent cause of further complications^(14,15). Fractures of this type represent 7-10% of tibial fractures and less than 1% of all fractures⁽¹⁶⁾. However, their number is growing in line with an increase in traffic

accidents (45% of all pilon fractures are attributed to traffic accidents)⁽¹⁷⁾.

Our findings show that during the study period, AO - 43C3 tibial pilon fractures were more frequent in women (63%), in contrast with what has been reported in the literature^(4,11). In previous studies, men accounted for 78.3% of victims (114,285), while women accounted for 21.7%⁽¹⁸⁾. Motorcycle accidents were the main cause (81%) of pilon fractures in our study, which is consistent with current epidemiological data^(9,11,19-21). The mean age of the 16 patients studied was 43.5 years (24-63 years), confirming that the majority of victims are of working age with a long life expectancy and that these fractures cause a loss of revenue⁽²⁰⁻²³⁾. In economic terms, the cost of these losses reaches approximately 1% of gross domestic product (GDP) in low-income countries and 2% of GDP in high-income countries. According to DATASUS⁽¹⁸⁾, in 2010, 145,920 traffic accident victim hospitalisations were financed by the Unified Health System (Sistema Único de Saúde - SUS), at a cost of approximately BRL 187 million.

The mean time interval between the first operation (external fixation in the emergency room) and the second operation (conversion to open reduction and internal fixation with orthogonal acetabular reconstruction plates or non-blocked distal tibia plates and screws) was 17 days (range 8- 26 days), which is consistent with the findings of other authors^(4,24-26). This time interval is necessary for soft tissue restoration, which significantly reduces associated complications.

The mean fracture healing time was 5 months, similar to that found by Bone et al.⁽²⁷⁾ in their study (4.5 months). The mean follow-up time was 20 months (range 6 to 48), which is the same time frame as reported elsewhere in the literature⁽²⁸⁻³⁰⁾.

In terms of the patients' ankle ROM at the final evaluation, according to Bone et al.⁽²⁷⁾ reference values, 7 patients had excellent results (dorsiflexion greater than 10° and plantar flexion greater than 30°), one had good results (dorsiflexion 5° - 10° and plantar flexion greater than 25°), 4 patients had moderate results (dorsiflexion 0° - 5° and plantar flexion 20°) and four had poor results (0° dorsiflexion and plantar flexion less than 20°). Overall, these outcomes were considered very good given the severity of the fractures. Correlation with other studies was difficult because we could not find previously published studies that only evaluated AO - 43C3 fractures. There are several studies that evaluated the ROM of patients with all types of pilon fractures in the AO group classification^(24,27).

Table 2. Results of the SF-36 Quality of Life Questionnaire

Patient	Physical functioning	Physical role functioning	Bodily pain	General health
JLO	70	0	51	55
ARA	30	0	31	82
EMF	90	100	84	92
LHCL	90	100	84	97
VCR	45	0	21	92
NWPO	95	75	54	82
WRS	95	100	61	100
MJSC	65	50	62	100
MHR	50	50	64	87
JDSF	90	100	74	92
CPG	65	0	64	87
EL	40	0	10	52
JLS	15	0	42	72
FHAS	50	25	52	100
LLCS	50	0	31	82
SESFB	30	0	41	72

Patients were evaluated using a specific and functional foot and ankle evaluation (the *Orthopaedic Foot and Ankle Score*, AOFAS), and the mean score was 65 points (out of 100 possible points), with a range of 30 to 88 points. Overall scores were excellent in five patients (80 to 100 points), good in 5 patients (60 to 80 points), satisfactory in 4 patients (40 to 60 points) and poor in 2 patients (less than 40). We could not find any previously published studies with functional outcomes specifically geared to AO C3 open fractures. Collinge et al.³¹ showed that patients with metaphyseal, extraarticular, high-energy distal tibia fractures treated with minimally invasive plate osteosynthesis (MIPO) achieved a mean AOFAS score of 83 points. Hong et al.²⁴ studied extra- and intraarticular distal tibia fractures and reported a mean AOFAS score of 87.3 points.

The four domains relating to the physical component of the SF-36 questionnaire were used to assess quality of life. Low means were observed for the physical functioning (60 points), physical role functioning (37 points) and bodily pain (51 points) domains. The mean score (84 points) in the general health domain was superior to the scores on the remaining domains, suggesting that these types of fractures cause functional impairment even when anatomic reduction is achieved. In an article on tibial pilon frac-

ture complications, Mauffrey et al.¹⁵ reported that scores for patients with type C fractures fell well below the mean scores for the general population. Low scores were also observed by Collinge et al.³¹ in a study of extra-articular distal tibia fractures, showing that even in fractures that do not affect the tibial pilon, there is functional limitation and a deterioration of quality of life.

Analysis of the data obtained from the AOFAS and SF-36 questionnaires reveals similar results, as patients with the worst AOFAS scores also had the worst SF-36 results. The same was also true of the patients with better results, suggesting a correlation between the two questionnaires.

CONCLUSION

The treatment of complex tibial pilon fractures resulting from high-energy trauma remains a challenge for orthopaedic surgeons. The use of a two-phase staged treatment protocol (external fixation followed by open reduction and internal fixation) is greatly beneficial with respect to soft tissue injury, associated damage control and ligamentotaxis. However, we found that this type of fracture negatively affects physical functioning and has a detrimental effect on patient quality of life, even with staged treatment.

Author's Contribution: Each author made significant individual contributions to this manuscript: AFMJ (<https://orcid.org/0000-0002-6430-8974>)* has conceived and planned the activities that led to the study, as written the article and participated in the review process, has interpreted the study results; AAMF (<https://orcid.org/0000-0001-6477-2913>)* has conceived and planned the activities that led to the study, has interpreted the study results; ETC (<https://orcid.org/0000-0002-1637-5953>)* has conceived and planned the activities that led to the study as written the article and participated in the review process, has interpreted the study results; JSM (<https://orcid.org/0000-0003-4742-1905>)* participated in the review process, has performed surgeries, has approved the final version. *ORCID (Open Researcher and Contributor ID).

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