

Epidemiological study of calcaneal fractures

Estudo epidemiológico das fraturas de calcâneo

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ABSTRACT

Objective: To analyze epidemiological characteristics of patients with calcaneal fractures. **Methods:** We included 181 medical records of patients diagnosed with calcaneal fracture from September 2008 to December 2015. Parameters analyzed were associated with patient's characteristics, trauma mechanism, if open or closed fracture, period of the day, seasonality, preoperative radiographic evaluation, Essex-Lopresti and Sanders classification, type of treatment and technique used. **Results:** Of patients included, 84% were white, 58.1% did not attend high school. Incidence of calcaneal fractures was 89.5% in men mean aged 43 years. There was no statistical significance concerning laterality, 8.8% of fractures were bilateral, and 74.6% of them occurred in the afternoon. The most frequent mechanism of injury was fall from a height (90.1%). According to Sanders classification type 3 AC fractures occurred in 41.6% of patients. **Conclusion:** Calcaneal fractures affect more often men working for construction companies, who are at productive period of life, and did not attend high school. Most frequent trauma mechanism was fall from a height.

Keywords:

Calcaneus/injuries; Fractures/epidemiology

INTRODUCTION

Calcaneal fracture is considered complex when compared with other fractures, and it accounts for about 60% of tarsal fractures and 2% of bone fractures.^(1,2) Anatomic characteristics, such as not very dense trabecular structure,

RESUMO

Objetivo: Analisar as características epidemiológicas de pacientes com fraturas de calcâneo. **Métodos:** Foram analisados 181 prontuários de pacientes atendidos com o diagnóstico de fratura de calcâneo no período de setembro de 2008 a agosto de 2015. Os parâmetros analisados estiveram relacionados às características do paciente, ao mecanismo de trauma, às fraturas associadas, se aberta ou fechada, ao período do dia, à sazonalidade, à avaliação radiográfica pré-operatória, às classificações de Essex-Lopresti e Sanders, ao tipo de tratamento e à técnica utilizada. **Resultados:** Dentre os pacientes da amostra, 84% eram brancos e 58,1% não tinham iniciado o Ensino Médio. As fraturas de calcâneo tiveram incidência de 89,5% no sexo masculino, com média de idade de 43 anos. Não houve significado estatístico quanto à lateralidade, sendo que 8,8% foram bilaterais e 74,6% ocorreram no período vespertino. O mecanismo de trauma mais frequente foi a queda de altura (90,1%). Conforme a classificação de Sanders, as fraturas do tipo 3 AC ocorreram em 41,6%. **Conclusão:** As fraturas de calcâneo acometeram principalmente pacientes do sexo masculino, em fase produtiva, se fizeram mais presentes em trabalhadores da construção civil, e que não cursaram o Ensino Médio. O mecanismo de trauma mais frequente foi a queda de altura.

Descritores:

Calcâneo/lesões; Fraturas/epidemiologia

re, thin cortical bones and vulnerable position of hindfoot makes this bone highly susceptible to fractures.^(3,4) Fractures of the calcaneus occur mainly in men aged 21 to 40 years (roughly 80% to 90% of cases) and primarily affect industrial workers.^(5,6) Calcaneus fractures can be bilateral in up

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to 20% of cases.⁽⁷⁾ These fractures are associated with lumbar spine fractures in 10% and with other fractures of the lower limbs in up to 26% of cases.^(8,9)

Two distinct trauma mechanisms can provoke calcaneal fractures: one via right vertical compression and the other by a combination of compression and movement of hindfoot equinus-valgus.⁽¹⁰⁾

Initial radiographic assessment includes profile radiography of the anterosuperior aspect of the hindfoot and the Harris-Beath axial view.⁽¹¹⁾ Computed tomography (CT) is indicated when radiography shows an intra-articular trait; CT enables analysis of the subtalar and calcaneocuboid joints with greater accuracy and, when results are interpreted correctly, guides the treatment and prognosis of the injury.^(12,13)

In 1952, Essex-Lopresti⁽¹⁴⁾ developed a radiological classification dividing calcaneal fractures into extra- and intra-articular categories. Articular fractures make up approximately 75% of cases and are subdivided into tong type and central depression type.⁽¹⁵⁾

In 1993, Sanders⁽¹⁶⁾ developed a tomographic classification based on coronal cuts of the posterior facet of the calcaneus. Sanders' classification is based on many fracture traits and their location in relation to calcaneal tuberosity.

The traditional treatment method is indicated in cases without deviation and joint depression. Surgery is indicated in anatomic reduction by opening surgery, and internal fixation is indicated in cases of deviation of fragments of the joint surface. Closed reduction with percutaneous fixation of Essex-Lopresti type and arthrodesis can be also used, according to the type of fracture and its indication.⁽¹⁷⁾

Possible complications, after opening reduction and internal fixation of calcaneal fractures, are development of skin necrosis, hematomas and infections that occur because of fragile skin covering, especially in its lateral portion. The incidence of skin necrosis ranges between 2% and 11%, and infection of soft parts from 1.3% to 7%, with extended lateral access.⁽¹⁸⁾

The paucity of studies in the Brazilian national literature on epidemiology of calcaneus fractures prompted an in-depth study to obtain more information on these fractures. This study sought to analyze the epidemiologic characteristics of calcaneus fractures.

METHODS

This retrospective study used 181 medical records of patients diagnosed with calcaneus fracture from September

2008 to December 2015 and who were seen at Hospital Santa Marcelina, São Paulo, Brazil. Parameters analyzed were age, sex, laterality, skin color, profession, level of education, trauma mechanism, associated fractures, open or closed method, period of the day, season, preoperative radiographic evaluation (Bohler and Gissane angles), Essex-Lopresti and Sanders classification, type of treatment and technique used.

RESULTS

Of 181 patients with calcaneal fracture who were evaluated, 74.6% had sustained the fracture in the afternoon (Table 1), 84% were white, 13.8% were Pardo, and 2.2% were black; 58.1% did not attend high school.

Most of individuals worked in the construction field; such jobs accounted for 31% of fractures, 13.3% of which occurred in the masonry field. There was no statistical difference concerning seasonality (Table 2) and laterality. The right side was affected in 83 patients (45.9%) and left side in 82 patients (45.3%); 16 patients (8.8%) had bilateral fractures (Tables 2 and 3).

The incidence of calcaneal fractures among men was 89.5%, a proportion of 8.5:1 compared with women. The mean patient age was 43 years (range, 10 to 83 years; standard deviation, 15.3).

The most frequent trauma mechanism was fall from a height (90.1%), followed by automobile accident (4.4%) (Table 3).

In 171 patients (94.5%), fractures were closed; 10 had open fractures (94.5%). Associated fractures occurred in 8.3% of the sample, and the most frequent such fracture was of the lumbar spine (9 patients), followed by fractures of the tibial plateau (4 patients) and proximal femur (2 patients).

Table 1 | Distribution of fractures according to time of day

Time of day	n (%)	P value
Morning	30 (16.6)	<0.001
Night	16 (8.8)	<0.001
Afternoon	135 (74.6)	Ref.

Table 2 | Distribution of fractures according to season

Season	n (%)	P value
Winter	47 (26.0)	0.294
Fall	34 (18.8)	0.007
Spring	44 (24.3)	0.158
Summer	56 (30.9)	Ref.

In radiographic assessment before the surgery, the mean Bohler angle was 22.4° and the mean Gissane angle was 112.4°. The Essex-Loprest classification was applied to 197 fractures of the calcaneus (including bilateral cases), and 113 fractures (57.36%) were intra-articular.

The Sanders classification was used in intra-articular fractures, and the most common fracture was type 3AC, which occurred in 41.6% of fractures (Table 4), followed by type 3AB fractures in 18.6% of cases.

Surgical treatment was needed in 55.87% of patients. The most frequently used technique was open reduction and internal fixation with plate and screw (92.6% of surgical cases).

Table 3 | Distribution of fractures according to trauma mechanism

Mechanism	n (%)	P value
Automobile accident	8 (4.4)	<0.001
Run over	2 (1.1)	<0.001
Sprain	5 (2.8)	<0.001
Smashing	1 (0.6)	<0.001
Explosion	1 (0.6)	<0.001
Fall from height	163 (90.1)	Ref.
Kick	1 (0.6)	<0.001

Table 4 | Distribution according to Sanders classification

Sanders	n (%)	P value
1	8 (7.0)	<0.001
2A	9 (8)	<0.001
2B	10 (8.9)	<0.001
2C	8 (7.1)	<0.001
3AB	21 (18.6)	<0.001
3AC	47 (41.6)	Ref.
3BC	6 (5.3)	<0.001
4	4 (3.5)	<0.001
Total	113	

DISCUSSION

A total of 181 patients were assisted at our service and 197 calcaneal fractures were assisted in the emergency department from September 2008 to August 2015 (83 months), corresponding to an incidence of 24.6 fractures yearly.

Of the total, 94.5% of patients had closed fractures and only 5.5% patients had exposed fractures. Heieret et al.,⁽¹⁹⁾ over 8 years of follow-up, evaluated 503 calcaneal fractures, 43 of which were open (8.5%).

Although less frequent, calcaneal fractures occur predominantly in economically active men. Rehabilitation of these patient might take years and therefore pose a large economic burden on society.^(5,6) These patients can remain unable to work for up to 3 years after the injury.⁽²⁰⁾

In our analysis, the incidence of this fracture was highest among men (89.5% of patients), mean age of 43 years. In a study by Paula et al.⁽²¹⁾ among 71 patients with calcaneal deviated intra-articular fractures, 88.73% of patients were men, with a mean age of 41.41 years. Mitchell et al.,⁽²²⁾ after a follow-up of 126 months (January 1995 to June 2005), analyzed 752 calcaneal fractures and observed an incidence of 11.5/100,000 per year. The incidence of fracture in men was 16.5/100,000 per year, and occurrence was greater among those aged 20 to 29 years.

A divergence found in our study compared with the literature was the incidence of associated fractures; 5% of our patients had a lumbar spine fracture and 4.4% had fractures of a lower limb. Thordarson et al.⁽²³⁾ estimated that about 10% of patients with calcaneal fractures also had fracture of the lumbar spine and 26% had associated fractures in a lower limb.

The most frequently described trauma mechanism in the literature is fall from a height with axial trauma over the calcaneus.⁽²⁴⁾ In our study, the incidence of fractures of fall from a height was 90.1%, followed by automobile accident (4.4%); this differs from findings of Mitchel and colleagues' study,⁽²²⁾ which observed that only 71.5% of fractures were caused by fall from a height, 64.3% of which were falls from heights greater than 1.8 meters. However, fall from a height remains the main cause of these fractures.

We classified fractures radiographically using the Essex-Lopresti classification; 55.32% of them were depression type, a percentage similar to that reported by Kuschnaroff Contreras et al.,⁽²⁵⁾ who reported that about 60% of fractures were depression type. When Sanders tomography classification was used for calcaneal deviated intra-articular fractures, we verified that most fractures were type 3 (46.66%) and 26.66% were type 3BC. In our study, fractures classified as Sanders type 3 were found in 65.6% of the sample; among this group, 41.6% were classified as type 3AC.

Kuschnaroff Contreras et al.⁽²⁵⁾ reported a mean of pre-operative values of Bohlerde of 9.73±15.09 and mean of values of Gissane angle of 117.06±9.44. In our study, the mean Bohler angle was 22.4±1.3, with coefficient ranging from 41%, and mean Gissane angle was 112.4±1.9, with coefficient ranging from 12%. We highlight that a ranging coefficient lower than 50% indicates low variability and,

consequently, homogeneity of results. According to Essex-Lopresti, a greater Bohler angle

after surgery is a prognostic factor indicating better results with surgical treatment.⁽¹⁴⁾

Treatment of calcaneal fractures is still controversial. Some authors support open treatment and believe it yields good functional results over the long term and prevents surgical complications.⁽²⁶⁻²⁹⁾ However, other authors advocate closed treatment and believe that reestablishment of the form and joint congruence of the calcaneus can prevent late complications.⁽³⁰⁻³²⁾ In our sample, surgical treatment was used in 109 patients (55.87%), and the most frequently used technique was open reduction and internal fixation with plates and screws (92.6% of cases).

Analysis of our data shows that calcaneus fractures, although making up a small proportion of all fractures assisted in the orthopedic and traumatology emergency departments, must be treated correctly and precisely because they most often affect economically active young adult men. If these fractures are not treated adequately, limitations and prolonged sick leaves may occur.

This study helped us to recognize the epidemiologic profile of fractures assisted at our service.

CONCLUSION

Calcaneal fractures assisted at our service occurred mainly among men with a mean age of 43 years. Most cases happened in the afternoon, and the work area most associated with the fractures was construction. The main cause was fall from a height, and associated fractures were seen. The most common fracture was Sanders type 3AC.

REFERENCES

- Sanders RW, Clare MP. Fractures of calcaneus. In: Rockwood and Green's fractures in adults. 6th ed. Philadelphia: Lippincott Raven; 2006.
- Atkins RM, Allen PE, Livingstone JA. Demographic features of intra-articular fractures of the calcaneum. *Foot Ankle Surg.* 2001;7:77-84.
- Moraes-Filho DC, Provenzano E, Mattos JR, Batista LC, Galbiatti JA, Ferreira JC, et al. Avaliação preliminar do tratamento cirúrgico de fraturas intra-articulares do calcâneo. *Rev Bras Ortop.* 1998;33(7):511-8.
- Poeze M, Verbruggen JP, Brink PR. The relationship between the outcome of operatively treated calcaneal fractures and institutional fracture load. A systematic review of the literature. *J Bone Joint Surg Am.* 2008; 90(5):1013-21.
- Roukis TS, Wünschel M, Lutz HP, Kirschner P, Zgonis T. Treatment of displaced intra-articular calcaneal fractures with triangular tube-to-bar external fixation: long-term clinical follow-up and radiographic analysis. *Clin Podiatr Med Surg.* 2008;25(2):285-99, vii-viii.
- Bareil DP, Bellabarba C, Sangeorzan BJ, Benirschke SK. Fractures of the calcaneus. *Orthop Clin North Am.* 2002;33(1):263-85, x.
- Cyteval C, Blin D, Sarrabère MP, Larroque G, Decoux E. [Imaging of traumatic injuries of the foot and ankle]. *J Radiol.* 2007;88(5 Pt 2):789-800. French.
- Lindsay WRN, Dewar FP. Fractures of the os calcis. *Am J Surg.* 1958;95:555-76.
- Rowe CR, Sakellarides H, Freeman P, et al. Fractures of os calcis: a long-term follow-up study of one hundred forty-six patients. *JAMA.* 1963;184:920.
- Soeuer R, Remy R. Fractures of the calcaneus with displacement of thalamic portion. *J Bone Joint Surg Br.* 1975;57(4):413-21.
- Isherwood I. A radiographic approach to the subtalar joint. *J Bone Joint Surg Br.* 1961;43(3):566-574.
- Eastwood DM, Gregg PJ, Atkins RM. Intra-articular fracture of the calcaneus. Part I: Pathological anatomy and classification. *J Bone Joint Surg.* 1931;13:75-89.
- Lowrie IG, Finlay DB, Brenkel IJ, Gregg PJ. Computerized tomographic assessment of the subtalar joint in calcaneal fractures. *J Bone Joint Surg Br.* 1988;70(2):247-50.
- Essex-Lopresti P. The mechanism, reduction technique, and results in fractures of the os calcis. *Br J Surg.* 1952;39(157):395-419.
- Fitzgibbons TC, McMullen ST, Mormino MA. Fractures and dislocations of the calcaneus. In: Buchholz RW, Heckman JD. Fractures in adults. Philadelphia: Lippincott Williams & Wilkins; 2002. p. 2151-2.
- Sanders R. Intra-articular fractures of the calcaneus: present state of the art. *J Orthop Trauma.* 1992;6(2):252-65.
- Bohler L. Diagnosis, pathology, and treatment of fractures of the Os Calcis. *J Bone Joint Surg.* 1931;13(1):75-89.
- Harvey EJ, Grujic L, Early JS, Benirschke SK, Sangeorzan BJ. Morbidity associated with ORIF of intra-articular calcaneus fractures using a lateral approach. *Foot Ankle Int.* 2001;22(11):868-73.
- Heier KA, Infante AF, Walling AK, Sanders RW. Open fractures of the calcaneus: soft-tissue injury determines outcome. *J Bone Joint Surg Am.* 2003;85-A(12):2276-82.
- Buckley R, Tough S, McCormack R, Pate G, Leighton R, Petrie D, et al. Operative compared with nonoperative treatment of displaced intra-articular calcaneal fractures: a prospective, randomized, controlled multicenter trial. *J Bone Joint Surg Am.* 2002;84(10):1733-44.
- Paula SS, Biondo-Simões ML, Luzzi R. Evolução das fraturas intra-articulares desviadas do calcâneo com tratamento cirúrgico. *Acta Ortop Bras.* 2006;14(1):35-9.
- Mitchell MJ, McKinley JC, Robinson CM. The epidemiology of calcaneal fractures. *Foot (Edinb).* 2009;19(4):197-200.
- Thordarson DB, Krieger LE. Operative vs. non operative treatment of intra-articular fractures of the calcaneus: a prospective randomized trial. *Foot Ankle Int.* 1996;17(1):2-9.
- Sanders R. Displaced intra-articular fractures of the calcaneus. *J Bone Joint Surg Am.* 2000;82(2):225-50. Review.
- Kuschnaroff Contreras ME, Kroth LM, Kotani KL, Da Silva Junior JL, De Andrade MC, Vargas Ávila AO, et al. Intra articular calcaneal fractures: a clinical and biomechanical analysis. *Rev Bras Ortop.* 2009;44(6):496-503
- Kitaoka H, Schaap EJ, Chaq YS, An KN. Displaced intra-articular fractures of the calcaneus treated non-operatively – Clinical results and analysis of motion and group reaction and temporal forces. *J Bone Joint Surg Am.* 1994;76(10):1531-9.
- Parmar HV, Triffitt PD, Gregg PJ. Intra-articular fractures of the calcaneum treated operatively or conservatively. A prospective study. *J Bone Joint Surg Br.* 1993;75(6):932-7.
- Miller WE. Pain and impairment considerations following treatment of disruptive os calcis fractures. *Clin Orthop.* 1993;(177):82-6.

29. Levin IS, Nunley JA. The management of soft-tissue problems associated with calcaneal fractures. *Clin Orthop.* 1993;(290):151-6.
30. Mulcahy DM, McCormack DM, Stephens MM. Intra-articular calcaneal fractures: effect of open reduction and internal fixation on the contact characteristics of the subtalar joint. *Foot Ankle Int.* 1998; 19(12):842-8.
31. Thermann H, Krettek C, Hüfner T, Schrott HE, Albrecht K, Tscherne H. Management of calcaneal fractures in adults. Conservative versus operative treatment. *Clin Orthop.* 1998;(353):107-24.
32. Johnson EE, Gebhardt JS. Surgical management of calcaneal fractures using bilateral incisions and minimal internal fixation. *Clin Orthop.* 1993;(290):117-23.