

# Analysis of Demographic Characteristics in a Series of 94 Patients with Articular Calcaneal Fractures

Maximiliano Seletti, Ana Pendino, Ernesto Lombardo

Foot and Ankle Unit, Orthopedics and Traumatology Service, Hospital de Emergencias "Dr. Clemente Álvarez", Rosario, Santa Fe, Argentina

## ABSTRACT

**Objective:** To analyze the demographic characteristics of patients with articular calcaneal fractures in connection with trauma mechanisms and fracture patterns, according to the Sanders and Essex-Lopresti classifications. **Materials and Methods:** 94 patients and 111 articular calcaneal fractures were evaluated retrospectively, analyzing the following variables: age, gender, fractured side, mechanism of trauma, and associated injuries. The patients were initially evaluated through foot radiographs (anteroposterior and lateral) and axial computerized tomography with multiplanar reconstruction. Demographic data were analyzed combined with the types of fracture. **Results:** 94 patients (78 men and 16 women) who presented 105 intra-articular calcaneal fractures (11.7% were bilateral) were evaluated. The average age was  $40.1 \pm 12.5$  years. 9.8% of the fractures were caused by high-level falls and 20.1% by traffic accidents. 9.5% had associated injuries. The patients with bilateral fractures presented more associated injuries ( $p = 0.0123$ ) and the same fracture pattern and Sanders type in both feet. The Sanders classification and Essex-Lopresti patterns were unrelated to age, gender, and trauma mechanism. **Conclusion:** Calcaneal fractures are more frequent in male and young patients, and the most common trauma mechanism is a high-level fall. Patients with bilateral fractures present a higher rate of associated injuries and the same Sanders type fracture and Essex-Lopresti pattern in both feet.

**Keywords:** Calcaneal fractures, intra-articular, demographic features, epidemiology

**Level of Evidence:** IV

## Análisis de las características demográficas de 94 pacientes con fracturas articulares de calcáneo

## RESUMEN

**Objetivo:** Analizar las características demográficas de los pacientes con fracturas articulares de calcáneo en relación con el mecanismo del trauma y los patrones fracturarios según las clasificaciones de Sanders y Essex-Lopresti. **Materiales y Métodos:** Se evaluó retrospectivamente a 94 pacientes (111 fracturas articulares de calcáneo). Se analizaron las siguientes variables: edad, sexo, lado fracturado, mecanismo del trauma y lesiones asociadas. Al ingresar, se tomaron radiografías de pie, de frente y de perfil, y se realizó una tomografía computarizada con reconstrucción multiplanar. Se analizaron los datos demográficos combinándolos con los tipos de fracturas. **Resultados:** Se evaluó a 94 pacientes (78 hombres y 16 mujeres) que tenían 105 fracturas intrarticulares de calcáneo (11,7% bilaterales). La edad promedio era de  $40.1 \pm 12.5$  años. El 79,8% de las fracturas se había producido por caída de altura y el 20,1%, por accidente de tránsito. El 9,5% tenía lesiones asociadas. Los pacientes con fracturas bilaterales tenían más lesiones asociadas ( $p = 0,0123$ ) y el mismo patrón fracturario y tipo de Sanders en ambos pies. No hubo relación entre la clasificación de Sanders y los patrones de Essex-Lopresti con la edad, el sexo y el mecanismo del trauma. **Conclusiones:** Las fracturas de calcáneo son más frecuentes en hombres y en pacientes jóvenes, y el mecanismo del trauma más común es una caída de altura. Los pacientes con fracturas bilaterales tienen una tasa más alta de lesiones asociadas y el mismo tipo de fractura según la clasificación de Sanders y el patrón fracturario de Essex-Lopresti en ambos pies.

**Palabras clave:** Fractura de calcáneo; intrarticulares; características demográficas; epidemiología.

**Nivel de Evidencia:** IV

Received on September 4<sup>th</sup>, 2022. Accepted after evaluation on October 26<sup>th</sup>, 2022 • Dr. MAXIMILIANO SELETTI • selettimaximiliano@gmail.com  <https://orcid.org/0000-0001-6021-2898>

**How to cite this article:** Seletti M, Pendino A, Lombardo E. Analysis of Demographic Characteristics in a Series of 94 Patients with Articular Calcaneal Fractures. *Rev Asoc Argent Ortop Traumatol* 2023;88(1):59-65. <https://doi.org/10.15417/issn.1852-7434.2023.88.1.1662>



## INTRODUCTION

Calcaneus fractures represent less than 2% of all fractures, although they are the most frequent tarsus injury.<sup>1</sup> These fractures usually occur in workspaces, the most common trauma mechanism being height falls, and in many cases produce sequelae with different kinds of disabilities. As a result, they cause considerable economic losses which are out of proportion with the low prevalence of said injury.<sup>2</sup> Most studies focus on the various treatments and fundamentally on surgical techniques,<sup>3,4</sup> but there are few publications on its epidemiology and the demographic characteristics of patients with calcaneus fractures.<sup>5-8</sup>

The aim of this study was to analyze the demographic characteristics in a series of 94 patients with intra-articular calcaneus fractures, assessing their relation to the trauma mechanism, the fracture patterns according to Essex-Lopresti, and the Sanders classification.

## MATERIALS AND METHODS

We retrospectively evaluated 100 patients with calcaneal joint fractures (111) who were treated at our Service between January 2010 and December 2020. Upon admission, anteroposterior and lateral radiographs of the foot were taken. In the lateral image, the beam was centered on the medial malleolus; in the anteroposterior image, on the medial cuneiform. The beam was parallel in the lateral image, and inclined 15° in the inferior apical direction in the anteroposterior image. The distance from the tube to the cassette was 120 cm in both projections. Before surgery, a multiplanar computerized tomography was performed with slices <1 mm, in the axial, sagittal and semi-coronal planes (30° angle), and 3D reconstruction was used.

Six patients with unilateral fractures who had not been fully evaluated upon admission were excluded. The demographic data analyzed were: age, sex, fractured side, trauma mechanism, and associated injuries. The Sanders classification was used<sup>3</sup> and the fracture patterns were evaluated as “tongue” or “joint depression”, following Essex-Lopresti<sup>9</sup>. The statistical analysis was carried out through descriptive measures (mean and standard deviation, maximum and minimum). The data were loaded into the EPIDAT version 4.2 system. A p-value <0.05 was considered significant.

## FINDINGS

### Age and sex

94 patients (78 men and 16 women) with 105 intra-articular calcaneus fractures were evaluated. The average age was  $40.1 \pm 12.5$  years (range 18-65). The average age for women was  $40.44 \pm 13.59$  (range 19-57), and for men,  $40 \pm 12.33$  (range 18-65).

### Age and unilateral or bilateral fractures

Eighty-three patients (89.3%) had unilateral fractures (46 right and 37 left) and the average age was  $41 \pm 13$  years (range 18-65). Eleven (11.70%) had bilateral fractures and the average age was  $35 \pm 10$  years (range 19-55). The right side was predominant (55.4%). There was no difference between the age of men and women, nor between age, and unilateral and bilateral fractures.

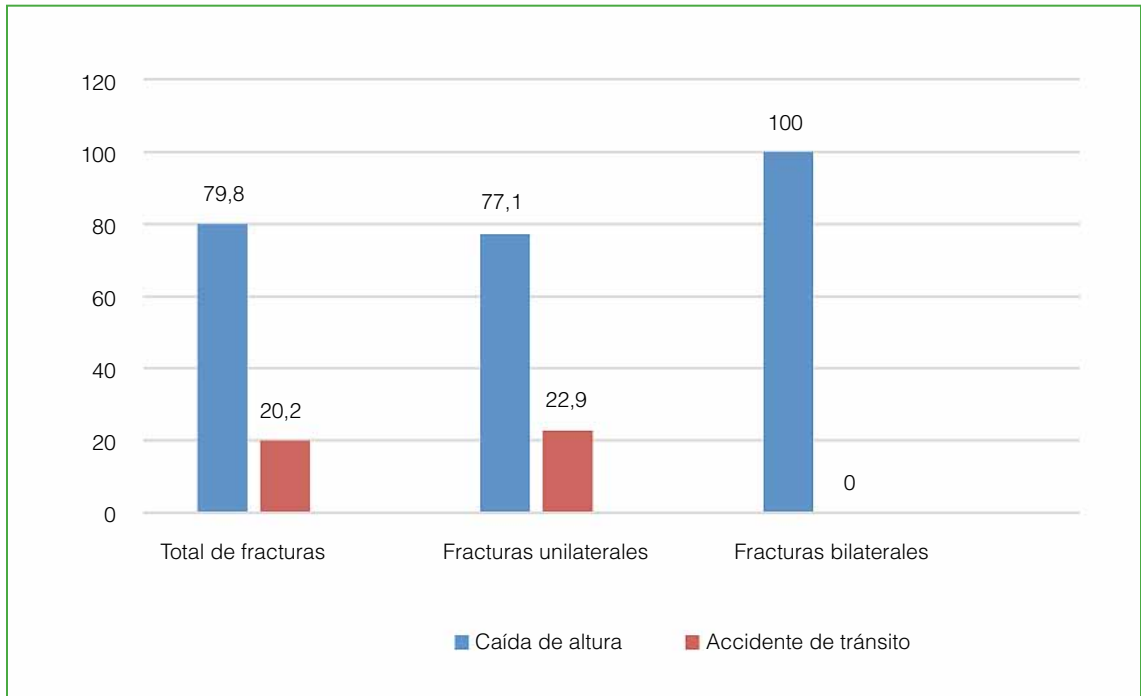
### Trauma mechanism, sex, and unilateral or bilateral fractures

The trauma mechanism was a fall from height in 79.8% of cases and traffic accidents in the rest. All patients with bilateral fractures had suffered a height fall. 77.10% of unilateral fractures were due to this mechanism, and the rest were due to traffic accidents (Figure 1).

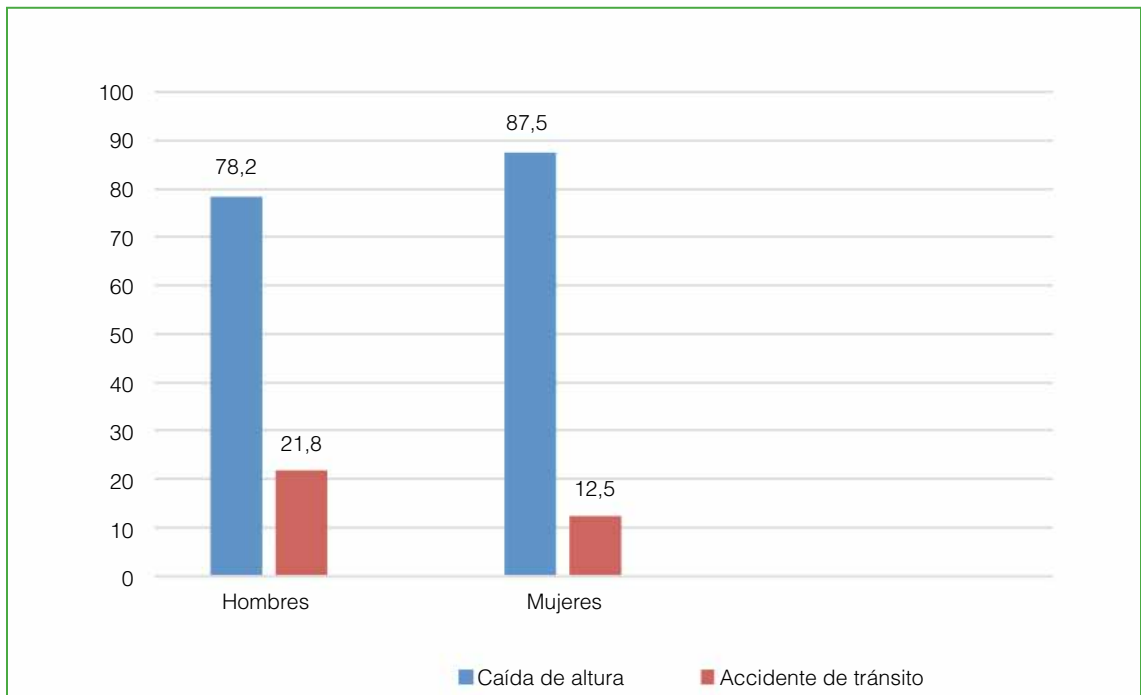
Figure 2 shows trauma mechanisms according to sex. There were no statistically relevant differences between the trauma mechanism and the patient's sex, and between unilateral or bilateral fractures, although bilateral fractures were caused by height falls.

### Associated injuries

Nine patients (9.5%) had associated injuries (27% with bilateral fractures and 7.2% with unilateral fractures). Patients with bilateral fractures presented more associated injuries ( $p = 0.0123$ ).



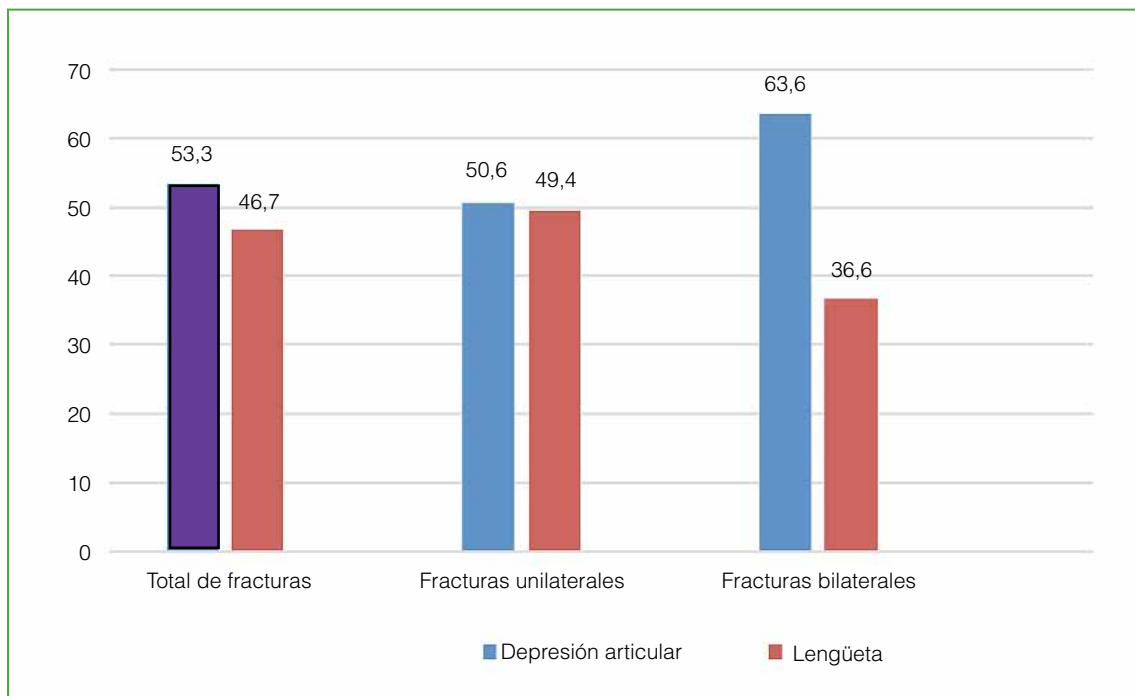
**Figure 1.** Trauma mechanism for unilateral and bilateral fractures, in all fractures.



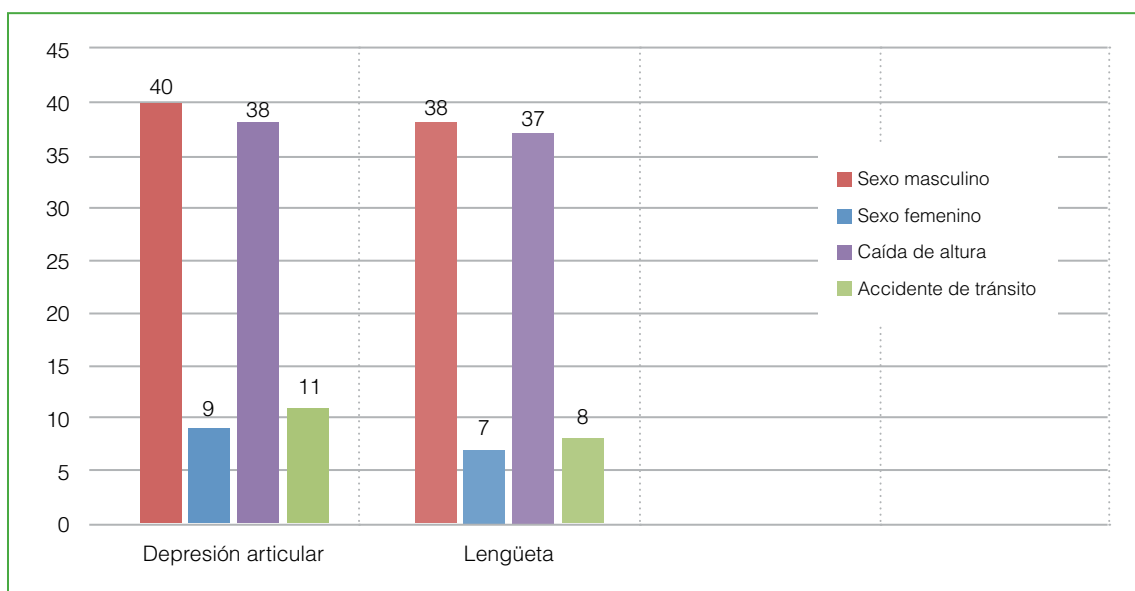
**Figure 2.** Trauma mechanisms according to sex.

### Essex-Lopresti fracture pattern

53.3% of fractures (56 cases) corresponded to the Essex-Lopresti “joint depression” type. 63.6% were bilateral and 50.6% were unilateral. The rest (47.7%) was classified as “tongue” (49.4% unilateral and 36.4% bilateral). Bilateral fractures had the same fracture pattern in both feet, seven of the “joint depression” and four of the “tongue” type. The age of patients with the “joint depression” fracture type was  $40.67 \pm 13.10$  years; for “tongue” fracture patients, it was  $40.04 \pm 12.41$  years. 81% of patients with “joint depression” fractures were men, and 84% of patients with “tongue” fractures were men. There was no difference between Essex-Lopresti fracture pattern, and age, sex and trauma mechanism (Figures 3 and 4).



**Figure 3.** Distribution according to Essex-Lopresti fracture pattern into unilateral, bilateral, and total fractures.



**Figure 4.** Essex-Lopresti fracture pattern according to trauma mechanism and sex.

### Sanders classification

Regarding the Sanders classification, 66 unilateral fractures were type II (79.5%); 15, type III (18%); and two, type IV (2.4%). The subtype IIA was the most frequent (63%). As regards bilateral fractures, 18 (82%) were type II and four, type III (18%); subtype IIA was the most frequent (50%). Bilateral fractures shared the same Sanders type in both feet. Nine patients were observed to have Sanders type II fractures, and two were type III. The Sanders types were fully matching, but not in every subtype: only in subtypes IIC and IIAB. 80% of type II, 82% of type III, and 100% of type IV fractures corresponded to men. The average age of patients with type II fractures was  $39.7 \pm 11.8$  years; for those with type III, it was  $42.9 \pm 13.8$  years; and for those with type IV,  $44.5 \pm 28.9$ . There was no link between Sanders classification, and age, sex and trauma mechanism (Figure 5).

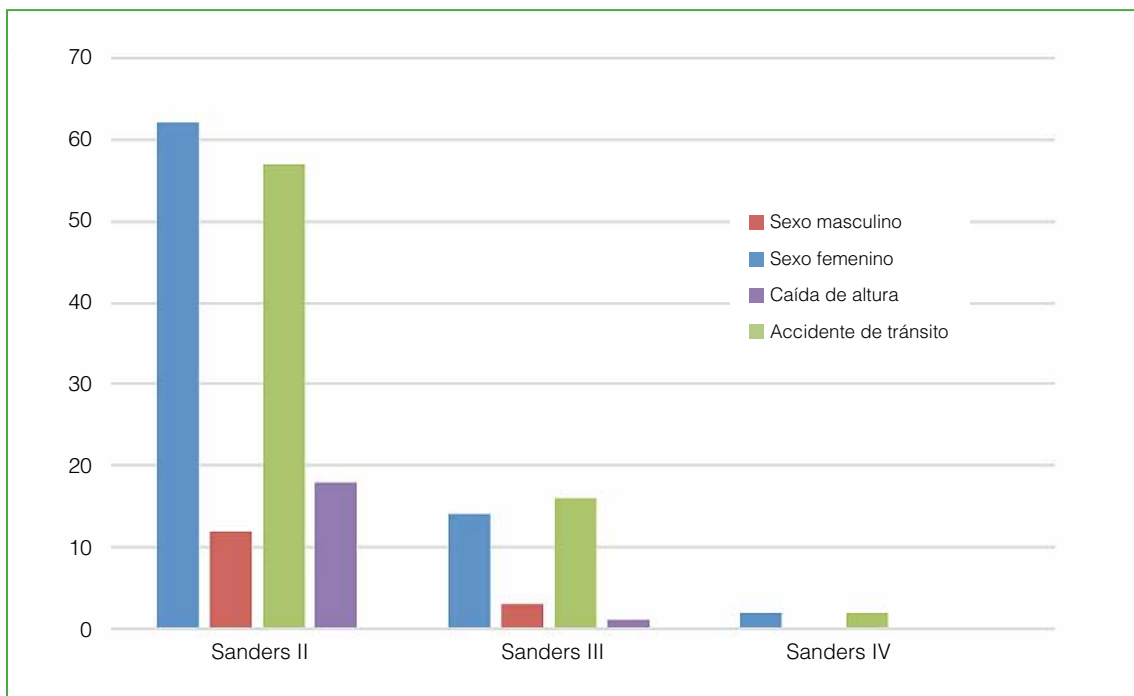


Figure 5. Sanders classification distribution according to trauma mechanism and sex.

## DISCUSSION

Calcaneus fractures account for 2% of all fractures and most occur in adults. The treatment is still controversial, as similar results have been published for conservative and surgical management.<sup>10,11</sup>

The analysis of our series shows that most patients are men (82%) and, according to the literature, this injury occurs more commonly in workspaces.<sup>8</sup> The average age of the patients was  $40.1 \pm 12.5$  years, with no statistically relevant differences between both sexes, a similar figure to those previously published.<sup>6,7</sup>

In these fractures, bilaterality was 7-13%.<sup>2,12</sup> Although there are no demographic differences between patients with unilateral and bilateral fractures, the latter could be more prevalent among younger adults.<sup>3</sup> In our series, all of them were caused by height falls in workspaces, predominantly on men (63%). These account for 11.7% of the entire series.

The two most common trauma mechanisms are height falls and traffic accidents.<sup>6-8</sup> In Atkins's series, height falls amounted to 91%. In our analysis, we observed that 79.8% of unilateral and all bilateral fractures owed to height falls. The trauma mechanism was similar for both sexes.

According to the different publications, the presence of associated injuries is very variable. Bohl *et al.*<sup>8</sup> communicate a 77% of associated injuries; Mitchell *et al.*,<sup>6</sup> a 22%; and Benson *et al.*,<sup>7</sup> a 93%. In our series, 9.5% had associated injuries. In bilateral fractures, the rate of associated injuries was higher (27%) than in unilateral fractures. This is explained by higher-energy traumas.

When the fracture pattern was analyzed based on Essex-Lopresti,<sup>9</sup> a similar distribution was observed in all fractures, of both the “tongue” and “joint depression” types. In bilateral fractures, the predominant fracture pattern was the “joint depression” type (63.6%). No correlation between this classification, and age, trauma mechanism and sex was found. We did observe that bilateral fractures presented the same fracture pattern in both feet.

A prevalence of Sanders type II fractures was detected in both unilateral (79.5%) and bilateral (82%) cases, while type III fractures amounted to 18% in both. Bilateral fractures shared the same Sanders type in both feet, but not the same subtype. No correlation between this classification, and age, trauma mechanism and sex was found.

One of the limitations of this series is its retrospective design, but the number of patients is significant.

## CONCLUSIONS

The analysis of our series allows us to conclude that calcaneus fractures are more frequent in males and young patients, and that the most common trauma mechanism is a height fall. In patients with bilateral fractures, the rate of associated injuries is higher, and the type of fracture is the same in both feet, according to the Sanders classification and the Essex-Lopresti fracture pattern.

Conflict of interest: The authors declare no conflicts of interest.

A. Pendino ORCID ID: <https://orcid.org/0000-0002-7391-6541>

E. Lombardo ORCID ID: <https://orcid.org/0000-0003-3600-628X>

## REFERENCES

1. Schepers T, van Lieshout EMM, van Ginhoven TM, Heetveld MJ, Patka P. Current concepts in the treatment of intra-articular calcaneal fractures: results of a nationwide survey. *Int Orthop* 2008;32:711-5. <https://doi.org/10.1007/s00264-007-0385-y>
2. Brauer CA, Manns BJ, Ko M, Donaldson C, Buckley R. An economic evaluation of operative compared with nonoperative management of displaced intra-articular calcaneal fractures. *J Bone Joint Surg Am* 2005;8(12):2741-9. <https://doi.org/10.2106/JBJS.E.00166>
3. Sanders R, Fortin P, DiPasquale T, Walling A. Operative treatment in 120 displaced intraarticular calcaneal fractures. Results using a prognostic computed tomography scan classification. *Clin Orthop Relat Res* 1993;(290):87-95. PMID: 8472475
4. Backes M, Schepers T, Beerekamp MSH, Luitse JSK, Goslings JC, Schep NWL. Wound infections following open reduction and internal fixation of calcaneal fractures with an extended lateral approach. *Int Orthop* 2014;38(4):767-73. <https://doi.org/10.1007/s00264-013-2181-1>
5. Atkins RM, Allen PE, Livingstone JA. Demographic features of intra-articular fractures of the calcaneum. *Foot Ankle Surg* 2001;7(2):77-84. <https://doi.org/10.1046/j.1460-9584.2001.00242.x>
6. Mitchell MJ, McKinley JC, Robinson CM. The epidemiology of calcaneal fractures. *Foot (Edinb)* 2009;19(4):197-200. <https://doi.org/10.1016/j.foot.2009.05.001>
7. Benson E, Conroy C, Hoyt DB, Eastman AB, Pacyna S, Smith J, et al. Calcaneal fractures in occupants involved in severe frontal motor vehicle crashes. *Accid Anal Prev* 2007;39(4):794-9. <https://doi.org/10.1016/j.aap.2006.11.010>

8. Bohl DD, Ondeck NT, Samuel AM, Diaz-Collado PJ. Demographics, mechanisms of injury, and concurrent injuries associated with calcaneus fractures: A study of 14 516 patients in the American College of Surgeons National Trauma Data Bank. *Foot Ankle Spec* 2017;10(5):402-10. <https://doi.org/10.1177/1938640016679703>
9. Essex-Lopresti P. The mechanism, reduction technique, and results in fractures of the os calcis. *Br J Surg* 1952;39(157):395-419. <https://doi.org/10.1002/bjs.18003915704>
10. 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. <https://doi.org/10.2106/00004623-200210000-00001>
11. Thorogood M, Parsons N, Shaw E, Kulikov Y, Hutchinson C, Thorogood M, et al. Operative versus nonoperative treatment for closed, displaced, intraarticular fractures of the calcaneus: Randomised controlled trial. *BMJ* 2014;349:g4483. <https://doi.org/10.1136/bmj.g4483>
12. Dooley P, Buckley R, Tough S, McCormack B, Pate G, Leighton R, et al. Bilateral calcaneal fractures: operative versus nonoperative treatment. *Foot Ankle Int* 2004;25(2):47-52. <https://doi.org/10.1177/107110070402500202>