Original Article

Calcaneal Fractures in a Trauma Center: A Retrospective Study

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Abstract

Objectives: Although calcaneal fractures are relatively uncommon, they are among injuries that may lead to short- and long-term morbidity regardless of the treatment. The Saudi Arabian literature showed a shortage of studies that analyzed the epidemiology of this fracture. This study aimed to analyze the epidemiology and characteristics of patients with calcaneus fractures. **Methods:** A retrospective study of all patients with calcaneal fractures admitted to King Fahd Hospital in Almadinah Almunawwarah City, Saudi Arabia, over a 4-year-period (January 2016–December 2019). Data such as age, gender, trauma mechanism, laterality of fracture, and associated injuries, were extracted from patients' medical files and analyzed using appropriate statistical tests. **Results:** The study analyzed data of 130 patients with calcaneal fractures (156 calcaneal fractures). Male patients (86.2%) were more commonly affected than females, at a ratio of 6.2:1. Ninety-three (71.5%) of the cases resulted from low-energy falls and road traffic accidents (RTA). Low-energy falls and falling from a height as injury mechanisms were higher in female patients, while RTA was more frequent in males. Bilateral fractures were found in 20% of cases, with a significantly higher rate in male patients. The associated skeletal injuries were more frequent in females than male patients (66.7% vs. 43.8%), while associated nonskeletal injuries were only found in 15 male patients, particularly those aged <40 years. **Conclusion:** Calcaneal fractures have a high rate of associated skeletal and nonskeletal injuries indicating the seriousness of these fractures. More research using data from multi-centers is warranted.

Keywords: Calcaneus, epidemiology, fracture, obesity, Saudi Arabia

Introduction

Calcaneal fractures are relatively uncommon and account for approximately 2% of all body fractures.[1-3] The treatment of such fractures and their outcome are based on several factors related to fracture characteristics, local soft tissue status, and presence or absence of concomitant injuries.[4] However, calcaneal fractures are among injuries that may lead to short- and long-term morbidity if missed or not treated properly.[5] Most calcaneal fractures result from falls from heights and Road Traffic Accidents (RTA) and they are known to be associated with high-energy axial trauma.[6-8] The most frequent associations with the calcaneal fractures were other skeletal injuries, particularly lower limb, foot, and spinal fractures. To a less extent, associated soft tissue injuries were mainly related to the chest and abdomen.[4]

The basic epidemiological data on the epidemiology of calcaneal fractures in Saudi Arabia are sparse, even though studies on the epidemiology of other fractures in the country are well-reported.[9-12] From this point of view, the present study aimed to analyze the recorded data of calcaneal fractures in a single trauma center in Almadinah Almunawwarah City, Saudi Arabia, over a 4-year-period providing new information on the epidemiology of calcaneal fractures in Saudi Arabia.

Subjects and Methods

A retrospective observational study was carried out by collecting data from the medical records and imaging studies of patients with acute calcaneal fractures admitted to King Fahd Hospital in Almadinah Almunawwarah City, Saudi Arabia.

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King Fahd Hospital is a major tertiary regional referral center with a highly equipped orthopedic unit and presence of board-certified orthopedic surgeons. It serves the region of Almadinah Almunawwarah population along with the myriad of pilgrims throughout the year. The study included all patients admitted to this hospital with a documented diagnosis of "calcaneus fracture," regardless of the treatment plan, from January 2016 to the end of December 2019. Patients with missing medical files' data have been excluded.

After approval from the Ethical and Research Committee and necessary administrative permissions, the following parameters were extracted from the patients' medical files and imaging archiving system: age, gender, trauma mechanism, laterality, and associated injuries. Low-energy falls have been defined as simple falling down from height of 5 feet or less. Because of missing data, the presence of open fractures and treatment procedures done for the cases were not included in the analysis. The collected data were analyzed using SPSS (version 22.0, IBM Corp., Armonk, NY, USA). Data of the studied subjects were presented in tables and charts. Comparison of the studied cases by the studied parameters was made by using Chi-square and Fischer's exact test as appropriate. $P \leq 0.05$ was used as an indicator of statistically significant differences. The confidentiality and privacy of the collected data were ensured by using anonymous data entry and analysis.

Results

The present retrospective study analyzed data from 130 patients with 156 calcaneus fractures admitted to the hospital from 2016 to 2019 (inclusive). The annual distribution of calcaneal fractures among the studied patients is illustrated in Figure 1. Most fractures affected males compared to females (86.2% vs. 13.8%). The average age of males was 33.9 ± 11.9 years, 34.9 ± 13.6 years for females ($P = 0.02$). In the male group, 74 of the cases (66.1%), and in the female group, 13 of the cases (72.2%) were below the age of 40 ($P = 0.60$). Ninety-three (71.5%) of the cases resulted from low-energy falls and RTAs.

Table 1 shows the mechanisms of calcaneus fractures among the studied cases by their gender. Although no significant differences were detected, low-energy falls (simple falling down from height of 5 feet or less) and falling from height were higher among female patients compared to males (50% and 22.2% vs. 34.8% and 18.8%, respectively). On the other hand, RTAs were more frequent in male patients (37.5%) compared to females (27.8%).

The distribution of the mechanisms of calcaneus fractures among the studied cases according to their age groups is shown in Table 2. Low-energy falls and falling from height were significantly higher among cases aged ≥40 years compared to those <40 years (46.5% and 20.9% vs.32.2% and 18.4%, respectively). However, RTA as a mechanism of injury was significantly more frequent in those cases <40 years (43.7%).

Bilateral fractures [Table 3] were found in 26 cases (20%), with significant differences between males (23/26) and females (3/26). Associated skeletal injuries were more frequent among females compared to males (66.7% vs. 43.8%). The

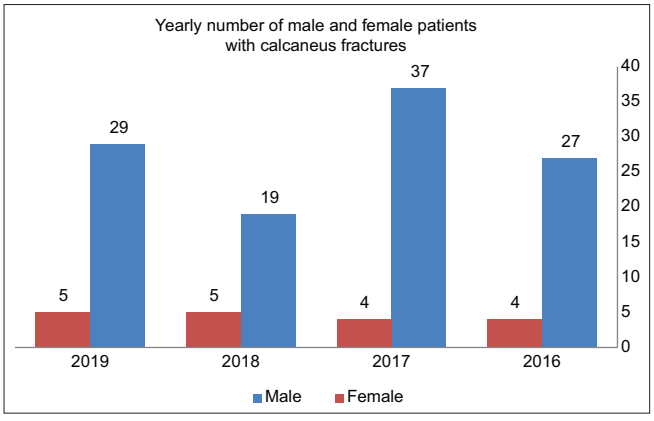

Figure 1: Yearly number of calcaneal fractures among the studied patients

Table 1: Causes of calcaneus fractures among the studied cases by their gender

Mechanism of fractures	Males (%)	Females (%)	*P*
Fall from height	21 (18.8)	4 (22.2)	0.47
Low-energy fall	39 (34.8)	9 (50.0)	
Road traffic accidents	42 (37.5)	5 (27.8)	
Direct trauma	10 (8.9)	0	
Total	112 (100)	18 (100)	

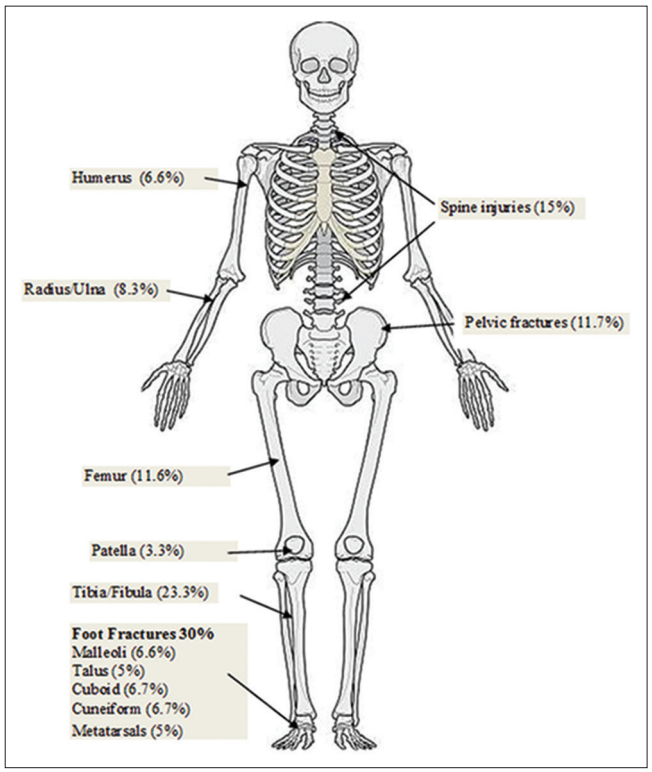

Figure 2: Skeletal sketch depicting the distribution of the 46.2% of patients with other skeletal injuries associated with calcaneus fractures

associated skeletal injuries in the studied 60 cases (46.2%) were depicted in a skeletal sketch [Figure 2]. Nonskeletal injuries, however, were only found in males, although the difference was not statistically significant, but it indicates that male injuries were more severe. Of nonskeletal injuries, the frequency was 5 cases with brain injury, 3 cases with chest injuries, and 7 cases with an abdominal injury.

Spinal injuries were present in association with calcaneal fractures in 20 cases. The majority were isolated lumbar spine fractures (12 out of 20), accounting for 60% of spinal injuries. Concomitant thoracic and lumbar spine injuries were the second most common with 25% (5 out of 20 cases). Two patients had isolated cervical spine injury and one suffered from a thoracic spine injury. It is worth noting that RTAs were the most common mechanism of injury in cases of concomitant calcaneal and spine injuries (75%), where falling from height accounted for the reminder. Another fact is that 30% of spinal injuries (6 out of 20 cases) occurred when there were bilateral calcaneal fractures.

Table 2: Causes of calcaneus fractures among the studied cases by their age groups

Mechanism of fractures	<40 years (%)	≥40 years (%)	*P*
Fall from height	16 (18.4)	9 (20.9)	0.04
Low-energy fall	28 (32.2)	20 (46.5)	
Road traffic accidents	38 (43.7)	9 (20.9)	
Direct trauma	5 (5.7)	5 (11.6)	
Total	87 (100)	43 (100)	

Table 3: Laterality of fractures and associated injuries among the studied cases by their gender

	Male (%)	Female (%)	*P*
Laterality			
Bilateral	23 (20.5)	3 (16.7)	0.004
Unilateral (right)	38 (34.0)	13 (72.2)	
Unilateral (left)	51 (45.5)	2 (11.1)	
Associated injuries			
No	49 (43.8)	6 (33.3)	0.10
Skeletal	48 (43.8)	12 (66.7)	
Nonskeletal	15 (13.4)	0	
Total	112 (100)	18 (100)	

Table 4: Laterality of fractures and associated injuries among the studied cases by their age groups

	<40 years (%)	≥40 years (%)	*P*
Laterality			
Bilateral	18 (20.7)	8 (18.6)	0.97
Unilateral (right)	34 (39.1)	17 (39.5)	
Unilateral (left)	35 (40.2)	18 (41.9)	
Associated injuries			
No	35 (40.2)	20 (46.5)	0.50
Skeletal	40 (46.0)	20 (46.5)	
Nonskeletal	12 (13.8)	3 (7.0)	
Total	87 (100)	43 (100)	

The laterality of fractures and associated injuries by patients' age group are illustrated in Table 4. Although comparable, the bilateral fractures rate was slightly higher in patients aged <40 years (20.7% vs. 18.8%). Nonskeletal injuries were found only in male patients and they were more frequent in cases <40 years compared with those aged ≥40 years (13.8% vs. 7%), although the difference was not significant.

Discussion

The present study showed that low-energy falls and falling from height were the main cause of calcaneal fractures among female patients, while RTAs were the main cause in males. Until near time in Saudi Arabia, women did not drive motor vehicles and may, therefore, were not involved frequently in RTAs as drivers. This was reflected in the present analysis, where male subjects were more commonly affected than female. However, that might not be entirely true as women could be involved in RTAs as passengers. Similar to these findings, Mitchell *et al.* reported calcaneus fractures due to falling from a height to represent more than 70% of their cases in a retrospective analysis on 697 cases over a 10-year-period.[3] In a study on 14516 patients with calcaneal fractures in the United States, Bohl *et al.* found that 37% of cases resulted from motor vehicle accidents, and 43% were due to falls.[2] In a recent retrospective analysis of 52 cases of calcaneal fractures, admitted to the Institute of Orthopedics and Traumatology of Sao Paulo in Brazil between 2006 and 2010, falling from height was the most dominant mechanism of injury (75%), followed by motorcycle accidents (11.5%) and automobile accidents (9.6%).[8]

Most fractures in the present study were found in male patients (86.4%), particularly among young patients aged <40 years. This finding was like that observed in several previous studies in the literature.[4,13] The higher incidence of calcaneal fractures among young males may be related to their frequent exposure to trauma mechanisms such as falls and RTAs. As the calcaneal fractures may require a minimum of 1 year to achieve complete functional recovery, and in some patients, the involvement of this young and productive group of the population might have worse consequences on public health and the national economy.[8]

The present study findings showed that bilateral fractures were found in 26 (20%) of the studied cases. This rate was higher compared with similar previous studies, which showed low rates of bilaterality ranged from 3.2% to 7.9%.[3,4] However, the rate of bilaterality (19.2%) reported in a previous recent study by Leite *et al.* was comparable to that reported in this study.[8] Compared with unilateral fracture, bilateral calcaneal fractures may be associated with higher rates of complications, and poorer prognosis.[13] The high rate of bilaterality in the present study might reflect the nature of the center where the study performed. The studied center represents the main trauma and referral center in Almadinah Almunawwarah region with a large catchment area.

The associated injuries in the present study were found in 69 cases (57.5%), and this relatively high rate might reflect the high energy of the injury suffered by many of the cases. Among these cases, skeletal injuries were detected in 60 cases (46.2%) and the foot bones were the most commonly affected, being found in 18 out of 60 cases (30%). Tibia and fibula fractures were the next most common associated fractures (23.3%), followed by spine fractures (15%), upper limb (14.9%), and finally femur (11.6%). There have been wide variations on orthopedics injuries associated with calcaneal fractures in different studies. A low rate of associated skeletal fractures was reported by Mitchell *et al.* study, where associated fractures were found in the lower limbs (13.2%) and spinal injuries (6.3%).[3] However, a higher rate of associated skeletal injuries, was reported by Leite *et al.,* where the rate of associated fractures was as high as 48% of the studied 52 cases.[8] In Bohl *et al.* study, lower limb fractures were found in 61% of the studied cases, while spinal injuries were found in 23% of the cases. In the latter study, lumbar spine fractures were the most associated spinal injuries.[2] In the present study, isolated lumbar spine fractures were observed in 60% of the associated spinal injuries (12 out of 20 spinal injury cases). What was observed in this study and other similar studies, that lower limb fractures (particularly foot and leg bones) were the most common associated skeletal injuries followed by spinal fractures (particularly lumbar spine).[2,3,8]

Nonskeletal injuries in the present study, were found only in male patients and were more frequent in younger patients (<40 years). The most frequent were head and abdominal injuries. A retrospective study by Worsham *et al.* on 62 cases with open calcaneus fractures, over 10 years' period reported 10 (16.1%) patients with an associated closed head injury and 6 (9.6%) with an abdominal injury.[4]

This study's strengths include that it is the first study, up to authors' knowledge, examining the epidemiology of calcaneal fractures in Almadinah Almunawwarah City, Saudi Arabia. The authors are unaware of similar studies in Saudi Arabia. Furthermore, the study has presented the data according to the studied patients' gender and age. Although the present study included a greater number compared to other studies, a relatively low number of subjects can be considered a limitation of the present study.[8] Like other retrospective studies, the potential risk of missing data could not be prevented, and thus, the study analysis did not extend the analysis to examine the treatment protocols and other predictors of outcome. However, this study's main aim was to provide Saudi literature with new information about the epidemiologic patterns of calcaneal fractures in Almadinah Almunawwarah, particularly in terms of associated injuries.

Conclusion

The prevalence of calcaneal fractures has appeared relatively uncommon, particularly when compared with other types of fractures. Men younger than age of 40 years have experienced higher occurrence of calcaneal fractures.

Recommendations

Understanding the prevalence and distribution of this rare fracture through epidemiological studies is very useful in its prevention and control programs. Future studies are needed taking into consideration the management and outcome of these patients during hospitalization.

Ethical approval

The ethical approval was granted from the Research Ethics Committee, College of Medicine, Taibah University, Almadinah Almunawwarah under study ID: TU-20-008 on 25/12/2020.

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Conflicts of interest

There are no conflicts of interest.

Authors' contributions

YA has designed the study, the main contributor for all phases of the study, ethical board review application, reviewed the data, and edited the manuscript throughout the whole process. All co-authors have substantially contributed to literature research, manuscript preparation, critical analysis of the final draft. AS, HOA, HAS, and AK shared in data acquisition. AS, AK, AG, and HMA shared in data analysis. YA is the guarantor of the study. All authors have critically reviewed and approved the final draft and are responsible for the manuscript's content and similarity index.

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