



The role of patient positioning in surgical fixation of the calcaneus fractures using the lateral extensile approach

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Abstract

Introduction Calcaneus is the most commonly fractured tarsal bone. Open reduction and internal fixation of the displaced intra-articular fractures is considered the gold standard treatment. The lateral extensile approach is the most commonly used approach, and usually, the patients are kept in lateral decubitus position. Recent study has described calcaneus fracture fixation utilizing the lateral extensile approach with the patient in prone position. The aim of this study was to compare the postoperative radiological outcome, reoperation rate, operative and anesthesia time, infection and the wound complications rate between the two groups.

Methods The data of 49 adult patients with unilateral closed calcaneus fracture underwent open reduction and internal fixation using lateral extensile approach were collected. Postoperative Bohler's, Gissane angles and complications rate were compared between the two groups.

Results A total of 49 patients were included. Lateral position was utilized in 26 patients (53.1%), while 23 patients (46.9%) were operated in prone position. Majority of the patients were males 87.8% (43 patients), and the mean age of the patients was 31.12 ± 7.50 . The most commonly mechanism of injury was fall from height in (91.8%) of the patients.

The mean preoperative Bohler's angle was 9.33 ± 13.07 and increased to 22.69 ± 9.15 postoperatively. The mean preoperative angle of Gissane was 130.45 ± 26.98 whereas it was 124.76 ± 17.20 postoperatively. The mean postoperative Bohler's angle and angle of Gissane were significantly higher among patient who underwent fixation in lateral position (25.88 ± 6.62 , 137.15 ± 11.17) when compared to the prone one (19.09 ± 10.35 , 110.74 ± 10.81). There was no significant difference between the two groups regarding the reoperation rate (p 0.947), infection (p 0.659, operative time (p 0.688), anesthesia time (p 0.522) and wound complications (p 0.773).

Conclusion Surgical restoration of the Bohler's and Gissane's angles with the patient placed in the lateral decubitus position remains superior to the prone position with no difference in the complication rate between the two groups.

Keywords Calcaneal fracture · Lateral extensile approach · Prone position · Lateral position · Calcaneus fixation

Introduction

Calcaneus is the most commonly fractured tarsal bone and accounts for approximately 60% of all tarsal bone fractures and 2% of all bone fractures [1, 2]. Anatomical characteristics of the calcaneus such as loose trabecular bone with thin

cortices and its position in the hindfoot make it susceptible for fractures [2, 3]. These fractures are mainly occupational injuries that occur secondary to a fall from height in young laborer men [4–9]. Controversy on the treatment of calcaneus fractures remains, as several different operative and non-operative surgical strategies exist [10–12]. However, open reduction and internal fixation has been considered the gold standard treatment for intra-articular displaced calcaneus fractures, as it generally provides good functional outcomes and the ability to anatomically restore the subtalar joint [4].

Several surgical approaches have been described previously in the literature, with the extended lateral approach

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being the mostly used approach [11, 13–15]. Usually, patients undergoing surgical treatment with lateral extensile approach are placed in the lateral decubitus position [16]. A recent study by Hasan et al. has described the fixation of calcaneus fracture in prone position [17].

Up to our knowledge, there have been no studies in the literature comparing the effect of lateral versus prone position in the surgical management of calcaneus fractures.

The aim of this study was to investigate the effect of patient position on the postoperative radiological outcome and the complications rate in patients undergoing surgical fixation of the calcaneus utilizing the lateral extensile approach.

Methodology

Study design

This retrospective cohort study was conducted at an academic level I trauma center, and it was approved by the institutional review board. All the medical records, preoperative and postoperative radiographs of the surgically treated calcaneus fracture between [2006 and 2011 + 2015 and 2016] were reviewed to identify the eligible patients. The study compared the prone versus the lateral position for open reduction and internal fixation of displaced calcaneus fracture utilizing the L-shape extensile approach. The primary outcome was the postoperative Bohler's angle. The secondary outcomes were as follows: Angle of Gissane, operative time, anesthesia time, infection rate, reoperation rate, and wound complications. Sanders' classification was used to describe the fractures.

Eligibility criteria

The inclusion criteria were patients above the age of 18, who sustained a unilateral closed calcaneus fracture Sanders II or III, that underwent open reduction and internal fixation using the L shaped extensile approach. The exclusion criteria were as follows: Patients below the age of 18, Sander I and IV, bilateral injuries, sinus tarsi approach, closed or open reduction and K-wire pinning, open injuries, incomplete documentation and lack of postoperative X-rays.

Data analysis

Categorical variables were presented as counts and percentages while continuous variables were interpreted as mean, standard deviation and range. The differences in the characteristics and the outcomes of the patients operated in the lateral and prone positions were done using Chi-square test and T test for categorical and continuous variables, respectively.

Variables that were significant in the Chi-square and T test were subsequently tested in the **multivariable logistic regression** to test the association between patients position and the outcomes of interest. Any test with a *P* value < 0.05 was considered significant. The data analysis was done using IBM-SPSS v.25.

Results

Participants

A total number of 110 patients were identified in our database search, 61 of who were excluded, as they did not meet the eligibility criteria. The total number of the included patients with surgically treated calcaneus fractures was 49 patients. Lateral position was utilized in 26 patients (53.1%), while the rest were operated in prone position.

Majority of the patients were males 87.8% (43 patients) with a mean age of 31.12 ± 7.50 . Falling from height was the most commonly mechanism of injury (91.8%). Sanders Classification of the fracture among the included patients showed that 61.2% of the fractures were Type III and the rest were Type II. Infections occurred only in 2.0% of the patients. Furthermore, reoperation and wound complications occurred in 4.9 and 8.3%, respectively. The mean preoperative Bohler angle was 9.33 ± 13.07 while it was 22.69 ± 9.15 postoperatively. The mean preoperative angle of Gissane was 130.45 ± 26.98 whereas it was 124.76 ± 17.20 postoperatively. The characteristics of the included patients are described in Table 1.

Differences between Lateral and Prone Position in the Characteristics and the Outcomes

The patient's mean age was significantly higher in the lateral position group (33.31 ± 7.85) than the prone group (28.65 ± 6.37). Moreover, there was significant difference in the sanders classification between the two groups. The lateral position group had higher number of type III fracture (76.9%) when compared to the prone position (43.5%). Additionally, the frequency of associated injuries, as well as the mean preoperative Bohler's and Gissane's angles, were significantly higher in the lateral group. Also, the mean postoperative Bohler's angle and angle of Gissane were significantly higher among the lateral group (25.88 ± 6.62 , 137.15 ± 11.17) when compared to the prone one (19.09 ± 10.35 , 110.74 ± 10.81), respectively (Table 2).

There was no significant difference between the two groups regarding the reoperation rate (*p* 0.947), infection (*p* 0.659), operative time (*p* 0.688), anesthesia time (*p* 0.522) and wound complications (*p* 0.773).

Table 1 Demographic characteristics of participants

Variable	Response	Frequency (<i>n</i> = 49)	Percentage (%)
Sex	Male	43	87.8
	Female	6	12.2
Mechanism of injury	FFH	45	91.8
	Others	4	8.2
Laterality of the fracture	Left	23	46.9
	Right	25	51.0
	Bilateral	1	2.0
Sanders classification based on CT scan	Class 2	19	38.8
	Class 3	30	61.2
Patient position	Lateral	26	53.1
	Prone	23	46.9
Infection	Yes	1	2.0
	No	48	98.0
Associated injuries	Yes	18	36.7
	No	31	63.3
Reoperation	Yes	2	4.9
	No	39	95.1
Wound complications	Yes	4	8.3
	No	44	91.7
Variable	Mean	SD	Range
Age	31.12	7.50	30
Anesthesia time (minutes)	164.18	43.87	210
Operative time	128.47	38.42	200
Preoperative Bohler angle	9.33	13.07	86
Postoperative Bohler angle	22.69	9.15	45
Preoperative angle of Gissane	130.45	26.98	105
Postoperative angle of Gissane	124.76	17.20	67

Factors Associated with Postoperative Bohler's Angle and Angle of Gissane

The multivariable logistic regression analysis for the factors associated with postoperative Bohler Angle showed that only preoperative Bohler angle was significantly associated with postoperative Bohler Angle (Table 3; Adjusted $B = 0.35$; 95%CI: 0.16–0.55). Additionally, the multivariable regression analysis for the factors associated with postoperative angle of Gissane revealed that only patients' position during the operation was significantly associated with postoperative angle of Gissane as prone position was significantly associated with reduction in postoperative angle of Gissane (Table 4; Adjusted $B = -21.80$; 95%CI: -37.41 – -6.18).

Discussion

The most important finding of the present study is that there was a significant difference between the two groups with better restoration of the Gissane's and Bohler's angles in patients undergoing open reduction and internal fixation in the lateral decubitus position compared to prone position. However, there was no significant difference between the two groups regarding reoperation rate, infection, operative time, anesthesia time and wound complications.

Treatment of calcaneus fracture remains controversial, because of the suboptimal results and the high incidence of complications associated with both non-operative as well as operative treatments. On one hand, non-operative treatment

Table 2 Differences between lateral and prone positions

Variable		Lateral (n=29)	Prone (n=23)	P value
Sex	Females	2 (7.7)	4 (17.4)	0.239
	Males	24 (92.3)	19 (82.6)	
Mechanism of injury	FFH	25 (96.2)	20 (87.0)	0.455
	Others	1 (3.8)	3 (13.0)	
Laterality	Left	14 (53.8)	9 (39.1)	0.293
	Right	11 (42.3)	14 (60.9)	
	Bilateral	1 (3.8)	0 (0.0)	
Sanders classification	Class 2	6 (23.1)	13 (56.5)	0.035
	Class 3	20 (76.9)	10 (43.5)	
Infection	Yes	0 (0.0)	1 (4.3)	0.659
	No	26 (100.0)	22 (95.7)	
Associated injuries	Yes	15 (57.7)	3 (13.0)	0.004
	No	11 (42.3)	20 (87.0)	
Reoperation rate	Yes	1 (5.6)	1 (4.3)	0.947
	No	17 (94.4)	22 (95.7)	
Wound complications	Yes	2 (7.7)	2 (9.1)	0.773
	No	27 (92.3)	20 (90.9)	

Variable	Lateral (n=29)	Prone (n=23)	P value
Age	33.31 ± 7.85	28.65 ± 6.37	0.028
Anesthesia time	167.88 ± 54.11	160.00 ± 28.92	0.522
Operative time	130.58 ± 46.38	126.09 ± 27.67	0.688
Preoperative Bohler angle	13.81 ± 4.71	4.26 ± 17.23	0.016
Preoperative angle of Gissane	152.54 ± 7.79	105.48 ± 17.06	0.000
Postoperative Bohler angle	25.88 ± 6.62	19.09 ± 10.35	0.010
Postoperative angle of Gissane	137.15 ± 11.17	110.74 ± 10.81	0.000

Table 3 Factors associated with postoperative Bohler Angle

Variable	Adjusted B	(95%CI)
Sanders classification	2.31	(− 2.87–7.48)
Associated injuries	− 0.42	(− 4.98–5.82)
Age	− 0.12	(− 0.450–0.21)
Preoperative Bohler angle	0.35	(0.16–0.55)
Preoperative angle of Gissane	0.02	(− 0.16–0.20)
Patients position	− 1.96	(− 12.79–8.88)

Table 4 Factors associated with postoperative angle of Gissane

Variable	Adjusted B	(95%CI)
Sanders Classification	1.87	(− 5.59–9.32)
Associated Injuries	− 1.55	(− 9.33–6.23)
Age	− 0.05	(− 0.52–0.43)
Preoperative Bohler Angle	0.21	(− 0.07–0.49)
Preoperative Angle of Gissane	0.06	(− 0.20–0.32)
Patients Position	− 21.80	(− 37.41–− 6.18)

is associated with higher percentage of joint arthritis, chronic pain and stiffness; on the other hand, surgical treatment is associated with higher incidence of wound complications and neurovascular injuries [4, 11, 14, 18–25].

The surgical aim of calcaneus fracture fixation is restoration of the articular facets, calcaneal height as well as the heel width. This can be achieved by restoration of the Bohler's angle which assesses the degree of joint depression and loss of height, and the Gissane's angle which assesses the relation between the calcaneal facets [26].

Loucks and Buckley evaluated the correlation of Bohler's angle with surgical reduction of calcaneal fractures and concluded that surgical reduction improves the angles values and the patients function [27].

There have been no previous reports of comparing these two angles in patient undergoing calcaneal fixation in prone position versus lateral position.

Hasan et al. has reported significant restoration of the Gissane's and Bohler's angles with prone position [17].

Another finding of this study was a low incidence of infection (2%) and wound dehiscence (8%) compared

to what has been reported in literature. The incidence of superficial infection has been reported to be as high as 27%, whereas deep infection was reported between 1.3 and 2.5% [4, 16].

This study had several limitations such as the retrospective design of the study and its associated biases. Additionally, multiple surgeons were involved in the operations. Moreover, the small number of cases, failure to report functional outcomes and lack of long term postoperative complications add to the limitations of this study. Therefore, a larger prospective study can be undertaken in the future to avoid these limitations.

Conclusion

Surgical restoration of the Bohler's and Gissane's angles with the patient placed in the lateral decubitus position remains superior to the prone position and is associated with better restorations of the angles. However, there was no difference in reoperation rate, infection, operative and anaesthesia time and wound complications between the two groups.

Authors' contribution All authors made a substantial contribution to the manuscript. HK, IM, and AH performed the literature review. HK, IM, MR and OB collected the data. AT performed the statistical analysis. HK, AH, AT and MAA wrote the manuscript. MA and GA supervised the whole project, helped prepare the manuscript and reviewed the final manuscript.

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Declarations

Conflict of interest The authors declare that they have no competing interests.

Ethical approval Not applicable.

Informed consent Not applicable.

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References

1. Cave EF (1963) Fracture of the os calcis—the problem in general. *Clin Orthop Relat Res* 30:64–66
2. Atkins RM, Allen PE, Livingstone JA (2001) Demographic features of intra-articular fractures of the calcaneum. *Foot Ankle Surg* 7(2):77–84
3. Poeze M, Verbruggen JPAM, Brink PRG (2008) 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* 90(5):1013–21
4. Sanders R (2000) Displaced intra-articular fractures of the calcaneus*: The Journal of Bone and Joint Surgery-American Volume, 82(2): 225–50
5. Barei DP, Bellabarba C, Sangeorzan BJ, Benirschke SK (2002) Fractures of the calcaneus. *Orthop Clin North Am* 33(1):263–85
6. Roukis TS, Wünschel M, Lutz HP, Kirschner P, Zgonis T (2008) 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* 25(2):285–99
7. Schepers T (2019) Sinus Tarsi approach with screws-only fixation for displaced intra-articular calcaneal fractures. *Clin Podiatr Med Surg* 36(2):211–224
8. Hordyk PJ, Fuerbringer BA, Roukis TS (2019) Clinical management of acute, closed displaced intra-articular calcaneal fractures. *Clin Podiatr Med Surg* 36(2):163–171
9. Su Y, Chen W, Zhang T, Wu X, Wu Z, Zhang Y (2013) Bohler's angle's role in assessing the injury severity and functional outcome of internal fixation for displaced intra-articular calcaneal fractures: a retrospective study. *BMC Surg* 13:40
10. Bajammal S, Tornetta P, Sanders D, Bhandari M (2005) Displaced intra-articular calcaneal fractures. *J Orthop Trauma* 19(5):360–364
11. Buckley R, Tough S, McCormack R, Pate G, Leighton R, Petrie D et al (2002) Operative compared with nonoperative treatment of displaced intra-articular calcaneal fractures: a prospective, randomized, controlled multicenter trial. *J Bone Joint Surg Am* 84(10):1733–1744
12. Essex-Lopresti P (1952) The mechanism, reduction technique, and results in fractures of the os calcis. *Br J Surg* 39(157):395–419
13. Sanders R, Fortin P, DiPasquale T, Walling A (1993) Operative treatment in 120 displaced intraarticular calcaneal fractures. Results using a prognostic computed tomography scan classification. *Clin Orthop Relat Res* 290:87–95
14. Benirschke SK, Sangeorzan BJ (1993) Extensive intraarticular fractures of the foot. Surgical management of calcaneal fractures. *Clin Orthop Relat Res* 292:128–134
15. Zwipp H, Tscherner H, Thermann H, Weber T (1993) Osteosynthesis of displaced intraarticular fractures of the calcaneus. Results in 123 cases. *Clin Orthop Relat Res* 290:76–86
16. Rak V, Ira D, Masek M (2009) Operative treatment of intra-articular calcaneal fractures with calcaneal plates and its complications. *Indian J Orthop* 43(3):271–280
17. Hasan K, Foodoul M, Kayum S, AbuHejleh H, AlKhayarin M (2023) Calcaneus fracture fixation in prone position: a novel technique and case series. *Cureus*. <https://doi.org/10.7759/cureus.28480>
18. Raymakers JTFJ, Dekkers GHG, Brink PRG (1998) Results after operative treatment of intra-articular calcaneal fractures with a minimum follow-up of 2years. *Injury* 29(8):593–599
19. Pozo JL, Kirwan EO, Jackson AM (1984) The long-term results of conservative management of severely displaced fractures of the calcaneus. *J Bone Joint Surg Br* 66(3):386–390

20. Slätis P, Kiviluoto O, Santavirta S, Laasonen EM (1979) Fractures of the calcaneum. *J Trauma* 19(12):939–943
21. Crosby LA, Fitzgibbons T (1990) Computerized tomography scanning of acute intra-articular fractures of the calcaneus. A new classification system. *J Bone Joint Surg Am* 72(6):852–9
22. Kitaoka HB, Schaap EJ, Chao EY, An KN (1994) Displaced intra-articular fractures of the calcaneus treated non-operatively. Clinical results and analysis of motion and ground-reaction and temporal forces. *J Bone Joint Surg Am* 76(10):1531–40
23. Leung KS, Chan WS, Shen WY, Pak PP, So WS, Leung PC (1989) Operative treatment of intraarticular fractures of the os calcis—the role of rigid internal fixation and primary bone grafting: preliminary results. *J Orthop Trauma* 3(3):232–240
24. Folk JW, Starr AJ, Early JS (1999) Early wound complications of operative treatment of calcaneus fractures: analysis of 190 fractures. *J Orthop Trauma* 13(5):369–372
25. Abidi NA, Dhawan S, Gruen GS, Vogt MT, Conti SF (1998) Wound-healing risk factors after open reduction and internal fixation of calcaneal fractures. *Foot Ankle Int* 19(12):856–861
26. Guerado E, Bertrand ML, Cano JR (2012) Management of calcaneal fractures. *Injury* 43(10):1640–1650
27. Loucks C, Buckley R (1999) Bohler's angle: correlation with outcome in displaced intra-articular calcaneal fractures. *J Orthop Trauma* 13(8):554–558

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