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Original Research Article

A Comparative Study of Displaced Intra-Articular Fractures of Calcaneum Treated by Extensile Lateral Versus Sinus Tarsi Approach

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Abstract

Introduction: Currently, Open Reduction Internal Fixation (ORIF) through the Extensile Lateral approach is considered the most widely accepted surgical procedure for displaced intra- articular calcaneal fracture. Minimally invasive reduction and fixation techniques via Sinus Tarsi approach (STA) have been developed in attempts to avoid potential complications associated with an extensile lateral approach, The purpose of this study is to evaluate functional and clinical outcome of displaced intra- articular fractures of calcaneum (DIACF) treated by using Extensile Lateral and Sinus Tarsi approaches.

Materials and Methods: This study was carried out in GMERS Medical College and General Hospital Gotri Vadodara from August 2020 to May 2022, consisting of total 42 patients of intra-articular fractures of calcaneum. This was a comparative prospective study. All the patients were operated by surgeons experienced in both the approaches.

Results: Majority were male patients with mean age of 37 years and had history of fall from height as mode of injury and had unilateral calcaneum fracture. 90.5% of patients for ST approach were operated within 4 days of admission as compared to 61.9% of patients for EL approach who were operated within 4-6 days of admission. Days of hospitalization were more for EL compared to ST group with significant difference ($P<0.005$) Functional outcome at 24 weeks by AOFAS scoring system depends on fracture pattern and approach used for it. AOFAS score 78/100 for ST approach for Sanders type 2 and 75/100 for EL approach for Sanders type 3. EL group had more complications in the form of plate removal due to infection, skin necrosis or wound dehiscence as compared to ST group.

Conclusion: Our study showed better results for Sander's Type II Calcaneal fractures by Sinus Tarsi approach and better results for Sander's Type III Calcaneal fractures by Extensile Lateral approach.

Keywords: Extensile Lateral Approach, Sinus Tarsi Approach, Calcaneum Fractures.

INTRODUCTION

Fracture of the calcaneum remains among the most challenging for the orthopedic surgeon[1]. Calcaneus fractures account for approximately 2% of all fractures, displaced intra-articular fracture comprising 60% to 75% of these injuries[2]. They occur more commonly in males, accounting for 60% of all tarsal fractures3. Most common mechanism of injury is fall from a height with axial loading of calcaneus.

Calcaneus is a weight bearing bone and forms the subtalar joint which helps in fine movements of the foot. So, intra-articular fracture of calcaneum can cause subtalar arthritis and lead to walking on uneven surface extremely painfu[4]. Calcaneum fracture, when it is severe and comminuted, leaves behind a lifelong disability[5].

There exist many different views regarding the management of calcaneum fracture. These fractures become a challenge due to the irregular bony anatomy and the joint between the tarsal bones and soft tissue[6].

Management of calcaneum fracture is always a controversy, due to a low level of evidence[7]. And some authors have suggested conservative treatment over operative management for displaced intra-articular calcaneal fractures, which has shown poor results[8].

Randomized control trial and Meta-analysis have shown that surgical treatment is preferred for calcaneum fracture[9]. Currently, Open Reduction Internal Fixation (ORIF) through the Extensile Lateral approach is considered the most widely accepted surgical procedure for displaced intra- articular calcaneal fracture[10]. Using this approach, one can manipulate the sub-talar joint and achieve anatomical reduction. We can get satisfactory lateral wall for rigid fixation. With this approach, exposure of fracture fragment is very good and easily reducible[11]. However, ORIF technique is related to wound related complications like infections, wound dehiscence and skin necrosis[12]. In such cases, patient must be operated again for removal of the implant along with surgical debridement and some kind of soft tissue procedure. This increases the hospital stay, rehabilitation is delayed and patient misses their jobs causing further social-economic stress[13].

These complications of ORIF have driven surgeons to look for conservative management, closed reduction, external fixation or percutaneous technique in order to reduce complication rate and hospitalization time[14]. Various minimally invasive surgical techniques have been developed to reduce the complication rate which provides acceptable reduction of fracture[15].

Minimally invasive reduction and fixation techniques via Sinus Tarsi approach (STA) have been developed in attempts to avoid potential complications associated with an extensile lateral approach[16]. This approach directly visualizes the subtalar joint and aids in percutaneous reduction and fixation techniques. However, this technique poses some difficulty in hind foot alignment restoration and may result in some varus deformity or at times subtalar stiffness[17].

The purpose of this study is to evaluate functional and clinical outcome of displaced intra- articular fractures of calcaneum (DIACF) treated by using Extensile Lateral and Sinus Tarsi approaches. Several studies have compared the results of these two approaches and have varied result.

MATERIALS AND METHODS

Place of Study: GMERS Medical College, Gotri, Vadodara, Gujarat 390021

Study Population: Patients with displaced intraarticular fracture of calcaneum satisfying inclusion criteria admitted in indoor ward of Department of Orthopedics, G.M.E.R.S. Medical college and Hospital, Gotri, Vadodara 390021 during the study period of August 2020 to May 2022 were included in the study.

Duration of Study: 24 months or till desired sample size is attained (whichever is earlier)

Sample Size: As per inclusion criteria, 42 patients were included into the study. (21 in each group)

Study Design: Comparative study.

Study Type: Prospective.

Data Collection Methods: All patients satisfying inclusion criteria were included and worked up clinically and radiologically and examined according to protocol, associated injuries, were noted and investigations carried out in order to evaluate fitness for surgery.

Statistical Methods: Sample size is calculated at study power of 80% and α-error of

0.05 assuming SD of 6 unit

(Sample size will be calculated using good to excellent functional outcomes to be 85%. The precision taken as 15% and alpha error of 5%)

Inclusion Criteria:
1. Sanders type II and III fractures of calcaneum.
2. Age group-18 to 70 years.
3. Both male and female patients.
4. Patients giving consent for operative procedure.

Exclusion Criteria:
1. Patients not giving consent for operative procedure.
2. Open injuries.
3. Patients not fit for surgery.
4. Polytrauma patients
5. Case with neurovascular deficit.
6. Patients having bilateral calcaneum fracture.

Data Collection

On admission vitals of all cases were assessed and examination was done for any associated injury. All cases were evaluated radio logically with lateral and axial view of calcaneum, in addition X rays of spine and pelvis were also done to rule out associated injuries.

3D CT scan also done in all cases. Patients were given strict limb elevation and below knee slab and medication given to reduce oedema.

Pre-operatively Bohler's angle and Crucial angle of Gissane were measured in all patients. All the fractures of calcaneum were classified according to Sanders classification based on CT scan.

The technique used was dependent on type of fracture, quality of bone and soft tissue, and the age and reliability and functional demands of the patients. Following Two approaches have been used:

1. Extensile Lateral approach

2. Sinus Tarsi approach.

1. **Extensile lateral approach for open reduction and internal fixation with plating:** Patient is taken on simple table and semilateral or lateral position is given. Painting and draping is done. Injectable antibiotics are given before tourniquet inflation. Tourniquet is inflated after keeping the affected limb elevated for few minutes. In selected patients, EL approach is used. Lateral wall is lifted to visualized posterior facet. One Schanz pin is inserted to manipulate the tuberosity fragment and disimpact it. This allows to correct the alignment during the whole procedure. Now depressed posterior facet fragment is elevated by using a blunt instrument like punch and temporarily fixed with K-wires inserted subchondrally from lateral to medial and/or heel to sustentaculum tali fixed to sustentaculum fragment. Now, if required cortico-cancellous iliac crest bone graft is inserted into the void created. Tuberosity fragment is fixed provisionally with multiple K-wires in posterior-anterior direction after alignment. Fluoroscopic lateral and axial images are taken and articular reduction as well as alignment is checked. Lateral wall fragment is replaced back into its position. Now the appropriate sized anatomical plate is selected and final fixation is done by using plate and screws. Final reduction and implant position is checked under fluoroscopy. Tourniquet is deflated and hemostasis is achieved. The wound is thoroughly irrigated with saline. Subcutaneous tissue is closed intermittently with absorbable suture polyglactin 910 no.2-0 and skin is closed

intermittently with non-absorbable suture material monofilament polyamide ethilon no.2-0. Drain is not used in any patient. Padded dressing is applied.

2. Sinus Tarsi approach: Patient is taken on simple table and semi lateral or lateral position is given. After painting and draping, ST approach is taken. One ST pin is inserted into tuberosity fragment from lateral to medial direction and/or posterior-anterior direction to manipulate the tuberosity fragment achieve alignment and alignment is achieved any depressed intra-articular fragment if present is elevated using blunt instrument. Sometimes if required subtalar joint is distracted using Push screw technique with using 6.5mm CC screw. Now fracture is provisionally fixed with K-wires from posterior to anterior direction through tuberosity fragment across the fracture site. Now fluoroscopic lateral and axial image are taken and reduction as well as position of wires is checked. Now if reduction is found to be acceptable, the fracture is either permanently fixed with K-wires or CC screw from posterior to anterior direction. If additional fixation is required to support depressed posterior facet fragment, it is fixed with additional CC screw from lateral to medial direction aiming to fix it to sustentaculum fragment. Fixation and reduction of fracture fragments is checked under fluoroscopy image. The wound is thoroughly irrigated with saline. Subcutaneous tissue is closed intermittently with absorbable suture polyglactin 910 no.2-0 and skin is closed intermittently with non-absorbable suture material monofilament polyamide ethilon no.2-0. Drain is not used in any patient. Padded dressing is applied.

Post operative protocol for both approaches:

- Below knee slab and limb elevation.
- Injectable antibiotics for Two days followed by oral antibiotics for Five days.
- Sutures removal at 2-3 week and ankle range of motion.
- Radiographs at 6 weeks to assess union, Bohler's angle and Gissane's angle and subtalar arthritis.
- Subtalar and ankle range of movement with strict non weight bearing for another 4-6 weeks.
- Progressive weight bearing

Post operative pain at 24, 48 and 72hr is assessed by Visual Analogue Scale.

At each visit patients are physically examined regarding the condition of scar, any sign of infection, heel width, subtalar and ankle movements and any other possible complications.

Final functional outcome of operative management was assessed by **AOFAS Score**. Outcome measures:

1. For Pain:

Visual Analogue Scale

2. For Functional outcome: AOFAS scoring system: Out of 100
Excellent: 86-100
Good: 70-85
Fair: 55-70

3. For Radiological outcome:

Following were assessed on radiograph:

Bohler and Gissane angle measurement at each visit Subtalar arthritis

RESULTS

Variables	Categories	EL (%)	ST (%)	Total (%)	P-Value
Sex	Male	20(95.2)	18(85.7)	38 (90.5)	0.6
	Female	1 (4.8)	3 (14.3)	4 (9.5)	
	Road Traffic	5 (23.8)	11(52.4)	16 (38.1)	
Mode of Injury	Accident				0.1
	Fall from Height	16(76.2)	10(47.6)	26 (61.9)	

	Construction worker	8 (38.1)	2 (9.5)	10 (23.8)	
	Farmer	1 (4.8)	3 (14.3)	4 (9.5)	
Occupation	Labourer	6 (28.6)	6 (28.6)	12 (28.6)	0.2
	Painter	2 (9.5)	3 (14.3)	5 (11.9)	
	Student	3 (14.3)	2 (9.5)	5 (11.9)	
	Teacher	0 (0.0)	2 (9.5)	2 (4.8)	
Fracture Side	Rt	11(52.4)	13(61.9)	24 (57.1)	0.8
	Lt	10(47.6)	8 (38.1)	18 (42.9)	
Sanders Type	II	8 (38.1)	12(57.1)	20 (47.6)	0.4
	III	13(61.9)	9 (42.9)	22 (52.4)	
Admission to Surgery Duration	< 4 days	5 (23.8)	19(90.5)	24 (57.1)	
	4 – 6 days	13(61.9)	2 (9.5)	15 (35.7)	**<0.001**
	> 6 days	3 (14.3)	0 (0.0)	3 (7.1)	
Fracture Union Duration	< 2.5 months	8 (38.1)	8 (38.1)	16 (38.1)	0.6

From the above frequency distribution table, we can conclude that only the variable "Injury to Surgery Duration" is statistically significantly different in EL and ST approaches as the P-value

<0.05. All other variables have P-values>0.05 and therefore, those variables are not significantly different in EL and ST approaches in our study.

90.5% patients operated within 4 days with STapproach and it took 4-6 days for 61.9% patients to get operated for EL approach.

For sample size of 42 patients 21:21 for each EL and ST approach suggest that majority of Male (90.5%) were involved with 61.9% had history of fall from height. Among them 12% were doing labourer work.

According to above data, Right side (57.1%) and Sanders type 3 (52.4%) more commonly involved.

Data for EL approach denotes that patients mean age was 37 year with mean duration of hospitalization of 11 days. In this group of data patients having pre and post operative Ba was 18.71 and 32.38 respectively and pre and post operative Ga was 142.33 and 127.62. All patients under EL approach have mean AOFAS at 24week was 75.62 and mean VAS was 9.76, 8.62 and 7.29 for 24hr, 48hr and 72hr respectively.

Data for ST approach denotes that patients mean age was 36.19 year with mean duration of hospitalisation of 7.62 days. In this group of data patients having pre and post operative Ba was 19.57 and 31.57 respectively and pre and post operative Ga was 142.05 and 124.33. All patients under ST approach have mean AOFAS at 12 week and 24week was 53.71 and 78.95 respectively. Mean VAS was 8.57, 7.86 and 6.71 for 24hr, 48hr and 72hr respectively.

Comparison of final outcome among both groups:

Ankle-Hindfoot Scale	EL (%)	ST (%)	Total (%)	P-value
Excellent (86-100)	0 (0.0)	1 (4.8)	1 (2.4)	
Good (71-85)	18 (85.7)	12 (57.1)	30 (71.4)	0.107
Fair (56-70)	3 (14.3)	8 (38.1)	11 (26.2)	
Total	21 (100.0)	21 (100.0)	42 (100.0)	

Mean AOFAS @24 weeks for Sander's Type II and Type III:

Sander's Type	EL	ST
Type II	76.63	78
Type III	75	69.51

DISCUSSION

All the patients presenting to the outpatient department and Emergency department with history of trauma and displaced intra-articular calcaneal fractures, willing to get operated, were admitted.

A total sample size of 42 patients were divided equally into EL and ST groups. Among them Sander's type 2 and 3 were distributed randomly into each groups.

All the subjects included in the study volunteered after proper consent and reported for follow up at proposed interval. The study was conducted after obtaining clearance from the Ethics committee of the institute.

The data collection was done by using predesigned pretested questionnaire. The questionnaire consisted of two parts. The first part included socio-demographic details and complete medical and surgical history. The second part consisted of the functional outcome after follow up of six months.

Epidemiology:

Age Distribution: In the present study, the distribution of patients according to age showed that majority of patients were in age group 35-45years. The mean age was 37 years. Similarly, in study by Carlo Biz et al. [18], to compare the clinical and radiological results of open technique (ORIF) and percutaneous surgical procedures (PS), the observed mean age was 48.6 years.

Mitchell et al. [19], in their epidemiological study, detected frequency peaks between 20 and 50 years of age with mean at 35 years.

Sex Distribution: It was observed that majority of patients were males in both groups (90%) because they are involved in outdoor activities. Similarly, in study by Carlo Biz et al. [18] observed male dominance of 63.25% was observed. Mitchell et al. [19] also observed male dominance in his study.

Mechanism of Injury: The distribution of patients according to mode of injury showed that among 30 patients 15 (50%) had history of road traffic injury (RTI). Similarly, in study by Carlo Biz et al. [18]] history of fall from height in 94.4% was observed.

Days of Hospital stay: It was observed that mean duration of hospital stay in Group ST and Group EL was 7 and 11 days respectively. Similarly, in study of Carlo Biz et al. [18] observed mean hospitalization of 15 and 6 days in open technique (ORIF) and percutaneous surgical procedures (PS) respectively.

STUDY	Mean days of hospitalization	
	Group ST	Group EL
Carlo Biz et al	6.07 ±1.83	10.07 ±1.38
Shah et al	7	11

Radiological Evaluation: In our study, 100% of patients pre-operatively had Gissane's angle more than 140°.Post- operatively Gissane's angle in Group EL and Group ST were 127.62° and 124.33° respectively showing statistical significance($P<0.05$). Whereas mean Bohler's angle in our study was 18.7° & 19.57° in EL and ST group respectively. Postoperatively we could achieve acceptable Bohler's angle within normal range in all subjects.

Study	Mean Bohler angle	
	Pre-operative	Post Operative
	Group EL	Group EL
Our study	18.71	32.38
Carlo biz et al[18]	21.5	29
Study	Mean Bohler angle	
	Pre-operative	Post Operative
	Group ST	Group ST
Our study	19.57	31.57
Carlo biz et al[18]	21.5	29

In our study, the fractures treated with Extensile Lateral approach united radiologically at 3.5 months (12week to 16week) and those treated with Sinus Tarsi approach united at 3months (11week to 13week).

Functional Outcome:

Range of movements of Subtalar Joint (Eversion and Inversion), Ankle joint (flexion-extension), hind foot stability (varus-valgus) was assessed at final follow-up in both EL & ST groups for types 2 & 3 Sander's fractures.

Carlo biz et al. [18] study showed mild stiffness in 8 patients of ORIF group (42%), 22 of the CC Screw group (62.9 %) and 16 of K-wire group (48.5 %).

Study	Patients with Good Result in Sanders type 2 fractures	
	Group ST/CRIF	Group EL/ORIF
Carlo Biz et al	55%	42%
Shah et al	68%	30%

Study	Patients with Good Result Sanders type 3 fractures	
	Group ST/CRIF	Group EL/ORIF
Carlo Biz et al	55%	42%
Our Study	37%	55%

In Sinus Tarsi group with Sander's type 2 fracture 73.3% were bearing full weight at affected limb at 8-10 week whereas in EL approach full weight bearing delayed to 10-12 weeks in Sander's type 2. Similarly in Sanders type 3 fractures 70.51% patients of group Extensile Lateral approach started full weight bearing between 12-14 week compared to group ST delayed to 14-16 weeks.

AOFAS score, at 24 weeks, for Sanders type 2 fractures, was 78/100 for ST approach compared to 76.63/100 for EL approach. AOFAS for Sanders type 3 at 24 weeks for EL approach was 75/100 as compared to 69.51/100 for ST approach.

Complication: Among all the patients treated by either approach, complications were present in Ten patients, out of which, eight were from EL group and two were from ST group.

Carlo Biz et al[18] observed Three patients with deep infections (15.8 %) in the group ORIF and one patient (2.8 %) in the CC Screw group. Five patients in group ORIF (26.3 %) had wound dehiscence or necrosis, two patients (5.7 %) in the CC Screw group had complain of skin impinging.

Haroon Majeed et al[20] observed incidence of wound-related complications in minimal invasive group; 4.3% compared to 21.2% with ORIF group.

We observed various complications in our case series [10/42]. The total number of patients with complications were 10, of which, 8 were in EL group and 2 in ST group.

Socioeconomic Impact: 73.3% patients in Extensile Lateral group and 86.7% patients in Sinus Tarsi group returned to their pre-injury activity level @ final follow up. There was no significant statistical difference in this regard.

In study by Carlo biz et al, 82.3% & 65.2% patients from open reduction group (ORIF) and percutaneous group (CRIF) reached normal resumption of daily activities, which was statistically significant.

Summary: The present study was a comparative prospective study undertaken to study functional outcome of displaced intra-articular calcaneal fractures in 42 patients treated by EL versus ST approach, 21 for each group.

Following results were observed in our study:

- Majority were male patients with mean age of 37 years and had history of fall from height as mode of injury and had unilateral calcaneum fracture.
- 90.5% of patients for ST approach were operated within 4 days of admission as compared to 61.9% of patients for EL approach who were operated within 4-6 days of admission.
- Days of hospitalization were more for EL compared to ST group with significant difference ($P<0.005$).
- Functional outcome at 24 weeks by AOFAS scoring system depends on fracture pattern and approach used for it. AOFAS score 78/100 for ST approach for Sanders type 2 and 75/100 for EL approach for Sanders type 3.
- EL group had more complications in the form of plate removal due to infection, skin necrosis or wound dehiscence as compared to ST group.

CONCLUSIONS

Our study showed better results for Sander's Type II Calcaneal fractures by Sinus Tarsi approach and better results for Sander's Type III Calcaneal fractures by Extensile Lateral approach.

REFERENCE

1. Barei DP, Bellabarba C, Sangeorzan BJ, Benirschke SK. Fractures of the calcaneus. Orthop Clin North Am. 2002; 33:263 85.
2. Rockwood and Green's Fractures in Adults, 8th edition,
3. Zwipp H, Rammelt S, Barthel S. [Fracture of the calcaneus]. Der Unfallchirurg 2005; 108:737.
4. Stehlík J, Štulík J, Havránek P, Tvrdek M. Calcaneal fractures. 1st ed. Prague: Galén; 2010;9.
5. Stehlík J, Štulík J, Havránek P, Tvrdek M. Calcaneal fractures. 1st ed. Prague: Galén; 2010;9.
6. Surgical management of intraarticular fractures of the calcaneus. Mehmet Asik & Cengiz Sen Archives of Orthopaedic and Trauma Surgery. 2000;122: 354- 359.
7. Cohen M. Calcaneal fractures. Foot and Ankle Surgery. 2001; 2:1819–1863.
8. Pozo JL, Kirwan EO, Jackson AM. The long-term results of conservative management of severely displaced fractures of the calcaneus. J Bone Joint Surg Br. 1984; 66(3):386–390.
9. Ibrahim T, Rowsell M, Rennie W, et al. Displaced intra-articular calcaneal fractures: 15-year follow-up of a randomised controlled trial of conservative versus operative treatment. Injury 2007; 38:848–55.
10. Leung KS, Yuen KM, Chan WS. Operative treatment of displaced intra-articular fractures of the calcaneus. Medium-term results. J Bone Joint Surg Br. 1993; 75(2):196–201.
11. O'Farrell DA, O'Byme JM, McCabe JP, Stephens MM. Fractures of the os

calcis: improved results with internal fixation. Injury. 1993; 24:263–265.
12. Abidi NA, Dhawan S, Gruen GS, Vogt MT, Conti SF. Wound healing risk factors after open reduction and internal fixation of calcaneal fractures. Foot Ankle Int. 1998; 19:856-61.
13. Ibrahim T. Rowsell M. Rennie W. Brown AR, Taylor GJ, Gregg PJ. Displaced intra- articular calcaneal fractures: 15-year follow-up of a randomised controlled trial of conservative versus operative treatment. Injury. 2007; 38: 848-855.
14. Kline AJ, Anderson RB, Davis WH, Jones CP, Cohen BE. Minimally invasive technique versus an extensile lateral approach for intra-articular calcaneal fractures. Foot Ankle Int. 2013; 34: 773-780.
15. Meraj A, Zahid M. Ahmad S. Management of intraarticular calcaneal fractures by minimally invasive sinus tarsi approach early results, Malays Orthop. 2012; 6:13-17.
16. Zhang F, Tian H, Li S, et al. Meta-analysis of two surgical approaches for calcaneal fractures: sinus tarsi versus extensile lateral approach. ANZ J Surg. 2017; 87:126–31.
17. Schepers T. The sinus tarsi approach in displaced intra-articular calcaneal fractures: a systematic review. Int Orthop. 2011; 35(5):697–703.
18. Carlo Biz, Elia Barison, Pietro Ruggieri and Claudio Iacobellis. Radiographic and functional outcomes after displaced intra-articular calcaneal fractures: a comparative cohort study among the traditional open technique (ORIF) and percutaneous surgical procedures (PS). Journal of Orthopaedic Surgery and Research. 2016; 11:92.
19. Mitchell MJ, McKinley JC, Robinson CM. The epidemiology of calcaneal fractures. Foot. 2009;19(4):197–200.
20. Haroon Majeed, James Barrie, Wendy Munro, Donald McBride. Minimally invasive reduction and percutaneous fixation versus open reduction and internal fixation for displaced intra-articular calcaneal fractures: a systematic review of the literature. EFORT Open Rev. 2018; 3:418-425.