Original article

Patient satisfaction after open reduction and internal fixation through lateral extensile approach in displaced intraarticular calcaneal fractures (Sander's type II and III)

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ARTICLE INFO

Article history:

Received 2 June 2015

Received in revised form 30 April 2016

Accepted 10 June 2016

Available online 23 June 2016

Keywords:

Calcaneum

Displaced intraarticular calcaneal fracture

Open reduction

Internal fixation

Heel

ABSTRACT

Aim: To determine patient satisfaction in the patients of displaced intraarticular calcaneal fractures treated with standard lateral approach.

Method: The patients of displaced calcaneal fractures (Sander's type II and III) treated between March 2009 and March 2012 were included in the retrospective review and functional outcome was evaluated using American Orthopaedic Foot and Ankle Society (AOFAS) hind foot score, Creighton Nebraska Health Foundation Assessment (CNHFA) scale and foot function index (FFI).

Result: The cohort included 26 patients (19 males: seven were females) with a mean age of 38.16 ± 13.53 years (range 18–64 years). The mean period of follow-up was 24.42 ± 6.68 months. The patients achieved good functional scores after anatomical reduction of the fracture. The complication rate was low following strict inclusion criteria.

Conclusion: Careful patient selection in displaced intraarticular calcaneal fractures treated through lateral extensile approach achieves good patient satisfaction.

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1. Introduction

Calcaneal fractures constitute the majority of the tarsal bone fractures.¹ The intraarticular involvement is present in 3/4th of the cases² and usually there is associated heel widening with varus deformity, decrease in calcaneal height and incongruity of subtalar joint.³

Surgical management of these fractures with open reduction and internal fixation can restore the anatomical parameters of the calcaneum with normal subtalar joint motion.^{4,5} It is also associated with lower incidence of subtalar arthrodesis and shorter time off from the workplace.⁶ On the other hand, non-operative treatment of intraarticular fractures with loss of Bohler's angle consistently results in poor functional outcome.⁷

However, open reduction is not advised univocally in displaced intraarticular fractures of calcaneum as in other parts of the body and there is ambiguity in management of these cases.^{8,9} In addition to articular damage and foot widening, there is damage to medial and lateral soft tissue envelope.¹⁰ Sander's et al.¹¹ in their case series of 120 patients had reported wound dehiscence in eight patients and required flaps to cover wound in five patients. Three patients had to undergo below knee amputation in the same series. The incidence of wound complications can be reduced with the appropriate selection of patients.¹²

Displaced intraarticular calcaneal fractures (DIACFs) are associated with substantial morbidity across all age groups. The perception of health care provider and patient can be different regarding the final outcome. Patient satisfaction is increasingly being given importance with achievement of radiological parameters. During the past few decades, there has been shift of focus from surgeon satisfaction to patient satisfaction.

The purpose of the current study was to evaluate the functional outcome, patient satisfaction and complications after open reduction and internal fixation through lateral extensile approach in Sander's type II and III displaced intraarticular calcaneal fractures (DIACFs).

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2. Patient and methods

The study was conducted at level 1 trauma centre with the approval of ethics committee of the institution. The study was performed in accordance with the ethical standards of the 1964 declaration of Helsinki as revised in the year 2000. The DIACF was defined as those with more than two millimetres of displacement of subtalar joint, decreased Bohler's angle or increased Gissane's angle, valgus deviation of greater than 10°, varus deviation of greater than 5° and widened heel. Sander's classification system was used to categorise the calcaneal fractures.¹¹

Patients excluded from the study were the following:

- (1) Patients treated non-operatively.
- (2) Open calcaneal fractures.
- (3) Bilateral calcaneal fractures.
- (4) Prior involvement of ipsilateral foot and or ankle due to surgery or arthritis.
- (5) Undisplaced intraarticular, Sander's type IV and extraarticular calcaneal fractures.
- (6) Patients with peripheral vascular diseases, skin infection and compartment syndrome.
- (7) Those who had sustained neurologic deficit with head or spinal injury and associated lower limb fractures.
- (8) Patients with diabetes mellitus and known smokers.

The inpatient record of patients with DIACF treated with open reduction and internal fixation between March 2009 and March 2012 was searched from the medical record section of the institution. The hospital record included clinical history sheet and operative notes. They were studied for demographic data, mode of injury, delay in surgery, treatment given, complications of either the fracture or treatment and revision surgery if any required. The data regarding comorbid conditions, associated limb injuries and side of injury were also collected. The patients were contacted by telephone provided in the medical record section of the institution and also by letter. They were asked to come up to the hospital for one additional visit. All patients were provided with informed consent for participation in the study.

A total of 36 patients of DIACFs fulfilled the inclusion criteria. One patient had died due to associated cardiac problem; six patients could not be located and three patients were not willing to participate in the study. So, twenty-six patients were included in the study.

Among the 26 patients included in this study, 19 were males and seven were females. Their average age was 38.16 ± 13.53 years (range 18–64 years). The mean period of follow-up was 24.42 ± 6.68 months. The right side was involved in ten cases and the left side was involved in sixteen cases. The mechanism of injury was motor vehicle accident (MVA) in seventeen patients and a fall from height in nine patients. Nine patients had associated upper limb and axial skeletal injuries. Delay in surgery was defined as time interval between injury and surgery. Delay in surgery was influenced by late referral from the primary or secondary care centres and wait period until subsidence of swelling.

All the selected cases were taken up for surgery after the subsidence of soft tissue oedema and appearance of wrinkle sign in the hind foot (range 6–29 days, mean 13.5 ± 5.06 days). The operative procedures were performed under general or spinal anaesthesia, with the patient placed in lateral decubitus position. The lateral extensile approach and locking plates were used to treat the fracture. The bone graft or bone graft substitutes were used by the operating surgeon as per his discretion. The artificial bone graft in the form of calcium hydroxyapatite (G-bone, Surgiwear Pvt. Ltd. Shahjahanpur, India) was used in the five cases and autologous bone graft was not used in any case. Postoperatively, the limb was elevated

and actively assisted along with active movements at subtalar joint that were started under the supervision of a physiotherapist as per the comfort of the patient. Strengthening exercises for the muscles of foot and ankle were started at one month postoperatively. Gait training was started at 10 weeks and full weight bearing was allowed at three months.

The follow-up radiographs were taken immediately in the postoperative period, at six weeks, twelve weeks and at one-year follow-up (Fig. 1). The radiographs included lateral, Broden and Harris axial view. Bohler's angle was measured by a manual standard goniometer by placing it over the lateral radiograph of the hind foot and comparing it with the angle measured in uninjured foot. This method of angle measurement is reliable and validated.¹³ The criteria described by Sander's et al.¹¹ was used to assess subtalar joint reduction. However, for the purpose of grouping, the results were tabulated as anatomic, near anatomic and non-anatomic (includes approximate and failure of reduction) as per Sander's criteria. The hind foot alignment was calculated as varus, valgus or neutral with respect to long axis of calcaneum relative to long axis of leg (Fig. 2).

The functional outcome was evaluated using American Orthopaedic Foot and Ankle Society (AOFAS) hind foot score,¹⁴ Creighton Nebraska Health Foundation Assessment (CNHFA) scale¹⁵ and foot function index (FFI).¹⁶ The AOFAS ankle hind foot score consists of two sections: objective section to be completed by surgeon and subjective section completed by the patient. The maximum attainable score is 100. The functional outcome was defined as excellent with score between 90 and 100, good between 75 and 89, fair ranging within 50 and 74 and poor as less than 50 points.

Creighton Nebraska Health Foundation assessment (CNHFA) scale is specific for assessment of calcaneal fractures. It is a 100-point questionnaire about pain during activity and rest, subtalar range of motion, change in shoe size, hind foot swelling and patient's ability to return to work. The maximum possible score is 100 points. A score between 90 and 100 points is considered excellent, 80 and 89 is considered good, between 65 and 79 indicates fair result and less than 64 points is indicative of poor outcome.

Foot function index was designed to measure the effect of pathology on the function of foot with respect to pain, disability and activity restriction. It consists of 23 items divided into three subscales. The pain and disability subscale consists of nine items each, while activity limitation subscale has five items in the questionnaire. For each question, a score is assigned on a scale of zero indicating no difficulty or pain and ten denoting worst imaginable pain or difficulty and requiring help. The total of three subclasses lies between zero and 100. The lower scores denote good functional outcome while higher scores represent poor outcome. All the three outcome measurement scales (AOFAS, CNHFA scale and FFI) are reliable and validated.¹⁷

2.1. Statistical analysis

The end point of study was the findings noted at the time of last follow-up. Data were analysed by using Student's *t* test and correlations were analysed using the Pearson correlation coefficient. The statistical significance was determined at *p* value less than 0.05. With a sample size of 26, a beta of 0.2 and an alpha of 0.05, there was sufficient power to detect a difference of more than 10 points in CNHFA, AOFAS and FFI scales.

3. Results

Twenty-six patients participated in the retrospective cohort study, and among them, eleven patients had sustained Sanders type II fracture (group A) and fifteen patients had Sanders Type III

Fig. 1. (a) Computerised tomographic images showing calcaneal fracture; (b) follow-up of lateral and axial radiographs showing union at the fracture site with maintained radiographic parameters.

Fig. 2. Clinical image showing hind foot alignment (a, b), eversion and inversion (c, d) with goniometer (d) to document the movements at the subtalar joint.

fracture (group B). The results of both the groups have been tabulated in [Tables 1 and 2](#). The mean age in group A was 36 ± 10.55 years, while it was 40.06 ± 14.79 years in group B. There was no statistically significant difference between group A and group B in age distribution ($p = 0.46$). There were eight males and three females in group A, while in group B, it was eleven males and four females.

3.1. Functional and radiological outcome

The functional evaluation was done by AOFAS hind foot score, CNHFA scale and FFI score. In group A, the mean CNHFA score was 83.81 ± 3.65 , AOFAS hind foot score was 91.54 ± 2.65 and FFI score was 9.09 ± 1.92 , while in group B, CNHFA score was 78.33 ± 10.60 ,

Table 1

Patient characteristics and results of open reduction and internal fixation of eleven patients of Sander's type II calcaneal fractures (group A).

S. No.	Age	Sex	Mechanism of injury	Side	Delay in surgery (in days)	CNHFA score	AOFAS score	FFI score	Bohler angle	Quality of reduction	Duration of follow-up (in month)
1	24	M	MVA	R	6	85	91	9	38 (40)	Anatomic	28
2	29	M	MVA	R	8	89	94	7	38 (37)	Anatomic	31
3	34	M	MVA	L	8	87	92	8	42 (40)	Anatomic	36
4	56	M	MVA	L	10	78	88	11	24 (32)	Non-anatomic	20
5	29	F	Fall	L	12	82	90	11	35 (32)	Near anatomic	29
6	34	M	MVA	L	13	85	94	8	34 (35)	Anatomic	36
7	31	M	MVA	L	15	79	86	13	25 (34)	Non-anatomic	17
8	49	F	MVA	R	11	84	94	10	32 (37)	Near anatomic	27
9	49	M	Fall	L	20	80	92	8	35 (34)	Anatomic	22
10	26	M	MVA	L	9	85	92	8	36 (36)	Anatomic	27
11	35	F	Fall	R	12	88	94	7	30 (32)	Anatomic	34

Abbreviations: M, male; F, female; CNHFA, Creighton Nebraska Health Foundation Assessment; AOFAS, American Orthopaedic Foot and Ankle Society (AOFAS) hind foot score; FFI, foot function index (FFI); Bohler angle denotes postoperative angle of the operated foot and that of uninjured foot is given in parentheses.

Table 2

Patient characteristics and results of open reduction and internal fixation of fifteen patients of Sander's type III calcaneal fractures (group B).

S. No.	Age	Sex	Mechanism of injury	Side	Delay in surgery (in days)	CNHFA score	AOFAS score	FFI score	Bohler angle	Quality of reduction	Duration of follow-up (in months)
1	38	F	Fall	R	15	74	88	10	28 (30)	Anatomic	14
2	42	M	MVA	L	14	60	72	27	24 (34)	Non-anatomic	14
3	18	M	MVA	L	8	89	96	8	35 (37)	Anatomic	17
4	64	M	MVA	R	18	58	69	29	23 (36)	Non-anatomic	21
5	18	M	Fall	R	14	82	86	11	29 (34)	Anatomic	13
6	36	F	MVA	R	11	77	88	10	32 (34)	Anatomic	25
7	37	M	MVA	L	17	69	75	24	24 (34)	Non-anatomic	28
8	23	M	MVA	L	15	81	88	14	33 (33)	Near anatomic	21
9	54	M	Fall	R	13	83	93	13	34 (35)	Anatomic	18
10	56	M	MVA	L	12	75	85	17	24 (33)	Non-anatomic	25
11	60	M	Fall	L	29	91	93	7	36 (34)	Anatomic	28
12	44	M	MVA	R	21	93	100	3	37 (35)	Anatomic	27
13	23	F	MVA	L	15	89	90	8	30 (32)	Anatomic	33
14	42	M	Fall	L	10	63	88	10	25 (34)	Non-anatomic	21
15	46	F	Fall	L	11	88	93	9	37 (35)	Anatomic	23

Abbreviations: M, male; F, female; CNHFA, Creighton Nebraska Health Foundation Assessment; AOFAS, American Orthopaedic Foot and Ankle Society (AOFAS) hind foot score; FFI, foot function index (FFI); Bohler angle denotes postoperative angle of the operated foot and that of uninjured foot is given in parentheses.

AOFAS hind foot score was 86.93 ± 8.73 and FFI hind foot score was 13.33 ± 7.65 (Table 3). The difference in functional outcome scores was not statistically significant between the two groups.

The average postoperative Bohler's angle was 34 ± 1.51 in group A and 30 ± 4.01 in group B. There was no statistically significant difference between the same ($p = 0.1$). However, the restoration of Bohler's angle was associated with good functional scores as compared to the group with lower functional scores (Tables 1 and 2). The higher CNHFA scores, AOFAS ankle hind foot scores and lower FFI scores were noticed in patients with anatomic reduction and near anatomic reduction. Anatomic reduction could not be achieved in two cases of Sanders type II (group A) and in five cases of Sanders type III (group B).

Table 3

Comparison of AOFAS, CNHFA and FFI scoring scales between different fracture groups.

Functional scoring	Sander's type II (group A)	Sander's type III (group B)	<i>p</i> value*
Mean AOFAS score	91.54 ± 2.65	86.93 ± 8.73	0.12
Mean CNHFA score	83.81 ± 3.65	78.33 ± 10.60	0.13
Mean FFI score	9.09 ± 1.92	13.33 ± 7.65	0.10

Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society (AOFAS) hind foot score; CNHFA, Creighton Nebraska Health Foundation Assessment; FFI, foot function index (FFI).

* The difference in mean functional score was not statistically significant in two groups.

All patients had returned to their original occupation at the time of last follow-up except a thirty-seven-year-old male patient who developed deep-seated infection. The patient changed his occupation from salesman to computer operator at final follow-up (28 months).

3.2. Complications

Eight patients (33.3%) had developed superficial necrosis at the skin margins. Among them, seven patients required only local wound care (Fig. 3). One patient (37-year-old male) had partial wound breakdown with exposure of implant and developed deep-seated infection. He had to undergo repeated wound debridement. Subsequently, with local wound care and fasciocutaneous flap, the wound healed. In another patient, a screw was removed from the locking plate as it was impinging on inversion of the hind foot. Two of the five patients included in Sander's type III group who had non-anatomic reduction experienced disability affecting their daily lifestyle; however, they were not willing for any secondary procedure (Fig. 4). There was no case of malalignment, non-union or malunion. No patient had any additional surgical procedure for implant removal.

4. Discussion

In the past, the pendulum has swung between operative and non-operative treatment in the management of calcaneal fractures.

Fig. 3. (a) Photograph of the patient with wound dehiscence at 14 days postoperatively; (b) image of the same patient showing complete healing of the wound at the time of last follow-up (26 months).

Fig. 4. Follow-up radiograph showing loss of radiographic parameters with loss of subtalar joint space.

There were periods of authors supporting operative intervention and then moving towards non-operative management due to high incidence of complications associated with extensive operative procedures. Jiang et al.¹⁸ in their meta-analysis had reported better results with operative management but observed higher complication rate. Agren et al.¹⁹ in their multicentric, prospective, randomised trial had reported similar functional outcomes in displaced intraarticular calcaneal fractures, whether treated operatively or non-operatively. However, at eight- to twelve-year follow-up, better pain scores, functional outcome and lower incidence of post-traumatic subtalar arthritis were seen in operatively treated group. The proponents of operative and non-operative management of displaced calcaneal fractures are at loggerheads from many years.

The group supporting operative intervention postulates that the movements at the subtalar joint reduce the rotatory strains at the ankle joint, and in the absence of this mechanism, the ankle joint shall be subjected to great stress predisposing to ankle arthritis.²⁰ The intraarticular calcaneal fractures involve the subtalar joint and hence can have adverse effects over the ankle joint. The operative management gives better functional results in comparison to non-operative management of displaced calcaneal fractures.²¹ So, these fractures should be anatomically reduced and mobilised early to achieve good functional results. Brattebo et al.²² had suggested that the subtalar joint should be reconstructed irrespective of the treatment modality chosen. The restoration of

Böhler angle and calcaneal width is the main goal in the management of the calcaneal fractures. Brauers⁶ in their study on cost effectiveness of operative treatment had concluded that it is better to operate than conservatively manage the DIACFs.

The extensive lateral approach provides excellent exposure of the calcaneal articular surface and body, especially in the management of severe joint depression, fragment rotation, severe valgus or varus and in cases of lateral wall blowout.²³ It is the most versatile approach in the management of DIACFs.²⁴ Less invasive and arthroscopically assisted techniques have limited application in the treatment of these extensive injuries. The locking plates provide stable fixation and enable early weight bearing without the fear of loss reduction.²⁵

The use of bone graft has not been advocated consistently. Few authors had advocated the use of bone grafts²⁶; however, others were against the use of the same.^{27,28} The proponents of bone grafting had postulated it to prevent subtalar joint collapse. In our study, the use of bone graft was left to the discretion of the operating surgeon and bone grafting was done in five cases. No subtalar joint collapse was noted in our study.

There may arise differences between objective findings recorded by the patient and patient satisfaction. This is especially true in the case of lower limb fractures, as the objective parameters like bony union may not show collinear relation with patient satisfaction parameters like pain and cosmetic appearance.²⁸ All the studies favouring operative intervention had stressed upon the

importance of careful selection of the subjects for optimal results. In our study, the effort was made to exclude the known major risk factors like diabetes mellitus, smoking and open fractures predisposing to wound complications. The reported complication rate in this study was similar to that reported in recent literature, suggesting enhanced understanding of patient profile, fracture pattern and improvement in surgical techniques.

Like with any retrospective cohort study, we acknowledge the associated limitations. A lack of control group managed conservatively was lacking and the study had a small sample size. The small sample size could have been due to strict inclusion criteria. The follow-up duration was variable in the study. The concomitant injuries have a substantial impact on the patient outcome measures in the calcaneal fractures. The present study lacked the statistical power to find relationship between multiple injured patients and calcaneal fractures. The strengths of the study include the use of validated injury specific scales to evaluate the results and number of patients with similar fracture configuration. The study makes a contribution towards understanding the patient perception about the extensive calcaneal surgery in a selected cohort of patients.

Conflicts of interest

The authors have none to declare.

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