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Case Report

Functional outcomes of primary subtalar arthrodesis in sanders type IV calcaneal fractures, a case series☆

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ABSTRACT

Background: Primary subtalar arthrodesis (PSTA) is a valid option in treating Sanders IV calcaneal fractures with few studies to assess its outcomes.
Methods: Seventeen patients with Sanders IV calcaneal fractures were managed by open reduction and primary subtalar arthrodesis. Functional outcomes were measured by AOFAS-AHS and FAAM-ADL. We also documented time to return to work, union rate, wound complications and the need for second surgeries.
Results: Fourteen patients were followed for two years. At final follow-up, the mean AOFAS-AHS score was 74.42 ± 1.95, while the mean FAAM- ADL score was 59.21 ± 1.6.
Conclusion: PSTA is a valid option in treating these severe fractures. It may reduce the overall disability time.

Introduction

Displaced intraarticular calcaneal fractures are common and challenging [1]. There is no consensus about managing Sanders IV calcaneal fractures [2]. Some authors reported no difference between operative and nonoperative treatment [3,4]. Regardless the management, up to 72 % of Sanders IV fractures led to posttraumatic subtalar arthritis. They were 5.5 times more likely to require subtalar arthrodesis than Sanders II fractures [2,5].

.M,eanwhile, other authors advocated that malunited calcaneus, after nonoperative management, compromised the outcomes of potential late subtalar fusion [6]; and surgical intervention (fixation or fusion) showed better outcomes in some patients [7]. Additionally, primary subtalar arthrodesis (PSTA) healed faster with no need for further surgeries [8].

We hypothesized that open reduction and PSTA, in Sanders type IV calcaneal fractures, has a good functional outcome. Our goal was to measure this outcome and the rate of associated complications.

We were primarily concerned about the impact of this intervention on patients' quality of life and readily resumption of their former daily activities.

☆ Ethical approval for this study was obtained from the Research Ethics Committee (REC) at the faculty of medicine, Ain shams university (No. FWA00017585).

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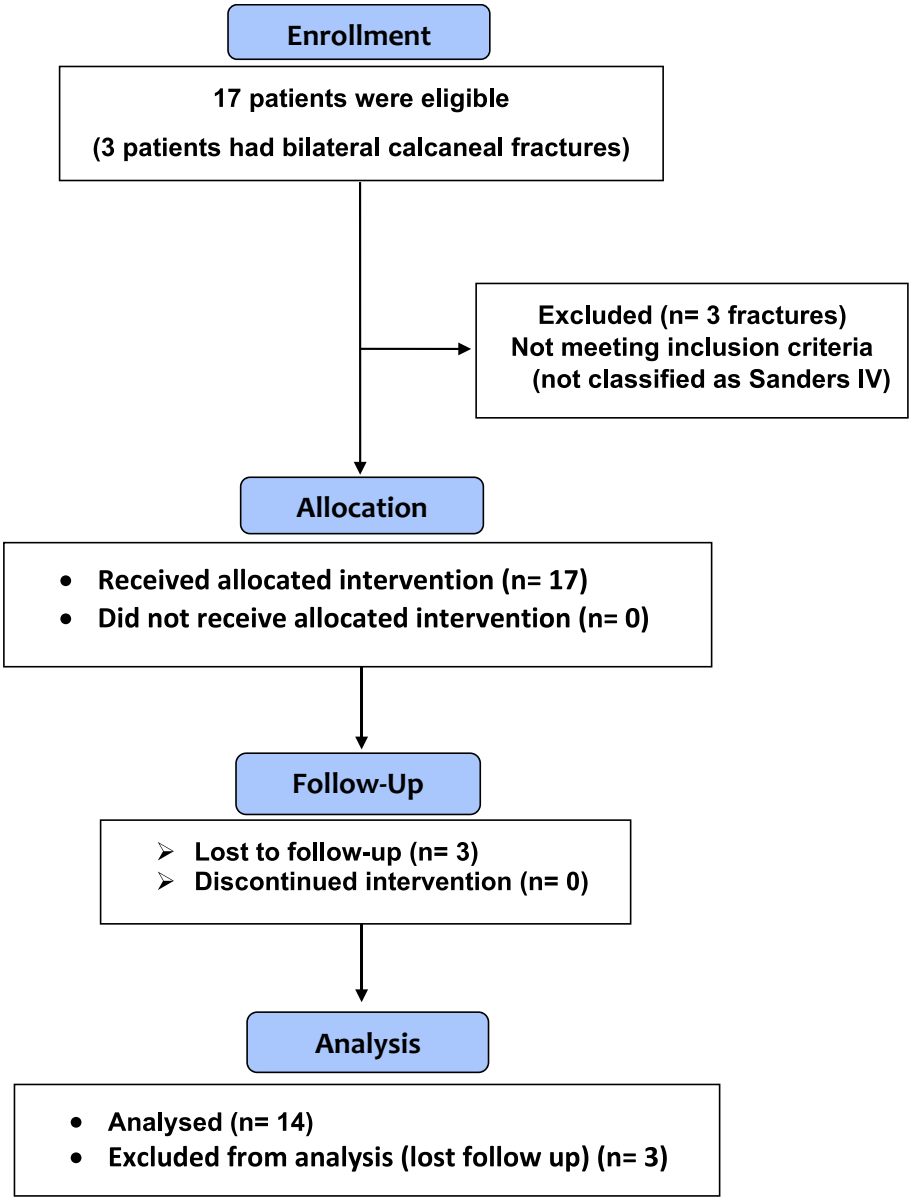

Fig. 1. A flow chart diagram demonstrates the patient selection process.

Methods

This study was held in our hospital from September 2019 till October 2022.

Inclusion criteria

Adult patients (age from 16 to 60) with Sanders type IV displaced intraarticular calcaneal fractures confirmed by initial CT scan [9] and able to.

Exclusion criteria

Patients with general contraindication to surgery, co-existent ipsilateral lower limb fracture, motor weakness or open calcaneal fractures.

We are a tertiary center and some patients were referred from other hospitals. Fractures older than one month were excluded to eliminate the effect of delay on outcomes.

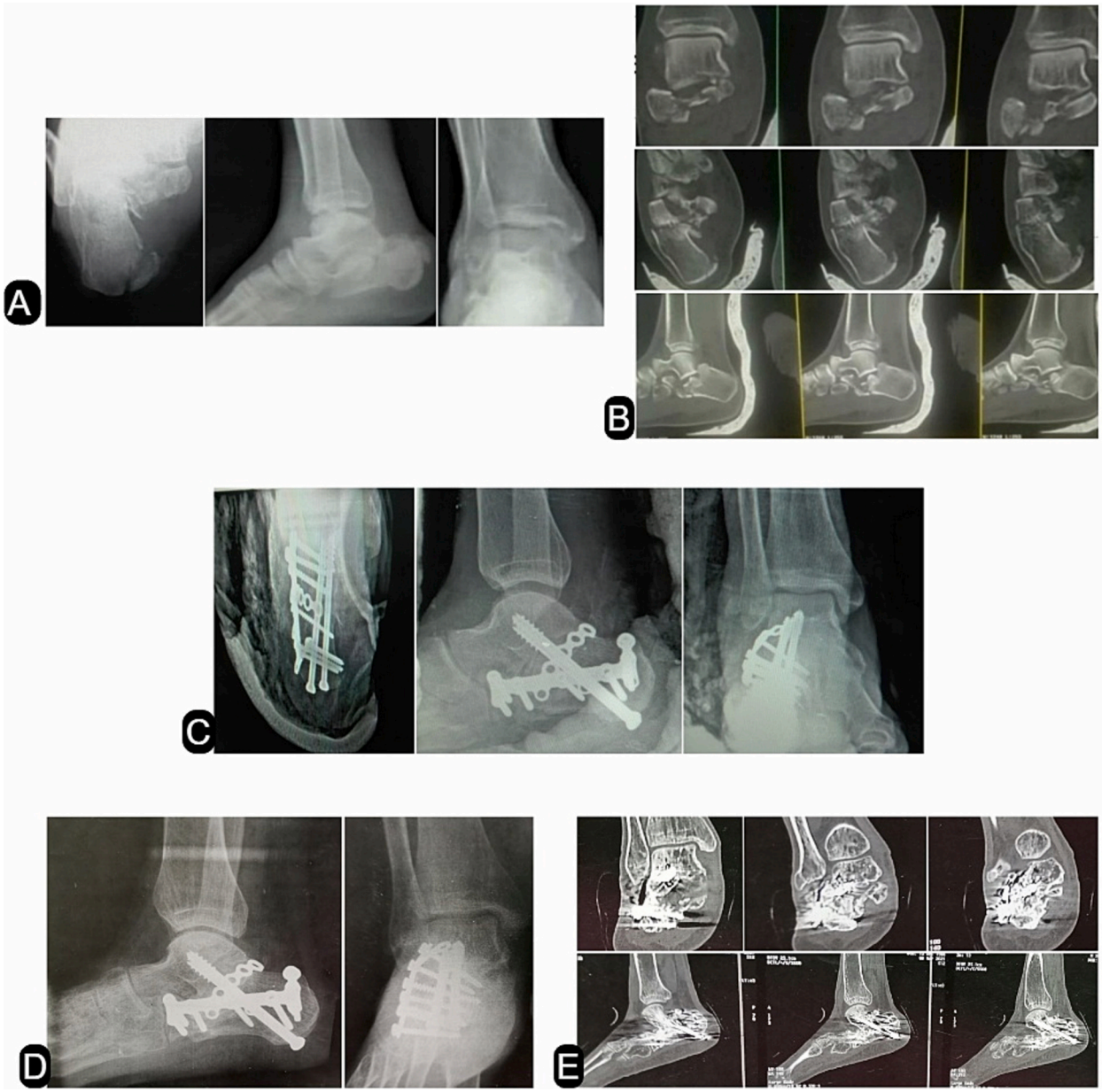

Fig. 2. Radiology of a patient in group A underwent primary subtalar arthrodesis following sanders type IV right calcaneal fracture; (A) initial trauma ankle X rays, (B) initial trauma ankle CT scan, (C) immediate postoperative X rays, (D) ankle X rays one year after surgery, (E) ankle CT scan one year after surgery.

Intervention

Patients were initially treated with below knee slab, limb elevation and analgesics. We scheduled surgery after resolution of the edema and appearance of wrinkle sign. Surgery was done under tourniquet in lateral position. Lateral extensile approach was used. A full flap was developed by subperiosteal dissection with protection of sural nerve and peroneal tendons. Three k-wires were inserted in fibula, lateral surface of talus and cuboid bone as retractors. Lateral wall of the calcaneus was retracted. Articular cartilage of inferior surface of the talus and posterior facet of the calcaneus were debrided thoroughly and drilled by 2 mm k-wire. A 4 mm schanz was inserted in the calcaneal tuberosity to restore calcaneal height and hindfoot alignment. A lateral nonlocked plate was applied to reduce the lateral wall blow out and calcaneal broadening. A tricortical iliac bone autograft was harvested and inserted in the subtalar joint. Two guide wires were introduced, under fluoroscopic guidance, from the calcaneal tuberosity to the talus then two cannulated partially threaded 7.3 mm screws over the guide wires. The wound was closed in two layers (subcutaneous and skin) after homeostasis and below knee slab was applied. Patients were kept non-weightbearing for six weeks.

Table 1
Baseline demographics and clinical characteristics of enrolled patients.

	Age		Gender				Smokers		Co-morbidities		Associated fractures[a]	
			Male		Female							
	Mean	SD	No.	%	No.	%	No.	%	No.	%	No.	%
Group A ($N = 14$)	37.64	10.16	12	85.7	2	14.3	3	21.4	1	7.1	6	42.9

[a] Ipsilateral lower limb fractures are not included from the start.

Table 2
Pre injury occupation and return to work.

	Pre injury occupation				Return to work						Time from injury to return to work (months)	
					Yes				No			
	Heavy manual		Light manual		Same job		New job		unemployed			
	No.	%	No.	%	No.	%	No.	%	No.	%	Mean	SD
Group A (N = 14)	8	57.1	6	42.9	10	71.43	3	21.43	1	7.14	7.46	1.85

Table 3
Functional scores at one year and two years after surgery.

	American Orthopaedic Foot and Ankle Society's Ankle-Hindfoot scale (AOFAS-AHS)				Foot and Ankle Ability Measure (FAAM)			
	One-year		Two-year		One-year		Two-year	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group A (N = 14)	72.86	3.13	74.42	1.95	57.29/84 (68.20 %)	2.27	59.21/84 (70.49 %)	1.6

Patients were followed after intervention every two weeks for six weeks then every three months for one year then at two years. Follow-up X-rays were done next day after surgery, 6 weeks later and every 3 months till radiological union. CT scans were done at one year to confirm union.

Outcomes

two scores were used to assess the functional outcomes [1]; the American Orthopaedic Foot and Ankle Society's Ankle-Hindfoot scale (AOFAS-AHS) [10] and [2] Foot and Ankle Ability Measure-Activities of Daily Living sub scale (FAAM-ADL) [11]. We calculated the functional scores using questionnaires at 6, 12 and 24 months. Data were collected by the authors in the clinic. The minimum follow-up duration was two years.

We asked the patients to describe the physical demand of their previous jobs to categorize themselves into heavy or light manual job. We documented if they returned to work after injury (same or new job) and the time to return to it. We also evaluated wound complications, second surgeries and union at one year.

Statistical analysis

We used statistical package for social science (SPSS 15.0.1 for windows; SPSS Inc., Chicago, 2001). For normally distributed continuous variables, data was presented as Mean and Standard deviation. Categorical data was presented as frequency and percentage.

All participants provided a written informed consent by themselves.

Results

From September 2019 till October 2022, seventeen patients were recruited. A flow chart diagram in Fig. 1 demonstrates the patient selection process. They were all consented for surgical management. The average time interval between trauma and surgery was 18 (range, 9–25) days. They had the same surgery (open reduction and primary subtalar arthrodesis using a tricortical iliac bone autograft). Fig. 2 demonstrates the radiology of one patient.

The data of fourteen patients were collected for analysis, while 3 patients were lost during follow-up. Patients were assessed regarding age, gender, smoking, co-morbidities and associated fractures. Ipsilateral lower limb fractures were not included from the start. Their demographics are summarized in (Table 1).

All patients -except one- returned to work after the mean time of 7.46 ± 1.85 months. Pre-injury occupation and the time to return

Table 4
The rate of wound complications and need for further surgeries.

	Wound complications						The need for further surgeries			
	Superficial infection		Delayed healing		No wound complications		Yes		No	
	No.	%	No.	%	No.	%	No.	%	No.	%
Group A (N = 14)	1	7.14	1	7.14	12	85.7	2	14.3	12	85.7

Table 5
Our results compared to literature.

	Almeida et al. [17]	Our study
Number of patients	41 patients in 4 studies	14 patients
Male	52 %–92 %	85.7 %
Age (years)	40 to 53.8	37.64 ± 10.16
Follow-up (years)	2 to 4.9	2
Time from injury to surgery	6 to 42 days	18 (9 to 25) days
Return to work	Not reported	92.86 %
Time to return to work (months)	Not reported	7.14 ± 1.85
AOFAS-AHS	65.5 to 86.8	74.42 ± 1.95
FAAM-ADL	Not reported	59.21 ± 1.6
Wound complications	Not clarified in 2 studies 0 % in 2 studies	14.3 %
Second surgeries (other than removal)	One patient (hematoma revision)	One patient (calcaneal osteotomy for valgus heel)
Implant removal	Not reported in one study One patient (16.66 %) Four patients (66.66 %) Five patients (29.4 %)	One patient
Union rate	Not reported	100 %

to work are summarized in (Table 2).

At one-year follow-up, the mean AOFAS score was 72.86 ± 3.13, while the mean FAAM score was 57.29 ± 2.27. At two-year follow-up, the mean AOFAS was 74.42 ± 1.95, while the mean FAAM score was 59.21 ± 1.6. The two scores are reported in (Table 3).

We had one patient (7.14 %) with delayed wound healing (more than three weeks) and one patient (7.14 %) with superficial wound infection. No deep infection was encountered and the two patients were managed by dressings without any further interventions.

Two patients had a second surgery. The first one complained of excessive heel valgus. After 6 months, we removed the implants and performed a medial displacement calcaneal osteotomy which was fixed by one cannulated screw. The second patient complained of pain because of prominent cannulated screws from posterior and they were removed.

Both wound Complications and the need for further surgeries are mentioned in (Table 4). CT scan at one year showed union in 100 % of patients.

Discussion

There are few trials discussing primary subtalar arthrodesis in calcaneal type IV calcaneal fractures.

We used AOFAS score to compare our results to the literature but recently there is emphasis on patient-reported outcome measures without interpretation by healthcare providers [12]. So we used FAAM score to assess the function. The low AOFAS and FAAM scores reflect the severity of the injury.

Almeida et al. [13] reviewed the previous clinical trials of the primary subtalar fusion from 2005 to 2020. Four studies [8,14,15,16] used the AOFAS score and the mean scores ranged from 65.8 to 86.8 points at the last follow up (2 to 5 years). The trials did not report the wound complications or the union rate. The need for second surgery in primary subtalar arthrodesis ranged from 16.6 % to 66.6 %. It was mostly implant removal due to skin irritation by hardware [13] (Table 5).

Driessen et al., reported that 68 % of patients after surgical management of calcaneal fracture- not specific for sanders type IV- were able to return to work after a median time 6 months (Interquartile range, 3–7) [17].

Regarding strengths, it is a prospective single-center study. We stratified only Sanders type IV calcaneal fractures to recruit. Surgeries were done by experienced foot and ankle surgeons. Our case series is the first to report the time to return to work and union rate after primary subtalar arthrodesis. We achieved two years follow up although the difficulties imposed by the corona pandemic.

Our weaknesses include the small number of patients. Our study was not randomized or comparative. We did not use a validated method to categorize the pre injury occupation.

In summary, primary subtalar arthrodesis has good functional outcomes with comparable complications. Based on our results we cannot recommend PSTA for all patients with Sanders type IV calcaneal fractures or even a specific subgroup. However in these fractures, the patient should be counseled for this possible intervention preoperatively and the surgeon should consider it intra-operatively, especially when anatomical reduction and fixation is non-feasible.

More comparative studies are needed to establish the best management for these challenging debilitating fractures.

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Declaration of competing interest

None declared.

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References

[1] A. Razik, M. Harris, A. Trompeter, Calcaneal fractures: where are we now? Strateg. Trauma Limb. Reconstr. 13 (1) (2018) 1–11.
[2] P.J. Sharr, M.M. Mangupli, I.G. Winson, R.E. Buckley, Current management options for displaced intra-articular calcaneal fractures: non-operative, ORIF, minimally invasive reduction and fixation or primary ORIF and subtalar arthrodesis. A contemporary review, Foot Ankle Surg. [Internet] 22 (1) (2016) 1–8. Available from: https://doi.org/10.1016/j.fas.2015.10.003.
[3] M.S. Dhillon, S. Prabhakar, Treatment of displaced intra-articular calcaneus fractures: a current concepts review, Sicot-J 3 (2017) 0–4.
[4] D. Griffin, N. Parsons, E. Shaw, Y. Kulikov, C. Hutchinson, M. Thorogood, et al., Operative versus non-operative treatment for closed, displaced, intra-articular fractures of the calcaneus: randomised controlled trial, BMJ 349 (Jul 2014), g4483.
[5] M. Csizy, R. Buckley, S. Tough, R. Leighton, J. Smith, R. McCormack, et al., Displaced intra-articular calcaneal fractures: variables predicting late subtalar fusion, J. Orthop. Trauma 17 (2) (Feb 2003) 106–112.
[6] B.C.S. Radnay, M.P. Clare, R.W. Sanders, Subtalar fusion after displaced intra-articular calcaneal fractures: does initial operative treatment matter? Surg. Tech. 1 (Part 1) (2010) 32–43.
[7] R. Buckley, S. Tough, R. McCormack, G. Pate, R. Leighton, D. Petrie, et al., Operative compared with nonoperative treatment of displaced intra-articular calcaneal fractures: a prospective, randomized, controlled multicenter trial, J. Bone Joint Surg. Am. 84 (10) (Oct 2002) 1733–1744.
[8] R. Buckley, R. Leighton, D. Sanders, J. Poon, C.P. Coles, D. Stephen, et al., Open reduction and internal fixation compared with ORIF and primary subtalar arthrodesis for treatment of Sanders type IV calcaneal fractures: a randomized multicenter trial, J. Orthop. Trauma 28 (10) (Oct 2014) 577–583.
[9] R. Sanders, P. Fortin, T. DiPasquale, A. Walling, Operative treatment in 120 displaced intraarticular calcaneal fractures. Results using a prognostic computed tomography scan classification, Clin. Orthop. Relat. Res. (290) (May 1993) 87–95.
[10] M. Alhadhoud, N. Alsiri, M. Alsaffar, M. Glazebrook, Cross-cultural adaptation and validation of an Arabic version of the American Orthopedics Foot and Ankle Score (AOFAS), Foot Ankle Surg. Off. J. Eur. Soc. Foot Ankle Surg. 26 (8) (Dec 2020) 876–882.
[11] L.M. Matheny, Clanton TO, Rasch analysis of reliability and validity of scores from the Foot and Ankle Ability Measure (FAAM), Foot Ankle Int. 41 (2) (Feb 2020) 229–236.
[12] H.B. Kitaoka, J.E. Meeker, P. Phisitkul, S.B.J. Adams, J.R. Kaplan, E. Wagner, AOFAS position statement regarding patient-reported outcome measures, Foot Ankle Int. 39 (12) (Dec 2018) 1389–1393.
[13] J.F. Almeida, C. Vale, T. Gonzalez, T.M. Gomes, X.M. Oliva, Osteosynthesis or primary arthrodesis for displaced intra-articular calcaneus fractures Sanders type IV - a systematic review, Foot Ankle Surg. Off. J. Eur. Soc. Foot Ankle Surg. 28 (3) (Apr 2022) 281–287.
[14] T. Hüfner, J. Geerling, T. Gerich, J. Zeichen, M. Richter, C. Krettek, Open reduction and internal fixation by primary subtalar arthrodesis for intraarticular calcaneal fractures, Oper. Orthop. Traumatol. 19 (2) (Jun 2007) 155–169.
[15] V. Potenza, R. Caterini, P. Farsetti, S. Bisicchia, E. Ippolito, Primary subtalar arthrodesis for the treatment of comminuted intra-articular calcaneal fractures, Injury 41 (7) (Jul 2010) 702–706.
[16] J.L. Holm, S.E. Laxson, J.M. Schuberth, Primary subtalar joint arthrodesis for comminuted fractures of the calcaneus, J. Foot Ankle Surg. [Internet] 54 (1) (2015) 61–65. Available from: https://doi.org/10.1053/j.jfas.2014.07.013.
[17] M.L.S. Driessen, C. Verstappen, M. Poeze, M. Edwards, J. Biert, E. Hermans, Treatment of displaced intra-articular calcaneal fractures: a single-center experience study with 20 years follow-up, Injury 53 (10) (Oct 2022) 3535–3542.