



Functional Outcome of Intra-Articular Joint Depressed Fractures of Calcaneum Treated by Lateral Plating- A Case Series of 35 Patients Followed For an Average Duration of 24 Months

Authors

**Dr Arun Kumar Pandey¹, Dr Ranjeet Kumar Patel^{2*}, Prof. Rahmat Ali³,
Dr Saurabh Agarwal⁴**

¹MS (Ortho), ²S.R. (Dept. of Orthopaedics)

Maharshi Vashishtha Autonomous State Medical College, Basti

³Associate Professor and HOD (Dept. of Orthopaedic), Maharshi Vashishtha
Autonomous State Medical College, Basti

⁴Associate Professor, M.L.B. Medical College, Jhansi

*Corresponding Author

Dr Ranjeet Kumar Patel

S.R. (Dept. of Orthopaedics), Maharshi Vashishtha Autonomous State Medical College, Basti

Abstract

Background: *There is no consensus as to which is the best treatment for intraarticular fractures of the calcaneus. Many people treat it conservatively whereas many go for operative procedures. Even for surgical treatment many do it by percutaneous technique many go for open reduction and internal fixation with plate or cancellous screws.*

Purpose: *To present a case series of 35 patients with intra-articular joint depressed fractures of calcaneum treated by open reduction and internal fixation with plate through a lateral approach.*

Material and Methods: *A retrospective study was done in a level 1 trauma centre in which 35 patients (29 males and 6 females) of joint depressed type of calcaneum fractures were treated by open reduction and fixation by plate. All had acute trauma. Based on 2-dimensional CT scans, the fractures were categorized using Sanders classification. Radiographs and Maryland foot scores were used for evaluation of the results. Average follow-up was 24 months.*

Results: *30 patients had full sub-talar range of movement and 5 patients had restricted range of movement. 11 of 12 patients returned to manual labour jobs, the others were not employed at the time of injury. 26 patients had an excellent Maryland foot score and 9 patients had a good score.*

Interpretation: *Intra-articular calcaneum fractures are associated with high chances of sub-talar arthritis with loss of sub-talar movement if not treated properly. Reduction of posterior facet is more important in joint depressed type of fracture. Lateral plating for these complicated fractures resulted in good to excellent sub-talar joint function with restoration of heel height, width and normal heel valgus.*

Keyword: *Intra-articular calcaneum fractures, trauma, plate, treatment outcome.*

Introduction

Injury mechanisms and fracture patterns largely determine treatment results of calcaneal fractures.¹

Controversy has existed over closed^{7,13,14,21} versus

open^{1-4,155,22} treatments. A number of treatment classifications have been proposed based on plain radiography.^{7,17,18,20}

Improvement in imaging technology has allowed a better understanding of fracture pathology and provided the basis for newer classifications.^{19,5}

Intra-articular fractures of the calcaneum are amongst the most challenging fractures for orthopaedic surgeon because of complicated anatomy and difficulty in evaluating the fractures properly. Those who sustain them face a slow recovery, with possible permanent deformity and disability. When the fracture is joint depressed type of fracture, formal open reduction of fracture through a lateral approach, elevation of depressed posterior facet and fixation with a plate is required. This is a case series using a lateral approach for intra-articular fractures of calcaneum as previously described.

Patient and Methods

(a) Patient Selection: This is a retrospective review of case series 30 intra-articular joint depressed fractures of calcaneum that came to our institute from April,2013 to August,2016. All the patients had joint depressed type of fracture according to Essex-Lopresti classification and had Sander's type ranging from Type 1 to Type 4. There were 27 males and 3 females with age range from 20-60 years. All the injuries were due to road traffic accident {RTA}. 32 fractures were closed and 3 were compound Grade 1 (Gustilo-Anderson type). 21 patients had right sided calcaneal fracture whereas 11 patients had left side and 3 patient had bilateral calcaneal fracture. The mean time from injury to surgery was 5 days after confirming the "wrinkle test". All the patients were operated by open reduction and internal fixation with a plate. Patients with more than 3 week old or general conditions precluding surgery were excluded. The mean follow up duration was 24 months (range 11 to 36 months). The procedure was performed in lateral position. A pre-operative planning after studying the x-rays {antero-posterior view, lateral view, Harris axial view (Fig 1(b)), Brodens view (Fig 1(a))}, CT scan and the 3-D reconstruction was done. The major fragments were labeled and the set of instruments

and implants were kept ready accordingly. The depressed posterior facet in depressed type of fractures was first elevated and then the plate was fixed. The void created after elevation of depressed posterior facet was filled by bone graft in 2 patients. Congruity of anterior facet, middle facet and calcaneo-cuboid joint was also confirmed. Newer plates like calcaneum locking compression plates {LCP} were used in 2 cases.

(b) Operative Procedure: After induction of spinal/epidural anaesthesia, the patient was placed in the lateral position with a pneumatic tourniquet placed high in the thigh with sandbag behind and all the bony prominences well padded. Prophylactic antibiotics are administered. An L-shaped incision⁹ (Fig 1(c)) was taken halfway between the Achilles tendon and the fibula proximally and at the junction of the plantar and lateral skin distally which created a viable skin flap. The peroneal tendons were freed after releasing the calcaneofibular] ligament. Special care to explore sural nerve and retract it, so as to avoid post-operative anesthesia over lateral aspect of foot was taken. After exploration of fracture site the posterior facet was visualized, most of times the fracture was an intra-articular depressed type which was elevated with the help of homanns elevator or a bone hook or by joystick maneuver with the help of Steinmann pin and was fixed with a 4.0mm cancellous screw. Sometimes a second cancellous screw is required to fix the fragment. Reduction of anterior and middle facet was also performed. Intra-operative Brodens view and Harris axial views were taken on image intensifier to judge the reduction. A pre-contoured plate was fixed to lateral aspect of calcaneum and screws were passed from lateral to medial taking care it just pierces the medial cortex to avoid any neurovascular injury. Two screws were tried to accommodate in sustentaculum tali. Again a antero-posterior view, Lateral view, Brodens view, Harris axial view was taken and reduction was judged in terms of heel width, height, articular congruency, positioning of screws and plates. (figure 3)

The wound was irrigated and closed over a suction drain. Post-operative patient was given a below knee plaster splint which was converted to a below knee plaster cast after a week once the wound condition was good. The plaster cast was cut after 4 weeks. The patient was kept non weight bearing 6 weeks post-operatively. Routine radiographs were obtained 4 weeks after surgery and every 4 weeks after until fracture healing.

The Bohler and Gissane angles as well as calcaneal height and width before and after surgery were compared. Subtalar movement was compared with that of the normal foot and expressed as a percentage. Functional assessment was carried out at the one-year follow-up, using the Maryland Foot Score.¹⁹ (Table 1).



Fig 1(a) Brodens View



Fig 1(b) Harris Axial View



Fig 1(c) Incision Mark for ORIF

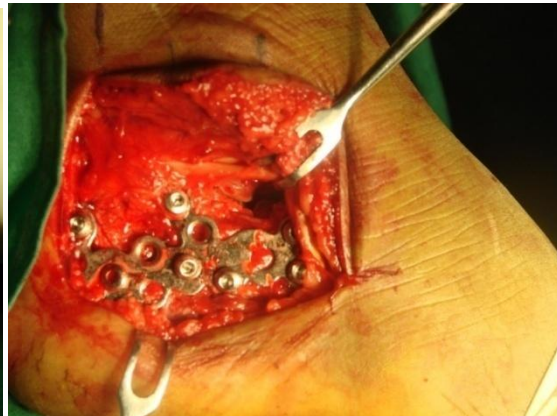


Fig 1(d) Final Plate Fixation

Table 1

Maryland Foot Score		Limp	
1. Pain		None	4
None - including with sports	45	Slight	3
Slight - no change in ADL's or work ability	40	Moderate	2
Mild - minimal change in ADL's work	35	Severe	1
Moderate - significant decrease in ADL's	30	Unable to wear shoes	0
Marked - during minimal ADL's e.g. bathrooms	10	Shoes	
Simple housework. Stronger, more frequent analgesics	5	Any type	10
Disabled - unable to work or shop	5	Minor concession	9
		Flat laced	7
		With Orthotics	5
		Space shoes	5
		Unable to wear shoes	0
2. Function Gait		Stairs	
Distance walked		Normally	4
Unlimited	10	With banister	3
Slight limitation	8	Any method	0
Moderate limitation (2-3 blocks)	5	Unable	0
Severe limitation (1 block)	2	Terrain	
Indoors only	0	No problems with any surface	4
Stability Normal	4	Problems on stones, hills	2
Weak feeling - no true giving way	3	Problems on flat surfaces	0
Occasional giving way (1-2 mos)	2	Cosmosis	
Frequent giving way	1	Normal	10
Orthotic device used	0	Mild Deformity	8
Support		Moderate	6
None	4	Severe	0
Cane	3	Multiple deformities	0
Crutches	1	Motion (ankle, subtalar, midfoot/ tarsophalangial)	
Wheelchair	0	Normal	5
		Slightly decreased	4
		Markedly decreased	2
		Ankylosed	0

* Based on the Maryland Foot Score Excellent = 90-100 points, good = 75-89 points, fair = 50-74 points, and failure less than 50 points.

Results

26 patients had full sub-talar range of movement and 4 patients had restricted range of movement. All the patients returned back to their routine activities. 2 patients with compound fractures had superficial infection at the incision site which was treated with debridement¹¹ and antibiotic impregnated beads insertion after which the infection subsided. 23 cases had post operative

Bohlers angle in normal limits, that is 25-40^{0.7} cases had Bohlers angle <25⁰. 23 cases had post operative crucial angle of Gissane in normal limits. 23 cases had normal heel height and 7 patients had minimal decrease in heel height. At the latest follow-up, there were 3 patients who had early sub-talar arthritis (figure 4) with restricted range of motion. 27 patients had normal heel valgus, 2 had neutral heel alignment, 1 had varus heel alignment in the last follow-up. 2 patients had partial wound dehiscence^{8,16} which healed by daily dressing by secondary intention. All the fractures went on to full healing without signs of collapse of posterior facet. None of the patients required any fusion. None of the patients had any peroneal tendon entrapment especially in the patients who had post-operative varus heel (figure 2) alignment. 23 patients had Maryland foot score which was excellent and 7 patients had score which was good (Table 2).

Table 2

Sr. No.	Age / Sex	Sander's CT classification	Plate type	Subtalar Rom	Bohlers angle pre-op	Bohlers angle post-op	Gissanes angle pre-op	Gissanes angle post-op	Congruity of subtalar joint	Heel alignment	Heel Height (MM) [POST OPERATIVE]	Heel alignment (POST OPERATIVE)	Maryland Foot Score
1	24/F	3A	Mod.sanders	Full	2	25	140	105	Congruent	N.valg	34	5 ⁰ valgus	92
2	28/M	3A	Mod.sanders	Full	18	29	124	110	Congruent	N.valg	32	6 ⁰ valgus	96
3	34/M	3B	Mod.sanders	Full	5	26	125	106	Congruent	N.valg	32	5 ⁰ valgus	91
4	22/M	1	LCP	Full	3	25	150	108	Congruent	N.valg	33	4 ⁰ valgus	93
5	53/M	2C	3.5mmDCP	Full	40	40	123	110	Congruent	N.valg	34.5	6 ⁰ valgus	90
6	52/M	3B	1/3 rd tubular	Full	6	25	122	110	Congruent	N.valg	33.5	7 ⁰ valgus	85
7	37/M	4	3.5mmDCP	Full	7	27	129	104	Congruent	N.valg	32.5	4 ⁰ valgus	93
8	29/M	2B	Mod.sanders	Full	2	14	119	84	Congruent	N.valg	28	Neutral	96
9	22/M	2A	1/3 rd tubular	Full	20	34	141	106	Congruent	N.valg	32	5 ⁰ valgus	91
10	26/M	1	Mod.sanders	Full	30	30	136	101	Congruent	N.valg	33	7 ⁰ valgus	91
11	33/F	3C	3.5mmDCP	Full	5	28	138	106	Congruent	N.valg	33	7 ⁰ valgus	94
12	47/M	3A	3.5mmDCP	Full	3	17	160	90	Incongruent	N.valg	29	6 ⁰ valgus	92
13	27/M	4	Mod.sanders	Full	5	32	137	98	Congruent	N.valg	31.5	5 ⁰ valgus	79
14	31/F	1	1/3 rd tubular	Full	12	28	144	110	Congruent	N.valg	34	5 ⁰ valgus	90
15	25/M	2A	1/3 rd tubular	Restricted	15	15	146	96	Incongruent	N.valg	28	6 ⁰ valgus	88
16	55/M	3B	Mod.sanders	Full	17	32	138	104	Congruent	N.valg	32.5	6 ⁰ valgus	93
17	24/M	2C	Mod.sanders	Restricted	14	17	135	88	Congruent	Neutral	28	Neutral	95
18	44/M	3A	1/3 rd tubular	Full	8	38	152	104	Congruent	N.valg	32	7 ⁰ valgus	92
19	22/M	4	1/3 rd tubular	Full	2	27	141	101	Congruent	N.valg	32	5 ⁰ valgus	86
20	21/M	2A	LCP	Full	7	30	128	101	Congruent	N.valg	31.5	5 ⁰ valgus	94
21	27/M	1	1/3 rd tubular	Full	12	19	122	93	Congruent	N.valg	30	7 ⁰ valgus	77
22	28/M	3C	1/3 rd tubular	Full	19	37	131	102	Congruent	Neutral	34.5	4 ⁰ valgus	96
23	29/M	3C	Mod.sanders	Full	4	33	127	106	Congruent	N.valg	32.5	4 ⁰ valgus	91
24	23/M	3A	Mod.sanders	Full	16	31	120	100	Congruent	N.valg	31	5 ⁰ valgus	91
25	38/M	4	Mod.sanders	Full	11	29	118	103	Congruent	N.valg	32.5	4 ⁰ valgus	94
26	26/M	3C	1/3 rd tubular	Restricted	7	12	143	90	Incongruent	Varus	27	7 ⁰ valgus	97
27	21/M	3B	Mod.sanders	Full	14	33	126	107	Congruent	N.valg	31	5 ⁰ valgus	93
28	21/M	3C	Mod.sanders	Restricted	11	12	133	88	Incongruent	N.valg	27	5 ⁰ varus	93
29	27/M	1	3.5mmDCP	Full	20	34	132	103	Congruent	N.valg	32	4 ⁰ valgus	79
30	28/M	4	3.5mmDCP	Full	13	30	121	107	Congruent	N.valg	31	7 ⁰ valgus	84

N=Normal Sup.=Superficial Mod.=Modified

Thus the difference between pre-operative Bohlers angle and Gissanes angle and post-

operative Bohlers and Gissanes angle is significant after T-TEST with probability<0.01.

	MEAN	STANDARD DEVIATION	T - TEST	PROBABILITY
PRE -OP BOHLERS ANGLE	11.6	8.518	7.40	P<0.01
POST - OP BOHLERS ANGLE	26.966	7.53		
PRE-OP GISSANES ANGLE	133.366	10.6	13.67	P < 0.01
POST - OP GISSANES ANGLE	101.366	7.29		

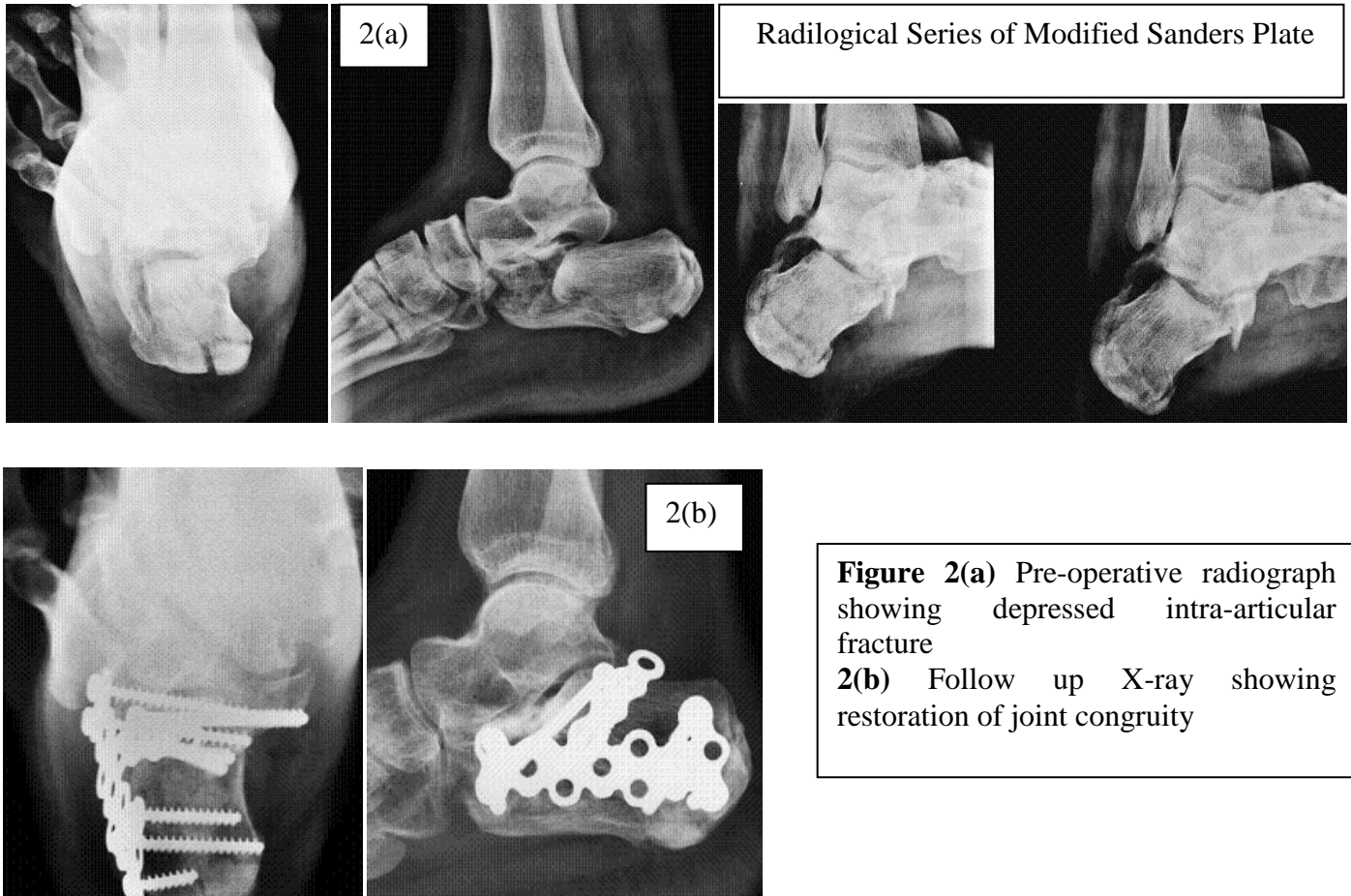


Figure 2(a) Pre-operative radiograph showing depressed intra-articular fracture
2(b) Follow up X-ray showing restoration of joint congruity

Discussion

Intra-articular fractures of calcaneum can be treated either conservatively in the form of closed reduction and cast or it can be treated operatively with open reduction and fixation with screws and plate. Buckley et. al⁸ have done a comparative study of non-operative treatment in the form of closed reduction and cast with operative treatment in the form of open reduction and cast.

They found that the short term results of both the modalities of treatment is the same but medium

term and long term results of the operative treatment were much better as compared to cast treatment. The patients treated with cast had residual pain and over a course of time gradually developed sub-talar arthritis and were performing functionally less than the patients in operative group. The patient with operative approach were able to perform better and functionally had no residual pain and had minimum chances for developing sub-talar arthritis.

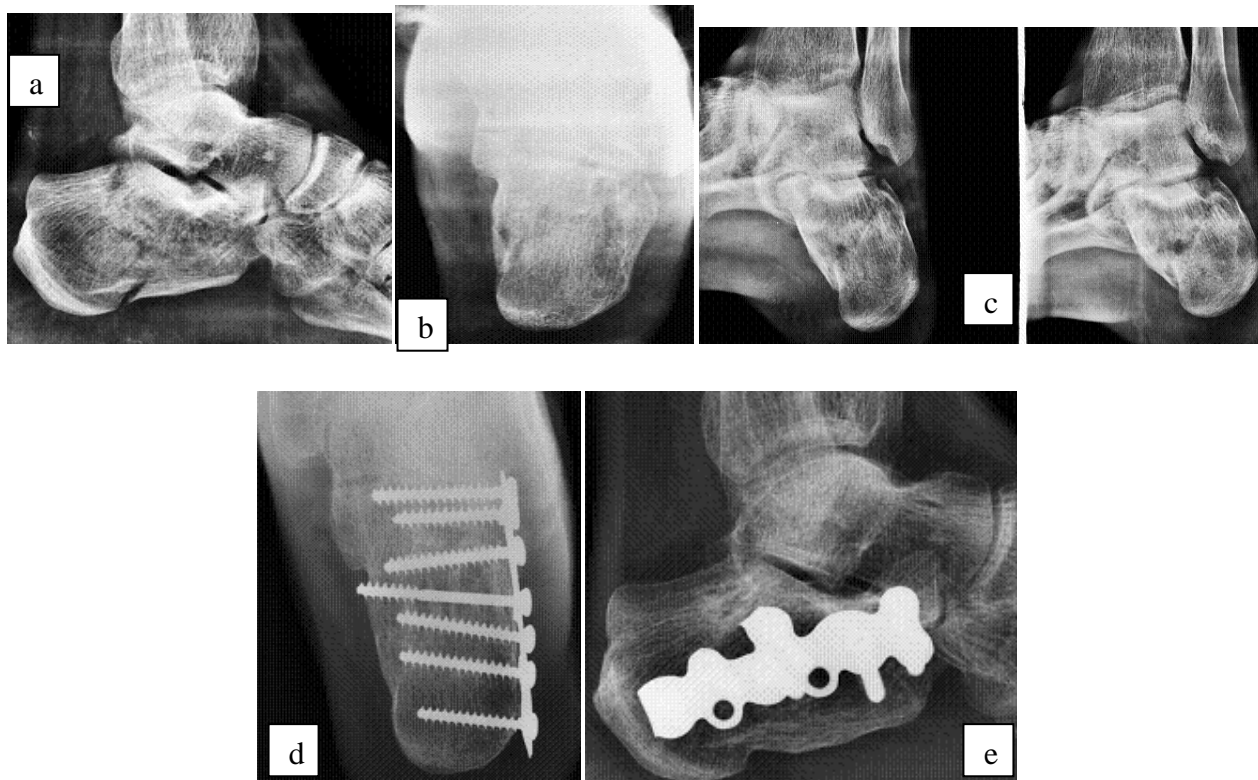


Figure 3:- (a)Lateral (b)Harris axial (c)Brodens view radiographs of intra-articular calcaneum fracture. Post operative follow up (d) Harris axial (e)lateral views showing restoration of anatomy after open reduction.

The guideline principles for treating these fractures were

- 1) Reduction of depressed posterior facet, anterior and middle facet.
- 2) Stabilization of the fragment by 4.0mm cancellous screws
- 3) Proper sized plate fixation laterally with screws directed from lateral to medial
- 4) Restoration of heel width, height, valgus alignment.
- 5) Intra-operative fluoroscopy to judge the reduction of the fracture and calcaneocuboid joint.
- 6) Decompression of subfibular space available for the peroneal tendons.

Controversy exists over non-operative versus operative treatment. 17 of 27 fractures treated by conservative means attained fair to poor results.¹⁴ Results are worse with increasing degrees of comminution of the posterior facet.^{5,6} The results of operative treatment are variable, mostly related to the quality of the posterior facet reduction; 80% of patients with successful reductions had satisfactory results.⁷ In another series, 76% of patients attained satisfactory results based on CT assessment of the fracture reduction.¹²

Unsatisfactory results were associated with failure to obtain or maintain a satisfactory reduction.

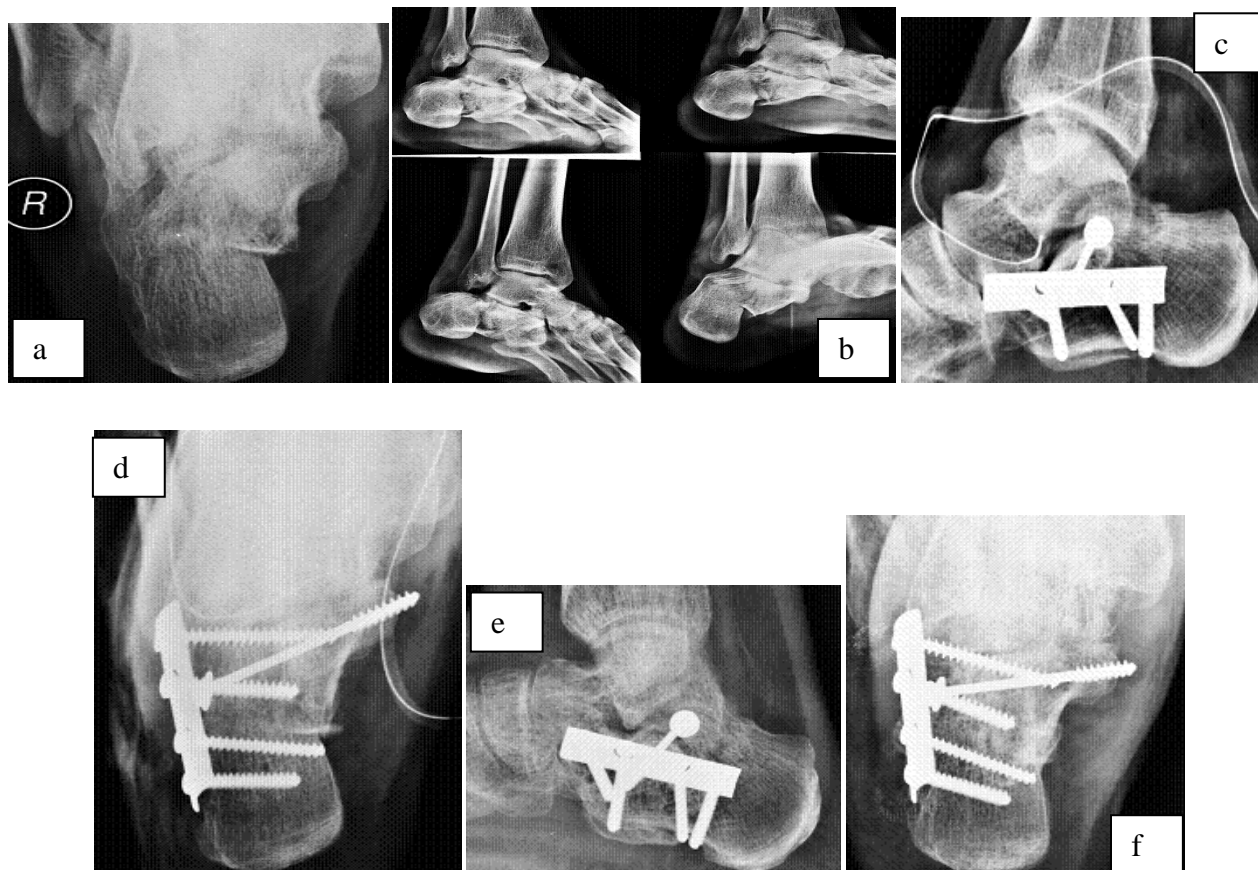


Figure 4:- (a) Harris axial, (b) Broden view radiograph of depressed fracture of calcaneum. Immediate post operative (c) lateral and (d) Harris axial view. Follow up (e) lateral, (f) Harris axial radiographs showing subtalar arthritis with fracture united.

Lateral, axial, anteroposterior and Broden view radiographs are used to examine calcaneal fractures. Extension of the fracture into the posterior facet is clearly visualized using the Broden view, but overlap of tarsal bones and articular surfaces makes assessment of the exact fracture anatomy difficult. 2-Dimensional CT scans help in pre-operative planning and give additional information on

- Calculation of Bohlers and Gissanes angle.
- Calculation of heel height and width.
- Size and number of fracture fragments.
- Proper labeling the major fragments and methods to stabilize them.
- Size and displacement of sustentaculum tali relative to superomedial fragments.
- Presence of step or diastasis of the posterior facet.
- Impingement of the fibular malleolus on the tuberosity of calcaneum¹⁰.

Such scans also provide information regarding fractures involving the sinus tarsi, calcocuboid joint, and anterior calcaneal process, all of which could be relevant while planning lateral surgical approach.

Buckley R, Meek R compared closed and open reduction of intra-articular fractures of calcaneum and found good results in open reduction methods for these fractures. Freeman BJC, Duff S, Allen PE, et al advocated extended lateral approach for treating intra-articular fractures of calcaneum. With direct visualization of fracture through a lateral approach, anatomic reduction of the fracture was possible, also the elevation of depressed posterior facet fragment was possible, easier decompression of the lateral wall and the plate was applied on the lateral surface of calcaneum which acted as a buttress.

Conclusion

Intra-articular fractures of calcaneum are challenging fractures with a significant potential for complications. However ORIF (open reduction and internal fixation) utilizing lateral incision can result in excellent sub-talar and hindfoot function for these patients.

In conclusion, this study confirms that the intra-articular fractures of calcaneum can be best treated by open reduction and internal fixation with a plate and function of the calcaneus and subtalar joint be restored.

References

1. Benirschke SK, Sangeorzan BJ. Extensive intraarticular fractures of the foot. Surgical management of calcaneal fractures. Clin Orthop Relat Res 1993;292:128–34.
2. Burdeaux BD. Reduction of calcaneal fractures by the McReynolds medial approach technique and its experimental basis. Clin Orthop Relat Res 1983;177:87–103.
3. Carr JB. Surgical treatment of the intra-articular calcaneus fracture. Orthop Clin North Am 1994;25:665–75.
4. Chan S, Ip FK. Open reduction and internal fixation for displaced intra-articular fractures of the os calcis. Injury 1995;26:111–5.
5. Crosby LA, Fitzgibbons T. Computed tomography scanning of acute intra-articular fractures of the calcaneus. A new classification system. J Bone Joint Surg Am 1990;72:852–9.
6. Crosby LA, Fitzgibbons T. Intraarticular calcaneal fractures. Results of closed treatment. Clin Orthop Relat Res 1993;290:47–54.
7. Essex-Lopresti P. The mechanism, reduction technique, and results in fractures of the os calcis, 1951-52. Clin Orthop Relat Res 1993;290:3–16.
8. Folk JW, Starr AJ, Early JS. Early wound complications of operative treatment of calcaneus fracture: Analysis of 190 fractures. J Orthop Trauma 1999;13:369–370.
9. Gould, N. Lateral approach to the Os calcis. Foot Ankle.1984;4:218-220
10. Heger L, Wulff K, Seddiqi MS. Computed tomography of calcaneal fractures. AJR Am J Roentgenol 1985;145:131–7.
11. Heir Ka, Infante AF, Walling AK, et al. Open fractures of calcaneus: Soft tissue injury determined outcome. J Bone Joint Surg Am 2003;85:2276-2282.
12. Hutchinson F 3rd, Huebner MK. Treatment of os calcis fractures by open reduction and internal fixation. Foot Ankle Int 1994;15:225–32.
13. Jarvholm, U, Korner L, Thoren O, Wiklund L.M. Fractures of the calcaneus. A comparison of open and closed treatment. Acta Orthop. Scand 1984; 55: 652-6.
14. Kitaoka HB, Schaap EJ, Chao EY, An KN. 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 1994;76:1531–40.
15. Letournel E. Open treatment of acute calcaneal fractures. Clin Orthop Relat Res 1993;290:60–7.
16. Levin LS, Nunley JA. The management of soft tissue problem associated with calcaneus fractures. Clin Orthop 1993;290:151-156.
17. Nade S, Monahan PR. Fractures of the calcaneum: a study of the long-term prognosis. Injury 1973;4:200–7.
18. Paley D, Hall H. Intra-articular fractures of calcaneus. A critical analysis of results and prognostic factors. J Bone Joint Surg Am 1993;75:342–54.
19. Sanders R, Fortin P, DiPasquale T, Walling A. Operative treatment in 120 displaced intraarticular calcaneal fractures. Results using a prognostic computed

- tomography scan classification. Clin Orthop Relat Res 1993;290:87–95.
20. Soeur R, Remy R. Fractures of the calcaneus with displacement of the thalamic portion. J Bone Joint Surg Br 1975;57:413–21.
 21. Thordarson DB, Krieger LE. Operative vs. nonoperative treatment of intra-articular fractures of the calcaneus: a prospective randomized trial. Foot Ankle Int 1996;17:2–9.
 22. Zwipp H, Tscherne H, Thermann H, Weber T. Osteosynthesis of displaced intraarticular fractures of the calcaneus. Results in 123 cases. Clin Orthop Relat Res 1993;290:76–86.