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ORIGINAL RESEARCH

Comparative Study of Conservative versus Open Reduction and Internal Fixation of Intraarticular Fractures of Calcaneum

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Abstract

Aim: To compare conservative versus open reduction and internal fixation of intraarticular fractures of calcaneum.

Material and methods: This prospective study was conducted in the Department of Orthopaedics Surgery at MKCG Medical College &Hospital, Brahmapur, Odisha from October 2018 to November 2020 among 31 cases of either sex having intra-articular fractures of calcaneus, who were admitted and treated in the department were included in the study. All the cases were prospectively randomized into two categories of non-operative or operative. Radiological evaluation was done by antero-posterior, lateral, Broden's and Harris axial views. CT scan was performed in every case and cases were classified according to Essex-Lopresti's and Sanders's classification systems. We used either non-operative treatment in the form of closed manipulation and plaster casting or operative treatment in the form of open reduction and internal fixation with plates and screws for stabilization of intra-articular fractures of the calcaneus. Follow-up visits were scheduled at regular intervals. At every review visit, clinical and radiological assessment was performed for every case.

Results: Complications were significantly more in conservative group (p value<0.01). Average radiological union time was 13.3 weeks in conservative group, as compared to 12.5 weeks in the operative group. On final result analysis, the majority of patients (66.7%) in conservative group had fair outcomes, whereas only 25% patients had good outcomes. On the other hand, in the operative group 53.3% patients had a good outcome and another 40% had a fair outcome. Overall only one patient had an excellent outcome, who belongs to the operative group and only one patient had poor outcome who belongs to conservative group.

Conclusion: The authors concluded that considering the functional outcomes and rate of complications, operative management gives superior results being associated with better restoration of Bohler's Angle, joint congruity and heel width.

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Introduction

Calcaneal fractures are one of the most challenging fractures for the orthopedic surgeons. Although calcaneal fractures unite well, the results are disabling for most of the patients.[1-3] Fracture of calcaneus leads to considerable morbidity and hence was historically quoted that "Ordinarily speaking the man who breaks his heel bone is done, so far as his industrial future is concerned". So, despite the surgeon's extensive experience with this injury, it has a major socio-economic impact with regards to the time lost from work and recreation. The frequent occurrence during the active years of life further increases the economic burden. The rehabilitation process is time consuming, may take up to 9 months and even longer in a large percentage of patients, which adds to socioeconomic burden.[4-6]

Calcaneal fractures are typically the result of high energy trauma most commonly due to fall from height and less commonly from motor vehicle accidents. Incidence of calcaneal fractures is increasing in recent times due to industrialization and increase in high-rise constructions[7,8]. Currently, calcaneal fractures are estimated to comprise approximately 1-2% of all fractures, 60% of all tarsal fractures.

The management of intra-articular calcaneal fractures remains a controversy with strong arguments supporting both conservative and operative management. Treatment goals focus on the minimization of pain and maximization of functional use of the foot in performing activities of daily living. Union is not a problem with calcaneal fractures, but results in loss of height of calcaneus, relative lengthening of Achilles tendon, incongruity of subtalar joint, increased heel width and encroachment of peroneal tendons. Open reduction and internal fixation aims to restore the normal anatomy of heel bone and congruence of subtalar joints for speedy recovery and return to activities. Over the years, various techniques have been developed to accomplish this goal[9].

With these controversies and observations in mind, this study was taken up at the Department of Orthopedics, MKCG Medical College and Hospital, Berhampur to evaluate the outcomes of surgical management of intra-articular calcaneal fractures and compare them with the results of conservative management.We expect that this study will be of use in outlining the outcomes of management of intra-articular fractures of the calcaneus. This study will also be of use to test whether the recent advances in fracture management, better understanding of fracture patterns, rigid fixation, near restoration of articular surface and early mobilization has any positive effect on the outcomes of calcaneus fractures.

Material and methods

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This prospective study was conducted in the Department of Orthopaedics Surgery at MKCG Medical College &Hospital, Brahmapur, Odisha from October 2018 to November 2020. It was a hospital based study of 31 cases, who fulfilled the inclusion and exclusion criteria. During the above said period, adult patients of either sex having intra-articular fractures of calcaneus, who were admitted and treated in the department were included in the study.

Inclusion criteria

1. Intra-articular calcaneal fracture.
2. Acute fracture (not more than 3 weeks old)
3. Close fractures.
4. Age more than 18 years.
5. Patients who are medically fit for surgery
6. Patients who had given written informed consent for the procedure and for complications associated with it.
7. Patients should be walking prior to the fracture.
8. Normal neuro-vascular status of the limb both prior and after the fracture.

Exclusion Criteria

1. Age less than 18 years.
2. Patient medically unfit for surgery.
3. Paraplegia paraparesis, as they interfere with assessment of the functional results of the surgery
4. Extra articular fractures of calcaneus
5. Uncontrolled hypertensive & diabetics
6. Pregnancy
7. Patients with local infections
8. Open fractures
9. Pathological fractures
10. Calcaneal fractures with other associated fracture in the ipsilateral lower limb.
11. Sanders Type I & IV
12. Severely osteoporotic bone
13. Peripheral vascular disease

For every patient, demographic data, history, clinical examination and details of hematological tests, X-rays etc. were recorded in the study proforma. Radiological evaluation was done by antero-posterior, lateral, Broden's and Harris axial views. On an antero-posterior

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View, anterior process fracture, calcaneo-cuboid joint involvement, lateral spread of calcaneus and subluxation of the talo-navicular joint was assessed. In all cases, x-rays of the opposite calcaneus were also taken for comparative studies. CT scan was performed in every case and cases were classified according to Essex-Lopresti's and Sanders's classification systems. Specific mention about the presence or absence of vascular or neurological deficits, open or closed injury, associated injuries like spinal injuries, extremity injuries, etc. were made.

We used either non-operative treatment in the form of closed manipulation and plaster casting or operative treatment in the form of open reduction and internal fixation with plates and screws for stabilization of intra-articular fractures of the calcaneus.

All the cases were prospectively randomized into two categories of non-operative or operative. Randomization was done on the basis of indoor registration number of patients. Patients with odd registration numbers were given non-operative intervention and those with even serial numbers were treated operatively.

Follow up

Follow-up visits were scheduled at regular intervals. At every review visit, clinical and radiological assessment was performed for every case. The results were evaluated as following:

1. **Clinical assessment:**

- Status of union- Clinically status of union was assessed by complete weight bearing without pain.
- Deformity- Cases were assessed to look for any visible deformity like varus mal-union, contracture of toes etc.
- Heel width Patients were clinically assessed for broadening of heel. Width of both the heels was measured with the help of calipers and compared.
- Complications- Patients were observed for development of various complications like skin necrosis, wound infections, peroneal tendonitis, sub-talar arthritis, complex regional pain syndrome etc.
- Morbidities

2. **Radiological assessment:**

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- Status of union
- Bohler's Angle Ratio- Also known as the tuberosity joint angle, or the “salient" angle, is obtained on lateral view. In calcaneal fractures this angle decreases and can therefore be taken as a relative measure of the degree of compression and deformity in calcaneal fractures. The angles in the right and left calcaneus of the same individual are equal.

In this study, ratio between Bohler's Angle of the side of the fracture to the normal side was measured in Lateral view of the foot, at radiological union to assess the degree of restoration achieved.

3. Functional assessment:

- Creighton and Nebraska Health Foundation Assessment Score for Fractures of the Calcaneus- Functional assessment was done using this score at 9 months post-injury. This score is based upon the assessment of activity and rest related pain, ability to walk, range-of-motion of sub-talar joint, return to previous work, change in shoe-size and presence or absence of foot swelling. The total score is 100 points. Pain is given the maximum weightage with total of 30 points, whereas ability to walk, sub-talar joint motion, ability to return to previous work are given 20 points each; change in shoe size and presence of swelling are given 5 points each. A score of 90-100 is considered to be excellent, 80-89 is good, 65-79 is fair and less than 65 is poor functional outcome.

Statistical method

Data so collected was tabulated in an excel sheet, under the guidance of statistician. The means and standard deviations of the measurements per group were used for statistical analysis (SPSS 22.00 for windows; SPSS inc, Chicago, USA). Difference between two groups was determined using student t-test as well as chi square test and the level of significance was set at $p < 0.05$.

Results

Of the 31 patients, 3 were lost to follow up, leaving us with 28 patients. After randomization, 12 patients were treated by close manipulation and plaster casting and 15 patients were treated by open reduction and internal fixation with plates and screws. One patient who had bilateral fractures was randomized to both groups, i.e. right and left foot received operative and conservative treatment respectively. In the conservative group there were 8 males and 4 females while in operative group, there were 9 males and 6 females. One patient who had

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bilateral calcaneus fracture was male. Males clearly outnumbered females in both the groups. Age of the patients under study varied from 23-51 years; the average age being 36.24 years. Right side was most commonly involved in both the groups.

The most common mode of injury in both the groups was fall from height, responsible for 26 fractures in 25 patients. Joint-depression fractures constituted the majority of fractures i.e. 72%.Overall the sanders type III BC was the most common fracture, comprising 27.59% of all fractures. In the conservative group III AB and III BC were equally common, each comprising 25% of total patients (table 1).

Table 1: Mode of Injury, Essex-Lopresti type and Sanders type of Fractures

Mode of Injury	**Group**			**Total**	**Chi Square**	**p value**
	Conservative	**Operative**	**Both**			
Fall from height	11	13	1	25[92.1%]	0.17	0.68
Road traffic accident	1	2	0	3 [7.9%]		
Essex Lopresti Type						
Tongue type	3	5	0	8[27.6%]	0.22	0.64
Joint depression type	9	10	2	21[72.4%]		
Sanders Type						
IIA	1	3	0	4[13.8%]	1.92	0.86
IIB	2	1	1	4[13.8%]		
IIC	1	1	0	2[6.9%]		
IIIAB	3	2	1	6[20.7%]		
IIIAC	2	3	0	5[17.2%]		
IIIBC	3	5	0	8[27.6%]		
Total	12[100%]	15[100%]	2[100%]	29[100%]		

The interval between fracture and intervention was observed in each patient. They were grouped into those treated within one, two and three weeks of injury. On analysis, it was found that the maximum number of patients in both the groups, received intervention in the second week. Only 2 patients, both belonging to the operative group, intervened in the first week. Average injury-intervention interval in conservative group was 13.9 days as against

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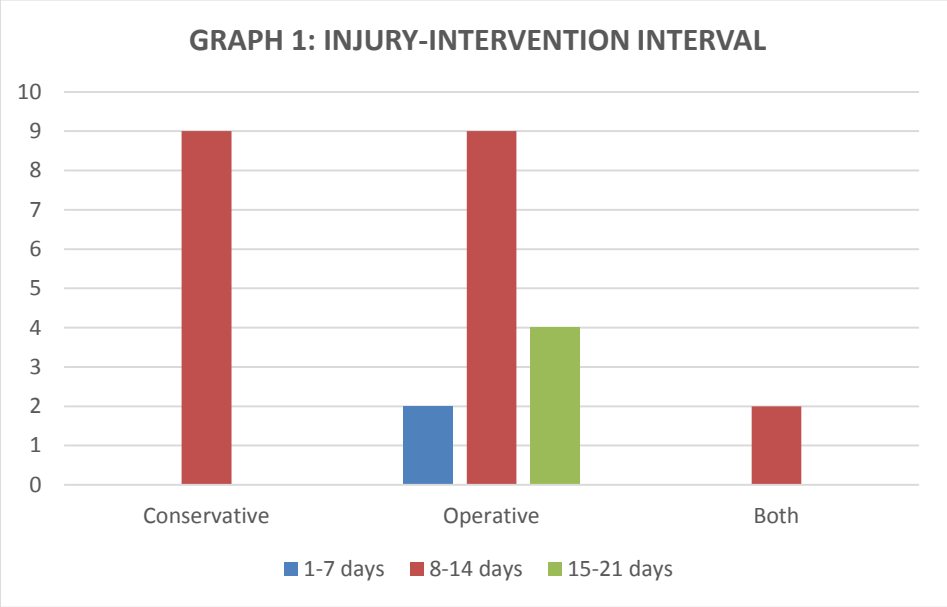
12.2 days in the operative group. However, the differences were statistically insignificant (p value=0.4) as shown in graph 1.



In the conservative group there were a total of 30 complications in 13 fractures, whereas in the operative group there were 24 complications in 16 fractures. Complications were significantly more in conservative group (p value<0.01) as described in table 2.

Table 2: Complications

Complication	Group		Total (29 fractures)
	Conservative (13 fractures)	Operative (16 fractures)	
Foot Swelling	3[23.1%]	0	3[10.3%]
Skin Necrosis	0	2[12.5%]	2[6.9%]
Wound Infection	0	1[6.3%]	1[3.5%]
Heel broadening & Loss of Height	7[53.9%]	1[6.3%]	8[27.6%]
Subfibular impingement of peroneal tendons	2[15.4%]	0	2[6.9%]
Peroneal Entrapment & tendonitis	4[30.8%]	3[18.8%]	7[24.1%]
Sub-talar arthritis	5[38.5%]	2[12.5%]	7[24.1%]
Sural Nerve injury	0	6[37.5%]	6[20.7%]
Toe stiffness	6[46.2%]	4[25%]	10[34.5%]
CRPS	3[23.1%]	5[31.3%]	8[27.6%]

Chi-square test, χ^2 = 14.634, P value=<0.001, Significant

Average time taken for clinical union was 11.23 and 10.06 weeks in conservative and operative groups, respectively. So the healing rate was relatively faster in the operative group as compared to conservative group. The difference was statistically significant, p

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value=0.038. In conservative group radiological healing was also delayed as compared to operative group. Average radiological union time was 13.3 weeks in conservative group, as compared to 12.5 weeks in the operative group. The difference was statistically significant (p value=0.025) as shown in table 3.

Table 3: Clinical and Radiological union (weeks) among the study groups

Clinical Union (in weeks)	Group		Total	p value
	Conservative	Operative		
7-9	1	6	7[24.1%]	0.038*
10-12	11	10	1[72.4%]	
13-15	1	0	1[3.5%]	
Radiological Union (in weeks)				
10-12	4	10	14[48.3%]	0.025*
13-15	9	6	15[51.7%]	

*: statistically significant

In the conservative group, the mean Bohler's Angle ratio after union was 64.36, with the majority of patients having a ratio between 60 and 79. In the operative group the mean ratio was 80.04, with the majority of patients having a ratio between 70 and 89. The difference was statistically significant (p value=0.0005) as shown in table 4.

Table 4: Bohler's angle ratio

Groups	N	Mean	Std. Deviation
Conservative	12	64.36	10.04
Operative	15	80.04	10.06

The outcome of treatment was evaluated using Creighton & Nebraska Score at 9 month post injury. In conservative and Operative group, the mean scores were 72.92 and 83.13 respectively. The patient with bilateral fractures had the score of 66. The scores were significantly better in the operative group as compared to the nonoperative group (p value=0.0017).On final result analysis, the majority of patients (66.7%) in conservative group had fair outcomes, whereas only 25% patients had good outcomes. On the other hand, in the operative group 53.3% patients had a good outcome and another 40% had a fair outcome. Overall only one patient had an excellent outcome, who belongs to the operative group and only one patient had poor outcome who belongs to conservative group. The patient with bilateral fractures had good outcome in operatively treated limb and fair outcome in conservatively treated limb. The difference between the final outcomes of two groups was

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statistically significant(table 5).

Table 5: Final result analysis

Result	Group			Total
	Conservative12 patients)	Operative(15 patients)	Both(1 patient)	
Excellent	0	1 [6.7%]	0	1 [3.6%]
Good	3 [25%]	8 [53.3%]	0	11 [39.3%]
Fair	8 [66.7%]	6 [40%]	1	15 [53.6%]
Poor	1 [8.3%]	0	0	1 [3.6%]
Total	12	15	1	28

Chi-square test, χ^2 = 29.517, P value < 0.001, Significant.

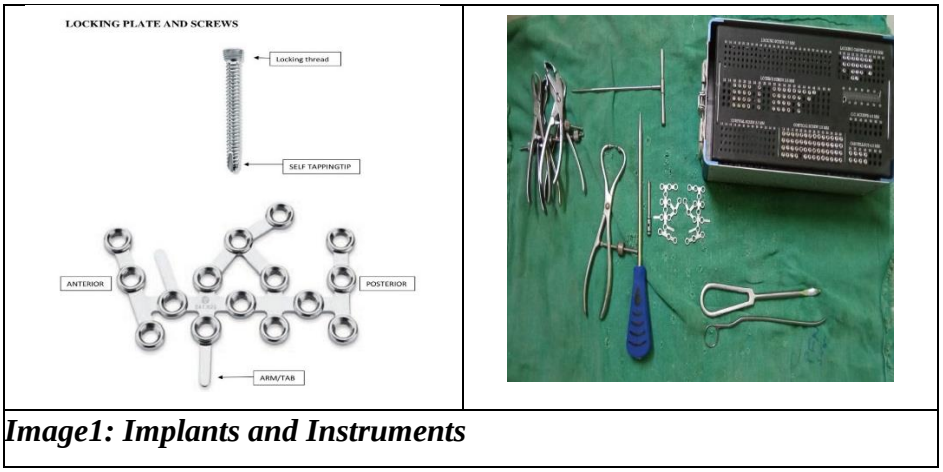

Image1: Implants and Instruments

Image 2a: Position – Leg Hanging From Table, 2b: Close Manipulation to Decrease Heel Width, 2c Below knee plaster cast.

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Image 3a: Pre-op Lateral & Axial view

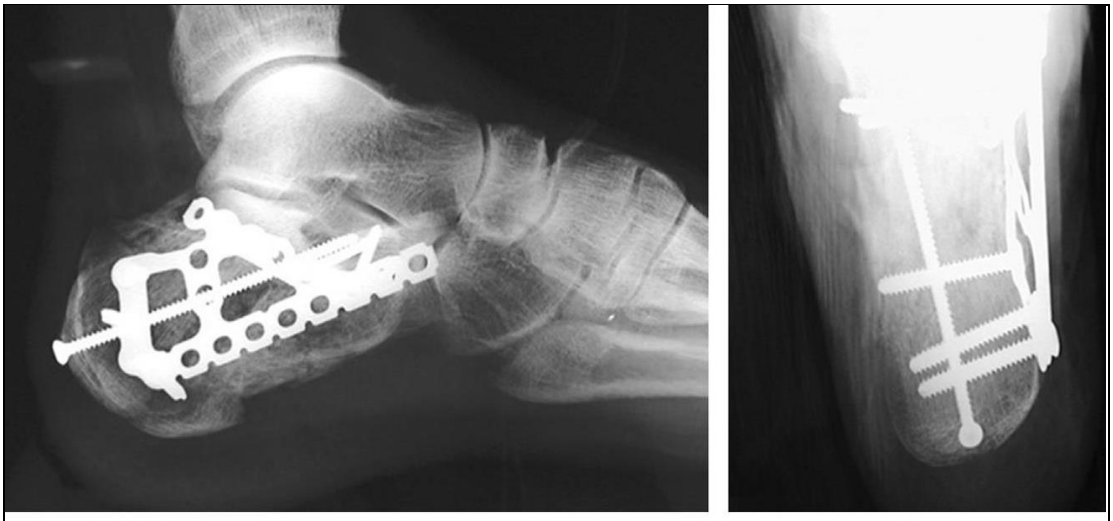

Image 3b: **Post-op Lateral & Axial view**

Discussion

Both conservative and operative treatment modalities for calcaneus fracture management have complications with significant effect on fracture prognosis and final outcomes. Complications can be described as early e.g. loss of reduction, pain, infection and late e.g. non-union, implant breakage and post-traumatic arthritis.Most of the complications of the calcaneal fractures are directly or indirectly due to soft tissue damage.Chechiket al[10]observed that superficial infection was seen in 1 (6%) out of 16 conservatively treated cases, whereas 10 (32.3%) out of 31 operatively managed cases reported wound breakdown and infection. Singh &Vinay[11] in their series of 390 operatively treated calcaneal fractures, reported superficial wound dehiscence in 26 (6.7%) patients and wound infection in 25 (6.4%) patients. In this study, wound infection and skin necrosis was seen in 3 (18.75%) fractures, all

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of whom were treated operatively. The wound infection subsided with dressing and administration of antibiotics in accordance with culture and sensitivity report. The skin necrosis necessitated debridement and split skin grafting. The incidence of wound infection and skin necrosis in the present study was comparable to the previous studies. Skin closure is difficult in many cases leading to skin necrosis. Large skin incisions, extensile exposures, poor soft-tissue respect and the long duration of operation lead to wound dehiscence and infections.

Due to common use of the lateral approach, iatrogenic injury to Sural nerve is the most common neurologic complication associated with operative management of calcaneal fractures. The nerve may be injured at either the proximal or distal portions of the incision, and the injury may vary from a neuropraxia to complete laceration of the nerve. Chechiket al[10] in their series of 47 calcaneal fractures, reported Sural neuropathy in 4 (8.5%) cases.

In the present series, Sural nerve injury was reported in 6 (37.5%) out of 16 operatively managed cases. None of the conservatively managed cases reported abnormal Sural nerve function. All 6 cases of Sural nerve injury were managed with methylcobalamin or amitriptyline medication and physical therapy. The overall incidence of Sural nerve injury was higher in the present study as compared to the previous studies. This may be due to less meticulous surgical dissection and irritation by implants.

Complex Regional Pain Syndrome (CRPS) may occur following both operative and conservative management. In our study, overall incidence of CRPS was 27.6%. Out of 8 cases presented with CRPS, 3 (23.1%) belonged to conservative group and 5 (31.3%) belonged to the operative group. CRPS results in long-term potentially permanent functional impairment of the patient. Early joint motion and progressive weight bearing may avoid this complication. In the present study, all the cases were managed by aggressive physical therapy and massage.

Impaired subtalar joint function after calcaneal fractures is common. This is thought to result from damage to the joint surface as a result of initial trauma or surgical exposure for fixation or to both. In a series of 70 patients by Paul et al[12], 17 out of 18 patients with un-displaced fractures and 15 out of 23 patients with intra-articular fractures treated conservatively had moderate to severe restriction of subtalar joint motion. Soeur& Rong[13] in their series of 105 patients, reported that the movements along the ankle were full and movements of subtalar joints were normal in 20 cases, diminished in 13 and absent in 12 and one patient had subtalar arthritis.

In this study, 5 (31.3%) fractures in the operative group and 1 (7.7%) in the conservative

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group had subtalar joint motion restored to more than 80%. 9 (69.2%%) patients in the conservative group and 10 (62.5%) in the operative group had subtalar joint movements in the range of 50%-60% only. 2 (15.4%) conservatively treated patients and 1 (6.3%) operatively treated patient had motion of subtalar joint essentially lost, with range of motion restored to 20-40%. 1 (7.7%%) patient in the conservative group had absolutely no motion of the subtalar joint. Extensor mechanism scarring, with or without arthrofibrosis of subtalar joint, can lead to restricted subtalar movements. These effects are greatly magnified by immobilization after fracture or internal fixation.

The Bohler's angles in the right and left calcaneus of the same individual are equal. In severe fractures of the calcaneus, this angle becomes smaller, straight or even reversed. Therefore, the ratio between angles of two sides can act as a measure for joint congruity restoration. In the present study, we have compared Bohler' s angle in normal foot and operated foot of patient and have statistically analyzed the outcome with the Bohler's angle ratio. In the conservative group, the mean Bohler's Angle ratio after union was 64.36, with the majority of patients having a ratio between 60 and 79. Inoperative group the mean ratio was 80.04, with the majority of patients having a ratio between 70 and 89. On final analysis, the patients with higher ratio and better restoration of Bohler's angle had less incidence of pain and loss of motion and subsequently better outcomes. These observations were in accordance with those made by Allmacher[14], Murphy[15] and Sanders[16] who also found restoration of Bohler's angle as an important prognostic factor.

Several methods are available for the functional assessment of patients with calcaneus fractures. We had followed the Creighton-Nebraska Health Foundation Assessment Score For Calcaneus Fractures, as it is simple and allows rapid and complete assessment of function, with due consideration to the complications.

Paul et al[12] reported a series of 70 patients, in which all the 18 patients with un-displaced fractures had good results and all 23 patients of intra-articular fractures treated non-operatively had fair results. Raket al[17] in their series of 76 fractures, used AOFAS (Ankle-Hindfoot scale) for evaluating outcomes and reported excellent outcomes in 54.5% of the patients. Chechiket al[10] used AOFAS to evaluate outcomes, and reported excellent outcomes 14 (30%), good in 9 (19%), fair in 8 (17%) and poor in 16 (34%) patients. Singh & Vinay[11] in a series of 390 operatively managed calcaneal fractures reported, more than 30% had excellent outcomes, nearly 65% had good to fair outcomes and only 4% patients had poor outcomes.

In our study the final outcomes were analyzed using Creighton & Nebraska Score. We found

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that the results were excellent in only 1 (3.6%) patient who was treated operatively. Good results were obtained in 3 (25%) patients in the conservative group and 8 (53.3%) patients in the operative group. Fair results were found in 8 (66.7%) cases in the conservative group and 6 (40%) cases in the operative group. Only 1 (3.6%) patient in the whole study had a poor outcome, who was treated conservatively. The patient with bilateral fractures had a fair outcome.

The operative management of intra-articular fracture of management has been found to give superior results as far as subtalar joint movement, absence of pain and Swelling and valgus/varus deformity of the ankle are concerned; however infection and skin necrosis remains a threat and it requires a skilled surgical team and adequate facilities including image intensifier.

In this study, operatively treated patients had comparatively better outcomes. Among the operative group, 1 fracture had an excellent outcome, 8 had good, 6 had fair and poor results, whereas; in conservative group 3 good, 8 fair, 1 poor and no excellent result was seen.

The fallacies in our study are small sample size and short study period.

Conclusion

Both the modalities of treatment i.e. conservative closed manipulation and plaster casting and operative open reduction and internal fixation give good results as far as union of the fracture is concerned. However, considering the functional outcomes and rate of complications, operative management gives superior results being associated with better restoration of Bohler's Angle, joint congruity and heel width. The function of the ankle joint was also found to be better preserved in operatively managed cases with lower incidence of ankle pain, peroneal tendon subluxation and post-traumatic arthritis.

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