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A study to evaluate the role and effectiveness of trans-calcaneal wire as provisional fixation tool during fixation of bimalleolar ankle fracture with ankle subluxation

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Abstract

Background: Bimalleolar ankle fractures with ankle subluxation forms the type of fractures difficult to treat and causes long term sequelae of complications if not treated well. Majority of bimalleolar fractures with ankle subluxation are treated with open reduction and internal fixation. The purpose of this study is to evaluate the role and effectiveness of Trans-calcaneal wire as a provisional fixation tool during fixation of bimalleolar ankle fracture with ankle subluxation.

Material and Methods: 30 patients of bimalleolar ankle fracture with ankle subluxation were treated between June 2017 to June 2019 at Govt Medical College and Rajindra Hospital, Patiala. Patients having bimalleolar ankle fracture with ankle subluxation and skeletally mature patients willing to participate in the study were included. In all cases, ankle subluxation was first reduced by closed means and after checking the reduction in both orthogonal views under fluoroscopy, a trans-calcaneal K-wire was introduced through heel passing through calcaneum and talus and distal tibia. After reduction of ankle joint, fibula was fixed in all the cases with plating, followed by fixation of medial malleolus with 2 screws or 1 screw and 1 K-wire depending upon the size of fracture fragment. The trans-calcaneal Wire was removed in all the cases after fixation of both malleoli.

Results: Mean age of patients was 36.5 years. As per the Lauge- Hansen classification systems, 15 cases (50%), had Supination External Rotation type of injury, which was most common. Radiological union was seen at 15 ± 3.2 weeks in 19 cases (63.3%). 2 cases (6.7%) had superficial infection. There were no cases of non-union or malunion in the study. As per the Baird Jackson scoring system, 16 (53.3%) cases had excellent results, 8 (26.7%) cases had good results, 4 (13.3%) cases had fair results and 2 (6.7%) cases had poor results.

Conclusion: Ankle reduction forms the mainstay in the treatment of bimalleolar fractures with ankle subluxation, as even a small displacement of the talus of even 1 mm can result in incongruity of the joint surfaces as to produce point loading of the articular cartilage sufficient to result in early degenerative arthritis. Trans-calcaneal K-wire has proved to be an effective tool for provisional reduction of ankle while fixing such fractures with good to excellent results in 80% of cases and does not cause any joint arthritis in long term.

Keywords: bimalleolar fractures, ankle subluxation, trans-calcaneal wire

Introduction

Ankle fractures are the most common type of fractures treated by orthopaedic surgeons accounting for 10% of all fractures with the increasing prevalence over the last 2 decades, both the young, active patients and the elderly [1-3]. Most ankle fractures are complex injuries which are difficult to manage. These injuries gain importance because the whole body weight is transmitted through the ankle and locomotion depends upon the stability of the ankle joint. They have the potential to produce significant long-term disability and complications in the form of the instability, pain and early degenerative arthritis.[3,4] Surgical internal fixation following bimalleolar fractures is accepted by most of surgeons, as the treatment of choice as bimalleolar fractures are unstable fractures as these are associated with complications as mentioned above. The stability of the ankle joint depends on the arrangement of bones,

ligaments, muscles and gravitational effects and positioning. Most ankle injuries are produced by abnormal movement of talus, in which a malleolus is either pushed or pulled by means of ligamentous attachments. In general, fractures produced by ligamentous avulsion are transverse and those produced by Talar impact are oblique. In nearly all published studies of treatment of ankle fracture, it has been shown that the functional result is proportional to the quality of final reduction of the displacement. Even a small displacement of the talus of even 1 mm, can result in incongruity of the joint surfaces as to produce point loading of the articular cartilage sufficient to result in early degenerative arthritis. So, internal fixation with anatomical reduction assumes a greater role in treatment of malleolar fractures.

Bimalleolar fractures with ankle subluxation is a difficult type of fracture where reduction is difficult and it is more difficult to hold the reduction, while fixing the malleoli. A smooth trans-calcaneal wire of 1.5 mm has proved to be a good provisional fixation tool during fixation of bimalleolar ankle fracture with ankle subluxation.

This study has been undertaken to evaluate the role and effectiveness of a trans-calcaneal wire as a provisional fixation tool during fixation of bimalleolar ankle fracture with ankle subluxation.

Methods

This is the prospective study to evaluate the role and effectiveness of a trans-calcaneal wire as a provisional fixation tool during fixation of bimalleolar ankle fracture with ankle subluxation. 30 skeletally mature patients of bimalleolar fracture with ankle subluxation admitted in Government Medical College and Rajindra Hospital, Patiala between June 2017 to June 2019 and willing to participate in the study were included in the study. Patients with compound fractures, pilon fractures and pathological fractures or skeletally immature patients were excluded from the study. All the necessary pre-operative work-up was done in the form of radiological and hematological investigations. All the fractures were classified using the Lauge-Hansen classification system. A written informed consent was taken from all the patients enrolled in the study. Regular follow-up was done at 3, 6 and 12 months post operatively. The final results were calculated using the Baird Jackson scoring systems.

Assessment of results: Baird and Jackson scoring system^[5] was used to evaluate the patients at the end of 6th month. Finally, correlation between results of the score and clinical data were used to evaluate functional outcome of ankle joint after internal fixation of bimalleolar fracture.

Baird and Jackson scoring system:^[5]

1) Pain Score

- | | |
|----------------------------------------------|----|
| a) No Pain | 15 |
| b) Mild Pain with strenuous activity | 12 |
| c) Mild pain with activities of daily living | 8 |
| d) Pain with weight bearing | 4 |
| e) Pain at rest | 0 |

2) Stability of ankle

- | | |
|------------------------------------------------|----|
| a) No clinical stability | 15 |
| b) Instability with sports activities | 5 |
| c) Instability with activities of daily living | 0 |

3) Able to walk

- | | |
|------------------------------------------------------------|----|
| a) Able to walk desired distances without limp or pain | 15 |
| b) Able to walk desired distances with a mild limp or pain | 12 |
| c) Moderately restricted inability to walk | 8 |
| d) Able to walk short distances only | 4 |
| e) Unable to walk | 0 |

4) Able to run

- | | |
|----------------------------------------------------------|----|
| a) Able to run desired distances without pain | 10 |
| b) Able to run desired distances with slight pain | 8 |
| c) Moderate restriction in ability to run with mild pain | 6 |
| d) Able to run short distances only | 3 |
| e) Unable to run | 0 |

5) Ability to work

- | | |
|------------------------------------------------------------------------------------|----|
| a) Able to perform usual occupation without restrictions | 10 |
| b) Able to perform usual occupation with restrictions in some strenuous activities | 8 |
| c) Able to perform usual occupation with substantial restriction | 6 |
| d) Partially disabled; selected jobs only | 3 |
| e) Unable to work | 0 |

6) Motion of the ankle

- | | |
|-------------------------------------------------------|----|
| a) Within 10 degrees of uninjured ankle | 10 |
| b) Within 15 degrees of uninjured ankle | 7 |
| c) Within 20 degrees of uninjured ankle | 4 |
| d) <50 of uninjured ankle, or dorsiflexion < 5 degree | 0 |

7) Radiographic Result

- | | |
|------------------------------------------------------------------------------------------------------------------------------------------|----|
| a) Anatomical with intact Mortis (Normal medial clear space, normal 2 mm superior joint space, no talar tilt) | 25 |
| b) Same as above with mild reactive changes at the joint margins | 15 |
| c) Measurable narrowing of the superior joint space, superior joint space 2 mm or talar tilt > 2 mm ---- | 10 |
| d) Moderate narrowing of the superior joint space, superior joint space between 2 and 1 mm – | 5 |
| e) Severe narrowing of the superior joint space, superior joint space < 1 mm widening of the medial clear space, severe reactive changes | 0 |

A Score according to the Baird and Jackson scoring system:

- | | |
|-----------|--------|
| Excellent | 96-100 |
| Good | 91-95 |
| Fair | 81-90 |
| Poor | 0-80 |

Surgical technique: The patient was placed in supine position of administration of spinal and /or epidural anaesthesia. A standbag was placed under the ipsilateral buttock. A pneumatic tourniquet with the pressure of 300 mm of mercury was used in all the cases. Standard surgical steps were followed in all the cases.

Trans-calcaneal Wire (Kahal *et al.* technique):

Initially closed reduction of ankle was done (Fig 1 and 2).



Fig 1: Pre-operative bimalleolar fracture



Fig 2: Intra-operative image showing closed reduction before trans-calcaneal k-wire

This was checked under fluoroscopy and reduction of ankle was provisionally fixed with trans-calcaneal smooth wire of 1.5 mm. This k-wire is passed percutaneously from heel through calcaneum to talus and then to distal tibia and reduction of ankle and placement of wire checked under fluoroscopy as in Fig 3.

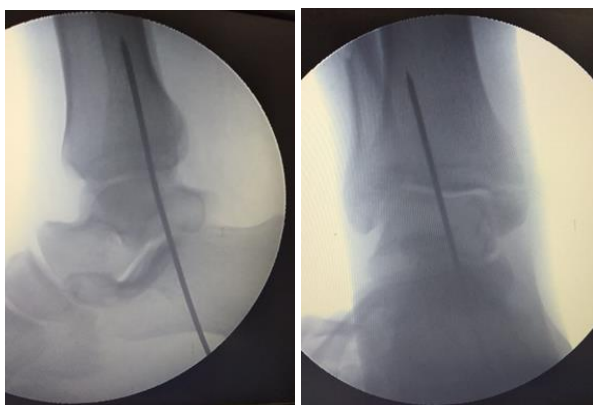


Fig 3: Intra Operative temporary fixation by trans-calcaneal k-wire

The cases where we were not able to do closed reduction of ankle, in those cases, the lateral and medial exposure was done and soft tissue interposition was looked into and then reduction was done and after that, a smooth trans-calcaneal wire was passed. But in all the cases, trans-calcaneal wire passed first and then, fixation of fibula followed by medial malleolus.

Approach to Fibula

A direct lateral approach over the fibula was taken with the dissection plane between the Peroneus tertius anteriorly and peroneus longus and brevis posteriorly. Soft tissues and periosteum were cleared a few millimetres of the fracture edge and fracture fragments were visualized. Fracture reduction was done. Preliminary fixation of fragments was done using the inter-fragmentary lag screws (in oblique fractures) which was later followed by application of 3.5 mm low contact dynamic compression plate / distal fibula anatomical LCP or a reconstruction plate was applied on the lateral or posterior surface of the fibula as appropriate. The reduction was visualized at every step under the fluoroscopy in both the orthogonal views. Meticulous closure was done in all the cases.

Approach to medial malleolus

The sandbag under the buttock was removed to facilitate the approach for medial malleolus fracture. Anteromedial approach centered over the fracture was used in all the cases. Fracture fragment was reduced and articular surface was visualized for any soft tissue interposition. Fracture was fixed with 2 cannulated cancellous screws or 1 malleolar screw and 1 k wire depending upon size of the fracture fragment. Meticulous closure and repair of deltoid ligament was done wherever needed.

After fixation of both fibula and medial malleolus, the trans-calcaneal wire was removed and reduction is cross-checked under fluoroscopy. After satisfactory fixation, wound was closed. Post-operative x-rays were done (Fig 4).



Fig 4: Post-operative x-rays

Results

The mean age of the patients was 36.5 years. There were 23 males (76.7%) and 7 females (23.3%) in the present study. Right sided preponderance was seen in the present study accounting for 20 cases (66.67%). 15 (50%) cases had road-traffic accident as a mechanism of injury, 12 (40%) cases had accidental fall, whereas 3 (10%) had twisting injury.

According to Lauge-Hansen classification systems, 3 cases (10%) had supination adduction injury, 15 cases (50%) had supination external rotation injury, 7 cases (23.33%), had pronation external rotation injury and 5 cases (16.67%) had pronation abduction injury pattern. Radiological union was seen at 15 ± 3.2 weeks in 19 cases (63.33%) and 18 ± 3.4 weeks in 7 cases (23.33%) and 21 ± 3.2 weeks in 4 cases (13.33%). 2 cases (6.67%) had superficial infection, which was sent for pus culture sensitivity to microbiology department and was treated accordingly with oral antibiotics.

and resolved completely. As per the Baird and Jackson Scoring system, 16 (53.33%) cases had excellent results, 8 (26.67%) cases had good results, 4 (13.33%) cases had fair results and 2 (6.67%) cases had poor results.

Discussion

This study consisted of 30 cases of bimalleolar ankle fractures with ankle subluxation treated at Govt Medical College and Rajindra Hospital, Patiala. Bimalleolar fracture had a male predominance with 76.7% and male: female ratio of 23:7, which is comparable to Motwani and Maruthi CV study. (Table 1)

Table 1: Sex distribution in various studies

Study	No. of patients	Male : Female	% Males
Motwani GN ^[6]	40	5 : 1	82.5
Maruthi CV ^[7]	40	28 : 12	70
Present study	30	23 : 7	76.7

Mean age of patients in this study was 36.5 years. Similar results were observed in Beris *et al.* with mean age of 30 years. However, finding by Mohapatra A, Raj K, mean age was 43.8 and Roberts RS was 40. (Table 2)

Table 2: Mean Age Distribution in various studies

Study	No. of Patients	Mean Age
Mohapatra A, Raj K ^[8]	84	43.8
Beris <i>et al.</i> ^[9]	144	30
Roberts RS ^[10]	25	40
Present Study	30	36.5

Most common mode of injury is road-traffic accidents which was seen in 15 patients (50%). The number of road traffic accident patients was in accordance with study by Mohapatra A, Raj K, Lee *et al.* (Table 3)

Table 3: Mode of Injury in various studies

Study	Number of Patients	Common mode of injury
Lee <i>et al.</i> ^[11]	168 (98)	Road traffic Accidents
Mohapatra A, Raj K ^[8]	84 (43)	Road traffic Accidents
Present study	30 (15)	Road traffic Accidents

Out of 30 patients, 3 cases (10%) had supination adduction injury, 15 cases (50%) had supination external rotation injury, 7 cases (23.33%), had pronation external rotation injury and 5 cases (16.67%) had pronation abduction injury pattern. So, most common injury pattern was supination external rotation injury which is in accordance with study by Parvataneni Prathap DA, Roberts RS and Beris *et al.* (Table 4)

Table 4: Common type of injury pattern in various studies

Study	No. of Patients	Most common type	Percentage of SER
Pravataneni Prathap ^[12]	30	SER	46.6
Roberts RS ^[10]	25	SER	34
Beris <i>et al.</i> ^[9]	144	SER	45
Present Study	30	SER	50

Range of motion of ankle joint at the end of 6 months was 30 degrees or more in 26 (86.7%) patients and dorsiflexion of more than 20 degrees in 25 (83.3%) patients, which has similar results to Shah ZA, Arif U study. (Table 5)

Table 5: Range of Motion in various studies

Study	Time Duration	>30° Plantarflexion	>20° Dorsiflexion
Shah ZA, Arif U ^[13]	6 months	87.5 %	82.5%
Present Study	6 months	86.7 %	83.3%

According to Baird and Jackson Score at the end of 6 months, out of the 30 patients, 16 (53.33%) cases had excellent results, 8 (26.67%) cases had good results, 4 (13.33%) cases had fair results and 2 (6.67%) cases had poor results, Similar results were observed in other study like Shah ZA, Arif U, De Souza *et al.*, Beris *et al.*, Motwani GN. (Table 6)

Table 6: Comparative results in various studies

Study	Good to Excellent	Fair	Poor
Shah ZA, Arif U ^[13]	33 (82.5%)	5 (12.5%)	2 (5%)
Beris <i>et al.</i> ^[9]	105 (74.3%)	21 (14.6%)	16 (11.1%)
De Souza <i>et al.</i> ^[14]	135 (90%)	9(6%)	6 (4%)
Motwani GN ^[6]	33 (82.5%)	5 (12.5%)	2 (5%)
Present Study	24 (80%)	4 (13.3%)	2 (6.67%)

In our study, 2 cases (6.67%) had superficial infection, which was sent for pus culture sensitivity to microbiology department and was treated accordingly with oral antibiotics and resolved completely as compared to Shah ZA, Arif U study, which had 4 patients with superficial infection.

Conclusion

In this study, it was observed that bimalleolar ankle fractures with the ankle subluxation treated with open reduction and internal fixation gained excellent to good ankle function by using Baird and Jackson scoring system and trans-calcaneal smooth wire used for provisional fixation of ankle reduction intra-operatively proved to be an effective tool in maintaining reduction while fixing fibula and medial malleolus and passing a smooth 1.5 mm K-wire through calcaneum, talus and distal tibia does not affect the joint mobility later on and does not cause any arthritis in long-term. Supination external rotation type of injury was most common and supination adduction and pronation abduction type of injury was less. The anatomical reduction and stable internal fixation restore the articular congruity of ankle joint in excellent to good functional outcome and helps in early mobilization after surgery.

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