



TREATMENT OF DISPLACED INTRA-ARTICULAR CALCANEAL FRACTURES WITH OR WITHOUT BONE GRAFT SUBSTITUTE HYDROXYAPATITE - A COMPARATIVE STUDY

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ABSTRACT

Introduction: Calcaneum is a cancellous bone that tend to unite with collapse after fracture. Controversy is ongoing regarding the use of bone grafts to fill cavities that occur with collapse of the posterior facet in the joint and for repair of the calcaneal height with plating.

Aim of The Study: The aim is "To compare the results of displaced intra-articular calcaneal fractures treated with and without bone graft substitute Hydroxyapatite".

Materials And Methods: The study included 20 patients of intra articular calcaneal fractures admitted in RMMCH from June 2015 to September 2017. All the patients are treated with open reduction and internal fixation with locking calcaneal plate. By random allocation in 10 patients artificial bone graft substitute Hydroxyapatite is used and in 10 patients bone graft substitute was not used. The calcaneal height and Bohler's angle were compared between the 2 groups. The final functional outcome was evaluated by Modified Maryland Foot Score, with excellent defined as 90 - 100 points, good as 75 - 89 points, fair as 50 - 74 points and poor as <50 points.

Results: In patients treated with bone graft Excellent Modified Maryland Foot Score was achieved in 6 patients, Good in 2, Fair in 1 and poor in 1 patient. In patients treated without bone graft Excellent modified Maryland Foot score was achieved in 7 patients, good in 1, fair in 1 and poor in 1 patient.

Conclusion: There is no significant difference in the functional outcome between patients treated with bone graft substitute and patients treated without bone graft substitute.

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INTRODUCTION

Displaced intra-articular calcaneal fractures are generally the result of high-energy trauma such as a fall from a height or a motor vehicle accident⁽¹⁾. 60 - 70% of calcaneal fractures are intra-articular, with 2 or 3 fracture lines, particularly on the posterior facet of the talocalcaneal joint surface, and include collapse of the joint. The current primary treatment method for displaced intra-articular calcaneal fractures is open reduction and internal fixation. A stable plate applied by lateral approach is considered the reference standard of open reduction and internal fixation^(2,3). Using this approach, 3-dimensional restoration of the anatomic structure of the calcaneus and

restoration of the calcaneocuboid joint can be achieved, and the calcaneal height and width can be restored.

There is controversy regarding the use of bone grafts^(7,8,9) to fill cavities that occur with collapse of the posterior facet in the joint and for repair of the calcaneal height with plating. Autograft, Allograft or bone graft substitute⁽⁹⁾ can be used as graft material.

In our study we have used bone graft substitute⁽⁹⁾ Hydroxyapatite (Trade name G BONE) as graft material. Although the advantages include mechanical support, the grafts have also been associated with greater infection rates, blood loss, and postoperative pain⁽⁶⁾.

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MATERIALS AND METHODS

20 patients (17 male and 3 female) with intra articular calcaneal fractures admitted in Rajah Muthiah Medical College Hospital from June 2015 to September 2017 were included in the study.

Patients were evaluated by X-ray -AP, lateral and Harris axial view. The fractures were classified on the basis of computed tomography (CT) findings as Sanders type I to IV⁽⁴⁾.

Inclusion Criteria

- Patient aged between 18 to 70 years
- Displaced Intra articular calcaneal fractures - Sander's Type II, III& IV.
- Bohler's Angle < 20°
- Gissane Angle > 135°

Exclusion Criteria

- Extra articular fractures
- Undisplaced Intra articular calcaneal fractures- Sander's Type 1
- Paediatric fractures
- Bohler's Angle 20-40°
- Gissane Angle 105-135°
- Compound fractures
- Head injury and poly trauma patients with GCS less than 8.

All the patients (n=20) treated by open reduction and internal fixation with locking calcaneal plate by lateral approach. Among them (n=20) patients were randomly allocated to both groups. 10 patients (9 male and 1 female) were treated with bone graft substitute and 10 patients (8 male and 2 females) were treated without bone graft substitute.

Surgical Management

The aim of surgery is to achieve anatomical reconstruction of all articular surfaces, restore Bohler's⁽¹⁰⁾ and Gissane angles, to carry out primary stable fixation and begin early mobilization.

Patients were given a below knee slab. Strict limb elevation and anti-edema measures were done and watched for the swelling to subside and appearance of "wrinkle sign". Surgery was performed only after the edema had resolved. All patients were operated with an average of 7-15 days from the time of fracture if the soft tissue condition was good.

Surgical Technique

Surgery was performed in lateral position either in general or regional anaesthesia by extensile lateral approach in all patients. The land marks are lateral malleolus, calcaneo-cuboid joint and base of fifth metatarsal. Incision made in a right angled fashion with the vertical line starting 4cm above the lateral malleoli between fibula and tendoachilles and extended downward till the junction of dorsal and plantar skin.

The horizontal line is extended distally up to the base of fifth metatarsal. The incision is carried straight down to the bone at its angle and then developed to allow a single, thick flap to be lifted from the periosteal surface. A "no touch" technique is employed by retracting the flap with K wires in the talus and cuboid. Reduction aided by periosteal elevator or osteotome. The posterior facet and the anterior facets were reduced. Reduction verified with C-arm. Low profile locking plates were contoured and positioned. In patients (n=10) treated with bone graft substitute hydroxyapatite the cavity in the bone is filled with the graft material. In the other group (n=10) no graft is used.

Table 1 Sander's Classification Distribution

| Sander's Classification | Group | | | | Total | |
|-------------------------|-----------------|-------|--------------------|-------|-------|-------|
| | With Bone Graft | | Without Bone Graft | | N | % |
| | N | % | N | % | | |
| Type II | 2 | 20.0 | 2 | 20.0 | 4 | 20.0 |
| Type III | 6 | 60.0 | 7 | 70.0 | 13 | 65.0 |
| Type IV | 2 | 20.0 | 1 | 10.0 | 3 | 15.0 |
| Total | 10 | 100.0 | 10 | 100.0 | 20 | 100.0 |

Table 2 Comparison of Bohler's Angle and Calcaneal Height

| VARIABLES | GROUPS | N | Mean | Std. Deviation | P value |
|--------------------------------|--------------------|----|---------|----------------|---------|
| Bohler's Angle Pre Op (°) | With Bone Graft | 10 | 9.2000 | 10.44350 | 0.696 |
| | Without Bone Graft | 10 | 10.6000 | 3.86437 | |
| Bohler's Angle Post Op (°) | With Bone Graft | 10 | 24.3000 | 6.84836 | 0.924 |
| | Without Bone Graft | 10 | 24.0000 | 7.08676 | |
| Bohler's Angle After Union (°) | With Bone Graft | 10 | 20.4500 | 5.2465 | 0.152 |
| | Without Bone Graft | 10 | 18.7500 | 4.8562 | |
| Height Pre Op (mm) | With Bone Graft | 10 | 32.2000 | 1.61933 | 0.236 |
| | Without Bone Graft | 10 | 33.1000 | 1.66333 | |
| Height Post Op (mm) | With Bone Graft | 10 | 43.5000 | 3.74907 | 0.501 |
| | Without Bone Graft | 10 | 44.4300 | 2.67706 | |
| Height After Union (mm) | With Bone Graft | 10 | 41.8300 | 3.60210 | 0.856 |
| | Without Bone Graft | 10 | 41.5701 | 2.54629 | |

The plate is secured by 3.5mm cancellous locking screws of various length. Subcutaneous tissue is closed using 2-0 vicryl and tension free skin closure done using 3-0 ethilon. Multiple small drain tubes inserted in between. Tight dressing and compression bandage applied. Below knee slab given.

Post-Operative Protocol and Follow Up

All patients were immobilized in posterior plaster splint and limb elevated. Drain is removed after 48 hours and first wound inspection done on 2nd day. Suture removal done after 13th day (13 to 18th day). After suture removal below knee cast applied. All patients were regularly followed up with X - rays and based on the signs of union partial weight bearing allowed by 8 to 10 weeks and full weight bearing allowed at 12 to 14 weeks.

Functional outcomes were evaluated by Modified Maryland Foot Score, with excellent defined as 90 - 100 points, good as 75 - 89 points, fair as 50 - 74 points and poor as <50 points..

RESULTS

In our study of the 20 patients, 17 patients were male and 3 patients were female. 14 were due to fall from height and 6 were due to road traffic accidents. The mean age in both groups is 35 years. Only Sander’s Type II, III and IV are included in the study.

In patients with bone graft substitute(n=10) the mean bohler’s angle in the early post operative period is 24.3° and the mean bohler’s angle after union is 20.45°. The mean angle loss is 3.85°. In patients without bone graft substitute (n=10) the mean bohler’s angle in the early post operative period is 24.00° and the mean bohler’s angle after union is 18.75°. The mean angle loss is 5.25°. On comparing the two groups the P value is >0.05 which is statistically not significant.

In patients with bone graft substitute (n=10) the mean calcaneal height in the early post operative period is 43.5mm and the mean calcaneal height after union is 41.83mm. The mean height loss is 1.67mm. In patients without bone graft substitute (n=10) the mean calcaneal height in the early post operative period is 44.43mm and the mean calcaneal height after union is 41.57mm. The mean height loss is 2.86mm. On comparing the two groups the P value is >0.05 which is statistically not significant.

In patients treated with bone graft the complications are heel pain (n=1), joint stiffness (n=1), wound dehiscence (n=1) and superficial wound infection (n=1). There is no case of deep infection and calcaneal osteomyelitis.

In patients treated without bone graft the complications are heel pain (n=1) and joint stiffness (n=1). There is no wound complications.

In patients treated with bone graft Excellent Modified Maryland Foot Score was achieved in 6 patients, Good in 2, Fair in 1 and poor in 1 patient. In patients treated without bone graft Excellent Modified Maryland Foot score was achieved in 7 patients, good in 1, fair in 1 and poor in 1 patient.

Table 3 Modified Maryland Foot Score

| SCORE | WITH BONE GRAFT | | WITHOUT BONE GRAFT | | Total |
|-----------|-----------------|---------|--------------------|---------|-------|
| | N | Mean | N | Mean | |
| EXCELLENT | 6 | 95.1667 | 7 | 93.7143 | 13 |
| GOOD | 2 | 84.5000 | 1 | 85.0000 | 2 |
| FAIR | 1 | 68.0000 | 1 | 61.0000 | 3 |
| POOR | 1 | 45.0000 | 1 | 44.0000 | 2 |
| Total | 10 | 85.3000 | 10 | 84.6000 | 20 |

Table 4 Modified Maryland Foot Score

| GROUPS | N | Mean | Std. Deviation | P value |
|--------------------|----|---------|----------------|---------|
| With bone graft | 10 | 85.3000 | 16.81302 | 0.929 |
| Without bone graft | 10 | 84.6000 | 17.67736 | |
| Total | 20 | 84.9500 | 16.79434 | |

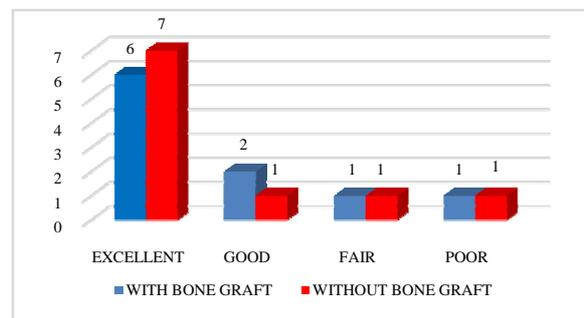
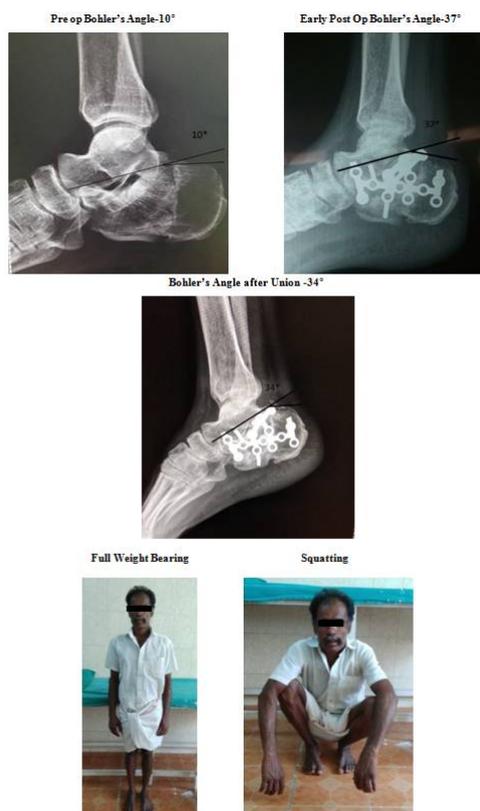


Fig 1 Modified Maryland Foot Score-Comparison Of With and Without Bone Graft

Case I with Bone Graft Substitute



Case II With Out Bone Graft Substitute**DISCUSSION**

The current primary treatment of displaced intra-articular calcaneal fractures is open reduction and internal fixation. The aim of treatment is to correct the height, width, and achieving anatomic restoration of the displaced joint surfaces. Bone grafts used for defective areas of the displaced intra-articular calcaneus fill significant bone gaps, provide mechanical support, and promote bone healing.

Bone grafts can be in the form of autografts or alternative grafts (allografts, demineralized bone matrix, synthetic bone grafts^(7,8), bone morphogenetic proteins). Morbidity related to the iliac wing⁽⁶⁾, from which the autograft is taken, is widespread, and problems near the wound site such as pain, paresthesia, hematoma, and infection generally prolong the hospital stay. In addition, the longer operating time and greater blood loss can lead to increased morbidity. Therefore, although autografts are the reference standard for such cases, we have used bone graft substitute⁽⁹⁾ hydroxyapatite (Trade name G Bone).

Sanders et al⁽⁴⁾ and Letournel⁽⁵⁾ reported that sufficient fixation of the bone gap could be achieved using a plate and removable screws without the need for bone grafting, and that it was not appropriate to assume the extra risk of grafting.

Stephenson⁽¹¹⁾ reported that grafting was not needed in patients in whom sufficient and appropriate reduction has been achieved, but that autografts could be applied for extensive cancellous or corticocancellous defects.

In our study, in patients with bone graft substitute (n=10) the mean Bohler's angle loss is 3.85°. In patients without

bone graft substitute (n=10) the mean Bohler's angle loss is 5.25°. On comparing the two groups the P value is >0.05 which is statistically not significant.

In patients with bone graft substitute (n=10) the mean calcaneal height loss is 1.67mm. In patients without bone graft substitute (n=10) the mean calcaneal height loss is 2.86mm. On comparing the two groups the P value is >0.05 which is statistically not significant.

In patients treated with bone graft substitute there is one case of wound dehiscence and one case of superficial infection. Both are treated conservatively and healed well. There is no case of wound complications in patients treated without bone graft substitute.

In patients treated with bone graft substitute Excellent and Good Modified Maryland Foot Score was achieved in 80% of patients and fair and poor score was achieved in 20% of patients. In patients treated without bone graft substitute Excellent and Good Modified Maryland Foot score was achieved in 80% of patients, fair and poor score in 20% of patients. On comparing the mean scores of both groups the P value is 0.929 which is not statistically significant.

CONCLUSION

There is no significant difference in the functional outcome between patients treated with bone graft substitute and patients treated without bone graft substitute. Infection rates are higher in patients treated with bone graft substitute. Thus bone graft substitute can be used only if there is a large gap in the bone.

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