Study of clinical outcome in posterior plating for fibula in bimalleolar fracture ankle

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Abstract
Introduction: The anatomy of the joint makes it very unstable in cases of fractures or ligamentous injuries of the ankle, because the whole body weight is transmitted through the ankle and locomotion depends upon the stability of the ankle joint. In the post-operative period, the protocol of mobilization of the ankle has been a topic of conflict. The goals of treatment include achieving sound union of fracture and an ankle that moves and functions normally without pain.

Materials and Methods: This is a prospective consecutive series case of 60 patients of bimalleolar ankle fracture, undergone internal fixation in the form of plate fixation over posterior surface of fibula for lateral malleolus and cancellous screw fixation for medial malleolus. Data collection was done using history sheet, clinical examination, and radiological examination at intervals while functional outcome was assessed at follow up visits using Weber’s assessment protocol.

Results: 50 (83.3%) cases radiological union is achieved by 6 weeks while 10 (16.7%) cases union time was 10 weeks. Average time for union was 6.7 weeks. The final outcome as per the Weber’s assessment protocol was 50% as excellent, 40% as good and 10% as poor result which showed good correlation with level of reduction achieved graded from immediate post-operative radiographs.

Conclusion: Accuracy of reduction and rigid fixation was found to be a major determinant of functional outcome irrespective of the type of fracture. Posterior plate fixation gives bicortical screw purchase leading to secure fixation, no intra-articular penetration, decreased complications, hardware prominence and wound dehiscence.

Keywords: Bimalleolar ankle fracture, Weber’s assessment, Lateral malleolus, Kristensens grade, Lauge-hansen classification.
Exclusion Criteria: Patients with co-morbid conditions preventing surgical intervention, more than 3 weeks duration of injury, immature skeleton, local tissue condition preventing or prolonging immediate surgery, Pilon fractures, posterior malleolar fractures. The entire lower leg, including the full length fibula was examined. Patients were stabilized haemodynamically and were administered adequate analgesia. Antero-posterior x-ray was taken in line with the second ray of the foot. The lateral view was obtained with the tibia perpendicular to the long axis of the foot and the beam was centered on the talus.

For assessment of the LCL complex, an anterior drawer lateral view was obtained with the foot supported by a pad under the heel and a posteriorly directed force applied to the distal tibia. Brostrom claimed that as little as 3-mm anterior talar displacement indicates LCL rupture. Injury to syndesmosis was seen commonly in PER, PA and some SER type of injury in which lateral displacement of the talus and widening of distal syndesmosis was noted on stress view. The fractures were classified according to the Lauge-Hansen’s classification depending on radiological assessment. Informed consent for the surgical procedure was obtained. Antibiotics were administered at the time of induction of anesthesia. The patient was placed in supine position with a sand bag under the ipsilateral buttoc. The affected limb was prepared with a primary scrub with betadine. The parts were then painted with betadine and spirit. The reconstruction of the fibula was given priority and therefore the lateral side was dealt with before the medial side.

Approach to the Lateral Malleolus: A 10 to 15-cm longitudinal incision was made along the posterior border of the fibula all the way to its distal end and continuing for a further 2 cm, centering the incision at the level of the fracture. Full thickness skin flap was created up to peroneal fascia. Injury to superficial peroneal nerve was avoided by retracting it along with muscles. Fracture site was opened by gentle distraction, re-creating the mechanism of injury, and organized hematoma was drained and periosteum was elevated at fracture site.

Implants: The implants used for the fixation of fractures were as follows:
The medial malleolus was fixed with 4mm cancellous screws in 60 cases. Of which six were single screw and additional k-wire due to small fragment while other 54 cases two screws were used. The lateral malleolus was fixed with Dynamic compression plate in all 60 patients.
Fig. 5: Lateral malleolus exposure

Fig. 6: Shape of distal fibula and contouring of plate

Reduction and Fixation

Fig. 7: Medial malleolus reduction

Fig. 8: Medial malleolus fixation

Fig. 9: Lateral malleolus reduction

Fig. 10: Lateral malleolus fixation

Fig. 11: Post-operative intensifier image
plate, depending on the type and location of the fibular injury.

Post-op: Patients were administered adequate analgesics. I.V. Antibiotics were administered for 72 hours postoperatively followed by oral antibiotics for 7 days. Radiological assessment of reduction was done using modified Kristensen’s criteria\textsuperscript{10} post operatively. The criteria for the radiological assessment of reduction were given by Good, Fair and Poor.

Sutures were removed at follow up in the outpatient clinic at 11\textsuperscript{th} post-operative day. Patients were advised to continue toe-touch weight bearing ambulation with a walker for a period of 6 weeks. However in patients who had other associated injuries, ambulation was delayed or mobilized on a wheelchair. Radiographs were done at six weeks. Presence of callus and status of the joint was noted. Partial weight bearing with support was started depending upon radiographic findings, where patients were allowed to put up to 50% of the body weight.

Patients were followed up at 10 weeks after which foot flat weight bearing as tolerated with walker support was started where patients were allowed to put more than 50% of the body weight as tolerated. Patients were followed up monthly up to six months and yearly thereafter.

At each assessment, all patients were questioned with regard to pain, use of analgesics, stiffness, swelling, activities of daily living, use of walking aids, and return to work and participation in sports. At examination, the gait, any thickening, swelling, tenderness of the ankle and the range of motion of the ankle and subtalar joint were evaluated. Antero posterior and lateral radiographs of ankle were made at the time of examination. The patients were evaluated as per the rating of the Weber’s functional assessment protocol.\textsuperscript{11}

Statistical Analysis: Descriptive statistics such as mean, SD and percentage were used to present the data. Comparison between categorical variables was done by using Fisher’s exact test. Association between categorical variables was tested by using chi-square ($\chi^2$) test. A p-value less than 0.05 were considered as significant. Analysis of data was carried out using Software Package for Social Sciences (SPSS v.16).

Approach to the medial Malleolus: A 10-cm longitudinal curved incision on the medial aspect of the ankle, with its midpoint just anterior to the tip of the medial malleolus was made. Periosteum was elevated at fracture site and edges were freshened. Reduction was done under direct vision and periosteum interposition between fracture edges was avoided. Medial malleolus was fixed with partially threaded 4mm cancellous screws directed obliquely upwards.

Syndesmosis Transfixation: Decision regarding syndesmotic fixation was made after fixation of medial and lateral malleoli depending upon intra-operative fluoroscopic picture. Cotton’s test\textsuperscript{8} was done to find out syndesmotic instability. The reduction of the tibiofibular joint was maintained during placement syndesmotic screw with clamps. The fixation screw was used independently or in conjunction with a
Supination– External rotation injury was the most common mechanism of injury observed in our study as per Lauge-Hansen’s classification comprising up to 40% of the total number.

Table 2: Level of reduction achieved over post-op radiograph

<table>
<thead>
<tr>
<th>Kristensen Grade</th>
<th>No of patients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>40</td>
<td>66.7</td>
</tr>
<tr>
<td>Fair</td>
<td>20</td>
<td>33.3</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>

Post-operatively 66.7% of patients were graded as good reduction, 33.3% were as fair reduction and none of the patient was graded as poor reduction according to modified Kristensen’s criteria.

Table 3: Time required for union after surgical management

<table>
<thead>
<tr>
<th>Time for union (weeks)</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 week</td>
<td>50</td>
<td>83.3</td>
</tr>
<tr>
<td>10 week</td>
<td>10</td>
<td>16.7</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>100.0</td>
</tr>
</tbody>
</table>

50 (83.3%) cases radiological union was achieved by 6 weeks while 10(16.7%) casesunion time was 10 weeks. Average time for union was 6.7 weeks.

Table 4: Final outcome according to Weber’s grade

<table>
<thead>
<tr>
<th>Final outcome</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>30</td>
<td>50.0</td>
</tr>
<tr>
<td>Good</td>
<td>24</td>
<td>40.0</td>
</tr>
<tr>
<td>Poor</td>
<td>6</td>
<td>10.0</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>100.0</td>
</tr>
</tbody>
</table>

30 cases (50%) were graded as excellent and 24 cases (40%) as good results. 6 cases (10%) were graded as poor outcome. All the patients who were graded as excellent and good results returned to normal activity and had regained their full ankle movements by the end of three months.

Association of Final outcome and Lauge-Hansen Classification: In supination external rotation group 11 cases out of 24 (45.83%) were graded as excellent and 9 cases (37.50%) were graded as good while 4 cases (16.67%) as poor outcome.

In pronation external rotation group 11 cases out of 20 (55%) were graded as excellent and 7 cases (35%) were graded as good whereas 2 cases (10%) as poor outcome.

In supination adduction group 5 cases out of 12 (41.67%) were graded as excellent and 7 cases...
(58.33%) were graded as good and no case in this group was graded as poor outcome.

In pronation abduction 2 cases out of 2(100%) were graded as excellent outcome.

In pronation dorsiflexion group 1 out of 2(50%) was graded as excellent and one case (50%) was graded as good outcome.

**Table 5: Distribution of cases according to Lauge-Hansen Classification and outcome**

<table>
<thead>
<tr>
<th>Lauge-Hansen’s class</th>
<th>Final Outcome (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>Pronation Abduction</td>
<td>2 (100)</td>
<td>0</td>
</tr>
<tr>
<td>Pronation Dorsiflexion</td>
<td>1 (50)</td>
<td>1 (50)</td>
</tr>
<tr>
<td>Pronation External Rotation</td>
<td>11 (55)</td>
<td>7 (35)</td>
</tr>
<tr>
<td>Supination Adduction</td>
<td>5 (22)</td>
<td>7 (38)</td>
</tr>
<tr>
<td>Supination External Rotation</td>
<td>11 (46)</td>
<td>9 (38)</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>24</td>
</tr>
</tbody>
</table>

χ² = 1.17, df=2, p=0.56

There was no statistical significant association found between final outcome and type of fracture according to Lauge-Hansen’s classification (p=0.56). This could be attributed to smaller sample size and smaller follow up duration.

**Correlation between Post-operative Reduction and final Outcome:** In the present study, 40 patients were graded to have good post-op reduction while 20 patients were graded as fair reduction on immediate post-op radiographs as per the stated criterion. 30(75%) cases out of 40 with good post-operative reduction were graded as excellent according to Weber’s assessment protocol whereas 10(25%) cases achieved good functional results. None of the case with good post-operative reduction was graded as poor functional outcome.

Out of 20 cases with fair post-operative reduction, 14(70%) cases were graded as good functional results while 6(30%) cases were graded as poor results. None of the cases with fair level of post-op reduction were able to achieve excellent functional outcome.

**Table 6: Correlation between Post-operative radiographic grading based on Kristensen’s radiological criteria and final outcome**

<table>
<thead>
<tr>
<th>Post-op radiograph grade</th>
<th>Final Outcome (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>Fair</td>
<td>0</td>
<td>14 (70)</td>
</tr>
<tr>
<td>Good</td>
<td>30 (75)</td>
<td>10 (25)</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>24</td>
</tr>
</tbody>
</table>

χ² = 30, df=1, p <0.0001

The statistical association between functional outcome and level of reduction achieved on post-operative radiographs was significant with p-value <0.0001. Level of reduction on immediate post-operative radiograph was found to correlate statistically with functional outcome. Final outcome was found as dependent over level of reduction achieved by doing open reduction and internal fixation. Adequacy of reduction can be stated as determinant of final outcome.

**Discussion**

Bimalleolar ankle fractures are intra-articular fractures and commonly caused by rotational forces. Most of these are displaced and unstable fractures demands accurate reduction and stable fixation. Treatment of bimalleolar fractures with accurate open reduction and internal fixation by placing plate over posterior aspect of fibula is being proven biomechanically superior.12,13

The fractures of the ankle are injuries seen in the young and middle aged patients commonly. The mean age in our series was noted to be 36.85 yr. with a male predominance of 70%.

**Mechanism of Injury according to Lauge-Hansen Classification:** The most common mechanism of injury was Supination-external rotation injury with 40% incidence followed by pronation external rotation in 33.3% of the cases. Supination external rotation was most common pattern observed in our study (40%). The findings were similar to observations of Roberts SR14 study, Beris15 et al study.

**Radiographic Evaluation:** Post operatively 66.7% of patients were classified as a good result whereas 33.3% achieved fair results with no case was graded as poor result radiologically. As most of the fractures included in the study were displaced fractures and with surgical intervention in the form of open reduction
and internal fixation we were able to get anatomical reduction in most of the cases.

**Time for Union:** 50 (83.3%) cases radiological union was achieved by 6 weeks while 10(16.7%) cases union time was 10 weeks. Average time for union was 6.7 weeks. No cases of malunion, non-union were noted during study. These results were comparable to Gul16 et al study in which time required to join work (union and full weight bearing without support) was calculated 54.6 15.5 days from date of injury. In that study they used lateral semi tubular plate fixation and observed one case of loss of reduction and one case of non-union. In another similar study by Simanski17 et al concluded that average time for union with early weight bearing were able to be full weight bearing was by 7 week 3 days and returned to work by 8 week 5days. Time for bone union was comparable to Gul16 et al study and Simanski17 et al study.

Jung Ho Noh18 et al in his study used immobilization short leg splint for two weeks and functional bracing for next four weeks with active assisted ankle movement followed by non-weight bearing and full weight bearing as tolerated as mobilization protocol concluded mean union time as 15.8 weeks in metallic implant group.

We concluded from our study that using DCP as osteosynthesis material had given more rigid support as compared to semi tubular plate and early weight bearing was started without risk of implant failure or loss of reduction.

**Functional Outcome:** In present study, based on the Weber’s assessment protocol11 50% of the patients achieved excellent functional results while 40% were good and 10% of the patient graded as poor results.

In Noe Martinez Velez19 et al study functional outcome was graded 13.63% as excellent, 81.81% as good and 4.5% as poor.

In Winkler-Weber study20 66.65% were graded as excellent, 27.95% graded as good and 5.4% were graded as poor.

In Beris21 et al study 74.3% were graded as good to excellent, 14.6% graded as fair and 11.1% as poor.

In Erhan Yilmaz22 et al study 58% were graded as good to excellent, 26% graded as fair and 16% as poor.

Results of the present study are closely comparable to Winkler-Weber20 study. The functional results were better than that of Noe Martinez Velez19 et al where they obtained 13.63% results as excellent and 81.81% results as good outcomes. This was observed because Noe Martinez Velez19 et al study included patients with injury less than 2 weeks whereas present study maximum patients were operated within 24 hours. Poor outcome of present study was 10%, was found to be comparable with Beris21 et al study which had poor outcome in 11.1% of the cases and Erhan Yilmaz22 et al study, who observed poor outcome as 16% of cases. It was observed to be more than Noe Martinez Velez19 et al study (4.5%), Winkler-Weber20 study (5.4%), which could be attributed to period of post-operative immobilization in plaster cast for six weeks in those studies while in present study, no immobilization and early weight bearing was practiced.

In the present study, 40 patients were reported to be having good post-op reduction while 20 patients had fair reduction on immediate post-op radiographs.

30(75%) cases out of 40 with good post-operative reduction were noted to have excellent outcome according to Weber’s assessment protocol11 whereas 10(25%) noted to achieve good functional results. None of the case with good post-operative reduction was noted to have poor functional outcome.

Out of 20 cases with fair post-operative reduction, 14(70%) cases noted to have good functional results while 6(30%) cases achieved poor results. These results were statistically significant with p-value of <0.0001. Quality of reduction based on immediate post-operative radiograph was found to be closely correlating with final functional outcome and could be used as one of the predictor of excellent outcome.

**Conclusion**

Accuracy of reduction and rigid fixation was found to be a major determinant of functional outcome irrespective of the type of fracture. Posterior plate fixation gave bicortical screw purchase leading to secure fixation, early post-operative mobilization and early weight bearing, decreased complications, reduced intra-articular screw penetration, hardware prominence and wound dehiscence. Early post-operative mobilization and early weight bearing had led to early functional recovery.

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