Comparison of open reduction and internal fixation versus closed reduction and percutaneous fixation for medial malleolus fractures

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Disclosure

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Medial Malleolus Fracture Fixation

Standard accepted techniques for medial malleolus (MM) fracture fixation involve open reduction and internal fixation (ORIF).

ORIF for MM fractures may entail significant risk of specific complications such as wound complication and infection.

Data comparing closed reduction and percutaneous fixation (CRPF) to traditional ORIF is lacking.

Aim:

Compare two groups of patients with MM fractures treated ORIF versus CRPF.
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Methods

Retrospective case series
490 patients identified with MM fractures managed with internal fixation over a four year span.

Exclusion Factors

- Pilon Fx, ipsilateral tibial shaft Fx, pathologic Fx
- Patients < 18 years old
- Lack of clinical/radiographic data
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184 patients included in study
  ORIF – 144
  CRPF - 40

Injury pattern assessed on injury radiographs based on Orthopaedic Trauma Association (OTA) fracture classification.
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Clinical Course
All surgeries performed at academic tertiary care center in standard manner by 5 fellowship-trained attending surgeons

All surgeons performed ORIF and CRPF techniques

ORIF
- incision over fracture, AO technique for fixation with screws only, buttress plate or tension band construct

CRPF
- No incision, reduction clamp applied percutaneously, fluoroscopically guided placement of cannulated partially threaded screws
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Clinical Course

2 week, 6 week, 3 month, 6 month postoperative visits

2 weeks
remove sutures, short leg casts, non-weight bearing (NWB)

6 weeks
remove cast, weight-bearing as tolerated in CAM boot
extension of NWB time period (by 2-6 weeks)

concern for delayed union, diabetes, mobility
concerns, syndesmotic injuries

Radiographs

Interpreted by treating clinician and musculoskeletal
radiologist at time of surgery, and 2 independent researchers
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Data Collection

Fracture union definition
- Resolution of fracture line on radiograph
- Painless weight-bearing
- Zero-to-minimal tenderness to palpation over fracture site

Malunion definition
- $\geq 2\text{mm}$ of articular surface step-off observed radiographically after fracture united

Statistical Analysis

Chi-square test for proportions, Student T-test for averages with normal distribution or Wilcoxon-rank-sum for averages non-normal distribution.
Alpha-level of 0.05 was the standard cut-off.
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Radiographic Measurements

Solid line: articular surface displacement

Dotted line: MM fracture fragment length
# Results

<table>
<thead>
<tr>
<th>Patient Factors</th>
<th>Percutaneous</th>
<th>Open</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Male Gender (%)</strong></td>
<td>13 (32)</td>
<td>63 (44)</td>
<td>0.20</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td>55 (18-84)</td>
<td>48 (18-89)</td>
<td><strong>0.03</strong></td>
</tr>
<tr>
<td><strong>Body Mass Index (kg/m²)</strong></td>
<td>29 ± 6</td>
<td>30 ± 7</td>
<td>0.11</td>
</tr>
<tr>
<td><strong>Diabetes Mellitus (%)</strong></td>
<td>5 (12)</td>
<td>23 (16)</td>
<td>0.59</td>
</tr>
<tr>
<td><strong>Peripheral vascular disease (%)</strong></td>
<td>4 (10)</td>
<td>10 (7)</td>
<td>0.52</td>
</tr>
<tr>
<td><strong>Tobacco usage (%)</strong></td>
<td>4 (10)</td>
<td>24 (17)</td>
<td>0.30</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td><strong>Injury Factors</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>High-energy mechanism (%)</strong></td>
<td>10 (25)</td>
<td>33 (23)</td>
<td>0.78</td>
</tr>
<tr>
<td><strong>Fibula fracture (%)</strong></td>
<td>34 (85)</td>
<td>113 (78)</td>
<td>0.57</td>
</tr>
<tr>
<td><strong>Open fracture (%)</strong></td>
<td>9 (22)</td>
<td>10 (7)</td>
<td><strong>&lt;0.01</strong></td>
</tr>
<tr>
<td><strong>Transverse fracture (%)</strong></td>
<td>31 (78)</td>
<td>105 (73)</td>
<td>0.56</td>
</tr>
<tr>
<td><strong>Fragment size (mm)</strong></td>
<td>17 ± 5</td>
<td>17 ± 5</td>
<td>0.73</td>
</tr>
<tr>
<td><strong>Fragment displacement (mm)</strong></td>
<td>10 ± 10</td>
<td>8 ± 8</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>Comminution (%)</strong></td>
<td>5 (12)</td>
<td>42 (29)</td>
<td><strong>0.03</strong></td>
</tr>
<tr>
<td><strong>Definitive management delay (days)</strong></td>
<td>14 ± 9</td>
<td>14 ± 10</td>
<td>0.85</td>
</tr>
</tbody>
</table>

**Value given is raw number with percentage in parentheses, mean ± standard deviation, or median with range in parenthesis. Statistically significant values are in bold and italicized.**
## Results

<table>
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<tr>
<th>Outcome</th>
<th>Percutaneous</th>
<th>Open</th>
<th>p-value</th>
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<tr>
<td>Follow-up (weeks)</td>
<td>46 (13-140)</td>
<td>45 (13-222)</td>
<td>0.99</td>
</tr>
<tr>
<td>Anatomic reduction (%)</td>
<td>36 (90)</td>
<td>133 (92)</td>
<td>0.63</td>
</tr>
<tr>
<td>Time to union (weeks)</td>
<td>10 ± 4</td>
<td>10 ± 11</td>
<td>0.75</td>
</tr>
<tr>
<td>Nonunion (%)</td>
<td>1 (2)</td>
<td>5 (3)</td>
<td>0.76</td>
</tr>
<tr>
<td>Malunion (%)</td>
<td>4 (10)</td>
<td>7 (5)</td>
<td>0.22</td>
</tr>
<tr>
<td>Removal of hardware (%)</td>
<td>3 (8)</td>
<td>20 (14)</td>
<td>0.30</td>
</tr>
<tr>
<td>Wound complication (%)</td>
<td>0 (0)</td>
<td>6 (4)</td>
<td>0.95</td>
</tr>
</tbody>
</table>

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Case Example #1: CRPF
Anterior posterior and oblique radiographs of a 46-year-old male who sustained a twisting injury and underwent CRPF (left) of an isolated MM fracture.

(Left) At 3 months postoperatively the fracture had fully healed.
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Case Example #2: CRPF malunion
Anterior posterior radiograph (left) of a 72-year-old woman with diabetes and peripheral vascular disease who was in a motor vehicle collision and sustained a bimalleolar ankle fracture.

Though reduction appeared acceptable at the time of percutaneous fixation, she went on to develop malunion of the MM fracture as seen on radiographs at four months postoperatively (right)
Case Example #3: ORIF nonunion

Anterior posterior and oblique radiographs of a 37-year-old male smoker who was in a motor vehicle collision and sustained a bimalleolar ankle fracture (left).

He underwent ORIF (left), however went on to develop nonunion as seen on radiographs at seven months postoperatively (right).
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Discussion

Compared to patients who underwent traditional ORIF, those who underwent CRPF were older and more often had open fractures and had less fracture comminution.

No statistically significant different in outcomes, particularly nonunion or malunion, between two treatment groups.

Non-union, a rare complication (3.0%) of patients overall without significant variation between CRPF (n=1) and ORIF (n=4).
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Discussion

Removal of hardware was performed at a lower rate in CRPF group (6.5%) v. ORIF (12.7%), though this difference was not statistically significant.

Medial wound complication rate for ORIF was 3.0%, and 0% for CRPF, though this difference was not statistically significant.

Previous studies wound complication rate- 4-22%.

Screw selection

Partially threaded vs. fully threaded
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Limitations

Selection bias

Small sample size relative to outcome of interest (nonunion)

Poorly controlled treatment groups
Conclusion

CRPF and ORIF resulted in acceptable radiographic outcomes and low complication rates for surgical management of medial malleolar fractures.

CRPF may be an appropriate option for simple fracture patterns in patients where there is or has been a threat to the soft tissue envelope.

Further, prospective data is needed to evaluate and validate the efficacy of CRPF given the concern for inadequate fracture debridement and reduction.


