Screw fixation versus arthroplasty versus plate fixation for 3-part radial head fractures

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ABSTRACT

Purpose. To compare the outcome following headless compression screw fixation versus radial head arthroplasty versus plate fixation for 3-part Mason types III or IV radial head fracture.

Methods. Records of 25 men and 16 women aged 21 to 80 (mean, 43.3) years who underwent fixation using 2 to 3 2-mm cannulated headless compression screws (n=16), radial head arthroplasty (n=13), or fixation with a 2-mm Synthes plate (n=12) for 3-part Mason types III or IV radial head and neck fracture were reviewed. Treatment option was decided by the surgeon based on the presence of associated injury, neurovascular deficit, and the Mason classification. Bone union, callus formation, and complications (such as heterotopic ossification, malunion, and non-union) were assessed by an independent registrar or consultant using radiographs. The Mayo Elbow Performance Score and range of motion were assessed by an independent physiotherapist.

Results. The median age of the 3 groups were comparable. Associated injuries were most common in patients with arthroplasty, followed by screw fixation and plate fixation (61.5% vs. 50% vs. 33%, p=0.54). The median time to bone union was shorter after screw fixation than plate fixation (55 vs. 86 days, p=0.05). No patient with screw fixation had non-union, but 4 patients with plate fixation had non-union. The 3 groups were comparable in terms of the mean Mayo Elbow Performance Score (p=0.56) and the mean range of motion (p=0.45). The complication rate was highest after plate fixation, followed by screw fixation and arthroplasty (50% vs. 18.8% vs. 15.4%, p=0.048). Excluding 20 patients with associated injuries (8 in screw fixation, 8 in arthroplasty, and 4 in plate fixation), the 3 groups were comparable in terms of the median time to bone union (p=0.109), mean Mayo Elbow Performance Score (p=0.260), mean range of motion (p=0.162), and complication rate (p=0.096).

Conclusion. Headless compression screw fixation is a viable option for 3-part radial head fracture. It achieves earlier bone union with fewer complications.

Key words: bone plates; bone screws; fracture fixation, internal; radius fractures

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INTRODUCTION

Radial head fracture accounts for 5.4% of all adult fractures, with an incidence of 25 in 100,000 adults. It occurs more commonly in younger men; 26% of these fractures occur with associated injuries. The usual injury mechanism is a fall on an outstretched arm, and an axial or valgus force impacts the radial head against the capitellum. Comminuted fractures can occur after high energy falls and trauma.

According to the Mason classification, radial head fracture can be classified into 3 types: type I (non-displaced radial head fracture), type II (marginal displacement), and type III (displaced head fracture with full radial head involved). The classification was modified to include the extent of radial head and neck involvement. A Mason-Johnston type IV was added to include radial head fracture associated with elbow dislocation.

The radial head acts as a key secondary stabiliser of valgus stress, especially in the medial collateral ligament (MCL)-deficient elbow. Therefore, reconstruction of the radial head and maintenance of radiocapitellar articulation is crucial for elbow stability and early recovery. The importance of radial head preservation is the rationale for radial head arthroplasty, plate fixation, and open reduction and internal fixation using Kirschner wires, mini-compression, or AO screws. Nonetheless, the optimal treatment for radial head fractures remains controversial.

Fixation using cannulated compression screws has achieved good results for Mason types II and III fractures. Fixation using the headless compression screws provides good axial loading strength in cadavers. This study compared the outcome following fixation with cannulated headless compression screws versus radial head arthroplasty versus plate fixation for 3-part Mason types III or IV radial head fractures.

MATERIALS AND METHODS

Records of 25 men and 16 women aged 21 to 80 (mean, 43.3) years who underwent fixation using 2 to 3 2-mm headless compression screws (n=16), radial head arthroplasty (n=13), or fixation with a 2-mm Synthes plate (n=12) for 3-part Mason types III or IV radial head and neck fractures from March 2009 to March 2014 by consultant surgeons were reviewed. Treatment option was decided by the surgeon based on the presence of associated injury, neurovascular deficit, and the Mason classification. Patients with pathological fracture, open fracture, non-3-part fracture, or combination of fixations with plate, headless screws, cement spacer, and/or excision arthroplasty were excluded.

Bone union, callus formation, and complications (such as heterotopic ossification, malunion, and non-union) were assessed by an independent registrar or consultant using radiographs. The Mayo Elbow Performance Score and range of motion were assessed by an independent physiotherapist. The Mayo Elbow Performance Score measures pain intensity, motion, stability and function related to the activities of daily living. A score of >90 is regarded as excellent, 75 to 89 as good, 60 to 74 as fair, and <60 as poor.

Numerical outcomes of the 3 groups were compared using the Kruskal-Wallis test. The categorical outcomes of the 3 groups were compared using the Chi-square test or Fisher exact test. A p value of <0.05 was considered statistically significant.

RESULTS

All patients were aged 21 to 60 years, except for a
A 77-year-old man who underwent screw fixation and a 70-year-old woman and a 80-year-old man who underwent arthroplasty. The median age of the 3 groups were comparable (Table).

Associated injuries were most common in patients with arthroplasty, followed by screw fixation and plate fixation (61.5% vs. 50% vs. 33%, p=0.54). The associated injuries comprised terrible triad, coronoid fracture, proximal ulnar fracture, and medial collateral ligament rupture.

The median time to bone union was shorter after screw fixation than plate fixation (55 vs. 86 days, p=0.05). No patient with screw fixation had non-union, but 4 patients with plate fixation had non-union. The time to bone union was not applicable to patients with arthroplasty. The median medical leave taken was shortest after screw fixation, followed by arthroplasty and plate fixation (41 vs. 77 vs. 95 days, p=0.37). The 3 groups were comparable in terms of the mean Mayo Elbow Performance Score (p=0.56) and the mean range of motion (p=0.45).

The complication rate was highest after plate fixation, followed by screw fixation and arthroplasty (50% [6/12] vs. 18.8% [3/16] vs. 15.4% [2/13], p=0.048). Of the 6 patients with complications after plate fixation, 2 underwent radial head arthroplasty for non-union, 2 underwent excision arthroplasty for non-union, and 2 underwent conservative

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Headless compression screw fixation (n=16)</th>
<th>Radial head arthroplasty (n=13)</th>
<th>Plate fixation (n=12)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>40 (24–77)</td>
<td>46 (27–80)</td>
<td>45 (21–59)</td>
<td>0.65</td>
</tr>
<tr>
<td>No. of males: females</td>
<td>9:7</td>
<td>10:3</td>
<td>6:6</td>
<td>0.37</td>
</tr>
<tr>
<td>Fracture type</td>
<td></td>
<td></td>
<td></td>
<td>0.41</td>
</tr>
<tr>
<td>Mason type III</td>
<td>11 (69)</td>
<td>8 (61.5)</td>
<td>9 (75)</td>
<td></td>
</tr>
<tr>
<td>Mason-Johnston type IV</td>
<td>5 (31)</td>
<td>5 (38.5)</td>
<td>3 (25)</td>
<td></td>
</tr>
<tr>
<td>Associated injuries</td>
<td>8 (50)</td>
<td>8 (61.5)</td>
<td>4 (33)</td>
<td>0.54</td>
</tr>
<tr>
<td>Operating time (minutes)</td>
<td>115 (51–209)</td>
<td>110 (50–345)</td>
<td>120 (112–135)</td>
<td>0.33</td>
</tr>
<tr>
<td>Length of hospital stay (days)</td>
<td>1 (0–6)</td>
<td>2 (0–10)</td>
<td>1 (1–3)</td>
<td>0.79</td>
</tr>
<tr>
<td>Follow-up (days)</td>
<td>437 (140–696)</td>
<td>495 (195–1710)</td>
<td>560 (140–1825)</td>
<td>0.21</td>
</tr>
<tr>
<td>Medical leave (days)</td>
<td>41 (15–185)</td>
<td>77 (21–363)</td>
<td>95 (84–383)</td>
<td>0.37</td>
</tr>
</tbody>
</table>

* Data are presented as median (range), mean (range), mean±SD, or no. (%) of patients
treatment for heterotrophic ossification. Of the 3 patients with complications after screw fixation, 2 underwent screw removal following bone union for implant prominence and pain, and one underwent conservative management for elbow pain. Of the 2 patients with complications after arthroplasty, both underwent revision surgery for radial head subluxation (n=1) or implant loosening (n=1).

Excluding 20 patients with associated injuries (8 in screw fixation, 8 in arthroplasty, and 4 in plate fixation), the 3 groups were comparable in terms of the median time to bone union (p=0.109), mean Mayo Elbow Performance Score (p=0.260), mean range of motion (p=0.162), and complication rate (p=0.096).

**DISCUSSION**

Open reduction and internal fixation using a plate or screws for Mason types II to IV fractures has achieved good results. These implants are placed within a safe zone of the radial head using an osteosynthesis technique; this prevents implant impingement and limitation of range of motion.

Plate fixation has also achieved good results for radial head fractures. However, different morphologies of the radial head and neck result in ineffective congruency of plates; this leads to poor reconstruction of the radial head, elbow stiffness, and poor reduction. In our study, plate fixation had a higher complication rate due to non-union, displacement, and heterotrophic ossification.

Radial head arthroplasty is appropriate for unreconstructible comminuted fractures. However, there have been reports of early implant loosening and problems with ‘over-stuffing’ by the radial head prosthesis. It has a higher incidence of heterotopic ossification probably because of soft tissue dissection and loss of elbow flexion and forearm rotation.

Headless compression screw fixation enables flexibility in placing the screws in the radial head. The screws can be placed within or outside the safe zone for optimal fixation without causing any impingement or stiffness owing to the well-buried heads. In our study, all 16 patients with screw fixation achieved good-to-excellent results, compared with 92.3% in radial head arthroplasty and 75% in plate fixation. The better outcome after screw fixation was due to the smaller surgical exposure, compared with the larger exposure in plate fixation or arthroplasty. Screw head coverage can be easily achieved with soft tissue, annular ligament, and capsular repair due to low implant prominence. Headless compression screws, unlike plates, do not need precontouring and can fit in any morphology of the radial head and neck. Hence, they cause less soft tissue irritation and interference with elbow or forearm movement. Nonetheless, there is a learning curve for headless compression screw fixation. It is important to not fragment the fracture and ensure anatomic reduction of the articular surface. Postoperatively, any supination/pronation should be avoided for the first 2 weeks.

In our study, the time to bone union was shorter after headless compression screw fixation than plate fixation. This was attributed to the minimum periosteal stripping and less soft tissue dissection along the radial neck. The vascular supply to the radial head was minimally disturbed. Headless compression screw fixation enabled rigid fixation of the radial head to the shaft, comparable with that achieved by plate fixation. The less stiff construct of screw fixation does not affect union rate and hence allows earlier rehabilitation, although screw fixation is only viable when the fracture does not extend too distally into the radial shaft. In this case, plate is more appropriate for more stable fixation.

In our study, the complication and revision rates were lower in headless compression screw fixation than plate fixation. All patients achieved bone union after screw fixation, compared with 67% after plate fixation. Fixation using low-profile AO screws has also resulted in a lower complication rate than plate fixation. Nonetheless, in patients with displaced, comminuted fractures, open reduction and internal fixation results in more complications than radial head arthroplasty, with an increased risk of elbow subluxation for unstable elbow injuries such as terrible triad. Furthermore, it is difficult to restore radiocapitellar contact in highly comminuted fractures using screws only. Despite this, in 3-part radial head fracture with good bone quality, screw fixation is recommended. Radial head fractures associated with elbow dislocation and/or ligamentous injury such as terrible triad or torn medial collateral ligament result in unstable elbow; restoration of the radiocapitellar articulation is crucial for optimal function. In more severe comminuted fractures and in brittle and osteoporotic bone, arthroplasty and plate fixation remain good options for fixation.

There were limitations to this study. It was a non-randomised study and treatment options were determined by different consultant surgeons based on fracture severity and preference. This may have caused bias. Bone mineral density of patients was not measured, although only 3 patients were aged >60 years. The follow-up period was short and long-term outcome was not known. The number of patients in
each group was small and thus the results did not reach statistical significance.

CONCLUSION

Headless compression screw fixation is a viable option for 3-part radial head fractures. It achieves earlier bone union with fewer complications.

DISCLOSURE

No conflicts of interest were declared by the authors.

REFERENCES