ABSTRACT

Purpose. To compare the treatment outcome of Acutrak versus Herbert screw fixation for scaphoid non-union and delayed union.

Methods. Records of 132 patients who underwent Herbert screw fixation (n=61) or Acutrak screw fixation (n=71) with or without bone grafting for scaphoid non-union and delayed union by a single surgeon were reviewed. The most common fracture site was the waist of the scaphoid (n=95), followed by the proximal pole (n=31) and the distal pole (n=6). Screw placement was considered accurate (n=120) when the screw was placed in the central one-third (axially) of the scaphoid; otherwise it was eccentric (n=12). Bone union was assessed radiographically and clinically. Functional outcome was assessed using the modified Mayo wrist score.

Results. Respectively in the Herbert and Acutrak screw groups, the mean patient ages were 25.3 and 27.3 years (p=0.28), the mean intervals between injury and screw fixation were 12.2 and 17 months (p=0.38), the mean durations to bone union were 2.1 and 1.8 months (p=0.63), and the union rates were 77% and 93% (p=0.01). The union rate was significantly higher in fractures of the waist of the scaphoid than in the proximal and distal poles (94% vs. 71% vs. 33%, p=0.001). The union rate was significantly higher when the screw was placed accurately (axially) than eccentrically (Herbert screw: 84% vs. 40%, p=0.006; Acutrak screw: 96% vs. 0%, p=0.004). 84% of the Herbert screws were placed axially, compared to 97% for the Acutrak screws. Respectively, 67% and 85% of patients had satisfactory functional outcomes (p=0.03), whereas 23% and 7% of the patients had persistent non-union (p=0.05).

Conclusion. The Acutrak screw enabled more accurate screw placement and achieved higher union rates and modified Mayo wrist scores than the Herbert screw did.

Key words: bone screws; fracture fixation, internal; scaphoid bone

INTRODUCTION

Non-union rates of scaphoid fractures treated with a plaster cast were 5 to 10%\(^1\) to up to 50%.\(^2\) Surgical intervention is needed to achieve stable union, restore scaphoid anatomy, and prevent/reverse carpal collapse. Fixation with a Herbert screw with or without bone grafting is commonly performed. Cannulated screws (e.g. Acutrak) are superior to the Herbert screw in terms of compression force,\(^3\)\(^-\)\(^6\) which enables rigid fixation, prevents displacement, and shortens the time of immobilisation, and thus improve functional outcome. In addition to the compromised blood supply, the persistent bending force applied to the scaphoid as a result of its position between the proximal and distal carpal rows may lead to non-union. This bending force tends to cause dorsal angulation when the scaphoid is fractured.\(^7\)\(^,\)\(^8\)

The number of loading cycles required to displace a Acutrak screw is 1.6 times more than that for the Herbert screw.\(^5\)

Accurate placement of the screw is important in restoring the bone alignment and in preventing malrotation. The union time is shorter when the proximal screw threads are located in the centre of the proximal pole.\(^9\) The Acutrak screw is cannulated for easy placement over a guide wire. This avoids the need for jigs, which may malrotate the fragments during screw insertion.\(^10\) We compared the treatment outcome of Acutrak versus Herbert screw fixation for scaphoid non-union and delayed union.

MATERIALS AND METHODS

Records of 132 patients with scaphoid non-union and delayed union who underwent Herbert screw fixation (n=61, between July 1996 and June 2000) or Acutrak screw fixation (n=71, between July 2000 and December 2005) with or without iliac crest bone grafting by a single surgeon were reviewed (Fig.). Patients with acute scaphoid fractures, degenerative changes, or incomplete peri-operative or functional outcome data were excluded. Scaphoid fractures were categorised according to the fracture sites\(^11\); the most common was the waist (n=95), followed by the proximal pole (n=31) and the distal pole (n=6).

The Russe approach was used for waist fractures, whereas the dorsal approach was used for proximal pole fractures. Sclerotic and fibrous tissues were resected. Corticocancellous bone grafts from the iliac crest were used to restore the length and to correct any hump back deformity after resection of pseudoarthrosis. Bone grafts were placed in the centre of the defect. The Herbert screw was inserted using a Huene jig, whereas the Acutrak screw was inserted over a guide wire. Any gap between the graft and fracture ends was packed with cancellous bone chips. Screw placement was considered accurate (n=120) when the screw was placed in the central one-third (axially) of the scaphoid; otherwise it was eccentric (n=12).\(^7\) The final position of the screw was confirmed by fluoroscopy. Capsular repair was performed for all patients.

Postoperatively, a Plaster of Paris back slab was applied for 10 to 14 days and then the sutures were removed. A full cast was used for further 4 to 6 weeks.
Clinical and radiographic outcomes were assessed at weeks 6, 12, and 24. All patients had a minimum follow-up of 2 years.

Clinical bone union was defined as no tenderness, whereas radiological union was evaluated using the Fillan and Herbert criteria. A modified Mayo wrist score was used for functional assessment (Table 1). Screw failure was defined as revision for non-union, regardless of the reason.

The Herbert and Acutrak screw groups were compared using the Mann-Whitney U test, Fisher’s exact test, or Chi-squared test, as appropriate. A p value of <0.05 was considered statistically significant.

RESULTS

Respectively in the Herbert and Acutrak screw groups, the mean patient ages were 25.3 and 27.3 years (p=0.28, Table 2), the mean intervals between injury and screw fixation were 12.2 (range, 3–144) and 17 (range, 4–180) months (p=0.38), and the mean durations to bone union were 2.1±3.6 and 1.8±3.6 months (p=0.63).

The union rate was significantly higher in fractures of the waist of the scaphoid than in the proximal and distal poles (94% vs. 71% vs. 33%, p=0.001, Table 3). The union rate was significantly higher when the screw was placed accurately (axially) than eccentrically (Herbert screw: 84% vs. 40%, p=0.006; Acutrak screw: 96% vs. 0%, p=0.004; Table 3). 84% of the Herbert screws were placed axially, compared to 97% of the Acutrak screws. The union rate was significantly lower in the Herbert than Acutrak screw group (77% vs. 93%, p=0.01, Fisher’s exact test). Patient age and the interval between injury and screw fixation did not affect the union rate.

Respectively in the Herbert and Acutrak screw groups, functional outcomes were excellent in 41% of the Herbert screws and 65% of the Acutrak screws. The union rate was significantly higher in fractures of the waist of the scaphoid than in the proximal and distal poles (94% vs. 71% vs. 33%, p=0.001, Table 3). The union rate was significantly higher when the screw was placed accurately (axially) than eccentrically (Herbert screw: 84% vs. 40%, p=0.006; Acutrak screw: 96% vs. 0%, p=0.004; Table 3). 84% of the Herbert screws were placed axially, compared to 97% of the Acutrak screws. The union rate was significantly lower in the Herbert than Acutrak screw group (77% vs. 93%, p=0.01, Fisher’s exact test). Patient age and the interval between injury and screw fixation did not affect the union rate.

Respectively in the Herbert and Acutrak screw groups, functional outcomes were excellent in 41%
Table 4
Revision for both Herbert and Acutrak screw fixations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Herbert screw</th>
<th>Acutrak screw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-union</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Revision</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Regrafting</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Exchange to Acutrak screw</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Salvage procedure (wrist fusion and 4-corner fusion)</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

and 60% of the patients, good in 26% and 25%, fair in 22% and 10%, and poor in 11% and 5% (p=0.03). 23% and 7% of the patients had persistent non-union (p=0.05) [Table 4]. Two from each group were due to avascular necrosis; all 4 failed to unite after revision surgery, except for one Acutrak screw patient who (despite union) eventually underwent 4-corner fusion owing to persistent pain from carpal instability of the scapholunate joint. Four other patients in the Herbert screw group and one patient in the Acutrak screw group also underwent fusion owing to progressive wrist pain (Table 4). One patient in the Herbert screw group had persistent paraesthesia due to injury to an aberrant branch of the radial nerve.

**DISCUSSION**

The union rate for cannulated screw fixation and pedicle vascularised bone grafting can be as high as 96%, which is similar to the 93% in our Acutrak screw fixation group. In our study, the union rate for Herbert screw fixation was 77%, which is comparable to that reported in another study. Outcomes of the 2 screw fixation systems are similar.

Bone union strongly correlates with technical factors related to the procedure. Adequate realignment and proper screw length are essential. In our study, the screw was placed accurately (axially) in 97% of the patients in the Acutrak screw group, compared to 84% in the Herbert screw group. Eccentric placement lowers the union rate and may lead to screw breakage. The Acutrak screw is cannulated, which facilitates screw placement over a guide wire. The use of the Huene device or other jigs may potentially malrotate fragments during compression. Failure can also be due to inadequate screw length and inaccurate jig placement. Application of a jig may damage the scaphotrapezial joint and lead to secondary arthritis. Herbert screw fixation is technically more demanding and requires more skill and experience. In cases of failure, repeat bone grafting and internal fixation is advised if feasible. Salvage procedure should be reserved for those with carpal collapse.

There were 2 limitations in our study. Smoking affects the union rate after fixation for scaphoid non-union. Nonetheless, patient characteristics of the 2 groups were very similar. The surgeon may have attained more skills and experience in the later group of patients. A cannulated variety of the Herbert screw (Herbert-Whipple screw) may provide equal advantage as the Acutrak screw. Furthermore, the fluoroscopy had also improved with time and achieved better visualisation in cannulated wire placement. The superiority of Acutrak screw fixation to Herbert screw fixation in terms of the union rate was partly due to more accurate screw placement.

**REFERENCES**