



Comparison of Herbert and Acutrak screws in the treatment of scaphoid non-union and delayed union

Jonathan J. GREGORY, Randip S. MOHIL, Aaron B. NG, James G. WARNER, Stephen P. HODGSON

From the Royal Bolton Hospital, Bolton, United Kingdom

A retrospective analysis was performed on patients who had undergone surgery for delayed union or non-union of a scaphoid fracture. This was conducted to investigate if there was a difference in outcome between patients treated with the Acutrak screw or the Herbert screw. Twenty two cases were treated with a Herbert screw and 23 with an Acutrak screw. The patient demographics, aetiology of injury and fracture types were similar between the two groups. There was no significant difference in union rate or time to union for fractures treated with the Herbert screw or the Acutrak screw. There appears to be no difference in outcome for cases of scaphoid fracture delayed union and non-union treated with either the Herbert screw or the Acutrak screw.

Keywords : scaphoid fracture ; non-union ; delayed union ; internal fixation ; bone graft ; outcome.

INTRODUCTION

The majority of scaphoid fractures can be treated successfully with plaster cast immobilisation (9). The aim of surgery for scaphoid non-union is to obtain healing of the fracture and to restore normal carpal height and kinematics. Numerous methods of fixation (6,7,9,14) and types of bone graft (12) have been used in the treatment of scaphoid non-union. Conventional grafting such as the Matti-Russe inlay graft technique is successful in obtaining union in approximately 70% of cases. Internal fixation aims to provide fracture site stability. Many fixation

devices also generate compression of the fracture with the intention of promoting healing. Different internal fixation devices generate different levels of compression (1,3,4,11). The optimal level of compression to obtain healing has not been identified. Many of the comparison studies are based on *in vitro* data relating to compression forces, with few studies comparing clinical outcome. We describe our experience comparing the Herbert screw (10) and Acutrak screw (4) in the surgical treatment of scaphoid delayed union and non-union.

■ Jonathan J. Gregory, MD, Specialist Registrar Trauma and Orthopaedic Surgery.

■ Randip S. Mohil, MD, Specialist Registrar Trauma and Orthopaedic Surgery.

■ Aaron B. Ng, MD, Specialist Registrar Trauma and Orthopaedic Surgery.

■ James G. Warner, MD, Consultant Trauma and Orthopaedic Surgeon.

■ Stephen P. Hodgson, MD, Consultant Trauma and Orthopaedic Surgeon.

Department of Trauma and Orthopaedic Surgery, Royal Bolton Hospital, Minerva Road, Farnworth, Bolton, BL4 0JE, United Kingdom.

Correspondence : Mr J. Gregory, 5 Mill Meadow, Laundry Lane, Shrewsbury, Shropshire, SY2 6EU, United Kingdom.

E-mail : jjgregory@doctors.org.uk

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Fig. 1. — Radiographs demonstrating scaphoid fixation with the Acutrak screw (a) and Herbert screw (b).

METHODS

Cases of open reduction and internal fixation for delayed union and non-union of a scaphoid fracture were identified and retrospectively analysed. Fifty cases were identified over a 10 year period. Five cases were excluded as they involved the treatment of acute scaphoid injuries. Therefore forty five cases were examined further. During this time there was a change from treating these fractures with the Herbert screw to the Acutrak screw. This change was based upon the Acutrak screw being cannulated which was felt to be an advantage over the Herbert screw. All cases were supervised or performed by one of two consultant upper limb surgeons in a single institution.

The diagnosis of delayed union or non-union was based upon patient history, clinical examination and plain radiographic findings. Delayed union was diagnosed when a fracture was still symptomatic or radiologically evident after 3 months of non-operative treatment. CT scanning was not routinely available for scaphoid fractures.

Fractures of the scaphoid located at the waist or distal pole were treated via a volar approach to the scaphoid. Cases where the fracture was in the proximal third of the scaphoid were approached dorsally.

When using the Herbert screw the fracture was reduced and held using a Huene jig. The jig was used to determine the length of screw required and to pre-compress the fracture prior to screw insertion. When the Acutrak screw was used, once the fracture had been reduced the Acutrak guidewire was passed across the fracture. An image intensifier was used to confirm that the guidewire was in a satisfactory position. The guidewire was then measured to determine the Acutrak screw length. Two millimetres were subtracted from the measured length to reduce the risk of the screw being too long.

The use of bone graft was based upon the presence or absence of bleeding from the scaphoid at surgery and if correction of deformity or collapse was required. When osteoinduction and structural support were required, bone graft was harvested from the iliac crest. When only osteoinductive properties were required cancellous bone was harvested from the distal radius via a cortical trap door.

The carpal ligaments were repaired in all cases with absorbable sutures and the skin closed with non-absorbable sutures. All patients were placed in a plaster of Paris backslab postoperatively for 10-14 days to allow soft tissue healing.

Patients attended clinic at approximately day 14 to have their backslab and sutures removed. They were provided with a Futura splint for comfort and allowed to use their hand as pain allowed, avoiding heavy manual work and sport. Patients were followed-up at 6, 12 and 24 weeks post-operation and longer if union was delayed. The diagnosis of union was made based upon history, clinical examination and plain radiographs.

Case notes were analysed to record patient demographic data, details of the fracture, surgical method, outcome, complications and the need for further surgery. A statistician performed the Mann-Whitney U Test or Fisher's Exact Test where appropriate to determine significance using SPSS statistical software.

RESULTS

The case notes of fifty patients who had undergone open reduction and internal fixation of a delayed union or non-union of a scaphoid fracture were reviewed. Five patients who were treated acutely for their scaphoid fracture due to the degree of displacement were excluded. The notes of the 45 remaining patients were analysed in detail. Twenty two patients had undergone Herbert screw fixation and 23 had received Acutrak fixation. The two groups were similar with respect to age, sex, affected limb and mechanism of injury (table I).

The fractures were classified as affecting the proximal, middle or distal third of the scaphoid based upon radiographic features or description at operation. The majority were middle third fractures passing through the waist of the scaphoid. There were smaller numbers of proximal and distal third fractures. Four of the 5 distal third fractures and 7 of the 10 proximal third fractures were treated with

Table I. — Patient demographics

	Herbert screw	Acutrak screw
Number of patients	22	23
Age (years)	27.8 (range : 19 to 43)	26.7 (range : 16 to 57)
Sex M:F	20:2	23:0
Side R:L	15:7	10:13
Mechanism	Fall 14, sport 5, RTA 2, Fight 1	Fall 16, Sport 5, RTA 1, Fight 1

Acutrak screw fixation. Twenty six out of thirty middle third fractures (86%) and 8 out of 10 proximal third fractures united. There were 2 cases of non-union in the five distal third fractures. This is higher than would be expected but the two cases involved very small distal scaphoid fragments which were difficult to fix securely due to their size.

The two groups were compared to see if there was a difference in time from injury to surgery. The median time from injury to surgery was 7.5 months (range : 2 to 144) in the Herbert screw group compared to 4 months (range : 2 to 48) in the Acutrak group. The data was not normally distributed (skewness 2.414). A Mann Whitney U test shows a significant difference between the groups ($p = 0.048$). However three patients in the Herbert screw group had their surgery more than 80 months after injury. When these cases are removed from the analysis there is no significant difference between the two groups with regard to time from injury to surgery ($p = 0.185$).

The data was analysed to see if there was a difference between cases which underwent surgery more than 6 months post injury compared to those who had surgery within 6 months of injury regardless of method of fixation. Of those who had surgery after six months 15 out of 20 went on to union, versus 22 out of 25 patients who had surgery within six months. There is no significant difference in union rate between these groups (Fisher's Exact test, $p = 0.435$).

There was no significant difference in the use of bone graft between the two groups. Bone graft was used in 20 of 23 cases undergoing Acutrak fixation and 21 of 22 cases undergoing Herbert screw fixation. The graft was from the distal radius in 12 cases in each group, and from the iliac crest in the other cases.

Union rates were not significantly different between the two groups. Nineteen of 23 fractures treated by Acutrak fixation united and 18 of 22 fractures treated with Herbert screw fixation united (Mann Whitney, $p = 0.862$). The time taken for a diagnosis of union to be made was not significantly different between the two groups (median values : 7 months Acutrak (range : 4 to 13) and 6.5 months Herbert (range : 3 to 18). The diagnosis of union was based upon clinical and radiographic features, CT scanning was not employed.

As no significant differences were found between the two groups a power calculation was performed. Using NQuery advisor software and the observed median and variation in each of the groups, it was found that a study with 50 subjects in each group would have 80% power to detect a statistically significant difference between the two groups at the 5% level.

Data regarding range of motion at discharge was available for most patients (19/23 Acutrak and 19/22 Herbert) (table II). There was no difference between the two groups with regard to range of motion at final clinic visit. There was no difference between the two groups with regard to pain at final follow-up. Of the patients who had undergone Herbert screw fixation 13 were pain free, 6 reported mild pain and no data was available for 3 patients. In the group which had undergone Acutrak fixation 15 were pain free, 4 had mild pain and no data was available for 4 patients.

Further surgery was required in 6 patients who had undergone Herbert screw fixation and in 6 patients following Acutrak fixation. Two patients from the Herbert screw group and 5 from the Acutrak group had their metal work removed. This was due to symptoms from the scapho-trapezoid joint due to the screws being prominent. Three

Table II. — Range of motion at final clinic appointment

	Herbert screw	Acutrak screw
Flexion		
< 30 degrees	1	1
30 – 60 degrees	1	1
> 60 degrees	17	17
Missing data	3	4
Extension		
< 30 degrees	1	2
30 – 60 degrees	0	0
> 60 degrees	18	17
Missing data	3	4

procedures were required in the Herbert screw group for persistent problems with the scaphoid. One patient underwent revision screw fixation and grafting and went on to healing of the fracture. Another patient had excision of the proximal pole of the scaphoid due to non-union and a further patient underwent excision of the entire scaphoid. The sixth patient who required further surgery in the Herbert screw group underwent arthroscopy due to persistent symptoms and was found to have a TFCC tear. In addition to the five cases requiring screw removal one patient in the Acutrak group required further surgery for problems with the scaphoid. They underwent 3 further procedures in total due to non-union of their fracture and were finally managed with a 4-corner fusion.

DISCUSSION

We did not find any significant difference between patients treated with Herbert screws or Acutrak screws for delayed union or non-union of scaphoid fractures. There were no differences in terms of union rate, time to union, functional outcome or requirement for further surgery between the two groups. The two groups were well matched demographically. The distribution of fracture types was similar between the two groups as was the use of bone graft.

Our study is a retrospective analysis. The data used as the basis for this study is of good quality as all patients received consultant led follow-up. One of the two senior authors (who are consultants

specialising in hand surgery) performed or supervised every procedure.

Smoking appears to have a retardant effect on bone healing (5,8). There was insufficient data regarding patients smoking status to prove that there wasn't a significant difference in smoking status between the two groups. The authors have no reason to believe that a difference does exist between the groups which were otherwise well matched as regards demographic data.

There was no difference in outcome when the fractures are analysed on the basis of the source of the bone graft. Twenty four patients had graft taken from their distal radius and in seventeen the iliac crest was used as the source of bone graft. There is no difference in time to union or union rate between the grafts. This finding is in keeping with that of Tambe *et al* (12). Iliac crest was used in the more challenging cases when structural support in addition to osteoinduction was required, distal radial graft being used only in fractures without deformity when osteoinduction was required.

CT scans were not obtained on any patients. CT scanning was not routinely available in our institution for scaphoid fractures except for diagnosis during the time covered by this work. The diagnosis of union or non-union was based upon history, clinical examination and plain radiographs. This means that fractures which had incomplete union or fibrous union may have been classed as united by our study. However in the context of a symptom free patient this would not have altered further management.

Cases which underwent surgery more than 6 months after injury appeared to have a lower union rate (15 out of 20) than those treated earlier (22 out of 25) but this was not statistically significant. This is in agreement with previously published work (13) which also found no association between interval from injury to surgery and union rate.

Compression has been shown to help maintain fracture reduction and promote healing (2). Scaphoid non union surgery does appear to be less successful when the fracture and graft are only maintained in alignment without compression. Tambe *et al* (12) found a significantly lower rate of union in cases of scaphoid non union treated with

bone grafting and K-wire fixation compared to those treated with bone grafting and fixation with a compression screw. The optimal amount of compression required is a source of debate. Many of the implants available for scaphoid fixation have had *in vitro* measurements of compression made (1,3,4,11). Currently it is unknown how well this compression is maintained *in vivo* and what level of compression best promotes healing of scaphoid fractures. The Acutrak screw appears to generate greater compression than the Herbert screw on biomechanical testing. There are too many variables in our study and the numbers are too small to conclude that the greater compression generated by the Acutrak screw does not result in improved fracture healing rates compared to the lower level of compression from the Herbert screw.

We found no difference in the outcome of cases of scaphoid fracture non-union and delayed union treated by either the Herbert screw or the Acutrak screw.

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