

Original Research Article

Correlation between functional and radiological outcome after surgical stabilization of volar Barton fracture with plating: a comparative study

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ABSTRACT

Background: The objective of the study was to evaluate the functional and radiological outcomes after open reduction with internal fixation of volar Barton's fracture of the wrist and compare their outcomes.

Methods: Total of 30 cases of volar Barton fractures were operated by open reduction and internal fixation with plating. Mean follow up period was 6 months. Patients were assessed both radiological and functional outcome and compare between the two outcomes.

Results: All fractures were healed in a mean period of 7 weeks (range 6-9 weeks). The mean disabilities of the arm, shoulder and hand (DASH) score was 13.21 points (range: 10.3 to 30), thus confirming the patient's good functional capacity. The higher the DASH score was (i.e. the worse the functional result), the smaller were the flexion ($p=0.01$), pronation ($p=0.03$), supination ($p<0.0001$) and radial deviation ($p=0.005$) of the wrist that underwent the surgical procedure after the fracture of the distal extremity of the radius. The radiological results were evaluated by modified Lidstrom criteria.

Conclusions: The radiographic results did not influence the DASH score. There was no statistical relationship between the DASH score and the radial height or the volar tilt or the radial tilt of the distal extremity of the operated radius.

Keywords: Volar Barton fracture, Plating, Functional outcome, Radiological outcome

INTRODUCTION

Barton's fractures, named after the American surgeon John Rhea Barton, who first described it in 1838, is a fracture of the distal end of the radius which involves the articular surface.¹ This fracture can be either an anterior marginal (volar Barton) or posterior (dorsal Barton) marginal fracture. These fractures may be either due to low energy or high energy injuries but high energy injuries are more frequent cause of volar Barton's fracture.²⁻⁵ Volar Barton's fractures are different from other distal radius fractures in that there is an associated radio carpal dislocation. Conservative treatment is usually unsuccessful in these

fractures unlike other distal radius fractures which have good functional outcome with conservative treatment. These fractures are associated with complications like loss of reduction, malunion, nonunion, deformity, subluxation and instability.⁶⁻⁸ Various surgical treatment modalities are reported in literature. Open reduction and internal fixation (osteosynthesis) with a volar plate system have shown good results. The advantages of this system are good reduction of articular surface and achieves immediate stability of joint leading to early mobilization of wrist and potential reduction of wrist and finger stiffness and reduction of early onset of wrist osteoarthritis.⁹⁻¹¹ The aim of this study is to correlate between functional and

radiological outcome after surgical stabilization of volar Barton fracture with plating.

METHODS

This study was conducted in the Department of Orthopaedics, Kamineni Hospitals, Hyderabad from May 2015 to January 2017. It was a prospective comparative study. Total of 30 cases of volar Barton fractures were operated by open reduction and internal fixation (ORIF) with plating. The mean age of the 20 men and 10 women was 30 years (range: 20-65 years). The mechanism of injury was road traffic accident (high velocity) in 18 cases and fall on outstretched hand in 12 cases. The Barton’s fractures were classified according to a comprehensive classification system based on radiographic and operative findings.¹² All 30 cases were type-B3 fractures. In terms of fracture subtype, 8 cases were B3.1 (fracture characterised by a small volar fragment and an intact sigmoid notch), 10 were B3.2 fractures (a large volar fragment that included the sigmoid notch), and 12 were B3.3 fractures (comminution of the volar fragment).

Table 1: Sarmiento radiological score (modified Lidstrom criteria).

Outcome	Loss of palmar tilt	Radial shortening	Loss of radial deviation
Excellent	<0°	<3 mm	<4°
Good	1-10°	3-6 mm	5-9°
Fair	11-14°	7-11 mm	10-14°
Poor	>15°	>12 mm	>15°

Inclusion criteria

Adults over 18 yrs of age, both male and female with volar Barton fracture with or without other associated injuries, patients medically fit for surgery, patients willing for surgical treatment and have given informed written consent were included.

Exclusion criteria

Open fractures requiring soft tissue reconstruction, intra articular fractures with dorsal comminution, pathological fractures, patients with neurovascular injury, patient not willing for consent were excluded.

Surgical technique

General anesthesia with interscalene block was used for all patients. A pneumatic tourniquet was used in all cases in order to provide bloodless field during surgery. The fracture site was exposed through the distal part of the modified Henry approach.¹³ Open reduction of all major fragments was performed, focusing on restoring articular congruity. Kirschner wires were used to temporarily stabilise the position of fracture fragments. Definitive fixation was done with a 3.5 mm Ellis T-plate (B3.1 and B3.2) and variable angle locking plate for B3.3 fractures.

Post op dressing done on 2nd day and suture removal done after 10 days from date of surgery. Finger range of motion exercises started immediately after surgery and active movement of wrist was started after 2 weeks of surgery. Post op radiographs were taken immediately, 3 weeks, 3 months and final evaluation at 6 months (Figure 1). At final evaluation the functional results were analysed using the protocol for dysfunctions of the arm, shoulder and hand (DASH) and radiological results were evaluated in accordance with the Sarmiento radiological score, modified Lidstrom anatomical-radiological classification for fractures of the distal extremity of the radius, as excellent, good, fair or poor (Table 1).^{14,15}

The data were reported as the mean±SD. The Spearman rho test was used to assess the variables. A “p” value of <0.05 using a two-tailed test was taken as being of significance for all statistical tests. All data were analysed with a statistical software package (SPSS, version 19.0 for windows).



Figure 1: Preoperative radiograph of a 28-year-old male with a B3.2 volar Barton fracture, (B) postoperative radiograph after ORIF with T plate, (C) at 6 months follow up showing good union.

RESULTS

Thirty cases of volar Barton’s fracture were operated by ORIF. There were 20 (66%) males and 10 (34%) females. The mean age was 30 years (range: 20-65 years). The mean follow up was 6 months. The right hand was involved in 18 (60%) patients. The mechanism of injury was high-energy trauma (i.e. road traffic accident) in 17 (51.6%) patients, fall in 10 (33.3%) and 3 (10%) patients had polytrauma.

All fractures were healed in a mean period of 7 weeks (range 6-9 weeks). There were no significant postoperative complications. The mean DASH score was 13.21 points (range: 10.3 to 30), thus confirming the patients’ good functional capacity. The patients had greatest difficulty with regard to their ability to carry heavy objects (more than 5 kg), perform activities that required an impact and doing heavy domestic tasks.



Figure 2 (A-D): Movements at follow up after 6 months showing full range of motion.

The following mean ranges of motion were documented: wrist flexion of 67° (normal up to 80°), extension of 66° (normal up to 70°), pronation of 65° (normal up to 90°), supination of 66° (normal up to 90°), ulnar displacement of 24° (normal up to 45°) and radial displacement of 11° (normal up to 15°) (Figure 2).

Table 2: Distribution of patients according to their demographic and clinical characteristics.

Variables	N (%)
Age distribution (in years)	
20-30	7 (23.3)
31-40	9 (30.0)
41-50	12 (40.0)
51-60	2 (6.7)
Gender distribution	
Females	10 (66.7)
Males	20 (33.3)
Side involved	
Right	18 (60.0)
Left	12 (40.0)
Mode of injury	
Road traffic accidents	18 (60.0)
Fall of height	12 (40.0)
Type of fracture	
B3.1	8 (26.7)
B3.2	10 (33.3)
B3.3	12 (40.0)
Union in weeks	
12	5 (16.7)
14	17 (56.7)
16	8 (26.7)
Complications	
Nil	25 (83.3)
Stiffness	3 (10.0)
Malunion	1 (3.3)
EPL tendon irritation	1 (3.3)
Lidstrom criteria	
Excellent	5 (16.6)
Good	18 (60)
Fair	7 (23.4)
Poor	0

Table 3: Hypothesis test summary (non parametric test) each variable is correlated with DASH scoring.

Null hypothesis	Test	Significance	Decision
The distribution of variable (radial height) normal with mean 5.26 and standard deviation 4.237	One sample Kolmogorov – Smirnov test	0.158	Retain the null hypothesis
The distribution of variable (volar tilt) normal with mean 4.64 and standard deviation 1.449	One sample Kolmogorov – Smirnov test	0.200	Retain the null hypothesis
The distribution of variable (radial tilt) normal with mean 7.43 and standard deviation 2.646	One sample Kolmogorov – Smirnov test	0.200	Retain the null hypothesis

The significance level is 0.05.

The radiological results were evaluated by modified Lidstrom criteria, we had rated as excellent in 5 (16.6%) patients, as they had no or insignificant deformity, loss of palmar tilt $\geq 0^\circ$, shortening of < 3 mm, loss of radial deviation $< 4^\circ$ with no complications. 18 (60%) patients had slight deformity, loss of palmar tilt of $1-10^\circ$, shortening of 3-6 mm, loss of radial deviation $5-9^\circ$, so the result was rated as good. 7 (23.4%) patients had moderate deformity, loss of palmar tilt of $11-14^\circ$, shortening of 7-11 mm, loss of radial deviation $10-14^\circ$ and the result was rated as fair.

Three patients (10%) developed stiffness due to failure to compliance with postoperative physical therapy. One patient (3.3%) had extensor pollicis longus tendon irritation due to long volar to dorsal screw and one patient (3.3%) developed radiocarpal arthrosis due to malunion (Table 2).

Correlation between clinical and radiographic results

The functional and radiographic results were correlated by means of statistical analysis. Firstly, an analysis was performed between the DASH score and the documented range of motion of each of the patients in the study. It was observed that the flexion, pronation, supination and radial deviation were correlated with the DASH score, with statistical significance ($p < 0.05$). The higher the DASH score was (i.e. the worse the functional result), the smaller were the flexion ($p = 0.01$), pronation ($p = 0.03$), supination ($p < 0.0001$) and radial deviation ($p = 0.005$) of the wrist that underwent the surgical procedure after the fracture of the distal extremity of the radius. Subsequently, an analysis was performed between the DASH score and the radiographic results obtained. The radiographic results did not influence the DASH score. There was no statistical relationship between the DASH score and the radial height or the volar tilt or the radial tilt of the distal extremity of the operated radius (Table 3).

DISCUSSION

Over the last decade, several studies have been directed towards clarifying which surgical treatment method would be best for fracture of the distal extremity of the radius. In this context, Osada et al, demonstrated that volar plates are well tolerated, allow early mobilization and provide good support for deforming muscle forces after the surgical reduction, even in intra-articular fracture.¹⁶

We did not observe any correlation between the radiographic outcome and the functional result. This ratifies the findings of Tsukazaki et al, i.e. that the severity of the initial displacement, the involvement of the radiocarpal or distal radioulnar joint and the presence of fracture of the styloid process of the ulna did not affect the functional result from treating the fracture of the distal extremity of the radius with a fixed-angle plate.¹⁷

Fujii et al observed that there was no relationship between the functional result and reestablishment of the radiographic parameters of the distal extremity of the radius to the way they were before the fracture.¹⁸ Moreover, in the study by Jaremko et al patients undergoing conservative treatment for fractures of the distal extremity of the radius were evaluated and it was observed that there was no relationship between the functional results and reduction of the fracture to acceptable radiographic levels.¹⁹ Our data confirm the findings of Fujii et al and Jaremko et al, i.e. that the radiological values did not influence the range of motion. Thus, the final change in dorsal tilt of the radius seen on lateral-view radiographs, and the change in radial tilt and height seen on anteroposterior-view radiographs that were produced as routine postoperative check-ups on the patients in the study were inconclusive for affirming that there were any relationship with the range of motion of the wrist.

We found that the range of motion of the wrist joint, and particularly the flexion, pronation, supination and radial deviation were influenced by the DASH score result. There was an inversely proportional relationship between the range of motion of the wrist that underwent the surgical procedure and the DASH score, and this was statistically significant ($p < 0.05$). We found that with greater flexion, pronation, supination and radial displacement of the wrist, we obtained a better functional result (lower numerical DASH score).

As observed in the study by Chung et al, open reduction and internal fixation enabled early mobilization and an earlier return to normal activities that with plaster-cast immobilization of the wrist for six weeks.²⁰ Wakefield et al. also observed that carrying out exercises at home was a form of rehabilitation that was as good as having regular physiotherapy sessions after treatment of non-complicated fractures of the distal extremity of the radius.²¹

CONCLUSION

We conclude that, based on the functional results obtained by using the wrist rom and DASH scoring system, and radiological results obtained by using Sarmiento modification of Lidstrom criteria, treatment of distal radius volar Barton fracture by using volar plating technique showed good results even though radiological results are fair or poor. This study demonstrates that the subjective functional results are influenced by the range of motion, particularly volar and dorsal flexion, supination, pronation and radial deviation of the wrist after the surgical procedure, which shows early rehabilitation as key in such cases.

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