Restoration of Radiological Parameters with Fragment Specific Fixation for Distal Radius Fractures: A Case Series

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ABSTRACT

Objective: To assess the radiological outcomes of fragment-specific fixation for complex distal radius fractures.

Methods: We conducted a retrospective case series of patients presenting with complex distal radius fractures and undergoing fragment-specific fixation between 1st January 2018 and 31st December 2019. Demographic information and mechanism of injury were recorded. Pre- and post-operative radiographs were analysed for fracture type, radial height, radial inclination, and palmar tilt.

Results: A total of 15 patients were included in the study with a mean age of 40 ± 10 years. Most common mechanism of injury was RTA (67%) followed by fall. The most common fracture was noted to be AO type C3.1t (33%). A significant improvement in radial height and radial inclination was noted post-operatively (P-values = 0.014 and 0.038 respectively). Mean palmar tilt improved from 0.44° ± 17.5° preoperatively to 7.11° ± 6.64° post-operatively.

Conclusion: Fragment-specific fixation is an effective treatment option for complex distal radius fractures with the ability to restore normal radiological parameters after surgery.

Keywords: Distal Radius; Fragment-specific, Radiological outcomes.

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INTRODUCTION

Distal radius fractures are one of the most common fractures to be encountered by orthopaedic surgeons and account for one-sixth of all orthopaedic related fractures[1]. It is also a cause of considerable concern for orthopaedic surgeons as its incidence is increasing internationally amongst various age groups including paediatric population, young adults and the elderly[1,2]. Multiple treatment modalities have been used to effectively manage these fractures, with a common goal of restoring joint function and limiting pain as much as possible[3].

Stable and non displaced distal radius fractures can be managed conservatively with acceptable results, however, unstable fractures with considerable displacement require operative intervention to restore alignment and functionality[4]. Complex Type C fractures, as per AO classification, carry a worse prognosis compared to other types due to the instability of the distal radioulnar and radiocarpal joints as well as injury to the surrounding ligaments[5,6]. Hence, various surgical procedures including external fixation, K-wire pinning, ORIF with volar plate, and ORIF with fragment specific fixation have been used in the management of distal radius fractures[3].

External fixation and pinning have been associated with radial neuritis, loss of reduction, stiffness of fingers and wrist, and pin tract infections thereby limiting its use[7]. Volar fixed-angle plate on the other hand, can successfully be used to treat distal radius fractures with fragments large enough to be secured to the plate using screws. However, in cases with marked comminution, the procedure is ineffective due to lack of purchase on small fragments using distal screws and thus leading to collapse of fragments[8].

More recently, distal radius fractures specifically intra articular fractures are being managed with fragment specific fixation using a combination of mini plates and K-wire designed to match the anatomy of the distal radius[3]. Studies have shown this approach

to have better stability than external fixation or volar plates. In addition, proper positioning of implants also results in the sustainability of physiological load associated with early range of motion, therefore allowing early mobilisation after surgery[9,10].

As fragment-specific fixation is a relatively new method of fixaton and still growing in popularity, there is a scarcity of literature showing its effectiveness especially from a developing country. Therefore, the objective of this study is to assess the radiological outcomes of fragment-specific fixation for complex distal radius fractures.

MATERIAL AND METHODS

A case series was carried out at Aga Khan University Hospital, Pakistan between 1st January 2018 till 31st January 2019. All patients with complex distal radius fractures who had undergone fragment-specific fixation at the mentioned hospital were included. The exclusion criteria included patients with skeletal immaturity, open fracture or extensive comminution of the distal radius with the unrepairable intra-articular surface. Ethical Review Committee (ERC) was obtained from our institution.

Medical record files for all patients were reviewed for baseline characteristics including age, gender, smoking status, comorbidities, mechanism of injury, and the type of fracture according to the AO classification. Pre- and post-operative radiographs were analysed by a senior orthopaedic resident for radial height, radial inclination, and palmar tilt. Figures 1 and 2 show pre- and post- operative radiographs of 2 patients.

Analysis was performed with SPSS version 21. We measured quantitative variables by taking mean ± standard deviation and range where appropriate. Qualitative variables were expressed as percentages. Analytical tests including Independent and Paired sample T-tests for numerical variables, and Chi-squared test for categorical variables. P-value of <0.05 was considered as significant.

RESULTS

A total of 15 patients were studied and the mean age of the study population was 40.4 ± 10.3 years. The majority of our patients were males (80%) while the most common fracture site was the right side (73.3%) as shown in Table 1. Most of the patients had no comorbid conditions or history of smoking and in terms of mechanism of injury, road traffic accidents (RTA) accounted for 66.7% of cases followed by history of fall in the remaining patients. The most common fracture type in terms of AO classification was found to be C3.1t (33%) followed by C1.3t (20%).

With respect to radiological outcomes, a significant improvement in radial height and radial inclination was noted postoperatively compared to preoperative measurements (P-values = 0.014 and 0.038 respectively) as shown in Table 2. The mean palmar tilt pre-operatively was noted to be 0.44 ± 17.5° (range = -25.0 to 36.8°). This was improved to 7.11 ± 6.64° (range = -3.6 to 18.9°) after surgery, however, no statistical significance was found (P-value = 0.17).

Table 1: Baseline characteristics of patients

Characteristics	No. of patients (%)
Gender	
Male	12 (80)
Female	3 (20)
Comorbidities	
None	10 (66.7)
One	4 (26.7)
>1	1 (6.7)
Smoking history	
Yes	4 (26.7)
No	11 (73.3)
Fracture site	
Right	11 (73.3)
Left	4 (26.7)
Hand dominance	
Right	12 (80.0)
Left	3 (20.0)
Mechanism of injury	
RTA	10 (66.7)
Fall	5 (33.3)
AO Classification*	
B1.1t	1 (6.7)
B2.1t	1 (6.7)
B2.2u	1 (6.7)
C1.2t	1 (6.7)
C1.3t	3 (20.0)
C3.1t	5 (33.3)
C3.1u	2 (13.3)
C3.2t	1 (6.7)

*t =DRUJ stable , u = DRUJ unstable

Table 2: Comparison between pre- and post-operative radiological outcomes

Outcome Measures	Mean ± standard deviation		P-value
	Pre-operative	Post-operative	
Radial height (mm)	8.83 ± 3.22	12.0 ± 2.48	0.014
Radial Inclination (°)	17.9 ± 3.84	20.9 ± 3.01	0.038
Palmar tilt (°)	0.44 ± 17.5	7.11 ± 6.64	0.17

Fig. 1: (A). Plain radiographs of the right wrist of the patient showing highly comminuted intraarticular fracture of the distal radius. **(B).** Three-dimensional CT showing small sized fragments of volar lunate, sigmoid notch, styloid radius with extensive communition of Dorsal rim and a scaphoid fracture. **(C)** After fixation with a dorsal fragment plates and three Kirschner wires, one to hold the radial styloid fragment, the second to hold the scapholunate joint, and the third to hold thearticular surface to the metaphyseal bone. **(D)** Plain Radiograph of right wrist of of a patient showing complex intra articular with volar and dosrals communition. **(E)** CT 3D reconstruction of distal radius showing the amount of communition in more detail. **(F)** Post Op fixation with both volar and dorsal fixation of individual fragments and restoration of radiological parameters of distal radius

DISCUSSION

Distal radius fractures with intra articular comminution are usually associated with high-velocity injuries or weak osteoporotic bone and poses a great challenge for orthopaedic surgeons. In such cases, the prognosis is usually dependent on radial shortening and reduction of radio-carpal and radio-ulnar articular surfaces post-operatively[11]. More recently, fragment specific fixation is being more commonly used to treat comminuted distal radius fractures as multiple comminuted fracture patterns cannot be adequately reduced using a single plate[12]. Fernandez DL and Geissler WB, in 1991, described the importance of fracture-specific fixation using multiple plates to fix the radial styloid, lunate facet fragments, and metaphyseal shaft separately, thus allowing adequate reduction of multiple fracture segments[13].

Following this, various studies have shown the effectiveness of fragment specific fixation in treating intra articular distal radius fractures. Hozack BA and Tosti RJ in their review in 2019 concluded that a fragment-specific approach should be adapted in cases where stabilisation of individual articular segments is needed. Specific implants for the radial styloid, dorsal wall, volar rim, and dorsal-ulnar corner can be used to achieve adequate reduction and satisfactory functional outcomes[4]. Similarly, in another study, Konrath GA and Bahler S also showed that reliable anatomic reduction of unstable distal radius fractures can be achieved with fragment specific fixation, and range of motion can be initiated immediately even following markedly comminuted fractures. They reported acceptable alignment of fracture in 25 out of 27 patients with displaced distal radius fractures[14].

While reporting the results of treating unstable distal radius fractures (AO Type C2) via the fragment specific fixation approach, Babikir EME et al in 2017 showed post-operative improvement in radial height (0.9 ± 0.39cm to 1.2 ± 0.22cm), radial inclination (16.3 ± 5.5° to 19.7 ± 4.2°) and palmar tilt (3.8 ± 5.1° to 7.2 ± 7.3°). All movements at the wrist joint also showed considerable improvement and the average grip strength at the fractured site was noted to improve to about 76% when comparing it to the opposite side. Additionally, no sensory loss or infections was noted till one year postoperatively[4]. Another study conducted in The United States of America reported average dorsiflexion of 61° and palmar flexion of 54° post-operatively after treatment of unstable distal radius fractures with fragment-specific approach. They also reported a mean DASH score of 17 ± 18[14].

The current study also shows satisfactory restoration of normal distal radius radiological parameters after utilising the fragment specific fixation approach. A significant improvement in radial height and radial inclination in the current study proves the effectiveness of this technique.

International studies have been conducted to compare outcomes between fragment specific fixation and volar fixed angle locking plate. A prospective cohort study conducted in 2008 concluded that volar locking plate resulted in better stability of fixation as well as reduced rate of complications compared to fragment-specific fixation. Although the radiological outcomes were superior in the volar locking plate cohort, no significant clinical difference was noted[15]. Later on in 2012, Schneppendahl J et al summarised all available treatment strategies for distal radius fracture and stated that fragment-specific fixation may have a higher complication rate than volar locking plate, but it provides the surgeon with a valuable option for fixation; in cases where no other procedure is possible due to extensive comminution[16]. Lam J and Wolfe SW in 2010 also concluded that volar fixed angle plate is one of the most useful treatment modality for distal radius fractures, however, fragment specific fixation can successfully be used in treating complex fractures, which otherwise cannot be adequately reduced using any single implant[17].

It has been shown that fragment-specific fixation is a technically demanding procedure and requires experience and considerable expertise on part of the surgeon[16]. Therefore, the financial constraints and lack of resources in developing countries might be the reason for decreased popularity of the technique in these regions, further contributing to the lack of literature in this regard. However, the comparable results of this study to international literature show that fragment-specific fixation can be practiced effectively in developing countries as well. The current study may contribute towards increasing the popularity of this approach in the developing world and adding more elaborate literature on this topic with multi-centre prospective studies, which are required to authenticate the findings of this study and setup guidelines for the treatment of complex distal radius fractures. Limitations of the study are the retrospective nature of the study with a small sample size. Also the absence of functional outcomes and comparison to other fixation methods is lacking which will help in deciding the usefulness of the technique in managing distal radius fractures. These limitations will be addressed in upcoming studies being performed at our institute.

CONCLUSION

Fragment-specific fixation is an effective treatment option for complex distal radius fractures with the ability to restore normal radiological parameters after surgery.

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