Original Article

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Quick Response Code:

Website: www.joas.org.in
DOI: 10.4103/joas.joas_6_19

Distal radius fractures with unstable distal radioulnar joint treated by volar plate: A comparative study of immobilization versus early mobilization

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Abstract:

BACKGROUND: Instability of distal radioulnar joint (DRUJ) following distal radius fracture is a treatment enigma with few options and uncertain outcome. Different studies have been conducted in this regard which came out with contradicting results. The aim of this study was to analyze whether immobilization of unstable DRUJ with above-elbow cast for 6 weeks has any advantages versus immobilization for 3 weeks similarly after anatomical fixation with volar plates.

MATERIALS AND METHOD: We conducted a prospective study on patients with unstable distal radius fractures treated by open reduction with volar buttress plate from 2013 to 2016. Patients were grouped into Groups 1 and 2 depending on the postoperative immobilization protocol (each group with 21 patients). Group 1 patients were immobilized with above-elbow cast for 3 weeks and Group 2 patients for 6 weeks. Results were compared using wrist range of movements, patient-oriented Patient-Rated Wrist Evaluation (PRWE) and physician-based Sarmiento modified Gartland–Werley (GW) demerit scoring. All patients were evaluated for the persistence of DRUJ instability.

RESULTS: Demographic data were comparable between the groups. AO type C fracture (67%) was common in both groups. The range of movements was comparable in both groups ($P > 0.11$). There was no statistically significant difference found in GW and PRWE scoring ($P > 0.05$). There were two patients with unstable DRUJ with decreased radial height and positive ulnar variance who needed further treatment.

CONCLUSION: Prolonged immobilization (6 weeks) contributed no extra benefit when DRUJ is well reduced with anatomical fracture fixation. The instability recovered with healing of ligamentous injuries and fractures after stabilization of unstable bony fragments with surgical fixation of distal radius fracture.

Keywords:

Distal radioulnar joint, mobilization, unstable distal radius fracture, volar plating

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Received: 25 January 2019
Revised: 09 February 2019
Accepted: 15 June 2019
Published: 13 December 2019

Introduction

Distal radioulnar joint (DRUJ) injury is commonly associated with distal and distal third radial fractures.[1,2] Its association with fracture of the ulnar styloid process and Essex–Lopresti injury is well documented. Acute and chronic injuries of this joint are well described by Palmer. Bony and ligamentous counterparts of DRUJ control supination and pronation movements.[3] The ulnar head moves over the sigmoid notch, the undersurfaces of fibrocartilaginous disc, a component of triangular fibrocartilage complex (TFCC). Triangular fibrocartilage, volar and dorsal radioulnar ligaments, and sheath of the flexor carpi ulnaris constitute the intrinsic stabilizers of the joint. Majority

How to cite this article: Kuloor SB, Shareef AJ. Distal radius fractures with unstable distal radioulnar joint treated by volar plate: A comparative study of immobilization versus early mobilization. J Orthop Spine 2019;7:46-50.

of the stability is contributed by TFCC.[4] Intra and extra-articular distal radius fractures contribute toward this injury. It is reported by May *et al*. that 10%–19% of patients with distal radius fractures suffer from DRUJ problems.[5] There are various risk factors associated with distal radius fractures which arouse the suspicion of DRUJ injury among surgeons. Displaced ulnar styloid base fracture, fractures involving the sigmoid notch of the radius, and increased gap of DRUJ give a hint of TFCC injury.[6] Distal radius fractures are treated by various types of fixation such as open reduction and internal fixation with volar locking plates, closed reduction and k-wire fixation, external fixators, and dorsal bridge plating. DRUJ dislocations are usually treated by closed or open reduction and cast immobilization or temporary k-wire immobilization. Open surgical procedures are required for complex acute dislocations. Arthroscopic repairs are also practiced with good results.[7] Considering the large volume of distal radius fractures with DRUJ injuries, it may not be practical to do primary repair in each case. It is interesting to know the incidence of DRUJ associated with distal radius fractures and the residual instability after anatomical fixation with volar plating technique. Different studies have been conducted with this regard which came out with contradicting results. The aim of this study was to analyze whether immobilization of unstable DRUJ with above-elbow cast for 6 weeks has any advantages versus immobilization for 3 weeks similarly after anatomical fixation with volar plates.

Materials and Methods

We conducted a prospective study on patients with unstable distal radius fractures treated in our tertiary medical center by open reduction with volar buttress plate from 2013 to 2016. Ethical committee's approval was obtained from the institution before starting the study. Patients with unstable distal radius fractures surgically treated with volar buttress plate with unstable DRUJ joint between the age group of 18 and 75 years were included in the study. We excluded cases with other fractures around the wrist joint, Essex–Lopresti injuries, fractures more than 3 weeks old, severe head injury where clinical assessment is difficult, and with previous wrist injuries. Patients treated with other modes of treatment such as k wires, external fixators, and dorsal bridge plate were also not included in this study.

We enrolled 361 patients who satisfied inclusion criteria over a period of 4 years. X-ray features such as ulnar styloid process fracture, magnitude of fracture, radial translation in posteroanterior (PA) view, and sagittal translation in lateral view hinted about instability.[6] The criteria for surgical fixation were radial shortening more than 3 mm, dorsal tilt above 10°, and intra-articular step of 2 mm.[8] All cases were reviewed for possible DRUJ disruption with hints obtained from the radiological survey of the cases. We treated 46 patients with DRUJ instability with volar plating. One patient expired due to road traffic accident and another three lost to follow-up. We have included cases with a minimum follow-up of 1 year.

Volar plating was done using Henry's approach with 3.5-mm plates. Anatomical reduction was achieved. All cases were reinspected during surgery after fixation of radius by anteroposterior movements of the ulna over DRUJ. Excessive movements with no solid endpoints were considered as instability of the radioulnar joint. It was categorized as no instability, moderate instability (increased translation with a firm end), or severe instability (increased translation without a firm end). In case of any doubt, it was checked under c arm and compared with opposite side.

We categorized the patients into two groups on surgeon's preference. Group 1 was immobilized with above-elbow cast for 6 weeks. Group 2 patients were treated with above-elbow cast for 3 weeks. Patients were followed up regularly at 2, 4, and 6 weeks. Mobilization was started by 6 weeks in Group 1 after removal of the above-elbow cast. X-rays were taken at every follow-up visit to analyze fracture union. Plaster was removed by 3 weeks in Group 2. Rehabilitation was started immediately with active mobilization of the wrist and finger joints. Physiotherapy was done to improve the range of joint movements. Patients were followed up every 3 weeks until 3 months and then by 6 and 12 months. X-rays were taken in each visit to assess fracture union. Radial inclination, radial height, and ulnar variance were noted. DRUJ integrity was checked clinically in both groups by doing piano key test. We measured supination, pronation, flexion, and extension of the wrist and elbow joints. We decided to use both physician-based Sarmiento modified Gartland–Werley (GW)[9] and patient-oriented Patient-Rated Wrist Evaluation (PRWE)[10] scoring systems. The GW combines subjective and objective factors rated by the evaluator. The evaluator rates pain, deformity, and stiffness with scoring between 0 and 6. Objective evaluations such as grip strength, range of motion, and radioulnar joint pain accounted for 17 points. Complications such as arthritis and nerve dysfunction accounted for 23 points. The total score was 52, with excellent range between 0 and 2, good between 3 and 8, and fair between 9 and 29. The PRWE consists of two parts of pain and function (usual and specific). There are five items in pain domain and ten in function. The response to each part is scored between 0 and 10. The pain score is the sum of five items. The total score of PRWE ranges from 0 to 100.

Statistical analysis

Data were entered into Microsoft Excel (Windows 7; Version 2007), and analyses were done using the Statistical Package for Social Sciences (SPSS) for Windows software (version 18.0; SPSS Inc., Chicago, IL, USA). The level of significance was set at 0.05. Analysis and comparison of wrist movements and GW scoring were done using Mann–Whitney U-test. Independent *t*-test was used for comparing means of PRWE scores and radiological assessment values. Analysis of significance of difference between qualitative data was done using Pearson's Chi-square test.

Results

Demographic characteristics were compared between the two groups [Table 1]. The minimum age was 18 years, and maximum was 74 years. Few elderly patients refused surgical management. Majority of the patients were of type C (AO) fracture. We had 11 cases of A3 fractures. Road traffic accident and fall from height were the two major causes of injury in both groups. We found majority of patients between 40 and 50 years' age group, which is comparable in both groups.

Range of wrist movements was analyzed and recorded. Both group of patients had reasonably good range of movements as shown in Table 2. *P* value revealed no significant difference between these groups.

The modified GW demerit scoring showed excellent results in 12 and 13 patients in Groups 1 and 2, respectively ($P = 0.94$). One patient from each group showed fair result due to persisting DRUJ instability. There was positive ulnar variance with decreased radial height. The different scoring of various entities in the GW scoring is shown in Table 3. *P* values revealed no significant difference between the two groups.

The PRWE scores of two groups are summarized in Table 4. There was some better results in mobilized groups but statistically not significant as depicted by *P* values in the chart. The radiographic analysis of the two groups is summarized in Table 5. The two groups were comparable as all the three parameters exhibited $P > 0.05$.

Table 1: Demographic data

Variables	Group 1	Group 2	*P*
Age	45	46	0.72
Male:female	14:7	13:8	0.065
Fracture types			
Closed:open	19:2	14:7	0.06
Fracture classification			
A3	6	5	0.788
B2	1	0	
B3	1	1	
C1	5	3	
C2	5	7	
C3	3	5	
Side of fracture			
Right:left	10:11	10:11	1.000

Table 2: Wrist movement in two groups

Movements	Cases	*n*	Mean rank	Sum of ranks	*P*
Dorsiflexion	Immobilized	21	22.38	470.00	0.638
	Mobilized	21	20.62	433.00	
	Total	42			
Palmar flexion	Immobilized	21	21.07	442.50	0.819
	Mobilized	21	21.93	460.50	
	Total	42			
Ulnar deviation	Immobilized	21	20.79	436.50	0.69
	Mobilized	21	22.21	466.50	
	Total	42			
Radial deviation	Immobilized	21	18.81	395.00	0.116
	Mobilized	21	24.19	508.00	
	Total	42			
Supination	Immobilized	21	19.36	406.50	0.247
	Mobilized	21	23.64	496.50	
	Total	42			
Pronation	Immobilized	21	20.88	438.50	0.739
	Mobilized	21	22.12	464.50	
	Total	42			

Table 3: Gartland–Werley group statistics

0bservations	Cases	*n*	Mean	SD	SEM	*P*
Residual	1	21	0.52	0.750	0.164	0.86
	2	21	0.57	1.076	0.235	
Subjective	1	21	1.14	1.014	0.221	0.34
	2	21	1.43	0.926	0.202	
Objective	1	21	1.10	0.625	0.136	0.57
	2	21	0.95	0.973	0.212	
Complications	1	21	1.24	1.136	0.248	0.23
	2	21	0.86	0.910	0.199	
Points	1	21	4.00	2.510	0.548	0.77
	2	21	3.76	2.773	0.605	

SD=Standard deviation, SEM=Standard error of mean

Discussion

We studied 42 patients with unstable DRUJ-associated distal radius fractures managed with volar plating technique. We divided these patients into two groups where one group was immobilized for 6 weeks, whereas the other was for 3 weeks. Above-elbow cast was used in both groups. These patients were regularly followed up and assessed for stability of DRUJ, range of movements, and radiological parameters such as radial height, radial tilt, and ulnar variance. Sarmiento's modified GW demerit scoring and PRWE were used for grading outcomes.

A prospective study of distal radius fracture treated with volar plates by Fujitani *et al*. showed that normal DRUJ gap in PA view was the most important predictor of

Table 4: Patient-rated wrist evaluation group statistics

Observations	Cases	*n*	Mean	SD	SEM	*P*
Pain	Immobilized	21	1.33	0.577	0.126	0.05
	Mobilized	21	1.67	0.483	0.105	
Specific activity	Immobilized	21	3.10	0.700	0.153	0.64
	Mobilized	21	3.00	0.632	0.138	
Usual activity	Immobilized	21	1.33	0.730	0.159	0.47
	Mobilized	21	1.52	0.981	0.214	
Score	Immobilized	21	6.14	1.526	0.333	0.84
	Mobilized	21	6.24	1.609	0.351	

SD: Standard deviation, SEM: Standard error of mean

Table 5: Radiological evaluation

Parameters	Cases	*n*	Mean	SD	SEM	*P*
Radial height	Immobilized	21	8.78	0.454	0.099	0.07
	Mobilized	21	8.47	0.615	0.135	
Radial tilt	Immobilized	21	19.00	1.22	0.267	0.90
	Mobilized	21	18.95	1.39	0.305	
Ulnar variance	Immobilized	21	0.438	0.269	0.05	0.09
	Mobilized	21	0.581	0.271	0.059	

SD=Standard deviation, SEM=Standard error of mean

instability in an unstable fracture.[11] Open wound and ulnar variance of 6 mm in radiograph also predicted DRUJ injuries.[12] We studied the instability of DRUJ following surgical fixation with volar plates. Follow-up examination found that well-reduced unstable distal radius fractures had stable DRUJ. The piano key test was negative in the majority of patients following surgical treatment. We found that moderate instability was persisting in eight of Group 1 and seven of Group 2 patients immediately after surgical fixation. At the end of 1-year follow-up, it was persisting in only three patients. Two of these patients were having positive ulnar variance and reduced radial height in the postoperative period (one from each group). The third patient is not having malunion but pure ligamentous injuries (Group 1). Our findings are similar to the above study and in addition, we could show that above-elbow immobilization for 6 weeks did not provide extra benefits in these anatomically fixed patients.

Distal radius fracture is very common, and computed tomography (CT) scanning may not be practical in all patients. The CT scan reports did not correlate well with stress test results, and the scan reports were influenced by residual deformities.[13] we assessed fractures and DRUJ instability by radiographic and clinical methods.

In the present study, intra-articular and extra-articular malunions following distal radius fractures were associated with DRUJ dysfunction. Wrist functions improved following corrective osteotomy and surgical fixation with volar plates.[14] Khan *et al*. in their study revealed that primary volar plating for unstable distal radius fracture provides a stable construct and prevents malunion.[15] Early surgical fixations helped us to achieve good anatomical parameters except in two cases. Patients with loss of radial length with negative ulnar variance had persisting DRUJ dysfunction and need further salvage procedure.

Ulnar styloid process fracture is an important counterpart of DRUJ injury. Fractures at the ulnar styloid base were found to be significantly associated with DRUJ instability.[16] We had 10 and 12 patients with ulnar styloid process in Groups 1 and 2, respectively. Two patients had fracture of the ulnar styloid base which was fixed with a K-wire. These patients did not show DRUJ instability following fracture fixation.

Liu *et al*. in their retrospective study compared the results of volar plating of distal radius fracture with unstable DRUJ. They found that anatomical fixation of the fracture with volar plate exhibited comparable results irrespective of DRUJ fixation with K-wire.[17] We did not fix the DRUJ with K-wires in control group as done in this study but immobilized for 6 weeks in the above-elbow cast. These patients showed excellent results in both groups, and <5% needed further addressal of DRUJ instability.

A clinical study revealed that 30% of cases with DRUJ instability were intra-articular.[12] An arthroscopic study of soft-tissue injuries associated with distal radius fracture showed that TFCC was torn in 35% intra-articular and 53% extra-articular fractures.[18] In the present study, 25% of the cases with DRUJ instability were extra-articular. This disparity between arthroscopic and clinical studies proves that both TFCC and osseous stability are equally important for the integrity of DRUJ.

A study by Lee *et al*. reported similar results in both surgical and conservative treatment methods for DRUJ instability after fixation of distal radius fracture. DRUJ transfixation, arthroscopic triangular fibrocartilage repair, and immobilization by supination sugar tong splinting yielded comparable results.[19] The average splint application duration was 6.6 weeks. A study by Fok *et al*. evaluated the status of triangular fibrocartilage by arthroscopic examination after union of distal radius fracture. It was found that many TFCC tears remained unhealed even when patients were asymptomatic.[20]

Distal radius fracture being a common injury treated both in secondary and tertiary hospitals in India, the primary reconstruction of DRUJ may not be practical in our scenario. This study has got much relevance as it showed that no extra concern was required for unstable DRUJ in majority of patients. Probably, there is healing of ligamentous injuries with stabilization of unstable bony fragments, but DRUJ instability with significant ligamentous or osseous damage may still require further

treatment of the problem. This study has an average follow-up of 22 months with a small sample size. A multicentric study with longer follow-up is required for further substantiating the findings.

Conclusion

Prolonged immobilization (6 weeks) contributed no extra benefit when DRUJ is well reduced with anatomical fracture fixation. The instability recovered with healing of ligamentous injuries and fractures after stabilization of unstable bony fragments with surgical fixation of distal radius fracture.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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