

## Grading of unstable distal radius fractures and its evaluation using JESS fixation

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### Abstract

**Introduction:** Unstable distal end radius fractures are a common entity with various treatment options. The degree of instability varies with each fracture and it has a bearing on the treatment outcome. We are trying to grade the instability and its use in predicting treatment outcome.

**Materials and Method:** 48 adult patients with unstable distal radius fractures were classified into three grades according to our instability grading. All were treated with Joshi's external stabilizing system and their anatomical and functional results were analyzed at one year.

**Result:** 91% had excellent or good functional results and there were statistically significant differences in functional outcome among the three grades.

**Conclusion:** The proposed grading system is simple and will help to predict functional out come and duration of JESS fixation in unstable distal radius fractures.

**Keywords:** Unstable distal radius fracture, JESS fixation

### Introduction

Fractures of distal end radius are one of the commonest musculoskeletal injuries encountered in orthopedic practice and are often subjected to conservative treatment because of the false notion that even malunion will give a satisfactory function. With increasing number of people involved in aggressive recreational activities and high velocity accidents, increasingly complex fractures are seen in young adults. Studies have shown that the results are not as good as it was once thought to be with conservative treatment.<sup>(1,2,3)</sup>

Unstable fractures of distal radius are well documented and are among the most difficult fractures to treat. Treatment options vary from simple plaster casting to external fixators to various open techniques. External fixation of an unstable fracture of the distal end of the radius provides a simple way to maintain axial alignment through ligamentotaxis and to neutralize external forces during healing. There is no definite consensus on the duration of external fixation in the literature. Late collapse of the distal radius is also well documented following treatment of unstable distal radius fractures. This shows that there are a group of unstable fractures that needs prolonged treatment. The duration of treatment in such cases can be reduced to some extent by using autologous bone grafting that stimulates healing and adds mechanical support.

In this study, we are trying to grade unstable distal radius fractures and to propose definite treatment duration of external fixator for each grade. This grading system is useful in pre-operative assessment, planning and postoperative evaluation.

### Materials and Method

This study was conducted in the Department of Orthopedics, PK DAS Institute of medical sciences, Vaniamkulam during a period between January 2014 and August 2015. Ethical committee approval was obtained for the study. 48 adult patients with unstable distal radius fractures who were treated with ligamentotaxis and completed a minimum of one year follow up were included in the study. Stable fractures, severely osteoporotic fractures, open fractures and fractures with infection were excluded.

Out of the 48 patients, 6 (12.5%) were females and 42 (87.5%) were males. Fracture was on the right side in 30(62.5%) patients and left in 18(37.5%) cases. Their ages ranged from 24 to 44 years (average 35.4 years). Mechanism of injury was road traffic accident in 24(50%) and falls from height on an outstretched hand in 24 patients.

Criteria for unstable fracture on the initial radiograph included dorsal angulation of more than 20 degrees; fractures extending to the wrist joint; radial shortening of more than 5 mm; and severe dorsal comminution at the fracture site.<sup>(4,5,6)</sup> It is generally agreed that although reduction of these fractures may be easy to achieve, it is extremely difficult to maintain. The metaphyseal void was measured after initial closed reduction and noted. This is important as the metaphyseal defect which persists after reduction can lead to malunion.<sup>(4,7)</sup> Dorsal angulation was measured using the same technique as Van der Linden and Ericson<sup>(8)</sup> and expressed as the number of degrees from the neutral position.

Instability of all the patients were scored according to our scoring system based on the pre and post reduction radiographs (Table 1). Based on the score, the fractures were graded into three groups (Table 2).

**Table 1: Scoring of radiological findings**

Sl. No.	Radiological Findings	Score		
		0	1	2
1	Dorsal comminution	30 – 50 %	50 – 75 %	> 75%
2	Dorsal angulation	Up to 20 <sup>0</sup>	20 -30 <sup>0</sup>	> 30 <sup>0</sup>
3	Radial shortening	<5 mm	5 -10 mm	> 10 mm
4	Intra-articular extension	Undisplaced/ upto 1mm step	2 -3 mm step	> 3 mm step
5	Metaphyseal void	Upto 5 mm	5-10 mm	> 10 mm

**Table 2: Instability Grading**

Grade	Score
Grade 1	Up to 2
Grade 2	3 -4
Grade 3	More than 4

**Surgical Procedure:** All procedures were done under regional /general anesthesia with image intensifier guidance and with prophylactic antibiotics. Two Schanz pins (3.5mm in diameter) were placed in the radius shaft and two Schanz pins(2.5mm) were placed in the second metacarpal. Fracture was reduced with traction and manipulation under image. Then pins were connected with a JESS (Joshi’s external stabilizing system) distractor. Cancellous bone grafting was done if the metaphyseal void was more than 10mm.

Post operative radiograph was taken and mobilization of the fingers started immediately. Daily pin-track care using antiseptic solution is taught to the patient. Once the x-ray showed features of union and no local tenderness at fracture site, the fixator was removed. If the duration of immobilization was more than 6 weeks the fixator is changed to radio-radial non-bridging type, by introducing pin in the distal radius fragment & removing metacarpal pins. After this, the patients were allowed moderate use of the hand. Protective splinting was given for two weeks after removal of fixator. Patients were advised to use their hand for daily activities but to refrain from heavy work for further six weeks. Radiographs were also taken at three, six and 12 months.

At end of one year anatomical and functional results were assessed. For assessment of the anatomical result we used Sarmiento and Latta's modification of Lidström grading.<sup>(9)</sup> For assessment of the functional result we used Lucas modification Sarmiento demerit point system,<sup>(9,10,11)</sup> which is again a modification of the system outlined by Gartland and Werley in 1951.<sup>(10)</sup>

Grip strength was assessed using blood pressure apparatus, asking the patient to press on the inflated cuff and comparing it with the opposite side. Wrist movements were measured using goniometer.

Collected data was analyzed with the software SPSS. To find out the significance level Pearson Chi-Square test and ANOVA were used where ever necessary. The level of significance was put at p< 0.05.

**Observations**

48 patients were followed up for one year. The incidence of each grade is given in Table 3.

**Table 3: Grading of the fractures in patients**

	No of patients	Percentage
Grade 1	8	16.7%
Grade 2	15	31.3%
Grade 3	25	52.1%
Total	48	100%

There was no significant statistical difference of age or sex between the groups (p value 0.113 & 0.282 respectively).

**Radial shortening:** Average shortening in the series was 2.4 mm. 52.1% had less than 3mm of shortening. There was no much difference in shortening among the three grades.

**Volar tilt:** Volar tilt was the most difficult to restore with ligamentotaxis. Only one patient in grade 3 could regain more than 5<sup>0</sup> of volar tilt. In 30 (62.5%) patients mild dorsal tilt persisted.

**Radial tilt:** Radial tilt was near normal in 64.6% of total patients. Three patients had loss of Radial tilt more than 10<sup>0</sup>, of which two were in grade 3.

**Anatomical End Results**

**Table 4: Anatomical end result**

	Grade 1	Grade 2	Grade 3	Total
No deformity	4 (50%)	7 (46.7%)	7 (28.0%)	18 (37.5%)
Mild deformity	4 (50%)	7 (46.7%)	14 (56.0%)	25 (52.1)
Moderate deformity	0	1 (6.7%)	4 (16.0%)	5 (10.4%)
Severe deformity	0	0	0	0
Total	8	15	25	48 (100%)

43 (89.6%) patients had no or mild deformity. There was no case of severe deformity. 50% in grade 1 had no deformity whereas only 28% in grade 3 could attain this result. Out of 5 patients with moderate

deformity 4 were having grade 3 instability. So, the anatomical end result was poorer as grade of instability increases. But there was no statistical significance as per Pearson Chi-Square test (p value 0.522 at 95% C.I with degrees of freedom 4).

**Wrist movements at one year follow up:** There was some limitation of forearm rotation in the early phase, before removal of the fixator, but effective rotation was regained in over 95% of patients at the end of the study. Palmar flexion was more limited probably because of the persistent dorsal tilt of articular surface.

**Functional outcome**

**Table 5: Functional end result**

Functional result	Grade 1	Grade 2	Grade 3	Total
Excellent	7 (87.5%)	11 (73.3%)	6 (24.0%)	24 (50.0%)
Good	1 (12.5%)	4 (26.7%)	1 (60.0%)	20 (41.7%)
Fair	0	0	4 (16.0%)	4 (8.3%)
Poor	0	0	0	0
Total	8	15	25	48 (100%)

Despite the severity of the injuries, 44 (91.7%) had excellent or good functional results and 4 (8.3%) had fair results. There was no case of poor functional result. Thus, ligamentotaxis with bone grafting appears to be a good treatment option for unstable distal radius fractures. All cases with fair results belonged to grade 3 instability. There were only 24% excellent results in grade3 whereas 50% of grade 1 fractures attained excellent functional results. These differences were found to be statistically significant as per Pearson Chi-Square test with a p value of 0.004 (p <0.05). Thus our grading system was useful in predicting the functional outcome of unstable distal radius fractures. We found no correlation between fracture grade and radiological appearance at follow-up and this suggests that cartilage contusion and associated soft-tissue damage play a significant role in the ultimate result. Grip strength was excellent and comparable to the normal side in all patients.

We found no statistical correlation between the final anatomical and functional outcome.

**Duration of treatment:** Mean time of fixator removal was 5 weeks for grade one, 6.47 weeks for grade 2 and 10.8 weeks for grade 3. This result was statistically tested with ANOVA and found to be significant. It was again tested using Chi –Square test by taking intervals and again found to be statistically significant (p= 0.00).

**Table 6: Treatment duration in each grade**

	Mean time of treatment in weeks	Std. Deviation	Mean +/- 2 Std. deviation
Grade 1	5.00	0.76	4.24 – 5.76
Grade 2	6.47	0.74	5.73 – 7.21
Grade 3	10.80	0.96	9.84 – 11.76

**Complications:** Superficial pin track sepsis occurred in six patients (12.5%), but resolved with antibiotics. There was no case of pin loosening or deep bone infection. Three patients had symptoms relating to superficial sensory branch of the radial nerve. All recovered fully and spontaneously. One patient developed reflex sympathetic dystrophy and required lengthy physiotherapy but recovered completely.





## Discussion

Treatment of displaced fractures of the distal end of the radius has changed over the course of time. In our study we are trying to grade the instability of unstable fractures and evaluate the use of JESS distractor and bone grafting in their treatment.

Jakim et al<sup>(12)</sup> had tried to classify comminuted distal radius fractures in a study published in 1991, but they based their classification only on displacement. Other features of instability were not taken into account.

48 patients treated with ligamentotaxis using JESS distractor were followed up for one year. 87.5% patients were males in our study. Male preponderance was noticed in other published studies also.<sup>(13,14)</sup> The dominant limb was affected in 62.5% similar to Jakim et al's study (1991).<sup>(12)</sup>

Volar tilt was the most difficult to restore with ligamentotaxis in our study. In 30 (62.5%) patients' mild dorsal tilt remained. Only one patient (4%) in grade 3 could regain more than 5° of volar tilt whereas 50% in grade 1 could attain this. This is consistent with Bartosh and Saldana's<sup>(15)</sup> finding that when closed reduction is performed the palmar ligaments are brought out to length and pull on the distal fragment before the thinner dorsal ligaments exert any traction, thus limiting the ability of any technique of closed reduction to restore palmar tilt. Volar tilt remained unsatisfactory in Jakim et al<sup>(12)</sup> and McQueen et al<sup>(16)</sup> study. In grade 3 fractures, which are high energy injuries, associated soft tissue injury also may adversely affect ligamentotaxis.

Average shortening in the series was 2.4 mm. Only one patient had a shortening more than 6mm and it was a grade 3 patient. 52.1% had less than 3mm of shortening. There was no much difference in shortening among the three grades. Shortening of greater than 5 mm is not acceptable.<sup>(17)</sup>

Satisfactory radial tilt was also attained in 93.8% patients. Only 3 patients in grade 3 group had a loss of radial tilt more than 10°.

Our anatomical end results were also comparable to other published data. A review of the literature suggested that external fixation resulted in good

functional end results in 80% to 97% of patients.<sup>(6,18)</sup> In our study also 89.6% patients had no or mild deformity. There was no case of severe deformity. Among the 5 (10.4%) patients with moderate deformity 4 were in grade 3 and one in grade 2. But statistically there was no significant difference in anatomical results among the various grades (p value 0.522). This may suggest that cartilage contusion and associated soft-tissue damage play a significant role in the ultimate result. Good anatomical results at end of one year also suggest that early bone grafting could reduce the late collapse at the fracture site.

Functional results were excellent or good in 44 (91.7%) patients. No patient had a poor functional outcome. 87.5% grade 1 and 73.3% grade 2 had excellent results whereas only 24% grade 3 patients had excellent results. 16% of grade 3 had only fair results. There was statistically significant difference in functional outcome among the 3 groups. This indicate that functional outcome depends on the severity of injury and higher the grade of instability lesser the chance of attaining good functional results.

There was no statistical correlation between anatomical and functional results (p value < 0.05). Roumen et al<sup>(19)</sup> also found no correlation between final anatomical and functional outcome, and concluded that the severity of the original soft-tissue injury and its complications are the major determinants of functional end result.

There was significant difference in the duration of treatment among the three grades. Mean time of fixator removal was 5 weeks for grade one, 6.47 weeks for grade 2 and 10.8 weeks for grade 3. Thus our grading system was also helpful in predicting the treatment duration for an unstable distal radius fracture. There is no consensus on treatment duration in literature. The recommended period of immobilization has varied from author to author, Jenkins et al.<sup>(6)</sup> - four weeks, Howard et al<sup>(18)</sup> - five to six weeks, Cooney et al.<sup>(4)</sup> - eight to ten weeks, Vaughan et al<sup>(5)</sup> eight weeks and Gupta et al<sup>(14)</sup> five to eleven.

There was no major complication in our study. There was no case of carpal tunnel syndrome in our series though it is reported in literature.<sup>(16)</sup> 12.5% developed mild pin tract infection which resolved with antibiotics. Incidence of superficial pin track sepsis in literature varies from 5.2% to 23%.<sup>(6,16,18,19)</sup> Only one case of Reflex sympathetic dystrophy was noted which improved with exercise.

Thus external fixation with bone grafting is a good technique for unstable distal radius fractures. A number of studies have shown favorable results after external fixation of distal radius fractures.<sup>(4,5,6,18,19)</sup>

## Conclusion

Unstable distal radius fractures are a challenge to the orthopaedic surgeons. Its high incidence in the active young age group further increases the demand on

the surgeon. External fixation with autologous cancellous bone graft is a well accepted mode of treatment for these kinds of fractures. Ligamentotaxis using the JESS distractor is a very effective and cheap treatment which avoids costly external fixators. Wrist mobilization is also possible once it is converted to non-bridging radio-radial construct. Early bone grafting of the metaphyseal void enhances healing and late metaphyseal collapse.

But all unstable distal radius fractures are not equally unstable. The degree of instability varies from fracture to fracture. More unstable fractures require more prolonged treatment to avoid late collapse. This may be one reason why some unstable fractures present with late collapse even after 8 weeks of external fixation. Early bone grafting of the metaphyseal void also prevents collapse of the articular surface. The grading of unstable distal radius fractures which we have suggested is simple, practical and comprehensive. This will help us to identify highly unstable fractures and decide treatment duration and predict functional outcome.

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