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Dr. Jaspreet Singh
Medical Officer, Orthopaedics, Civil Hospital, Rajpura, Punjab, India

Dr. Harpal Singh
Professor, Department of Orthopaedics Dayanand Medical College & Hospital Ludhiana, Punjab, India

Dr. Parveen Kumar
Department of Orthopaedics Dayanand Medical College & Hospital Ludhiana, Punjab, India

Dr. Gurleen Kaur
Associate Professor, Department of Pharmacology Adesh Medical College & Hospital Shahabad M, Haryana, India

Correspondence
Dr. Gurleen Kaur
Associate Professor, Department of Pharmacology Adesh Medical College & Hospital Shahabad M, Haryana, India

Study of the outcome in fractures of the distal radius managed with external fixator

Dr. Jaspreet Singh, Dr. Harpal Singh, Dr. Parveen Kumar and Dr. Gurleen Kaur

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Abstract
The ideal method of fixation of distal radius fractures is still unclear with many new and old techniques having varying degree of success. This study assesses the outcome of use of external fixators in distal radius fractures. The study was done to study the various parameters in fractures of the distal radius managed with external fixator like time to bony union, functional outcome, complications, failures and secondary procedures required. The present prospective study included twenty-three patients of comminuted fracture of distal end radius admitted to the Department of Orthopaedics at Dayanand Medical College and Hospital, Ludhiana who were managed with external fixator. Out of 23 cases, 3 were lost to follow-up. Excellent outcome was seen in 20% patients, good outcome in 45% patients, fair outcome in 30% patients and poor outcome in 5% patients. The fixator adequately hold the reduction for the period needed to consolidate the fracture. Limited open technique of fixator application may be used safely to treat distal radius fractures without serious complications.

Keywords: Distal radius, external fixator, wrist stiffness

Introduction
Distal radius fractures are the commonest fractures occurring in the upper extremity. Distal radius fractures are very common injuries accounting for 16% of all fractures treated in the emergency room. They represent 74.5% of all fractures of forearm [1].
In spite of the high incidence of this fracture pattern, there is no satisfactory treatment for this injury. Treatment options vary from POP cast to surgical methods. Recent advances in evaluation of fracture patterns and results of treatment have demonstrated the need for surgical intervention in fractures demonstrating instability with or without articular incongruity. Goals in the treatment of distal radius fractures remain the same regardless of the method employed i.e. restoration of articular anatomy, elimination of angular/rotational deformity, stabilization of fracture, rapid mobilization. Various modalities of treatment have evolved over the years for these injuries [1].
Initial method of treatment was closed reduction and plaster immobilization. This method was found to be unsatisfactory for unstable fractures with displacement and those having extensive dorsal comminution. Kirschner wires applied by various methods may not hold the fracture fragments effectively. The fixation with plates and screws were not that successive either as implants were too large or could not be used to fix the multiple fragments or could not hold the osteoporotic bone. The external fixator requires prolonged application and has also been linked with a high rate of complication e.g. pin tract infection, loss of reduction, iatrogenic fractures, stiffness of wrist, decreased range of motion, damage to nerves and other soft tissues. Reducing the duration of external fixation could aid in reducing the number of complications.
This study was designed to assess various parameters in fractures of the distal radius managed with external fixator. These included time to bony union, objective and subjective functional outcome, complications of the procedure, secondary procedures performed to achieve bony union, and incidence of failure of this procedure.

Material and Methods

This was a prospective study of fractures of distal radius managed with external fixation. The prospective trial included all patients presenting to the emergency and outpatient department of Dayanand Medical College and Hospital, Ludhiana for the period from September 2006 to June 2008 with fracture of distal radius. The inclusion criteria was distal radius fractures with unstable fracture patterns, comminuted fractures, and open or closed fractures. The exclusion criteria were incomplete fractures, undis placed fractures, patients refusing consent, previous infection, skin lesions interfering with pin placement, and pre-existing psychiatric illness.

The patients admitted were evaluated in the emergency with attention to airway, breathing and circulation of trauma care. Primary survey of the patient was conducted regarding the presence of other associated injuries and complications. Neurological and vascular assessment of the involved extremity was done. Wound lavage, dressing and splintage was done as per initial assessment and injury to the patient. Analgesics, antibiotics and IV fluids were given as per protocol. Blood investigations were done. Patient was taken up for surgery after reviewing the blood investigations and getting PAC done. The fracture was reduced under image intensifier and stabilized with Kirschner wires, then bridging external fixator was applied, using standard protocol of 3.5 mm Schanz pin for radius (2 in number) and 2.5 mm Schanz pin for second metacarpal (2 in number). The fixator construct was completed using clamps and rods to achieve stable construct. In open fractures, debridement and irrigation of the wound was done as per protocol. The soft tissue damage was managed according to the severity of the injury.

Post-operative limb was kept elevated and check X-rays were done to document proper reduction. Active and passive mobilization was encouraged. Outcome of external fixation was evaluated on the basis of functional and radiological demerit point system of Saito. Follow-up was done twice a week, then weekly for 4 weeks. X-rays were done immediately after surgery; 2 weeks post-operative, then at 4 week interval to assess bony union. The pin sites were inspected on 3rd post-operative day, 7th post-operative day and weekly thereafter. Antibiotics were prescribed according to the condition of the pin sites. The fixator was removed once there was evidence of the union. Brace was applied till consolidation of the fracture. The patient was under follow up till bony union of the fracture. The final result was based on functional and radiological outcome.

Results

Out of 23 patients enrolled during the study period, 20 patients completed the study period till the last follow up i.e. 6 months. 1patient expired due to multiple associated injuries and 2 patients did not come for follow-up after fixator application.

The age of patients varied between 21 to 82 years with the mean age of 43.25 ± 14.64 years. The maximum numbers of patients were in the age group of 31-40 and 41-50 with both groups having approximately 30% of patients each. 5 cases (21%) were open fractures while the rest were closed fractures. The injuries were sustained in Road traffic accidents (69.5%), fall (26.1%) and machine injury (4.4%).

Since all these injuries were high velocity injuries, a greater number of them were expected to be of a higher Frykman-type as seen from the data in Table 1, which shows 52.17% patients belonged to grade 8.

Table 1: Distribution of patients according to Grade of Fracture

Grade of fracture	Number	%age
3	2	8.7
4	4	17.39
6	1	4.35
7	4	17.39
8	12	52.17
Total	23	
Mean ± SD	6.65 ± 1.90	

The radiological score was evaluated after measuring the dorsal angle (0-22°), loss of radial length (11-22 mm), and loss of radial angle (16-28°). The trend in radiological assessment of the cases is summarized in fig 1.

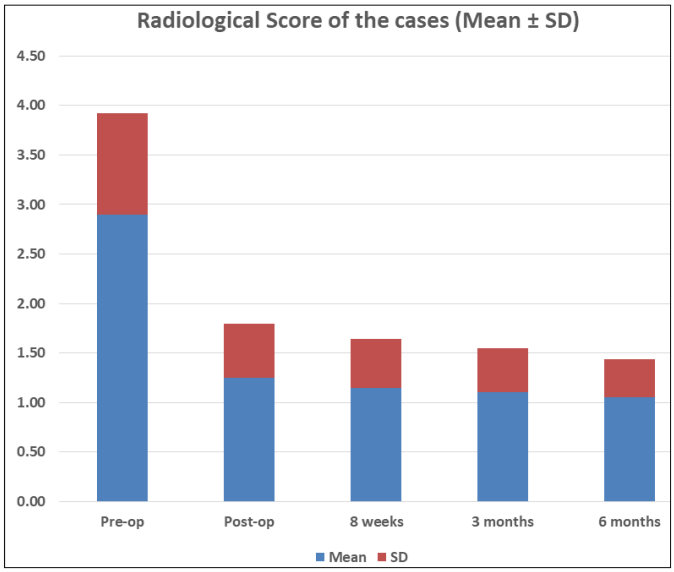

Fig 1: Trends in Radiological assessment (p-value=0.00066, C.D.=0.49)

Preoperatively, 11 patients had dorsal angle in between 11-14°and 9 patients had more than 15° of dorsal angle. At 8 weeks, none of the patients had dorsal angle more than 15° and 15 patients had dorsal angle of 1-10°, 4 patients had dorsal angle of 11-14° while 1 patient had dorsal angle of zero degree.

Eleven patients had loss of radial length in between 7-11 mm and nine patients had more than 12mm loss of radial length. Maximum patients had loss of radial length between 3-6 mm at 8 weeks. About the loss of radial angle, 11 patients had loss in between 10-14° and nine patients had loss of more than 15°. The loss of radial angle also improved, maximum patients had loss of radial angle in between 5-9° at eight weeks.

The radiological score immediately at post reduction and at eight weeks remained the same. After removal of fixator at eight weeks, the radiological score did not worsen as recorded at 3rd and 6th month. Hence, 8 weeks can be said to adequate time for restoration of strength of the metaphyseal bone to prevent collapse. So, the fixator can be safely removed at eight weeks.

Radiological score after removal of fixator has gradually improved with time from 3 months to 6 months. This could be due to continuous remodelling of bone with time.

The subjective assessment was done by asking simple questions to patients like pain at fracture site, overall movements at fingers and wrist, restriction of daily activities.

The subjective functional assessment scores improved with time from 8 weeks to 6 months because of physiotherapy which was started after fixator removal. The objective assessment was done by measuring dorsiflexion, palmer flexion, pronation and supination at the wrist joint, as summarized in Table 2. Preoperatively, all the objective parameters were poor. Range of motion improved from the time of fixator removal at 8 weeks and progressed gradually till 6 months.

Table 2: Distribution of cases according to Objective Evaluation

	Dorsiflexion		Palmer Flexion		Pronation		Supination	
	<45°	>45°	<30°	>30°	<50°	>50°	<50°	>50°
Pre-op	20	-	20	-	20	-	20	-
8 weeks	20	-	20	-	20	-	20	-
3 months	4	16	8	12	8	12	8	12
6 months	3	17	4	16	2	18	2	18

Outcome in fractures of distal radius managed with external fixation were evaluated on basis of functional and radiological demerit point system of Saito at 8 weeks, 3 month and 6 month-follow-up. The present study showed that 20% patients had excellent outcome, 45% had good outcome and 30% had fair outcome, as explained in Fig 2. Only 5% had poor outcome at six months follow-up.

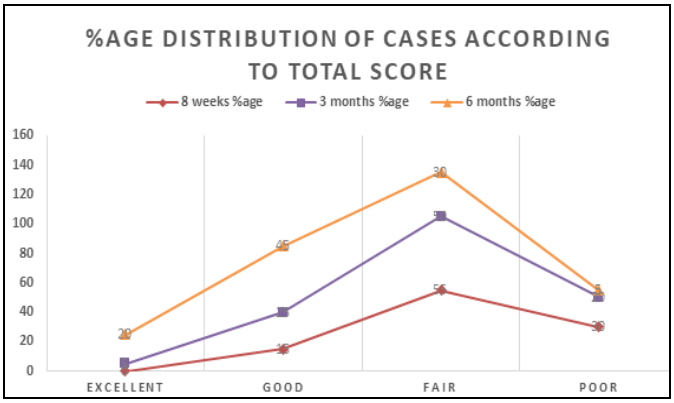

Fig 2: Percentage distribution of subjects according to total score

The complications which may occur in distal end radius fractures are non-union, mal-union, pin site infections, residual pain and stiffness. Out of these complications, two complications were seen in the present study i.e. pin site infections in four patients which were managed with regular ASD and oral antibiotics; and residual pain with restriction of pronation and supination which was managed by Kapandji Procedure.

Discussion

Even after so many years after the description of the fracture, the percentage of unsatisfactory results continue to be high [2]. The external fixator has a role in some complex comminuted distal end radius fractures [3]. This present study recruited 23 patients with comminuted distal end radius fractures which were treated with trans-articular spanning external fixator after closed reduction. The fixator was kept for about 8 weeks and patients were under regular follow-up for 6 months.

We could achieve a closed reduction in 16 patients. In others, it was unsatisfactory due to high Frykman grade and severe comminution. In eight patients, the fixator was supplemented by K-wires. A study, on the treatment of distal radius fractures by Bae *et al.*, concluded that, to obtain better reduction and function result, external fixations supplemented with K-wire need to be taken into consideration [4]. Hove *et al.* reported a failure of reduction after removal of fixator at 3 to 5 weeks and advocated fixator use for 6 to 8 weeks [5].

The radiological determinants in the present study were dorsal angle, loss of radial length and loss of radial angle. Majority of patients had dorsal angle <10° and loss of radial length <6mm at 6 months. The pre-operative radiological mean was 2.90 and post-op mean was 1.25. A study by Mehboob *et al.* had radial shortening of 1 to 6 mm with mean of 3.2 mm [3]. McQueen *et al.* studied 20 patients of unstable distal end radius fixed with Hoffman 2 compact external fixator. The volar tilt was regained and mean radial shortening was 1 mm at final review [6].

The subjective and objective assessment of wrist function was also done. Dorsiflexion was better restored than palmer flexion. Grip strength was better restored in dominant hand. Mehboob *et al.* found wrist dorsiflexion of 65 to 75° till the fixator was applied, which improved after the fixator was removed.[3] McQueen found that the grip strength returned to a mean of 74% of the opposite (normal) side in the whole group [6].

In the present study, outcome was evaluated by functional and radiological demerit point system of Saito[7] at 8 weeks, 3 months and 6 months. 35% patients with fair and poor outcome at 6 months are those with exceptionally comminuted fractures, Frykman Grade 8 and lack of physiotherapy.

Fujii *et al.* [8] in his study followed up fractures of distal radius for 24 months and found that 64% had excellent results and 36% had good results. Boparai *et al.* [9] had excellent to good results in 73.34% cases and fair to poor results in 26.66% cases. Mehboob *et al.* [3] had excellent to good results in 70% of patients. Asche *et al.* [10] used a dynamic external fixator which allowed wrist motion in immediate post-operative period while maintaining ligamentotaxis. The results were very good to good in 91% cases and moderate in 2% cases. However, the dynamic external fixator is associated with some loss of fixation [11]. Sommerkamp *et al.* [11] found a statistically significant loss of radial length when using dynamic external fixator. In this study dynamic fixator had 76% excellent to good result and static fixator had 92% excellent to good result.

Agee *et al.* [12] found that immobilization of wrist in palmer flexed position caused finger stiffness and needed prolonged physiotherapy. In our study, pin track infection were seen in 4 patients. None resulted in loosening or osteitis. In the study by Mehboob *et al.* [3], two patients developed shoulder stiffness, which required physiotherapy and three patients had pin track infection, which was treated by antibiotics and daily dressings.

In percutaneous method of fixator application, there is risk of injury to lateral cutaneous nerve of thigh, sensory branch of radial nerve, impalement of brachioradialis tendon and Extensor carpi radialis longus tendons. These can be avoided by using the mini open technique of fixator application as described by Seitz [13].

The fixator adequately hold the reduction for the period needed to consolidate the fracture without producing unnecessary stiffness or deformity.

Conclusion

We recommend closed reduction and external fixator application with or without K-wire fixation for 8 weeks with limited open technique for comminuted distal end radius fracture and wrist held in neutral position.

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