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**Tabish Tahir**  
Resident, Department of  
Orthopaedics, Government  
Hospital for Bone and Joint  
Surgery, Barzulla, Govt. Medical  
College, Srinagar, Jammu and  
Kashmir, India

**Qazi Waris Manzoor**  
Resident, Department of  
Orthopaedics, Government  
Hospital for Bone and Joint  
Surgery, Barzulla, Govt. Medical  
College, Srinagar, Jammu and  
Kashmir, India

**Shamim Ahmad Bhat**  
Assistant Professor, Department  
of Orthopedics, SHKM  
Government Medical College,  
Mewat, Haryana, India

**Khurshid Anmad Kangoo**  
Professor, Department of  
Orthopaedics, Government  
Hospital for Bone and Joint  
Surgery, Barzulla, Govt. Medical  
College, Srinagar, Jammu and  
Kashmir, India

**Correspondence**  
**Tabish Tahir**  
Resident, Department of  
Orthopaedics, Government  
Hospital for Bone and Joint  
Surgery, Barzulla, Govt. Medical  
College, Srinagar, Jammu and  
Kashmir, India

## Functional outcome of external fixators in unstable distal radius fractures

**Tabish Tahir, Qazi Waris Manzoor, Shamim Ahmad Bhat and Khurshid Anmad Kangoo**

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### Abstract

**Background:** Fractures of distal radius are very common injuries, accounting for about 15% workload of an Orthopedic trauma unit. While cast treatment is universal for stable fractures, unstable fractures with comminution and intrarticular involvement are a different injury and are treated mainly by ligamentotaxis with proper restoration of anatomy. In this study, we evaluated the effectiveness of external fixator with or without augmentation for management of unstable distal radius fractures.

**Methods:** The study was performed on 49 patients with unstable distal radius fractures admitted in the emergency department. Patients who met inclusion criteria, were operated with bridging external fixation using 2 pins in radius and 2 pins in second metacarpal augmented with percutaneous K wires in some patients. Functional evaluation at 12 months was done using Solgaard Scoring.

**Results:** The study comprised of 49 patients in age group of 20-60 years, including 28 males and 21 females with a mean age of 42 years. Laterality included right side (n=23) and left (n=26). Mechanism of injury was road traffic accident (n=19), fall from height (n=17) and fall from standing height (n=13). The mean admission to surgery interval was 1.2 days, the mean operative time was 35 minutes and the mean time to union was 7.2 weeks. Complications included pin tract infections (n=7), transient neuropathies (n=5), early sympathetic dystrophy (n=2), malunion (n=2) and loss of motion more than 20° (n=9). Final evaluation done using Solgaard scoring system revealed excellent results in 22 patients, Good in 18 patients, Fair in 8 patients and Poor in one patient.

**Conclusion:** For unstable distal radius fractures excluding shear injuries, external fixation with or without augmentation is the preferred method of treatment as it is simple, less expensive, with acceptable complications and yields excellent results in a majority of patients.

**Keywords:** Distal radius fractures, comminution, external fixator, complications

### 1. Introduction

Abraham Colles, an Irish surgeon first described the Colle's fracture in 1814<sup>[1]</sup>. Fractures of distal radius are very common especially in osteoporotic post-menopausal women and contribute significantly to the work in orthopedic emergency. They usually result due to fall on outstretched hand and subsequent fracture because of osteoporosis. In young people they usually are a result of high energy trauma such as motor vehicle accidents and fall from height with marked displacement and comminution of distal radius <sup>[2]</sup>. Due to significant comminution and intrarticular involvement, Jupiter and Lipton described these as 'pilon fractures of upper extremity' <sup>[3]</sup>.

Classification schemes for distal radial fractures are controversial with limited usefulness, reproducibility and practicality <sup>[4]</sup>. Frykman's and AO classifications are the most commonly used <sup>[5]</sup>. Various important factors to consider while treating these injuries are fracture displacement, articular involvement, distal radio ulnar joint involvement and assessment of bone quality. The various radiographic parameters to consider are radial length, radial inclination, volar tilt and amount of articular step. The criteria for acceptable reduction varies with age of patient <sup>[6]</sup>. Table 1 summarizes the normal and acceptable radiographic parameters for young active individuals <sup>[7]</sup>.

**Table 1:** Acceptable reduction parameters<sup>7</sup>:

Radiographic parameter	Normal	Acceptable
Radial length (comparing level of lunate facet to ulnar head)	Within 2mm	No more than 2mm of shortening relative to ulna
Radial inclination (measured from lunate facet to radial styloid)	20°	Not less than 10°
Lateral tilt (volar tilt)	11°	Neutral
Articular step	None	Less than 2 mm

Most of the distal radial fractures are treated nonoperatively by applying the traction to reduce the fracture followed by casting for a period of 6 weeks. It has been observed that in patients with articular involvement and comminution, there is loss of reduction with collapse of distal radius with this form of treatment [8]. Patients usually have chronic wrist pain, difficulty in routine activities of daily living and lifting weights, poor functional result and unacceptable clinical deformity [9]. Casting supplemented with percutaneous K wires have also been associated with same problems, plus the chances of wires getting infected beneath the plaster. The goal of treating these fractures is to restore radial length and inclination, volar tilt and articular congruency. Open reduction and internal fixation (ORIF) with a volar plate is indicated for volar and dorsal Barton fractures, where it is the treatment of choice. But in patients with metaphyseal comminution and significant articular involvement, ORIF is difficult and amount of soft tissue stripping negates any potential benefit [10].

Recently a prospective randomized trial found out that the external fixation and percutaneous pinning is the most efficacious for treating unstable distal radius fractures [11]. Initially advocated by Anderson and O'Neil, several authors have reported excellent results with this form of treatment [12-15]. The external fixation is based on the principle of ligamentotaxis, maintaining the length of radius and reduction of articular fracture fragments through the radioscapohcapitate and long radiolunate ligaments. However, volar tilt and lateral translation are not significantly corrected with this form of treatment. This procedure can be augmented by percutaneous K wires to reduce and fix any large fragments [16]. We conducted a study to evaluate the outcome of unstable distal radial fractures treated with external fixation augmented with percutaneous pins.

## 2. Methodology

The present study was conducted in the Department of Orthopedics, Government Medical College Srinagar, from January 2016 to December 2017. Patients aged between 20 to 60 years with closed unstable distal radius fractures were included in the study. We included AO type 23 B1 and 23 C fractures only. Exclusion criteria were simple extrarticular fractures, open injuries, volar and dorsal shear injuries (Barton fractures). All the patients were evaluated thoroughly including distal neurovascular status, and any associated injuries ruled out. Patients were operated as early as possible.

### 2.1. Surgical Technique

Under brachial/general anesthesia, fractures were reduced. After standard draping and painting, external fixator with four pins (3.5mm) and a rod were used for stabilizing the fracture. The proximal pin in radius was placed first at about the junction of upper and lower half of radius inclined at 30-40 degrees dorsal to the frontal plane of forearm. Another pin was placed in the index metacarpal base in line with the first pin in the radius. The pins were joined by a rod and the upper pin was tightened to the rod using a clamp. Traction was manually applied in the longitudinal direction with counter

traction applied at the level of elbow. Then the metacarpal pin was tightened keeping hand slightly in volar flexion. Another 3.5 mm pins were added in the radius about one inch above the fracture and in the metacarpal head for added stability. The whole procedure was performed under fluoroscopic control. The fixation was augmented with the percutaneous K wires in cases with radial styloid or dorsal fragments for added stability. One K wire was placed from the tip of radial styloid laterally to engage the medial cortex of proximal fragment. Another K wire was placed from the dorsal aspect to engage the proximal fragment. Pin site dressings were done and limb was elevated to reduce swelling. Post-operative radiographs were assessed for fracture reduction, maintenance of radial length and inclination, lateral tilt and articular step, placement of fixator pins and K wires. Active and passive finger motion, elbow motion was started from the first postoperative day. Patients were followed up at 2, 4, 6, 8 weeks. The external fixator and pins were usually removed at 6 weeks after bridging trabeculae across the fracture site. A below elbow cast was applied for another 2 weeks followed by wrist mobilization exercises. Patients were followed monthly till 6 months and then 3 monthly till final followup at 12 months. Functional evaluation was done using Solgaard scoring modified from Gartland and Werley (Table 2) [17, 18].

**Table 2:** Solgaard scoring of functional outcome modified from Gartland and Werley [17, 18].

Parameters	Maximum points
Deformity	6
Subjective evaluation	6
Range of motion	6
Grip strength	6
Complications	15
Total score	
Excellent	0-2
Good	3-7
Fair	8-18
Poor	19-39

## 3. Results

From January 2016 to December 2017, 54 patients with unstable distal radius fractures were treated by external fixation at our institute out of which 5 were lost to follow up and 49 patients were available till final followup at one year. There were 28 males (57.1%) and 21 females (42.9%) in the age group of 20 to 60 years with mean age of 42 years. Right side was involved in 23 patients (46.9%) and left side in 26 patients (53.1%). The mechanism of injury included motor vehicle accident (n=19, 38.8%), fall from height (n=17, 34.7%) and fall from standing height (n=13, 26.5%). As per AO classification, most of fractures were 23 C2 (n=18, 36.7%), followed by 23 C1 (n=11, 22.4%), 23 C1 (n=11, 22.4%) and 23B1 (n=9, 18.5%) [Table 3]. Associated injuries were present in a significant number of patients and are listed in Table 4.

**Table 3:** Demographic details

Gender	Males (n=28)
	Females (n=21)
Laterality	Right (n=23)
	Left (n=26)
Mechanism of injury	Motor vehicle accident (n=19)
	Fall from height (n=17)
	Fall from standing height (n=13)
AO classification	23 B1 (n=9)
	23 C1 (n=11)
	23 C2 (n=18)
	23 C3 (n=11)

**Table 4:** Associated fractures

Associated fractures	Number of patients
Spine fractures	8
Long bone fractures	7
Hip fractures	5
Head injuries	3

The mean interval from admission to surgery was 1.2 days with a range of zero to seven days. Most of the patients were operated on the same day of admission in emergency theatre (n=26, 53.1%). Patients with associated fractures were operated in a single setting in routine theatres, while patients with head injuries were operated once the patient was fit for anesthesia after a delay of 5-7 days. Similarly majority of patients were discharged on the first postoperative day (n=24, 49%), while patients with associated injuries and head injuries had a mean hospital stay of 5.6 days. The mean duration of the operative procedure was 35 minutes. All the patients started finger mobilization exercises on the first postoperative day. The mean time to union was 7.2 weeks with a range of 6 to 9 weeks. Union was defined when patient had no pain and tenderness with bridging callus present across the fracture site. There was no case of nonunion or deep infection in our series. Final evaluation was done using Solgaard scoring system at 12 months. Results were Excellent in 22 patients, Good in 18 patients, Fair in 8 patients and Poor in one patient (Figures 1, 2, 3).



**Fig 1A**

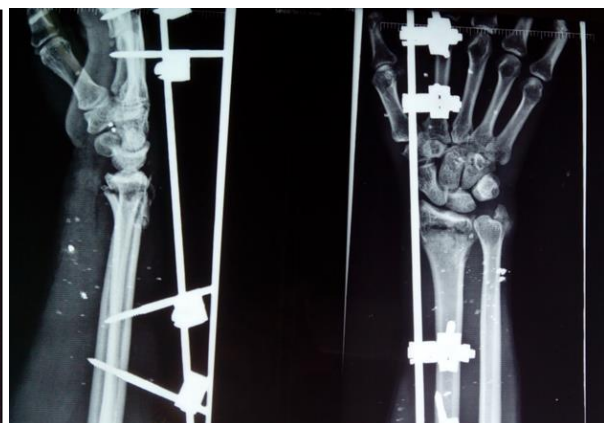


**Fig 1B**

**Fig 1A and 1B:** Preop and Postop AP and Lateral radiographs of one patient.



**Fig 2A**



**Fig 2B**

**Fig 2A and 2B:** Preop and Postop AP and Lateral radiographs of second patient.



Fig 3: Clinical photographs of patient at final followup.

#### 4. Complications

The most common complication in our series was superficial pin tract infection in 7 patients. It resolved with daily dressings, local care and oral antibiotics in all patients but one patient had associated loosening of pin. Median nerve compression (n=2) and superficial radial nerve symptoms (n=3) resolved in all patients with conservative treatment. Early reflex sympathetic dystrophy was present in two cases and resolved with physiotherapy and medications. One patient had a fracture of second metacarpal intraoperatively while pinning. Malunion with 15° of dorsal tilt was present in 2 patients, among which one patient had pain and limitation of activities at final followup with early arthritis on radiographs. Loss of motion (including palmar and dorsal flexion, radial and ulnar deviation, supination and pronation) more than 20° as compared to opposite side was present in 9 patients (Table 5). There were no cases of stiffness or well developed arthritis at final followup. There were no cases of tendon ruptures or midcarpal instability in our series.

Table 5: Complications

Complications	Number of patients
Pin tract infections	7
Neurological problems	
Median nerve	2
Superficial radial nerve	3
Reflex sympathetic dystrophy	2
Malunion	2
Loss of motion >20°	9

#### 5. Discussion

For distal radial fractures, the functional result is most important in assessing the outcomes [19]. For stable metaphyseal fractures cast method provides the best functional result. However for unstable comminuted intrarticular fractures, external fixation with or without augmentation has become the treatment of choice [11]. Comminuted intrarticular fractures deserve special attention because neither casting method nor ORIF is suitable for these

fractures. With casting method and percutaneous K wires, most of these fracture redisplace leading to a poor result. ORIF with a volar plate is also not suitable because the fragments are too small to hold screws, soft tissue stripping and osteoporosis is common in elderly [20].

In 1923 Bohler recognized need for maintaining fixed traction using pins and plaster, while Anderson and O'Neil in 1944 first recommended external fixation [21]. The present day external fixators are lighter and comfortable allowing cleaning of pin sites, remanipulation and any necessary adjustments. The duration of external fixation is also debatable with some authors advocating early removal at 3 weeks while others advocating routine removal at 6 weeks. The concerns with early removal are redisplacement, however Haddad M *et al* in a study of 36 patients using external fixator for 3 weeks and 5 weeks, found no significant difference in the two groups [15]. They reported excellent results in 30 patients using Solgaard scoring. Jakim I *et al* reported 83% good to excellent results and only a few complications [22]. Using the same scoring, our study showed good to excellent results in 40 patients (81.6%).

The use of external fixator is still not that popular, primarily because of its complications. Also some authors doubt on its ability to maintain reduction. The loss of reduction is primarily due to infection with pin loosening and failure of the fixator [23]. Various authors recommend not to use fixators above 65 years of age [24]. The complications can be minimized by proper patient selection and strict attention to surgical technique. Adequate skin incisions and blunt dissection upto bone, predrilling and daily pin site care reduce the pin site infections significantly. McKenna J *et al* in a study of 48 patients had pin track infection in 7 cases with 2 cases requiring early fixator removal [25]. Anderson JT *et al* reported complications in 16 of 24 patients with 9 cases of pin track infection and two of pin loosening. They concluded that complications in external fixation are frequent, and their effect on long term functional results and patient satisfaction is negligible [26]. Out of 51 cases, Seitz WH *et al* had 5 cases of superficial pin tract infections. In our study there were superficial pin track infections in 7 patients all of whom subsided with conservative treatment [14].

Cooney WP used four different configurations of external fixations in a series of 100 unstable distal radius fractures and obtained 86% good to excellent results [13]. The quadrilateral frame provided the most effective immobilization among the four. Joosten U *et al* in a long term study of 8 years on 174 patients with unstable distal radius fractures concluded that restoration of radial length is important in order to achieve a good outcome. They achieved 71.8% good to excellent results [27].

Our study had various limitations as various other methods for treating distal radius fractures were not compared with the external fixation method. Also the followup was short and long term randomized comparative studies are needed to document the efficacy of this method of fixation.

## 6. Conclusion

External fixation augmented with percutaneous K wires is an excellent option for treating unstable distal radius fractures. The technique is fairly simple with low learning curve, has low reoperation rate, acceptable rate of complications and produces satisfactory outcome in majority of fractures. A wise judgment is needed for restoring radial length and inclination which are important for a good outcome. The technique should not be used for shear fractures which are primarily

treated with ORIF.

**Conflict of interest:** None

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**Ethical Approval:** From Institute Ethical Committee

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