Original article

Results of Intra-Articular Fractures of the Distal Radius Treated with Simple Uniplaner External Fixator


Abstract
Severely comminuted intra-articular fractures of distal radius are still challenging problem despite the varieties of modalities of treatment options. We report the result of a prospective study of thirty-five patients, who were treated by close reduction and simple single bar Uniplaner external fixator. The patients were followed for an average of nine months (ranges from six to 12 months). 20 patients had excellent result; 13 patients had good result and two patients had poor results. The results were calculated in term of pain, range of motion, power and radiological appearance. After nine months of postoperative period; the mean arc of motion (flexion and extension) was 80 per cent of that of normal side and average grip strength was 85 per cent of that of uninjured side. The articular step up was 1.5 mm and radial length was restored to a mean of 10 mm.

Complications were low and there was no loss of fixation of the pins. Regarding minor complications, there were seven pin tract infections, which were healed in due time; two superficial nerve injuries and one case of sympathetic dystrophy. Overall complication rate was 37 per cent.

Close reduction and simple single bar Uniplaner external fixation by the principle of ligamentotaxis, can restore radiological parameters to nearly normal values; maintain reduction throughout the period of fracture healing and produce good to excellent result.

Introduction
Severely comminuted unstable intra-articular fractures of distal radius are still challenging problem despite continued refinements in treatment. If these fractures are allowed to collapse, radial shortening, angulations, and articular incongruity may cause permanent deformity and loss of function. Restoration of radial length, volar tilt, dorsal angulation and articular congruity are of prime importance.1, 3, 4, 5

Although most of these comminuted fractures of lower radius are treated by close reduction and cast immobilization,6,7,8 but simple cast immobilization are usually unsatisfactory. Most authors have reported skeletal fixation is needed to maintain the reduction and is the treatment of choice for these comminuted fractures of lower radius.2, 4, 9, 10, 11 Since pins and plaster introduced by Bohler in 1929,12 followed by development of external fixator by Anderson and O’ Neil in 1944,13 many external fixation devices have become popular. However, the rate of complications ranges from 10 to 61 per cent.10, 14, including infections, loosening of the pins loss of reduction of the fracture, permanent stiffness and weakness. Many previous studies are difficult to analyze and compare due to heterogeneous study population. Some series have included less severe extra-articular fractures as well as more severe injury such as complex open fractures, and other associated injuries in the ipsilateral limb.5, 15, 16 Some authors excluded very elderly

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patients because of loosening of the pins in osteoporotic bone. Most of the report has lack of information about specific indications and the details of treatment.\textsuperscript{4,14}

During this last decade, multi-planer, hinged so called dynamic fixator have been popular, which has complexing operative protocol, difficulty in controlling the position of distal radio-ulnar joint and expensive too.\textsuperscript{18, 19,20,21} The purpose of this study was to analyze the results in adult patients in whom a severely comminuted close intra-articular fracture of the distal end of the radius has been treated by a simple, small, Uniplaner external fixator by a standard open technique, which is cost effective, easily available and easy to apply in our setting.

Fig. 1: Antero-posterior and lateral radiograph showing a comminuted intra-articular fracture of distal radius (Frykman type VII) with radial shortening

Fig. 2: Immediate postoperative X-ray with pin in situ

Fig. 3: Radiograph showing healing of fracture after six weeks of operation

**Methods and Materials**

During the period from March 2007 to March 2008, 35 patients with severely comminuted intra-articular unstable fractures of distal radius were treated by simple India made Uniplaner external fixator (Green’s surgical implants) in Department of Orthopaedics, Bir Hospital, National Academy of medical Science (NAMS), Kathmandu, Nepal. Prerequisite for this treatment included:

- Severe comminution of the fracture,
- Fracture extension into the radio carpal joint and or involvement of distal radio-ulnar joint,
- Dorsal angulation of more than 25 degrees
- Articular stepping more than 2-3 mm

Of the 37 patients, two patients were lost from follow up, so 35 patients were included in this study. There were 20 men and 15 women. The ages of the patients were ranges from 17 to 60 years with mean age of 37 years; the mechanism of injury was fall in 26 patients; motor vehicle accident in seven patients and direct blow in two patients. All the patients had intra-articular involvement of both radiocarpal joint and radio-ulnar joint or only radiocarpal joint with severe comminution.

Distal radius fractures were classified according to Frykman classification\textsuperscript{22} system and type VII-
VIII fractures were mostly included in the study. The indication for external fixation of distal radius fractures are based on the Frykman classification (Table 1).

Table 1. Unstable Distal Radius Fractures; Indication for External Fixation

<table>
<thead>
<tr>
<th>Type of Fracture</th>
<th>Radiocarpal</th>
<th>Radio-ulnar</th>
<th>Radiocarpal and Radio-ulnar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-articular</td>
<td>III</td>
<td>IV</td>
<td>VII</td>
</tr>
<tr>
<td>Comminuted displaced fractures (Frykman types)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distal ulnar fractures</td>
<td>No</td>
<td>Yes</td>
<td></td>
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</tbody>
</table>

Patients who had an open fracture or an associated fracture of the ipsilateral extremity and patients treated by k-wire fixation in addition to pin fixation were excluded from the study. All the patients were treated with same surgical technique by same group of surgeons. The external fixator was applied on the same day of injury in half of the cases. Average duration from the injury to the operation was five days and longest delay was 10 days.

The duration of follow-up ranges from six months to one year (average nine months). During follow-up all patients were examined by our Orthopaedics group and confirmed all measurements. The examination included inspection for deformity and scars, palpation for tenderness over the pin tract scar and for instability of the distal radio-ulnar joint; grip strength with dynamometer; measurement of range of motion of the digits, wrist, elbow, and shoulder with a goniometer; and assessment of tightness of intrinsic muscles of the hand. Function of median nerve was also evaluated. The contra-lateral limb was taken as a control for all measurements. The subjective evaluation included assessment of pain, functional limitations and over all satisfaction with the results.

During regular follow-up, radiological investigation was done which included standard Antero-Posterior (AP) and Lateral view of the operated wrist. Radiological evaluation was done in one week Post operatively and three weekly when there were pins in situ and later three monthly after the removal of pins. The evaluations done during radiograph were radial length, articular congruity, articular tilt, non-union of the ulnar styloid process and carpal instability. Carpal distraction was also evaluated during the period of fixation, which was measured from the base of the 3rd metacarpal to the radial articular surface. These values were compared with the radiological values after removal of the fixator. Osteoporosis was assessed by measurement of the cortical thickness of the index metacarpal as described by Dias et al.\(^\text{23}\) The criteria of Gartland and Werely as modified by Serminto et al.\(^\text{6,24}\) were used to rate each result on the basis of the subjective, objective and radiographic findings.

**Surgical (Operative) Technique**

External fixator was applied under general anaesthesia, or supraclavicular regional block. Patient was put on supine position and horizontally placed extremity was draped with full sterile technique and tourniquet was applied to all patients. Two longitudinal incisions about 2 cm in length were made on the dorso-lateral aspect of the radius at least 2-3 cm proximal to the fracture site. The distances between two incisions were approximately 5-6 cm, in which there is less chance of superficial radial nerve injury. This branch of superficial radial nerve is carefully protected during exposure of radius by blunt dissection. In most of the cases we predrilled the bone with 2.2 mm drill bit using 3 mm drill sleeve. We did not use the power drill as it generated excessive heat, which predisposed early loosening of the pins and osteomyelitis. Partially threaded pins were then inserted with help of T handle and perforated both the cortices in the plane approximately midway between the sagittal and coronal plane in parallel fashion.\(^\text{25}\) For distal fixation, two incisions were made over the index metacarpal lateral to the extensor tendons. Proximal pin for distal fixation was inserted into the base of the metacarpal at the metaphyseal flare, and distal pin was inserted two cm distally.
at the metacarpal shaft, 2-3 cm proximally from the metacarpo-phalangeal (MCP) joint. MCP joint was held in flexion until the metacarpal pins were inserted to prevent postoperative extension contracture secondary to tethering of the dorsal hood. The diameter of the distal pins was one mm smaller than the size of the radial pins. Couplar clamps were kept loose to allow distraction and proper positioning of the wrist, and then connecting bars were attached. Close reduction was performed and the assistant tightened clamps while the surgeon holds the wrist in the desired position. The wrist was placed in flexion and ulnar deviation as desired to restore a more normal tilt of the articular surface. Sterile dressing was applied and forearm was supported by a arm sling and then postoperative radiograph was taken.

Most of the patients were returned home same day of surgery or next day. We used three consecutive days of broad-spectrum antibiotics postoperatively to all patients. Dressing was changed after seven days of operation and then care of pins with spirit was begun. Early postoperative active exercise was advised; especially emphasis was given for flexion of the MCP joints. Gentle pronation and supination in each direction was allowed and sutures were removed after 8-10 days of surgery.

External fixator was removed after 6-8 weeks (Mean 6.5 weeks) of operation, which was confirmed by radiological evidence of healing and then physiotherapy of hand, wrist and elbow was initiated.

Results
All the patients were tolerated external fixator very well till the removal. Appearance of the wrist was good in most of the cases, only two cases had puckering of the scar. There was no evidence of prominence of distal ulna in all cases.

Functional Outcome

Pain was completely absent in 28 patients. In five patients pain was only during strenuous physical activity. Only 2 patients had mild to moderate pain at rest, otherwise all the patients were returned back to their previous occupation.

Objective Outcomes
In all patients

- Grip strength ranges from 30-100 per cent of the contra lateral side (average 85 per cent).
- Dorsiflexion of the wrist were ranges from 30-80 degrees (averages 60 degrees); 90 per cent of the normal.
- Palmer flexion ranges from 40-80 degrees (averages 65 degrees); 85 per cent of normal.
- Radial deviation flexi ranges from 7-30 degrees (averages 15 degrees); 92 per cent of normal.
- Ulnar deviation flexion ranges from 10-30 degrees (averages 22 degrees); 90 per cent of normal.
- Supination flexion ranges from 30-80 degrees (averages 75 degrees); 85 per cent of normal.
- Pronation flexion ranges from 50-95 degrees (averages 85 degrees); 90 per cent of normal.

Motion of the shoulder and elbow was normal in all patients. Intrinsic tightness and motion of MCP joint restriction by 15 degrees was observed in 10 patients, which were resolved by continuous physiotherapy.

Radiological Outcomes

- Radiograph of the wrist demonstrated maintenance of radial length within1.5 mm of the original reduction in all patients.
- Shortening or elongation of radial length by 3 mm was noticed in compare to normal side.
- The articular step up ranged from 0-2.5 mm (average 1.5 mm), only 2 patients had step up 3-4 mm.
On the lateral radiograph the tilt of the distal radial articular surface ranged from 10 degrees of dorsal flexion to 20 degree of palmer flexion (average seven degrees)

- Carpal distraction ranged from 1-6 mm (average 4 mm).

**Outcome of evaluation according to Clinical rating System**

According to the modified scoring system of Serminto et al, the over all functional results were excellent in 20 patients (57 per cent), good in 13 patients(37 per cent) and poor in two patients(5 per cent); overall good and excellent result in 33 patients(94 per cent).

**Complication**

Superficial pin tract infection was present in 10 (28 per cent) patients which was resolved in due time by dressing with betadine and antibiotics; one patient developed reflex sympathetic dystrophy and was underwent long term medication and physiotherapy. None of the patient had loss of fixation or breakage of the pins during the 8th weeks of fixation period. Two patients had transient involvement of the superficial radial nerve that was resolved after removal of the fixator. Over all complication was 37.5 pe cent, but no major complication were observed.

**Discussion**

A small Uniplaner external fixator is a simple and reliable means of treating unstable severely comminuted intraarticular fracture of the distal radius with the proved and accepted concept of ligamentotaxis. Basic principle of maintaining traction by external fixator was first described by Bohler. This concept of external fixation and ligamentotaxis was further confirmed by the number of other studies in past several years. Many authors have continued to apply the Roger-Anderson apparatus for unstable distal radius fractures as described by Cooney et al in 1979; with good to excellent results. Like wise Hoffman and mini Hoffman frame was also used to treat same type of radial fracture and surprisingly results were fairly similar with mini fixator. It was also proved by the series of small AO fixator in severely comminuted intra-articular fracture of the distal radius and by Edward et al in 1991.

Results of our series are fairly comparable with other’s series regardless of type of external fixator and duration of the immobilization in the fixation. However a quadrilateral frame provides rigid fixation of the difficult unstable radial fractures. Tensile distraction through the distal radial fragment provides the optimum environment for the fracture healing without displacement as described by Cooney et al.

In all multiplaner, multiaxial, multibared, hinged type of external fixator so called dynamic fixator, there is complexity of the fixation procedure, and are all expensive and sophisticated; but the results were not much superior to the simple Uniplaner small external fixator in terms of functional and anatomic outcome as described by JB Jupiter and other series. In our poor community, economic condition of the patients to afford the treatment modality is the first priority before initiation of the treatment protocol.

The high percentage of the complications (Table 2), as loosening of the pins is a problem that has been reported by many authors in their series. So pin loosening was not a problem in our series probably due to younger age group in our series, most of the patients were below the age of 50 years.

<table>
<thead>
<tr>
<th>Series</th>
<th>Per cent</th>
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<tbody>
<tr>
<td>Cooney et al</td>
<td>11</td>
</tr>
<tr>
<td>Szobo and Weber</td>
<td>30</td>
</tr>
<tr>
<td>Chand et al</td>
<td>20</td>
</tr>
<tr>
<td>Our series</td>
<td>37</td>
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</table>
Considering the loosening of the pins in elderly Cooney and Clybar\textsuperscript{15,16} discouraged the use of external fixator in elderly patients older than 65 years. Jacob and Fernandez\textsuperscript{10} recommended 65 years as the maximum age for use of external fixator.

In majority of the cases the radial height was maintained even after the pin removal. This may be attributed to the continuous carpal distraction by the distraction devices in every follow up period. The carpal distraction immediately after the operation and before the removal of external fixator was measured in average of 4 mm. Distraction was maintained in near constantly throughout the treatment, leading to negligible loss of radial length.

The radial sensory nerve generally is not at risk when pins are placed four fingers breadth or more proximal to the radial styloid and pins are placed by open technique, which we performed in our series. Dysfunction of the median nerve has been the frequent complication in most series. In several studies the transient neuropathy associated with the injury has not appeared to be related to the type of fracture. In our study we did not observed any median nerve dysfunction after removal of the fixator.

There are many reports of post traumatic arthritis after intra-articular fracture of the distal radius\textsuperscript{5,11,17,30,33,34}. Smaill\textsuperscript{17} noted that ten of the forty-one patients followed for 5-6 years after trauma had radiological changes of osteoarthritis. Broadway et al\textsuperscript{33} and Knrik and Jupiter\textsuperscript{34} showed that more than two mm of articular incongruity (step-up) was associated with a high prevalence of post traumatic arthritis and poorer functional results. In our series articular step-up was less than 1.5 mm. We could not asss the osteoarthritic changes and symptoms of arthritis as our follow-up was only nine months to one year.

Complication regarding adhesion involving flexor and extensor tendon, rupture of the tendons were not observed in our series. As from the first postoperative day active finger exercises were initiated. The extensor pollicis longus is the tendon, which is most frequently ruptured. The excellent and good results and low rate of complications in our series were explained by various factors i.e. simple design of fixator, small threaded pins, early exercise of the joints, open technique, use of hand drill, regular postoperative follow up, technique of close reduction and verification by C-arm or portable X-ray, close fracture without injuries of ipsilateral extremity and young age of the patients.

Limitation of our study is the small number of patients, the lack of a control group, and short term of follow up. A randomized prospective study and a control group treated with external fixator of different types and long-term follow up would have been better.

**Conclusion**

In severely comminuted unstable intra-articular fracture of the lower end of the radius, close reduction and external fixation using simple Uniplaner small fixator is recommended method of treatment in our community, which is simple apparatus for application and cost effective, can produce excellent to good result despite of common post operative complications related to the external fixator.

**References**


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