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FUNCTIONAL OUTCOME OF INTRA-ARTICULAR FRACTURE OF DISTAL RADIUS USING EXTERNAL FIXATOR

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ABSTRACT

Introduction: *Distal radius fractures commonly occur in the upper limb after highvelocity trauma and can be managed by several methods. External fixation using the principle of ligamentotaxis aims to restore radial length, volar tilt, and radial inclination. This study assesses outcomes of ligamentotaxis-based external fixation for intraarticular distal radius fractures.*

Materials and Methods: *In this prospective interventional study, 50 patients with distal radius fractures were treated with external fixation. Included were patients aged 15–79 years, with Frykman types III–VIII fractures, failed closed reduction with casting, Gustilo–Anderson grade I–II open fractures, and those fit for surgery. Outcomes were measured by the Demerit Point System of Gartland and Werley, modified by Sarmiento.*

Results: *Among the 50 patients, most were male and the mean age was 40.28 years (SD ±13.64). Anatomical outcomes were rated excellent to good in 80% of cases. Functional outcomes were excellent to good in 64% of patients. A small number experienced persistent pain.*

Conclusion: *External fixation employing ligamentotaxis is a suitable option for managing intraarticular distal radius fractures, yielding satisfactory anatomical and functional outcomes in most patients*

Keywords: *Distal Radius Fracture, External Fixation, Ligamentotaxis*

INTRODUCTION

Distal radius fractures rank among the most frequently treated injuries in orthopedic practice.[1,2] These fractures compromise the structural support of the hand and can profoundly impair hand function. The ligaments, retinacula, tendons, and periosteum that surround the distal radius both obstruct open reduction and, conversely, enable closed reduction through ligamentotaxis.[3]

Timely identification of articular fragment displacement, fracture stability, and reducibility is crucial for choosing optimal treatment for complex distal radius injuries. While many distal radius fractures are simple and respond well to closed reduction and casting, unstable or intraarticular patterns threaten joint congruity and wrist mechanics.[4]

Evidence suggests a large proportion of distal radius fractures involve the articular surface, disrupting the radiocarpal and distal radioulnar joints.[5] Nearly half of metaphyseal fractures extend into one of these joints.[4] Intraarticular injuries are generally unstable, difficult to restore anatomically with closed methods, and carry higher complication rates.[6]

Changes in injury mechanisms, a trend toward younger patients sustaining these fractures, greater functional expectations, improved understanding of fracture morphology, and advances in wrist biomechanics and classification systems challenge the notion that all distal radius fractures eventually recover well. Highenergy injuries in particular are associated with poorer outcomes and more complications.[4]

Maintaining articular congruity is essential for a good recovery, but the optimal technique to achieve and preserve precise joint anatomy remains contested.[7]

External skeletal fixation with ligamentotaxis offers a minimally invasive option for displaced, unstable distal radius fractures, aiming to restore length and alignment of fragments and thereby improve anatomical and functional outcomes, including grip strength and endurance. Although satisfactory results may sometimes be obtained despite imperfect radiographic reductions in elderly, lowdemand patients, younger or more active individuals require preservation of wrist integrity and motion.[8]

Because distal radius fractures are common and local data on external fixation are limited, we performed this prospective hospitalbased study to evaluate the functional outcomes of intraarticular distal radius fractures treated with external fixation at our center.

MATERIAL AND METHODS

This prospective interventional study enrolled among 50 patients at the Department of Orthopaedics, National Medical College, Birgunj, Nepal, from 10 April 2023 to 9 April 2024, after approval from the Institutional Review Committee (Ref. FNMC/554/078079).

Inclusion criteria were unstable intraarticular distal radius fractures (Frykman types III–VIII), unstable extraarticular fractures with marked metaphyseal comminution or loss of reduction after attempted closed reduction and casting, open distal radius fractures requiring wound management and patient fitness for surgery. Exclusion criteria comprised poor general health, hemorrhagic shock, concomitant head, chest and abdominal injuries needed active management, age <15 or >80 years, neurovascular deficits from more proximal injuries, ipsilateral fractures of the second metacarpal or radial shaft, refusal to consent, and medical unfitness for surgery. Purposive sampling was used.

Diagnosis was established clinically and radiologically and fractures were classified by Frykman.[7] Procedures were performed under general anesthesia or regional anesthesia (interscalene/brachial plexus block) for highrisk patients. The limb was painted and draped using standard aseptic technique. To protect superficial structures such as the radial cutaneous nerve and to ensure accurate pin placement, a limited open approach was employed. Two 2.5cm incisions were made: one approximately 10 cm proximal to the radial styloid on the radial forearm and one over the dorsoradial base of the second metacarpal. Under direct visualization, the radius was predrilled with a 2.7mm sharp drill bit; the hole was then exchanged for a selftapping 3.5mm Schanz pin using a Thandle.

At the distal fixation site, soft tissues were retracted to expose bone and predrilled with a 1.7mm bit through the bases of the index and middle metacarpals and the proximal shaft of the index metacarpal, achieving purchase in four cortices. Sequentially, these were replaced with 2.5mm selftapping Schanz pins. This pin configuration avoided the second interosseous space, minimizing risk to intrinsic compartments and subsequent scarring while providing secure distal fixation. Soft tissues were permitted to fall back and skin incisions were closed with simple sutures around the pins.

With pins in place, the external fixator was mounted in a fully loosened position. Gentle, sustained traction (avoiding hyperflexion or hyperextension) and manual molding were applied to realign fracture fragments. For dorsally displaced fragments, gentle flexion with ulnar deviation was used; for volar displacement, gentle supination with slight dorsiflexion aided reduction. Once adequate alignment was achieved, the frame was locked and reduction verified with fluoroscopy. The construct preserved overall length, angulation, and rotational alignment. Palmar translation of the hand on the forearm was used to restore volar tilt after radial length was reestablished. In some cases, the construct was augmented with percutaneous Kirschner wires (2.5mm for the radius, 2mm for metacarpals) connected with knurled rods and clamps.

The wrist and hand were positioned neutrally with the forearm to relax extensor tendons and allow free finger flexion. Frame tension was adjusted so that on the AP radiograph the radiocarpal joint space measured no more than 1 mm and there was no midcarpal distraction. Pin sites were dressed with povidoneiodine–soaked gauze and the limb received a soft bulky dressing.

Kwires were removed at 3–4 weeks once radiographic healing signs were present; the external distractor was removed at approximately 6 weeks. Patients followed an intensive postoperative physiotherapy program. All patients were followed for six months. Functional outcomes were assessed subjectively using the Gartland and Werley demerit point system as modified by Sarmiento (1975).[8] Anatomic results were evaluated with Lidström and Frykman criteria modified by Sarmiento (1980).[9] Data were managed and analysed using MS Office and SPSS version 26.

RESULTS

Among 50 patients of distal radius fractures, males 45(90%) and Females 5(10%),

mean age of our patients was 40.28 (SD±13.64) years. Maximum patients included in our study belonged in age group 21-40 years. Age distribution of participants are summarized in Table 1

Table 1: Age distribution of study participants (N=50)

Age Group (years)	Frequency (n)	Percentage (%)
0-20	02	04
21-40	27	54
41-60	16	32
61-80	05	10
Total	50	100

Majority of our patients were either farmers 12(24%) or were currently unemployed 12 (24%).

Right side 35(70%) was involved more than left side 15(30%). mechanism due to fall on outstretched hand 23(46%) and fall from height 18(36%). Majority of our patients had no associated injury (n=44; 88%).

Closed fractures (n=46; 92%) was more than open fractures 4(8%). Majority of our patients had Frykman grade VII fracture (n=13; 26%). distribution of participants according to Frykman classification was listed in Table 2.

Table 2: Distribution of participants by frykman's classification (N=50)

Frykman's Type	Frequency (n)	Percentage (%)
Type III	01	02
Type IV	07	14
Type V	10	20
Type VI	09	18
Type VII	13	26
Type VIII	10	20
Total	50	100

The mean interval between fracture of distal radius and surgery was 2.58 (SD±1.59) days. Fracture started showing signs of healing in mean 4.9 weeks. Mean duration of external fixation was 6.04 (SD±0.78) weeks. All cases were followed up for a minimum period of six months. Mean follow up period was 36.84 (SD±6.71) weeks.

Average loss in radial length was 3.54 (SD±2.10) mm, the average radial angle obtained was 18.02 (SD±2.40) and average palmar tilt obtained was 1.34 (SD±1.76) ˚in our cases.

Residual pain (n=15; 30%) was the most frequent complication seen in our cases. Which was subsided after physiotherapy.

Functional results were assessed as per De merit point system of Gartland and Werley (modified by Sarmiento). Majority of our patients (64%) had excellent (38%) to good (26%) functional outcome (Table 3).

Table 3: Functional outcomes of study participants (N=50)

Functional Result	Frequency (n)	Percentage (%)
Excellent	19	38
Good	13	26
Fair	09	18
Poor	09	18
Total	50	100

Anatomical results were assessed as per criteria by Sarmiento. Majority (80%) of our patients had excellent (40%) to good (40%) anatomical results (Table 4).

Table 4: Anatomical outcomes of study participants (N=50)

Functional Result	Frequency (n)	Percentage (%)
Excellent	20	40
Good	20	40
Fair	07	14
Poor	03	06
Total	50	100

DISCUSSION

The prospective interventional study was carried out for a period of 12 months and included 50 cases of distal radius fracture fulfilling inclusion and exclusion criteria.

The mean age of our patients was 40.28 (SD±13.64) years. Several studies have observed similar mean age of their patients ranging from 34.8-45 years.[10-14] The higher incidence of distal radius fractures around this age can be explained due to the active life style which is prone for accidents and results in high velocity injuries.

A male preponderance (n=45; 90%) was observed in our study. This is similar to observations made in several studies.[10,11,14,15] The higher preponderance in males can be attributed to the occupational and ambulant life led by them. Also, males have increased access to health facilities.

Similar studies by Leung et al. and Krishna NVSR et al., the dominant right hand was involved (n=35; 70%) in majority of our patients.[10,14] This may be attributed to tendency of stretching the dominant hand as a reflex while RTA / fall to avoid injury to face and head.

Fracture of distal radius usually results from road traffic accident, fall on outstretched hand or fall from height. Majority of our patients suffered from distal radius fracture due to fall on outstretched hand (n=23; 46%). Similar observation was made by Aggarwal et al. in their study.[13] However, studies differ with regards to the most common mechanism of injury in fracture of distal radius.[14,15] The observed difference can be accounted due to geographical variance.

As per, Frykman classification, our indications for fracture of distal radius for external fixation are comparable to that of other standard studies. Most of our cases had a higher Frykman grade, with Grade VII and Grade VIII, constituting 26% and 20% of patients, respectively. This is in concordance with other studies.[10,14-16] Mean duration of external fixation was 6.04 weeks as advised by Nagi On et al. compared to that of Gunaki RB et al., where it was 7.2 weeks.[17,18]

The fixator was removed after radiological and clinical union on out-patient basis and range of movements were started immediately. All cases were followed up for a minimum period of 6 months. Radial length is one of the crucial factors for regaining good wrist function. The radial shortening due to loss of reduction was measured as the difference between initial post reduction and final X -ray made for each patient as suggested by Cooney et al.[16] According to Collins, radial shortening of 4-6mm compromises DRUJ.[19] In our series average loss of radial length was 3.54 mm, which was slightly higher as compared to observations made by Gunaki RB et al.[18] The residual tilt depended upon extent of dorsal angulation before reduction and adequacy of restoration of palmar tilt after reduction. The average palmar tilt obtained in our study was 1.34˚. The findings are comparable to observations made by Krishna NVSR et. al., who observed a palmar tilt of 1.52˚ in their study.[14] Even small change in palmar tilt leads to radiocarpal dysfunction and causes midcarpal instabilities due to change in load distribution.

At the end of follow up of 6 months, average range of movement achieved was 56.96˚ dorsiflexion, 50.90˚ palmar flexion, 17.10˚ radial deviation, 23.70˚ ulnar deviation, 73.80˚ supination and 70.70˚ pronation. The observed findings are comparable to other studies.[14,18] Also, the results obtained are well above the minimum range of movement required for normal function, as advocated by Sarmiento.[8]

Fifteen patients experienced residual wrist pain, which was generally mild and provoked by activity but did not substantially interfere with activities of daily living. Six patients had limited wrist range of motion and seven developed finger stiffness, findings that may reflect suboptimal adherence to an intensive rehabilitation program. Four cases developed a mild form of Sudek's dystrophy, which resolved with physiotherapy and analgesics. There were no instances of non-union or carpal tunnel syndrome in our series.

Results were assessed as per De merit system of Gartland and werley (1951) for functional outcome at the end of 6 months of follow up.[8] Majority of our patients (64%) had excellent (38%) to good (26%) outcome. Similar results were obtained in various studies.[11,14,20] Some studies had a higher percentage of patients with excellent to good

results.[10,18] Higher number of patients adhering vigorous rehabilitation program may explain the better results obtained by these studies.

Anatomical results were assessed as per Lidstorm and Frykman Criteria modified by Sarmiento (1980) at the end of 6 months of follow up. Majority (80%) of our patients had excellent (40%) to good results (40%). This is comparable to several studies, who also obtained excellent to good results in majority of their patients.[14,17,20]

External fixation is a simple and cost-effective treatment method for distal radius fractures. It provides effective fracture stabilization while permitting hand movement and reducing the risk of stiffness. Conventional treatment methods for comminuted intra-articular fractures are often associated with pain and limited joint mobility. In contrast, treatment with an external fixator based on the principle of ligamentotaxis allows more reliable anatomical reduction at the fracture site. Although some patients may experience residual joint stiffness, pain and post-traumatic arthritis can largely be minimized. The advantages of external fixation appear to outweigh its potential complications, making it an appealing surgical option for intra-articular distal radius fractures. Its simplicity, versatility, and proven clinical outcomes have established it as an effective tool in the management of these injuries.

CONCLUSION

External fixation offers a suitable and cost affective modality of treatment for intra-articular distal radius fracture. A large multicentred study is required to evaluate the functional outcome of intra-articular fracture of distal radius using external fixator

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