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Functional assessment of external fixation for surgical management of communited intra articular distal radius fractures among adults in a tertiary care hospital

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Abstract
Distal radius fractures are the most frequent fractures occurring in the upper extremity. There is always controversy as to which treatment is to be preferred for distal radius intra articular fractures, internal fixation or external fixation. We conducted a prospective hospital-based clinical study on the management of distal radius fractures with external fixation.
Aim: To assess anatomical and functional outcome and to asses the effectiveness of external fixation in the intra-articular distal end of radius fractures.
Materials and methods: This prospective study comprised 20 patients treated with external fixation. The patients were followed up at six weeks, three months, 6 months and one year after surgery. The assessment of pain, range of motion, grip strength and activity were assessed and scored according to Gartland and Werley scoring systems. Radiographic measurements were also evaluated.
Results: Gartland and wereley scoring were used to evaluate the overall functional results. Excellent to good results were in 85% of patients, and fair to poor results were seen in 15% of patients. Two patients developed pin site infections.
Conclusion: External fixation used for ligamentotaxis is an effective method of treating intra articular distal radius fractures. External fixation as a method in the management of distal radius fracture is an effective method when performed with strict surgical guidelines, under aseptic precautions, and proper reduction of fracture with minimal complication rates and good functional outcome based on Gartland and Werley scoring. The procedure is quick, and the technical learning curve is shorter. Complications like pin site infections can be managed with appropriate antibiotics.

Keywords: External fixator, Gartland and wereley scoring system

Introduction
Fractures of the distal radius are the most common skeletal injuries treated by orthopedic surgeons. It has bimodal age distribution with a peak incidence among young patients with high energy trauma and elderly patients with low energy falls [1]. Distal radius fractures boost up substantial economic costs annually which is gradually increasing with the aging of the population gradually [2]. In the past, closed reduction with immobilization in a plaster cast was considered to be the treatment of choice. However, fractures that involve the articular surfaces and relatively unstable can jeopardize the integrity of the articular congruence and the kinematics of these articulations.
Restoration of volar angulation, radial length, radial inclination are essential for the good functional outcome at the wrist joint.
Unstable fractures of the distal part of the radius have shown an inherent tendency towards loss of reduction after non-operative treatment [3]. In 1929, Bohler lamented that "reduction of this type of fracture-dislocation is obtained relatively easily. However, in the most severe cases, the fragments cannot usually be maintained in a good position by an unpadded plaster cast." It has been recognized that, often, the ultimate functional result will depend, in large part, on the anatomical restoration of the fractured radius. Maintenance of articular congruity and stable fixation decrease the incidence of osteoarthritis and helps with earlier rehabilitation [4].

External fixation has been popular for the treatment of distal radius intraarticular fractures because it combines a minimally invasive procedure with reduction by ligamentotaxis [5].
In view of minimally invasive surgery, we set out to evaluate the radiological and functional outcome of this method to treat distal radius intraarticular fractures.

Aims

1. To assess anatomical and functional outcomes.
2. To asses the effectiveness of external fixation in the intra-articular distal end of radius fractures.

Materials and Methods

This study was performed between JAN 2018 and AUG 2019 on patients with distal radius fractures who visited GSL general hospital, Rajahmundry. The patient criteria for inclusion in this study were age 18-65 years without any other skeletal injury and with fractures with increased volar/dorsal comminution,>10 degrees angulation of major fragments, more than 2mm of articular incongruity, those patients in whom reduction could not be maintained by closed methods, open distal radius fractures. Patients with any other associated injury/fracture, distal radius fractures associated head injury and patients with comorbid conditions rendering them unfit for surgery, patients not willing for the study were excluded from the study.
Fracture management: In the emergency department an initial closed reduction and application of below elbow slab was done for all patients
Radiographs of the forearm with wrist joint in posterior anterior and lateral view were taken and fractures were classified according to Frykmans classification

Frykmans classification

Table 1: Frykmans classification

Fracture	Distal ulnar fracture absent	Distal ulnar fracture present
Extra articular	I.	II.
Intra articular involving radiocarpal joint	III.	IV.
Intraarticular involving distal RU joint	V.	VI.
Intraarticular involving both radiocarpal and distal radioulnar joints	VII.	VIII.

Surgical technique

Under general or regional anesthesia, the patient in a supine position with the injured arm placed on the sidearm board. The longitudinal traction is given with elbow in 90 degrees of flexion while the fracture is being reduced with the wrist in flexion and ulnar deviation. Two 2.5-mm Schanz pins in the second metacarpal and two 3.5-mm pins in the radius proximal to the fracture were inserted. The pins were interconnected and tightened with solid connecting rod and link joints after attaining satisfied closed reduction using image intensifier. In cases of incomplete reduction (eg, step off deformity greater than 2 mm, dorsal tilting, or radial shortening greater than 2 mm) after closed manipulation, we used a percutaneous K-wire, which was inserted through a small incision, to manipulate the fragments and for fixation of radial styloid fractures. One uniplanar bridging EF system was used throughout the study.
After the application of a frame, the final reduction was checked in the C-arm in antero-posterior and lateral views. Sterile betadine dressing of the pin tract site was performed.
Postoperative protocol: Forearm is kept elevated for 24 hrs and active finger, elbow and shoulder movements were started.
The patients were discharged 10 days after surgery under proper antibiotic coverage and active finger movements were advised. The patients were recalled to see the reduction in fracture radiologically after 6 weeks. Acceptable criteria for fracture reduction were:

1. Radial inclination of >15°.
2. Radial shortening of <5 mm compared to the contralateral side.
3. The sagittal tilt between 15° dorsal and 20° volar tilt.
4. Intra-articular step-off of <2 mm.

All external fixators were removed at 6- 8 weeks and monitored physiotherapy started.
All the patients were followed for 6 weeks, 3 months, 6 months and 1 year after surgery and assessed for pain, grip strength, wrist range of motion (ROM) and activity, and scored according to Gartland and Werley.

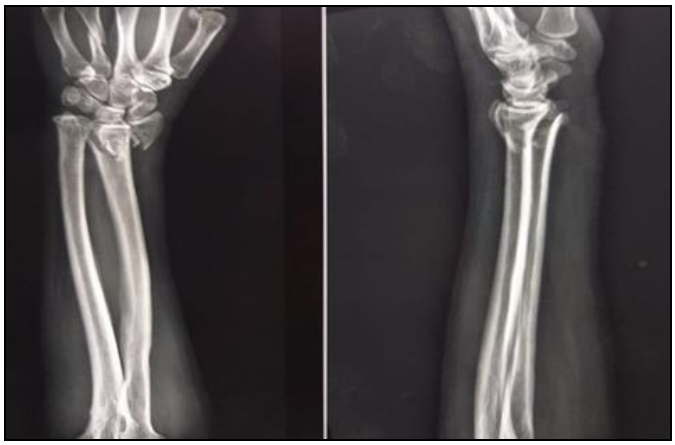

Fig 1: Pre op X ray

Fig 2: Implants and instrument set

Fig 3: Introp Images

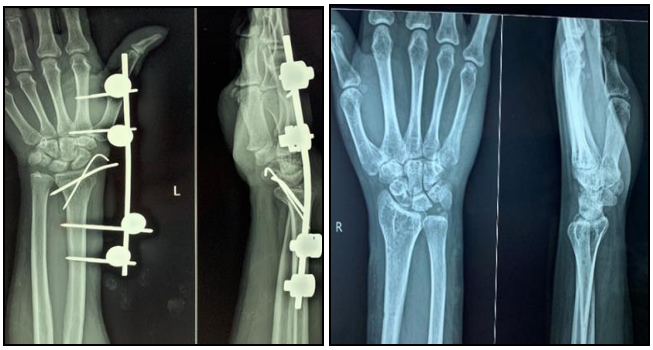

Fig 4: 6W and 6 months postopxray

Fig 5: Wrist extension and flexion

Statistical analysis: All data were entered in SPSS 20.0

Results

In this study, 20 cases were included and all of them were followed up to one year, most of them were in the age group of 31 to 40 years. Among them 13 were males and 7 were females. In 11 patients' dominant side was affected and in 9 patients non dominant side affected. Mode of injury was due to road traffic accidents in 11 patients and in 9 patients it was due to fall.

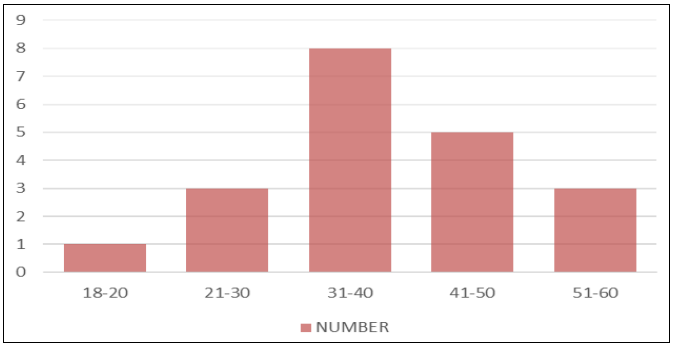

Fig 6: Age Distribution

Functional outcome in 4 patients was excellent, 13 patients had good outcome and 3 patients had fair outcome according to Gartland and Werleys scoring system.

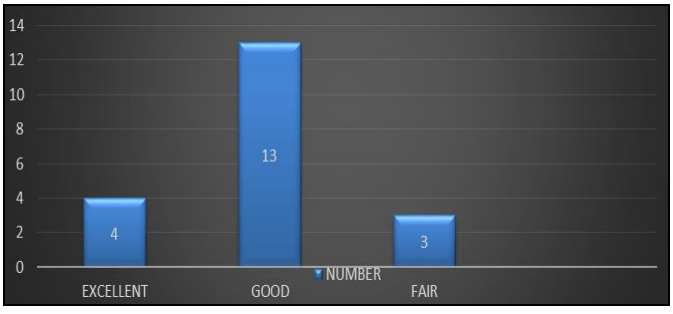

Fig 7: Number

Radiological outcome according to Sarmiento radiological score had an excellent result in 7 patients and good outcome in 10 patients and fair outcome in 3 patients

Complications

Two patients developed pin site infections. We observed a significant reduction in pain, increased ROM, grip strength, activity and final score after 1 year follow-up compared to that at 6 month follow-up.

Discussion

Distal end radius fracture is the most common fracture we treat. Closed reduction and cast immobilization is still the mainstay of treatment for nondisplaced, stable fractures which are characterized by minimal radial metaphyseal comminution, minimal or no loss of height, and no substantial displacement or angulation. Management of comminuted intra-articular fractures has always posed a challenge to the orthopaedic surgeon in terms of fracture reduction, maintenance of reduction while the fracture unites and achieving a functional range of movement of joint after the union of the fracture. Post union functioning of the joint is the most difficult part of the management of comminuted intraarticular fractures. Patient's expectations are very high and good results are not always possible due to the severity of injury, soft tissue damage and periarticular fibrosis that result in the process of healing. Failure in management may cause permanent disability [6].

Intraarticular fractures occur mainly in young patients with good bone stock as a result of violent compression forces and are associated with articular and periarticular tissue damage. High energy injury pathomechanism involved axial load transfer from hand to the articular surface of the distal radius. This cause shearing force which leads to impacted fracture and marked displacement [7]. The male population is 1.7 times more prone to such injuries as is supported by other studies [8-10].

Current treatment goals are centered in the restitution of bony anatomy of the distal radius (radial angle, radial length, and volar tilt) with specific attention to the restoration of articular surfaces of radiocarpal and radioulnar joints [11, 12].

An external fixator is a versatile tool in the treatment of intra-articular fractures of the distal radius. Our standard reduction procedure is similar to the conservative management of these fractures. Continued traction results in controlled distraction of the fracture and facilitates manipulation. This technique is simpler than other techniques. The procedure is performed during a short hospital stay.

The efficacy of ligamentotaxis in neutralizing detrimental compression forces, which are likely to cause displacement of unstable fracture with radial shortening, is a significant and increasingly appealing advance in the management of distal radius fracture.

A large variety of devices are available for external fixation of fractures of the distal aspect of the radius. All involve distraction across the wrist joint with the placement of pins in the radius and the metacarpals. Newer external fixation devices are lighter, easier to assemble and implant, adjustable once the device is secured, and they are radiolucent.

Usual indications of External Fixator are [13].

1. Actual or predicted instability in the dorsally displaced extra-articular or minimal articular fracture of the distal radius.
2. Severe articular fractures and open injuries.

Knirk and Jupiter found that radiological arthritis developed in 91% of wrists which had any degree of articular step and in all of those with a step greater than 2 mm [12]. Their work and that of Melone [14] had resulted in the acceptance of a step in the articular surface up to 2 mm. Mehta *et al*. [15] in their arthroscopic assisted treatment of intra-articular fractures of the distal radius demonstrated that the incidence of pain is significantly related to the size of the step. Patients with no step, <1 mm step and >1 mm step had an incidence of pain of 18%, 38% and 100%, respectively in their study. In our study, we found that intra-articular step of more than 2 mm leads to residual pain and arthritis, and recommend anatomical reduction and acceptance of a step of <2 mm since the size of the step is related to the incidence of pain.

Studies had been done to compare external fixation with percutaneous pin and open reduction with plate fixation for distal radius fracture [16-18]. Williksen *et al.* and Roh *et al*. found that the ORIF group showed an advantage in ulnar variance compared with EF group [17, 18]. Wright *et al*. and Rizzo *et al*. reported better recovery in open reduction and internal fixation (ORIF) compared with EF group in ulnar variance and volar tilt [19, 20]. Most of the results are in favor of volar locking plate, for its radiological and clinical outcome.

To date, there is still no cogent conclusion to favor VLP fixation over an external fixation or vice versa. External fixation relies solely on ligamentotaxis to correct and maintain fracture alignment until healing is achieved [21]. Being less invasive and hence with less surgical trauma and moreover low technically demanding tools to apply, the external fixator is favorable for some surgeons.

Lin *et al*. reported that external fixation is widely used to treat these fractures for its minimally invasive technique [22]. External fixation application did not cause any trauma to soft tissue adjacent to the fracture site and thus prevented the devascularization of the fracture site [23, 24]. The unnecessity for further implant removal surgery is considered to be a favorable factor in some developing countries. Therefore, health care cost would be reduced. EF is also able to prevent further complications that could arise from secondary surgery (implant removal) since EF removal is feasible to be done in office setting under local anesthesia manner.

Table 2: Comparative statistics of functional outcome in distal radius fractures managed by external fixation method can be seen in following table

S. No.	Name of series	Modality of treatment	No of cases	Functional result (good to excellent)	Functional result (fair to poor)
1	XuSQ *et al*. [25]	AO	60	96%	4%
2	Vamshi Krishna *et al*. [26]	AO	26	88.45%	11.54%
3	Deepak CD *et al*. [27]	AO	20	75%	25%
4	Rajeev Shukla *et al*. [28]	JESS	72	77.8%	22.2%
5	Present study	AO	20	85%	15%

Conclusion

In conclusion, after acceptable radiological reduction was achieved in all patients, external fixation has good functional outcome after 1 year of follow-up. Therefore external fixation technique is recommended in treating displaced intra-articular distal end radius fractures

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