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Functional outcome of intraarticular distal end radius fractures in adults fixed with external fixators: A modality of management

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Abstract

Distal radius fractures are a common orthopaedic injury that can be challenging to treat, particularly when they are caused by severe high-energy trauma and involve intra-articular comminution. Conservative methods, such as immobilization in a cast, may not be sufficient for intra-articular fractures due to the complex anatomy of the wrist joint and the high rates of complications associated with these injuries. Therefore, there is a growing interest in exploring innovative treatment options that can improve outcomes for patients with intra-articular fractures of the distal end of the radius.

The aim of this study is to evaluate the functional outcome of the wrist in the management of comminuted intra-articular distal end radius fractures by external fixators. The use of external fixators has been found to be particularly effective in severely comminuted fractures, with minimal complications. The present study aimed to assess the outcomes achieved through external fixation for comminuted intra-articular distal end radius fractures, with a focus on functional outcomes and post-operative complications. The study involved a total of 50 patients who were treated with external fixation and followed up for a minimum of 12 months. The outcomes assessed included range of motion, grip strength, radiographic measures of articular congruity, and the presence of post-operative complications. The results of this study suggest that external fixation is an effective method for treating comminuted intra-articular distal end radius fractures, with good outcomes achieved in terms of functional recovery and prevention of deformity and disability due to malunion. The technique was found to allow for early mobilization and rehabilitation, with a relatively short duration of immobilization required. In addition, the technique was associated with minimal post-operative complications.

The study thus highlights the importance of careful consideration of the choice of fixation method in the treatment of distal radius fractures and the potential benefits of external fixators. The use of novel technologies, such as 3D-printed patient-specific implants and advanced imaging techniques, may offer new treatment options for patients with distal radius fractures. Further studies are also needed to evaluate the long-term outcomes and cost-effectiveness of different treatment modalities, including external fixation, to ensure that patients receive the best possible care.

Keywords: Radius fractures, intra-articular fractures, advanced imaging techniques

Introduction

Lower-end radius fractures are becoming increasingly common due to factors such as age-related osteoporosis and higher energy trauma [1]. Fractures of the lower end of the radius caused by severe high-energy trauma can be particularly challenging to treat due to severe intraarticular comminution, making anatomical reduction and stabilization difficult, and are highly associated with complications [2]. Fractures of the distal end of the radius are the most common fractures treated by orthopaedic surgeons and are often articular injuries that result in disruption of either the radiocarpal joint or the distal radioulnar joint, or both. Intra-articular fractures are often unstable, and reducing them anatomically and immobilizing them in a plaster of Paris (POP) cast can be difficult. As a result, intra-articular fractures of the distal end of the radius are associated with a high rate of complications.

The challenges posed by intra-articular fractures of the distal end of the radius highlight the need for improved treatment methods and techniques. While conservative methods such as

immobilization in a cast are effective for some fractures, such methods may not be sufficient for intra-articular fractures. Therefore, there is a growing interest in exploring innovative treatment options that can improve outcomes for patients with intra-articular fractures of the distal end of the radius.

Closed reduction and immobilization in a cast are often successful for uncomplicated fractures. The best modality of attaining and preserving anatomic reduction of articular surface still remains to be topic of discussion [3]. However, displaced fractures may lead to malunion, making skeletal fixation a recommended alternative [4]. Also, fractures caused by high-energy trauma with severe comminution and intra-articular components can prove more difficult to treat, with conservative options often insufficient [5].

Recent studies have suggested that open reduction fixation with plates, or the use of external fixation, are the most effective techniques for treating these fractures in older patients. External fixation, in particular, offers the advantage of closed reduction while also allowing for the maintenance of accurate radio-carpal alignment [6].

Despite being a low-cost and accessible option, closed reduction and immobilization in a cast do not provide the same level of anatomical reconstruction for bone fragments and joint cartilage as other treatment methods [7]. Given the ongoing debate over the most effective treatment options for these fractures, the aim of this study is to evaluate the outcomes achieved through external fixation [8]. The external fixator has been shown to produce good outcomes in comminuted intra-articular fractures due to its ability to maintain radial length through sustained ligamentotaxis. Its use has been found to be particularly effective in severely comminuted fractures, with minimal complications [9]. In cases of comminuted fractures of the distal radius, trans-articular distraction can lead to satisfactory reduction as the capsular and ligamentous structures are usually preserved [10].

A new approach, dynamic external fixation, allows for movement of the wrist joint during the fixation period, and may improve end functional results [11]. However, restoration of articular congruity remains the most critical factor for a successful outcome [12]. External fixation is a commonly used method for the treatment of unstable distal radius fractures, relying on ligamentotaxis across the wrist joints for approximately six to eight weeks. The primary goals of treatment for distal radius intra-articular fractures are achieving anatomic reduction, stable fixation, and early mobilization [13].

This study aims to evaluate the functional outcome of the wrist in the management of comminuted intra-articular distal end radius fractures by external fixators. The objectives of the study include assessing the duration of immobilization in external fixation, determining the effectiveness of the technique in allowing early mobilization of digits and rehabilitation, evaluating the prevention of deformity and disability due to malunion, examining post-operative complications, and performing a functional assessment of the wrist joint.

Materials and Methods

Study Population: The study population comprised all patients with comminuted intra-articular fractures of the distal end of the radius who met the inclusion criteria and attended the outpatient and inpatient department of Orthopaedics at a tertiary care centre during the study period from September 2020 to November 2022.

Study Design

This was a prospective study conducted over a period of two years, from September 2020 to November 2022. The study included cases that met the inclusion and exclusion criteria. Preoperative clinical evaluation was conducted, which showed deformity and swelling on inspection, tenderness on palpation of the distal end of radius, and restricted painful movements at the wrist. Fracture classification was done according to Frykman's classification system based on the preoperative radiological evaluation. Routine blood and urine investigations were carried out, and consent for surgery was taken. The study only included comminuted intra-articular fractures in adults and excluded extra-articular fractures and children.

Inclusion Criteria

- Skeletally mature patients
- All displaced intra-articular comminuted fractures of the distal end of the radius, including open fractures.
- Injury less than 2 weeks old.

Exclusion Criteria

- Skeletally immature patients
- Pathological fractures other than osteoporosis
- Uncooperative patients.

Surgical Preparations

The study included 30 patients who underwent surgery for comminuted intra-articular distal end radius fractures. Supraclavicular block was administered to 19 cases, while general anesthesia was given to 11 cases. The external fixator system used in the study consisted of a 3.5mm Schantz pin for the radius, a 2.5 mm Schantz pin for metacarpals, a rod to pin Aesculap clamps, and connecting rods of 4mm/ radial distractor.

Surgical Technique

Under suitable anesthesia, the patient was placed supine on the operating table with the arm on a side armrest. Linear sustained traction with manipulation of the deformity was performed. Palmar flexion and ulnar deviation were given to maintain radial length and volar angulation. Forearm and hand were painted and draped under all aseptic precautions. The wrist was kept in palmar flexion and ulnar deviation, and primary reduction was achieved and maintained with K-wires. A stab incision was made approximately 10 cm proximal to the fracture site by palpating the lateral border of the radius. Soft tissue was displaced, and the drill was positioned centrally to avoid injuring any soft tissue during drilling. The radius was drilled with a 2.5 mm drill bit and fixed with a 3.5 mm Schantz pin. Another stab incision was made over the lateral aspect of the hand over the base of the 2nd metacarpal. It was drilled with a 1.5mm drill bit and fixed with a 2.5mm Schantz pin.

The 4mm connecting rod was fixed to the Schantz pins with the clamps. The remaining 2 pins, one in the shaft of the radius and the other in the second metacarpal, were fixed. The external fixation device was then tightened, and reduction was carefully assessed under fluoroscopy guidance. At the end of the surgical procedure, sterile dressings were done to the Schantz pins, and fingers were checked for capillary refilling. The fingers were left free to allow full range of motion. As post-operative care, antibiotics (Inj. Ceftriaxone 500mg twice daily for 5 days) were given along with adequate analgesia as

needed.

Results

Sex Distribution: Out of the 30 patients, the majority were males, with 26 (87%) males and 4 (13%) females.

Mode of Trauma

Most of the cases (80%) were due to road traffic accidents (RTA), followed by fractures due to falling on an outstretched hand (13%) and assault (7%) (Table 1).

Table 1: Frequencies for mode of trauma

Mode of Trauma	Frequency	Percent (%)
Assault	2	6.667
Fall	4	13.333
Road Traffic Accident (RTA)	24	80
Total	30	100

Frykman’s Type: The majority of the cases were Type VII, constituting approximately 33% of all cases (Fig. 1).

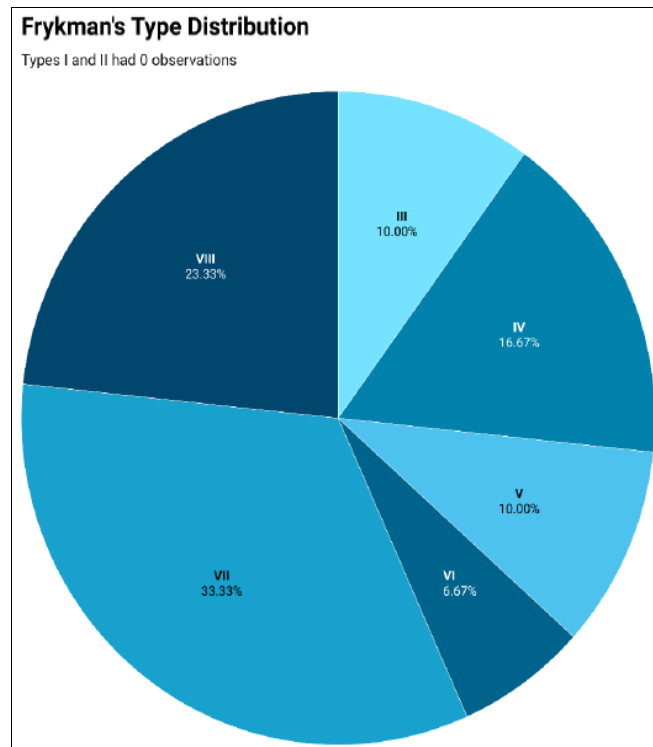


Fig 1: Pie chart - Frykman type distribution

Functional Assessment

The Modified Green O’Brian Scoring system was used for functional assessment (Table 2).

Table 2: Modified Green O’Brian Scoring

Category	Score	Findings
Pain	25	None
	20	Mild
	15	Moderate
	0	Severe
Functional status	25	Same job
	20	Different job
	15	Able, no job
	0	Unable
Palmer-Dorsiflexion Arc	25	100%
	15	75-99%
	10	50-74%
	5	25-49%
Grip Strength	0	0-24%
	5	25-49%
	10	50-74%
	15	75-99%
Scoring:		
Excellent: 90-100		
Good: 80-89		
Fair: 65-79		
Poor: <65		

Out of the 30 patients, 5 had no deformity or pain and had less than 25% limitation of range at the wrist and forearm compared to normal. These patients did not present with any complications and were rated as excellent.

Eleven patients had no wrist deformity. Some initial pain and limitation of motion were present. The limitation of motion of the wrist and forearm was less than 20% compared to normal. One patient had a superficial pin tract infection that was controlled with oral antibiotics. The result was rated as good.

On subjective evaluation, five patients experienced pain, limitation of motion, and restricted activities around the wrist. Their range of motion of the wrist and forearm was limited to less than 50% compared to normal. One of these patients had ulnar styloid process prominence, and the result was rated as fair.

One patient who underwent surgery 12 days after the injury had a dinner fork deformity with pain, limitation of motion,

and restricted activities around the wrist. There was a limitation of motion of more than 50% associated with slight crepitation, and the result was rated as poor. The average duration from the date of injury to the date of operation was 1-3 days.

Radiographs

Radiographs demonstrated maintenance of radial length between 1-4 mm of original reduction in all patients.

In summary, the majority of cases were Type VII Frykman’s fracture, and most occurred due to RTAs. The Modified Green O’Brian Scoring system was used for functional assessment, and patients were rated as excellent, good, fair, or poor based on their presentation. Radiographs demonstrated that radial length was maintained between 1-4 mm of original reduction in all patients.

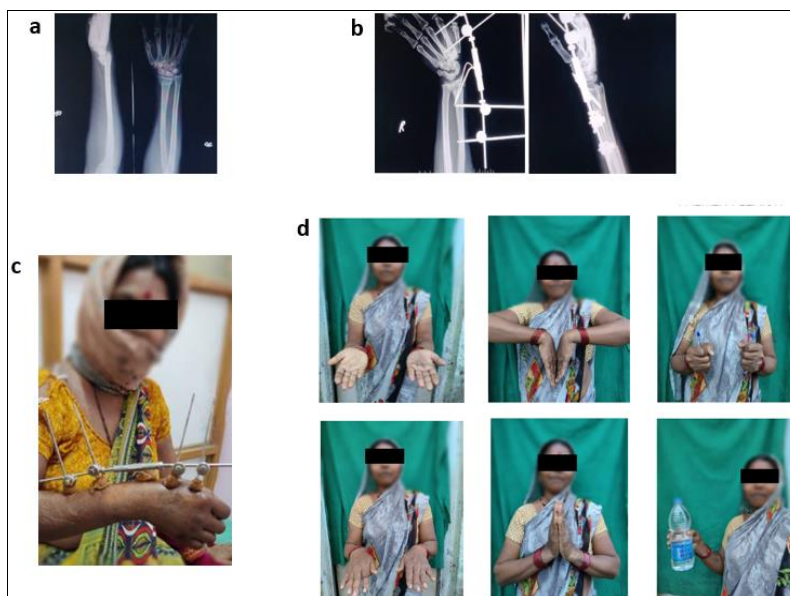


Fig 2: Case 1: a. Pre-operative X-Rays. b. Post-operative X-Rays. c. Post-operative clinical photo. d. Supination, Palmer Flexion and Grip Strength (Up, left to right), Pronation, Dorsi Flexion and Grip Strength (Down, left to right)

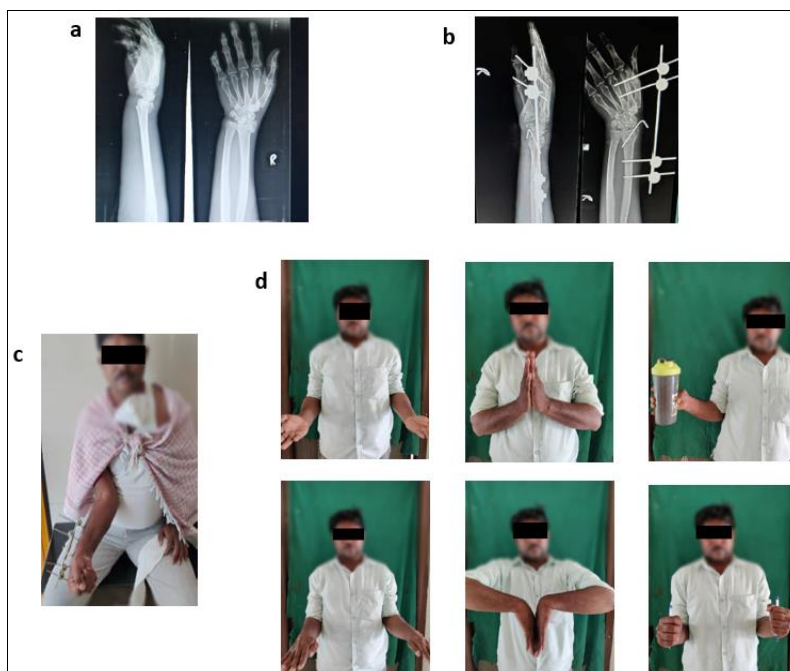


Fig 3: Case 2: a. Pre-operative X-Rays. b. Post-operative X-Rays. c. Post-operative clinical photo. d. Supination, Dorsi Flexion and Grip Strength (Up, left to right), Pronation, Palmer Flexion and Grip Strength (Down, left to right)

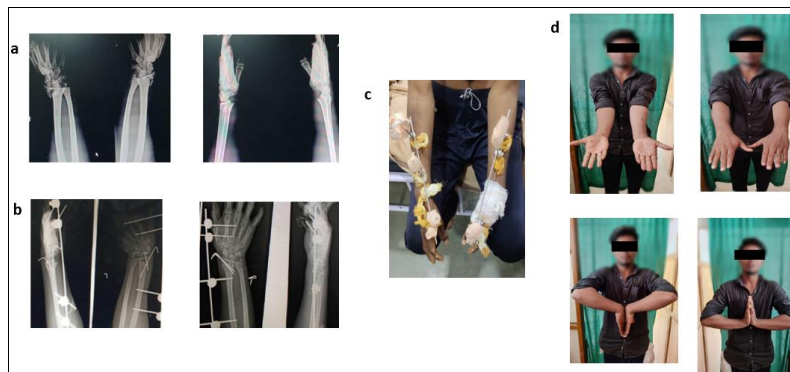


Fig 4: Case 3 & 4: a. Pre-operative X-Rays. b. Post-operative X-Rays. c. Post-operative clinical photo. d. Supination, Dorsi Flexion and Grip Strength (Up, left to right), Pronation, Palmer Flexion and Grip Strength (Down, left to right)

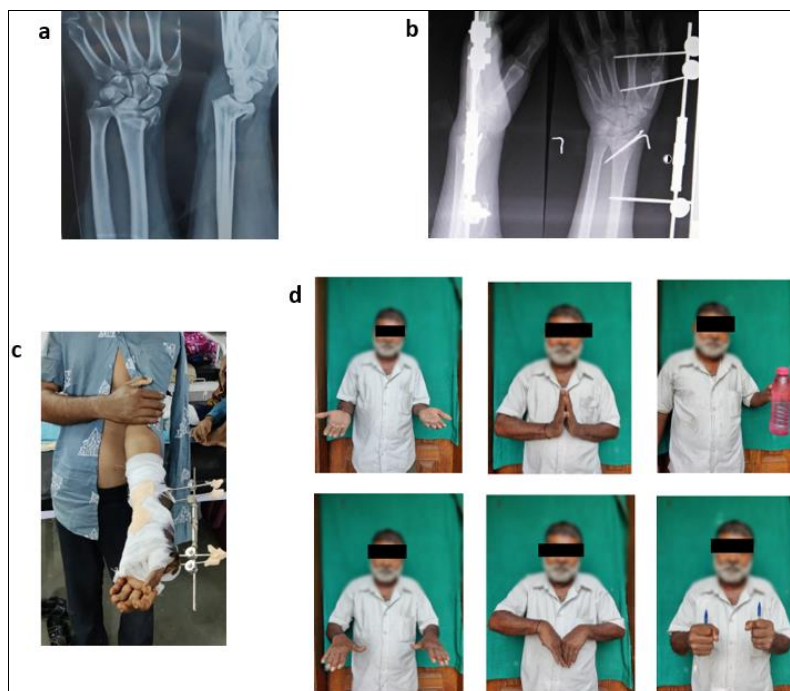


Fig 5: Case 5: a. Pre-operative X-Rays. b. Post-operative X-Rays. c. Post-operative clinical photo. d. Supination, Dorsi Flexion and Grip Strength (Up, left to right), Pronation, Palmer Flexion and Grip Strength (Down, left to right)

Discussion

The treatment of distal radial fractures has evolved significantly since A. Colles described his approach [14] in 1814. However, recent literature highlights that unsatisfactory outcomes are still prevalent in the management of these fractures. The management of these fractures has become more challenging due to the increased life expectancy and activity levels of the elderly population. This has led to the development of newer treatment options, such as external fixation, for comminuted intra-articular fractures of the distal radius. This discussion will review the literature on the prevalence of unsatisfactory outcomes and the evolution of management modalities.

Prevalence of unsatisfactory outcomes

DePalma (1952) [15] suggested that a residual dorsal tilt of more than 5 degrees of the distal end of the radius leads to a poor outcome. Gartland and Werley (1951) [16] reported that immobilization of a distal radius in POP cast alone resulted in 60% loss of articular reduction and an unsatisfactory outcome with regard to functional loss and pain in 19 (32%) of their 60 patients. Cole and Obletz (1966) [17] observed radial shortening in the majority of their patients. Chapman *et al.* reported radial shortening in a significant proportion of

patients managed by a similar technique, leading to a complication that required reoperation in some patients [18].

Functional outcomes

Short *et al.* observed that loss of volar angulation after a distal radius fracture leads to increasing load on the ulnocarpal and radio scaphoid joints, leading to pain and early arthritic changes [19]. Taleisnik and Watson (1987) [20] reported a correlation between malunion of the distal end of the radius and dynamic midcarpal instability. Hence, achieving good volar tilt is essential for good functional outcomes.

Evolution of management modalities

External fixation was critically reviewed by Cooney *et al.* in 1979 as a treatment modality for distal radial fractures [21]. They reported a good result for the majority of their patients, with good radial height and improved volar angulation. Since then, external fixators have become a popular and reliable treatment option. Currently, a common algorithm followed for unstable distal radial fractures is external fixation augmented with K-wires and the use of bone graft or its substitutes.

Ligamentotaxis by External Fixator

The ligamentotaxis by external fixator is a treatment option

for comminuted intra-articular fractures of the distal radius. The standard reduction procedure is similar to conservative management of these fractures. The method is simpler than other treatment options available and demands a short hospital stay. The external fixation technique is reliable for maintaining anatomic reduction longitudinally as well as of radial length. Vidal *et al.* showed that comminuted intra-articular fractures, which have dorsoulnar fracture fragments, can be reduced with sustained ligamentotaxis [22].

Efficacy of External Fixator

In comparison to other standard studies, our study results were similar. In our study, one case was operated on seven days after injury, he ended with poor results. The soft tissue changes that had occurred within these twelve days prevented adequate dorsiflexion and ulnar deviation. Hence, we recommend external fixator be applied within seventy-two hours to achieve favourable results. Good results were obtained in the majority of patients, and excellent results were obtained with low rates of complications. However, we observed that applying the external fixator within 72 hours of injury resulted in favourable outcomes. So delayed application resulted in poor results due to soft tissue changes.

Comparison with Other Treatment Modalities

Recently, open reduction fixation with plates, as well as external fixation, have become popular fixation techniques for the treatment of these fractures in the elderly. External fixation has the advantage of closed reduction and maintaining anatomic radio carpal alignment [6].

Advantages of External Fixator

External fixation maintains radial length best due to sustained ligamentotaxis. The procedure has minimal complications, making it an effective option for comminuted intra-articular fractures [9]. Satisfactory reduction may be obtained by trans-articular distraction in comminuted fractures of the distal radius, as the capsular and ligamentous structures are usually preserved [10]. Aggarwal A *et al.* (2004) [23] recommended that for maintaining the reduction of these fractures, external fixation is better than cast, percutaneous pinning or internal fixation, which is difficult in cases of comminuted fractures. External fixation is an effective option for comminuted intra-articular fractures of the distal radius. Applying the external fixator within 72 hours of injury can result in favourable outcomes, whereas delayed application can lead to poor results due to soft tissue changes. The ligamentotaxis by external fixator is a reliable treatment option that can maintain anatomic reduction longitudinally and of radial length. The use of external fixation can result in minimal complications and is an effective alternative to other treatment modalities for comminuted intra-articular fractures of the distal radius.

Conclusion

External fixation is a reliable, effective, and inexpensive treatment modality for distal end radius fractures. The use of external fixator has evolved and has become a well-established method for treating wrist fractures, providing anatomical reduction and preventing stiffness. Our study demonstrates that the external fixator is an attractive option for treating intra-articular distal end radius fractures, with excellent results obtained in 80% of cases. The result were also considered good in terms of wrist deformity. The procedure is associated with minimal complications, and careful dissection and pin placement can help to avoid nerve

and tendon injuries. The use of external fixation prevents joint stiffness and maintains radial length, making it a better option than open reduction and internal fixation with plating for severely comminuted fractures. Trans-articular distraction can also provide satisfactory reduction in comminuted fractures of the distal radius.

The findings of our study are consistent with previous literature, suggesting that external fixation is a versatile tool for the treatment of these injuries. Future research should focus on identifying optimal methods for pin placement, dressing, and management of complications, to improve outcomes further.

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Conflict of Interest

Not available

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Not available

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