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Original Research Article

Analysis of Outcomes between Intramedullary and Extramedullary Fixation of Fracture of Radius and Ulna

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Abstract:

Introduction: The radius and ulna are the most usually fractured upper extremity bones owing to falls on extended hands. Imaging confirms the diagnosis and children often have buckle or greenstick fractures treated by angulation. "Distal radius fractures" in adults are commonly splinted. Midshaft ulna fractures may need surgery or immobilisation. Surgery is frequently needed for many fractures. Elbow function is important with radial head fractures.

Aims and Objectives: This study compares intramedullary and extramedullary forearm fracture fixation procedures.

Method: This prospective study at Sheth L.G. Hospital in Ahmedabad, India, examined 18 to 65-year-olds with concurrent closed radius and ulna shaft fractures from July 2021 to May 2023. The surgery involved open reduction and dynamic compression plate or intramedullary nailing for internal fixation. Fracture union, comorbidities, and function were examined. Its rigorous methodology allowed a meaningful comparison of intramedullary and extramedullary fixation for both bone forearm fractures, providing clinical insights.

Result: Table 1 lists the anterior fascial compartment's forearm muscles' origins, insertions, and nerve supplies. These muscles include the Pronator Quadratus, which originates from the ulna's anterior surface and enters into the radius in Table 2. Table 3 shows primary function is forearm pronation, twisting the palm downward or posteriorly for actions like turning a doorknob or altering hand orientation. Innervated by the median nerve's anterior interosseous branch (C8, T1). This muscle coordinates forearm and hand movements in Table 4.

Conclusion: Our study found that intramedullary nail fixation for forearm fractures is comparable to plate fixation and has fewer complications.

Keywords: "Distal radius fractures", "Fracture union", "internal fixation", "ultrasonographic examination".

Introduction

The radius and ulna are the bones that fracture most commonly in the upper extremity, with distal fractures occurring more often than proximal fractures. A fall onto an outstretched hand is the most common mechanism of trauma leading to fractures of the radius and ulna [1]. The diagnosis may often be confirmed with radiographic or ultrasonographic examination. If the first imaging findings are negative but there remains a suspicion of a fracture, splints follow-up radiographs must be performed in seven to fourteen days. Children often sustain buckle (torus) fractures, incomplete fractures caused by compression without cortical damage. Children frequently get greenstick fractures, which include cortical damage. Buckle & fractures of the greenstick can be handled by immobilization, according to the degree of angulation [2]. The most frequent forearm fracture in adults is a distal radius fracture, which is often brought on by falling onto an extended hand. The first line of therapy for an is a sugar-tong splint nondisplaced or mildly displaced distal radius fracture [3]. Then a short-arm brace is put on for an initial period of three weeks. It should be emphasized that a median nerve lesion may exacerbate these fractures [4]. When the forearm is struck directly, solitary midshaft the ulna (nightstick) fractures frequently result. Whichever is the degree of dislocation and angulation, these fractures can either be treated surgically or by immobilization [5]. The treatment of multiple fractures affecting both the ulna & the radius usually involves surgery. Radial head fractures occur when there are limitations in elbow extension and supination following trauma should be considered even if they may be difficult to see on the first imaging. Using the Mason classification, the unique aspects of the fracture determine how to treat radial head fractures [6].

Forearm fractures in both bones are caused by high-energy trauma in young persons with good bone quality. Adult bone fractures are most frequently caused by falls from height, sports injuries, and automobile accidents [7]. The only people who frequently get both bone forearm cracks after low-energy trauma, such falling from a standing position, are those who have poor bone quality. Despite the prevalence of radial & ulnar shaft fractures, there are few studies that describe the epidemiology [8]. The age apparently bimodal distribution, with peaks before and after beyond the age of 40. When compared to women, men have both types of bone fractures at equal rates in infancy. After the age of 60, however, women incur a larger percentage of fractures. Active people and high school athletes have also been demonstrated to be at-risk groups [9]. When assessing the two bone forearm fractures, orthogonal radiography of the forearm ought to be taken. The forearm should be shown in both lateral and AP (anterior-posterior) views on standard radiographs [10]. When necessary, oblique forearm views and images of both the elbow and wrist should be taken into account. When there are both bone forearm fractures, a CT scan is rarely necessary, although it may be helpful for complicated fractures or if intraarticular involvement is a concern [11].

Method

Research Design

This prospective study was conducted at Sheth L.G. Hospital in Ahmedabad, India, from July 2021 to May 2023. The study specifically targeted patients with both bone forearm fractures and utilised rigorous inclusion and exclusion criteria. Inclusion criteria encompassed individuals between the ages of 18 and 65 who presented with concomitant closed fractures of the radius and ulna shaft. Eligible participants were required to express a willingness to partake in the study and possess a minimum follow-up period of 6 months. The study gathered extensive data, including clinical information, radiographic observations, fracture categorization, treatment methods (intramedullary or extramedullary fixation), and several subsequent examinations. The surgical procedures employed for the treatment of radius and ulna fractures encompassed open reduction and internal fixation utilising dynamic compression plates or intramedullary nailing. Following the surgical procedure, patients were administered antibiotic prophylaxis and underwent routine post-operative evaluations. The key end measures of the study encompassed the radiographic evaluation of fracture union, the surveillance of complications (such as infection, non-union, radio ulnar synostosis, and nerve palsy), and the assessment of functional outcomes utilising the modified Grace and Eversmann scoring systems. The research methodology employed in this study was comprehensive, allowing for a thorough comparison of treatment outcomes for forearm fractures including both bones. Specifically, the study compared the effectiveness of intramedullary and extramedullary fixation procedures. This research design was of great practical value within the clinical environment.

Inclusion and exclusion criteria

Inclusion

- The age range considered for this study is between 18 and 65 years.
- The patient presented with a case of closed simultaneous fractures involving the shafts of both the radius and ulna.
- Patients who express a willingness to engage.
- A minimum follow-up time of six months is required.

Exclusion

- Younger than 18 or older than 65.
- The topic is open fractures.
- Associated ipsilateral upper limb injuries.
- The topic is Galeazzi and Monteggia fracture-dislocations.
- Patients who need hybrid fixation (nailing and plating).
- Same-limb fractures before the current injury.
- Segmental diaphyseal fractures break a bone into two or more segments along its shaft.

Statistical analysis

The statistical analysis used descriptive statistics to summarise the study participants' demographic and clinical information, including age, gender, injury mechanisms, and fracture sites. The mean and standard deviation determined radiological union duration.

The study compared intramedullary and extramedullary fixing results. Chi-squared and t-tests were used to discover significant differences in functional outcomes, complications, and fracture union rates. The statistical significance threshold was set at $p < 0.05$. This study examined the efficacy of various repair methods for forearm fractures involving both bones.

Ethical Approval

This study was approved by the ethical committee of our hospital.

Result

Table 1 presents a comprehensive overview of the muscles located in the anterior fascial compartment of the forearm, providing detailed information regarding their origins, insertions, nerve supplies, nerve roots, and respective activities. One of the muscles in question is the Pronator Quadratus.

The muscle in question comes from the anterior surface of the ulna and enters into the anterior surface of the radius. The nerve supply of the muscle in question is derived from the median nerve, more specifically from its anterior interosseous branch. The innervation of this muscle is provided by the nerve roots C8 and T1. The principal role of the Pronator Quadratus muscle is to execute pronation of the forearm, a movement that entails the rotation of the forearm and hand in a manner that orients the palm in a downward or posterior direction.

This action is crucial for a multitude of actions, such manipulating a doorknob or executing a downward motion of the palm from an initially upward-facing hand. It facilitates the execution of diverse and synchronised movements involving the forearm and hand.

Table 1: Muscles of anterior fascial compartment of forearm

Name of Muscle	Origin	Insertion	Nerve Supply	Nerve Roots	Action
Flexor Carpi Ulnaris	Humeral head - medial epicondyle of the humerus Ulnar head - olecranon of the ulna.	Pisiform bone, hook of hamate, and base of the 5th metacarpal	Ulnar nerve	C7, C8, T1	Flexion and adduction at the wrist
Palmaris Longus	Medial epicondyle of humerus	Flexor retinaculum of the wrist	Median nerve	C7, C8	Flexion at the wrist
Flexor Carpi Radialis	Medial epicondyle of humerus	Base of second and third metacarpals	Median nerve	C6, C7	Flexion and abduction at the wrist
Pronator Teres	Medial epicondyle of humerus, and coronoid process of ulna	Mid-shaft of the radius	Median nerve	C6, C7	Pronation of the forearm
Flexor Digitorum Superficialis	Two heads – one originates from the medial epicondyle of the humerus, the other from the radius	Splits into four tendons at the wrist, which attach to the base of the middle phalanx of the four digits	Median nerve	C8, T1	Flexion at the metacarpophalangeal and proximal interphalangeal joints at the 4 fingers, and flexion at the wrist
Flexor Digitorum Profundus	Ulna and associated interosseous membrane	Splits into four tendons at the wrist, which attach to the base of the distal phalanx of the four digits	Medial half - ulnar nerve Lateral half - Anterior Interosseous branch of the Median nerve	C7, C8, T1	Flexion at distal interphalangeal joints of 4 fingers, flexion at metacarpophalangeal joints and at the wrist
Flexor Pollicis Longus	Anterior surface of the radius and surrounding interosseous membrane	Base of the distal phalanx of the thumb	Median nerve (anterior interosseous branch)	C8, T1	Flexion at the interphalangeal joint and metacarpophalangeal joints of the thumb
Pronator Quadratus	Anterior surface of the ulna	Anterior surface of the radius	Median nerve (anterior interosseous branch)	C8, T1	Pronates the forearm

Table 2 shows all injury characteristics and side distributions in the study population.

The majority (36.59%) of patients are 31-40 years old, followed by 18-30 (24.39%). 68.29% of the population is male and 31.71% female. The table shows that 57.32% of observations are on the left and 42.68% on the right. When considering gender and lateralization, 39.29% of male injuries were on the right side and 60.71% on the left. 38.46% of women were right-sided, while 42.31% were left-sided.

According to the report, 45.12% of injuries are caused by road traffic accidents, 25.61% by household falls, and 29.27% by attacks.

Comprehensive data helps explain the patient cohort's demographics and harm trends.

Table 2: Injury characteristics and Side distribution

Age group (years)	Number of patients	Percentage			
18-30	20	24.39%			
31-40	30	36.59%			
41-50	16	19.51%			
51-60	12	14.63%			
61-65	4	4.88%			
Sex	**Number of patients**	**Percentage**			
Male	56	68.29%			
Female	26	31.71%			
Side	**Number of patients**	**Percentage**			
Right	35	42.68%			
Left	47	57.32%			
Sex		**Side**		**Total**	
		Right	**Left**		
Male	Frequency	22	34	56	
	Percentage	39.29%	60.71%	100%	
Left	Frequency	13	13	26	
	Percentage	50%	50%	100%	
Mode of injury	**Frequency**	**Percentage**			
Road traffic accident	37	45.12%			
Domestic fall	21	25.61%			
Assault	24	29.27%			
Sex		**Mode of injury**			**Total**
		Road traffic accident	**Domestic fall**	**Assault**	
Male	Frequency	27	10	19	56
	Percentage	48.21%	17.86%	33.93%	100%
Female	Frequency	10	11	5	26
	Percentage	38.46%	42.31%	19.23%	100%

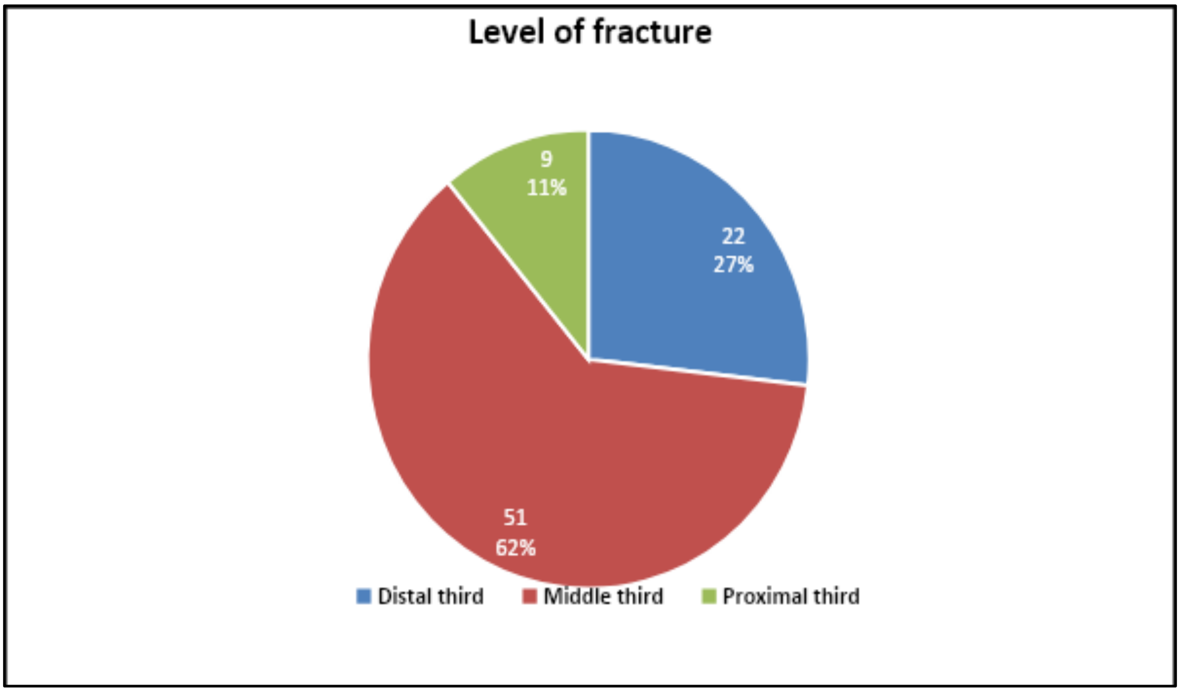

Figure 1: Level of fracture

Figure 1 shows bone fracture distribution by location. The bulk (62.20%) is in the central part of the bone. The proximal third accounts for 10.97% of fractures, while the distal third accounts for

26.83%. This information helps healthcare experts locate the fracture pattern, which can determine the best therapy.

Table 3 shows functional outcomes by medical fixing type. The publication gives a complete patient population overview with numerical data and percentages for each functional outcome category. The "Excellent" group has 27 patients, 32.93% of the population. However, 47 patients (57.32% of the population) are classified as "Good". A sample of 8 individuals, representing 9.75% of the population, had "fair" outcomes. In this study, no "Poor" results were recorded. The table categorises outputs by fixation type.

In extramedullary (plating) fixation, 39.02% of patients had "Excellent" outcomes while 53.66% had "Good" outcomes. Additionally, 7.32% of patients had "Fair" outcomes. In contrast, intramedullary (nailing) fixation yielded 26.82% "Excellent," 60.98% "Good," and 12.20% "Fair." This study helps healthcare providers make informed treatment decisions by improving understanding of functional outcomes from various fixation techniques.

Table 3: Functional outcome as per fixation

Functional outcome	**Number of patients**	**Percentage**				
Excellent	27	32.93%				
Good	47	57.32%				
Fair	8	9.75%				
Poor	0	-				
Fixation		**Functional outcome**				Total
		Excellent	Good	Fair	Poor	
Extramedullary (Plating)	Frequency	16	22	3	0	41
	Percentage	39.02%	53.66%	7.32%	-	100%
Intramedullary (Nailing)	Frequency	11	25	5	0	41
	Percentage	26.82%	60.98%	12.20%	-	100%

Table 4 presents a comprehensive overview of the problems linked to a certain medical operation or condition, including valuable information regarding their occurrence rates within the dataset. Two cases each of superficial infection and nail impingement were documented, while one case of olecranon bursitis was noted. The numerical data shown in this study signifies the frequency of each complication, underscoring the significance of maintaining a state of alertness and employing suitable strategies to guarantee patient well-being and the efficacy of the medical intervention. The monitoring and management of these problems are essential measures in enhancing patient outcomes and mitigating risks throughout the duration of therapy or procedures.

Table 4: Complications

Complications reported	**Frequency**
Superficial infection	2
Nail impingement	2
Olecranon bursitis	1

Discussion

The best method of fixation remains debatable when surgical stabilization of forearm injuries in older kids is required. Forearm fractures in children aged 10 to 15 were examined in the present investigation were treated with intramedullary nailing vs Plating to contrast the functional and radiographic outcomes [16]. Our preferred approach of treatment for youngsters between the ages of 10 and 16 who are skeletally immature length-stable forearm fractures is nailing rather than plating due to similar functional and radiological results [12]. IMT vs. EM fixation of the distal biceps pushbutton should be compared biomechanically under cyclic loading circumstances, since this is the condition that most accurately reflects postoperative physiologic state. When subjected to cyclic loading and overloading circumstances, there are no appreciable differences tendon gap between the IM and EM methods creation and loss of force [13]. Since there is less chance the posterior interosseous nerve may develop as a result of intentional injury with IM fixation than with bicortical extramedullary fixation, IM fixation may effectively enable optimum bone-tendon apposition [14].

Diaphyseal forearm fractures seldom fail to heal. They are typically linked to complicated injuries or complications like infections. Since most nonunions are atrophic and result in a clear bone, deformity. For the treatment of these instances, bridge plates for bone grafts were employed; however, a history of low bone quality, especially when the bone is not being used, may decrease the screw purchase and fixation stability [15]. Increased fixation stability and higher success rates may result from combining intramedullary and extramedullary fixing. In the study, combined intramedullary & extramedullary fixation having autologous iliac spine bone grafts were used to treat forearm nonunions with significant bone loss. Treatment for challenging forearm nonunions with considerable bone loss involves a combination of intramedullary as well as extramedullary fixation and autogenous bone transplantation [16].

The research was created to assess the effectiveness of the Foresight forearm interlocked intramedullary nails in treating forearm diaphyseal fractures. The Foresight forearm locking intramedullary spike was used to treat all fractures. With the help of the static interlocking approach, 18 fractures were stabilized [17]. Patients were evaluated based on their recovery duration, functional ability, and frequency of problems. Using Grace and Eversmann's assessment method, physical ability was evaluated. You may learn more about your disability by taking the DASH questionnaire the patient-rated result was evaluated [18]. It is appropriate to use forearm interlocking intramedullary nails to stabilise adult patients with displaced forearm diaphyseal fractures [19].

Up as 5.4% of all paediatric fractures in the UK are both-bone diaphyseal forearm fractures. With closed reduction with cast immobilisation, the majority of cases are manageable. Flexible intramedullary nailing & plating are surgical fixing methods [20]. However, there is debate on the best approach. The study's primary objective was to thoroughly review the literature on nailing and plating in both-bone diaphyseal forearm fractures among kids under the age of 18 and compare the functional outcomes, radiological outcomes, and side effects [21]. Placing instead of nailing in paediatric forearm injuries seems to be a safe and sensible choice based on comparable functional and radiological results. However, a thorough analysis of the research in this review revealed significant methodological flaws, and it is advised to conduct more prospective, randomised trials [22].

In individuals who had the aim of the present investigation was to evaluate the radiographic and functional outcomes of open reduction and internal fixation (ORIF) of both-bone forearm fractures utilising plates & intramedullary (IM) nailing [23]. When compared to ORIF, IM nailing has a shorter operating duration and reduced complication rate. Both toddlers and adults who have both forearm fractures can benefit from this efficient and secure course of therapy. To confirm these findings, however, large-scale, high-quality randomised controlled studies are required due to the study's limitations [24].

Conclusion

The study concluded that both bone forearm fractures, which involve simultaneous radius and ulna shaft diaphyseal fractures, are prevalent in orthopaedics and can impede forearm rotation and function if not effectively handled. Our study demonstrated that intramedullary nail fixation can achieve similar results to extramedullary fixation utilising open reduction and plate osteosynthesis, which is widely accepted. Anatomical alignment and robust plate fixation preserve the radial bow and improve function.

However, surgical exposure problems such as infection, devascularization, and neurovascular hazards have pushed us to consider intramedullary nailing for select individuals. Intramedullary nailing preserves local biology and improves cosmetics without precise anatomical reduction. We found no significant differences in time to radiological union and functional outcomes at 6 months between extramedullary plate and intramedullary nail fixation. Thus, while plate fixation is preferred for its rapid mobilisation and return to daily activities, intramedullary nail fixation may be an option for patients with appropriate canal dimensions and a willingness for extended immobilisation due to its lower risk of complications.

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