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Original Research Article

Functional outcome of intramedullary nailing in radius ulna shaft fracture-an observational study in tertiary centre

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Abstract

Background: The radius and ulna exist in a delicate anatomical balance that allows for pronation and supination of the hand in a 180-degree arc of motion. The anatomical bow of the radius allows for rotation around a fixed ulna, and its structure is critical for this motion. In the forearm fractures, the most common site is at the distal radius or ulna The forearm fractures may result from both low energy and high energy trauma. The most common mechanism of injury for such injuries is axial loading applied to the forearm, which is a fall onto an outstretched hand. Treatment options range from conservative to surgical methods. Conservative treatment includes Closed Reduction and plaster cast application. Surgical treatment comprises of Closed Reduction & Internal Fixation with Elastic Intramedullary nails & Open Reduction & Internal Fixation with plates.

Methods: In our study we included forty patients of both bone radius and ulna shaft fracture treated with open or close reduction with intramedullary nails. In this study we included patients with age above 10 years with diaphyseal shaft fracture of radius and ulna. We excluded patients with age less than 10 years, along with single bone shaft fracture. Also, patients with pathological fractures were excluded as well. We collected our data by interviewing and by regular follow up. Our study design is observational. Our study having maximum follow up of 3 to16 months for 2.5 years.

Results: We had almost equal amount of patient in males and females with both bone forearm fracture. Twenty-two patients had right sided fracture and eighteen patients had left sided fracture. Most common mode of injury was domestic fall and road traffic accident patients being second most common. In our study middle one third radius and ulna shaft fracture pattern was the commonest. In our study seven patients required mini open surgery after closed failed reduction. In our study of we observed 12.5% patients with excellent result, 75% with good result, 7.5% with fair result and 5% with poor result. Post operatively seven patient had complications in which three patients had superficial infection, nail impingement had each non-union as well as delayed union.

Conclusion: Our study involves of forty cases of both bone forearm fracture treated with intramedullary nails have advantages in terms of preservation of soft tissues and maintaining

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the fracture hematoma lead to less chances of infection, less timing for surgery, less postoperative complication and cosmetically preferable option. But our study also highlights on drawbacks of intramedullary nailing like nail impingement and chances of non-union with postoperatively late mobilization can lead to less full movement recovery and it also concluded that for both bone forearm fracture closed intramedullary nailing is preferable option over the standard operation like platting technique.

Keywords: Radius ulna fractures, forearm fractures, tens nail, square nail, rush nail

Introduction

The forearm consists of two relatively parallel bones that connect two joints: Elbow and wrist. Besides, the two bones themselves form joints that help in supination and pronation therefore, forearm fractures are considered intra-articular fractures. Proper management of such fractures is necessary to restore forearm functions, including supination and pronation, elbow and wrist movements, and handgrip strength [1, 2].

The radius and ulna exist in a delicate anatomical balance that allows for pronation and supination of the hand in a 180-degree arc of motion. The anatomical bow of the radius allows for rotation around a fixed ulna, and its structure is critical for this motion. Any disruption in the anatomy of the forearm can lead to a significant loss of the normal range of motion that allows for motions as complex as a golf swing or as simple as turning the page in a book [3].

The forearm fractures are common in the paediatric population, with an incidence of around 1 in 100 children each year, and the peak incidence occurs in the 5 to 14 years age group accounting for approximately 34% of the cases. Both bone diaphyseal forearm fractures constitute around 5.4% of all fractures in children under 16 years of age. Among adults, a relatively higher incidence is reported between 25 to 34 years of age group [3].

In the forearm fractures, the most common site is at the distal radius or ulna (32.9%) and the least common location is the proximal region (2.8%). Open fractures, on the other hand, most commonly involve the diaphyseal region [4, 5].

The forearm fractures may result from both low energy and high energy trauma. The most common mechanism of injury for such injuries is axial loading applied to the forearm, which is a fall onto an outstretched hand [6]. In adults, the other common mode of injuries that result in forearm fractures are motor vehicle accidents, athletic injuries, and falls from height.

Treatment options range from conservative to surgical methods. Conservative treatment includes Closed Reduction and plaster cast application. Surgical treatment comprises of Closed Reduction & Internal Fixation with Elastic Intramedullary nails & Open Reduction & Internal Fixation with plates [7]. Various techniques of internal fixation of these fractures had been reported in the literatures. Intramedullary nailing of forearm fractures was successfully used long time ago. The advantages of the closed nailing technique include early union, low incidence of infection, small scars, less blood loss, and, frequently, relatively short operating time with minimal surgical trauma [8].

In our study we included forty patients with both bone forearm fractures fixed with intramedullary elastic or flexible nail. We produce results of that and compared those results with others.

Aim

To study the functional outcome of both forearm bone radius and ulna fractures treated with intramedullary elastic nails in both the bones, evaluate the restoration of movements of wrist, elbow and forearm and compare the results with others.

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Materials and Methods

In our study we included forty patients of both bone radius and ulna shaft fracture treated with open or close reduction with intramedullary nails. In this study we included patients with age above 10 years with diaphyseal shaft fracture of radius and ulna. We excluded patients with age less than 10 years, along with single bone shaft fracture. Also, patients with pathological fractures were excluded as well. We collected our data by interviewing and by regular follow up. Our study design is observational. Our study having maximum follow up of 16 months and minimum of 3 months from April 2019 to September 2021.
Patients from adolescent to third decade of life & onwards and both the sexes, presenting to the orthopaedic outdoor patient department or in emergency department with history of fall down with minor or major trauma or with history of road traffic accident or with history of assault were included.

Method of collection of data

Patients with fracture were primarily assessed by ABC management, general condition, vitals, distal neurovascular status, distal pulsation and movement was checked.
Fracture assessment was done and above elbow slab of plaster of paris was given in affected limb with sling support. Other associated injuries were rule out.
Intravenous analgesics for pain and antibiotics for open wound or for chest conditions with intravenous fluids if the patients were hemodynamically unstable were given.
After that all patients were subjected to radiographic examination. This included standard radiographs, anterior and lateral view of affected forearm in view of elbow and wrist joint.
After the primary assessment, patient prepared for surgical procedure. Good quality radiographs to assess and complete examination of the patient are an essential pre-requisite. Adequate blood was arranged for surgery for any intraoperative transfusion, if required. The patient was fully explained about the nature of the fracture, anaesthesia, the planned operation; its need, nature & benefits, possible pre/intra/post-operative blood transfusion, the possible postoperative complications; in his own language. After admission all the patients were fully investigated as per requirement for obtaining surgical fitness. An informed, valid, explained, documented, signed, and witnessed consent was taken from all the patients undergoing operation.
The patient was shaved from axilla to the whole affected upper limb, after removing all the accessories and trimming the nails kept nil by mouth from the previous night. Catheterization done as per requirement.

Implant

Titanium elastic nails were used for most patients for both radius and ulnar repair. Nail diameters were 2.0mm, 2.5mm, 3.0mm, or 3.5mm, with nail lengths from 16cm to 36 cm for all surgical procedures. These are the elastic nails which adds to the flexibility and ease of negotiation along the radial bow.

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Fig 1: TENS Nail

316L stainless steel Square nail of diameters 2.0mm, 2.5mm, 3.0mm, or 3.5mm, with nail lengths from 16cms to 36 cm were also used. The ulnar nail is straight with a trocar tip, while the radius nail has a beveled edge with a 1 cm notch for the tip.

Fig 2: Square nail

Rush nails with diameter of 2 mm 2.5mm and 3 mm used.

Fig 3: Rush nail

Operative procedure

On the day of operation patient shifted to operation theatre at around 8 am in autoclaved clothes. After primary assessment by anaesthetics, patient shifted to operation theatre. First

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fractured limb confirmed under image intensifying television.
Then patient was given either supraclavicular block or general anesthesia according to patient condition. Patient then placed supine on an operating table with arm supported on a radiolucent arm support.
Betadine wash given to affected upper limb from hand to axilla. Painting and draping of local area were done in sterile manner.
First ulna nail inserted. For that the shoulder is abducted and internally rotated, and the elbow is flexed to 90 degrees. The elbow is supported with a folded drape for easier access to the olecranon. Fracture reduction was accomplished by a closed or open method. Closed nailing was preferred first. Closed reduction is achieved by longitudinal traction by holding fingers and counter traction by holding arm or by applying direct pressure at the fracture site. After adequate attempts of close reduction method if fracture not reduced in proper position, then open reduction done. About 2- 3 cm long incision made at the fracture area and the fracture was reduced with clamps.
An incision of 1cm over the olecranon tip was made deep down to the bone.
Entry is made with an awl. The position of the awl is checked under C-arm image intensifier in the anteroposterior and lateral view.

Fig 4: Clinical Image Entry

Fig 5: IITV Image Lateral View

Fig 6: IITV image AP view

An ulnar nail of appropriate size is selected and loaded over a T-handle. The nail is pushed free hand into the medullary canal of the ulna while the assistant applied traction in the position favoring reduction, depending on the type of fracture.
If the nail did get jammed, it can be hammered lightly so that it made its way into the medullary canal. The position was checked using the image intensifier. The distal end of the nail is usually within 1 cm of the tip of ulna. After measuring the length extra nail was cut and tip of the nail was buried in the olecranon.
For radius nailing, the entry was made either at styloid process or at lister tubercle. In lister tubercle entry, superficial radial nerve is safe and nail impingement is less but there are chances of damaging extensor tendons of 2nd and 3rd compartment.
In radial styloid entry, dorsal sensory branch of radial nerve is likely to damage and also nail impingement is more but it is cosmetically better.

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Fig 6: Incision marking for radius nailing

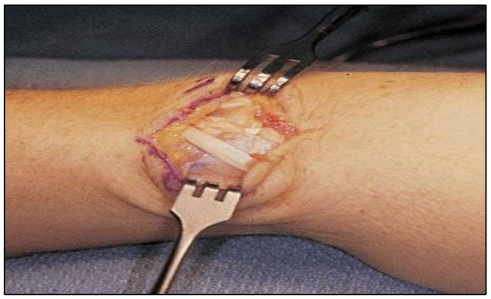

Fig 7: Incision for radius nail

First, 2 cm incision is made just lateral to Lister's tubercle of the distal radius.
Skin and subcutaneous tissue cut. The extensor retinaculum is divided to expose and identify the extensor pollicis longus (EPL) tendon which is then released from its sheath around Lister's tubercle. The interval between the short and long wrist extensors is identified. The interval between the extensor carpi radialis longus (ECRL) is developed. The EPL is retracted radially with the ECRL. The awl is introduced at a point 5 mm from the distal edge of the radius. The awl is started vertically so entry into the bone can be gained. The wrist is flexed and placed over a stack of towels to prevent perforation of the volar cortex. The wrist is flexed and the awl is brought into a more horizontal direction to avoid penetration of the volar cortex.

Fig 8: IITV AP view

Fig 9: IITV lateral view

For radial styloid entry, 2 Cm incision is placed over lateral aspect of radial styloid beneath extensor pollicis tendon, care is taken to protect dorsal sensory branch of radial nerve. A radius nail of appropriate size is selected. The radius nail is loaded over the T-handle and introduced in the canal through entry point. The assistant holds and assists in reduction of the fracture. The position of the nail is checked repeatedly under C-arm in both planes during the procedure. The radial nail is inserted up to the proximal border of the bicipital tuberosity of the radius. Distally the nail is buried flush with the bone.

Post-operative management

All patients were immobilized with an above elbow slab and asked to perform active finger movements. Movement of the thumb was especially checked for any injury to the EPL tendon during surgery.
Patients were discharged on the 3rd day post-op with an above elbow plaster.
Sutures were removed after 10-14 days and an above elbow cast was applied for further 4-6 weeks. After removal of the cast patients were sent to physiotherapist for active passive movement at wrist and elbow joint as well as supination and pronation of forearm.

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Patients were evaluated 4-weekly intervals till union and then at 3-monthly intervals. At each follow up patient is assessed clinically and x ray AP/LAT view of forearm is taken. The number of movements at the forearm is taken into consideration each time the patient turns up. All the patients in our study were followed up regularly and were asked specific questions and were evaluated subjectively on the basis of their answers. Our aim was to correlate the health status with objective and radiological outcomes in patients treated by intramedullary nailing for fractures of both bones of the forearm.
The ranges of movement of the forearm, wrist and elbow were measured objectively and standardized radiographs were evaluated. Operative stabilization of fractures of the radius and ulna led to a reliably acceptable functional outcome.

Observation

In our study, we observed outcome of intramedullary nailing in both bone forearm fracture with minimum follow-up of 3 months and maximum follow-up of 18 months. The analysis of the patient data, intra operative data & post-operative outcome is as follow

Table 1: Age of Patients

Age (years)	Number	Percentage
10-17	11	27.5%
18-29	8	20%
30-39	6	15%
40-49	7	17.5%
50-59	6	15%
>60	2	5%

Youngest age was 12 and oldest was 71 with an average of 47.5 years.
Maximum numbers of patients were from age group of 10-17 years (27.5%), followed by ages 18-29 years (20%). 52.5% patients in our study were from ages 18-49.

Table 2: Sex Distribution

Sex	Number	Percentage
Male	27	67.5
Female	13	32.5

In our study, majority of patients in our study were males with 67.5% with females having 32.5%.

Table 3: Side

Side of forearm	Number	Percentage
Left	18	45
Right	22	55

In our study, both sides were almost equally involved with left side of forearm having 45% and right side of forearm having 55%.

Table 4: Mode of injury

Mode of injury	Number	Percentage
Fall	19	47.5%
Assault	3	7.5%
Road Traffic Accident	18	45%

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In our study, domestic fall47.5%) was the most common cause of injury followed by Road traffic accident (45%) followed by assault (7.5%)

Table 5: Level of fracture

Level of fracture	Number	Percentage (%)
Proximal 3rd	4	10%
Middle 3rd	29	72.5%
Distal 3rd	7	17.5%

In our study, most of the forearm shaft fractures were located in middle third (72.5%), incidence of Proximal and distal third fractures were almost similar 10% and 17.5% respectively.

Table 6: Connection with environment

Connection with environment	Number	Percentage
Closed	35	87.5%
Open	5	12.5%
Grade 1	3	7.5%
Grade 2	2	5%

Most patients in our study had closed fracture (87.5%). There were 5 patients with open fractures (12.5%) where 7.5% patients had open grade 1 and 5% patients had open grade 2 injury.

Table 7: Fracture Reduction

Fracture reduction	Patient	Percentage
Close	33	82.5%
Open	7	17.5%

In our study, 7 patients (17.5%) required open reduction where 33 patients (82.5%) reduced with close reduction.

Table 8: Implant

Implant	Number of patients	Percentage
Rush Pin	1	2.5%
Tens	35	87.5%
Square Nail	4	10%

In our study, titanium elastic nails were used in most patients in our study (87.5%) and only in 4 patients treated with square nail and 1 patient with rush nail.

Result

In our study of forty patients with both bone forearm fracture treated with intramedullary nails. Functional outcome was measured by modified grace and eversmann scoring system.
We observed 5(12.5%) patients with excellent result, 30(75%) patients with good result, 3(7.5%) patients fair result and 2(5%) patients with poor result. Total numbers of patients with excellent and good results were in 87.5%. (Table 9).
In our study we had 40% patients with union in 12 weeks and 95% patient had union in 24 weeks. Average time of union was 15 weeks. We had radiological union in 39 (97.5%) patients and 1 (2.5%) patient with non-union and 1 (2.5%) patient with delayed union. (Table 10).

In our study we had superficial infection in 7.5% patients, nail impingement in 5% patients, delayed union in 2.5% patients and non-union in 2.5% patients. (Table 11)

Table 9: Result

Result	Functional Outcome	
	Total	Percentage
Excellent	5	12.5%
Good	30	75%
Fair	3	7.5%
Poor	2	5%
	40	

Table 10: Radiological union

Radiological Union (weeks)	Number of patients	Percentages (%)
<12	16	40%
13-16	14	35%
17-20	6	15%
>20	3	7.5%
Non Union	1	2.5%

Table 11: Complication

Complication	Number of patient	Percentage
Non Union	1	2.5%
Superficial Infection	3	7.5%
Nail Impingement	2	5%
Delayed union	1	2.5%
Total	7	

Discussion

In our study, we included forty patients with both bone forearm fracture and treated with flexible or elastic intramedullary nails and observed the functional outcome during the time period from April 2019 to September 2021.

In our study both bone forearm fracture was common in younger age group (10-17 years) and 52.5% patients belong from age group from 18-49 years. The average age was 47.5% (12-71 years). H N Burwell study has the similar observations with average age was 44.8% [9].

The incidence of forearm shaft fracture was more common in male patients about 67.5% followed by 32.5% in female patients. Similar results were found in Rao *et al*. study in which male patients were 69.23% [10, 11].

In our study, domestic fall (47.5%) was the most common cause of forearm shaft fractures followed by rode traffic accident (45%). Similar results were found in moda SK study in which incidence of domestic fall was 65.2% and road traffic accident was 34.8% [12].

In the present study most common level of fracture was found to be middle third (72.5%). Similar findings were found in N. Lil study in which the result was 78.7% [13].

There were 12.5% of open fractures in our study. Similar result was found with open fracture incidence of 13.00% in Moermann *et al*. study [14].

In our study, 17.5% cases required open reduction for irreducible fractures.

Similar finding was found in Nadeem Lil study (12.5%) [13]. In our study, radiological union was found in 97.5% patients with one patient with non-union. 40% patients had union within 12 weeks and 95% patients had union within 24 weeks. Average union time in our study was

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15 weeks. Similar results were found in yoligod study.

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In our study most common complication found was superficial infection followed by nail impingement followed by non-union and delayed union. Similar results were found in chapman at el study [15].
In our study total number of excellent and good outcome patients was 87.5% and poor outcome patients were in 5% patients. Similar results were found in N Lil study [13].

Cases

Fig 10: Preop **Fig 11:** Postop

Fig 12: 1 month and 6 month Follow up

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Fig 13: Clinical image post op 6 months

Case 2

Fig 14: Pre op and Post op X-ray Images

Fig 15: 6 month follow up X-rays

Fig 16: 6 Months clinical images

Conclusion

Our study involves observations of forty cases of both bone forearm fracture treated with intramedullary nails have advantages in terms of preservation of soft tissues and maintaining the fracture hematoma lead to less chances of infection, less timing for surgery, less postoperative complication n cosmetically preferable option. But our study also highlights on drawbacks of intramedullary nailing like nail impingement n chances of non-union with postoperatively late mobilization can lead to less full movement recovery.

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Our study concluded that for both bone forearm fracture closed intramedullary nailing is preferable option over the standard operation like platting technique.

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