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## Outcome analysis of hybrid fixation technique (radius nailing and ulna plating) in closed proximal radius and ulna fractures in adults

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### Abstract

**Background:** The aim of the study was to evaluate results of hybrid fixation technique (radius nailing and ulna plating) in closed proximal radius and ulna fractures in adults. The hypothesis behind hybrid fixation is to provide rigid fixation and restoration of forearm length, by ulna plating and large diameter square nail in radius gives rotational stability without any posterior interosseous nerve palsy in proximal radius and ulna fractures. Closed nailing of proximal radius avoid posterior interosseous nerve palsy which has high probability in open surgical approach.

**Materials and method:** We prospectively evaluated 25 patients with closed proximal radius and ulna fractures. 20 males and 5 females with mean age of 30.7 years underwent closed reduction and intramedullary nail fixation in radius and open reduction internal fixation in ulna with plating. The fractures were classified according to the AO/OTA system. The average follow up was 1 year (range 6 months – 18 months).

**Results:** The average time to union was 12.77 weeks (10-14 weeks). Union was achieved in all 25 patients in both radius and ulna. Using the Grace and Eversmann rating system 7 patients were excellent, 16 good, 1 acceptable and 1 unacceptable results. Using Andersons scale 23 patients had an excellent, 2 unsatisfactory, 0 failure. None of the patients had intraoperative as well as postoperative complications and no posterior interosseous nerve palsy occurred in any of case.

**Conclusion:** Closed reduction internal fixation with use of Hybrid fixation modality in closed proximal radius and ulna fractures has good results. Rigid fixation by ulna plating and rotational stability in radius by large diameter square nail provides almost the same construct as with dual plating with minimal invasive approach. Complication rates are lower as compared to plate osteosynthesis especially with similar union rates in terms of posterior interosseous nerve palsy.

**Keywords:** Closed proximal half radius-ulna fractures, hybrid forearm fixation technique, square nail, closed intramedullary radius nailing, ulna plating, posterior interosseous nerve palsy

### Introduction

Although forearm fractures are relatively common, the incidence of fracture is reported to be approximately 1 to 10 per 10,000 persons per year. Males are affected more than females. Mean age group ranges from 24-37 years.

The usual treatment preferred in adults is operative. There are various modes of operative fixations available, the choice of which rests with the treating surgeon. However there are always fair chances of posterior interosseous nerve injury in proximal radius plating. The reported incidence of posterior interosseous nerve palsy around 10% of all patients with proximal radius fractures treated with plating due to its sub muscular branches, which is somehow not acceptable if we have any alternative to save this.

Plate osteosynthesis is the most commonly used technique for the treatment of forearm fractures in adults. The use of intramedullary devices to stabilize fractures is not new, Intramedullary nailing usually used in open fractures in adults. But combination of radius nailing and ulna plating is new concept in orthopaedics trauma methodology in closed fractures.

Intramedullary nailing has its own sets of advantages and disadvantages. The infection rates are significantly decreased, as it is a closed procedure without periosteal stripping.

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There is no need of dissection in radius make the procedure almost free of any nerve injury while absolute rigid fixation provided by plating in ulna gives forearm rotational stability. It also has lower rates of re-fracture after implant removal, if needed.

The aim of this study was to assess, in adults, the results of closed radius nailing and ulna plating to evaluate the anatomical and functional acceptance of the procedure.

### Materials and Methods

The study was conducted in University Teaching Hospital, I.M.S., B.H.U, Varanasi after obtaining clearance from the ethical committee. All study participants given written informed consent for participation in this study. The study was conducted from July 2014 to June 2016 on patients admitted from the emergency or OPD of orthopaedics department of the hospital.

We evaluated 25 patients (20 males and 5 females) who met the inclusion and exclusion criteria.

### Inclusion Criteria

- Skeletally mature both- men and women.
- Proximal half of shaft fractures of radius and ulna fractures.
- All closed fractures without neurovascular deficit.
- Those who will give consent and willing to come for regular follow up.

### Exclusion Criteria

- Skeletally immaturity. (< 18 years)
- Single bone fractures,
- Presence of neurovascular deficit.
- Monteggia fractures (Except Type 4), pathological fractures, distal radio ulnar joint instability, bilateral fractures and bone loss.
- Open fractures.
- Old malunited fractures of radius/ulna.

All study participants were followed up for a minimum of one year and maximum of one year and half years.

### Implant Design

Stainless steel square nails/ Titanium elastic nails were used for all patients for radius nailing and 3.5 mm limited contact dynamic compressions plate / locking compression plate for ulna. Nail diameters were 2.0mm, 2.5mm, 3.0mm with nail lengths from 16cms to 25 cm. The radius nail has a bevelled edge this adds to the flexibility and ease of negotiation along the radial bow. Using large diameter tightly fitted square nail provides rotational stability to radius.

### Preoperative planning

Radiographs were evaluated for each patient for type and location of fractures. The size of the nails was estimated on the normal limb radiograph. The radius nail was measured from the Lister's tubercle to the lateral epicondyle minus 3cm.

### Operative procedure

Most of the times ulnar fixation was done primarily there by providing a more stable forearm for radius nailing.

### Technique for radius nailing

- \* Under general or regional (Axillary block) anaesthesia, the patient is positioned supine.
- \* Radial traction is needed to reduce fragments, though after ulnar fixation it usually align itself.

- \* A 2 cm incision is made just ulnar to the Lister's tubercle on the dorsal surface and soft tissue was divided.
- \* The 3rd extensor compartment is opened. The tendon of the extensor pollicis longus is identified and retracted.
- \* Nail is inserted up to proximal border of the bicipital tuberosity of the radius.

In none of the cases open reduction for radius was required. And open reduction internal fixation for ulna was done using 3.5 LCDCP.

### Post-operative

Patients were immobilized with an above elbow splint for 2-3 weeks and asked to perform active finger movements. Patients were discharged on the 3rd to 4th day post-op. Patients were evaluated monthly and radio graphically at 4-weekly intervals till union and then at 3-monthly intervals. Results were assessed on the basis of the time to union, functional recovery and complications.

Union was defined as the presence of bridging bone or trabeculae spanning the fracture site. All patients were prescribed physiotherapy for range of motion and strengthening exercises.

At the last assessment, the degree of forearm rotation was measured with a goniometer. Functional outcome was calculated using the system described by Grace and Eversman and Andersons scale, Mayo elbow performance score.

### Mayo elbow performance score

Criteria	Points
<b>Pain (45 points)</b>	
None	45
Mild	30
Moderate	15
Severe	0
<b>ROM (20 points)</b>	
100 degrees	20
50-100 degrees	15
< 50 degree	5
<b>Stability (10 points)</b>	
Stable	10
Moderate instability	5
Gross instability	0
<b>Daily function (25 points)</b>	
Combing hair	5
Feeding oneself	5
Hygiene	5
Putting on shirt	5
Putting on shoes	5

Total score 100 points

> 90 points = excellent, 75 to 89 points = good, 60 to 74 points = fair, and less than 60 points = poor

Stable = No apparent varus-valgus laxity clinically, moderate instability = less than 10 degrees of varus-valgus laxity, and gross instability = at least 10 degrees of varus-valgus laxity.

### Anderson devised an outcome scale based on final range of motion

- Excellent rating: patients with < 10 degree loss of flexion –extension and < 25% loss of pronation and supination.
- Unsatisfactory :> 30 degree loss of flexion –extension and > 50% loss of pronation and supination.
- Failure: defined as non union with or without loss of motion.

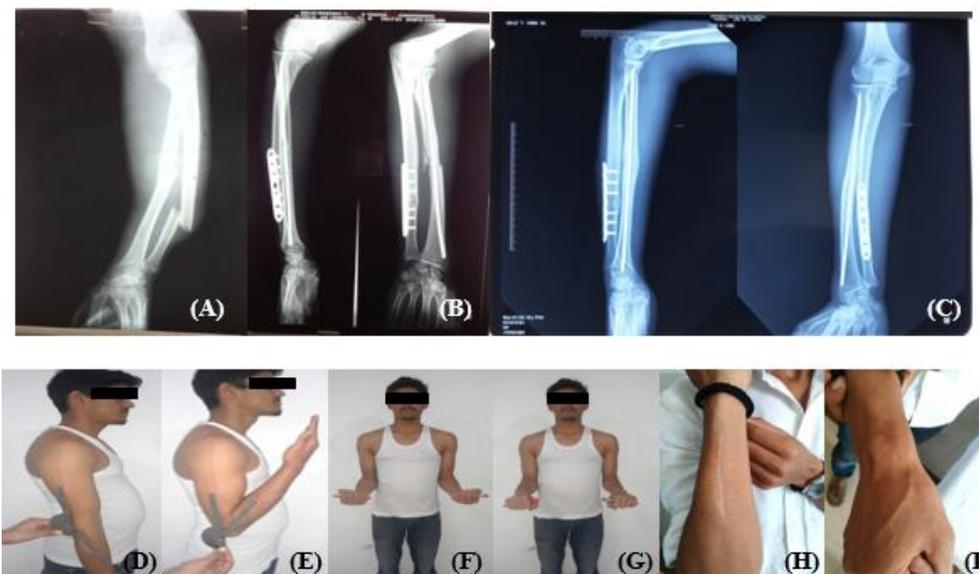
**Grace and Eversmann devised a similar outcome tool for range of motion and healing**

1. Excellent result: Healed fractures with at least 90% of normal rotation determined by uninjured contralateral side.
2. Good result: healed fracture with 80%-89% of normal rotation.

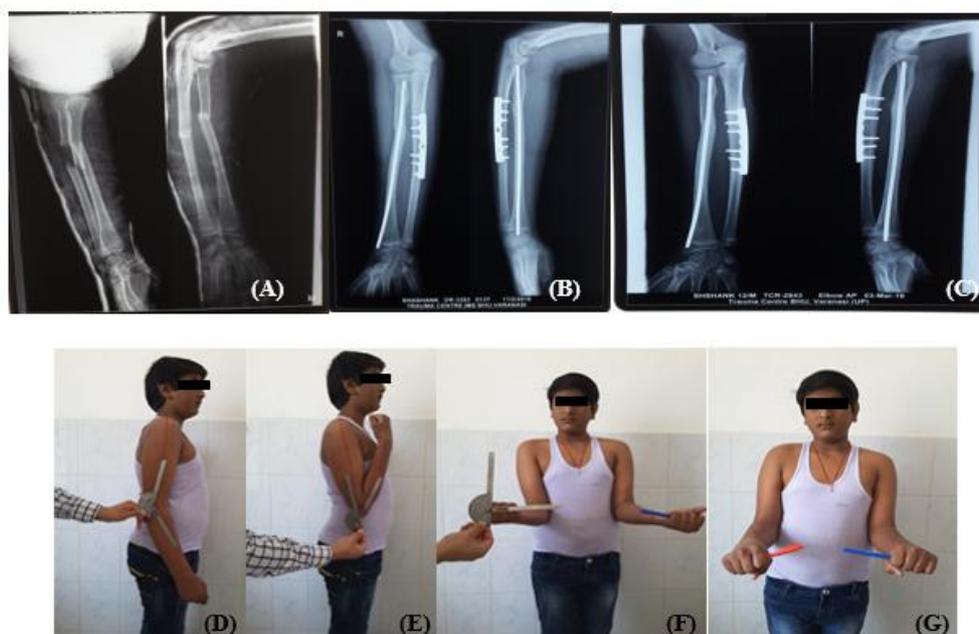
3. Acceptable result: Healed fracture with 60-79% of normal rotation.
4. Unacceptable result: Nonunion or fractures with < 60% of normal forearm rotation.

**Summary of patients**

Variables	
No. of patients	25
Mean age (years)	30.7
Sex (Male : Female)	4:1
Fracture site (Right : Left)	11:14
Injury mechanism	
Traffic accident	13
Work injury	3
Fall down	5
Sports injury	4
Follow up (Mean, weeks)	12



**Fig 1:** Case 1: 21/m alleged h/o road traffic accident, right side both bone forearm fracture. (A) Pre-op X-ray, (B) Immediate post-op X-ray, (C) Follow up at 4 months (D, E) Extension and Flexion at 4 months (F, G) supination & pronation (H, I) Scar – Ulna plating, radius nailing.



**Fig 2:** Case 2: 17 y/m, right side fracture, h/o RTA. (A) Pre-op X-ray, (B) Immediate post-op X-ray, (C) Followup at 3 months (D, E) Extension and Flexion at 3 months (F, G) supination & pronation.

## Results

<b>Variables</b>	
<b>Grace and Eversman</b>	
Excellent	7
Good	16
Acceptable	1
Unacceptable	1
<b>Andersons scale</b>	
Excellent	23
Unsatisfactory	2
Failure	0
<b>Mayo Elbow performance</b>	
> 90 points	21
75 – 89 points	4
60 – 74 points	0
< 60 points	0
<b>Union time weeks, Range of motion, Supination</b>	12.77wks
76-80 <sup>0</sup>	3
71-75 <sup>0</sup>	6
66-70 <sup>0</sup>	13
61-65 <sup>0</sup>	2
≤ 60 <sup>0</sup>	1
<b>Pronation</b>	
71-75 <sup>0</sup>	2
66-70 <sup>0</sup>	10
61-65 <sup>0</sup>	10
≤ 60 <sup>0</sup>	3
<b>Flexion</b>	
141-145 <sup>0</sup>	6
136-140 <sup>0</sup>	11
131-135 <sup>0</sup>	6
≤130 <sup>0</sup>	2
<b>Extension</b>	
> 30 <sup>0</sup>	1
21-30 <sup>0</sup>	8
11-20 <sup>0</sup>	12
00-10 <sup>0</sup>	4

The patients were followed up for a minimum of 6 months and maximum of one and half years postoperatively. The mean age of study participants was 30.7 years. The right limb was fractured in 11 subjects and the left limb was fractured in 14 subjects. The mode of injury was road traffic accidents 52%, falls 20%, Sports injury 16% work injury 12%.

The average operative time was 55 minutes, and average fluoroscopy unit exposure was 10 min. No intraoperative complication occurred nor was any radius nailing converted to some other method of fixation. The average hospital stay was 4 days (range, 2- 5 days).

The average time to union was 12.77 weeks (range, 10-14 weeks). Forearm brace with elbow hinge support was maintained for a mean of 3 weeks. Radius and ulna unites in all cases. There was > 30<sup>0</sup> loss of flexion or extension in 2 patients as compared to the other arm. Pronation and supination was restricted to > 50% in these 2 patients.

Using the rating system of Grace and Eversmann, 7 patients had an excellent, 16 good, 1 acceptable, 1 unacceptable results.

Using Andersons scale 23 patients had an excellent, 2 unsatisfactory, 0 failure results. None of the patients had intraoperative as well as postoperative complications and no neurological deficit (posterior interosseous nerve palsy).

## Discussion

Plate fixation has been the gold standard for fixation of forearm bones. To achieve good functional recovery

anatomical reduction is required for which open reduction internal fixation is often needed but few riders are there for opting radius nailing in proximal fractures due to high incidence of posterior interosseous nerve palsy.

We hypothesised intramedullary nailing is good option to be performed in closed proximal radius fractures keeping in view that there are high frequency of intraoperative nerve palsy (PIN) reported in proximal radius fractures. The reported incidence of posterior interosseous nerve palsy is 7-10% of all patients with proximal radius fractures treated with plating [3]. Plating is regarded safe modality, but many times a straight plate unable to restore radial bow in proximal radius fractures because of its anatomy [11]. At proximal-mid one third junction radius becomes circular to triangular. The concept behind hybrid fixation is to provide rigid fixation along with restoration of forearm length by ulna plating and a large diameter square nail in radius provides rotational stability without any posterior interosseous nerve palsy in proximal radius fractures.

Closed nailing has many advantages - low incidence of infection, small scars & good cosmetic results, less blood loss, relatively short operating time with minimal surgical trauma, less expenditure, less chances of compartment syndrome, less need of analgesics, less postoperative complications, no neurological deficit, no tourniquet palsy.

In our experience, the main complications during surgery were due to improper nail size. Another important advantage of intramedullary implants is their stress-sharing behaviour, which facilitates secondary periosteal callus formation.

The results of old methods of intramedullary nailing (K-wire, rush nail, Steinman pins) have high rates of non-union 20% [11, 16, 17]. But with the introduction of square design to improve rotational stability, which dramatically changed the non-union rates. Street *et al* reported 93% union rates and 84% good functional results with the use of square nails [10]. Intramedullary nailing creates a strong construct that is able to resist bending loads but less effective in resisting rotational loads. However square nail provides good rotational stability and in combination with rigid ulna plating, the overall forearm construct is biomechanically strong.

In one study of plate osteosynthesis vs nailing - plate osteosynthesis group radius showed union in 93.2% and ulna in 86.8%, and in closed nailing group both radius and ulna resulted in 100% union rate [5].

We achieved union in all cases in both radius and ulna and good functional outcome in 23 out of 25 patients (92%).

## Conclusion

Closed reduction internal fixation with use of hybrid fixation modality in closed proximal radius and ulna fractures has good results. Rigid fixation by ulna plating and rotational stability in radius by large diameter square nail provides almost the same construct as with dual plating with minimal invasive approach. Complication rates are lower as compared to plate osteosynthesis. Intramedullary nailing can be considered in repair of closed forearm fractures keeping in view its complications rates, cost, acceptable and good functional results.

Ethical standard: All the 25 study participants gave the informed consent prior to being included in the study. The procedure involving human participants were in accordance with the 'Ethical Guidelines for Biomedical Research on Human Subjects' laid down by the Indian Council of Medical Research in the year 2000.

This study was cleared from ethical committee meeting on 30.12.2015, EC registration no: ECR/526/Inst/UP/2014 Dt.31.1.14.

**Conflict of interest:** None

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