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Comparative Study of Outcome of Bothbone Forearm Fracture Treated with Rigid Fixation Vs Hybrid Fixation

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ABSTRACT

Forearm fractures involving both the radius and ulna diaphysis are complex orthopaedic injuries requiring precise anatomical restoration for functional recovery. Traditional treatment involves rigid fixation using plates for both bones. However, hybrid fixation, combining intramedullary nailing (IMN) of the ulna with plate fixation of the radius, has emerged as a less invasive alternative.

Aim

The Aim Of The Study Is To Compare Outcome Of Bothbone Forearm Fracture Treated With Rigid Fixation Vs Hybrid Fixation.

Objective

- To observe and compare differences in clinical outcomes of different fixation methods for both-bone diaphyseal fractures plate fixation to radius and ulna and intramedullary nailing of ulna and plate fixation of radius
- To assess the time related to mobilize patients post operatively in both the methods
- To assess union and evaluate union time for both methods
- intramedullary nailing of ulna and plate fixation of radius
- To observe complications in the study of both fixation types.
- To compare Anderson score for both bone diaphyseal fractures plate fixation to radius and ulna and intramedullary nailing of ulna and plate fixation of radius

Methodology

A prospective, comparative study was conducted at Krishna Hospital, Karad, over 18 months involving 48 patients with diaphyseal fractures of both forearm bones. Patients were randomized into two groups: Group 1 received rigid fixation (plating of both bones), and Group 2 received hybrid fixation (IMN for ulna + plate for radius). Functional outcomes, union rates, operative times, and complications were evaluated using standard statistical tools.

Results

Hybrid fixation demonstrated significantly shorter mean union time (8.9 weeks vs 10.4 weeks, p=0.03), superior flexion/extension and pronation/supination ranges, and lower rates of malunion (4.2% vs 12.5%, p=0.03). Functional outcomes based on Anderson scores favoured hybrid fixation, especially in distal fractures. Both groups had comparable mobilization times and similar infection rates.

Discussion

Hybrid fixation offers the benefits of minimally invasive surgery while maintaining sufficient biomechanical stability. It yielded better functional outcomes, faster union, and fewer complications in select fracture types.

Conclusion

Hybrid fixation is a viable alternative to rigid fixation for adult both-bone forearm fractures. With proper patient selection, it provides faster healing and better function, making it a suitable option in modern orthopaedics practice

1. INTRODUCTION

Forearm fractures, particularly diaphyseal fractures involving both the radius and ulna, represent a significant challenge in orthopedic trauma due to the complex anatomical and biomechanical roles these bones play. The forearm not only provides structural support for upper limb function but is also central to essential movements such as pronation and supination, which are critical for hand positioning and dexterity. Disruption of the forearm's anatomical alignment can result in profound functional impairment, making the restoration of normal anatomy and biomechanics a priority in management.

Both-bone diaphyseal forearm fractures often result from high-energy mechanisms, including motor vehicle accidents, sports injuries, and falls from height. Historically, treatment has evolved from conservative management—such as immobilization with plaster casts—to more sophisticated surgical interventions aimed at anatomical reduction and early mobilization. Although non-operative treatment may be suitable for select pediatric cases, it has shown poor results in adults due to high rates of malunion, nonunion, and functional limitations. This has cemented open reduction and internal fixation (ORIF) using compression plating as the gold standard for adult both-bone forearm fractures.

Rigid fixation with plates ensures precise anatomical alignment and rotational stability, which are critical to restoring the complex biomechanics of the forearm. However, this approach requires extensive soft tissue dissection, which can increase the risk of infection, delayed healing, and neurovascular complications. In response to these concerns, alternative surgical techniques have emerged—most notably, hybrid fixation, which combines intramedullary nailing (IMN) for the ulna with plate fixation for the radius.

Hybrid fixation aims to merge the benefits of intramedullary nailing—such as reduced operative time, less soft tissue disruption, and minimally invasive access—with the stability and anatomical precision of plate fixation. The ulna, being a relatively straight and subcutaneous bone, is well-suited for IMN. In contrast, the radius requires plate fixation to preserve its natural curvature and ensure optimal rotational recovery. The anatomical differences between the two bones make them amenable to this combined approach.

Despite the theoretical advantages of hybrid fixation, its clinical efficacy and long-term outcomes remain subjects of ongoing investigation. Existing literature suggests that this method may reduce complications, enhance fracture union, and allow earlier return to function, especially in patients with straightforward ulnar fractures or those at higher risk for soft tissue complications. However, concerns persist regarding the rotational control and stability of intramedullary nails, particularly in complex or comminuted fractures.

This study seeks to contribute to the growing body of evidence by directly comparing the outcomes of rigid fixation and hybrid fixation in adult patients with both-bone diaphyseal forearm fractures. By evaluating key parameters such as union time, functional recovery using standardized scoring systems, complication rates, and mobilization timelines, this research aims to provide evidence-based guidance for orthopaedics surgeons. Ultimately, the goal is to optimize patient outcomes by refining treatment protocols and individualizing fixation strategies based on fracture characteristics, patient profiles, and resource availability

2. METHODOLOGY

Study Design and Setting

This prospective, comparative study was conducted at the Department of Orthopaedics, Krishna Hospital and Medical Research Centre, Karad, over a period of 24 months—comprising 18 months of data collection (March 2023 – September 2024) and 6 months of data analysis (October 2024 – May 2025). The aim was to compare the clinical and functional

outcomes of rigid fixation versus hybrid fixation in adult diaphyseal fractures of both the radius and ulna.

Ethical Considerations

Prior to commencement, ethical approval was obtained from the Institutional Ethics Committee (IEC). Written informed consent was secured from all participants after explaining the nature of the study, potential risks, benefits, and follow-up requirements.

Patient Selection

Patients presenting with closed, diaphyseal fractures of both radius and ulna were screened.

Inclusion Criteria:

- Age >18 years
- Closed, radiologically confirmed diaphyseal fractures of both radius and ulna
- No prior trauma or surgery to the affected forearm
- Consent for participation

Exclusion Criteria:

- Open fractures
- Pathological or osteoporotic fractures
- Associated neurovascular injuries
- Monteggia or Galeazzi fracture-dislocations
- Associated injuries to adjacent joints

Sample Size and Randomization

A total of 48 patients were enrolled and randomized into two equal groups (n=24 each) using a simple random sampling method.

- **Group 1 (Rigid Fixation):** Plating of both radius and ulna
- **Group 2 (Hybrid Fixation):** Plating of the radius and intramedullary nailing of the ulna

Preoperative Evaluation

All patients underwent detailed clinical examination and radiological imaging (AP and lateral X-rays of forearm including elbow and wrist). Fractures were classified according to AO classification. Routine hematological and anesthetic evaluations were performed.

Surgical Procedure

All surgeries were performed under either regional or general anesthesia based on the patient's condition and surgical preference.

- **Group 1 (Rigid Fixation):**
  - **Ulna:** Approach via posterior subcutaneous border; open reduction and internal fixation using 3.5 mm DCP or LCP plates with at least three bicortical screws on either side.
  - **Radius:** Volar (Henry's) approach; open reduction and plate fixation preserving radial bow and alignment.
- **Group 2 (Hybrid Fixation):**
  - **Ulna:** Entry via olecranon; closed intramedullary nailing. In case of difficult reduction, a limited open approach was used.
  - **Radius:** Same volar approach and plating as in Group 1.

Postoperative Care and Rehabilitation

Postoperatively, patients were given intravenous antibiotics and analgesics. Immobilization was maintained for a short duration. Early active finger and wrist movements were encouraged from Day 1. Splints were removed after 1 week and range of motion exercises were initiated. Formal physiotherapy began after 2–3 weeks.

Follow-up and Outcome Measures

Patients were followed at 6 weeks, 2.5 months, 3 months, and 6 months postoperatively. Assessments included radiological union (bridging callus on 3 cortices), range of motion (ROM) at elbow and forearm, and functional evaluation using Anderson's scoring system. Complications such as infection, nonunion, malunion, implant failure, and nerve injuries were recorded.

Statistical Analysis

Data were analyzed using SPSS v26 and Microsoft Excel 2021. Quantitative data were compared using t-tests or Mann–Whitney U tests; categorical data were assessed using chi-square or Fisher's exact tests. A p-value < 0.05 was considered statistically significant.

3. RESULT

1)

Parameter	**Rigid Fixation (N=24)**	**Hybrid Fixation (N=24)**	**Significance**
Mean Surgery Duration (min)	131.2 ± 34.5	118.6 ± 29.8	p=0.08
Post-op Mobilization (days)	7.5 ± 2.1	6.8 ± 1.7	p=0.09

The surgical duration was shorter for hybrid fixation (118.6 ± 29.8 minutes) compared to rigid fixation

(131.2 ± 34.5 minute. The hybrid fixation technique is on par with rigid fixation in terms of Post-op mobilization.(6.8 ± 1.7 vs 7.5 ±2.1)

2)

Mobilization Time	Rigid Fixation (N=24)	Hybrid Fixation (N=24)	P-value
≤5 days	8 (33.3%)	7 (29.2%)	0.76 (NS)
6-7 days	10 (41.7%)	11 (45.8%)	
>7 days	6 (25.0%)	6 (25.0%)	

Both groups showed comparable postoperative mobilization patterns, with no statistically significant differences observed (p>0.05). The majority of patients in both groups mobilized within 6-7 days (Rigid: 41.7% vs Hybrid: 45.8%), while approximately one-quarter required more than 7 days for mobilization in each group (25.0% for both). The similar distribution suggests that the choice of fixation method did not significantly influence early postoperative mobility in this study population

3)

Union Parameter	Rigid Fixation (weeks)	Hybrid Fixation (weeks)	p-value
United	7	5	**0.02**
Delayed Union	5	8	0.11
Mean Union Time	10.4 ± 3.2	8.9 ± 2.7	**0.03**

The study compared union times between rigid and hybrid fixation methods, revealing that hybrid fixation achieved faster union (5 weeks vs. 7 weeks, p = 0.02) in united cases, while delayed unions trended toward longer healing with hybrid fixation (8 weeks vs. 5 weeks, p = 0.11). Overall, hybrid fixation demonstrated a significantly shorter mean union time (8.9 ± 2.7 weeks) compared to rigid fixation (10.4 ± 3.2 weeks, p = 0.03), suggesting its potential advantage in accelerating fracture healing. However, further investigation is needed regarding delayed unions.

4)

Fracture Type	Group	Excellent (%)	Good (%)	Fair (%)	Poor (%)	p-value
Proximal	Rigid	45	30	15	10	**0.04**
	Hybrid	50	25	20	5	
Midshaft	Rigid	47	33	15	5	**0.03**
	Hybrid	55	35	5	0	
Distal	Rigid	50	45	2	3	**0.02**
	Hybrid	64	27	8	1	

A significant difference ($p < 0.05$) was observed in functional outcomes assessed by the Anderson scoring system, particularly for distal fractures where hybrid fixation demonstrate- superior results (64% excellent vs. 50% with rigid fixation; *p = 0.02*). While proximal and midshaft fractures showed comparable excellent/good rates between groups, hybrid fixation eliminated poor outcomes in midshaft fractures (0% vs 5% with rigid fixation) and significantly reduced poor outcomes in proximal fractures (5% vs 10%; *p = 0.04*). These findings suggest hybrid fixation may offer clinically important advantages, especially for distal fractures.

4. DISCUSSION

This prospective comparative study evaluates the clinical and functional outcomes of rigid fixation (plate fixation for both the radius and ulna) versus hybrid fixation (intramedullary nailing of the ulna and plate fixation of the radius) in adult patients with diaphyseal forearm fractures. The forearm's functional anatomy and its role in pronation and supination necessitate anatomical alignment and stable fixation for optimal recovery, and this study was designed to explore whether a minimally invasive technique like hybrid fixation could offer comparable or superior results to traditional rigid fixation.

The results of our study reveal that hybrid fixation demonstrates certain advantages over rigid fixation. Most notably, the union time was significantly shorter in the hybrid group (mean 8.9 ± 2.7 weeks) compared to the rigid fixation group (10.4 ± 3.2 weeks), with a p-value of 0.03. This difference is clinically meaningful, as early fracture union facilitates quicker

mobilization and return to daily activities. The shorter operative time in the hybrid group (though not statistically significant) further underscores the procedural efficiency of intramedullary nailing.

Functional outcomes, assessed using the Anderson scoring system and range of motion measurements, consistently favoured hybrid fixation. Across proximal, midshaft, and distal fractures, patients treated with the hybrid technique demonstrated better flexion/extension, improved pronation/supination, and lower percentages of functional loss. These differences were statistically significant, particularly in distal fractures, where hybrid fixation achieved 64% excellent outcomes compared to 50% in the rigid group. The anatomical preservation of soft tissues with IMN likely contributed to the superior outcomes, especially in terms of pronation and supination – critical movements of the forearm.

From a complication standpoint, both techniques demonstrated low infection rates, but hybrid fixation had a lower incidence of malunion (4.2% vs. 12.5%), although this did not reach statistical significance. The minimal soft tissue disruption associated with IMN likely reduces the risk of periosteal stripping, thereby preserving biological healing potential. Implant-related complications, such as hardware prominence or irritation, were minimal in both groups, suggesting good procedural safety with experienced surgical hands.

However, the hybrid method is not without limitations. Its utility is restricted in complex or comminuted ulnar fractures, where rotational control and anatomical reduction are critical. In such cases, plate fixation provides superior rigidity and rotational stability. Furthermore, the technical demands of proper nail placement and alignment should not be underestimated, particularly in bowed or narrow ulnas. As a result, careful patient selection is essential when considering the hybrid approach.

Our findings align with prior studies, including those by Zhang et al. (2016) and Lee et al. (2019), which highlighted the biomechanical sufficiency and clinical viability of hybrid fixation. While rigid plating remains the gold standard, particularly in complex fractures, hybrid fixation offers a compelling alternative in select cases, balancing stability with soft tissue preservation and improved early functional outcomes.

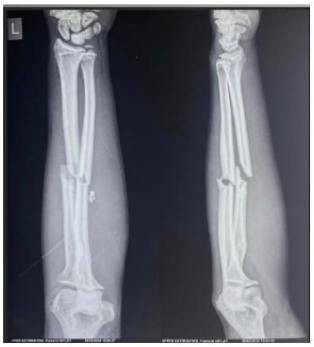
CASES

CASE-01

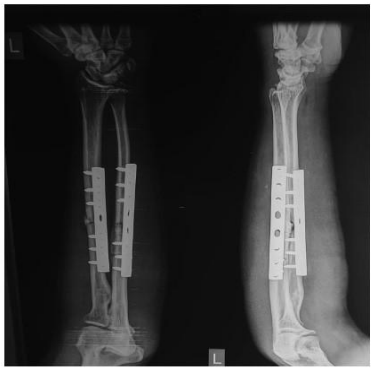
55 year old

Diagnosed with- Closed Comminuted Left Distal 1/3rd Shaft Radius-Ulna Fracture

PRE-OP XRAY



POST-OP XRAY

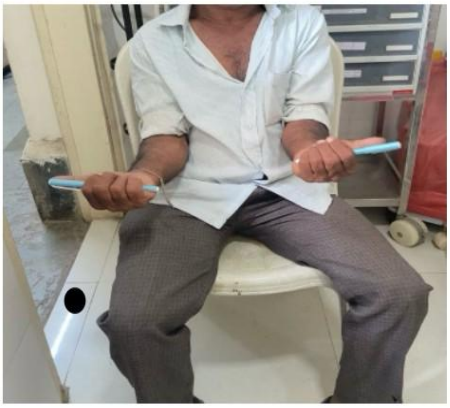


FOLLOW UP XRAYS-

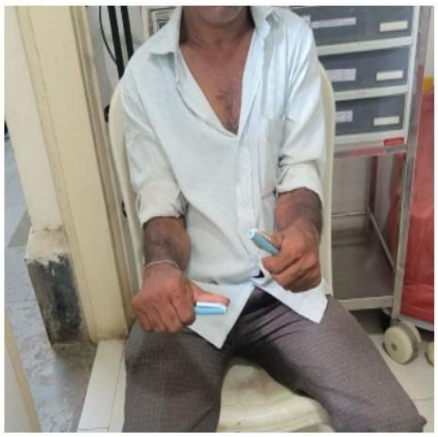
POD- 6 WEEKS

POD- 3 MONTHS

POD- 6 MONTHS



SUPINATION



PRONATION

ELBOW FLEXION

ELBOW EXTENSION

CASE-02

60 year old female

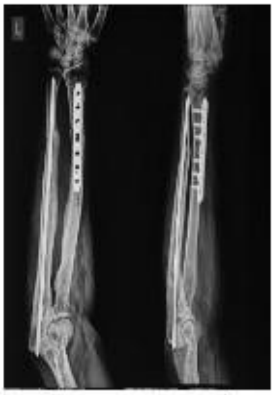
Closed Comminuted Left Distal 1/3rd Shaft Radius-Ulna Fracture

PRE-OP XRAY

POST-OP XRAY

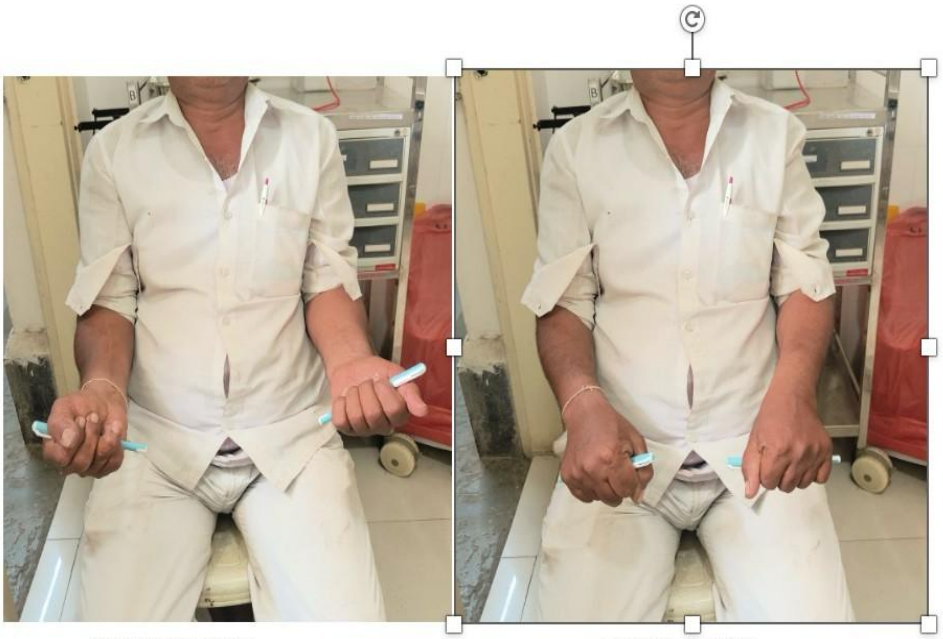
FOLLOW UP XRAYS-

POD- 6 WEEKS

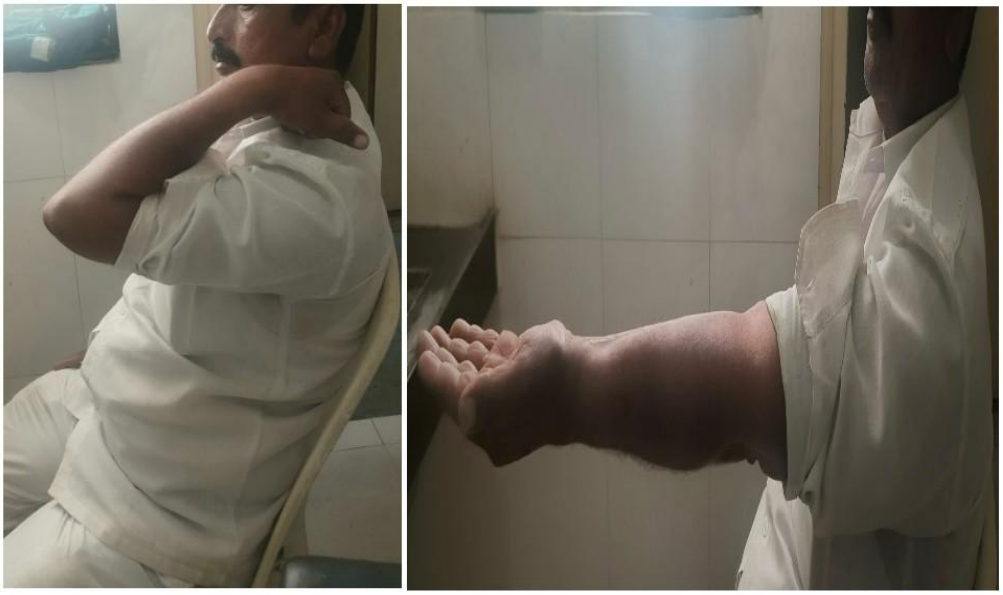


POD- 3 MONTHS

POD- 6 MONTHS



SUPINATION PRONATION



ELBOW FLEXION ELBOW EXTENSION

5. CONCLUSION

The hybrid approach resulted in improved union rates with shorter healing times, reduced complications viz malunion and infection, superior functional recovery as evidenced by better Anderson scores, comparable postoperative mobilization, less post-operative stiffness and better cosmesis. These findings align with several recent studies supporting hybrid fixation as a biomechanically sound and clinically effective alternative, particularly for patients requiring early rehabilitation. Lower soft tissue disruption, earlier return to function, and decreased complication profile make hybrid fixation a preferable surgical strategy for optimal patient outcomes. Our study demonstrates that hybrid fixation offers significant advantages over traditional rigid plate fixation of both bones in the treatment of diaphyseal fractures of the forearm. Further multicenter studies with long-term follow-up could strengthen these conclusions, but the current evidence strongly supports the adoption of hybrid fixation in appropriately selected cases

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