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Original Research Article

COMPARATIVE EVALUATION OF FUNCTIONAL AND RADIOLOGICAL OUTCOMES OF PLATING VERSUS INTRAMEDULLARY NAILING IN ADULT DIAPHYSEAL FOREARM FRACTURES

MD Anwar[1], S. Sharatkumar[2], Tavarakunta Abdul Rawoof [3], Mohammed Samiullah[4]

[1]*Assistant Professor, Department of Orthopaedics, MNR Medical College & Hospital, Sangareddy, Telangana, India.*
[2]*Assistant Professor, Department of Orthopaedics, MNR Medical College & Hospital, Sangareddy, Telangana, India.*
[3]*Assistant Professor, Department of Orthopaedics, MNR Medical College & Hospital, Sangareddy, Telangana, India.*
[4]*Assistant Professor, Department of Orthopaedics, MNR Medical College & Hospital, Sangareddy, Telangana, India.*

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Corresponding Author:
Dr. Mohammed Samiullah,
Assistant Professor, Department of Orthopaedics, MNR Medical College & Hospital, Sangareddy, Telangana, India.
Email: mohammedsamiullah36@gmail.com

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ABSTRACT

Background: Diaphyseal fractures involving both the radius and ulna in adults necessitate accurate anatomical reduction and secure fixation to restore normal forearm rotation and functionality.

Although plate osteosynthesis remains the gold standard, intramedullary nailing has been proposed as a minimally invasive alternative. This study compares the functional and radiological outcomes of plating versus nailing in adult both-bone forearm fractures.

Materials and Methods: A prospective comparative study was conducted on 54 adults with diaphyseal fractures of both bones of the forearm, allocated into plating (Group A, n=27) and nailing (Group B, n=27) groups. Demographics, fracture characteristics, operative details, functional outcome (DASH score and Grace & Eversmann criteria), range of motion, radiological union time, and postoperative complications were assessed. Statistical significance was set at $p < 0.05$.

Results: Both groups were comparable in baseline characteristics. Mean union time was significantly shorter in the plating group (13.4 ± 2.1 weeks) than in the nailing group (14.8 ± 2.6 weeks) ($p = 0.0249$). DASH scores at 12 weeks (26.5 vs. 30.1; $p = 0.0476$), 24 weeks (14.8 vs. 18.3; $p = 0.0301$), and 9 months (9.6 vs. 12.7; $p = 0.0265$) favoured plating. Loss of forearm supination was significantly lower in the plating group (8.4° vs. 11.6°, $p = 0.03$). The nailing group showed higher rates of delayed union (14.8% vs. 7.4%), non-union (7.4% vs. 3.7%), and implant prominence, though differences were not statistically significant.

Conclusion: Plate osteosynthesis provides faster union, superior functional recovery, and fewer complications compared with intramedullary nailing in adult diaphyseal forearm fractures. Plating remains the preferred method for achieving optimal anatomical and functional outcomes in this population.

Keywords: Forearm fractures; Diaphyseal fractures; Plating; Intramedullary nailing; DASH score; Functional outcome; Union time.

INTRODUCTION

Diaphyseal fractures of both the radius and ulna constitute a particularly complex category of injuries within adult orthopaedic trauma, attributable to the distinctive anatomical and functional attributes of the forearm. The forearm operates as a sophisticated assembly in which the radius and ulna engage to enable pronation and supination, rendering anatomical reduction and meticulous restoration of radial bow crucial for achieving optimal functional recovery. Even slight angular or rotational malalignment has been demonstrated to considerably hinder forearm motion, highlighting the necessity for

precise reconstruction.[1] Fractures of this nature generally arise as a consequence of significant trauma, including incidents such as vehicular collisions or falls, and frequently necessitate surgical procedures to ensure stable fixation and facilitate prompt mobilization.[2]

The procedure of open reduction and internal fixation utilizing compression plating has historically been regarded as the benchmark for the treatment of adult both-bone forearm fractures. Anderson et al. illustrated significant union rates and dependable healing through the application of compression plating, highlighting the critical role of rigid fixation and precise anatomical reduction.[3] Subsequent investigations have consistently validated the enhanced results associated with plating, especially regarding rotational stability and the restoration of forearm biomechanics.[4] Nonetheless, the application of plating techniques is linked to a heightened degree of soft-tissue dissection, extended operative duration, and an elevated risk of infection or nerve injury.

Intramedullary nailing has surfaced as a more refined alternative, presenting benefits such as reduced operative time, minimized incisions, and the maintenance of periosteal blood supply. Initial investigations conducted by Leung and Chow indicated that intramedullary devices could yield satisfactory outcomes; however, apprehensions surrounding rotational control, preservation of radial bow, and elevated instances of delayed union remain evident.[5] Comparative studies and systematic reviews persist in presenting varied findings, with numerous reports indicating suboptimal functional outcomes and elevated complication rates associated with nailing in adults.[6]

In light of the current discussions, assessing the functional and radiological results of plating compared to nailing continues to hold significant clinical relevance. This investigation seeks to evaluate the efficacy of two prevalent fixation techniques in the context of adult diaphyseal forearm fractures, employing standardized outcome measures for comparison.

MATERIALS AND METHODS

This prospective comparative study was conducted in the Department of Orthopaedics at MNR Medical College and Hospital during January 2024 to June 2025. A total 54 Adult cases with fractures of both radius and ulna who underwent operative fixation with either locking compression plating or intramedullary nailing were recruited. Written informed consent was obtained all the participants and study protocol was approved by the institutional ethics committee.

Inclusion Criteria: Cases above 18 years of age, with closed diaphyseal fractures of both radius and ulna, fractures within < 2 weeks from injury, fractures requiring operative fixation and cases willing to participate and comply with follow-up were included

Exclusion Criteria: Gustilo-Anderson grade II and III open fractures, pathological fractures, segmental or intra-articular extensions, skeletally immature patients (<18 years), Polytrauma cases with associated head and spinal injuries, cases with congenital deformities, functional limitation of ipsilateral upper limb and cases lost to follow-up before minimum follow-up of 6 months.

Study participants were randomly allocated to two groups. Group A (n=27) managed with locking compression plating method and Group B (n=27) managed with intramedullary nailing methods. All participants were subjected to detailed preoperative assessment and collected detailed history including mode of injury, time since injury, hand dominance, comorbidities. Clinical examination including deformity, swelling, tenderness, range of motion of elbow, wrist and forearm and neurovascular status were recorded. Cases were subjected to radiological evaluation including standard anteroposterior (AP) and lateral X-rays of the forearm including elbow and wrist joints. Fractures were classified according to AO/OTA classification of radius and ulna diaphyseal fractures.

Postoperative requirement of analgesia, limb elevation and neurovascular status were monitored. Postoperative X-rays (AP and lateral) were taken within 24-48 hours to assess alignment and implant position. Active finger and shoulder movements were started from day 1 after surgery. Forearm movements and wrist mobilization pain permitted were advised after 1-2 weeks and strengthening exercises after radiological signs of union of fracture. All the study participants were followed up postoperatively at 3 weeks, 6 weeks, 12 weeks, 24 weeks, and 9 months. In each follow up, pain, range of motion, grip strength and radiological assessment for callus formation, alignment, and union were done and complication were recorded. Parameters including profile of fracture union, DASH score, range of motion, and postoperative complications were recorded.

Statistical Analysis: The collected data was analysed using SPSS v.26.0. Continuous variables are expressed as mean ± standard deviation (SD). Categorical variables expressed as frequency and percentages. Comparison between study groups was done using unpaired t-test, and Chi-square test for categorical variables. p-value < 0.05 considered statistically significant outcome.

RESULTS

Table 1: Demographic characteristics of study participants (n = 54)

Demographic profile	Group A (n=27)	Group B (n=27)	p-value
Age range (years)			
<20	03 (11.1%)	02 (7.4%)	-
21-30	05 (18.5%)	05 (18.5%)	
31-40	08 (29.6%)	09 (33.3%)	
41-50	06 (22.2%)	05 (18.5%)	
51-60	04 (14.8%)	04 (14.8%)	
>60	01 (3.7%)	02 (7.4%)	
Age (years)	34.6 ± 10.2	33.8 ± 9.8	0.68
Gender			
Male:	19 (70.37%)	20 (74.07%)	0.54
Female	08 (29.62%)	07 (25.92%)	

Table 2: Fracture details among study participants

Parameter	Plating (n=27)	Nailing (n=27)	p-value
Mode of injury			
Road traffic accident	19 (70.4%)	20 (74.1%)	0.76
Fall from height	05 (18.5%)	05 (18.5%)	0.74
Assault	02 (7.4%)	02 (7.4%)	0.63
Others	01 (3.7%)	-	1.26
Side of injury			
Right	15 (55.6%)	14 (51.9%)	0.79
Left	12 (44.4%)	13 (48.1%)	
Fracture type			
Simple	14 (51.9%)	16 (59.3%)	-
Wedge	9 (33.3%)	8 (29.6%)	
Complex	4 (14.8%)	3 (11.1%)	

Table 3: Operative details

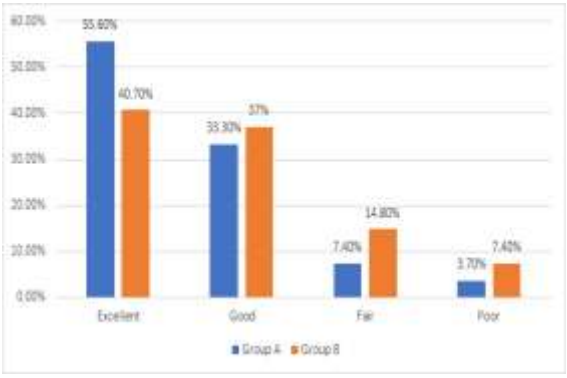
Parameter	Plating (n=27)	Nailing (n=27)	p-value
Mean time from injury to surgery (days)	4.1 ± 2.0	3.8 ± 1.9	0.52
Mean duration of surgery (minutes)	92.4 ± 18.3	68.7 ± 16.2	0.001
Mean intraoperative blood loss (ml)	180.5 ± 40.8	120.6 ± 35.2	0.001
Need for limited open reduction	–	7 (25.9%)	–

Table 4: Mean DASH score and radiological outcome among study groups

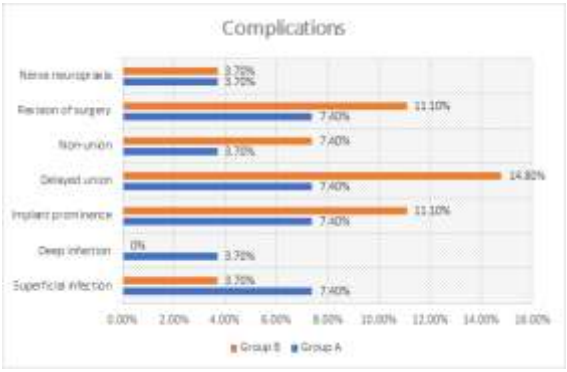
Parameter	Plating (n=27)	Nailing (n=27)	p-value
Mean DASH score			
6 weeks	44.2 ± 8.5	46.8 ± 9.1	0.269
12 weeks	26.5 ± 7.2	30.1 ± 7.8	0.0476
24 weeks	14.8 ± 6.0	18.3 ± 6.7	0.0301
9 months	9.6 ± 4.1	12.7 ± 4.9	0.0265
Radiological outcome			
Mean union time (weeks)	13.4 ± 2.1	14.8 ± 2.6	0.0249
Union ≤ 14 weeks	21 (77.8%)	16 (59.3%)	0.126
Delayed union	2 (7.4%)	4 (14.8%)	0.382
Non-union	1 (3.7%)	2 (7.4%)	0.558

Table 5: Mean loss of range of motion compared to contralateral limb at final follow-up

Motion (degrees)	Plating (mean loss)	Nailing (mean loss)	p-value
Elbow flexion-extension	4.2 ± 3.1	5.1 ± 3.6	0.32
Forearm pronation	7.8 ± 4.5	10.2 ± 5.1	0.06
Forearm supination	8.4 ± 4.7	11.6 ± 5.4	0.03
Wrist flexion-extension	5.6 ± 3.8	7.2 ± 4.1	0.11



Graph 1: Grace and Eversmann's criteria at final follow-up



Graph 2: Postoperative complications observed in both groups during follow-up

DISCUSSION

This research assessed the relative efficacy of plating compared to intramedullary nailing in adult diaphyseal fractures of both forearm bones, using functional (DASH score, range of motion, Grace and Eversmann criteria) and radiographic results. Our data indicate that plating yields superior functional recovery, expedited union, and reduced complications compared to nailing, aligning with known orthopedic literature. Our research revealed a comparable demographic distribution across groups, with a mean age of 34-35 years and a primarily male representation, indicative of the population often impacted by high-energy trauma. Road traffic accidents (72%) are the common mode of injury, which is similar to findings of Chapman et al. reported worldwide similar epidemiological patterns.[7] The resemblance among groups facilitated a dependable comparison.

The mean duration of union was comparatively less in the group A (13.4±2.1) compared to the group B (14.8±2.6). This is similar to findings of Anderson et al., which revealed reliable union and reduced complication rates associated with compression plating.[8] Saikia et al. found a considerably expedited union with plating (13.6 weeks) in contrast to intramedullary fixation (15.2 weeks), closely aligning with our findings.[9] The biomechanical advantages of plating, especially in attaining anatomic reduction and torsional stability, have been identified as a significant factor enhancing union rates.[10]

Functional results assessed by DASH scores were consistently superior in the plating group at 12 weeks, 24 weeks, and the 9-month follow-up. A study by Moed and Kellam underscored the significance of rotational alignment and radial bow repair in attaining improved forearm function parameters, which are more consistently restored with plating than nailing.[11] Finsen et al. also observed that compression plating significantly improved rotational results and reduced mobility loss.[12] The superior functional outcomes in our investigation are corroborated by the notably reduced loss of forearm supination in the plating group (8.4° vs. 11.6°, p=0.03), emphasizing the significance of anatomical alignment in forearm biomechanics. The Grace and Eversmann functional grades also favored plating, yielding a greater percentage of excellent and good results. This aligns with the findings of Schemitsch and Richards, who showed that changes in the radial bow associated with intramedullary fixation markedly impair pronation and supination.[13] The use of intramedullary nails in adult diaphyseal fractures has been challenged in many clinical studies due to its inability to consistently restore the radial bow.

The operative features of our study revealed that plating required an extended surgical duration and resulted in increased blood loss. The results align with other research, including those of Leung and Chow, who indicated heightened surgical demands associated with plating in comparison to intramedullary fixation.[14] Despite the extended duration of the operation, plating demonstrated markedly superior outcomes, suggesting that anatomic reduction outweighs these transient disadvantages. In the current investigation, complications were more prevalent in the nailing group, characterized by increased instances of delayed union, non-union, and implant prominence, but these differences lacked statistical significance. This tendency has been well documented. Leung et al. noted a much-elevated incidence of implant-associated discomfort and reduced loss with intramedullary nails.[15] Baldwin et al. conducted a comprehensive evaluation revealing consistently elevated re-operation rates for intramedullary fixation compared to plating.[16] Our analysis revealed that 11.1% of nailing patients required revision surgery, compared to 7.4% for plating, in line with existing data.

Adults have well established the biomechanical deficiencies of intramedullary implants. Adult forearm nails offer restricted rotational and axial stability, unlike pediatric elastic nails. Tarr et al. emphasized that even little angular or rotational misalignment results in considerable impairment of forearm rotation.[17] This elucidates the delayed functional recovery and increased problems seen in the nailing cohort of our investigation.

Nonetheless, intramedullary fixation has certain advantages, such as decreased soft-tissue stripping and a shortened surgical length. These benefits render nailing appropriate in some situations, including polytrauma, impaired soft tissue states, or instances necessitating rapid stabilization. Our results, in conjunction with existing literature, indicate that plating is the preferred technique for adult diaphyseal forearm fractures when the objectives are morphological reduction and maximal functional recovery.

CONCLUSION

Overall, the findings of this study reinforce that plate osteosynthesis remains the gold standard for the management of adult diaphyseal fractures of the radius and ulna, particularly when optimal functional restoration and reliable fracture healing are the desired outcomes. Intramedullary nailing may still serve as an alternative in select cases with soft-tissue compromise or polytrauma, but it cannot be recommended as a primary modality in routine adult forearm shaft fractures.

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