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Research Article

RETENTION VERSUS REMOVAL OF FOREARM FIXATION PLATES: A CLINICAL PERSPECTIVE

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Abstract: ***Introduction:*** Diaphyseal fractures of the forearm are commonly treated with plate osteosynthesis because it provides stable fixation, good alignment, and early functional recovery. However, the decision to remove forearm plates after fracture healing remains controversial, as implant removal may increase the risk of refracture and other postoperative complications.**Objectives**To compare the outcomes of forearm plate retention and implant removal and to identify factors associated with refracture and plate removal following fixation of forearm fractures.**Methods**This retrospective observational study was conducted in the Department of Orthopaedics at Sree Mookambika Institute of Medical Sciences from February 2024 to January 2025. A total of 660 patients with 940 diaphyseal forearm fractures treated with plate osteosynthesis were included. Patient demographics, fracture characteristics, implant details, plate removal status, and refracture patterns were evaluated using medical records and serial radiographs. Fractures were classified according to the AO/OTA classification system. Statistical analysis included Fisher's exact test, Mann–Whitney U test, and multivariable logistic regression analysis.**Results**Among the 940 fractures analysed, refracture was observed in 22 cases (2.3%). Refracture occurred more frequently following plate removal (8.8%) compared to retained implants (1.8%). Multivariable logistic regression analysis showed that implant removal was independently associated with a significantly increased risk of refracture (OR: 3.72; 95% CI: 1.20–11.66; p=0.023). Radius fractures demonstrated higher odds of refracture than ulnar fractures, although the association was not statistically significant. Plate removal was more commonly performed in ulnar fractures and AO/OTA Type A fractures, both of which showed a significant association on multivariable analysis.**Conclusion** Forearm plate removal was associated with a higher risk of refracture when compared with implant retention. Routine elective removal of implants in asymptomatic patients may therefore not be necessary. Decisions regarding implant removal should be individualised based on patient symptoms, fracture characteristics, and clinical assessment.

Keywords: Forearm fractures, plate osteosynthesis, implant removal, refracture, plate retention.

INTRODUCTION

In adults, fractures of the diaphysis of the forearm are recognized as a major orthopedic injury, commonly related to high-energy trauma and significant loss of function [1]. The radius and ulna act as a biomechanical unit, which enables pronation, supination, load transfer, and stability of the upper limb. Thus, even slight deformities can significantly impact forearm mechanics and manual dexterity [2]. Current orthopaedic practice tends to favor plate osteosynthesis for such fractures, as it provides accurate anatomical reduction, rigid fixation, and early rehabilitation leading to favorable rates of union and functional recovery [3, 4].

Open reduction and internal fixation (ORIF) using a compression plating is often regarded as the gold standard in the management of adult diaphyseal fractures of the forearm. (5) This technique offers accurate anatomical reduction, good rotational stability, and quick functional mobilization [6]. Modern plating technologies, such as locking plates and limited-contact compression plates, have also contributed to enhancing fixation durability, fracture consolidation, and postoperative functional outcomes [7]. Recent studies consistently reveal high rates of union and positive clinical results with contemporary plate osteosynthesis methodologies [8].

Historically, routine removal of implants following forearm fracture consolidation became a common practice in numerous institutions; however, contemporary evidence increasingly discourages routine removal in asymptomatic patients since retained plates are associated with lower refracture rates and prevention of additional surgical morbidity [9, 10].

The most common indications for removal of implants are severe pain, prominence of the implant, local irritation, infection, limitation of motion of forearm and the patient's inclination [11]. Other studies have also reported symptomatic hardware and soft tissue irritation

as the most common clinical signs for elective plate removal [12].

On the other hand, it is typically better to preserve the implants to prevent the requirement for a second operation, to avoid the cost, to avoid the risks of anesthesia, and to decrease the risk of neurovascular injury, infection, and postoperative refracture [9]. Meta-analyses and cohort studies in recent years have indicated a markedly increased incidence of refracture following the removal of plates as compared with retaining implants, particularly during the first few months after removal [13].

The recent literature also highlights that implant removal is not a trivial intervention, since complications such as infection, delayed healing, nerve damage, hemorrhage, and refracture can emerge after elective hardware removal [14].

The present literature shows significant controversy surrounding the elective removal of forearm plates, and there are no broadly accepted guidelines for routine implant removal after fracture consolidation [13]. Some recent studies encourage implant removal in symptomatic patients with pain, irritation, infection, or restricted motion, while other findings favor implant retention due to the potential risk of refracture and surgical injuries after removal [9].

The incidence of refracture after plate removal has been observed in recent meta-analyses and cohort studies to be low or markedly raised compared to retained implants [15]. Reported complications after removal consist of refracture, infection, nerve injury, wound problems, and prolonged pain, thus extending the focus on optimal management.

The present evidence on implant retention versus removal is limited by relatively small numbers, different fracture patterns, different implant designs, and nonuniformity of surgical evaluations [9]. Variations in follow-up duration and rehabilitation standards further decrease comparability across investigations [16]. Most of the available evidence is retrospective and limited, prospective comparative studies evaluating long-term functional outcomes and patient-reported satisfaction exist. Furthermore, there is no clear agreement on the best guidance and timing for elective plate removal after the forearm fracture healing process [13].

MATERIALS AND METHODS

This retrospective observational study was conducted in the Department of Orthopaedics at Sree Mookambika Institute of Medical Sciences from February 2024 to January 2025 after obtaining approval from the Institutional Ethics Committee. Adult patients aged 18 years and above who underwent plate osteosynthesis for diaphyseal fractures of the radius, ulna, or both forearm bones during the study period were included. Patients with pathological fractures, infected implants, nonunion requiring revision surgery, incomplete medical records, or unavailable radiographs were excluded from the study.

The study population was derived from all eligible patients who underwent plate osteosynthesis for diaphyseal forearm fractures at the study centre between February 2024 and January 2025. Patient selection was performed retrospectively using hospital records, operative notes, and radiographic databases. The estimated sample adequacy was guided by the refracture rate reported by Navapong Anantavorasakul et al. (2022), in which refracture following implant removal was observed in 6.3% of cases [10]. After applying the inclusion and exclusion criteria, a total of 660 patients with 940 fractures were included in the final analysis.

Patient records, operative details, and serial radiographs were reviewed retrospectively to collect demographic information, fracture characteristics, implant-related details, and postoperative outcomes. Fractures were classified according to the AO/OTA classification system. Data regarding age, sex, fracture type, implant type, plate retention or removal, and occurrence of refracture were recorded. Refracture was defined as a fracture occurring at the previous fracture site, adjacent screw hole, or near the plate following fixation or implant removal. Details regarding the indication and timing of implant removal were also documented.

The study procedure involved assessment of follow-up radiographs and clinical records to evaluate fracture union, implant retention, implant removal, and refracture patterns. The association between implant removal and refracture was analysed, along with factors influencing plate removal and refracture risk.

Statistical analysis was performed using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequency and percentage, while continuous variables were represented as median with interquartile range (IQR). Fisher's exact test and Mann–Whitney U test were used where appropriate. Variables with $p < 0.1$ on bivariate analysis were included in multivariable logistic regression analysis to identify factors independently associated with refracture and plate removal. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 660 patients with 940 forearm fractures were included in the study. The median age of the patients was 42.5 years (IQR: 25.2–56.5), with males accounting for 63.0% of the study population. Unilateral forearm fractures were more common than bilateral fractures (97.4% vs. 2.6%). Among the fractures analysed, ulnar fractures (53.8%) were slightly more common than radial fractures (46.2%). Fractures involving both bones of the forearm constituted the majority of cases (55.6%), followed by isolated ulnar fractures (26.6%) and isolated radial fractures (17.8%). Closed injuries accounted for 66.7% of fractures, while 33.3% were open injuries. According to the AO/OTA classification,

Type A fractures were the most common (48.2%), followed by Type B (30.7%) and Type C fractures (15.4%). Initial radiographs were unavailable in 5.7% of cases. Compression plates were the most frequently used implants (73.2%), followed by locking plates (25.9%) (Table 1).

Table 1: Study Population Characteristics

Variable	Value
Patient demographics (n=660)	
Age, Median (IQR), years	42.5 (25.2–56.5)
Gender, n (%)	
Male	416 (63.0%)
Female	244 (37.0%)
Laterality, n (%)	
Unilateral forearm fracture	643 (97.4%)
Bilateral forearm fracture	17 (2.6%)
Fracture characteristics (n=940)	
Bone involved, n (%)	
Radius	434 (46.2%)
Ulna	506 (53.8%)
Fracture pattern, n (%)	
Isolated radius	167 (17.8%)
Isolated ulna	250 (26.6%)
Both bone fractures	523 (55.6%)
Open fracture, n (%)	
Open injury	313 (33.3%)
Closed injury	627 (66.7%)
AO/OTA classification, n (%)	
Type A	322 (48.2%)
Type B	205 (30.7%)
Type C	103 (15.4%)
No initial X-ray available	38 (5.7%)
Type of implant, n (%)	
Compression plate	688 (73.2%)
Locking plate	243 (25.9%)
Unknown	9 (1.0%)

Refracture was observed in 22 of the 940 fractures analysed. The rate of refracture was higher following plate removal (8.8%) compared to retained implants (1.8%). Most refractures involved the radius (68.2%) and occurred in closed fractures (68.2%). AO/OTA Type A fractures accounted for the highest proportion of refractures (50.0%). No significant differences in refracture patterns were observed with respect to sex or implant type. On bivariate analysis, none of the studied variables showed a statistically significant association with refracture (Table 2).

Table 2: Factors Associated with Refracture

Variable	Refracture Yes (n=22)	Refracture No (n=918)	P-value
Overall plate removal, n (%)			0.07
Yes	6	62	
No	16	856	
Location, n (%)			0.17
Radius	15	419	
Ulna	7	499	
Type of fracture, n (%)			0.39
Open fracture	7	306	
Closed fracture	15	612	
AO/OTA classification, n (%)			0.28

Type A	11	311	
Type B	6	199	
Type C	5	98	
Gender			>0.99
Male	14	402	
Female	8	516	
Type of implant			0.75
Compression plate	14	674	
Locking plate	8	235	

Multivariable logistic regression analysis (Table 3) showed that plate removal was independently associated with a 3.72-fold increased risk of refracture (95% CI: 1.20–11.66; p=0.023). Radius fractures demonstrated 2.25-fold higher odds of refracture compared to ulnar fractures; however, the association did not reach statistical significance (p=0.06).

Table 3: Multivariable Logistic Regression for Refracture

Variable	OR	SE	95% CI	P-value
Plate removal	3.72	2.19	1.20–11.66	0.023
Radius	2.25	1.07	0.97–5.75	0.06

Plate removal was performed in 65 fractures and was more common in ulnar fractures (70.8%) than in radial fractures (29.2%) (p=0.003). AO/OTA Type A fractures constituted the largest proportion of implant removals (60.0%) and showed a significant association with plate removal (p=0.033). No significant association was observed between plate removal and fracture type, gender, or age (Table 4).

Table 4: Factors Associated with Plate Removal

Variable	Plate Removal Yes (n=65)	Plate Removal No (n=875)	P-value
Location, n (%)			**0.003**
Radius	19	415	
Ulna	46	460	
Type of fracture, n (%)			0.19
Open fracture	17	296	
Closed fracture	48	579	
AO/OTA classification, n (%)			**0.033**
Type A	39	283	
Type B	20	185	
Type C	6	97	
Gender			0.41
Male	38	378	
Female	27	217	
Age (years)			0.80
Median (IQR)	39.3 (29.4–49.4)	38.5 (25.8–53.6)	

Multivariable logistic regression analysis (Table 5) identified ulnar fractures as an independent predictor of plate removal, with 2.57-fold higher odds of implant removal compared to radial fractures (95% CI: 1.42–4.65; p=0.002). AO/OTA Type A fractures were also significantly associated with plate removal, demonstrating 3.19-fold increased odds (95% CI: 1.10–9.17; p=0.032). Although implant removal was less common in open fractures, the association did not reach statistical significance (p=0.06).

Table 5: Multivariable Logistic Regression for Plate Removal

Variable	OR	SE	95% CI	P-value
Ulna	2.57	0.78	1.42–4.65	**0.002**
Type A	3.19	1.17	1.10–9.17	**0.032**
Type B	2.35	1.32	0.78–7.08	0.128
Open fracture	0.55	0.17	0.29–1.04	0.06

DISCUSSION

This retrospective study consisted of 660 patients with 940 forearm fractures surgically treated with plate osteosynthesis, with an investigation of the clinical outcome of implant retention versus removal. The results are in agreement with and supplement data from several recently reported studies.

The median age of the study population was 42.5 years, with a male predominance of 63.0%, significantly following the demographic patterns established in similar cohort studies. Similarly, Köse et al. (2019) identified a male predominance for adult diaphyseal forearm fractures, which was related to higher rates of occupational and high-energy trauma in males [3]. Ulnar fractures (53.8%) appeared to be slightly more frequent than radial fractures (46.2%), and fractures that involved both bones were predominant (55.6%), in agreement with the outcomes of Vasara et al. (2024), who reported both-bone involvement to be the most common fracture pattern in adults who received treatment with compression plate fixation [5]. Our series had a relatively higher rate of open fractures (33.3%) when compared to other series. Saini et al. (2023) identified open injuries in around 20-25% of cases, and this may be a reflection of the variances in the mechanism of injury and trauma referral practices at the typical hospital [2]. The most frequent fracture type consisted of AO/OTA type A (48.2%), followed by type B (30.7%), and type C (15.4%). This distribution is in agreement with the outcomes presented by Factor et al. (2023), who identified simple fracture patterns as the most common in adult forearm fractures [7]. Compression plates were employed in 73.2%, while locking plates were implemented in 25.9% of cases. This is in accordance with the general surgical practice established by Justice et al. (2024), who showed that both types of plates provide similar levels of union and functional outcomes [8].

Refracture was identified in 22 of 940 fractures (2.3 % overall). Refracture rate was significantly higher in the plate removal group (8.8%) than in the implant retention group (1.8%). Multivariable logistic regression established that removal of the plate independently heightened the risk of refracture by 3.72-fold (95% CI: 1.20–11.66, p=0.023). The figures lend strong confirmation to the meta-analytic data of Cao et al. (2025), who demonstrated significantly elevated refracture risk after a plate removal compared to retaining implants, with pooled odds ratios higher than 3.0 across numerous subgroup analyses [9]. Yao et al. (2014) also identified a high risk of refracture after plate removal, most notably in the early postoperative period, and suggested long-term protective periods preceding elective removal [15]. This observation was further strengthened by Anantavorasakul et al. (2022), who demonstrated that retained forearm plates were correlated with significantly lower rates of mechanical failure [10]. The odds of refracture were 2.25 times more pronounced for the radius versus the ulna, but this was not statistically significant (p=0.06), perhaps attributed to a lack of statistical power from the relatively small number of refracture events.

Plate removal was performed in 65 (6.9%) of the 940 fractures analysed. Ulnar fractures showed significantly higher odds of implant removal (OR: 2.57; 95% CI: 1.42–4.65; p=0.002), which may be attributed to implant prominence and soft tissue irritation along the subcutaneous border of the ulna. Similar findings were reported by Chhawra et al., who identified implant prominence and local discomfort as common indications for elective hardware removal [11]. AO/OTA Type A fractures were also independently associated with plate removal (OR: 3.19; 95% CI: 1.10–9.17; p=0.032), possibly because uncomplicated fracture healing in these cases increases the likelihood of elective implant removal after union. Although plate removal was less common in open fractures, the association did not reach statistical significance (p=0.06). These findings are consistent with previous studies reporting that symptomatic hardware and patient preference are among the most frequent reasons for elective implant removal, particularly in younger and active individuals [14].

Present findings conform to the current consensus that routine elective plate removal in asymptomatic patients is not advisable. As previously mentioned by Cao et al. (2025) and Anantavorasakul et al. (2022), the hazards of refracture associated with plate extraction are a significant clinical risk that needs to be carefully weighed against any predicted benefit [9, 10]. It still is considered appropriate to proceed with symptomatic patients, especially those with ulnar hardware prominent features or AO/OTA Type A, in a tailored fashion. Future investigation with standardized follow-up protocols and patient-reported outcome evaluations is necessary to guide the development of more definitive guidelines for elective plate excision after consolidation of forearm fractures.

The present study has certain limitations, including its retrospective single-centre design and dependence on medical records and radiographic documentation.

Variability in follow-up duration and implant removal indications may also have influenced outcomes. Further prospective multicentre studies are required to validate these findings.

CONCLUSION

The findings of the present study suggest that elective removal of forearm fixation plates is associated with an increased risk of refracture and may not be routinely indicated in asymptomatic patients following fracture union. Plate retention appears to be a safer approach after successful fracture consolidation. Ulnar fractures and AO/OTA Type A fractures were identified as important factors associated with implant removal. These findings are consistent with recent literature supporting a selective, symptom-based approach rather than routine implant removal. Clinical decision-making should therefore be individualised based on patient symptoms, fracture characteristics, and overall functional outcome.

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REFERENCES

1. A. S, Mulimani V, Bannimatti KB. A Prospective Study of Functional Outcome of Diaphyseal Both Bone Forearm Fractures in Adults Treated with Plate Osteosynthesis. IJCPR. 2026 Feb 22;18(02). doi:10.25258/ijcpr.18.2.214
2. Saini R, Sharma A, Baisoya K, Ravalji D. A Comparative Study Between Plate Osteosynthesis and Intramedullary Nailing for Diaphyseal Fracture of Radius and Ulna in Adults. Cureus. 2023 Apr 8. doi:10.7759/cureus.37277
3. Köse A, Engin MÇ, Topal M, Paksoy AE, İpteç M, Öztürk İA, et al. Retrospective Evaluation of Adult Diaphyseal Forearm Fractures Result In The Treatment Of Plate Osteosynthesis. IKSST. 2019. doi:10.5222/iksstd.2019.41713
4. Hopf JC, Mehler D, Nowak TE, Gruszka D, Wagner D, Rommens PM. Nailing of diaphyseal ulna fractures in adults—biomechanical evaluation of a novel implant in comparison with locked plating. J Orthop Surg Res. 2020 Dec;15(1):158. doi:10.1186/s13018-020-01656-z
5. Vasara H, Stenroos A, Aspinen S, Kosola J, Anttila T, Nordback PH. Both-Bone Forearm Shaft Fractures Treated with Compression Plate Fixation in Adults: A Systematic Review on Adverse Events and Outcomes. JBJS Open Access. 2024 Oct;9(4). doi:10.2106/JBJS.OA.24.00129
6. Rafi V BM, Tiwari V. Forearm Fractures. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 [cited 2026 May 8]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK574580/ PubMed PMID: 34662094.
7. Factor S, Gurel R, Eisenberg G, Tordjman D, Rosenblatt Y, Pritsch T, et al. Predictive Factors for Union Time in Adult Diaphyseal Forearm Fractures. Surgical Techniques Development. 2023 Aug 9;12(3):135–44. doi:10.3390/std12030013
8. Justice W, Adams A, Kasper A, Takagi-Stewart J, Ilyas AM. Forearm Fracture Fixation with Locking Plates: Does Size Matter? J Hand Surg Glob Online. 2024 May;6(3):319–22. doi: 10.1016/j.jhsg.2024.01.007 PubMed PMID: 38817769; PubMed Central PMCID: PMC11133845.
9. Cao R, Zhang J, Sun W, Jiang X, Hua K, Xiao D, et al. Removal of Forearm Plate Leads to a Higher Risk of Refracture-A Systematic Review and Meta-Analysis. Orthop Surg. 2025 Jan;17(1):36–44. doi:10.1111/os.14307 PubMed PMID: 39660612; PubMed Central PMCID: PMC11735362.
10. Anantavorasakul N, Lans J, Wolvetang NHA, Walbeehm ET, Chen NC. Forearm Plate Fixation: Should Plates Be Removed? Arch Bone Jt Surg. 2022 Feb;10(2):153–9. doi:10.22038/ABJS.2021.45901.2255 PubMed PMID: 35655741; PubMed Central PMCID: PMC9117894.
11. Chhawra S, Jain R, Singh R, Singh G, Ansari AR, Kumar A, et al. Our experience regarding indications benefits complications in 200 cases with summarizing various techniques for orthopaedics implant removal. JOASP. 2025 Mar 25;12:6. doi:10.25259/Joasp_22_23
12. Brattgjerd JE, Aasheim C, Rosenberg A, Fotland C, Halvorsen V. Long-term implant retention after impacted elastic stable intramedullary nailing in pediatric diaphyseal forearm fractures: a retrospective cohort study. ActaO. 2026 Apr 1;97. doi:10.2340/17453674.2026.45693
13. Alıç T, Alıç SBT, Gürel S, Dündar A, İpek D, Çalbiyik M. Complication profile and risk patterns following elective implant removal in pediatric fractures: a 10-year retrospective analysis. J Orthop Surg Res. 2025 Sep 26;20(1):836. doi:10.1186/s13018-025-06264-3
14. Masoni V, Ciatti C, Andriollo L, Vicenti G, Rivera F. Implant removal: benefits and drawbacks - Results of a survey with five hundred participants from the Italian Society of Orthopedic Surgery and Traumatology (SIOT) and comparison with other international trends. International Orthopaedics (SICOT). 2025 Aug;49(8):1775–87. doi:10.1007/s00264-025-06564-7
15. Yao CK, Lin KC, Tarng YW, Chang WN, Renn JH. Removal of forearm plate leads to a high risk of refracture: decision regarding implant removal after fixation of the forearm and analysis of risk factors of refracture. Arch Orthop Trauma Surg. 2014 Dec;134(12):1691–7. doi:10.1007/s00402-014-2079-4 PubMed PMID: 25168787.
16. Tsai SW, Ma HH, Hsu FW, Chou TFA, Chen KH, Chiang CC, et al. Risk factors for refracture after

plate removal for midshaft clavicle fracture after bone union. J Orthop Surg Res. 2019 Dec;14(1):457. doi:10.1186/s13018-019-1516-z