Spinghar University- Kabul

Spinghar Journal of Biomedical Sciences (SJBS)

Vol. 2, No. 2, Oct 2026, pp.153-160

A Prospective Comparative Study of Rush Pin with Long-arm Cast Versus Dynamic Compression Plate for the Management of the Adult Closed Diaphyseal Fractures of Radius and Ulna

*Ahmad Shakib Mohebi [1], Sayed Rahman Hakimi [2], Ranjit Kumar Sah [3]

1. *Department of Orthopedic Surgery and Traumatology, Kabul Atlas Hospital, Kabul, Afghanistan*
2. *Department of Orthopedic Surgery and Traumatology, Wazir Mohammad Akbar Khan Hospital, Kabul, Afghanistan*
3. *Department of Orthopedic Surgery and Traumatology, Mayo Hospital, King Edward Medical University, Lahore, Pakistan*

ARTICLE INFO

Type: Original Article
Received: 17/02/2026
Accepted: 10/08/2026

*Corresponding Author:
Ahmad Shakib Mohebi

E-mail address:
ahmadshakibmohebi@gmail.com

DOI:
https://doi.org/10.64444/sjbs.55

ABSTRACT

Background: Dynamic compression plate (DCP) fixation is the standard treatment for adult diaphyseal forearm fractures but requires extensive exposure. Rush pin fixation may provide a less invasive alternative, although comparative evidence remains limited. We aimed to compare radiological and functional outcomes of Rush pin fixation with long-arm casting versus DCP fixation in adults with closed diaphyseal fractures of the radius and/or ulna.

Methods: This prospective, non-randomized comparative study included 70 adults treated at two orthopedic centers in Kabul, Afghanistan in 2025-26. Patients underwent DCP fixation (Group A, n = 35) or closed reduction with Rush pin fixation followed by long-arm casting (Group B, n = 35). Outcomes included operative time, intraoperative blood loss, fracture union rate, time to union, Disabilities of the Arm, Shoulder, and Hand (DASH) score, and Grace-Eversmann functional outcomes.

Results: Operative time was longer in Group A than Group B (88.80 ± 7.65 vs 65.10 ± 6.65 minutes; $P<0.001$), as was intraoperative blood loss (36.32 ± 4.30 vs 11.67 ± 2.50 Ml; $P<0.001$). union rates were 100% and 91.43%, respectively ($P = 0.239$). Mean time to union was significantly longer in Group A than in Group B (17.72 ± 3.61 vs. 12.50 ± 2.03 weeks; $P<0.001$). The mean DASH scores were 14.80 ± 5.68 in Group A and 12.57 ± 4.56 in Group B ($P = 0.098$). Grace-Eversmann outcomes did not differ significantly ($P = 0.061$).

Conclusions: Both methods demonstrated similar union rates and functional outcomes. Rush pin fixation with long-arm casting was associated with shorter operative time, less blood loss, and earlier radiological union.

Keywords: Forearm; Diaphyseal fracture; Rush Pin; Dynamic compression plate; Intramedullary fixation

Introduction

Diaphyseal fractures of the radius and ulna are common orthopedic injuries that frequently require surgical intervention [1]. The importance of these fractures lies in the forearme's essen-

Copyright © 2026. Spinghar Journal of Biomedical Sciences, and Spinghar University-Kabul. All rights reserved.
This work is licensed under a Creative Commons Attribution-Noncommercial 4.0 International License

tial role in positioning the hand in space, enabling flexion and extension at the elbow and wrist, as well as pronation and supination through the proximal and distal radioulnar joints [2]. The forearm provides the structural and muscular foundations necessary for optimal hand function in various positions. The radius and ulna facilitate flexion and extension at the elbow and wrist through diarthrodial joints [3]. Preservation of the anatomical integrity of the forearm is essential for maintaining normal rotational motion; therefore, disruption of this anatomy may significantly impair pronation and supination, resulting in functional limitations and difficulties in performing daily activities [4]. Adult forearm shaft fractures are relatively uncommon, with a reported annual incidence of approximately 1.35 per 10,000 population, although rates vary according to age, sex, and geographic region. In younger adults, these fractures are commonly associated with traumatic mechanisms, particularly high-energy injuries [5–8]. Forearm fractures are frequently associated with injuries to the distal or proximal radioulnar joints and elbow dislocations, making appropriate management essential for restoring optimal forearm function [9].

Inadequate treatment may result in functional impairment, restricted range of motion, and reduced quality of life [7]. Therefore, the primary objectives of treatment are to achieve anatomical reduction, stable fixation, fracture union, early functional recovery, and minimization of complications [9]. Several treatment modalities have been described for diaphyseal forearm fractures, including open reduction and internal fixation (ORIF), intramedullary (IM) fixation, and external fixation. Currently, ORIF using a dynamic compression plate (DCP) remains the gold-standard treatment because it provides stable fixation, high union rates, and reliable anatomical restoration [5,10].

However, DCP fixation has several limitations, including extensive surgical exposure, potential compromise of the periosteal blood supply, the risk of refracture following plate removal, and reduced suitability in patients with severe soft-tissue injury, marked swelling, open or segmental fractures, or multiple traumatic injuries. To overcome these limitations, IM fixation using Rush pins has been proposed as a less invasive alternative [11]. Nevertheless, its effectiveness has been demonstrated mainly in selected cases and has been associated with relatively high rates of nonunion, frequently requiring supplementary cast immobilization [5].

Although DCP fixation remains the recommended treatment for adult diaphyseal forearm fractures, its application may be limited in low-resource settings because of greater surgical exposure, longer operative time, and higher implant costs. In contrast, IM fixation using Rush pins combined with long-arm casting offers a simpler and more cost-effective alternative; however, evidence supporting its effectiveness remains limited, particularly in resource-constrained healthcare settings. Most comparative studies have been conducted in well-equipped orthopedic centers with access to intraoperative fluoroscopy and advanced implants, which may limit the generalizability of their findings to low-income healthcare systems. Consequently, the external validity of these findings in settings such as Afghanistan, where access to imaging facilities and fixation resources is often limited, remains uncertain. Furthermore, prospective comparative studies from Afghanistan evaluating DCP versus Rush pin fixation in adult forearm shaft fractures are lacking.

We aimed to compare the radiological and functional outcomes of DCP fixation and Rush pin fixation in adult patients with diaphyseal fractures of the radius and ulna.

Materials and Methods

Study design and setting

This prospective, non-randomized comparative study was conducted at Wazir Mohammad Ak-

bar Khan Hospital and Kabul Atlas Hospital, Kabul, Afghanistan, between 21 March 2025 and 20 March 2026.

Study population and eligibility criteria

All consecutive eligible adult patients presenting with Diaphyseal fractures of the radius and/or ulna during the study period were enrolled. No formal sample size calculation was performed. Patients were allocated to either treatment group based on the treating surgeon's clinical judgment, fracture characteristics, and implant availability. Thus, treatment allocation was non-randomized. decision and implant availability. The inclusion criteria were adults aged 18-45 years of either sex with a closed diaphyseal fracture (proximal/middle/distal third) of the radius, ulna, or both forearm bones.

The exclusion criteria were: forearm fractures in children, open fractures, pathological fractures, concomitant primary complications, and patients lost to follow-up after surgery whose radiological union data were unavailable.

Surgical technique

The diagnosis of diaphyseal forearm fractures was established by clinical examination and standard anteroposterior (AP) and lateral radiographs. Fractures were classified according to the Orthopaedic Trauma Association (OTA) classification system. All procedures were performed under general anesthesia with the patient in the supine position by a single experienced orthopedic surgeon to ensure consistency of surgical technique and minimize inter-operator variability.

Group A underwent ORIF using a DCP. Separate surgical approaches were used for each bone. The radius was exposed through the standard Henry's approach, whereas the ulna was approached through its subcutaneous border. The plate was secured with six cortices on each side of the fracture. Because rigid fixation was achieved, routine postoperative immobilization was not used. Patients were encouraged to begin active range-of-motion exercises of the wrist, elbow, and forearm as tolerated shortly after surgery.

Group B underwent closed reduction and internal fixation (CRIF) using Rush pins under fluoroscopic guidance. For ulnar fixation, the shoulder was abducted and the elbow flexed to 90º. A 1-cm incision was made over the olecranon tip, and the medullary canal was entered using a curved awl. The position of the awl was confirmed on anteroposterior (AP) and lateral fluoroscopic views. An ulnar Rush pin corresponding to approximately 80% of the medullary canal diameter was inserted while maintaining fracture reduction. The nail was gently impacted to achieve distal engagement, and its proximal end was buried flush with the olecranon.

For radial fixation, the upper limb was extended, and the entry point was created just ulnar to the radial styloid under C-arm guidance using a curved awl. A radial nail 2 cm shorter than the ulnar nail, with a bent tip, was inserted following traction-assisted reduction. Correct reduction and implant position were confirmed using AP and lateral fluoroscopic views throughout the procedure.

Following fixation, an above-elbow back slab was applied to maintain rotational stability. Active finger motion was encouraged immediately after surgery. The back slab was replaced with a long-arm cast on postoperative day 14. Immobilization was discontinued after the appearance of early radiological signs of union, followed by gradual active range-of-motion exercises of the wrist, forearm, and elbow. Functional outcomes were assessed using the Disabilities of the Arm, Shoulder, and Hand (DASH) score and the Grace-Eversmann criteria at 12 months postoperatively for all patients.

Ethical statement

Ethical approval was obtained from the institutional review board of Wazir Mohammad Ak-

bar Khan Hospital (protocol code 01, date 1404/01/01), which covered the study conducted at both Wazir Mohammad Akbar Khan Hospital and Kabul Atlas Hospital. Written informed consent was obtained from all participants before inclusion in the study. The study was conducted in accordance with the Declaration of Helsinki.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 20 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation (SD). Ninety-five percent confidence intervals (95% CI) were calculated for the primary continuous outcomes, including operative time, intraoperative blood loss, time to fracture union, and DASH score. Comparison between groups for continuous variables was performed using the independent-samples t test. Categorical variables were analyzed using the Chi-square test or Fisher's exact test, as appropriate. A two-sided *P* value of <0.05 was considered statistically significant.

Results

A total of 80 patients were initially considered for inclusion during the study period. Four patients were excluded because they did not meet the eligibility criteria, and six patients were lost to follow-up. Consequently, 70 patients were included in the final analysis, with 35 (50%) patients allocated to each group. Group A comprised 27 males (77.14%) and 8 females (22.86%), whereas Group B included 26 males (74.29%) and 9 females (25.71%). The mean age was 29.33 ± 4.23 years in Group A and 30.60 ± 7.69 years in Group B, with no significant difference between the groups ($P > 0.05$).

According to the OTA classification, type A fractures were the most common fracture pattern in both groups. In Group A, 29 patients (82.86%) had type A fractures, and 6 patients (17.14%) had type B fractures. In Group B, 25 patients (71.43%) had type A fractures, 5 (14.29%) had type B fractures, and 5 (14.29%) had type C fractures.

The right limb was affected in 25 patients (71.43%), and the left limb in 10 patients (28.57%) in Group A. In Group B, 23 patients (65.71%) had right-sided involvement, whereas 12 patients (34.29%) had left-sided involvement.

The mean operative time was significantly longer in Group A than in Group B (88.80 ± 7.65 minutes [range, 68-99] vs. 65.10 ± 6.65 minutes [range, 50-77]; mean difference, 23.70 minutes; 95% CI, 20.28-27.12; $P < 0.001$). Similarly, mean intraoperative blood loss was significantly greater in Group A than in Group B (36.32 ± 4.30 mL [range, 29-45] vs. 11.67 ± 2.50 mL [range, 10-15]; mean difference, 24.65 mL; 95% CI, 22.97-26.33; $P < 0.001$).

Complete fracture union was achieved in all patients in Group A, whereas union was achieved in 32 patients (91.43%) in Group B, with nonunion occurring in 3 patients (8.57%). The difference in union rate between the groups was not statistically significant ($P = 0.239$, Fisher's exact test). However, the mean time to union was significantly longer in Group A than in Group B (17.72 ± 3.61 weeks [range, 11-22] vs. 12.50 ± 2.03 weeks [range, 10-15]; mean difference, 5.22 weeks; 95% CI, 3.82-6.62; $P < 0.001$).

According to the Grace-Eversmann criteria, 25 patients (71.4%) in Group A achieved excellent outcomes, 9 (25.7%) had good outcomes, and 1 (2.9%) had a satisfactory outcome, with no patients classified as unsatisfactory. In the Rush pin group,28 patients (80.0%) had excellent, 3 (8.6%) had good, 1 (2.9%) had satisfactory, and 3 (8.6%) had unsatisfactory outcomes. No significant difference was observed between the groups (Fisher's exact test, $P = 0.061$) (Table 1). The mean DASH score was 14.80 ± 5.68 (range, 6-30) in Group A and 12.57 ± 4.56 (range, 3-25) in Group B, with a mean differ-

ence of 2.23 points (95% CI, -0.23 to 4.69) and no statistically significant difference between the groups (P = 0.098) (Table 2).

No other postoperative complications, including infection, implant failure, or neurovascular injury, were observed during the follow-up period.

Table 1: Grace and Eversmann Criteria in both groups

Outcome	*Rush Pin Group n (%)*	*DCP Group n (%)*
Excellent	28 (80.0)	25 (71.4)
Good	3 (8.6)	9 (25.7)
Satisfactory	1 (2.9)	1 (2.9)
Unsatisfactory	3 (8.6)	0 (0.0)
Total	35 (100.0)	35 (100.0)
Fisher's exact test	P = 0.061	

Abbreviations: DCP: Dynamic compression plate

Table 2: Comparison of DASH scores between the two treatment groups

Variable	*DCP Group*	*Rush Pin Group*	*P-value*
DASH score	14.80±5.68	12.57±4.56	0.098

Abbreviations: DASH: Disabilities of the Arm, Shoulder, and Hand; DCP: Dynamic compression plate

Discussion

The present study demonstrated comparable union rates between the two treatment modalities. Complete fracture union was achieved in all patients in group A, whereas union was observed in 91.43% of patients in group B, with a small proportion (8.57%) developing nonunion. Although this difference was not statistically significant, the mean time to union was significantly longer in group A (17.72 ± 3.61 weeks) than in group B (12.50 ± 2.03 weeks).

In addition to earlier fracture union, Rush pin fixation was associated with significantly shorter operative time and lower intraoperative blood loss. These findings indicate that both techniques achieved satisfactory fracture healing and functional outcomes; however, intramedullary fixation with Rush pins may facilitate earlier radiological union while reducing surgical time and intraoperative blood loss. The rehabilitation protocols differed between the two groups and may have influenced functional outcomes. Patients in the DCP group underwent early active range-of-motion exercises shortly after surgery, whereas patients in the Rush pin group remained immobilized in a long-arm cast until early radiological signs of union, followed by gradual mobilization. This differences in postoperative rehabilitation may have affected functional recovery and should therefore be considered when interpreting the comparable DASH and Grace-Eversmann outcomes between the groups.

The shorter time to union observed in the Rush pin group may be explained by the biological advantages of closed intramedullary fixation. Compared with DCP fixation, which typically requires greater soft-tissue dissection and periosteal stripping, Rush pin fixation better preserves the fracture hematoma and periosteal blood supply. Preservation of these biological factors promotes secondary bone healing and

callus formation, which may contribute to earlier radiological union.

Nevertheless, ORIF using a DCP remains the most widely accepted treatment for adult forearm shaft fractures. Previous studies have reported union rates ranging from 96% to 98%, satisfactory outcomes between 80% and 93%, and high levels of functional recovery following DCP fixation [12–14].

Evidence from resource-limited settings supports the present findings. A retrospective study evaluating Rush pin fixation for acute diaphyseal fractures of the radius and ulna in adults reported a union rate of 94% (66 fractures), with a mean union time of 73 days. Nonunion occurred in 6% of cases, while delayed union was not observed. The average duration of cast immobilization was 7.9 weeks, and the overall success rate was 83% [15]. These findings are broadly consistent with the results of the present study and support the role of Rush pin fixation as a reliable treatment option for achieving satisfactory fracture healing and favorable clinical outcomes.

Similarly, Saini et al. reported reduced operative time and earlier fracture union in the intramedullary fixation group, whereas functional outcomes remained comparable between treatment groups [16].

In contrast, Venkataraman et al. reported earlier union and higher union rates with DCP fixation than with intramedullary nailing. These differences may be attributed to variations in implant design, postoperative immobilization protocols, fracture characteristics, and patient populations [17].

Likewise, a previous study evaluating intramedullary rod fixation in 20 adult patients with diaphyseal fractures of the radius and ulna reported excellent outcomes in 70% of cases, good outcomes in 20%, and satisfactory outcomes in 10% according to the Grace-Eversmann criteria, supporting the ability of intramedullary fixation to achieve satisfactory functional outcomes in adult forearm shaft fractures [14].

Compared with the findings of Reddy et al., who reported faster radiological union in the DCP group, the present study demonstrated earlier radiological healing in the intramedullary fixation group. These contrasting findings may reflect differences in surgical technique and implant design. Nevertheless, both studies demonstrated comparable functional outcomes, although DCP fixation was associated with better radiological union in their study, whereas intramedullary fixation was associated with a shorter operative time in the present study [18].

Closed Rush pin fixation has also been associated with reduced infection risk, lower blood loss, minimal soft-tissue disruption, and a stress-sharing biomechanical construct that promotes secondary callus formation [13].

These characteristics may be particularly advantageous in resource-constrained healthcare settings. In many low-income countries, including Afghanistan, limited access to advanced implants, operative facilities, and fluoroscopic imaging, together with the financial burden on patients, remains a major challenge. Under these circumstances, Rush pin fixation combined with long-arm casting may represent a practical alternative to DCP fixation while maintaining comparable functional outcomes and reducing operative time and intraoperative blood loss.

Overall, the findings of the comparative studies suggest that differences in outcomes between plate fixation and intramedullary fixation may depend on several factors rather than on the fixation method alone. While some studies, including the present study and that of Saini et al. [16], reported shorter operative time or earlier union with intramedullary fixation, other studies, such as those by other authors [17-19], reported more favorable radiological outcomes with DCP fixation. These differences may reflect variations in fracture characteristics, implant design, postoperative mobilization proto-

cols, and patient populations, as well as differences in study design and clinical settings. The generally comparable functional outcomes reported across several studies, despite differences in radiological outcomes, further suggest that fracture healing and functional recovery may not necessarily follow the same pattern. However, these potential explanations should be interpreted cautiously, as the available studies do not establish the independent contribution of each factor to the observed differences.

In contrast, Al-Sadek et al. reported more favorable outcomes with DCP fixation than with Rush pin fixation. They observed a 100% union rate in the DCP group and a shorter mean time to union with DCP fixation (9.4 weeks) than with Rush pin fixation (10.2 weeks), supporting DCP fixation as the standard treatment for these fractures [19]. However, recent meta-analyses have reported favorable results for Rush pin fixation with respect to operative efficiency and safety [20].

Limitations

This study has certain limitations. Its non-randomized design may have introduced selection bias and limits causal inference. The imbalance in OTA fracture types between groups and the relatively small sample size may have affected the robustness and comparability of the findings. The exclusive distribution of OTA type C fractures in the Rush pin group may reflect the non-randomized allocation process and may have introduced confounding when comparing treatment outcomes between the groups. The absence of an a priori sample size calculation further limits the methodological strength of the study. The relatively short follow-up period precluded assessment of long-term outcomes, and the single-surgeon design may limit the generalizability of the findings because of potential operator-dependent variability.

Conclusion

Both treatment methods provide comparable functional outcomes and similar union rates in adult diaphyseal forearm fractures. However, a significantly shorter time to union was identified in patients treated with Rush pin fixation and long-arm casting. These findings should be interpreted cautiously due to the study's non-randomized design and limited follow-up, and warrant confirmation in larger prospective studies.

Funding

No funding was received for this study.

Conflicts of interest

The authors declare that there is no conflict of interest.

References

1. Schulte LM, Meals CG, Neviaser RJ. Management of Adult Diaphyseal Both-bone Forearm Fractures. J Am Acad Orthop Surg. 2014;22(7):437–446.
2. Soubeyrand M, Assabah B, Bégin M, Laemmel E, Dos Santos A, Crézé M. Pronation and supination of the hand: Anatomy and biomechanics. Hand Surg Rehabil. 2017;36(1):2–11.
3. Orbay JL, Cambo RA. Biomechanical Factors in Stability of the Forearm. Hand Clin. 2020;36(4):407–415.
4. Metoki Y, Sukegawa K, Mizuhashi T, Hirukawa K, Tada T, Onuma K, et al. How does a reduction in the radial bow, in addition to a rotational deformity of the radius, affect the range of motion of the forearm: an anatomical cadaver study? JSES Int. 2025;9(5):1813–1819.
5. Iacobellis C, Biz C. Plating in diaphyseal fractures of the forearm. Acta Biomed. 2014;84(3):202–211.

6. Alffram PA, Bauer GC. Epidemiology of fractures of the forearm. A biomechanical investigation of bone strength. J Bone Joint Surg Am. 1962;44-A:105–114.
7. Vasara H, Aspinen S, Kosola J, Sartanen J, Naalisvaara T, Myllykoski J, et al. Adverse Events After Surgical Treatment of Adult Diaphyseal Forearm Fractures: a Retrospective Analysis of 470 Patients. JBJS Open Access. 2023;8(3):e22.
8. Moss JP, Bynum DK. Diaphyseal Fractures of the Radius and Ulna in Adults. Hand Clin. 2007;23(2):143–151.
9. Factor S, Gurel R, Eisenberg G, Tordjman D, Rosenblatt Y, Pritsch T, et al. Predictive Factors for Union Time in Adult Diaphyseal Forearm Fractures. Surg Technol Dev. 2023;12(3):135–144.
10. Tseng TH, Hung CC, Yen HK, Chen HM, Wang CY, Tzeng SC, et al. Higher nonunion rates with locking plates compared to dynamic compression plates in forearm diaphyseal fractures: a multicenter study. J Orthop Traumatol. 2025;26(1):10.
11. Kim SB, Heo YM, Yi JW, Lee JB, Lim BG. Shaft Fractures of Both Forearm Bones: The Outcomes of Surgical Treatment with Plating Only and Combined Plating and Intramedullary Nailing. Clin Orthop Surg. 2015;7(3):282–289.
12. Chapman MW, Gordon JE, Zissimos AG. Compression-plate fixation of acute fractures of the diaphyses of the radius and ulna. J Bone Joint Surg Am. 1989;71(2):159–169.
13. Anderson LD, Sisk D, Tooms RE, Park WI. Compression-plate fixation in acute diaphyseal fractures of the radius and ulna. J Bone Joint Surg Am. 1975;57(3):287–297.
14. Hadden WA, Reschauer R, Seggl W. Results of AO plate fixation of forearm shaft fractures in adults. Injury. 1983;15(1):44–52.
15. Moerman J, Lenaert A, De Coninck D, Haeck L, Verbeke S, Uyttendaele D, et al. Intramedullary fixation of forearm fractures in adults. Acta Orthop Belg. 1996;62(1):34–40.
16. 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;15(4):e37277.
17. Venkataraman S, Ethiraj P, Shanthappa Naik AH, Angadi SP. Diaphyseal fractures of the forearm in adults, comparative study of dynamic compression plate versus intramedullary nail. Int J Res Orthop. 2019;5(5):916–920.
18. Reddy RC, Kumar MA. A retrospective comparative study of intramedually nailing versus plating in the management of diaphyseal bothbone forearm fractures among adults. Surg Update Int J Surg Orthop. 2019;5(3):94–99.
19. Al-Sadek TA, Niklev D, Al-Sadek A. Diaphyseal Fractures of the Forearm in Adults, Plating Or Intramedullary Nailing Is a Better Option for the Treatment? Open Access Maced J Med Sci. 2016;4(4):670–673.
20. Box MW, Stegelmann SD, Domingue GA, Wells ME, Werthmann NJ, Potgieter CJ, et al. Intramedullary nail fixation versus open reduction and internal fixation for treatment of adult diaphyseal forearm fractures: a systematic review and meta-analysis. J Orthop Surg. 2024;19(1):719.