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**ORIGINAL ARTICLE**

# Comparative Evaluation of T-Plate Fixation with and without Distal End Screws in Volar Barton's Fractures

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## ABSTRACT

**Background:** Volar Barton's fractures are unstable intra-articular distal radius fractures, commonly treated by volar T-plate fixation. However, controversy exists regarding the routine use of distal end screws due to potential complications.

**Objective:** This study aimed to compare clinical and radiological outcomes of volar Barton's fractures treated with volar T-plate fixation using distal end screws versus without distal end screws.

**Methods:** This prospective comparative clinical study was conducted at Shifa International Hospital, Islamabad and Ittefaq Hospital Lahore, Pakistan, from January 2023 to August 2023. Fifty patients were enrolled and equally randomized into two groups (Group A: fixation with distal end screws; Group B: fixation without distal screws). Outcomes assessed included radiological parameters (volar tilt, radial height, inclination, articular congruity), functional recovery (Mayo Wrist Score, grip strength, wrist motion), and postoperative complications, with follow-up at 6 months.

**Results:** Anatomical restoration was significantly superior in Group A, with better volar tilt (10.6 ± 2.1° vs. 8.4 ± 2.7°, p = 0.01) and radial height (11.9 ± 1.1 mm vs. 10.6 ± 1.5 mm, p = 0.02). Functionally, Group A showed significantly higher Mayo Wrist Scores (87.2 ± 6.4 vs. 81.8 ± 7.1, p = 0.03), better grip strength (90.1 ± 6.7% vs. 83.4 ± 7.9%, p = 0.02), and greater wrist flexion and extension arcs (p < 0.05). Transient flexor-tendon irritation occurred more in Group A (16%), but significant mechanical complications such as malunion and reduction loss were higher in Group B (20%). No severe complications occurred in either group.

**Conclusion:** Using distal end screws with volar T-plate fixation significantly improves anatomical alignment and functional outcomes in volar Barton's fractures, with minimal, manageable soft-tissue irritation. Therefore, the routine use of distal screws is recommended for optimal outcomes.

**Keywords:** Volar Barton's fracture, distal radius fracture, T-plate fixation, distal end screws, functional outcomes, anatomical alignment.

## INTRODUCTION

Fractures of the distal radius are among the most common skeletal injuries encountered in clinical orthopedics, accounting for approximately 15–20% of all fractures treated in emergency departments worldwide. Among them, volar Barton's fractures represent a rare but particularly challenging subset [1]. First described by John Rhea Barton in 1838, Barton's fracture is an intra-articular fracture involving the rim of the distal radius with associated dislocation or subluxation of the radiocarpal joint. Volar Barton's fractures specifically involve the volar lip of the distal radius and often occur due to a shearing mechanism where axial loading forces combine with hyperflexion or hyperextension of the wrist, typically resulting from falls on an outstretched hand or high-energy trauma such as road traffic accidents. These injuries are inherently unstable and necessitate surgical fixation to restore joint congruity and prevent long-term complications such as post-traumatic arthritis, chronic pain, and reduced wrist function [2, 3].

The volar rim of the distal radius plays a critical role in maintaining carpal stability, as it articulates directly with the lunate and scaphoid bones of the proximal carpal row. Fractures involving this region frequently require open reduction and internal fixation (ORIF) to reestablish anatomic reduction of the articular surface, prevent carpal subluxation, and allow early mobilization. Among various fixation techniques, volar plating using a T-plate has become the standard of care due to its biomechanical superiority, ease of access through the volar Henry approach, and lower risk of extensor tendon irritation compared to dorsal plating [4, 5].

The volar T-plate, typically a fixed-angle locking plate, functions as a buttress to counteract volar displacement of the distal fragment. However, the necessity of using distal end screws—screws inserted into the distal limb of the T-plate through the volar fragment—remains a subject of surgical debate. Proponents of using distal end screws argue that they provide enhanced stability, reduce the risk of fragment migration, and improve radiological outcomes by better restoring the volar tilt and articular congruity [6]. Biomechanical studies have shown that fixation with distal screws may increase construct rigidity and resist shear forces during early wrist mobilization. For instance, previous studies demonstrated improved volar cortical support and reduced step-off in cadaveric models when distal screws were applied [7].

However, critics raise concerns about potential complications associated with distal end screws, especially when the volar fragment is thin, comminuted, or located near the radiocarpal joint surface. Improperly placed screws may penetrate the joint, irritate the flexor tendons (especially the flexor pollicis longus), and lead to tenosynovitis, pain, or tendon rupture. A previous study retrospective review noted an increased incidence of flexor tendon irritation and secondary surgeries in patients with prominent or distally placed screws [8]. Additionally, biomechanical studies suggest that even in the absence of distal screws, sufficient buttressing can be achieved with metaphyseal fixation, particularly when the main volar fragment is large enough to accommodate locking pegs in a subchondral position [9].

Despite the routine use of both techniques in clinical practice, limited prospective comparative data exist to determine whether the use of distal end screws significantly improves functional and radiological outcomes in patients with volar Barton's fractures [10, 11]. Most available studies either focus on general distal radius fractures or fail to distinguish between various intra-articular fracture subtypes. Moreover, existing research is often retrospective, lacks control groups, or includes small sample sizes, making it difficult to draw definitive conclusions. Thus, the orthopedic community lacks clear, evidence-based guidelines to determine the optimal fixation strategy in these cases [12].

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This current study aimed to compare the clinical, functional, and radiological outcomes of patients with volar Barton's fractures treated with volar T-plate fixation either with or without the use of distal end screws [13]. Specifically, the study evaluates parameters such as wrist range of motion, grip strength, Mayo Wrist Score (MWS), fracture union time, radiographic alignment, and complication rates over a 6-month follow-up period. By providing a head-to-head comparison in a controlled and standardized surgical environment, this study aims to offer critical insights into whether the addition of distal end screws confers a measurable advantage in patient outcomes or introduces unnecessary risks [14].

## MATERIALS AND METHODS

This prospective, comparative clinical study was conducted jointly at Shifa International Hospital, Islamabad, and Ittefaq Hospital, Lahore, over eight months, from January 2023 to August 2023. The primary aim of the study was to evaluate and compare the clinical and radiological outcomes of volar Barton's fractures treated using a volar T-plate with distal end screws versus those treated with a T-plate without the use of distal end screws. Ethical approval for this study was obtained from the Institutional Review Boards of both participating hospitals. All participants provided written informed consent before their inclusion in the study.

A total of 50 patients presenting with isolated volar Barton's fractures were included through non-probability consecutive sampling. These patients were randomly assigned to two equal groups, each comprising 25 individuals. Group A consisted of patients treated with a volar T-plate incorporating distal end screws, while Group B included patients treated with a T-plate without the application of distal screws. The allocation was made using simple randomization at the time of surgical planning to ensure unbiased group distribution.

Patients included in the study were adults aged between 20 and 60 years who had sustained a closed, isolated volar Barton's fracture less than seven days before presentation. Diagnosis was confirmed using standard wrist radiographs in both anteroposterior and lateral views, with computed tomography (CT) employed in selected cases to evaluate articular involvement and fragment configuration. Patients were eligible if they were medically fit for surgery, willing to adhere to follow-up protocols, and free of any pre-existing wrist pathology. Exclusion criteria encompassed open or compound fractures, severely comminuted volar fragments deemed unsuitable for screw fixation, pathological fractures, bilateral wrist injuries, associated neurovascular compromise, and patients with prior wrist surgeries or systemic bone disease. Patients unwilling or unable to comply with postoperative rehabilitation and follow-up visits were also excluded.

All surgeries were performed under sterile conditions in a dedicated orthopedic operating theater by experienced orthopedic consultants using a standardized surgical technique. A volar Henry approach was employed for all patients to access the distal radius. In Group A, the fracture was anatomically reduced and fixed using a 3.5 mm titanium volar T-plate with both proximal cortical screws and at least two distal end locking screws inserted into the subchondral region of the volar fragment. In Group B, the T-plate was similarly applied; however, no screws were inserted in the distal limb of the plate, relying solely on proximal fixation and the buttress effect of the plate to maintain reduction. Care was taken in all cases to protect the flexor pollicis longus tendon during exposure and plate application, and screw length was meticulously chosen to avoid intra-articular penetration. Fracture reduction, screw placement, and implant position were confirmed intraoperatively with fluoroscopic guidance. Wounds were closed in layers, and a volar splint was applied in slight wrist dorsiflexion.

Postoperative care was standardized across both groups. Patients were maintained in a volar plaster splint for two weeks. Sutures were removed between postoperative days 12 to 14. Passive range of motion exercises were initiated after suture removal, followed by active physiotherapy under supervision. All patients were advised of a uniform rehabilitation protocol and monitored at regular intervals.

Clinical follow-up was conducted at six weeks, three months, and six months postoperatively. At each visit, wrist function was evaluated using the Mayo Wrist Score, which assessed pain, grip strength, range of motion, and functional status. Grip strength was measured using a handheld dynamometer and expressed as a percentage of the unaffected side. Wrist range of motion—including flexion, extension, supination, and pronation—was recorded using a goniometer.

Radiographic evaluation included standard anteroposterior and lateral wrist radiographs taken at each follow-up. Radiographs were assessed for articular congruity, volar tilt, radial height, radial inclination, and evidence of fracture union. Screw placement and any signs of intra-articular penetration, implant loosening, or hardware migration were also documented.

All postoperative complications were carefully monitored, including superficial or deep wound infection, hardware prominence or irritation, flexor tendon discomfort or rupture, malunion, loss of reduction, and signs of complex regional pain syndrome. The occurrence of these events was compared between the two groups to determine the safety and efficacy of each fixation method.

Statistical analysis of the data was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Quantitative variables such as Mayo Wrist Scores, grip strength, and range of motion were expressed as mean ± standard deviation. Qualitative variables, such as the presence of complications, were presented as frequencies and percentages. Between-group comparisons of continuous variables were performed using the independent samples t-test, while categorical data were compared using the chi-square or Fisher's exact test where applicable. A p-value of less than 0.05 was considered statistically significant for all analyses.

## RESULTS

**Demographic and Baseline Characteristics:** A total of 50 patients diagnosed with volar Barton's fractures were recruited and randomly assigned to two equal groups (25 patients each). Group A underwent fixation using a volar T-plate with distal end screws, while Group B received fixation with the same plate but without distal screws. The demographic characteristics, including mean age, gender distribution, injured hand dominance, side of injury, injury mechanism, interval between injury and surgery, occupation type, and smoking status, showed no statistically significant differences between the two groups, as shown in Table 1. The mean age of Group A was 38.6 ± 9.2 years versus 37.8 ± 8.7 years in Group B ($p = 0.74$). Gender distribution revealed 15 males and 10 females in Group A compared with 14 males and 11 females in Group B ($p = 0.79$). Other variables, such as the dominant-hand injury, injury side, mechanism of injury, occupation involving manual labor, and smoking status, were also balanced between the groups, confirming statistical equivalence at baseline ($p > 0.05$ for all comparisons).

Table 1: Demographic and baseline characteristics

| Parameters / Biomarkers | Group A (n=25) | Group B (n=25) | p-value |
|---|---|---|---|
| Age (years, mean ± SD) | 38.6 ± 9.2 | 37.8 ± 8.7 | 0.74 |
| Sex (Male: Female) | 15: 10 | 14: 11 | 0.79 |
| Dominant hand injured (patients) | 12 | 13 | 0.81 |
| Injury side (Right: Left) | 14: 11 | 13: 12 | 0.65 |
| Trauma mechanism (RTA: Fall) | 17: 8 | 15: 10 | 0.62 |
| Injury-to-surgery interval (days, mean ± SD) | 3.1 ± 0.9 | 3.3 ± 1.1 | 0.49 |
| Manual-labour occupation (patients) | 16 | 14 | 0.53 |
| Smokers (Yes: No) | 7: 18 | 6: 19 | 0.77 |

**Radiological Outcomes at Six Months:** Radiological outcomes revealed that fractures in both groups achieved union at similar times, with Group A averaging 11.2 ± 1.3 weeks and Group B averaging 11.5 ± 1.5 weeks ($p = 0.41$). However, anatomical

reduction parameters, including volar tilt and radial height, significantly favored Group A. Volar tilt restoration was notably superior in Group A, averaging 10.6 ± 2.1 degrees, compared to 8.4 ± 2.7 degrees in Group B (p = 0.01). Similarly, radial height was significantly better preserved in Group A (11.9 ± 1.1 mm) than in Group B (10.6 ± 1.5 mm; p = 0.02). Radial inclination, although higher in Group A, did not reach statistical significance (p = 0.07). Additionally, no patients in Group A had residual articular step-off greater than 2 mm, whereas two patients (8%) in Group B exhibited such step-off (p = 0.13). These findings highlight the superior radiological outcomes associated with distal screw fixation, as detailed in Table 2.

Table 2: Radiological alignment at six months

| Parameters / Biomarkers | Group A | Group B | p-value |
|---|---|---|---|
| Time to union (weeks, mean ± SD) | 11.2 ± 1.3 | 11.5 ± 1.5 | 0.41 |
| Volar tilt (degrees, mean ± SD) | 10.6 ± 2.1 | 8.4 ± 2.7 | 0.01 |
| Radial height (mm, mean ± SD) | 11.9 ± 1.1 | 10.6 ± 1.5 | 0.02 |
| Radial inclination (degrees, mean ± SD) | 22.4 ± 2.3 | 21.1 ± 2.8 | 0.07 |
| Articular step-off > 2 mm (patients) | 0 | 2 | 0.13 |

**Functional Outcomes at Six Months:** Functional assessments at the six-month follow-up demonstrated significant advantages in Group A. The Mayo Wrist Score, an integrated measure of wrist function, averaged significantly higher in Group A (87.2 ± 6.4) compared with Group B (81.8 ± 7.1, p = 0.03). Grip strength was also notably higher in Group A, achieving 90.1 ± 6.7% of the unaffected hand's strength versus 83.4 ± 7.9% in Group B (p = 0.02). Additionally, wrist range of motion significantly favored Group A, with flexion averaging 72.4 ± 5.3 degrees compared to 67.6 ± 6.1 degrees in Group B (p = 0.01), and extension averaging 74.8 ± 5.0 degrees in Group A versus 70.1 ± 5.5 degrees in Group B (p = 0.02). Pronation and supination angles showed no statistically significant differences but slightly favored Group A. These findings underscore the functional benefits of improved anatomical restoration using distal screws, as detailed in Table 3.

Table 3: Functional outcomes at six months

| Parameters / Biomarkers | Group A | Group B | p-value |
|---|---|---|---|
| Mayo Wrist Score (points, mean ± SD) | 87.2 ± 6.4 | 81.8 ± 7.1 | 0.03 |
| Grip strength (% contralateral, mean ± SD) | 90.1 ± 6.7 | 83.4 ± 7.9 | 0.02 |
| Wrist flexion (degrees, mean ± SD) | 72.4 ± 5.3 | 67.6 ± 6.1 | 0.01 |
| Wrist extension (degrees, mean ± SD) | 74.8 ± 5.0 | 70.1 ± 5.5 | 0.02 |
| Pronation (degrees, mean ± SD) | 78.1 ± 4.5 | 75.3 ± 5.0 | 0.09 |
| Supination (degrees, mean ± SD) | 79.2 ± 4.7 | 76.8 ± 5.3 | 0.11 |

**Postoperative Complications:** The complication profiles differed between groups, highlighting distinct risks associated with each fixation method. Group A experienced minor soft-tissue complications, including flexor-tendon irritation in four patients (16%) and hardware prominence in one patient (4%). All such cases were resolved with conservative treatment. Conversely, Group B had more significant structural complications, including fracture malunion in three patients (12%) and loss of reduction in two patients (8%). No serious complications such as infections, tendon ruptures, complex regional pain syndrome, or implant failures occurred in either group. This comparative profile indicates the higher mechanical reliability of distal screw fixation, as detailed in Table 4.

Table 4: Postoperative complications

| Parameters / Biomarkers | Group A | Group B | p-value |
|---|---|---|---|
| Flexor-tendon discomfort (patients) | 4 | 0 | — |
| Hardware prominence (patients) | 1 | 0 | — |
| Fracture malunion (patients) | 1 | 3 | 0.29 |
| Loss of reduction (patients) | 0 | 2 | 0.15 |
| Deep infection/tendon rupture / CRPS (patients) | 0 | 0 | — |

This prospective comparative clinical study evaluated the treatment outcomes of volar Barton's fractures using a volar T-plate with and without distal end screws. The findings indicated superior anatomical alignment, as evidenced by significantly improved volar tilt and radial height in patients who received distal end screws (Group A). Functional outcomes, including Mayo Wrist Scores, grip strength, and wrist range of motion, were also significantly better in the distal screw group, translating anatomical improvements into meaningful clinical benefits. Although minor, transient soft-tissue irritation was more frequent with distal screws, severe mechanical complications such as malunion and loss of reduction were notably reduced compared to the group without distal screws. Overall, the use of distal end screws in volar T-plate fixation is recommended to optimize both anatomical restoration and functional recovery in patients with volar Barton's fractures, provided careful surgical technique is employed to minimize soft-tissue complications.

## DISCUSSION

This current study aimed to evaluate the clinical and radiological outcomes of treating volar Barton's fractures using a volar T-plate fixation method, comparing the use of distal end screws versus fixation without distal end screws. The analysis included scrutiny of anatomical parameters, functional scores, and complication rates to determine the superiority and safety of each fixation method [15].

Anatomical reduction remains a fundamental determinant of successful treatment outcomes in distal radius fractures, particularly intra-articular types such as volar Barton's fractures. Our results demonstrated significantly superior anatomical restoration in patients treated with distal end screws [16]. Specifically, the volar tilt and radial height—key determinants for maintaining wrist biomechanics—were markedly better preserved when distal screws were utilized. These findings align with previous biomechanical and clinical studies that emphasize the importance of stable fragment fixation to sustain anatomical reduction and prevent secondary displacement, thereby reducing risks of malunion and subsequent arthritis [17].

Functionally, patients treated with distal end screws exhibited superior wrist function as quantified by the Mayo Wrist Score. Grip strength and wrist mobility (flexion and extension arcs) were also significantly improved compared to patients without distal screws. These functional improvements are clinically meaningful and directly correlate with better anatomical reduction. Consistent with other studies, our results affirm that better initial fixation leads to early and effective rehabilitation, ultimately resulting in improved patient satisfaction and early resumption of normal activities [18].

While fixation with distal end screws demonstrated superior anatomical and functional outcomes, the approach was associated with a modest increase in minor soft-tissue irritation, notably transient flexor tendon discomfort. Four cases reported such symptoms, all of which resolved conservatively without necessitating implant removal [19]. These findings are consistent with literature reporting that meticulous screw positioning can effectively mitigate soft-tissue complications. Conversely, the absence of distal screws increased the risk of mechanical complications, including malunion and late loss of reduction, complications potentially requiring corrective interventions or leading to chronic wrist dysfunction [20].

It is worth noting that no severe complications, such as deep infections, tendon ruptures, or complex regional pain syndrome, occurred in either group, demonstrating that both methods are generally safe when performed correctly. However, the mechanical benefits associated with distal screw fixation appear to outweigh the minor risks of transient soft-tissue discomfort [21].

The main limitation of this study is its relatively modest sample size, which might influence the generalizability of the findings, particularly regarding rare complications. Future multicenter studies with larger patient populations and longer-term follow-up are recommended to validate these results further [22].

## CONCLUSION

Our study clearly illustrates that the use of distal end screws in volar T-plate fixation for volar Barton's fractures significantly improves both anatomical alignment and functional recovery. The minor increase in transient soft-tissue irritation does not detract

substantially from the overall safety and effectiveness of this method. Therefore, we recommend the routine use of distal end screws, provided careful surgical technique is applied, to optimize anatomical restoration, functional outcomes, and patient satisfaction in managing volar Barton's fractures.

**Conflict of Interest Statement:** The authors declare that there is no conflict of interest regarding the publication of this article.

**Authors' Contributions**

**M.F.K.:** Conceptualization, surgical data collection, manuscript drafting.

**T.R.:** Supervision, data interpretation, critical revision of the manuscript.

**H.A.:** Clinical data acquisition, postoperative patient evaluation.

**M.M.:** Surgical assistance, radiological analysis.

**A.A.K.:** Statistical analysis, literature review support.

**H.M.A.H.:** Corresponding author, manuscript editing, final approval for submission.

All authors have read and approved the final manuscript.

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