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ORIGINAL ARTICLE

Effect of proximal cortical screw length of volar locking plates on clinical outcomes in distal radius fractures.

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ABSTRACT… Objective: To evaluate the impact of proximal cortical screw length in volar locking plates (VLPs) on clinical outcomes in patients with distal radius fractures (DRFs). **Study Design:** Prospective observational study. **Setting:** Department of Orthopedic Surgery, Nishtar Hospital, Multan, Pakistan. **Period:** June 2024 to April 2025. **Methods:** We enrolled 104 patients aged ≥18 years with DRFs treated with VLPs, followed for at least 12 months. Exclusion criteria included prior limb injuries, open fractures, non-VLP interventions, and extensor soreness from distal screws. Clinical outcomes, including grip strength (Jamar dynamometer), range of motion (ROM), Quick Disabilities of the Arm, Shoulder, and Hand (QDASH) scores, and extensor tendon complications, were assessed. Radiological evaluations measured dorsal cortical screw prominence (>1.2 mm) using postoperative X-rays. Surgical procedures used a Colar Henry incision and Acu-Loc VLP with unicortical distal and bicortical proximal screws. Data were analyzed using SPSS 26.0, with Mann-Whitney U and chi-square tests for non-normally distributed continuous and categorical variables, respectively. **Results:** Of 104 patients (63 males, 60.6%; mean age 49.13 years), 61 (58.7%) had right-sided fractures, primarily caused by road traffic accidents. Extensor sensitivity occurred in 36 (34.6%) cases. Proximal screw prominence >1.2 mm was significantly associated with extensor synovitis ($p<0.05$), but not with grip strength, ROM, or QDASH scores. Patient satisfaction was 50.96% (53/104). **Conclusion:** Proximal cortical screw prominence >1.2 mm in VLPs significantly increases extensor tendon irritation in DRFs, emphasizing the need for precise screw length to optimize clinical outcomes and patient satisfaction.

Key words: Dorsal Cortex Protrusion, Radius Fracture, Screw Prominence, Volar Locking Plate, Wrist.

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INTRODUCTION

Distal radius fractures (DRFs) are described as the most common type of fractures in the adult population and may increase in occurrence as adults continue to become more active in old age.[1,2] These are the difficult fractures that present meaningful challenges to the clinical setting because it can often need surgical measures to restore the functionality, as well as, to avoid long-term disability. The introduction of the volar locking plates (VLPs) transformed the way of managing DRFs and came with its complications because the technique also offers stable fixation. One of the complications that may occur after VLPs is irritation of extensor tendons that may cause tenosynovitis, rupture of tendons, and patient dissatisfaction. These complications have the risk of undermining functional outcome of an otherwise successful surgical procedure and hence the need to shed light on risk factors involved in VLP fixation and reducing these risk factors.

According to the current literature, extensor tendon complications, such as extensor pollicis longus (EPL) or extensor digitorum communis ruptures are also linked to the usage of VLPs and the incidence rates are reported to be less than 1 or more than 12.5 percent.[3-6] These problems are frequently caused by iatrogenic damages of drill penetration or dorsally prominent screws when using bicortical fixer, which can injure tendons around the dorsal cortex.[8,10] Even though, the biomechanical investigations indicate that unicortical distal screws with lengths more than 75 percent of the radar thickness can have similar stiffness to the bicortical fixation, such results are not fully replicable in the case of intra-articular DRFs.[7]

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Remarkably, most studies have been done on distal screw insertion and little was aimed at the role played by the proximal cortical prominence screw over the radial shaft.[9,10]

This particular study seeks to examine whether conspicuous proximal cortical screw insertion in VLPs is linked to extensor tendon friction or business break or pinch removal in patients getting surgical decontamination of DRFs. The assessment of these outcomes will allow the study to evidence the properties of surgical techniques, leading to the enhancement of clinical outcomes.

METHODS

It was a prospective observation study aimed at assessing clinical and radiological outcomes of distal rhythm fractures in cases operated with volar locking plates (VLP) conducted at Nishtar Hospital, Multan, Pakistan, within the Department of Orthopedic Surgery from June 2024 to April 2025.

A total of 104 patients with distal radius fractures treated with VLP were enrolled in the study.

A non-probability consecutive sampling technique was employed to recruit eligible patients presenting at the hospital during the study period.

Inclusion Criteria

Patients were included if they were at least 18 years old, had a distal radius fracture treated with VLP, and had a minimum follow-up period of 12 months.

Exclusion Criteria

Patients were excluded when they had previous break in the same limb, an open fracture, non-VLP surgical treatment (e.g., percutaneously pinning or external fixation), had plates and screws taken out because of intra-articular distal screw position or excessively long screws stuck in a joint, and did not attend their last follow-up visit. Also patients with a soreness of the extenders with the distal screws (those who experienced pain during the active extension of hand above Lister tubercle or palpation on the extensor compartments) and those who had the plates removed owing to the intra-articular screws were excluded.

At the last follow-up, clinical outcomes were evaluated, such as grip strength, tourniquet time, range of motion (ROM) extensor tendon rupture, complication, extensor tenosynovitis, and reoperation. Both the fractured and the healthy sides were used to measure the grip strength using the Jamar hand dynamometer (Asimow Engineering, Los Angeles, CA, USA) with the difference being noted. ROM was identified through the difference in measurements between the fractured side and the healthy one. A questionnaire known as Quick Disabilities of the Arm, Shoulder and Hand (QDASH) was administered to assess the pain, functional capacity in daily living activities and level of disturbance of the symptoms. The anamnesis and palpation revealed extensor tenosynovitis, during which discomfort was present during extension either at the radial shaft or Lister tubercle or both. Those patients who complained of pain around or at Listers tubercle were excluded.

Radiological evaluation was done on digital radiographs (PACS). Both the lateral and posterior X-rays were taken preoperatively and postoperatively to determine the radial height, ulnar variance, volar tilt and radial inclination. Dorsal cortical prominence was measured by using immediate postoperative radiographs, where the most prominent proximal cortical screw was identified and its measurement was obtained by finding an outer dorsal cortex to the tip. Radiological assessments were performed by two orthopedic surgeons with the help of PACS computerized tools to accurately measure the angles and distances.

Surgical procedures were performed under infraclavicular block anesthesia. Patients were positioned supine, and a pneumatic tourniquet was applied at 250 mmHg for 90 minutes. A Colar Henry incision was used to access the fracture, which was reduced and fixed with an Acu-Loc volar distal radius plate (Acumed, Hillsboro, OR, USA) secured with 2.7 mm and 3.5 mm screws. Distal locking screws were placed in a single cortical, while proximal screws engaged a second cortex. After hemostasis, the skin was closed, and a short arm splint was applied. Finger motion was initiated immediately, the splint was removed after two weeks to begin wrist movements, and strengthening exercises

commenced after six weeks of fracture healing.

The data were analysed using an IBM SPSS Version 26 (IBM Corp., Armonk, NY, USA). Continuous variables normality was determined using a Shapiro-Wilk test and was shown not to be normally distributed. They were hence quoted as medians and interquartile interval (IQR, 25 75). The comparison of Groups in continuous variables was performed with the help of Mann-Whitney U. Variables expressed as categories were presented in frequencies and as percentages, yet the distribution of the latter was analyzed with the help of the chi-square test.

The study was approved by the Institutional Review Board of Nishtar Hospital, Multan, under reference number 002/IRB/TCH/N-II. Informed consent was obtained from all participants.

RESULTS

We found 63 (60.6%) males and 41 (39.4%) females among all cases. The mean age was 49.13 years. Right side was the most common fracture side found in 61 (58.7%). RTA was the most common cause followed by fallen and sports. (Table-I)

TABLE-I

Patients detailed baseline information

Variables		No./%age
Average age (years)		49.13
Gender	Men	63 (60.6%)
	Women	41 (39.4%)
Affected Side	Right	61 (58.7%)
	Left	43 (41.3%)
Cause of fracture	RTA	47 (45.2%)
	Fallen	38 (36.5%)
	Sports	29 (27.9%)

Frequency of extensor sensitivity was found in 36 (34.6%) cases. (Figure-1)

For extensor synovitis, a proximal screw prominence greater than 1.2 mm was shown to be statistically significant ($p<0.05$). Factors such as grip strength, range of motion, QDASH, and other variables were not linked to extensor tenosynovitis. (Table-II)

FIGURE-1

Association of extensor sensitivity

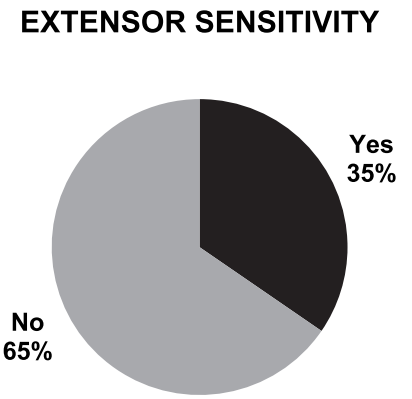


TABLE-II

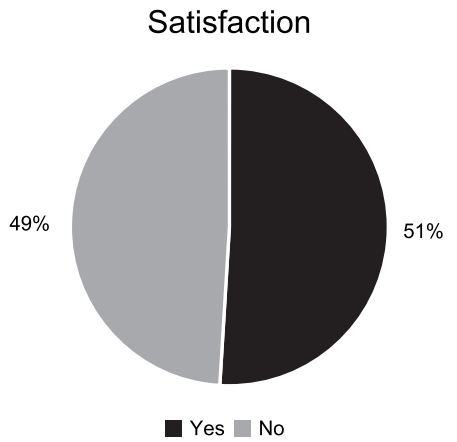
Association of variables with extensor tenosynovitis

Variables	Median [IQR] (36)	P Value
Length of Proximal Screw		
>1.2 mm	30 (83.3%)	<0.001
<1.2 mm	6 (16.7%)	
Frequency of proximal screw		
2 screws	5 (13.9%)	<0.002
2-3 screws	31 (76.1%)	
Mean QDASH	9.6 (2.2-30)	0.421
Radial inclination		
Pre-operative	15 (16-25)	0.354
Post-operative	20 (15-28)	
Radial Height		
Pre-operative	9 (2-12)	0.698
Post-operative	10 (7-15)	
Volar Tilt		
Pre-operative	-12 (-18 to -12)	0.594
Post-operative	9 (3-15)	

Frequency of satisfaction among all cases were 53 (50.96%). Figure-2

FIGURE-2

Post-operative satisfaction among all cases



DISCUSSION

This study identifies a significant association between proximal cortical screw prominence greater than 1.2 mm in volar locking plates (VLPs) and extensor tenosynovitis in distal radius fractures (DRFs), a finding that underscores the importance of proximal screw length. Unlike prior studies that often conflate the effects of proximal and distal screws when discussing extensor tendon irritation [11–14], our research specifically isolates the impact of proximal screw prominence in the radial shaft. This focus revealed that dorsal cortical protrusion exceeding 1.2 mm significantly increases the risk of extensor tenosynovitis ($p<0.05$), a novel threshold that contrasts with the broader focus on distal screws in existing literature. By excluding patients with distal screw-related irritation, we ensured a more precise evaluation of proximal screw effects, highlighting a previously underemphasized risk factor in VLP fixation.

Comparisons with biomechanical and clinical studies further contextualize our findings. Wall et al.[15] demonstrated that unicortical screws achieving 75% of radial thickness provide comparable rigidity to bicortical screws, suggesting that bicortical fixation may not always be necessary. However, our study diverges from Pulos et al.[11] who found proximal screw prominence clinically insignificant, possibly due to their inclusion of patients with implant removal for varied reasons. In contrast, White et al.[16] and Hong et al.[17] reported that dorsal prominence ≥2 mm increases tendinopathy and rupture risk, a higher threshold than our 1.2 mm finding. Our lower threshold suggests that even minor proximal screw prominence can compromise outcomes, advocating for meticulous screw length control to minimize complications.

Another critical aspect of our study is the influence of intraoperative techniques on screw prominence. Eng et al.[18] found that adjusting forearm supination-pronation by 10 degrees during proximal screw placement reduces prominence and associated complications. Our prospective study could not standardize intraoperative fluoroscopy for supination-pronation due to its observational design, relying instead on the most accurate postoperative radiographs to measure prominence. This limitation highlights the need for precise intraoperative imaging to optimize screw placement. We propose that maintaining proximal screw protrusion below 1.2 mm or using unicortical fixation could mitigate extensor tendon issues, offering a practical guideline for surgeons to enhance patient outcomes.

Despite its contributions, this study has limitations. The single-center design and sample size of 104 patients may limit generalizability. The prospective observational methodology precluded standardized intraoperative radiographs to assess supination-pronation angles, relying instead on postoperative X-rays, which may introduce measurement variability. Additionally, the assessment of extensor tendon irritation depended on subjective palpation data, potentially affecting reliability. Future multicenter studies with larger cohorts, standardized imaging protocols, and objective tendon irritation measures are needed to validate and expand upon these findings.

CONCLUSION

The surgeon's focus on the proximal cortical screws is just as important as the reduction quality, distal screw position and length, and overall success rate of using VLP in DRFs. Patients may experience extensor tendon soreness and dissatisfaction due to lengthy proximal cortical screws, even after a successful operation.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Muhammad Kamran Shafi:** Conceptualization, writing, formal analysis.
2	**Muhammad Ishfaq:** Methodology, data curation.
3	**Mukhtar Ahmad Tariq:** Inestigation, resources.
4	**Muhammad Rizwan Khan Lodhi:** Analysis, writing.
5	**Tauseef Raza:** Data entry.
6	**Yousaf Gul:** Supervision, conceptualization.