



Original Research Article

Comparative analysis of the functional and radiological outcome between T-plate and Variable angled volar locking plate in distal radius fracture

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Abstract: Aim and Objective: Distal radius fracture is one of the most common orthopaedic cases that present to the emergency department. The purpose of the present study was to compare clinical and radiological outcomes between T shaped plate and Variable angle volar locking plate for distal radius fractures. **Material and methods:** Study was conducted in Shija Academy of Health Sciences & Shija Hospitals, Imphal, Manipur. A total of 42 patients (21 patients with T-shaped plate and 21 patients with Variable angle volar locking plate) underwent ORIF for distal radius fracture. Clinical outcomes were evaluated at 6 weeks, 3 months, 6 months and 1 year after surgery. Anteroposterior and lateral radiographs were used to measure standard parameters before surgery, in the immediate post operative period, 6 weeks, 3 months, 6 months and 1 year. **Results:** There were no significant differences in any clinical outcome between the groups at any follow up time, however patients who underwent VALCP fixation had slight advantage over T shaped plate fixation in intra-articular distal radius fractures. The average follow up time was 2 weeks for suture removal, 6 weeks, 3 months, 6 months and 1 year. Results were analysed to fracture union, range of motion of wrist joint. **Conclusion:** Distal radius fracture treated with both T plate and VALCP shows good results and with good union, early mobilisation, and good radiological outcome. However, in my study comminuted distal radius fracture treated with VALCP has slight advantage over T shaped plate in intra-articular distal radius fractures.

Keywords: Distal radius fractures, Variable angle volar locking compression plate, T shaped plate, Open reduction internal fixation

INTRODUCTION

Distal radius fracture (DRF) represents the predominant type of fracture associated with falls and is also the most frequently occurring fracture within the upper extremities. The risk determinants for distal radius fractures (DRF) are influenced by variables such as age, sex, and environmental factors, with empirical evidence indicating that females

exhibit a higher propensity for experiencing a DRF in comparison to their male counterparts. Additional risk factors associated with distal radius fractures (DRF) encompass a diminished body mass index (BMI) and the propensity to experience falls due to an individual's compromised balance. (1) Throughout the two-decade research timeframe, there was a notable 31% escalation in the rate of

DRFs, with a predominance of female participants (75%) and 60% within the age demographic of 50–79 years. The incidence among women exhibited a 20% rise, in contrast to an 8% increase for men, and the disparity in incidence rates between women and men became particularly evident in the cohort of patients aged over 50 years. (2) The fracture of the distal radius constitutes the most encountered injury within the adult population, accounting for approximately 17.5% of all fracture occurrences. Distal radius fractures demonstrate a bimodal age distribution within the affected demographic, characterized by a peak incidence among individuals under the age of 18 years and a subsequent peak among those aged 50 years or older. The management of distal radius fractures incorporates both surgical and nonsurgical treatment options. However, a definitive consensus has yet to be reached regarding the most efficacious treatment strategy. Surgical intervention for distal radius fractures has been associated with an improvement in medium-term Disability Arm Shoulder Hand (DASH) scores when compared to nonsurgical management in the adult population. No substantial differences in complication rates were observed between the treatment groups. Moreover, an enhancement in grip strength was noted in favour of the surgical treatment approach. Nonetheless, no significant discrepancies were detected in medium-term DASH scores within the subset of studies that specifically focused on patients aged 60 years or older. (3) Many studies have suggested that volar plating is associated with a decreased incidence of complications, particularly in patients who exhibit intraarticular fractures, while nonbridging external fixation is linked to a lower complication rate in individuals experiencing extraarticular fractures. For patients aged over 60 years, nonoperative management may remain the most favoured therapeutic strategy, due to the lack of substantial evidence indicating a reliable decrease in complications or complications that require surgical intervention among the alternative treatment options. (4) Thus, our study will conduct a comparative analysis of the functional and radiological outcomes associated with the utilization of T-plate versus Variable Angled Volar Locking Plate in the context of distal radius fractures.

MATERIALS AND METHODS

The research was performed at the Shija Academy of Health Sciences and Shija Hospitals, located in

Imphal, Manipur. It was a hospital based prospective randomised control study. A cumulative total of 50 subjects were incorporated into the study, all of whom presented with distal radius fractures and were scheduled for surgical intervention. There were 8 total drops out due to failing to return for follow up radiographic and clinical evaluation. Selection of patients was based on specific inclusion criteria, which mandated that fractures had occurred within a week, while individuals with systemic illnesses, and patients unwilling to proceed with surgery were excluded from participation. Prior to the surgical procedures, comprehensive medical histories were meticulously recorded and thorough investigations were conducted. Written informed consent was acquired from all participants prior to the surgical intervention. The subjects were randomly allocated into two distinct groups, each comprising 21 patients. AO/OTA fracture classification were used to classify the type of fracture, in which there were patients with AO type A3, B2, B3, C1, C2 and C3. Mean age in volar plate group was (35.68 ± 12.83) years and in T shaped plate group was (34.61 ± 11.57) years ($p = 0.733$) with maximum incidence among 21e30 years age group. Out of 42 patients, 24 were males and 18 were females. The patients aged between 20 to 60 years, and agreed to be involved in the study were included. Along with the patients with a history of fractures, associated other injuries or fractures of the same limb, injury for more than 2 weeks, open fracture, associated head injury or multi organ injuries, pre-existing arthrosis or disability, associated neuro vascular deficit, psychiatric illness and pathological fracture were excluded. All the patients were divided into 2 groups. In Group I, T-shaped plates were employed, whereas in Group II, variable angle volar locking plates were utilized.

A Modified Henry approach was used for 21 patients operated by ORIF with VALCP and for T-shaped plate an extended Ulnar AO approach was used for 6 patients and 15 patients with modified henry approach for T-shaped plate.

Clinical final outcomes were systematically assessed after 1year post-surgery. Anteroposterior and lateral radiographs were employed to ascertain standardized parameters prior to surgery, immediately following the operative procedure, at 6 weeks, 3months,6 months and at the 1-year follow-up.

RESULTS

A total of 42 patients with intraarticular distal radius fractures were included in this study. All patients underwent Open Reduction and Internal Fixation (ORIF), with 21 patients receiving a Variable Angled Volar Locking Plate (VALCP) and the other 21 receiving a T-shaped plate. Radiological assessment confirmed that all fractures in both groups achieved union with an acceptable degree of reduction.

At the one-year postoperative evaluation, no statistically significant differences were found in functional performance

between the two groups ($p > 0.05$ for all parameters). Measures of flexion, extension, supination, pronation, and the Green O'Brien Score all yielded p-values greater than 0.05, indicating comparable functional recovery (Table 1). However, a marginal, non-significant superiority in variability was observed in the VALCP group.

Table 1: Functional Outcomes at 12-Month Follow-up

Functional Parameters	VALCP (Mean $\pm$ SD)	T-shaped plate (Mean $\pm$ SD)	p-value
Flexion ($^{\circ}$)	66.57 $\pm$ 5.73	66.67 $\pm$ 5.74	0.957
Extension ($^{\circ}$)	65.71 $\pm$ 5.76	64.33 $\pm$ 5.32	0.425
Supination ($^{\circ}$)	70.0 $\pm$ 5.0	67.24 $\pm$ 5.60	0.100
Pronation ($^{\circ}$)	65.0 $\pm$ 6.12	62.33 $\pm$ 4.93	0.128
Green O'Brien Score	86.90 $\pm$ 5.12	84.05 $\pm$ 7.68	0.164
*Independent t-test applied; p-value significant at $p < 0.05$ *			

The one-year radiographic assessment revealed a statistically significant difference in volar tilt. The VALCP group demonstrated a significantly greater volar tilt ($9.71^{\circ} \pm 0.95^{\circ}$) compared to the T-shaped plate group ($8.86^{\circ} \pm 1.46^{\circ}$; $p = 0.030$). No significant differences were observed in radial height or radial inclination between the groups (Table 2).

Table 2: Radiological Outcomes at 12-Month Follow-up

Radiological Parameters	VALCP (Mean $\pm$ SD)	T-shaped plate (Mean $\pm$ SD)	p-value
Volar tilt ($^{\circ}$)	9.71 $\pm$ 0.95	8.86 $\pm$ 1.46	0.030*
Radial height (mm)	9.43 $\pm$ 0.93	9.52 $\pm$ 1.66	0.820
Radial inclination ($^{\circ}$)	18.62 $\pm$ 2.01	17.71 $\pm$ 3.23	0.282
*Independent t-test applied; *p-value significant at $p < 0.05$ *			

The overall complication rates were low and not statistically significant between the two groups ($p > 0.05$). In the T-shaped plate group, one patient experienced delayed union and another developed arthritis. Symptoms of hand stiffness were observed in one patient from each group (Table 3).

Table 3: Postoperative Complications

Complication	VALCP (n)	T-shaped plate (n)	p-value
Arthritis	0	1	0.500
Stiffness	1	1	-
Delayed union	0	1	0.387
*Chi-square test applied; p-value significant at $p < 0.05$ *			

Figure 1: Functional and Radiological Outcomes Comparison

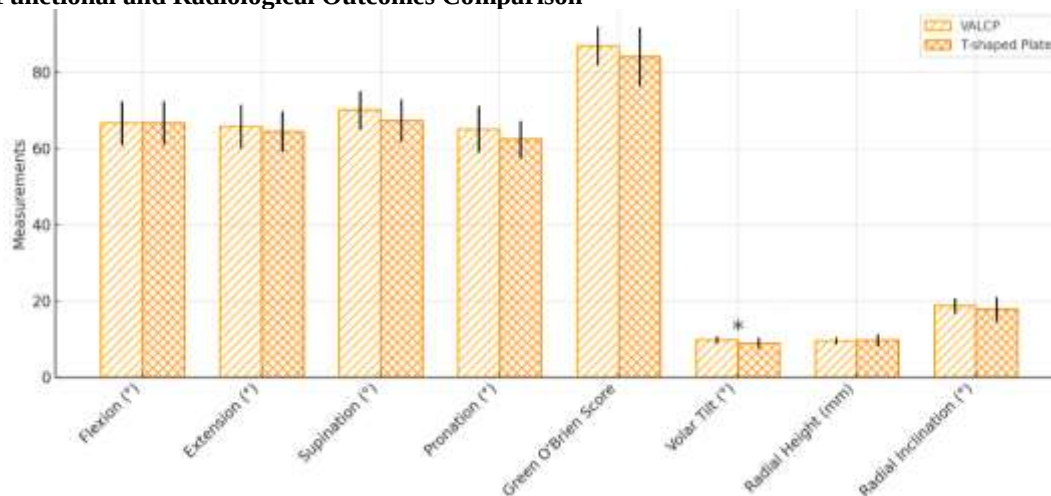


Figure 2: Volar Tilt Distribution

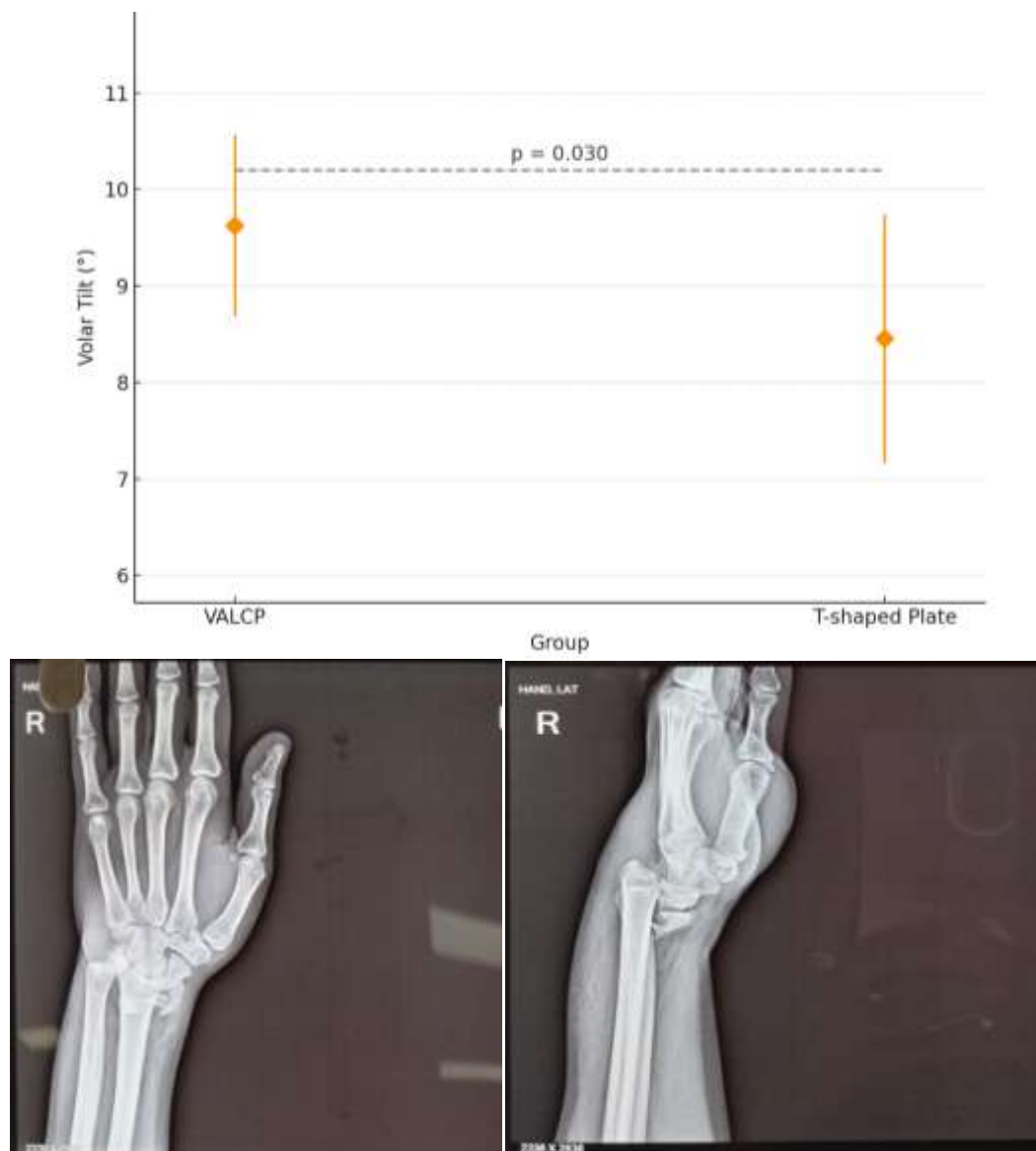


Fig 3: Pre-Op Xray AP and LAT view of distal radius fracture



Fig 4: Post Op Xray of VALCP plate fixation



Fig 5: Pre Op Xray AP and LAT view of distal radius fracture



Fig 6: Post Op Xray of T-plate fixation

DISCUSSION

This study evaluated and compared the functional and radiological outcomes of distal radius fractures (DRFs) managed using two volar plating techniques: the Variable-Angled Volar Locking Plate (VALCP) and the conventional T-shaped plate. While both groups demonstrated satisfactory fracture union, subtle distinctions were noted in radiological outcomes, particularly volar tilt, favouring VALCP. No significant differences in overall complications or functional parameters were observed. These findings resonate with the evolving consensus in literature, particularly concerning surgical indications, implant design, and outcome determinants.

DRFs are among the most common fractures, particularly affecting the elderly and young adults in a bimodal distribution. Luukkala et al. (2020) emphasized the prevalence of DRFs in the elderly, attributing high rates to osteoporotic bone and falls,

particularly among women [1]. This is further supported by Viberg et al. (2023), who observed a 31% increase in DRFs over two decades in Denmark, with a notably higher incidence among women above 50 years [2]. Although our study population was predominantly younger adults (mean age ~35 years), the underlying biomechanical and anatomical principles influencing fracture management remain universally relevant. The exclusion of older, osteoporotic patients in our study allows for a focused comparison of implant biomechanics without the confounding effects of poor bone quality.

Our study observed no statistically significant differences in flexion, extension, pronation, supination, or Green and O'Brien scores between VALCP and T-shaped plates at 12 months postoperatively. This aligns with findings by Ochen et al. (2020), whose meta-analysis concluded that operative treatment improves DASH scores over

nonoperative approaches in the general adult population but revealed minimal differences in functional outcomes between various surgical techniques [3]. Woolnough et al. (2021), in a comprehensive network meta-analysis of randomized controlled trials, echoed this by noting that while some plating systems may provide radiological benefits, the functional outcomes often converge across surgical techniques [4]. Furthermore, He et al. (2020) observed that both surgical and non-surgical approaches led to acceptable outcomes in DRFs, but surgical techniques showed faster return of function, particularly in younger patients [5]. Our cohort mirrors this trend, as both VALCP and T-shaped plate groups achieved near-normal range of motion and satisfactory Green and O'Brien scores by 12 months.

Interestingly, Abdel-Wahed et al. (2022) specifically evaluated variable-angle volar plates and concluded that they offered enhanced outcomes in intra-articular fractures due to better fragment-specific fixation [6]. Our findings partially support this, as patients with intra-articular fractures in the VALCP group showed marginally better functional trends, although statistical significance was not achieved. This may reflect the mechanical advantage of variable-angle screw trajectories in stabilizing complex fracture patterns.

Zhou et al. (2022) directly compared new-generation T-shaped plates with variable-angle volar locking plates and reported functional superiority in the VALCP group, particularly in pronation and grip strength [7]. While our study did not assess grip strength, the lack of significant differences in motion and subjective scores reinforces that while radiographic precision may be enhanced by VALCPs, the functional advantage may be more nuanced or case-dependent. The most notable radiological finding in our study was the significantly improved restoration of volar tilt in the VALCP group ($p = 0.030$), while radial height and inclination remained similar across both groups. Mignemi et al. (2013) emphasized the importance of restoring volar tilt to prevent post-traumatic arthritis and loss of wrist extension, especially in intra-articular fractures [8]. Our finding supports their conclusions, suggesting that the use of VALCP may facilitate better anatomical alignment due to its flexible screw orientation.

In a comprehensive meta-analysis by Wang et al. (2018), volar locking plates demonstrated superiority over external fixation in terms of radiological parameters such as volar tilt and radial height [9]. Although our study does not compare internal and external fixation, the superior volar tilt restoration seen with VALCP reiterates the broader advantage of volar locking systems in achieving and maintaining

anatomical reduction.

Additionally, Emet et al. (2024) investigated optimal plate positioning for volar fixed plates and concluded that positioning, combined with angle variability, significantly influenced outcomes [10]. This supports the premise that VALCP, with its multi-directional screw options, may offer better adaptability in aligning diverse fracture configurations. This adaptability may account for the improved volar tilt restoration in our study.

Both groups in our study demonstrated low complication rates. Only one patient in the T-shaped group experienced delayed union and another developed post-traumatic arthritis. One patient in each group reported stiffness. These results are consistent with prior literature indicating generally low complication rates for volar plating. For instance, Ochen et al. (2020) reported no significant difference in complication rates between operative and nonoperative approaches in their meta-analysis [3].

Abdel-Wahed et al. (2022) similarly observed that variable-angle plating did not increase complication risk and, in some scenarios, reduced tendon irritation due to improved screw trajectory [6]. In our study, no hardware-related complications or tendon ruptures were noted, possibly reflecting the precise intraoperative positioning and patient selection. Chavhan et al. (2017), in a prospective study of locking compression plates for DRFs, reported similar findings—low complication rates, high union rates, and good radiological alignment [11]. Our study supports this, adding to the growing evidence that both VALCP and T-shaped volar plates are safe and effective when appropriately selected.

In our methodology, a modified Henry approach was used for most patients, aligning with standard volar exposure techniques. This approach has been widely adopted in the literature due to its minimal soft tissue disruption and optimal visualization of the volar surface of the radius. Abdel-Wahed et al. (2022) emphasized that operative technique, including plate positioning and approach, is as important as implant design in ensuring outcomes [6]. Moreover, Emet et al. (2024) highlighted how plate position affects radiological and clinical success, which might partly explain our results showing better volar tilt in VALCP patients [10].

Our study cohort included predominantly male patients (24 out of 42), and most were aged 21–30 years. This contrasts with population-based studies such as those by Luukkala et al. (2020) and Viberg et al. (2023), which report a higher DRF incidence among older women [1,2]. The relatively young, active population in our study may have contributed to the generally favourable outcomes across both

groups. As Woolnough et al. (2021) noted, treatment strategies must consider patient-specific factors such as age, fracture pattern, and comorbidities to optimize outcomes [4]. While older patients often benefit from nonoperative management due to lower functional demands and higher complication risk, our younger cohort was well-suited for surgical fixation, and the absence of significant complications supports this approach. He et al. (2020) emphasized that surgical management shows the greatest benefit in functionally active patients, which corresponds with the favorable results observed in our study group [5].

This study has some limitations. First, the sample size (n = 42) limits generalizability, particularly for detecting rare complications or subtle functional differences. Second, the follow-up period of 12 months, while sufficient to capture union and early functional outcomes, may not detect long-term degenerative changes like arthritis. Third, the exclusion of patients over 60 years of age limits applicability to older, osteoporotic populations—a demographic where implant selection may carry different implications.

Additionally, functional outcomes were assessed using Green and O'Brien scores rather than more comprehensive patient-reported outcomes such as the DASH or PRWE. Future studies incorporating broader outcome measures and cost-effectiveness analysis would enhance clinical decision-making.

The findings of our study suggest that both VALCP and T-shaped plates provide reliable fixation for distal radius fractures in younger adults, with similar functional and complication outcomes. VALCP may offer an advantage in radiographic outcomes, particularly volar tilt, which could influence long-term joint function and degenerative changes. Future research should expand the study cohort to include older adults and osteoporotic fractures, where variable-angle constructs might demonstrate different performance profiles. Comparative studies evaluating cost, surgical time, implant removal rates, and patient satisfaction will further inform surgical decision-making. This study adds to the growing body of literature affirming that both variable-angle volar locking plates and traditional T-shaped plates are effective in managing distal radius fractures. While functional outcomes and complications are similar, VALCPs offer better restoration of volar tilt—a factor associated with improved long-term wrist biomechanics. These findings are consistent with prior studies, reinforcing the need to tailor surgical decisions to fracture characteristics, patient demographics, and surgeon expertise.

CONCLUSION

This prospective randomized study compared the clinical and radiological outcomes of distal radius fractures treated with Variable-Angled Volar Locking Plates (VALCP) and conventional T-shaped plates. Both treatment modalities demonstrated comparable functional recovery, union rates, and low complication incidence over a one-year follow-up. Notably, the VALCP group exhibited superior radiological restoration of volar tilt, suggesting a mechanical advantage in achieving more anatomical alignment, especially in intra-articular fractures. These findings are consistent with previous studies indicating that while functional outcomes may be similar across surgical modalities, radiographic precision and adaptability offered by variable-angle systems can enhance alignment and potentially reduce long-term degenerative sequelae. Given the absence of significant differences in functional scores and complications, implant selection should be guided by fracture complexity, surgeon experience, and patient-specific factors. Future research with larger, more diverse cohorts—including older osteoporotic patients—and longer follow-up durations is essential to determine whether the radiological advantages of VALCP translate into long-term functional benefits or reduced rates of post-traumatic arthritis.

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