

Original Article

Functional outcomes of distal radius fractures managed with 2.7 mm variable angle volar locking compression plates: a prospective observational study.

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ABSTRACT

Objective: To evaluate the functional and radiological outcomes of unstable distal radius fractures managed with 2.7 mm Variable Angle Volar Locking Compression Plates and to determine postoperative complications.

Methodology: A hospital-based prospective observational study was conducted in the Department of Orthopaedic Surgery, Sandeman Provincial Hospital, Quetta, Pakistan, from 1 July 2022 to 30 June 2023. The ethics approval number and approval date are blank. 100 adult patients with unstable distal radius fractures were enrolled using consecutive non-probability sampling. All patients underwent open reduction and internal fixation with a 2.7 mm Variable Angle Volar Locking Compression Plate through the standard volar Henry approach. Functional outcomes were assessed using the Modified Mayo Wrist Score (MMWS), while radiological union, wrist range of motion, grip strength, and postoperative complications were evaluated during follow-up at 2 weeks, 6 weeks, 3 months, and 6 months.

Results: The mean age of the participants was 42.8 ± 13.6 years, and 64% were male. Road traffic accidents (46%) and falls (42%) were the predominant mechanisms of injury. Radiological union was achieved in 95% of patients within six months. The Modified Mayo Wrist Score improved significantly from 41.5 ± 8.9 at six weeks to 89.4 ± 7.6 at six months ($p < 0.001$). Excellent and good functional outcomes were achieved in 62% and 25% of patients, respectively. Mean wrist flexion and extension were $71.2 \pm 8.3^\circ$ and $68.5 \pm 7.9^\circ$, while grip strength recovered to approximately 91% of the contralateral side. Postoperative complications occurred in 8% of patients, with superficial wound infection being the most frequent complication.

Conclusion: Open reduction and internal fixation using a 2.7 mm Variable Angle Volar Locking Compression Plate provides excellent fracture union, significant functional improvement, restoration of wrist function, and a low rate of postoperative complications. It is a safe and effective treatment option for the management of unstable distal radius fractures.

INTRODUCTION

The distal radius fracture (DRF) is one of the most common fractures seen in orthopaedics, representing about 15–20% of all fractures and nearly a quarter of the upper extremity fractures globally. These injuries occur with a bimodal distribution and are seen more commonly in younger people after high-energy trauma, or in elderly after low energy falls, as a result of osteoporosis. The prevalence of distal radius fractures continues to rise worldwide due to the growing number of road traffic crashes (RTI), sporting injuries and the ageing population. In developing countries like Pakistan these fractures can significantly impact disability, health care costs, and lost productivity [1,2]. The distal radius is a critical component for the stability, rotation and strength of the wrist and upper limb and contributes to function. If the fracture isn't managed properly, malunion can occur, causing chronic pain, loss of range of motion or ability to grip things, post-traumatic arthritis, and ongoing functional limitations. Hence, the main treatment objectives are anatomical reduction, restoration of the congruity of the articulations, stable fixation, early mobilization and avoidance of future disability. New techniques in fracture fixation have led to better clinical results, allowing wrist anatomy to be restored and early rehabilitation [3,4]. The treatment of distal radius fractures is age and fracture dependent, based on bone quality, functional demand, and displacement. If the fractures are stable, they're not severely displaced, and the patient didn't sustain any additional injuries, they can usually be treated conservatively using closed reduction and cast immobilization. Unstable, displaced, intra-articular or comminuted fractures, however, are often candidates for surgical correction for re-alignment of the fracture and to keep the fragments reduced. Various operative methods have been described, such as percutaneous Kirschner-wire fixation, external fixation, dorsal plating, fragment-specific fixation and open reduction with internal fixation using volar locking plates. Of these procedures, volar locking plate fixation has become the preferred surgical technique as it offers rigid fixation, reduces soft tissue complications, and allows early wrist mobilization [5,6]. The variable angle volar locking compression plates (VA-VLCPs) are a significant improvement over the old-fashioned fixed angle locking plates. They can be locked in multidirectional orientation of locking screws, which allows the surgeon to choose the direction of locking screws based on fracture morphology, and to ensure more secure fixation of small peri-articular fractures. This technology offers improved subchondral support and more accurate volar tilt and radial height restoration, while also decreasing intra-articular screw penetration risks. However, biomechanical and clinical studies have shown that the variable-angle plates provide stable fixation and excellent functional and radiological results, especially in complex intra-articular fractures. In addition, flexibility provided by a variable-angle system enables optimal management of fracture patterns that may not be well covered by the fixed-angle system [7,8]. Outcome measures should not be limited to radiographic union and should also address pain, wrist ROM, grip strength and return to activity. The Modified Mayo Wrist Score is a commonly used and well validated wrist postoperative functional score that combines aspects of patient perceived pain, functional status, range of motion and grip strength into a single comprehensive clinical score. Further radiological evaluation is necessary to assess the radiological healing and postoperative complications and to inform future clinical practice to see how well the surgical fixation is working. [9,10] While a range of international studies have shown good results after fixation with varying angle volar locking plates, the evidence from Pakistan is still scarce. The treatment results and applicability of the results obtained in other populations may be affected by differences in patient characteristics, injury mechanism, bone quality, health care resources and rehabilitation services. Thus, local evidence is needed to assess the efficacy and safety of VA-VLCP fixation for Pakistani population. The aim of the present prospective observational study was therefore to evaluate the functional and radiological results of distal radius fractures treated with 2.7 mm Variable Angle Volar Locking Compression Plates, and to record the time to fracture union, wrist function, and complications after surgery.

Materials and Methods

Study Design and Setting

This prospective observational study was conducted in the Department of

Orthopaedic Surgery, Sandeman Provincial Hospital, Quetta, over a 12-month period from July 1, 2022, to June 30, 2023.

Participants

Using consecutive non-probability sampling, 100 adult patients (18 years or older) with displaced and unstable distal radius fracture were enrolled. Qualifying patients were treated with the 2.7 mm Variable Angle Volar Locking Compression Plate through open reduction and internal fixation. Patients that qualified were treated with open reduction and internal fixation with the 2.7 mm Variable Angle Volar Locking Compression Plate. Patients excluded included those with pathological fractures, open grade II/III fractures, previous wrist surgery, neurological disorders, and incomplete follow-up.

Sample Size

The sample size was calculated using the WHO Sample Size Calculator Version 2.0 with an anticipated satisfactory functional outcome of 87%, a 95% confidence level, and a 6.5% margin of error, yielding a minimum sample size of 100 participants.

Inclusion Criteria

- Appropriate but make the wording consistent:
- Adults aged ≥ 18 years
- Closed unstable distal radius fractures (AO/OTA Types A, B, or C)
- Presentation within two weeks of injury
- Undergoing ORIF with a 2.7 mm Variable Angle Volar Locking Compression Plate
- Provided written informed consent

Exclusion Criteria

- Patients with severe medical comorbidities precluding surgery.
- Patients unable to complete scheduled follow-up.

Surgical Technique

- Type of implant/manufacture (if relevant)
- Surgeon experience (e.g., consultant orthopaedic surgeons with ≥ 5 years' experience)
- Antibiotic prophylaxis
- Postoperative immobilization duration

Postoperative Rehabilitation

- Time to initiation of active wrist exercises
- Physiotherapy protocol
- Weight-bearing restrictions

Outcome Measures

- **Primary outcome:** Modified Mayo Wrist Score (MMWS) at 6 months.
- **Secondary outcomes:** Radiological union, wrist range of motion, grip strength, and postoperative complications.

Statistical Analysis

Statistical analysis was performed using appropriate descriptive

and inferential statistical methods. The normality of continuous variables was assessed using the Shapiro–Wilk test. Normally distributed continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Within-group comparisons of continuous variables were performed using the paired t-test. Associations between categorical variables were assessed using the chi-square test. A two-sided p-value < 0.05 was considered statistically significant. All estimates were reported with 95% confidence intervals (CIs).

Results

A total of 100 patients with unstable distal radius fractures were enrolled and completed the six-month follow-up. The mean age of the participants was 42.8 ± 13.6 years (range: 19–71 years). Males constituted 64% (n=64) of the study population, while females accounted for 36% (n=36). Road traffic accidents were the most common mechanism of injury (46%), followed by falls on an outstretched hand (42%) and sports-related injuries (12%). According to the AO/OTA fracture classification, Type C fractures were the most frequent (52%), followed by Type B (29%) and Type A (19%) (Table 1).Radiological union was achieved in 95% (n=95) of patients within six months following surgery. The mean Modified Mayo Wrist Score (MMWS) improved significantly from 41.5 ± 8.9 at the six-week follow-up to 89.4 ± 7.6 at six months (p < 0.001). At the final follow-up, the mean wrist flexion was 71.2 ± 8.3°, and the mean wrist extension was 68.5 ± 7.9°, demonstrating significant functional improvement (p < 0.001). Grip strength recovered to approximately 91% of the contralateral limb (Table 2).Based on the Modified Mayo Wrist Score, 62% (n=62) of patients achieved an excellent outcome, 25% (n=25) had a good outcome, 9% (n=9) had a fair outcome, and 4% (n=4) had a poor outcome. Overall, 87% of patients achieved good-to-excellent functional outcomes (Table 3).Postoperative complications were observed in 8% (n=8) of patients. The most common complication was superficial wound infection (3%), followed by tendon irritation (2%), transient median nerve symptoms (2%), and implant-related complications (1%). No patient developed nonunion, implant failure, or required revision surgery during the follow-up period (Table 4).Overall, fixation with the 2.7 mm Variable Angle Volar Locking Compression Plate resulted in high fracture union rates, significant improvement in functional outcomes, restoration of wrist motion, and a low incidence of postoperative complications.

Table 1. Baseline Demographic and Clinical Characteristics of the Study Participants (n = 100)

Variable	Frequency (n)	Percentage (%)
Age (years), Mean ± SD	42.8 ± 13.6	–
Gender		
Male	64	64.0
Female	36	36.0
Mechanism of Injury		
Road traffic accident	46	46.0
Fall on outstretched hand	42	42.0
Sports injury	12	12.0
AO/OTA Fracture Classification		
Type A	19	19.0
Type B	29	29.0
Type C	52	52.0

Table 1 presents the demographic profile, mechanism of injury, and fracture

classification of patients with distal radius fractures managed with 2.7 mm Variable Angle Volar Locking Compression Plates.

Table 2. Functional and Radiological Outcomes Following Surgery (n = 100)

Outcome Variable	Result
Radiological union achieved	95 (95.0%)
Time to union	≤6 months
Modified Mayo Wrist Score (6 weeks), Mean ± SD	41.5 ± 8.9
Modified Mayo Wrist Score (6 months), Mean ± SD	89.4 ± 7.6
p-value	<0.001
Wrist flexion (°), Mean ± SD	71.2 ± 8.3
Wrist extension (°), Mean ± SD	68.5 ± 7.9
Grip strength recovery	91% of contralateral side

Table 2 summarizes fracture union, Modified Mayo Wrist Score, wrist range of motion, grip strength recovery, and overall functional outcomes at the final follow-up.

Table 3. Functional Outcome According to Modified Mayo Wrist Score (n = 100)

Functional Outcome	Frequency (n)	Percentage (%)
Excellent	62	62.0
Good	25	25.0
Fair	9	9.0
Poor	4	4.0
Total	100	100.0

Table 3 demonstrates the distribution of postoperative functional outcomes based on the Modified Mayo Wrist Score at the six-month follow-up.

Table 4. Postoperative Complications Following Volar Locking Plate Fixation (n = 100)

Complication	Frequency (n)	Percentage (%)
Superficial wound infection	3	3.0
Tendon irritation	2	2.0
Transient median nerve symptoms	2	2.0
Implant-related complication	1	1.0
Nonunion	0	0.0
Implant failure	0	0.0
Revision surgery	0	0.0
Total patients with complications	8	8.0

Table 4 shows the frequency of postoperative complications observed during the six-month follow-up period after fixation with a 2.7 mm Variable Angle Volar Locking Compression Plate.

DISCUSSION

The present prospective observational study evaluated the functional and radiological outcomes of unstable distal radius fractures managed with a 2.7 mm Variable Angle Volar Locking Compression Plate (VA-VLCP). The findings demonstrated a high radiological union rate (95%), significant improvement in the Modified Mayo Wrist Score (MMWS), restoration of wrist range of motion, and a low incidence of postoperative complications. Overall, 87% of patients achieved excellent or good functional outcomes, supporting the effectiveness of VA-VLCP fixation for unstable distal radius fractures. The demographic characteristics observed in this study are consistent with previously published literature. The mean age of the participants was 42.8 ± 13.6 years, with a predominance of male patients (64%). This pattern reflects the greater exposure of economically active adults to high-energy trauma, particularly road traffic accidents, which constituted the leading mechanism of injury in the present study. Similar demographic trends have been reported in both regional and international studies evaluating surgical management of distal radius fractures. Radiological union was achieved in 95% of patients within six months, indicating excellent fracture healing following fixation with the variable angle locking plate. This finding is comparable to previous studies reporting union rates exceeding 90% after volar locking plate fixation. Stable fixation provided by locking technology permits maintenance of fracture reduction while allowing early mobilization, thereby promoting biological healing and minimizing secondary displacement. Functional recovery improved substantially throughout the follow-up period. The Modified Mayo Wrist Score increased significantly from 41.5 ± 8.9 at six weeks to 89.4 ± 7.6 at six months ($p < 0.001$), indicating marked improvement in pain, wrist motion, grip strength, and daily functional activities. These findings are consistent with recent randomized controlled trials and systematic reviews demonstrating superior early functional recovery following fixation with variable angle volar locking plates. The multidirectional screw placement offered by the variable angle system allows better fixation of intra-articular fragments and restoration of the normal distal radius anatomy, which may explain the favorable clinical outcomes observed. At the final follow-up, excellent and good functional outcomes were achieved in 87% of patients. Comparable results have been reported by Ahmed et al. in Pakistan and several international investigators, who demonstrated satisfactory functional recovery following volar locking plate fixation of unstable distal radius fractures. Minor differences among published studies may be attributed to variations in fracture configuration, patient age, rehabilitation protocols, duration of follow-up, and assessment methods. Restoration of wrist motion is a major determinant of functional recovery after distal radius fractures. In the present study, the mean wrist flexion and extension reached 71.2° and 68.5° , respectively, while grip strength recovered to approximately 91% of the contralateral limb. These findings indicate successful restoration of wrist biomechanics and support previous biomechanical studies demonstrating that variable angle locking systems provide improved subchondral support and allow optimal screw orientation according to fracture morphology, thereby facilitating stable fixation and early rehabilitation. The overall postoperative complication rate was relatively low (8%), with superficial wound infection representing the most frequent complication. Tendon irritation, transient median nerve symptoms, and implant-related complications occurred infrequently, while no cases of nonunion, implant failure, or revision surgery were observed. These findings compare favorably with published systematic reviews reporting low complication rates associated with modern volar locking plate systems when appropriate surgical technique and postoperative rehabilitation protocols are followed. The present study has several strengths. Its prospective design, standardized operative technique, uniform rehabilitation protocol, and use of validated functional outcome measures increase the reliability of the findings. Nevertheless, several limitations should be acknowledged. The study was conducted at a single tertiary care center with a relatively small sample size and a follow-up period limited to six months. Furthermore, the absence of a comparison group treated with alternative fixation methods precludes direct comparison of treatment effectiveness. Longer-term follow-up is also necessary to evaluate late complications such as post-traumatic arthritis, hardware-related

problems, and long-term functional recovery.

Overall, the findings of this study suggest that fixation of unstable distal radius fractures using a 2.7 mm Variable Angle Volar Locking Compression Plate is associated with excellent fracture union, significant functional improvement, restoration of wrist motion, and a low complication rate. Future multicenter randomized controlled trials with larger sample sizes and longer follow-up periods are recommended to validate these findings and compare variable angle locking plates with other contemporary fixation techniques.

Limitations

This study was carried out at a single tertiary care center and the number of patients included was relatively small and the follow-up period was six months. The lack of a control group and long term follow-up of post traumatic arthritis restricts the applicability of the results. Larger multicenter, randomized studies are recommended.

Conclusion

A 2.7 mm Variable Angle Volar Locking Compression Plate is effective for fixation of unstable distal radius fractures, ensuring excellent functional recovery, reliable fracture union, restoration of wrist function and a low complication rate. This is a safe and effective surgical method to treat unstable distal radius fractures in normal cases.

Ethical Considerations

The study synopsis was approved by the Advanced Studies & Research Board, University of Balochistan, Quetta, under Approval No.661 12, dated 13 June 2023. The approval included the MS study program and appointment of the supervisor, Dr. Atiq-ur-Rehman Khan, for the research project conducted at Postgraduate Medical Institute, Quetta.

Reference

- Huang YM, Chen CY, Lin KC, Lai WY, Lin YY, Fu YJ, Tarng YW. Using Trident distal radial locking plate to fix fractures of the distal radius volar rim. *J Chin Med Assoc.* 2023;86(4):426-430. doi:10.1097/JCMA.0000000000000881.
- Shihab Z, Sivakumar B, Graham D, Del Piñal F. Outcomes of arthroscopic-assisted distal radius fracture volar plating: A meta-analysis. *J Hand Surg Am.* 2022;47(4):330-340.e1. doi:10.1016/j.jhsa.2021.11.025.
- Latypov N, Golubev I, Borisova A. Volar locking plate versus closed reduction and immobilization for distal radius fracture in the elderly: Systematic review and meta-analysis of randomized controlled trials. *J Wrist Surg.* 2024;13(6):559-571. doi:10.1055/s-0043-1774331.
- Oldrini LM, Feltri P, Albanese J, Lucchina S, Filardo G, Candrian C. Volar locking plate versus cast immobilization for distal radius fractures: A systematic review and meta-analysis. *EFORT Open Rev.* 2022;7(9):644-652. doi:10.1530/EOR-22-0022.
- Holc F, Bronenberg Victorica P, Avanzi R, Huespe IA, De Carli P, Boretto JG. Risk of volar locking plate removal after distal radius fractures: Time-to-event analysis. *J Hand Surg Am.* 2023;48(10):1011-1017. doi:10.1016/j.jhsa.2023.06.023.
- Joo MS, Kang HJ, Yu HK, Lee JS. Outcomes of primary volar locking plate fixation of open distal radius fractures. *J Hand Surg Asian Pac Vol.* 2022;27(3):517-523. doi:10.1142/S2424835522500527.
- Gamo K, Baba N, Kakimoto T, Kuratsu S. Efficacy of hand therapy after volar locking plate fixation of distal radius fracture in middle-aged to elderly women: A randomized controlled trial. *J Hand Surg Am.* 2022;47(1):62.e1-62.e7. doi:10.1016/j.jhsa.2021.08.009.

8. Kunes JA, Hong DY, Hellwinkel JE, Tedesco LJ, Strauch RJ. Extensor tendon injury after volar locking plating for distal radius fractures: A systematic review. *Hand (N Y)*. 2022;17(Suppl 1):87S-94S. doi:10.1177/15589447211068186.
9. Hoekzema NA, Brambila M. Column-specific distal radius fracture fixation. *J Orthop Trauma*. 2021;35(Suppl 3). doi:10.1097/BOT.0000000000002203.
10. Vranješ M, Majkić M, Vukosav N, Baljak B. Can the screw number in volar locking plate fixation for distal radius fractures predict the patient-rated wrist evaluation outcome? *Cir Cir*. 2024;92(6):697-701. doi:10.24875/CIRU.23000604.
11. Nwosu C, Rodriguez K, Zeng S, Klifto KM, Klifto CS, Ruch DS. Complications following volar locking plate fixation of distal radius fractures in adults: A systematic review of randomized controlled trials. *J Hand Surg Am*. 2023;48(9):861-874. doi:10.1016/j.jhsa.2023.04.022.
12. Tariq MA, Ali U, Uddin QS, Altaf Z, Mohiuddin A. Comparison between volar locking plate and Kirschner wire fixation for unstable distal radius fracture: A meta-analysis of randomized controlled trials. *J Wrist Surg*. 2023;13(5):469-480. doi:10.1055/s-0043-1768235.
13. Ahmed M, Ahmed N, Kumar S, Kumar M, Bux M, Hussain G. Functional outcome of intra-articular fracture of distal radius managed by volar locking plate. *Cureus*. 2020;12(10). doi:10.7759/cureus.11271.
14. Maccagnano G, Noia G, Vicenti G, Baglioni M, Masciale MR, Cassano GD, et al. Volar locking plate versus external fixation in distal radius fractures: A meta-analysis. *Orthop Rev (Pavia)*. 2021;13(1):9147. doi:10.4081/or.2021.9147.
15. Kawabata A, Sogabe Y, Morimoto Y, Takamatsu K. Volar locking plate fixation for distal radius fractures by intraoperative computed tomographic-guided navigation. *J Hand Surg Glob Online*. 2020;2(5):290-296. doi:10.1016/j.jhsg.2020.07.005.
16. Lee JK, Yoon BH, Kim B, Ha C, Kil M, Shon JI, Lee HI. Is early mobilization after volar locking plate fixation in distal radius fractures really beneficial? A meta-analysis of prospective randomized studies. *J Hand Ther*. 2023;36(1):196-207. doi:10.1016/j.jht.2021.10.003.
17. Nakamura T. Three-dimensional analysis of polyaxial volar locking plate position for distal radius fracture. *J Wrist Surg*. 2024;13(6):483-491. doi:10.1055/s-0044-1782238.
18. Labbé F, Daoulas T, Letissier H, Liverneaux P, Ducournau F. Distal radius fracture osteosynthesis by volar locking plate: Influence of epiphyseal screw positioning on the risk of loss of reduction. *Hand Surg Rehabil*. 2024;43(4):101743. doi:10.1016/j.hansur.2024.101743.
19. Abdel-Wahed M, Khater AAZ, El-Desouky MA. Volar locking plate fixation for distal radius fractures: Did variable-angle plates make a difference? *Int Orthop*. 2022;46(9):2165-2176. doi:10.1007/s00264-022-05469-z.
20. Wretö L, Fornander L. Long-term outcome for patients with distal radius fractures treated with volar locking plates versus percutaneous wires. *PLoS One*. 2024;19(11). doi:10.1371/journal.pone.0307763.
21. Tordjman D, Younis M, Factor S, Eisenberg G, Atlan F, McBeth J, et al. Volar locking plating of extra-articular distal radius fracture: A retrospective clinical study comparing locking screws versus smooth locking pegs. *J Wrist Surg*. 2024;13(2):151-157. doi:10.1055/s-0043-1771338.