Original Article | Journal of Clinical Orthopaedics | 2026 January-June; 11(1):-96-101

A Prospective Study in Surgical Management of Volar Barton Fracture with Variable Angle Locking Compression Plate

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Abstract

Background: Volar Barton fractures are unstable intra-articular distal radius fractures characterized by volar displacement of the distal fragment with radiocarpal subluxation. Conservative treatment is often associated with poor outcomes such as malunion, instability, and early osteoarthritis. Variable-angle locking compression plates (VALCP) offer the advantages of anatomical reduction, stable fixation, and early mobilization by allowing screw placement according to fracture geometry and minimizing periosteal compression. Objective of the study is to study the surgical management of Volar Barton fractures with variable angled locking compression plate.

Methods: A prospective study was conducted from April 2022 to November 2023 at tertiary hospitals attached to J.J.M. Medical College, Davanagere. Fifteen adult patients (>18 years) with Volar Barton fractures were managed operatively with VALCP fixation. Patients medically unfit for surgery, those with compound fractures, neurovascular compromise, or unwilling to undergo surgery, were excluded from the study. Functional outcomes were assessed using Modified Cooney, Green, and O'Brien scoring system during follow-up.

Results: Of the 20 patients, 65% achieved excellent results, 25% good, and 5% fair outcomes, and 5% poor results. Early physiotherapy contributed to improved functional recovery. Complications were observed in 2 patients (10%): One is superficial wound infection, and another one is reduced wrist range of motion.

Conclusion: VALCP provide excellent to good clinical and radiological outcomes in Volar Barton fractures, enabling anatomical reduction, stable fixation, and early mobilization. VALCP is a reliable implant for unstable and comminuted Volar Barton fractures, facilitating early return of wrist function and daily activities.

Keywords: Volar Barton fracture, distal radius fracture, variable-angle locking plate, internal fixation, prospective study.

Introduction

Fractures of the distal end of the radius vary widely influenced by factors such as age, the nature of force applied, mode of injury, and the quality of the bone. Examples include Colles' and Smith's fractures, as well as Volar and dorsal Barton's fracture [1].

Fractures of the distal radius are the most frequent fractures of the upper extremity encountered in clinical practice, comprising 17% of all fractures and 75% of all forearm fractures. Incidence rates range from 5.7 to 124.6/10,000 persons per year [2]. This type of fracture exhibits a bimodal age distribution, with higher occurrence observed in children and the elderly.

The goals of treating a distal radius fracture include restoring range of motion (ROM) and grip strength, promoting early return to normal daily activities for the patient, and reducing the risk of post-traumatic arthritis. In intra-articular distal radius fractures, the quality of anatomical reduction directly impacts the risk of developing post-traumatic arthritis. Conservative treatment typically yields poor outcomes and is associated with complications such as early osteoarthritis, deformity, subluxation, and instability [3, 4, 5].

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Submitted Date: 02-08-2025, Review Date: 18-08-2025, Accepted Date: 01-09-2025 & Published Date: 10-05-2026

Journal of Clinical Orthopaedics | Available on www.jcorth.com | DOI: https://doi.org/10.13107/jcorth.2026.v11.i01.852

Figure 1: Pre-operative.

The objective of treatment is to achieve effective reduction and immediate stability to promote anatomical union of the fracture. This approach facilitates early wrist mobilization and reduces the risk of fracture complications. Factors influencing fracture healing include the size of the gap, stability of the fracture site, and adequate blood supply.

The locking plate decreases compressive forces on the bone, which enhances stability. This reduces the risk of impairing blood supply and periosteal compression, making it advantageous for promoting fracture healing.

Several surgical techniques have been reported in the literature [10, 11, 12, 13, 14, 15], such as percutaneous pinning, external fixators, and internal fixation with locking compression plates. Currently, open reduction and internal fixation using a locking plate system are advocated for the treatment of distal end fractures, resulting in good reduction and providing immediate stability [3, 4, 16, 17]. When closed techniques fail to achieve adequate fracture reduction, internal fixation can restore anatomy and improve functional outcomes.

"The locking screw in a locking compression plate provides support to the subchondral bone and effectively resists axial forces. Unlike traditional compression plates, it does not require compression against the bone, thus preserving the periosteal blood supply [18]. This primary stability offered by the locking screw prevents secondary displacement, which is beneficial for both osteoporotic bones and younger patients [19], ensuring favorable treatment outcomes.

Furthermore, these plates allow screws to be angled around the central axis of the plate hole, facilitating better anatomical adaptation. This capability enables surgeons to align screws more precisely to match the patient's anatomy [10], which improves fixation stability and potentially enhances surgical outcomes and patient recovery.

Materials and Methods

This is a prospective study of 20 cases of Volar Barton fractures in adults admitted to Bapuji Hospital and Chigateri General Hospital attached to J.J.M. Medical College, Davangere between April 2022 and April 2024. Cases were taken according to inclusion and exclusion criteria, that is, with Volar Barton fractures above the age of 18 years and fit for surgery. Medically unfit and not willing for surgery were excluded from the study. Ethical approval was taken from the Ethical committee of the hospital, and informed consent was taken from all the patients about the surgery and their willingness and agreement for recruitment in the study (Ethical approval number is JJMMC/IEC-syc-124-2022). Detailed history, examination, and investigations were done, including an X-ray. After the pre anesthetic evaluation, all the patients underwent surgery as per Modified Henry's approach, and after that standard post-operative protocol was followed. Then, the patients were followed up for assessing functional Outcome graded by Modified Cooney, Green and O'Brien score.

Results

A total of 20 patients who had Volar Barton fracture were treated with Variable-angle locking compression plates (VALCP) and were followed as per protocol. The average age of the patients was 43 ± 14.82 years. Out of these 20 patients, 65% patients were male (n = 13) and 35% of patients were female (n = 7) (Table 1). Out of 20 patients Right side (dominant wrist) was involved in 13 (65%) patients and the left side was involved in 7 (35%) patients. As per Frykman's classification, out of 20 cases, 12 (60%) patients belong to Type III, and 8 (40%) patients belong to Type IV. In the present study, 15 (75%) patients had union in

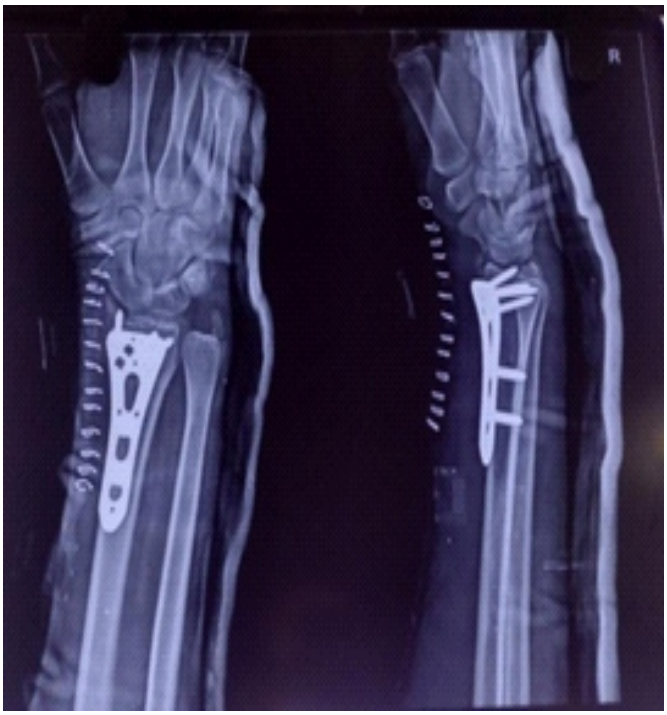

Figure2: Immediate post-operative.

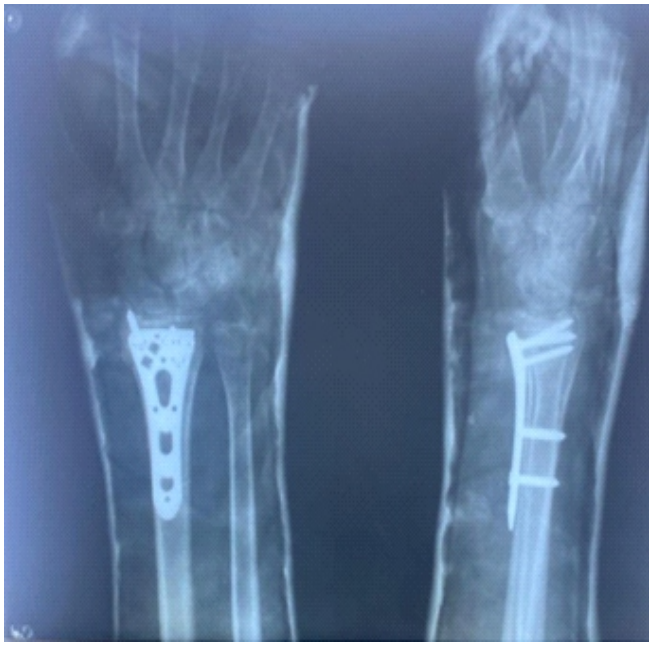

Figure3: Six months follow-up.

<3 months, and 5 (25%) patients had union in > 3 months. In our study, 20 (100%) patients had dorsiflexion within the normal functional range (minimum 45°), 20 (100%) had palmar flexion within the normal functional range (minimum 30°), 20 (100%) had pronation within the normal functional range (minimum 50°), 19 (95%) had supination within the normal functional range (minimum 50°), 18 (90%) had radial deviation within the normal functional range (minimum 15°) and 18 (90%) patients had ulnar deviation within the normal functional range (minimum 15°). 20 (100%) patients had grip strength more than 60% compared to the opposite side (Table 3). Of the complications, 5% of the patients (1 patient) got a superficial surgical site infection that was treated with debridement, culture, and sensitivity-based antibiotic therapy, and that was healed subsequently. About 5% of the patients (1 patient) had reduced ROM and underwent regular physiotherapy and achieved the satisfactory range of movement eventually (Table 3). None of the patients underwent revision surgery. Radiological assessment demonstrated that all the patients had achieved within the acceptable radiological parameters. Therefore, a 100% satisfaction on surgical improvements to daily activities and overall satisfaction was recorded across all patients.

Discussion

Volar Barton fractures are commonly encountered injuries in the upper extremity. The primary goal of treatment is to restore both anatomical integrity and functional capability. In cases of unstable intra-articular fractures, achieving proper alignment of the wrist joint and preserving radial parameters such as radial inclination, radial length, and radial tilt may not be feasible using non-surgical techniques. In these instances, open reduction and precise alignment become necessary.

Volar Barton's fracture is an unstable fracture of the distal radial, commonly accompanied by subluxation of the wrist joint. The primary goal in the treatment of this injury is to provide good reduction and immediate stability to achieve anatomic fracture union, allow the quick return of hand function, and avoid complications.

Fracture healing depends on a minimal gap, adequate stability, and sufficient blood supply. Enhanced comprehension of wrist anatomy and function from recent research, coupled with rising patient expectations, has broadened the scope of surgical interventions. Furthermore, advancements in fixation materials have introduced novel possibilities for treatment.

Nowadays, plate fixation is the widely recognized surgical method. Locking plates are yielding superior outcomes when compared to traditional plates. Their anatomical design, featuring screw-plate interlocking mechanisms, offers increased bio-mechanical stability against forces acting on fractured areas. Therefore, locked plates are favored in cases involving osteoporosis and/or multiple fractures.

There are so many approaches available for distal radius plating, but nowadays safer and with least complicated approach, Modified Henry's is preferred by surgeons worldwide.

In our study, volar Barton fracture was more common in the age group of 51–60 years and was related to a road traffic accident. The average age in our study is comparable to the studies of Chung et al. (2006), Kilic et al. (2009), and Anakwe et al. (2010), who had an average age of 48.9 years, 45 years, and 48 years, respectively. Rohit et al. (2007) and Mengcunchen et al. (2009) had an average age of 57 years and 52.94 years,

Figure 4: First-year follow-up.

Table 1: Demographic information

Demographic	Data
Total patients	20
Average age (years)	42
Male	65%
Female	35%

respectively, in their series.

Our study had a male preponderance with 13 male patients and seven female patients. Increased incidence in males is probably due to their involvement in outdoor activities, riding vehicles, and heavy manual labor.

In our study, 65% patients had excellent, 25% had good, 5% had fair, and 5% had poor results. Patients who obtained excellent results had no residual deformities or pain. ROM was within the normal functional range. They had no arthritic changes or other complications. They were operated within 4 days of the injury. Radial length, volar tilt, and articular step-off were within acceptable limits. They were co-operative to physiotherapy. Patients with good results had minimal residual deformities, pain, and slight limitation. Rest of their findings was within acceptable parameters. Patients with fair results, along with residual deformity, pain, and limitation, also had pain in the distal radio-ulnar joint and minimal complications. A few of their movements were less than that required for normal function.

Chung et al. (2006) outcome measures included radiographic parameters, grip strength, lateral pinch strength, the Jubsen Taylor test, wrist ROM, and Michigan hand questionnaire compared to the normal side. In his series, a decrease in mean grip strength, pinch strength, and mean flexion of the wrist was 86% of the normal side.

Our series is comparable to that of KIlic et al. (2009), who had 44.4% excellent, 44.4% good, 11.2% fair results. Anakwe et al. (2010) system outcome was assessed using clinical examination grip strength measures, radiographs, and patient-related wrist evaluation scoring. In his series, 95% patient very high level of satisfaction, good functional outcome, and increased grip strength.

In our study, we encountered 2 complications (10 %), which was comparable to Kilic et al., (2009), where he reported a complication rate of 11.1%, Chung et al., (2006) reported a complication rate of 9.1%, Anakwe et al. (2010) reported a complication rate of 4.8%, and Rohit et al. (2007) reported a complication rate of 57%, and Mengcunchen et al. (2019) reported 10% complication rate.

Table 3: Complications

Complications	Percentage of patients
Superficial wound infection	5
Decreased range of motion	5
Revision surgery required	0

Table 2: Range of motion

Movement (within normal function range)	No. Of Cases	Percentage
Dorsiflexion(min 45°)	20	100
Palmar flexion (min 30°)	20	100
Pronation(min 50°)	20	100
Supination (min 50°)	19	95
Radial deviation (min 15°)	18	90
Ulnar deviation (min 45°)	18	90

Conclusion

The present study was undertaken to assess the functional outcome of operative management of volar barton fractures in adults by a variable angle locking compression plate, and the following conclusions were drawn locked plates have been widely acknowledged in numerous studies as effective for treating unstable intra-articular fractures of the distal radius. In cases of Volar Barton fractures, these plates are chosen for their ability to achieve precise anatomical reduction, enabling early joint mobility due to their secure fixation. Their biomechanical advantages include close positioning to the joint surface and the flexibility to screw in various sequences. The Modified Volar Henry approach facilitates surgical access to the distal radius with minimal tissue trauma and ensures better integration with surrounding tissues during fixation.

In the subjects of our study, a successful anatomic alignment was acquired with the modified volar

Henry approach. The patients, who were young adults in the majority, went back to their daily activities with 90% recovery. Variable angled Locking compression plates are highly effective in treating Volar Barton fractures, consistently yielding good to excellent outcomes by restoring and maintaining the anatomy of the distal radius. These plates facilitate quicker recovery of joint motion and daily functionality, enabling patients to resume routine activities and work significantly sooner compared to alternative fixation methods. Patients often regain nearly normal wrist function, underscoring the plates' efficacy in promoting optimal rehabilitation.

Clinical relevance

This study validates the use of VALCP as a reliable and effective surgical treatment for unstable Volar Barton fractures of the distal radius. Utilizing VALCP allows for anatomical reduction, stable fixation, and early post-operative mobilization, which is crucial for preventing complications like malunion, instability, and subsequent osteoarthritis often associated with conservative treatment. The high rate of excellent to good functional outcomes (90%) demonstrated in the study, combined with a low complication rate, suggests that VALCP fixation should be the preferred management strategy for these complex intra-articular fractures. This approach ultimately facilitates the early return of patients' wrist function and daily activities.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

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Conflict of Interest: NIL
Source of Support: NIL

How to Cite this Article

Raghavendra KR, Hullatti P, Anaberu P, Prathik R, Gowtham BR, Kavya KB. A Prospective Study in Surgical Management of Volar Barton Fracture with Variable Angle Locking Compression Plate. Journal of Clinical Orthopaedics January-June 2026;11(1):96-101.