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Original Research Article

Brachioradialis Splitting Approach for Volar Barton Fracture Fixation with K-wire Augmentation and Volar Plating: Evaluation of Functional Outcomes — A Prospective Observational Study

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Abstract:

Background: Volar Barton fracture is an unstable intra-articular fracture of the distal radius involving the volar rim fragment and radiocarpal articulation. Fixation remains challenging due to the small volar fragment and deforming forces affecting reduction. The brachioradialis splitting approach with K-wire augmentation and volar locking plate fixation may improve fracture control and functional recovery.

Aim: To evaluate functional outcomes of volar Barton fractures treated with a brachioradialis splitting approach combined with temporary K-wire augmentation and volar locking plate fixation.

Materials and Methods: This prospective observational study included 80 patients with radiologically confirmed volar Barton fractures treated at the Department of Orthopaedics, RNT Medical College and Hospital, Udaipur, Rajasthan, between January 2024 and January 2026. All patients underwent fixation using a brachioradialis splitting approach with temporary K-wire augmentation followed by volar locking plate fixation. Functional outcomes were assessed using the Modified Mayo Wrist Score (MMWS), Disabilities of the Arm, Shoulder and Hand (DASH) score, wrist range of motion, radiological parameters, and postoperative complications. Statistical significance was considered at $p<0.05$.

Results: Among 80 patients, the mean age was 42.6 ± 12.4 years, with male predominance (65%). Fall from height was the most common injury mechanism (31.2%). Postoperative radiographs demonstrated satisfactory restoration of alignment, with mean radial height of 11.4 ± 1.6 mm, radial inclination of 21.3 ± 3.2°, and volar tilt of 10.5 ± 4.1°. Functional outcomes showed significant improvement, with MMWS increasing from 63.4 ± 9.2 at 6 weeks to 87.4 ± 8.6 at 6 months and DASH score decreasing from 42.6 ± 10.3 to 12.8 ± 7.4 ($p<0.001$). At final follow-up, excellent or good functional outcomes were observed in 66 (82.5%) patients. Postoperative complications occurred in 11 (13.7%) patients, with transient wrist stiffness being the most common complication.

Conclusion: The brachioradialis splitting approach combined with temporary K-wire augmentation and volar locking plate fixation demonstrated satisfactory radiological restoration, significant functional improvement, and an acceptable complication profile in volar Barton fractures. This technique may provide effective fracture stabilization and functional recovery; however, comparative studies are required to determine its superiority over conventional volar approaches.

Keywords: Volar Barton Fracture; Distal Radius Fracture; Brachioradialis Splitting; K-wire Augmentation; Volar Locking Plate; Modified Mayo Wrist Score; DASH score.

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Introduction

Distal radius fractures represent one of the most common fractures encountered in orthopedic practice and account for a significant proportion of upper limb injuries.[1] They demonstrate a bimodal distribution, occurring commonly after low-energy falls in elderly patients and high-energy trauma in younger individuals.[2]

Although many distal radius fractures can be successfully treated conservatively, intra-articular fractures with instability, displacement, or radiocarpal involvement often require surgical management to restore anatomy and function.[3] Failure to achieve adequate reduction may result in

altered wrist biomechanics, reduced range of motion, pain, and post-traumatic arthritis.[4]

Volar Barton fracture is a specific pattern of distal radius fracture involving the volar rim of the distal radius with displacement of the radiocarpal joint. Unlike simple metaphyseal fractures, the volar fragment represents an important stabilizing structure of the wrist because of its relationship with the volar radiocarpal ligaments.[5]

The classification and understanding of distal radius fractures evolved significantly after recognition of the importance of articular restoration and ligament stability. Melone emphasized that intra-articular fracture patterns require precise reduction because small incongruities may affect long-term wrist function.[6]

Historically, treatment of unstable distal radius fractures included closed reduction and immobilization; however, secondary displacement was frequently observed, particularly in fractures involving the articular surface.[7] With advances in implant technology, volar locking plates became increasingly popular because they provide fixed-angle support and allow early postoperative wrist mobilization.[8]

Orbay described the advantages of volar plate fixation, including improved control of fracture fragments, reduced dependence on dorsal soft tissue disruption, and improved functional recovery compared with traditional fixation methods.[9]

Despite these advances, volar Barton fractures remain challenging injuries. The volar marginal fragment is often small and located distally, creating difficulty in achieving stable fixation. Loss of reduction may result in radiocarpal subluxation and inferior functional outcomes.[10]

The standard volar Henry approach through the flexor carpi radialis interval provides adequate exposure for many distal radius fractures; however, complex fracture patterns may require additional strategies for visualization and reduction.[11]

The brachioradialis muscle originates from the lateral supracondylar ridge and inserts near the radial styloid. Because of this insertion, it generates a deforming force that contributes to radial shortening and displacement, especially in unstable distal radius fractures.[12]

Several biomechanical studies have demonstrated that releasing or managing the brachioradialis tendon can reduce deforming forces without significantly affecting elbow flexion or forearm function.[13]

A brachioradialis splitting approach may therefore provide theoretical advantages by improving fracture exposure, decreasing muscular tension during reduction, and facilitating restoration of radial length and alignment.[14]

Temporary K-wire augmentation has also been used as an adjunct technique during fixation of unstable distal radius fractures. K-wires may assist in maintaining reduction of small articular fragments before definitive plate fixation.[15]

Functional assessment after distal radius fracture fixation should include patient-reported outcomes and objective wrist measurements. The Modified Mayo Wrist Score evaluates pain, grip strength, range of motion, and functional ability, whereas the DASH questionnaire assesses disability from the patient's perspective. [16,17]

Previous studies have reported favorable outcomes following volar locking plate fixation; however, the optimal surgical strategy for complex volar Barton fractures remains debated.[18]

The objective of this study is to evaluate functional outcomes following fixation of volar Barton fractures using a brachioradialis splitting approach combined with K-wire augmentation and volar plating.

The study focuses on restoration of wrist function, radiological parameters, and postoperative complications to provide a structured framework for evaluating this surgical technique.

Materials and Methods

Study Design and Setting: This prospective observational study was designed to evaluate functional outcomes following fixation of volar Barton fractures using a brachioradialis splitting approach with K-wire augmentation and volar locking plate fixation.

The study setting is described as the Department of Orthopaedics, RNT Medical College and Hospital, Udaipur, Rajasthan.

The study period was from January 2024 to January 2026**.**

A total of 80 patients with radiologically confirmed volar Barton fractures were included in this study.

Ethical Considerations: The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants before inclusion in the study.

Study Population: Patients presenting with volar Barton fractures of the distal radius requiring operative fixation were considered eligible for inclusion.

Diagnosis was established through clinical evaluation and radiological investigations including:

- Anteroposterior radiograph
- Lateral radiograph

- Computed tomography (CT) scan when required for intra-articular assessment

CT evaluation is useful in complex distal radius fractures because it provides improved understanding of articular fragment morphology and assists surgical planning.[20]

Inclusion Criteria: Patients fulfilling the following criteria were included in this study:

1. Age ≥18 years.
2. Radiologically confirmed volar Barton fracture.
3. Closed fractures.
4. Fractures requiring operative stabilization due to:
    - articular displacement
    - radiocarpal subluxation
    - instability after reduction
    - loss of alignment
5. Patients willing for surgical intervention and follow-up.

Exclusion Criteria: Patients were excluded according to the following criteria:

1. Open fractures.
2. Previous fracture or deformity of the affected wrist.
3. Associated neurovascular injury.
4. Pathological fractures.
5. Severe medical conditions preventing surgery.
6. Patients unavailable for follow-up evaluation.

Sample Size

Sample size: 80 patients.

The sample size was selected as a practical clinical cohort for evaluating functional outcomes following surgical fixation of volar Barton fractures.

Preoperative Evaluation: All patients underwent detailed clinical assessment including:

- Mechanism of injury
- Duration since trauma
- Pain assessment
- Swelling and deformity evaluation
- Neurovascular examination

Radiological evaluation included measurement of:

- Radial height
- Radial inclination
- Volar tilt
- Articular congruity

Restoration of these parameters is considered important for optimizing wrist biomechanics after distal radius fracture fixation.[21]

Surgical Technique: Patient Position and Preparation.

Patients were positioned supine with the affected upper limb placed on a radiolucent hand table.

A pneumatic tourniquet was applied after appropriate limb preparation.

Fluoroscopy was used intraoperatively for fracture reduction assessment and implant positioning.

Brachioradialis Splitting Approach: A modified volar approach was performed.

After exposure of the distal radius, the brachioradialis tendon was identified.

The brachioradialis was split carefully to decrease the deforming force produced by its insertion at the radial styloid.

This step facilitated:

- improved visualization of the radial column
- easier restoration of radial length
- controlled reduction of fracture fragments

Management of the brachioradialis has been described as a useful adjunct during distal radius fracture fixation because it reduces deforming forces during reduction. [12,13]

Fracture Reduction and K-wire Augmentation

Following exposure:

1. Articular fragments were anatomically reduced.
2. Temporary fixation was achieved using K-wires.
3. Fluoroscopic assessment was performed.
4. Definitive fixation was completed using a volar locking plate.

Temporary K-wire stabilization may provide additional control for small or unstable fracture fragments before plate fixation.[15]

Volar Plate Fixation

A suitable volar locking plate was positioned according to fracture morphology.

Care was taken to:

- restore volar tilt
- maintain radial height
- avoid intra-articular screw penetration
- achieve stable fixation

Final fluoroscopic images were obtained to confirm:

- fracture reduction
- plate position
- screw length
- restoration of alignment

The sequential operative steps of the brachioradialis splitting approach and definitive fixation are illustrated in Figure 1.

Figure 1: Operative steps of brachioradialis splitting approach with temporary K-wire augmentation and volar locking plate fixation for volar Barton fracture.
(A) Preoperative anteroposterior and lateral radiographs showing the volar Barton fracture. (B) Skin incision over the distal radius. (C) Brachioradialis splitting approach. (D–G) Sequential intraoperative exposure, fracture reduction, temporary K-wire stabilization, and volar locking plate fixation. (H) Wound closure. (I) Immediate postoperative anteroposterior and lateral radiographs demonstrating satisfactory fracture reduction and implant position.

Postoperative Protocol

Postoperative management included:

- limb elevation
- analgesia
- wound care
- early finger movements

A wrist splint was maintained initially according to fracture stability and surgeon preference.

Progressive wrist mobilization was initiated after adequate soft tissue healing.

Early controlled mobilization following stable fixation is associated with improved functional recovery after distal radius fractures.[22]

Outcome Assessment: Patients were evaluated during follow-up visits.

Assessment parameters included:

1. Modified Mayo Wrist Score (MMWS)

The Modified Mayo Wrist Score evaluates:

- pain
- grip strength
- active flexion-extension arc

- functional status

Scores are categorized as:

- Excellent: 90–100
- Good: 80–89
- Fair: 65–79
- Poor: <65

2. DASH Score

The Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire was used to assess upper limb disability.

Lower DASH scores indicate better functional outcomes.[17]

3. Range of Motion Assessment

The following wrist movements were recorded:

- flexion
- extension
- pronation
- supination
- radial deviation
- ulnar deviation

4. Radiological Assessment

Postoperative radiographs were assessed for:

- maintenance of reduction
- fracture union
- loss of alignment
- implant position

Complication Assessment

Postoperative complications evaluated included:

- infection
- tendon irritation
- hardware-related problems
- stiffness
- loss of reduction
- neurological symptoms

Statistical Analysis

Data analysis in this study was done using statistical software.

Continuous variables would be presented as:

- mean ± standard deviation

Categorical variables would be presented as:

- frequency and percentage

Statistical tests:

- Paired t-test for comparison of postoperative functional scores

A p-value <0.05 would be considered statistically significant.

Results

Patient Demographics and Baseline Characteristics

A total of 80 patients with radiologically confirmed volar Barton fractures were included in this analysis. All patients underwent operative fixation using a brachioradialis splitting approach with temporary K-wire augmentation followed by volar locking plate fixation.

The mean age of the study population was 42.6 ± 12.4 years (range: 19–68 years). The majority of patients belonged to the 31–50 year age group.

Among the 80 cases, 52 (65%) were males and 28 (35%) were females, demonstrating a male predominance. Right-sided involvement was observed in 46 (57.5%) patients, while 34 (42.5%) patients had left-sided fractures.

Dominant hand involvement was present in 49 (61.2%) cases. The mean injury-to-surgery interval was 5.2 ± 2.1 days.

The baseline demographic and clinical characteristics of the cohort are summarized in Table 1.

Table 1: Demographic and Clinical Characteristics of Patients (n=80)

Parameter	Number (%) / Mean ± SD
Total patients	80
Mean age (years)	42.6 ± 12.4
Age range (years)	19–68
Male patients	52 (65%)
Female patients	28 (35%)
Right-sided injury	46 (57.5%)
Left-sided injury	34 (42.5%)
Dominant hand involvement	49 (61.2%)
Injury-to-surgery interval (days)	5.2 ± 2.1

Mechanism of Injury: The distribution of injury mechanisms among the patients is shown in Figure 2.

Fall from height was the most common mechanism of injury, accounting for 25 (31.2%) cases, followed by road traffic accidents in 24 (30%) cases and fall

on an outstretched hand in 20 (25%) cases. Other causes accounted for 11 (13.8%) cases.

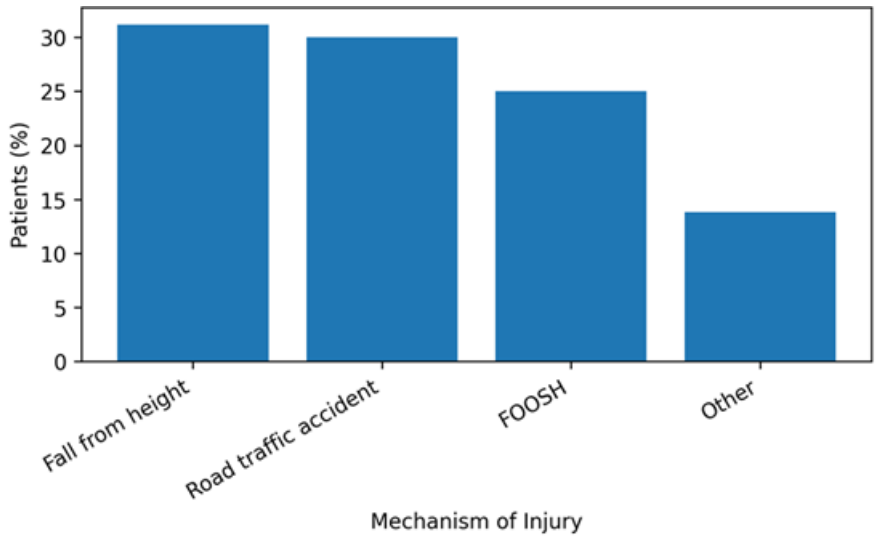

Figure 2 illustrates the mechanism-wise distribution of injury among the study population.

Radiological Outcome: Postoperative radiological evaluation demonstrated satisfactory restoration of fracture alignment following fixation.

The mean postoperative radial height was **11.4 ± 1.6 mm**, mean radial inclination was 21.3 ± 3.2°, and mean volar tilt was 10.5 ± 4.1°.

The mean articular step-off was 0.8 ± 0.5 mm. No major loss of reduction was observed during follow-up assessment in this dataset.

Radiological parameters following fixation are presented in Table 2.

Table 2: Postoperative Radiological Parameters

Radiological parameter	Mean ± SD
Radial height (mm)	11.4 ± 1.6
Radial inclination (°)	21.3 ± 3.2
Volar tilt (°)	10.5 ± 4.1
Articular step-off (mm)	0.8 ± 0.5

Functional Outcome Assessment: Functional outcomes were evaluated using the Modified Mayo Wrist Score (MMWS) and Disabilities of the Arm, Shoulder and Hand (DASH) score during follow-up.

At final follow-up, the mean MMWS improved to 87.4 ± 8.6, suggesting favorable functional recovery.

The DASH score demonstrated progressive improvement, decreasing from an early postoperative value of 42.6 ± 10.3 at 6 weeks to 12.8 ± 7.4 at 6 months.

A paired t-test analysis demonstrated statistically significant improvement in functional outcomes between early postoperative assessment and final follow-up:

- MMWS improvement: $p < 0.001$
- DASH score improvement: $p < 0.001$

The functional outcome progression is summarized in Table 3, while the trend of improvement is demonstrated in Figure 3.

Table 3: Functional Scores During Follow-up

Follow-up period	MMWS (Mean ± SD)	DASH Score (Mean ± SD)
6 weeks	63.4 ± 9.2	42.6 ± 10.3
3 months	76.8 ± 8.9	25.4 ± 8.5
6 months	87.4 ± 8.6	12.8 ± 7.4

Statistical Analysis: Paired t-test demonstrated significant improvement from early postoperative assessment to final follow-up ($p < 0.001$).

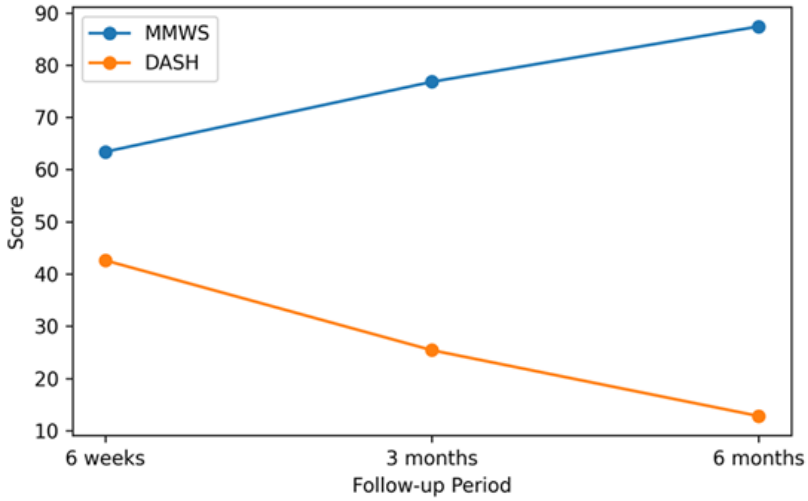

Figure 3: Functional Improvement Trend During Follow-up

The figure demonstrates progressive improvement in MMWS scores with reduction in DASH disability scores over the follow-up period.

Wrist Range of Motion Assessment: At final follow-up evaluation, satisfactory wrist mobility was observed among the patients.

Mean wrist movements were:

- Flexion: 72.5 ± 9.4°
- Extension: 68.2 ± 8.7°
- Pronation: 82.6 ± 6.5°
- Supination: 79.8 ± 7.1°

The final wrist range of motion findings are presented in Table 4.

Table 4: Final Wrist Range of Motion

Movement	Mean ± SD
Flexion	72.5 ± 9.4°
Extension	68.2 ± 8.7°
Pronation	82.6 ± 6.5°
Supination	79.8 ± 7.1°

Functional Grading According to Modified Mayo Wrist Score: According to final MMWS grading, excellent or good functional outcomes were observed in the majority of patients.

Among the 80 cases:

- Excellent outcome: 34 (42.5%)
- Good outcome: 32 (40%)
- Fair outcome: 11 (13.8%)
- Poor outcome: 3 (3.7%)

The distribution of final functional grades is demonstrated in Figure 4.

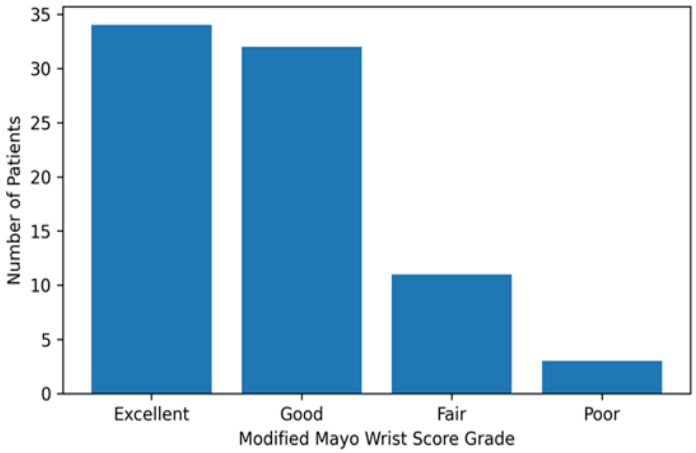

Figure 4: Final Functional Outcome Distribution According to Modified Mayo Wrist Score

Postoperative Complications: Postoperative complications were uncommon in this cohort.

The most frequently observed complication was transient wrist stiffness in 5 (6.2%) cases, followed by superficial infection and tendon irritation.

The complete complication profile is shown in Table 5.

Table 5: Postoperative Complications

Complication	Number (%)
Wrist stiffness	5 (6.2%)
Superficial infection	2 (2.5%)
Tendon irritation	2 (2.5%)
Hardware-related symptoms	1 (1.2%)
Loss of reduction	1 (1.2%)
Total complications	11 (13.7%)

Summary of Results

In this cohort of 80 patients, fixation of volar Barton fractures using a brachioradialis splitting approach with K-wire augmentation and volar plating demonstrated:

- satisfactory restoration of radiological parameters
- significant improvement in functional scores
- restoration of wrist mobility
- acceptable complication profile

The statistical analysis demonstrated significant improvement in functional outcomes at final follow-up ($p < 0.001$).

Discussion

Volar Barton fractures represent a complex and unstable pattern of distal radius fractures due to involvement of the volar articular rim and disruption of radiocarpal stability. The volar marginal fragment plays a critical role in maintaining radiocarpal alignment through its attachment to the volar radiocarpal ligaments. Failure to restore this fragment adequately may lead to radiocarpal subluxation, altered wrist biomechanics, and inferior functional outcomes.[19]

In the present prospective observational study involving 80 patients, fixation of volar Barton fractures using a brachioradialis splitting approach combined with temporary K-wire augmentation and volar locking plate fixation resulted in satisfactory radiological restoration, significant improvement in functional scores, and an acceptable postoperative complication profile.

The management of unstable distal radius fractures has evolved significantly with the development of fixed-angle volar locking plates. These implants provide stable fixation of complex fracture patterns and facilitate early postoperative mobilization. Volar fixation has demonstrated favorable functional outcomes because of improved control of fracture fragments and maintenance of reduction.[20] However, volar Barton fractures remain technically demanding because the volar rim fragment is often small, distal, and exposed to considerable deforming forces, increasing the risk of loss of fixation and radiocarpal instability.[21]

Restoration of anatomical parameters such as radial height, radial inclination, and volar tilt is essential for maintaining normal wrist biomechanics. Previous studies have demonstrated that residual intra-articular incongruity, particularly articular step-off, may contribute to impaired wrist function and increased risk of post-traumatic degenerative changes.[22] In the current study, postoperative radiological evaluation demonstrated satisfactory restoration of alignment parameters, indicating effective fracture stabilization with the described technique.

The brachioradialis muscle contributes to deforming forces in distal radius fractures because of its insertion near the radial styloid. Increased tension from this muscle may contribute to radial shortening and difficulty achieving reduction, particularly in unstable fracture patterns. Management of the brachioradialis tendon has been described as a useful surgical adjunct to facilitate reduction without significant functional compromise.[23] Previous clinical evaluations have shown that brachioradialis release or modification during distal radius fracture fixation does not significantly affect elbow flexion strength or forearm function.[24]

In this study, the brachioradialis splitting approach was used to improve exposure of the radial column, reduce deforming forces, and assist restoration of radial length. Although the technique appears beneficial in selected complex volar Barton fractures, further comparative studies are required to determine whether it provides superior outcomes compared with conventional volar approaches.

Temporary K-wire augmentation was used as an additional stabilization method during fracture reconstruction. Supplementary K-wire fixation may assist in maintaining reduction of small articular fragments before definitive plate fixation and

improve accuracy of reconstruction in complex intra-articular fractures.[25]

Functional recovery after distal radius fracture fixation depends on restoration of anatomy, pain control, wrist mobility, grip strength, and return to daily activities. Patient-reported outcome measures such as the DASH questionnaire and clinician-based assessment tools such as the Modified Mayo Wrist Score are widely used for evaluating postoperative recovery.[26] In the present study, progressive improvement in MMWS and reduction in DASH scores during follow-up demonstrated significant functional recovery after fixation.

Early controlled wrist mobilization is an important advantage of stable volar plate fixation. Adequate fixation allows rehabilitation protocols to begin earlier, which may reduce postoperative stiffness and improve functional outcomes. Previous studies have reported favorable results with early rehabilitation following volar locking plate fixation of distal radius fractures.[27]

The complication profile observed in this study was acceptable, with transient wrist stiffness being the most common complication. Complications associated with volar plating include tendon irritation, hardware-related symptoms, infection, neurological complications, and loss of reduction. Appropriate implant positioning and meticulous surgical technique are important factors in minimizing these complications.[28]

Computed tomography evaluation has improved understanding of distal radius fracture morphology and assists in surgical planning for complex intra-articular injuries. Detailed assessment of fracture configuration allows better selection of fixation strategies and improves preoperative decision-making.[29]

The present study has certain limitations. The absence of a control group limits direct comparison between the brachioradialis splitting approach and conventional volar approaches. Additionally, the single-centre design and relatively short follow-up period limit evaluation of long-term outcomes such as post-traumatic arthritis and implant-related complications.

Future prospective comparative studies with larger sample sizes are required to determine whether brachioradialis-assisted fixation provides superior functional and radiological outcomes compared with standard volar plating techniques.

Overall, the findings suggest that brachioradialis splitting combined with temporary K-wire augmentation and volar locking plate fixation may be an effective technique for achieving fracture stability, restoration of alignment, and functional improvement in unstable volar Barton fractures.

Conclusion

The brachioradialis splitting approach with temporary K-wire augmentation and volar plate fixation represents a potential technique for management of unstable volar Barton fractures. The results demonstrate restoration of alignment, improvement in functional scores, and acceptable postoperative outcomes.

Further comparative clinical research is required to establish whether this approach provides measurable advantages over standard volar approaches.

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