Functional and Radiological Outcomes of Herbert Screw Fixation in Capitellum Fractures - An Ambispective Comparative Cohort Study

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ABSTRACT

Background:

Capitellum fractures are rare intra-articular injuries of the distal humerus that present significant challenges due to their complex anatomy and the need for restoration of articular congruity. Stable fixation is essential to achieve fracture union and allow early mobilization. Herbert screw fixation provides headless compression with minimal articular surface disruption and has been increasingly used for the management of these fractures. This study evaluates the functional and radiological outcomes of Herbert screw fixation in capitellum fractures.

Materials and Methods:

An ambispective comparative cohort study was conducted involving 30 patients with capitellum fractures treated with Herbert screw fixation. Patients were evaluated clinically and radiologically. Functional outcomes were assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) score and elbow range of motion, while radiological outcomes were evaluated based on fracture union and postoperative complications. Outcomes were compared between retrospective (Cohort A) and prospective (Cohort B) groups.

Results:

The mean DASH score was 18.4 in Cohort A and 13.1 in Cohort B, demonstrating better functional outcomes in the prospective group. Mean radiological union time was 11.8 weeks in Cohort A and 10.6 weeks in Cohort B. Elbow flexion was improved in the prospective cohort (131° vs. 124°), with reduced extension lag (9° vs. 14°). The mean Mayo Elbow Performance Score (MEPS) improved from 84 in Cohort A to 92 in Cohort B, indicating superior functional outcomes in the prospective cohort following Herbert screw fixation. Complications were observed in 8 patients (26.7%), with elbow stiffness being the most common complication (13.3%), followed by heterotopic ossification (6.7%), superficial infection (3.3%), and avascular necrosis (3.3%). No implant backout was observed.

Conclusion:

Herbert screw fixation provides reliable fracture union and satisfactory functional outcomes in capitellum fractures. The prospective cohort demonstrated improved functional recovery, earlier union, and better elbow motion, emphasizing the importance of standardized surgical technique, early mobilization, and structured rehabilitation. Herbert screw fixation remains an effective option for displaced capitellum fractures when anatomical reduction and stable fixation are achieved.

Keywords:

Capitellum fracture; Distal humerus fracture; Herbert screw; Headless compression screw; Open reduction and internal fixation; Functional outcome; Radiological outcome; DASH score.

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INTRODUCTION

Capitellum fractures are rare intra-articular fractures of the distal humerus involving the articular surface of the lateral condyle. They account for approximately 1% of all elbow fractures and nearly 6% of distal humeral fractures, making them an uncommon injury encountered in orthopaedic practice.(1) These fractures usually result from axial loading transmitted through the radial head to the capitellum following a fall on an outstretched hand or high-energy trauma such as road traffic accidents. Elderly patients with osteoporosis may sustain these injuries even after low-energy falls. Because of their rarity and the complexity of elbow anatomy, capitellum fractures are frequently overlooked on initial assessment, leading to delayed diagnosis and treatment.

The capitellum plays an essential role in elbow stability and motion by articulating with the radial head. It contributes significantly to flexion-extension movements and forearm rotation. Since the capitellum is almost entirely covered by articular cartilage and has limited soft tissue attachment, displaced fractures may compromise blood supply, increasing the risk of avascular necrosis and delayed union. Restoration of normal radiocapitellar articulation is therefore essential for preserving elbow biomechanics and preventing long-term complications such as stiffness, instability, chronic pain, and post-traumatic osteoarthritis.(2)

Capitellum fractures may occur in isolation or in association with injuries such as radial head fractures, coronoid fractures, lateral collateral ligament injuries, and elbow dislocations. Recognition of these associated injuries is important because they influence surgical planning, fixation strategy, rehabilitation, and eventual functional outcome. A thorough clinical examination combined with appropriate imaging is therefore mandatory before definitive treatment.

Diagnosis of these fractures may be difficult using routine radiographs because the fracture fragment can be obscured on anteroposterior views. The lateral radiograph often demonstrates the characteristic coronal shear fragment and, in fractures involving the trochlea, the classical "double-arc sign." Computed tomography with three-dimensional reconstruction has become the investigation of choice because it accurately defines fracture morphology, fragment size, degree of comminution, and associated injuries, thereby facilitating preoperative planning and implant selection.(3)

Several classification systems have been described for capitellum fractures. The Bryan and Morrey classification, later modified by McKee, categorizes fractures into four major types based on fragment morphology and trochlear extension. More recently, the Dubberley classification has gained widespread acceptance because it incorporates posterior condylar comminution, which is an important determinant of fracture stability, fixation technique, and prognosis.(4)

Historically, treatment options included prolonged immobilization, closed reduction, and fragment excision. Conservative treatment was associated with poor functional outcomes due to prolonged immobilization, loss of reduction, persistent pain, elbow stiffness, and post-traumatic arthritis. Fragment excision, although previously recommended for small osteochondral fragments, has largely been abandoned because it compromises radiocapitellar stability and alters elbow biomechanics. Consequently, anatomical reduction with stable internal fixation has become the preferred treatment for displaced capitellum fractures.(5)

Advances in implant technology have considerably improved the surgical management of these injuries. Various fixation devices including Kirschner wires, cancellous screws, mini-fragment screws, bio absorbable implants, and headless compression screws have been described. Among these, **Herbert screws** have become one of the most widely accepted fixation devices because of their headless design and variable-pitch threads, which generate interfragmentary compression while remaining completely buried beneath the articular cartilage. This design minimizes hardware prominence, preserves the articular surface, and reduces the need for implant removal.(6)

Herbert screw fixation provides stable fixation even in relatively small osteochondral fragments and permits early active mobilization of the elbow. Early rehabilitation is particularly important because postoperative elbow stiffness remains one of the most common complications following elbow trauma. Biomechanical studies have demonstrated that headless compression screws provide superior fixation stability compared with conventional Kirschner wires, thereby allowing earlier movement and promoting fracture healing.(7)

Several clinical studies have demonstrated excellent radiological and functional outcomes following Herbert screw fixation. High rates of fracture union, restoration of elbow motion, and good to excellent functional scores have been consistently reported. Functional recovery is commonly assessed using validated outcome measures such as the Mayo Elbow Performance Score (MEPS) and Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, both of which evaluate pain, range of motion, stability, and activities of daily living. Early anatomical reduction and rigid fixation have been identified as the most important determinants of successful clinical outcomes.(8)

Despite these encouraging results, complications including elbow stiffness, heterotopic ossification, avascular necrosis, non-union, malunion, fixation failure, and post-traumatic arthritis continue to be reported. The occurrence of these complications depends on several factors including fracture pattern, associated injuries, surgical timing, fixation stability, quality of reduction, and adherence to rehabilitation protocols. Posterior condylar comminution and delayed surgical intervention have been associated with less favourable outcomes.(9)

The available literature on capitellum fractures remains limited because of the rarity of the injury. Most published studies are retrospective case series involving relatively small sample sizes, heterogeneous fracture patterns, and varying surgical techniques. Differences in surgical approach, direction of screw insertion, implant configuration, rehabilitation protocol, and methods of outcome assessment make comparison between studies difficult. Consequently, high-quality comparative studies evaluating standardized treatment protocols remain scarce.(10)

An ambispective comparative cohort study combines retrospective and prospective patient populations, thereby increasing sample size while allowing standardized assessment of functional and radiological outcomes. Such a design enables evaluation of treatment trends over time and comparison of clinical outcomes using uniform assessment criteria. Functional outcomes may be assessed using validated scoring systems, whereas radiological evaluation includes fracture union, maintenance of reduction, articular congruity, avascular necrosis, heterotopic ossification, implant-related complications, and degenerative changes of the elbow joint.(11)

Therefore, the present study was undertaken to evaluate the effectiveness of Herbert screw fixation in achieving fracture union and restoration of elbow function. The study also aims to compare the functional and radiological outcomes between retrospective and prospective cohorts and identify factors associated with successful clinical outcomes and postoperative complications. The findings are expected to strengthen the current evidence regarding the management of these uncommon fractures and provide guidance for optimizing surgical treatment and rehabilitation strategies.(12)

Aim

To evaluate functional (MEPS, DASH) and radiological outcomes of Herbert screw fixation and compare Cohort A (retrospective) vs. Cohort B (prospective).

Objectives

1. To assess functional outcomes following Herbert screw fixation using validated clinical scoring systems, namely the Mayo Elbow Performance Score (MEPS) and the Disabilities of the Arm, Shoulder and Hand (DASH) score.
2. To evaluate radiological outcomes, including fracture union, maintenance of reduction, and postoperative complications.
3. To compare the functional and radiological outcomes between the retrospective and prospective cohorts following Herbert screw fixation.

MATERIALS AND METHODS

Design: Ambispective comparative cohort study (1-year duration from June 2024 to June 2025), conducted at a tertiary orthopaedic centre (Saveetha Medical College and Hospital)

Sample: 30 patients

Cohort A: Retrospective (n=15)

Cohort B: Prospective (n=15)

Inclusion Criteria: Age >18; isolated capitellum fractures; Dubberley Type I & II; Herbert screw fixation; minimum 12-month follow-up. Surgery: ORIF via lateral/anterolateral approach; AP and lateral X-rays ± CT for morphology.

Exclusion Criteria: Patients with pathological fractures of the capitellum; open capitellum fractures with extensive soft tissue injury (Gustilo–Anderson Grade III); capitellum fractures managed by methods other than Herbert screw fixation (e.g., fragment excision, Kirschner wires, plates, or conservative treatment); associated ipsilateral upper limb fractures that significantly affect elbow function (e.g., shaft humerus, forearm, or wrist fractures); patients with pre-existing elbow disorders such as severe osteoarthritis, inflammatory arthritis, previous elbow surgery, or congenital

deformities; patients with neurovascular injuries affecting the injured limb; patients with inadequate radiological or clinical follow-up (less than 12 months) or incomplete medical records; patients who declined participation or were lost to follow-up (for the prospective cohort).

Outcomes: MEPS, DASH score, radiological union, elbow ROM (Flexion + extension lag), complications

Rehab: Brief immobilisation → supervised physiotherapy → gradual ROM exercises.

Statistical analysis: Statistical analysis was performed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation and compared between the retrospective and prospective cohorts using the independent Student's t-test for normally distributed data or the Mann–Whitney U test for non-normally distributed data. Categorical variables were presented as frequencies and percentages and analysed using the Chi-square test or Fisher's exact test where appropriate. A p-value of <0.05 was considered statistically significant.

RESULTS:

A total of 30 patients with capitellum fractures treated with Herbert screw fixation were included, comprising 15 patients in the retrospective group (Cohort A) and 15 patients in the prospective group (Cohort B). The mechanism of injury was predominantly a fall on an outstretched hand, with a smaller proportion resulting from road traffic accidents and other high-energy trauma (Fig. 1). Based on the Dubberley classification, fractures were distributed between Type I and Type II patterns across both cohorts (Fig. 2).

Functional outcomes were better in the prospective cohort. The mean DASH score was 18.4 in Cohort A compared with 13.1 in Cohort B, and the mean Mayo Elbow Performance Score (MEPS) improved from 84 in Cohort A to 92 in Cohort B, indicating superior functional recovery with standardized prospective management. Elbow range of motion also favoured the prospective cohort, with mean flexion of 131° versus 124° in Cohort A and reduced extension lag (9° versus 14°) (Fig. 3).

Radiologically, the mean time to fracture union was 11.8 weeks in Cohort A and 10.6 weeks in Cohort B, showing slightly earlier union in the prospective group (Fig. 4).

Postoperative complications occurred in 8 of 30 patients (26.7%). Elbow stiffness was the most common complication, seen in 4 patients (13.3%), followed by heterotopic ossification in 2 patients (6.7%), and superficial infection and avascular necrosis in 1 patient each (3.3%). No cases of implant backout were observed (Fig. 5).

FIG 1: MECHANISM OF INJURY

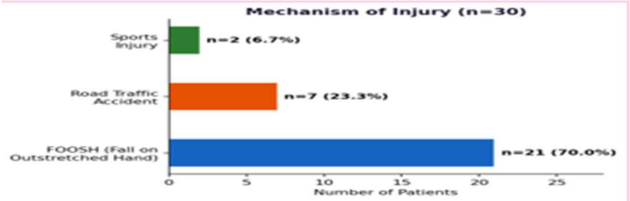


FIG 2: DUBBERLEY FRACTURE CLASSIFICATION

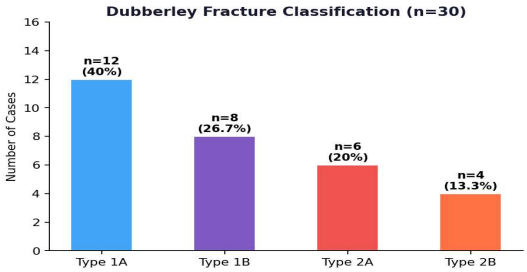


FIG 3: ELBOW RANGE OF MOTION

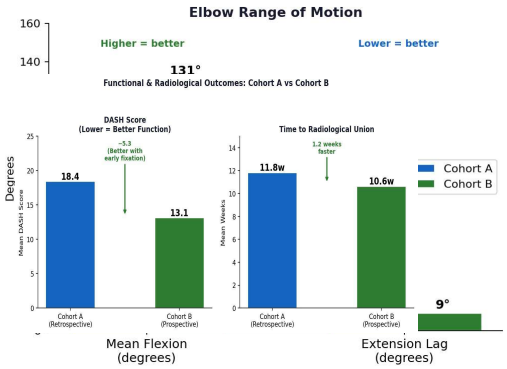
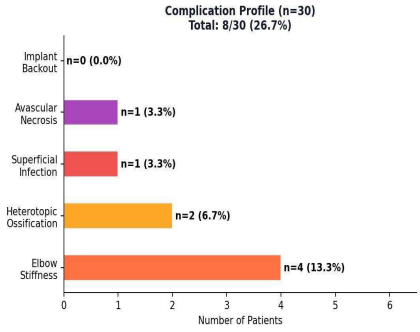


FIG 4: FUNCTIONAL &RADIOLOGICAL OUTCOME COHORT A vs. COHORT B

FIG 5: COMPLICATION PROFILE



DISCUSSION:

Capitellum fractures are uncommon but clinically significant injuries of the distal humerus that present considerable challenges due to their intra-articular nature, complex anatomy, and tendency to produce elbow stiffness. The primary objectives of surgical management are restoration of articular congruity, stable fixation, early mobilization, and prevention of long-term functional impairment. In the present ambispective comparative cohort study, 30 patients with capitellum fractures treated with Herbert screw fixation were evaluated for functional and radiological outcomes. The study demonstrated satisfactory fracture healing, improved functional outcomes, and acceptable complication rates, supporting Herbert screw fixation as an effective method for managing these injuries.

The functional outcomes in the present study showed better results in the prospective cohort compared with the retrospective cohort. The mean DASH score was 13.1 in Cohort B (prospective) compared with 18.4 in Cohort A (retrospective), indicating improved upper limb function following standardized prospective management. Since a lower DASH score represents better functional status, the findings suggest that early diagnosis, improved surgical planning, standardized rehabilitation, and closer follow-up may contribute to better patient outcomes. Similar observations have been reported in previous studies where anatomical reduction and stable fixation were associated with improved patient-reported functional outcomes following capitellum fracture fixation.(13)

Restoration of elbow motion is a major determinant of successful treatment following intra-articular distal humeral fractures. In the present study, the prospective cohort demonstrated better elbow range of motion, with mean flexion of 131° compared with 124° in the retrospective cohort. Similarly, extension lag was reduced from 14° in Cohort A to 9° in Cohort B. These findings highlight the importance of early mobilization following stable fixation. Herbert screws provide adequate compression and fixation stability while allowing early range-of-motion exercises, thereby reducing the incidence of postoperative stiffness, which remains one of the most frequent complications after elbow trauma.(14)

Radiological evaluation showed satisfactory fracture healing in both cohorts. The mean time to radiological union was 11.8 weeks in Cohort A and 10.6 weeks in Cohort B, demonstrating slightly faster union in the prospective group. The improvement may be attributed to optimized surgical technique, better postoperative protocols, and improved compliance with rehabilitation. Previous studies have reported union rates ranging from 90–100% following fixation of capitellum fractures using headless compression screws, provided adequate reduction and stable fixation are achieved.(15) The current findings are consistent with these reports and support the reliability of Herbert screw fixation for achieving fracture union.

The advantage of Herbert screw fixation lies in its headless design, which allows the implant to be buried beneath the articular cartilage while providing interfragmentary compression. This reduces cartilage irritation and eliminates the prominence associated with conventional screws. Stable fixation also facilitates early rehabilitation, which is essential for preserving elbow function. Previous biomechanical and clinical studies have demonstrated that headless compression screws provide sufficient stability for capitellar fragments and allow favourable functional recovery.(16)

Complications occurred in 8 out of 30 patients (26.7%) in the present study. The most common complication was elbow stiffness, observed in 4 patients (13.3%). Stiffness remains a recognized complication after capitellum fractures due to intra-articular involvement, postoperative fibrosis, and prolonged immobilization. However, the incidence in the current study is comparable with previously reported literature. Early physiotherapy and controlled mobilization after stable fixation are important strategies to minimize this complication.(17)

Heterotopic ossification was observed in 2 patients (6.7%), while superficial infection and avascular necrosis occurred in 1 patient each (3.3%). No cases of implant backout were noted, indicating adequate fixation strength and appropriate implant positioning. Avascular necrosis is a concern in capitellum fractures because of the limited vascularity of the fragment, particularly in cases with extensive cartilage disruption or delayed treatment. Nevertheless, the low incidence observed in this study suggests that careful handling of soft tissues and restoration of blood supply during surgery may reduce this risk. (18)

The absence of implant-related complications in the current study further supports the use of Herbert screws in capitellum fracture fixation. Unlike prominent implants, headless screws minimize irritation of surrounding soft tissues and reduce the likelihood of secondary procedures for hardware removal. However, successful outcomes depend not only on implant selection but also on accurate fracture reduction, appropriate screw placement, and adherence to postoperative rehabilitation protocols.

The slightly superior outcomes observed in the prospective cohort may reflect the benefits of a structured treatment protocol, improved imaging

assessment, standardized surgical technique, and regular postoperative monitoring. The use of computed tomography for fracture assessment and careful planning of screw orientation may improve the accuracy of reduction and fixation. Furthermore, early supervised rehabilitation may have contributed to improved motion and lower disability scores.

Despite favourable outcomes, this study has certain limitations. The relatively small sample size and inclusion of patients from a single centre may limit generalizability. The rarity of capitellum fractures makes large randomized trials difficult, and most available evidence consists of retrospective case series. Longer follow-up is required to assess late complications such as post-traumatic arthritis and delayed avascular necrosis. Future multicentre studies with larger patient populations may provide stronger evidence regarding optimal fixation strategies.

Overall, the findings of this study demonstrate that Herbert screw fixation provides reliable radiological union and satisfactory functional outcomes in capitellum fractures. The prospective cohort showed better DASH scores, improved elbow motion, and slightly earlier union compared with the retrospective cohort, emphasizing the importance of standardized management and rehabilitation. The complication profile was acceptable, with elbow stiffness being the most frequent issue. These results support Herbert screw fixation as an effective treatment option for displaced capitellum fractures when anatomical reduction and stable fixation are achieved. (19, 20)

CONCLUSION

Herbert screw fixation provides reliable radiological union and satisfactory functional outcomes in patients with capitellum fractures. In this study of 30 patients, stable fixation resulted in consistent fracture healing with a mean union time of 10.6–11.8 weeks. The prospective cohort demonstrated better functional outcomes, with lower DASH scores, improved elbow flexion, reduced extension lag, and earlier radiological union compared with the retrospective cohort. The overall complication rate was acceptable, with elbow stiffness being the most common complication. Herbert screws provide stable, headless compression fixation that facilitates early mobilization and restoration of elbow function. Therefore, Herbert screw fixation can be considered an effective treatment option for displaced capitellum fractures when anatomical reduction, stable fixation, and appropriate rehabilitation are ensured.

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