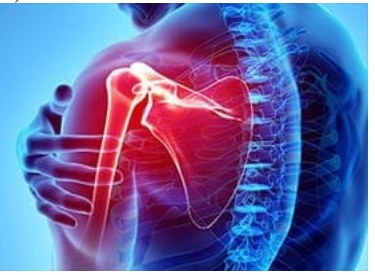


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## Functional outcome of capitulum fracture by open reduction internal fixation with herbert screws

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### Abstract

**Background:** Fractures of the capitellum are rare injuries of the elbow usually seen in the adolescents. This fracture is often missed in the emergency room if a proper radiograph is not available. Recent reports have described many modalities of treatment favoring headless screw for fixation. The facility for headless screw fixation, however, is not available in most centers. This paper presents the diagnosis and management of type 4 capitellar fractures (McKee) with gadgets available in a district hospital.

**Introduction:** 12 patients with capitellar fractures were included in this retrospective study. A well taken lateral radiograph was important and stressed upon in all patients. All fractures were open reduced and internally fixed using Herbert screws via an extensile lateral approach over a period of 2 years. Clinical, radiographic, and Mayo Elbow Performance Index were evaluated at a mean follow-up of 2years (1.5 to 2years)

**Results:** Nine type I and three type IV capitellar fractures were identified using Bryan and Morrey classification system. The average time to bone union was 14 weeks (range 8-16 weeks) with no case of nonunion. The mean range of flexion was 130° (range 125°-135°). The average extensor lag was 10° (range 0°-30°), with a functional range of motion of elbow achieved in all patients. On the final follow-up, one case of osteoarthritis was seen, but no evidence of avascular necrosis or heterotrophic ossification was seen. Two patients needed screw removal. The outcome was excellent in 10 patients and good in two patients

**Conclusion:** Double arc sign on lateral X-rays of the elbow along with pre-operative CT scan evaluation is important to avoid a missed diagnosis and analysis of type IV capitellur fracture. Fixation with non-cannulated ordinary Herbert screws using extended Kocher's lateral approach has given good results.

**Keywords:** Capitellum fracture, type 4 capitellum fracture, bone fixation, bone screw

### Introduction

Intraarticular coronal shear fractures of the capitellum are rare injuries and account for approximately 1% of all elbow fractures and 6% of all distal humeral fractures. Capitellar fracture was first described by Cooper as an isolated injury in 1841, followed by Hahn<sup>[4]</sup> in 1853, who also reported an isolated capitellar fracture in a 63-year-old woman who had poor results due to loss of elbow flexion. The classification of capitellar fractures into two types evolved after further reports of this injury by Kocher in 1896, Steinthal<sup>[6]</sup> in 1898, and Lorenz in 1905: type I or "Hahn-Steinthal" fracture and type II or "Kocher-Lorenz" fracture. Capitellar injuries are typically due to its axial loading by forces transmitted through the radial head<sup>[8, 9]</sup>. The fracture is caused by a fall onto the outstretched hand with the elbow in extension or in slight flexion. The impact on the hand creates a force that passes through the forearm to the head of the radius, which acts like a piston and shears off the capitellum<sup>[10]</sup>. Capitellar fractures can be sustained either by a direct injury with the elbow in flexion or indirectly through an extended radius, as in falling on an outstretched hand<sup>[11]</sup>. Nevertheless, both these mechanisms can produce a coronal shear fracture. Radial head fractures are associated with indirect trauma and are likely to be present in approximately 24% of patients. Presently, the Bryan and Morrey classification for capitellar fractures into three types with McKee *et al.*<sup>[9]</sup> adding a fourth type is in common use. In the AO classification system, capitellar fractures would be identified as 13 B3 (Distal end of the humerus, partial articular,

and frontal), with B3.1 indicating isolated capitellar fractures; B3.2, trochlear fractures; and B3.3, capitellar and trochlear fractures. Many treatments and management methods have been advocated and include closed reduction and immobilization, fracture fragment excision, open reduction with or without internal fixation using Kirschner wires (K-wires), cannulated screws or Herbert screws, and prosthetic replacement. Herbert screw provides some definite advantages over other methods of internal fixation. It achieves better fracture site compression, provides stable fixation without damaging the articular cartilage, allowing early joint motion and less or no need for second stage hardware removal. We present a retrospective study of 12 cases of capitellar fractures treated using Herbert screw fixation over a period of 2 years with a mean follow-up of 2 years. The purpose of this present study was to perform an objective and subjective evaluation with functional outcome of patients with capitellar fractures that were treated with internal fixation by inserting Herbert screws in an anterior-to-posterior direction after open reduction via an extensile lateral approach.

### Materials and Methods

Twelve patients with capitellar fractures were treated from January 2020 to December 2022 and were followed up till 2023. Patients included 8 female and 4 male patients aged 20-48 years (mean, 35 years), with fracture of the dominant right-hand elbow in three and nondominant left-hand elbow in 12 patients. Inclusion criteria were closed fractures in skeletally mature patients and exclusion criteria were joint laxity and prior degenerative or inflammatory arthritis. All fractures were closed and had occurred following a fall onto the flexed elbow in six or with outstretched hand in nine patients. Distal neurovascular examination of the limb was normal. All patients underwent plain radiographs (Anteroposterior and lateral), and CT scan with 3D reconstructions was performed only in cases with associated radial head and epi (a) condyle fractures. Fractures were classified according to the Bryan and Morrey classification and were of type I in nine and type IV in six patients. According to the AO classification, nine were of 13 B3.1 and six of 13 B3.3 type. Two patients had associated radial head fractures and one had lateral epicondyle fracture. All patients were operated within 7 days after injury. Patients were operated under general or regional anesthesia, with the patient in supine position. A pneumatic tourniquet was used in all cases. Varus and valgus stress tests were performed to rule out any ligamentous instability. Open reduction of fractures was performed via an extensile lateral approach [9]. A skin incision was made laterally at the elbow, centering over the lateral epicondyle and extending proximally 4-6 cm over the distal end of the humerus to approximately 2 cm distal to the radial head. Dissection was performed through the subcutaneous tissue layers, and the lateral column was identified along with the common extensor origin. The forearm is pronated to avoid any iatrogenic injury to the radial nerve, moving it away from the operating area. The common origin of the radial wrist extensors along with the anterior capsule of the elbow joint was sharply elevated as a single full-thickness flap from the lateral supracondylar ridge anterosuperiorly and distally connected to the "Kocher interval" to reach the fracture site, which was cleared of hematoma and soft-tissue debris so as to allow the proper visualization and orientation of the fracture using normal

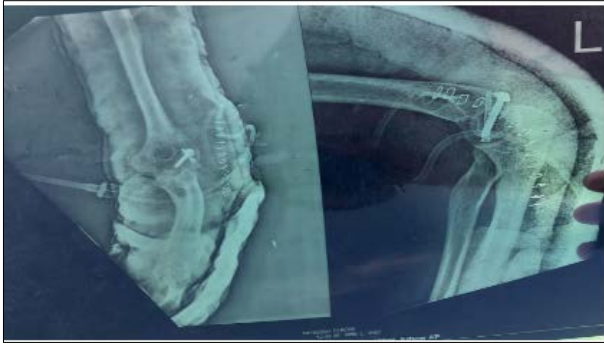
saline irrigation. Due care was taken to preserve the lateral ulnar collateral ligament origin at the lateral epicondyle along with vascular supply to the capitellum. Anatomic reduction was directly visualized as the fractured capitellum was reduced along the proximal metaphyseal margin and trochlea medially. Capitellar fractures were fixed using two headless cannulated Herbert screws, which were inserted over the guide wires in an anterior-to-posterior direction. Screws were sunk into the articular surface to avoid any damage to the radial head or impingement. The common wrist extensor origin was repaired back to soft tissues and periosteum over the lateral supracondylar ridge. The wound was closed in two layers. Radial head fractures in two patients were addressed through the same exposure and fixed using headless screws. The lateral epicondyle fracture in one patient was too small for screw fixation and was fixed using two K-wires, which were removed after 6 weeks. Compressive sterile dressing was applied, and the arm was placed in a long arm posterior plaster slab and with the elbow kept in flexion of around 90°. The plaster slab was removed after 1 week, and the sutures were removed and active range of motion exercises of the elbow and forearm were started. Strengthening exercises were delayed till clinical and radiographic evidence of bone union was seen. All patients were evaluated using the Mayo Elbow Performance Index (MEPI) Score for function, stability, pain, and range of motion (ROM) at the elbow. Radiographs were assessed for the status of bone union, signs of avascular necrosis (AVN), and osteoarthritis. Further assessment was also performed for wound complications, elbow function, and any other complications. The length of follow-up ranged from 1.5 to 2 years



**Fig 1:** Pre-operative Radiographs AP and lateral view



**Fig 2:** NCCT images Showing Capitulation Fracture)



**Fig 3:** Post-operative Radiographs of Elbow AP and lateral view



**Fig 4, 6:** month Follow-up Radiograph)



**Fig 5, 6, 7, 8:** Showing Range of Motion at elbow at 6month Followup in Flexion, Extension, Probation and supination)

## Results

Nine type I and 3 type IV fractures were identified in this series. All patients were right-handed. The dominant hand was injured in three cases only. The mechanism of injury was a low-energy fall in all cases. All fractures were closed. There were no associated neurovascular injuries. There were two ipsilateral radial head fractures and one lateral epicondyle fracture. No other concomitant upper limb musculoskeletal injuries were observed. Intraoperatively, trochlear involvement was identified in association with all type IV fractures. The lateral collateral ligament was intact in all fractured elbows, except in one where the lateral collateral ligament was found to be avulsed along with an attached lateral epicondyle fracture fragment. All fractures united well and the mean time to union was 12 weeks, ranging from 8 to 16 weeks (Fig. 2a, b). No patient had any residual elbow instability or weakness. Extensor power and grip strength were similar to that of the other side. Forearm rotations were not restricted in any of our patients including those with radial head fractures. The average Range of

flexion was 130° (range, 125°-135°). The mean extensor lag was 10° (range, 0°-30°), with the ROM of the elbow remaining functional in all patients. One patient had restriction of elbow extension due to the screw being too long and protruding into the olecranon fossa, thus impinging on the olecranon and not allowing full extension of the elbow. The screws in this patient were removed after 4 months of the primary procedure with some gain in extension. The mean extension lag was 17.5°±8.12 in six patients with type IV fracture compared with 5°±5.83 in nine patients with type I fracture ( $t=3.49$ ,  $p=0.0040$  which is significant). Post-traumatic arthritis was seen in one elbow; despite radiographic evidence of arthritis, the clinical and functional result was good. At the final follow-up, no evidence of AVN or heterotrophic ossification was seen in radiographs.

## Discussion

Despite its rarity, the prevalence of capitellar fractures is 2 times higher in women than in men, and it has been suggested that this is due to the greater carrying angle in females along with weaker bones (Osteoporosis) [11]. These injuries mostly occur in young persons, and the female preponderance seen in the present series coincides well with the reported literature. Patients with capitellar fractures mostly present with painful swelling of the elbow immediately after an injury. These fractures are often missed on anteroposterior radiographs because the fracture lines are not well recognizable against the profile of the distal humerus because of the overlap. They are typically picked and best seen on true lateral views. A high index of suspicion and good lateral view radiograph is thus warranted to avoid missing this injury. Additionally, in type IV injuries on a lateral view radiograph, a pathognomonic “double arc sign” formed by the overlap of subchondral bone of the capitellum and the trochlear ridge is often seen. CT scan with 3D reconstructions is usually advised to delineate the medial extent, articular impaction with metaphyseal, or condylar comminution of the fracture. CT scans may be used to properly delineate and classify the fracture preoperatively. We did not routinely perform CT scan in our patients, except in cases with associated injuries around the elbow. The most frequent type of capitellar fracture is type I (HahnSteinthal), which accounts for 47% of all fractures, and the majority of them occur due to fall from standing height [14]. In our study, nine patients were categorized into type I. Type II (Kocher-Lorenz) and type III (comminuted) fractures are found in significantly lower numbers. No type II or type III cases were present in this study. Type IV (McKee) accounts for approximately 36% of capitellar fractures in women and 54% in men [14]. In our study of 12 cases, there were 4 type IV fractures. Capitellar fractures with radial head fracture occurs in 24% of cases [14]. This series had two cases with radial head fractures and one with associated fracture of lateral epicondyle. Although there are many different treatment modalities described for capitellar fractures, including closed reduction and immobilization [14], excision of fracture fragments [15], prosthetic replacement, ORIF is presently considered as the best treatment. Fixation has been achieved using K-wires, cancellous screws [22] inserted from the posterior to anterior direction, and Herbert screws [23]. We used Herbert screws in our series, as fixation of the capitellar fracture using these screws has been found to be better than using Kwires or cancellous lag screws,

directed from the anterior to the posterior direction, as this eliminates the need for further soft-tissue dissection from the posterolateral aspect of condyle, besides achieving good fixation. Herbert screws are terminally threaded, providing fracture site compression through their variable thread pitch designs. The head is buried beneath the articular surface so that it does not hinder joint mobility. This also reduces the need of repeat surgery for screw removal. Two screws were always used to ensure a good rotational control. We used an extensile lateral approach, a common surgical approach in all patients as it provides adequate exposure to address any extension of the trochlea medially, any impaction, and/or comminution present type IV fractures, thus eliminating the need for the second approach. The skin incision is small, not larger than 6-8 cm. Further, neurovascular structures are not at risk, and radial head and lateral epicondylar fractures can be simultaneously addressed. Complication rates in our series were few and less than that reported in the literature. Two of our patients require reoperations for screw removal, with no influence on the final functional result. One screw was limiting extension, as it was protruding into the olecranon fossa, which improved after its removal. To prevent screw impingement like this, we recommend routine use of fluoroscopy during surgery so that proper position and screw length will be chosen. We had one post-traumatic osteoarthritis, and it has also been documented in other series.

**Conflict of Interest:** Not available

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