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Open reduction and fixation of capitellum fractures of the elbow using anterolateral approach...A prospective study

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Abstract

The objective of this work is to present a functional evaluation of patients treated with open reduction and internal fixation of capitellum fractures using anterolateral approach. We studied the outcome of 20 consecutive patients with capitellum fractures, with one year of follow-up. Mean age in our study was 44 (range 25-60) years. 60% of patients were females in our study and non-dominant side was involved in 70% of patients. All the patients reported normal elbow function prior to trauma. RTA was the cause of injury in majority of patients and non-dominant side was injured in majority of patients. The patients were evaluated with Mayo Elbow Performance Index. All the fractures united at an average duration of 18 weeks. Mean Mayo score was 93. Mean pronation and supination were 83 and 85 degrees respectively. There were two cases of superficial infection, however got resolved uneventfully. One case of delayed union, one case of implant failure (needed revision surgery) and four cases of stiffness. We conclude that open reduction and internal fixation of coronal shear fractures of capitellum using headless screw compression via the antero-lateral approach is a reliable treatment modality and results in stable fixation with restoration of a functional arc of motion.

Keywords: Capitellum fracture, internal fixation, Herbert screw, mayo elbow performance index

Introduction

The isolated fractures of the capitellum are rare, with an incidence of 1.5 per 100,000 population; these fractures have a bimodal distribution with one peak less than 19 years of age and other above the 80 years of age, with a female predominance. This type of fracture is usually associated with high energy forces in the younger population, and with osteoporosis in the older patients^[1]. Coronal plane fractures of the Capitellum were first described by Cooper and later a more detailed description was given by Hahn, Steintal and Kocher after whom they have been named. Such injuries usually result from low energy trauma; usually from fall on an outstretched hand with the elbow in extension. As the centre of rotation of Capitellum is anterior to the humeral shaft, it leads to the transmission of a shearing force resulting in a coronal fracture of the distal humerus. Trochlear fracture may result from transmission of a similar force from the coronoid. A higher female preponderance is explained on the basis of a larger carrying angle leading to greater transmission of contact forces to the lateral column^[2]. The fracture may occur after an episode of acute elbow dislocation/instability. Capitellum and trochlea may be sheared off by the radial head and coronoid following the reduction of a posterolateral subluxation or dislocation of the elbow. This might also explain distribution of damage from anterior to posterior, from lateral to medial in a sequential manner as described in elbow dislocation, commonly known as Circle of Horii.

Capitellum fractures may also be secondary to recurrent posterolateral instability of the elbow. Due to repeated subluxation and impingement of the radial head against capitellum, an osteochondral fracture of the posterolateral margin of capitellum may occur. It has been termed as Osborne-Cotterill lesion as they were first to describe it^[3]. The lesion is similar to Hill-Sachs lesion seen in humerus secondary to recurrent shoulder dislocation.

Patients usually present with pain and swelling around the elbow region. Examination of Bryan and Morrey type I fractures shows a mechanical block in elbow flexion, which is due to the anteriorly displaced fragment, whereas type II fractures usually show a mechanical block in extension as a result of the posteriorly displaced Osteo-chondral fragment.

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Pain over the medial aspect may indicate an underlying MCL avulsion or tear. Lateral tenderness may indicate an associated radial head fracture or LCL injury. X-rays especially lateral view and Greenspan view [4] are helpful in making the diagnosis. The typical semilunar fragment is displaced anteriorly and superiorly. In case of type 4 fractures in which the fragment consists of capitellum and the lateral half of trochlea, "McKee's double arc sign" is seen (Figure 1). The two arcs are due to the subcondral bone of capitellum and trochlea. CT scan provides a much more detailed view and should be performed in all the cases to know about the displacement pattern, amount of comminution, involvement of posterior cortex, epicondyles and radial head.

The most commonly used classification system is that of Bryan and Morrey [5]. Originally there were three types and a fourth type was later added by Mc Kee *et al.* [6] (Figure 2).

Type I involves the capitellar articular surface along with the subcondral bone (also known as Hahn Stienthal fracture).

Type II consists of a capitellar articular surface along with a thin shell of subcondral bone (also known as Kocher-Lorenz fracture).

Type III are the comminuted capitellar fractures.

Type IV (described by McKee) consists of a type I with medial extension to include the lateral half of the trochlea.

The management of the capitellar fractures could be non-operative or operative [1]. The non-operative management includes a closed reduction and casting, has a high failure index [7]. Therefore, the treatment of choice is open reduction and internal rigid fixation using headless screws [1, 7, 8]. The most common complication after the surgical management is elbow stiffness [9]. The purpose of our study is to evaluate the functional outcome of patients with fractures of the capitellum treated with an open reduction and fixation with headless screws using anterolateral approach with one year follow up using Mayo Elbow Performance Index (MEP).



Fig 1: Showing McKee's double arc sign

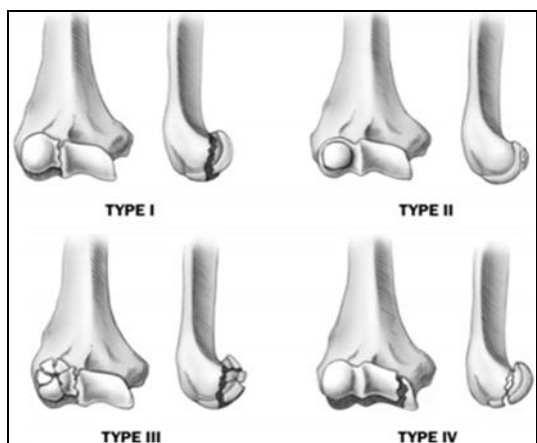


Fig 2: Bryan and Morrey classification

Patients and methods

This prospective study was conducted on 20 patients in the Department of Orthopaedics, Government Medical College Srinagar from June 2016 to August 2018. 8 males and 12 females were included in this study. Patients having neurovascular injury, associated ipsilateral upper limb fracture, patients having pre-existing deformities of ipsilateral shoulder, elbow or hand and medically unfit patients were excluded. 12 patients sustained injury due to Road Traffic Accident, 4 due to fall from height and 4 due to fall. All patients were initially evaluated with simple X-rays, an anteroposterior and lateral view of the elbow (Figure 3). A CT scan was taken to determine the fracture pattern. A posterior splint in 90° of flexion was initially applied in all patients. Fractures were classified with the Bryan and Morrey classification. The time interval between injury and surgery ranged from 5 to 10 (mean 7.5) days. All patients were treated, using the anterolateral approach. Headless screws were used for fixation, with a disposition anterior to posterior and lateral to medial.



Fig 3: AP and Lateral Radiograph

Surgical technique

The patients were placed supine and a tourniquet placed on the upper arm. We in the present series used an Anterolateral approach in all the cases. The arm was exsanguinated using an Esmarch bandage and tourniquet inflated. A curved S shaped incision was made, with the superior limb being along the lateral border of biceps. The incision was then curved medially at the level of elbow joint to avoid crossing a flexion crease at 90 degrees and distal limb of the incision is curved along the medial border of Brachioradialis. The lateral cutaneous nerve of the forearm was identified and preserved as it becomes superficial lateral to the biceps tendon. Proximally the plane between Brachialis and Brachioradialis was developed and distally the plane between medial border of Brachioradialis and lateral border of Pronator teres is developed. The radial nerve was identified proximally at the level of elbow joint between Brachialis and Brachioradialis. The nerve was traced distally and its three branches namely: Superficial Radial nerve which continues distally below the Brachioradialis, Posterior Interosseous which pierces the Supinator and the branch to extensor carpi radialis brevis (ECRB) which enters the muscle almost immediately, were identified and preserved throughout the procedure. The elbow joint capsule was incised longitudinally if not already torn and the fracture fragments were identified. Anterior approach provides direct access to anterior aspect of the medial and lateral column. K wires were introduced in the fracture fragments, used as joystick to manipulate them into anatomical reduction, and then driven across the fracture site into opposite cortex. Definitive fixation was achieved with the help of headless compression cannulated 2.4 mm Herbert screws, placed at right angles to the fracture site. While

exposing the LCL avulsion, elbow was pronated and a varus stress placed, so that the lateral epicondyle can be visualized adequately. Repair of the avulsed LCL fragment was therefore done last, so as avoid supinating the forearm afterwards. Associated injury of the LCL is repaired by using a running interlocking suture, which was fixed to its anatomical origin from the lateral epicondyle.

Post-operatively arm was placed in a Soft Dressing and arm sling for two weeks. Gentle active and active assisted range of motion exercises are started thereafter. During the weeks 2-4, stress was placed on achieving adequate range of motion: Flexion/Extension and Pronation/Supination. If concomitant LCL repair was done, then elbow was kept pronated for 4 weeks. After 4 weeks Muscle strengthening exercises were started, however arm pouch sling was continued till 6 weeks. Physical therapy sessions were continued for 8-10 weeks. A hinged Elbow Brace was used in four patients for 4 weeks in whom it was felt intraoperatively that fracture fixation was not stable enough due to extensive comminution and an associated LCL injury. In one of these patients fracture configuration was such that we were able to pass only one screw and supplemented by two K-wires (which were removed after 6 weeks), however fracture united without any complication (figure 4).

Patient's follow-up consisted in radiographic evaluation, Mayo Elbow Performance (MEP) Index that evaluates four aspects: pain, stability, range of motion and functional capacity; scores >90 points is excellent, 75-89 good, 60-74 fair and <60 bad (Table 1). Besides the range of motion in flexion, extension, pronation and supination were evaluated. All patients were evaluated at two and four weeks, and two, six and twelve months.

Table 1: Mayo Elbow Performance Index

Parameter	Result	Points
Pain (max points 45)	None	45
	Mild	30
	Moderate	15
	Severe	0
Motion (max points 20)	Arc of motion >100degrees	20
	Arc of motion >50 and <100 degrees	15
	Arc of motion <50 degrees	5
Stability (max points 20)	Stable	10
	Moderate stability	5
	Grossly unstable	0
Function (max points 25)	Can comb hair	5
	Can eat	5
	Can perform hygiene	5
	Can put on shirt	5
	Can put on shoe	5

Results

All the 20 patients with capitellum were operated by anterolateral approach were reviewed at 1 year follow-up. The mean age of our patients was 44 years ranging from 25 to 60 Years. 40% of patients in our series were males and 60% were females. The fracture was found in 70% on left side (non-dominant side). Road traffic accidents were the most common cause in our series (TABLE 2). There were 14 type I, 3 type III and 3 type IV fractures (Table 3). All the fractures united at an average duration of 18 weeks ranging from 12 to 30 weeks (figure 6). The complications are shown in Table 4. There was one case of delayed union. This patient took 30 weeks to unite. There were two cases of superficial wound infection. The superficial infections were cured with wound care and antibiotic administration. There were four cases of elbow stiffness (all type III and IV). Only 1 patient presented implant failure and was re-operated with another headless Herbert screw. The average operation time was 50 min ranging from 40 to 75 min. the Mayo Elbow Performance Index (mean 93) was excellent in 17 patients, good in two patients and fair in one patient. (Table 5). The mean range of motion in flexion/extension arc was from -5degrees to 130 degrees. Mean pronation and supination were 83 and 85 degrees respectively at final follow up.

Table 2: Mode of Trauma

Mode of trauma	Number of patients	Percentage
RTA	12	60
Fall from height	4	20
Fall	4	20

Table 3: Bryan and Morrey fracture type

Fracture type	Number of patients	Percentage
Type I	14	70
Type II	0	0
Type III	3	15
Type IV	3	15

Table 4: Complications

Complication	Number of patients	Percentage
Superficial infection	2	10
Delayed union	1	5
Loss of reduction	1	5
Stiffness	4	20

Table 5: Mayo Elbow Performance Index

Mayo score	Number of patients	Percentage	Result
>90	17	85	Excellent
75-89	2	10	Good
60-74	1	5	Fair
<60	0	0	Poor

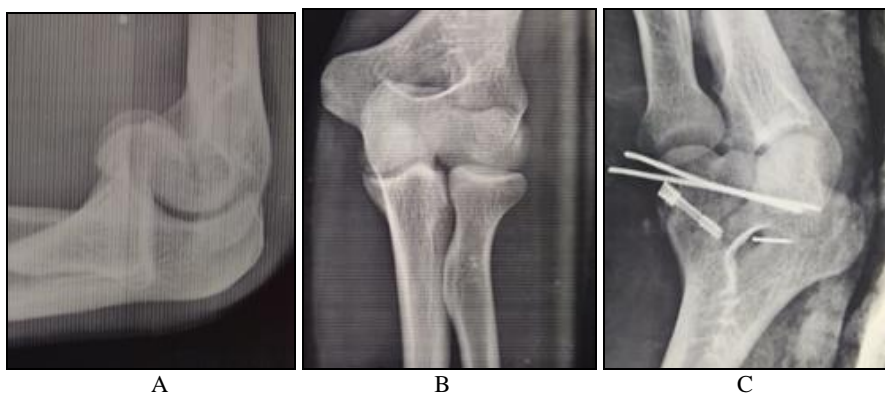


Fig 4A-C: Showing fracture fixation supplemented by K-Wires

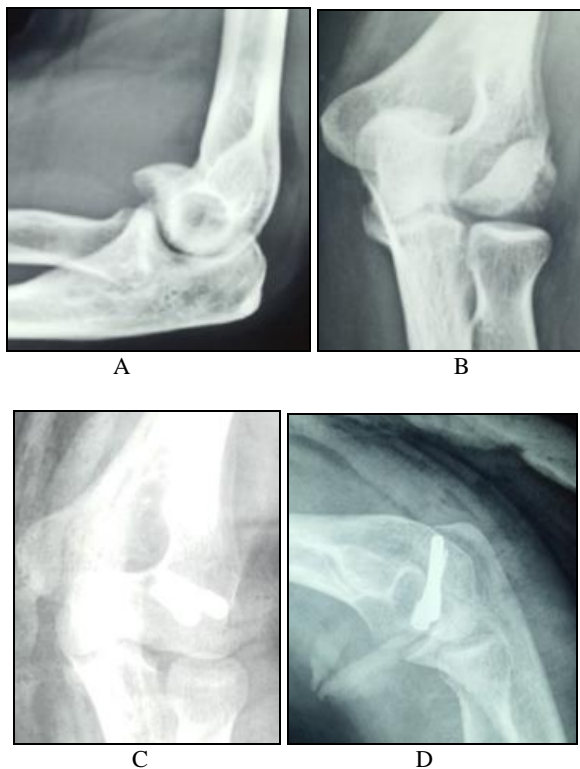


Fig 5A-D: Showing pre-op and post radiographs fixed with two Herbert screws



Fig 6: Showing united fracture

Discussion

Isolated coronal plane articular fractures are uncommon and challenging fractures. Their rarity and complexity along with the challenges in approaching and fixing them with unfamiliar approaches, prompted us to analyse and report our experience of surgical fixation using the anterolateral approach to elbow. Coronal plane injuries can be easily missed on the radiographs, especially only if AP views have been taken. Greenspan^[4] and Norman described a modified lateral view of the elbow in which the radiographic plate is placed under the elbow with the arm abducted 90° at shoulder and elbow flexed to 90°. Radiographic beam is centered on the radial head, and angled 45° dorsoventrally, eliminating the overlap of the humeroulnar and humeroradial articulations thus outlining the radial head and capitellum in profile. McKnee described the double arc sign indicating that a segment of trochlea is involved along with Capitellum. Yashwant Singh Tanwar *et al.*^[10], described “Triple Arc sign” in a patient in whom the whole of trochlea along with Capitellum was fractured in Coronal plane (Figure 9). One arc represented the Capitellum and the other two represented medial and lateral trochlear ridges.

A high index of suspicion is required and if in doubt a CT should always be performed. CT also give additional information regarding any associated occult fractures (such as radial head) and associated ligamentous injuries. Ring^[11] observed that the complexity so called “isolated” capitellar fractures was underestimated on plain X-rays. He described five different anatomic zones and classified the fracture patterns according to them: capitellum and the lateral aspect of the trochlea; lateral epicondyle; posterior aspect of the lateral column; posterior aspect of the trochlea; medial epicondyle. He also coined the term apparent capitellar fractures as it emphasizes the “need to look more closely”.

The best clinical results for patients with these injuries, are obtained with an open reduction and internal fixation with headless screws (Lopez 2016, Bilsel 2013)^[7-9, 12, 13]. Mighell *et al.*^[7], treated 18 patients using Herbert screws with a 26 month mean of follow up, they found a mean of 128° of flexion-extension with 176° of pronosupination; and an average of 93.3 in the Broberg Morey scale. In our study, the patients achieved similar outcomes, but we only did a 1 year follow up.

In the present series anterolateral approach was used in all the cases. Imatani^[14] showed excellent results using anterolateral approach. Yashwant Singh Tanwar *et al.*^[10] in their retrospective study of 13 patients concluded Open reduction and internal fixation of coronal shear fractures of capitellum and trochlea using headless screw compression via the anterolateral approach is a reliable treatment modality and results in stable fixation with restoration of a functional arc of motion.

The main advantage of using an anterior approach is the adequate exposure of the medial column, which may be required if there is extension of the fracture plane medially into the trochlea as in Bryan and Morrey type 4^[15]. One of the drawbacks of Anterolateral approach is inadequate posterior exposure to address the posterior comminution. CT scans should be carefully evaluated regarding the extent of comminution and whether it is amenable to surgical fixation.

The major nutrient artery of the humerus terminates proximal to the distal humerus so the elbow appears to be relatively dependent on local osseous perforating vessels for its blood supply. There are three arterial arcades (lateral, medial, and posterior) around the elbow. The radial and medial collateral arteries (branches of the profunda brachii) anastomose with the ascending interosseous and radial recurrent arteries to form the lateral arcade, which supplies the capitellum from its posterior aspect. The intraosseous pathway of the vessels shows a hypovascular area in the trochlear groove, making this area theoretically more susceptible to nonunion or avascular necrosis^[16]. Exposure via the Anterolateral approach avoids the posterior soft tissue dissection and thus the main blood supply to the capitellum is preserved, theoretically decreasing the chance of AVN.

There are other types of fixation which had shown good to excellent outcomes, as the use of bioabsorbable pins. Kraan *et al.* used an absorbable polyglycolide pin in a 24 year old male, reporting a full recovery with normal range of motion in a period of 6 months^[17]. Also, Hirvensalo *et al.* reported the use of absorbable pins in type I capitellum fractures with a stable reduction and a good long term functional outcome, but with one case of aseptic synovitis as a complication^[18].

In comparison to other studies, we only had one complication, which was the loss of reduction in one patient who went back to the operating room for a new ORIF and one case of delayed union. We did not find avascular necrosis or post-traumatic arthritis, but there is more time is needed to rule it out.

Conclusion

Open reduction and internal fixation of coronal shear fractures of capitellum using headless screw compression via the antero-lateral approach is a reliable treatment modality and results in stable fixation with restoration of a functional arc of motion. One of the limitations of our study was the small number of patients as well as a short follow-up period, however we could found excellent functional and radiographic results.

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