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Outcome of Open Reduction and Internal Fixation with K Wire and Blocking Screw for the Management of Capitellum Fractures

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Abstract

Background: Capitellar fractures are rare injuries. Due to its anatomic location, it is commonly fractured due to a fall on an outstretched hand.

Material and methods: 12 patients were evaluated retrospectively. Type I & type IV fractures of Bryan and Morrey classification system were selected. Extensile lateral approach was used and fracture was fixed with K-wire and blocking screws. This prospective and multicenter based study was conducted at national institute of traumatology and orthopedic rehabilitation (NITOR) and private hospitals outside NITOR, Dhaka, Bangladesh, between January 2018- July 2023. 12 patients were evaluated purposively. Type I & type IV fractures of Bryan and Morrey classification system were selected.

Results: 8 out of 12 patients were female and their mean age was 30.25 years (range 16-43). The radiographic union was noticed between 6 and 16 weeks, with a mean ± SD of 9.58 ± 3.02 weeks. The elbow's mean flexion was 120° (range 100-130°) and mean extension was 11.25° (range 0-30°). Seven patients (58.34%) had an excellent and good outcome based on the Mayo Elbow Performance Score (MEPS), two (16.67%) had a fair outcome, and two (16.67%) had a poor outcome.

Conclusion: Capitellum fractures can be effectively managed by K-wire and blocking screws with minimal complications.

Keywords: k-wire; Capitellum fractures; Outcome; Mayo elbow performance score; Blocking screws

Introduction

Capitellar fractures are rare injuries, accounting 0.5-1% of all elbow fractures and 6% of distal humeral fractures [1-5]. Hahn and Steinthal originally described the fracture pattern in 1853 [1]. These fractures are usually caused by a fall on an outstretched hand with the elbow extended. They are shearing injuries, but they can also occur from direct force application due to a fall on a flexed elbow [3]. Capitellum is located 10-15 mm anterior to the humeral shaft, which makes it vulnerable to shear injuries [1]. Forces that apply axial loading to the capitellum and cause fracture are often transferred to the radial head, lateral trochlear ridge, and lateral half of the trochlea [6]. Because women have a larger carrying angle than males, fractures are more common in women than in men [1] and uncommon in younger people [3]. It could be associated with posterior dislocation of the elbow and fractures of the radial head [1]. There are several classification systems for capitellar factures- Bryan and Morrey classification system [7], Dubberley classification

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system [8] and AO classification system [9]. X-ray (anterior-posterior view, lateral and radial head- capitellum view) and CT scan are preferred diagnostic modality for capitellum fractures [10,11].

A variety of treatment approaches are available, including non-operative, close reduction and immobilization [12,13], fragment excision [14,15], open reduction and internal fixation using resorbable polylactide [16], K wires and 4mm partially threaded cancellous screws, Herbert screws [16-18]. Some authors have advocated for arthroscopic repair of capitellum fractures in recent years [19-21].

As the capitellum fractures are intra articular fractures, open reduction permits anatomical reduction which maintains articular congruity and stable fixation allows early mobilization which prevents stiffness and degenerative changes to the joint [22]. Herbert screws allow for stable fixation and excellent compression, they are costly and available only in level 1 trauma centers. Discussion. Therefore, we used 1.5 mm K wires to fix the fractures and 4.5 mm fully threaded cancellous screws as blocking screws, which prevented proximal or superior migration of the fractured part. This method is cost-effective and easily available. The aim of the study was to evaluate the outcome of open reduction and internal fixation with K wire and blocking screw for the management of capitellar fractures.

Materials and Methods

This was a prospective and multicenter based study done at national institute of traumatology and orthopedic rehabilitation (NITOR) and private hospitals outside NITOR, Dhaka, Bangladesh from January 2018-July 2023. Patients were selected purposively according to inclusion criteria. Bryan and Morrey classification system was used for this study. Inclusion criteria were- patients aged 15 -60 years, duration of injury was less than 1 month, Bryan and Morrey type I and IV fractures, patients receiving no previous treatment and absence of other co-morbidities. Patients aged less than 15 years and more than 60 years were excluded, duration of injury more than 1 month and Bryan and Morrey type II and III were also excluded. After obtaining consent, we performed an open reduction and follow same technique in all patients. NITOR/IRB/2022/0090 was approved by the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR). The study, titled "Outcome of open reduction and internal fixation with K wire and blocking screw for the management of Capitellum fractures," was carried out in a tertiary healthcare facility and was approved by the IRB's scientific and ethical committees. Data were collected by a preset questionnaire. For Statistical analysis P value was set <.001 and statistical analysis of the findings was conducted using Microsoft Excel and processed by SPSS V 27.0. Armonk, NY: IBM Corp.

Patient evaluation: Patients usually present with pain and swelling with history of trauma. There may be soft tissue injury or elbow instability. Often the fractures are missed at initial radiographs. So careful evaluation of x-ray is mandatory. Standard Anterior/ Posterior view is sufficient. In addition to this radial head- capitellum view described by Greenspan et al. [10] showed useful technique to evaluate the fracture. Radial head-capitellum view is a modified lateral view of elbow joint where the tube is angled 45° cephalad to radial head. On the lateral view, the characteristic "double-arc sign" signifies the involvement of the lateral part of the trochlea. This double-arc sign is due to subchondral part of capitellum and lateral part of trochlea [1]. CT scan with 3D image is also helpful in diagnosis and preoperative planning [6].

Surgical technique: In all patients' regional anesthesia (subclavian block) was applied. Following anesthesia, the injured elbow's ligamentous stability was clinically evaluated. The patient was placed in a supine position. The tourniquet was then inflated with 250 mmHg. A lateral approach was preferred. Skin incision was made in the middle of the lateral epicondyle, running from the distal end of the humerus' to about 2 cm down the radial head. Subsequently, the lateral column was palpated. The forearm was pronated to protect the posterior intraosseous nerve as it moved away from the operative field. Then anterior flap was created by elevating the common extensor origin?? along with the anterior capsule. Kocher interval was created distally. Posterior dissection was avoided to avoid disrupting vascularity to the capitellum. Hematoma and soft tissue debris were removed. For further proper visualization saline irrigation was used. After that, fracture fragments were reduced and secured using 1.5 mm K-wires. Then 4.5 mm fully threaded cancellous screw was inserted above the fracture fragment as blocking screw to prevent upward migration of the fragment from anterior to posterior direction. Flexion- Extension of the elbow joint and Supination- pronation movement of superior radio-ulnar joint was evaluated intra-operatively. The Kocher interval was closed in continuity with the proximal portion, and the radial wrist extensors were restored to the soft tissue cuff. The remainder of the wound was closed in layers.

In all patients', a Plaster of Paris (POP) slab was applied with the forearm in neutral rotation and the elbow at 90 degrees of flexion. After three weeks, the back slab was removed. After six weeks, range-of-motion exercises were initiated. They were followed up, both clinically and radiologically, at six weeks, three months, six months, and one year. The radiographic evaluation followed the Broberg and Morrey grade scheme [23].

post-operative evaluation:

Clinical: A visual analogue scale was used to measure pain [24]. A goniometer was used to measure the flexion-

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extension and supination-pronation arches. Using particular provocative movements, anteroposterior, mediolateral, and rotatory instability were evaluated. The MRC grading method was used to evaluate and rank the forearm and elbow muscles [25].

Radiological: Fracture union was defined as formation of callous? and absence of a visible fracture line on x-ray. Serial x-ray was performed to evaluate loss of fracture reduction and complication such as- osteonecrosis, heterotopic ossification and post traumatic arthritis or degenerative joint disease.

Patients were assessed with the Mayo Elbow Performance Score at the time of the final follow-up [26]. It is based on a 100-point rating system with four subscales: function (25 points on five tasks), motion (20 points maximum), pain (maximum 45 points), and stability (10 points).

Results

Twelve patients were evaluated prospectively during the study period. Eight of them were female, half of them (50%) were between 26-35 years of age while age range (16-43) years. Six of them had a history of fall on outstretched hand on extended elbow. Operation delay was (mean ± SD) 13.25 ± 6.12 days while the range was 5-25 days. Fractures were classified according to Bryan and Morrey classification system. Most of them was classified as type I fractures (66.67%), and the rest or four of them were type IV fractures (33.3%). The radiographic union was noticed between 6 and 16 weeks, with a mean ± SD of 9.58 ± 3.02 weeks. The elbow's mean flexion was 120° (range 100-130°) and mean extension was 11.25° (range 0-30°). Type IV fractures showed adequate movement, while the majority of type I fractures had a decreased range of motion. Osteonecrosis, heterotopic ossification, or osteoarthritis were not observed in any of the patients with 12 months follow up; however, two (16.67%) of them experienced superficial infection?? 60. Ultimately, the Mayo Elbow Performance Score (MEPS) was used to assess the patients. Based on this score, two patients (16.67%) had fair results, two (16.67%) had poor results, and eight patients (66.67%) had Excellent and good results.

Table 1: Distribution of the patients according to mechanism of injury, Operation delay, type of fracture and radiograph union. (n = 12).

	(n=12)	(%)
Mechanism of injury		
Fall on outstretched hand	6	50
Fall on flexed elbow	4	33.3
Non-specific	2	16.7
Operation Delay (in days)		
5 – 10 days	5	41.7
11 – 15 days	3	25
16 – 20 days	3	25
21 – 25 days	1	8.3
Mean ± SD: 13.25 ± 6.12 days		
Type of Fracture		
Type I	8	66.7
Type II	0	0
Type III	0	0
Type IV	4	33.3
Radiographic union (in weeks)		
5-10 weeks	9	75
11-15 weeks	2	16.7
16-20 weeks	1	8.3

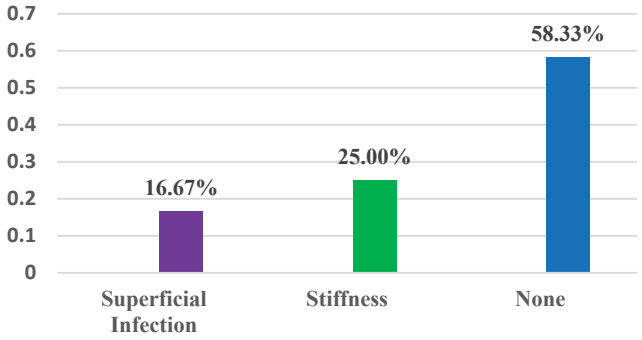

Figure 1: Distribution of the patients according to complication (n=12).

More than half of the patients 7 (58.33%) had no complication, 2 (16.67%) and 3 (25%) of them experienced superficial infection and stiffness.

Table 2: Mayo Elbow Performance Score with outcome of the patients according to radiographic union (n=12).

Mayo score	Number of patients(n)	Percentage (%)	Result
>90	6	50	Excellent
75-89	2	16.7	Good
60-74	2	16.7	Fair
<60	2	16.7	Poor

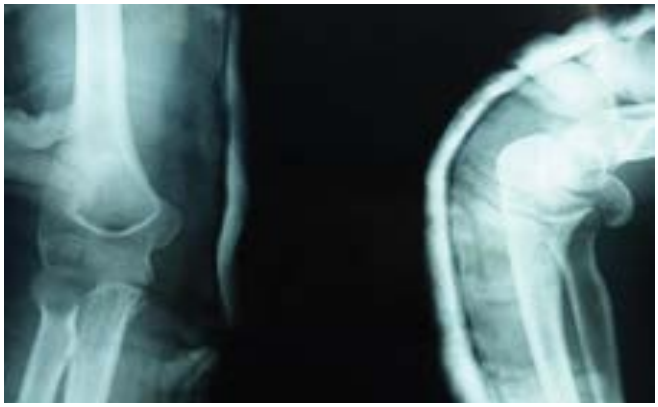

Figure 2: Pre-operative X- ray.

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2 (16.67%) patients had fair results, 2 (16.67%) had poor results, and 8(66.67%) had Excellent and good results.

Table 3: Association of the Operation Delay (in days) and Complication with Mayo Elbow Performance Score (n=12).

Variables	Mayo Elbow Performance Score				P value
	Excellent	Good	Fair	Poor	
Operation Delay (in days)					
5 – 10 days	2	0	1	1	0.352
11 – 15 days	0	1	0	0	
16 – 20 days	2	0	1	0	
21 – 25 days	0	0	0	1	
Complication					
Superficial infection	0	0	1	1	0.002
Stiffness	0	0	1	1	
None	6	2	0	0	
P-value reached from Chi square test or fisher exact test					

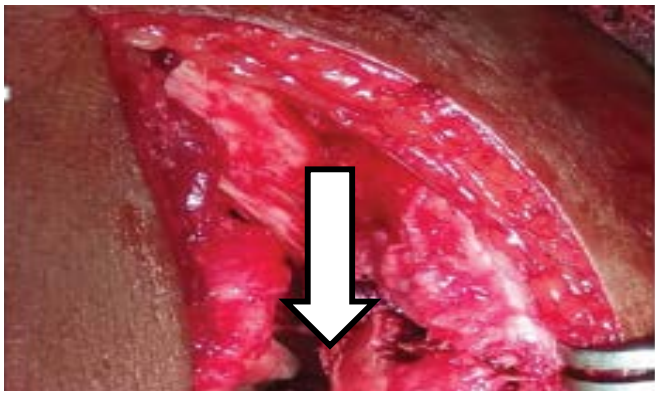

Figure 3: Intra operative image showing fixation and insertion of blocking screw.

We observed that there is no significant relationship between operation delay with Mayo Elbow Performance Score and complications of surgery adversely affect the outcome according to Mayo Elbow Performance Score. So, there was significant relationship between complications with Mayo Elbow Performance Score where P- value was 0.002, which was statistically significant. Patients were monitored using the Mayo Elbow Performance Score at the time of the final follow-up. It is based on a 100-point rating system with four subscales: function (25 points on five tasks), motion (20 points maximum), pain (maximum 45 points), and stability (10 points).

Statistical Analysis

- All the data were entered into a personal computer and thoroughly checked for any possible errors and then processed and analyzed by Statistical Package for Social Science (SPSS 26 Chicago, Illinois, 2020).

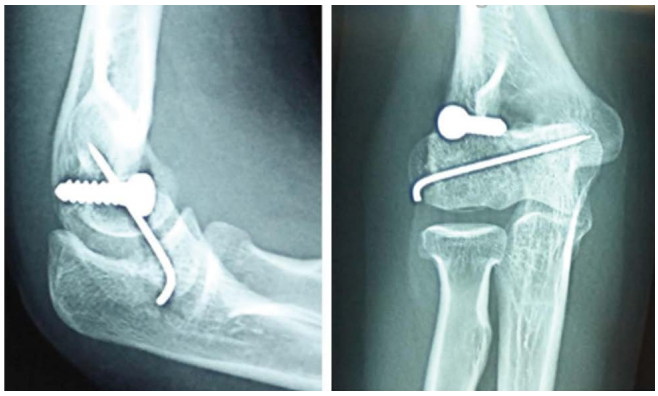

Figure 4: Images showing union of fracture 1 year after surgery, (e) Extension (0°) zero degree showing full range of movement.

Figure 5: Extension (0°) zero degree showing full range of movement (f) Flexion (120°) one hundred twenty degree showing full range of movement.

- Data were expressed as numbers and percentages for categorical variables (gender, clinical features) or as means for quantitative variables.
- To compare categorical variables between groups of patients with Mayo Elbow Performance Score, Chi-square test was used. Or Fisher exact test.
- Results of the statistical analysis were presented on tables and charts. For all statistical test p value of less than 0.001 was considered as statistically significant.

Discussion

Capitellum fractures are rare injuries. The anterior location of the capitellum in relation to humeral shaft renders them vulnerable to shearing injuries. The successful management of capitellum fractures depends on early diagnosis with a high index of suspicion, thorough clinical assessment to rule out ligamentous and other bony injuries, proper radiographic work up to evaluate the geometry of fractures, appropriate surgical approach, and stable fixation. Capitellum fractures are more common in non-dominant hand and young age group because of the frequent engagement of male patients in outdoor activities, however, the prevalence of fracture is four times higher in female than in the male. It has been attributed to increased carrying angle in a female that impacts

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more shear force in capitellum getting the fracture along with weaker bone (osteoporosis) in the female. Male- female ratio in this study was 1:3 corresponding to other literatures. This type of fracture is rare before 11 years of age, thus more common in adolescents. Most common mechanism of injury is fall on outstretched hand, but may also occur in fall on flexed elbow.

Treatment options ranges from open reduction and internal fixation, and close reduction to removal of the fragment. Extended immobilization due to close reduction result in loss of motion, especially extension [12,28]. In contrast, excision may cause articular incongruity, which can lead to instability and post-traumatic arthritis [14]. Numerous authors have advised open reduction and internal fixation because it permits anatomical reduction and early mobilization. [29,30]. Numerous fixation techniques exist, such as arthroscopic fixation, Herbert screw, 4.0 mm cancellous screw, and k-wire. Our method's benefits include little cartilage injury, affordability, accessibility, and early mobilization because of the blocking screw.

There are different approaches [31] for capitellar fracture fixation. Most of the authors used lateral or extended lateral approach [32]. Ballesteros et al. [33] used anterior limited approach for fixation of capitellum and trochlea. So, the choice of approach depends upon surgeon's and the fracture pattern.

In their work, Ruchelsman et al. [17] reported union in eleven weeks, while Ravishankar et al. [31] identified the radiological evidence at 10.9 ± 3.2 weeks. In the current study, radiographic union happened in (mean ± SD) 9.58 ± 3.02 weeks, with a range of 6-16 weeks. This could be because there was not much soft tissue handling done during surgery. In another study conducted by Kapil et al. shows the average time of union of fracture was 11.13±1.20 weeks (range 9 to 15).

In the current study, the average elbow extension was 11.25° (range 0-30°) and the average elbow flexion was 120◦ (range 100-130°). Singh AP et al. (6) found that the average flexion was 132° and the average extension was 7.5°. According to Ruchelsman et al. [17], the average extension/ flexion arc was 10°/133°. The current study's lower range of motion may be the result of insufficient exercise during the post-operative phase. Kapil et al. stated the mean range of movement for flexion and extension was 138.41±8.22 degree while the mean supination and pronation range was 161.59±6.79 degree.

Patients may develop osteoarthritis in later age which we could not evaluate in 12 months follow -up. Two patients had superficial infection and two patients had stiffness which was managed by antibiotics and regular dressings. At the final follow up, according to MEPS score eight patients had excellent and good outcome (58.34%), two (16.67%) had fair outcome and rest of the two poor outcome. According to another study, the average MEPS score at the latest follow-up was 90.22±8.65 (range 70 to 100) with a mean follow-up duration of 37.45±9.43 weeks (range 22 to 58 weeks). Likewise, the mean flexion and extension range was 138.41±8.22 degrees while the mean supination and pronation range was 161.59±6.79 degrees. No single case of secondary osteoarthritis and avascular necrosis of capitellum was noted in this study. Considering these clinical results, functional outcomes in our study are excellent. It was small scale study, to our best knowledge where there was no available data of this technique in previous literature. So, a comparative study with other fixation methods can be done for further study. The limitation of the study was, sample was collected purposively, so bias might be occurred and the sample size was small.

Conclusion

Careful preoperative assessment and radiological evaluation, along with protection of soft tissue attachments around the capitellum during surgery, are crucial. It is not uncommon for orthopedic surgeons to miss displaced or minimally displaced capitellum fractures, unless a true lateral view of the elbow is performed or meticulous observation and a high index of suspicion are maintained. Capitellum fractures can be effectively managed with K-wires and blocking screws, which are cost-effective and widely available, with minimal complications in our study.

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