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The effect of surgery on functional outcomes of the elbow in adults with isolated capitellar fractures

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ABSTRACT

Objectives. The aim of this study was to evaluate the factors affecting the functional outcomes together with the clinical and radiological findings obtained from the treatment of adult capitellar fractures through open reduction and internal fixation. ***Methods.*** Patients who applied our clinic between 2008 and 2013 with a mean age of 37.5 (range: 17-77) were treated surgically. A total of 11 patients, seven male, and four female, were included in the study. In the study, fracture types of the patients were determined according to McKee modification of the Bryan and Morrey classification. After the operation, patients were followed for an average 26 (15-63) months. In the radiological and clinical evaluations, carrying angle of the operated elbow was compared with the carrying angle values of the healthy elbow. Clinical assessment was made of the Mayo Elbow Performance Index (MEPI). ***Results.*** Patients were clinically assessed according to the MEPI scoring over 100 points. It was seen that five patients got 100 points (excellent) while 6 got 85 points (good). No significant difference was observed between fracture types regarding elbow flexion. Type III fractures were found to be significantly more limited than type I and type IV fractures regarding elbow extension degrees (p=0.040). ***Conclusions.*** This study yielded inferences that we considered important. Degenerative changes observed in type III fractures only show that this fracture type poses the risk of osteoarthritis development The fact that heterotopic ossification ossification causes movement restriction affect clinical findings adversely. We believe that degenerative arthritis would decrease, joint range could be maintained better, and functional results will be better by avoiding challenging passive exercise and suggesting active practice instead.

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Keywords: Capitellum; elbow fractures; heterotopic ossification; osteoarthritis; elbow

Introduction

Capitellum fractures account for less than 1% of elbow fractures [1,2]. These fractures are observed particularly in adults and women [3,4]. The fracture may be accompanied by soft tissue injury, and it can be seen together with other elbow fractures including isolated capitellar fracture or radial head in particular [5-9]. They result from a certain degree of flexion of the elbow and a fall onto the outstretched hand upon the transmission of force from the radial head to the capitulum. Capitellum fractures have long been classified as the thick fragment, thin fragment or comminuted fragment, and the most common of them (80%) appears to be the Hahn-Steinthal fracture (Type 1) [10]. The most frequent classification is Mc Knee

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modification of the Bryan and Morrey classification [11]. Most capitellar fractures are complex injuries that involve part of the trochlea [7, 12]. Different classifications have been offered to make fracture types more understandable, and studies have been carried out on the issue [13]. In the related literature, different approaches such as open reduction and internal fixation, excision and closed reduction can be seen in the treatment of capitellar fractures [9, 12, 14-18]. In the technically difficult procedure of closed reduction, cases of mal-union or avascular necrosis due to failure and often reduction loss have been reported [6, 17]. In excision cases, it is possible to observe valgus deformities, instability and joint stiffness and early joint degeneration resulting from joint compliance defect due to [6, 19, 20]. Lack of exercise and contractures in soft tissues may lead to joint stiffness. It is emphasized that angiogenesis mechanism is activated as a result of trauma; and with Platelet-Derived Growth Factor release, the increased vascularization in the damaged area is stated to cause heterotopic ossification development [21]. In elbow traumas, particularly those involving fractures and dislocations, one of the most important reasons for joint stiffness is heterotopic ossification [22-24]. All of these factors are effective in the functional results of the joint. Most studies in the literature include type I fractures, and the number of those carried out on the other types is limited, and most of them are case presentations. There are only a few studies examining all fracture types. The aim of the present study is to evaluate the functional results of our cases who had type I, II, III and IV fractures according to McKee modification Bryan and Morrey classification and were treated surgically for adult capitellar fractures and to specify the factors affecting results.

Methods

Patients who applied in our clinic between 2008 and 2013 with a mean age of 37.5 (range: 17-77) and were treated surgically. A total of 11 patients, seven male, and four female, were included in the study. All patients' pre-operational anterior-posterior radiographs were taken and to avoid inaccuracy in the classification of the fractures, computed tomography images were made for the operational plan before the operation. (Figure.1a-d).

Fracture types of the patients were determined according to McKee modification of the Bryan and Morrey classification (Table 1) [12]. Three of the patients were classified as Type I, one patient with Type II, five patients as Type III and two of them as Type IV. Herbert screws, cannulated screws, conical headless compression screws, breakable pins and Kirschner wires were used as fixation materials. Surgical intervention was made with Kocher's lateral approach. Patients were included in a physical treatment and rehabilitation program following the operation.

After the surgery, patients were followed for 26 months (range: 15-63) on average. At the final examinations, comparative anterior-posterior and lateral radiographs were taken of both elbows. In the radiological and clinical evaluations, carrying angle of the operated elbow was compared with the carrying angle values of the healthy elbow, and radiological measurements were assessed [25]. Clinical assessment was conducted by the Mayo Elbow Performance Index (MEPI), which evaluates patients' pain, the range of joint motion, stability and daily functions.

Statistical analysis

IBM Corp. (2012) IBM SPSS Statistics for Windows. Version 21.0 Armonk, NY: IBM Corp; 2012 Program was used for statistical analysis. Since the types of fractures grouped in the analytical method were not normally distributed and the variances were heterogeneous, the analysis of the numeric data was done with Kruskal-Wallis test. Categorical data were analyzed by Chi-square test.

Results

When patients were clinically assessed according to the Mayo Elbow Performance Index scoring over 100 points, it was seen that five patients got 100 points (excellent) while six patients got 85 points (good). Joint range of two type IV patients and one type II patient were completed, whereas limitation was observed in the joint movements of two type I patients and all type III patients. No significant difference was seen between fracture types regarding elbow flexion and rotation. However, type III fractures were found to be significantly more limited than type I and type IV fractures regarding elbow extension degrees (p=0.040).

There were no complaints or complications that

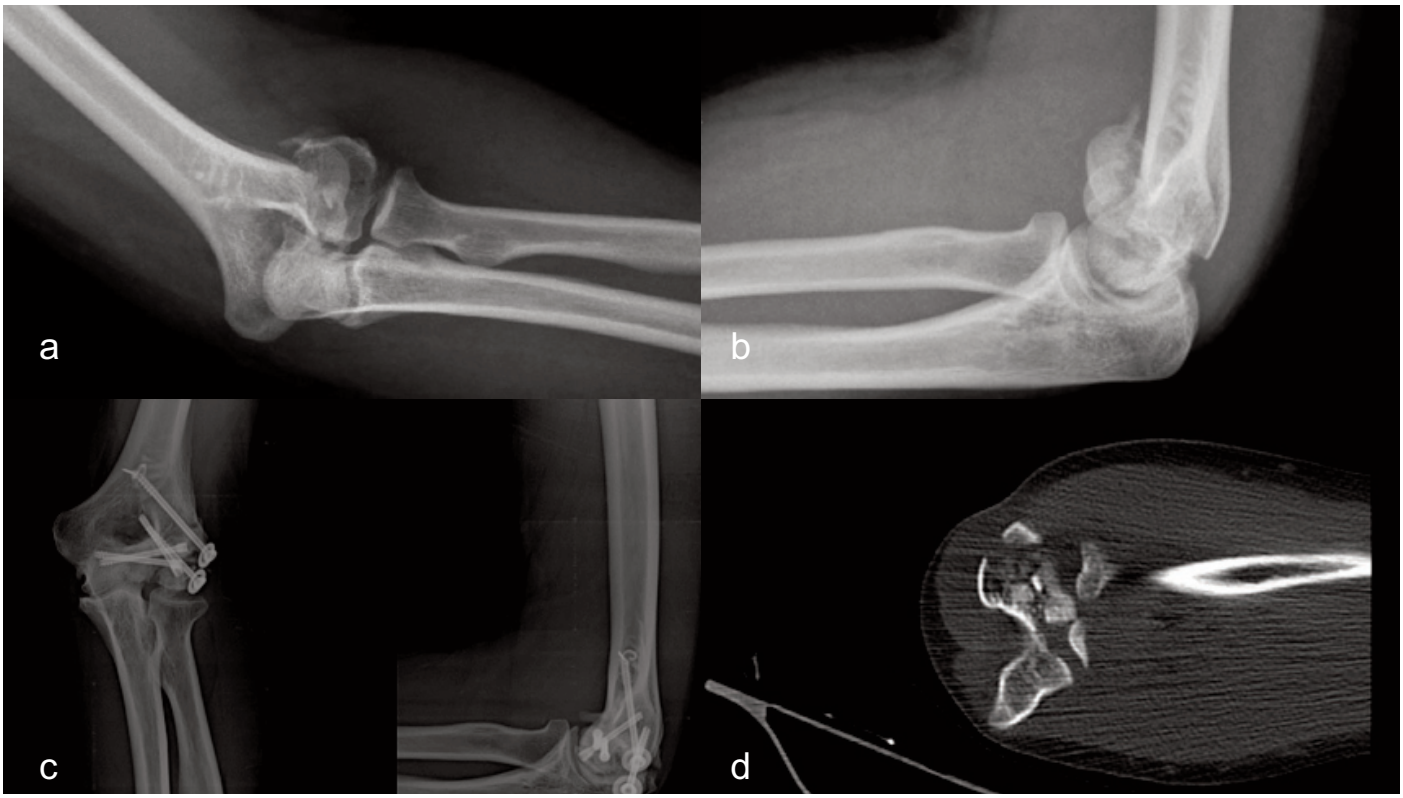

Figure 1. a) Preoperative radiography of elbow joint. b) Preoperative lateral radiography of elbow joint. c) Postoperative anterior-posterior radiography of elbow joint. d) Preoperative computerized tomography of elbow joint.

Table 1. Bryan and Morrey classification (McKee modification)

Type I	Hahn-Steinthal; large osseous fragment containing capitellum, may extend to trochlea.
Type II	Kocher-Lorenz; fracture of articular cartilage separation with very little subchondral bone attached.
Type III	Comminuted fracture.
Type IV	McKee modification; coronal separated fracture involving capitellum and trochlea.

would require removing the fixation material used in the patients. Heterotopic ossification was observed in five of the patients, and degenerative changes in five of them. None of them had avascular necrosis and nonunion. When the operated and healthy sides of the patients were compared, carrying angles were observed to have increased by 5.3˚ (1.1˚-12.0˚) on average. In the range of joint motion evaluation, flexion-extension range was measured as 131.8˚ (85˚-145˚) on average. Five patients were observed to have a rotation at non-significant levels.

No significant difference was found between heterotopic ossification and fracture types (p>0.05). Considering the degenerative changes, type III fractures were found to have a significantly higher risk than typeI fractures (p=0018) and type IV fractures (p=0.048) regarding osteoarthritis.

Discussion

Capitellar fractures usually occur as a result of falling onto the outstretched hand with the elbow at the extension. The accepted mechanism is the radial head's separation of capitellum by breaking it against proximal in the coronal plane with the force it axially transmits onto the capitellum [11].

Depending on this mechanism, formation of cubitis valgus or cubitis recurvatum in the normal elbow anatomy might make this injury more possible in the elbow [26]. It is stated that capitellar fractures occur more often in women than men because of the larger carrying angles of women [27]. However, no such relation was observed in our study.

Clinically, lateral elbow tenderness, pain, and minimal swelling are observed in capitellar fractures.

Table 2. Demographics and clinical results of the patients

Patients	Age	Gender	Side	Follow-up period (months)	Fracture type	MEPI	Flexion arc, range (angle)	Rotation arc	CAD	HO/DC
1	48	K	Left	37	Type 3	85 Good	10-145°	Full	+7.6°	-/+
2	18	E	Left	63	Type 4	100 Excellent	0-145°	25 Loss	+5.3°	-/-
3	55	E	Right	15	Type 3	85 Good	20-135	Full	+5.8°	+/+
4	77	E	Left	15	Type 1	100 Excellent	0-145°	20 Loss	+5.2°	-/-
5	17	E	Left	16	Type 1	100 Excellent	0-130°	Full	+4.8°	+/-
6	49	E	Right	21	Type 3	85 Good	10-145°	Full	+5.6°	-/+
7	28	K	Left	19	Type 2	100 Excellent	0-145°	20 Loss	+7.5°	-/-
8	27	K	Left	17	Type 3	85 Good	20-105°	20 Loss	+12°	+/+
9	24	E	Left	33	Type 1	85 Good	0-145°	25 Loss	+1.1°	+/-
10	18	E	Right	27	Type 4	100 Excellent	0-145°	Full	+2.3°	-/-
11	52	K	Left	26	Type 3	85 Good	20-145°	Full	+1.4°	+/+

MEPI=Mayo Elbow Performance Index, ROM=Range of motion CAD=Carrying angle difference, HO=Heterotopic ossification, DC=Degenerative changes, Rotation arc=Supination-Pronation arc

Diagnosis is usually made by the capitellum's semilunar displacement on the proximal found in the lateral elbow radiography. The fracture might not be noticed as the anterior-posterior radiography images may seem to be normal [28]. The importance of CT is emphasized particularly in the diagnosis of type IV capitellar fractures [29]. CT is recommended in the surgical planning of type III and type IV fractures [30]. All patients underwent CT scans together with the evaluations in the elbow anterior-posterior and lateral graphs to decrease errors in the classification of fractures and to make accurate surgical plans.

In these rare injuries, non-separated capitellar fractures may be followed up with plasters or immobilization. For separated fracture, on the other hand, closed reduction and plaster treatment are controversial as their anatomical reduction and fixation are tough [31]. However, in an 8-case study, which applied closed reduction in type I fractures, favorable results have been reported [32]. Similarly, three previous studies have produced promising results in closed reduction practices [15-17]. Those arguing the necessity of open reduction internal fixation have reported reduction loss and resulting avascular necrosis and malunion development. However, different clinical and radiological results in type I capitellar fractures given internal fixation are also controversial [7, 9, 12, 14]. The lateral Kocher approach is recommended for the surgical treatment of these fractures. Therefore, we employed the lateral Kocher approach for all our patients. Herbert screws and headless conical compression screws are claimed to be more stable as fixation materials in the literature. Their advantage over other materials is that they can be applied because of the joint and do not require removing [33-35]. In one study, maxillofacial plates were used alternatively and yielded good results [36]. Most of our cases were operated using Herbert screws and Headless Conical Compression screws. When needed, they were combined with Kirschner wires and cannulated screws.

In the treatment of capitellar fractures, joint stiffness and limitation of movement occur at individual rates. It is also possible to observe keloid formation due to surgical scar, neurologic complications, avascular necrosis, infection, osteoarthritis, heterotopic ossification, non-union, malunion, fixation material incompetence or reduction [37]. Heterotopic ossification development and the degenerative changes seen only in patients with type III fractures are complications we have observed.

Some researchers have suggested that the excision of simple fracture fragments for which fixation is not possible [4, 18, 38]. Johanson and Rosman stated that they obtained good results from a case that they applied excision [38]. However, it is reported in another study that capitellar excision may lead to valgus instability [39].

Similarly, non-fixable fragments were excised in one of our cases and a good outcome was obtained according to the Mayo Elbow performance index. However, it has been stated that although a small fragment excision yields good results in the short term, joint stiffness and instability may develop in the future [4, 40, 41]. The defect in capitellum, radial head fracture, and accompanying coronoid defect may disrupt radio-capitellar stability seriously and lead to elbow instability [42]. Research has shown that

recurrent posterolateral instability may develop in the elbow due to radial head fractures [43, 44]. We performed fragment excision in one of our cases and did not observe instability. It is possible to see radial head fracture accompanying capitellar fracture and radial head posterior impaction [45]. However, sometimes there may not be fractures in these impaction injuries, but subchondral separation and lateral ulnar collateral ligament injury might be present. Therefore, magnetic resonance imaging is important for diagnosis and posterior bone marrow edema in the images indicate avulsion of the lateral ulnar collateral ligament [45, 46]. We did not use magnetic resonance imaging in our cases and did not observe elbow instability in the post-operative follow-ups. Since isolated capitellar fractures are rare instances, the small number of patients and the lack of extended follow-up results are the limitations of the present study.

It was seen in the evaluation of our cases that degenerative changes occurred only in type III fractures and that the functional results of type III fractures were worse than the other types. Studies in the literature also support this finding [30].

It is stated that careless surgical approach, insufficient irrigation of the surgical area and passive exercise may lead to heterotopic ossification [31, 47]. It is also reported that challenging passive exercise may result in soft tissue injuries and increase the risk of heterotopic ossification [48, 49]. Despite being a strong joint, tolerance of the elbow joint to trauma is weak and joint stiffness rates are high. One of the major reasons for this joint stiffness is heterotopic ossification. There are intrinsic, extrinsic or combined reasons for this stiffness in the elbow [50]. Non-steroidal anti-inflammatory drugs and radiotherapy are used to prevent heterotopic ossification. All our patients were given non-steroidal anti-inflammatory treatment after the operation. However, non-steroidal anti-inflammatory drugs have been shown to disrupt bone recovery [51]. Experimental studies have been conducted with recently developed medicines and favorable outcomes have been obtained [21].

In one of the studies, heterotopic ossification is reported to be located in the medial collateral ligament, ulna and radius proximal and most commonly in the distal humerus anterior [24]. In our cases, it was also observed in the elbow posterior and affected joint movement significantly (Figure 2).

Figure 2. Heterotopik ossification appearance in elbow joint at the last follow-up.

In some of our cases, we found heterotopic ossification in the elbow anterior, posterior, medial, or more than one location (Figure 1c). Cases with joint movement restriction due to degenerative changes or heterotopic ossification, it was seen that degrees of the extension were affected more than those of flexion and that there was more movement restriction particularly in type III fractures than type I and type IV fractures (p=0.040).

None of our case with complete flexion-extension range had degenerative changes and one of them developed heterotopic ossification. When the patients with restriction in the extension-flexion range were evaluated, it was seen that two patients were type I, and one patient was type III. Patients with complete flexion-extension range, two patients were type IV, one patient was type II and two patients were type I.

These findings show that movement restriction is one of the most important factors affecting functional results in capitellar fractures.

The finding that movement restriction is frequent in patients with heterotopic ossification and degenerative changes in the joint is significant. While heterotopic ossification could be seen in all fracture types, degenerative changes rather occurred in type III fractures in which joint surface is damaged more.

Conclusion

Since isolated capitellar fractures are rare cases and the number of patients is too small, it becomes harder to comprehend the phenomena thoroughly. There is an obvious need for studies with more series of patients. Nevertheless, in the present study covering all fracture types, we have made significant conclusions. Degenerative changes observed in type III fractures only show that this fracture type poses the risk of osteoarthritis development. The fact that heterotopic ossification causes movement restriction affects clinical findings adversely. We recommend excision of small undetermined pieces. In addition to the need for the development of preventive and therapeutic methods of treatment, we believe that degenerative arthritis would decrease, joint range could be maintained better, and functional results will be better by avoiding challenging passive exercise and suggesting active use instead.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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