Fractures of capitellum: a review of 14 cases treated by open reduction and internal fixation with Herbert screws

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Abstract Fourteen patients with displaced fractures of the humeral capitellum were treated by open reduction and internal fixation of the capitellar fragments with Herbert screws. As per Bryan and Morrey classification, there were seven type I fractures, one type II fracture, three type III fractures, and three non-unions. Patient outcomes were evaluated using the Mayo elbow performance score. The follow-up period ranged from three to seven years (mean 4.8 years). All patients had a stable, pain-free elbow with good range of motion at follow-up. There was no evidence of avascular necrosis or degenerative change.

Introduction

Fractures of the humeral capitellum are rare and account for 1% of elbow fractures [1, 2]. Injuries to the capitellum are usually a result of axial loading of the capitellum by forces transmitted through the radial head, the lateral trochlear ridge and the lateral half of the trochlea [3, 4]. As the complex nature of capitellar fractures has become better appreciated, treatment options have evolved from closed reduction, immobilisation and fragment excision to a preference for open reduction and internal fixation with Kirschner wires (K-wires), cannulated cancellous screws and Herbert screws [5, 6]. The Herbert screw offers distinct

advantages over other modes of fixation. It provides excellent compression at the fracture site and stable fixation with the least damage to articular surfaces. Moreover, early mobilisation can be started and the hardware need not be removed later [7].

We report a retrospective study of 14 cases of capitellum fractures treated by Herbert screw fixation over a period of five years with a mean follow-up of 4.8 years (range 3–7 years).

Material and methods

Fourteen patients between the ages of 16 and 46 years (mean 33 years) with capitellar fractures were treated by open reduction and Herbert screw fixation between May 2001 and July 2006. Three patients presented to us after six months of conservative treatment and 11 within nine days of injury. All underwent open reduction of the displaced capitellum. Eight patients had fracture after falling on an outstretched hand, three fell on a flexed elbow, and the mechanism of injury was unclear in the remaining patients. None of the patients had any concomitant injury. Fractures were classified on anteroposterior and lateral radiographs according to the classification of Bryan and Morrey [8]. A careful preoperative plan was executed in each case with regards to reduction and implant fixation. Computed tomography (CT) was done in cases with comminuted fracture to define the fracture better and to aid in preoperative planning.

Surgical technique

All cases were operated upon under regional anaesthesia. The injured elbow was assessed clinically for ligamentous

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stability. A sterile tourniquet was used in all cases. The elbow was handled through an extensile lateral approach. A skin incision was centred over the lateral epicondyle extending from the anterior aspect of the lateral column of the distal end of the humerus to approximately 2 cm distal to the radial head. Following dissection through the subcutaneous tissue layers, the lateral column was palpated. The forearm was pronated to move the radial nerve away from the surgical field. A flap was raised by elevating the common extensor origin along with the anterior capsule and connected to the Kocher interval distally. This resulted in a continuous full-thickness anterior soft tissue flap. The fracture site was debrided of haematoma and soft-tissue debris to allow visualisation of the fracture fragments. Saline irrigation was used to achieve greater clarity.

In patients with a lateral epicondylar fracture fragment, the epicondylar fragment with the lateral collateral ligamentous complex origin was reflected distally to enhance exposure. Fracture fragments were reduced and provisionally fixed with K-wires. The terminally threaded Herbert screws, directed posterior to anterior were used to fix the fracture. The distal thread was buried beneath the articular surface. With an exception of very small fragments, we used two screws to fix the fracture. In cases of non-union, augmentation with bone graft from the ipsilateral olecranon was done. Supplemental fixation with mini-fragment screws or Kirschner wires was used to reconstruct more complex fracture patterns with lateral metaphyseal comminution and/or trochlear extension. The radial wrist extensors were repaired to the soft-tissue cuff on the lateral supracondylar ridge, and the Kocher interval was closed in continuity with the proximal exposure of the lateral column. The remainder of the wound was closed in layers.

Postoperatively, the elbow was immobilised in a splint for four to six days following which range of motion exercises were initiated under supervision. Patients were followed up at regular intervals and clinico-radiological evaluation was done. The condition of bone union, evidence of avascular necrosis on radiographs, wound healing problems or other complications, if any, were recorded. Stability, pain, and range of motion of the elbow joint were evaluated according to the Mayo elbow performance score.

Results

Nine patients were males and five were females. The right side was involved in eight cases and the left side in six cases. The dominant limb was involved in ten and the non-dominant in four cases. Of the fresh fractures, seven fractures were classified as type I, one as type II and three as type IV. All three non-unions were type I fractures. The mean operative time was 1.30 hours (range 1–1.50 hours).

Peroperatively, in two cases, capitellum fragments were found free and devoid of soft tissue attachments. These were replaced, fixed and showed good union in due course. No intraoperative or postoperative complication was encountered. The mean extension of the elbow was 7.5° (range 0°–20°) and the mean flexion was 132° (range 128°–135°). All patients had full pronation and supination. All patients had good stability, and none had residual pain. Overall, ten results were found to be excellent and four good.

Follow-up period ranged from four to seven years (mean 4.8 years). All patients were satisfied with the operative outcome and returned to their previous levels of activity. All fractures healed well. No evidence of avascular necrosis of the fragments was noted and no incidence of osteoarthritis has been noticed so far.

Illustrative case reports

Case 1

A 25-year-old man sustained an injury to his left (dominant) elbow when he fell on the flexed elbow while getting out of a vehicle. Radiographs and CT with three-dimensional images showed a fracture of the capitellum that was displaced anteriorly and superiorly including a trochlear fragment and comminuted fracture of the lateral condyle (Fig. 1a, b). Peroperatively, the fragment had no soft tissue attachments (Fig. 1c). The fragment was reduced and fixation was secured with two Herbert screws directed posteroanteriorly (Fig. 1d). The fracture united very well and range of motion of the elbow at five-year follow-up was from 10° to 135°. There was no evidence of avascular necrosis or degenerative changes (Fig. 1d) and the result was evaluated as excellent.

Case 2

A 40-year-old female presented six months after sustaining a type 1 fracture capitellum of her left (nondominant) elbow (Fig. 2a). The injury was the result of a fall from a standing height. She was treated in a splint for 12 weeks by a bone setter. The capitellum fracture fragment was ununited, and the patient had pain and restricted motion of elbow. After elbow capsulectomy, debridement of the nonunion site and removal of articular adhesions, fixation was achieved with one screw and the screw thread buried beneath the articular surface (Fig. 2b). The fracture was augmented with cancellous bone graft. Active-assisted elbow exercises were started on the first postoperative day. Functional use of the limb for light tasks was encouraged. Resistive exercises were delayed until the fracture healed radiologically. The patient eventually progressed to have range of motion from 18°–110°. Forearm rotation was not restricted.

Fig. 1 Preoperative X-ray (a) and 3D computed tomogram (b) showing type IV fracture of the capitellum in a 25-year-old man. c Free capitellotrochlear fragment devoid of any soft tissue attachment. d Three-year follow-up radiograph showing good union and reconstructed joint space

Discussion

Patients with capitellar fractures usually present with pain and swelling of the elbow after injury. Fractures of the capitellum are frequently missed on first examination [7]. They are not obvious on anteroposterior radiographs because the fracture line may not be recognised against the background of the distal humerus. They are best seen on a true lateral view [7]. In type IV injuries on lateral view, a double-arc sign representing the subchondral arc of bone of the capitellum and the lateral trochlear ridge is considered pathognomonic [4]. We did not find double arc signs in any of the three patients of capitellum and trochlear fracture with comminuted lateral condyle fracture. This sign may not be radiographically apparent in all type IV fractures

because of the presence of an internally rotated capitellum and trochlea fragment [6, 9]. Radiographs must be carefully assessed for the presence of medial trochlear extension, metaphyseal comminution, and associated radial head and/or neck pathology. Exact morphology of the capitellar fracture is often difficult to ascertain from preoperative plain radiographs alone [4, 6, 10, 11]. CT scan with sagittal and coronal plane reconstructions is recommended to define the medial extent of the fracture, articular impaction, and metaphyseal and condylar comminution [12]. CT also aids in preoperative planning with regard to the choice of internal fixation implants. Concomitant lateral and/or medial collateral ligament disruptions or their osseous functional equivalents must be recognised and repaired in order to restore elbow stability.

Fig. 2 a Preoperative X-ray of six-month-old type I capitellum fracture in a 40-year-old female. b Two-year follow-up X-ray showing union and well-maintained joint space after reduction and fixation with the Herbert screw

An untreated displaced capitellar fragment undergoes changes resulting from bony absorption to bony proliferation and obliterates the radial fossa [7]. Eventually arthritic degeneration of the elbow joint ensues limiting range of motion [13, 14]. A variety of methods of treating capitellum fractures have been described. These include closed reduction, excision, and open reduction with or without internal fixation. Closed reduction of type I capitellar fractures has been reported in a few series [14, 15]. Disadvantages of this treatment are the long period of immobilisation and unsatisfactory functional results [4, 16]. Excision of the capitellar fragment [13, 17] is a simple procedure but after resection of the capitellar fragment, the remaining raw bone surface predisposes the elbow to capsular adhesions and results in restricted elbow mobility, instability, valgus deformity of the elbow and risk of subsequent ulnar neuritis [7].

Open reduction and internal fixation is a suitable method for maintaining joint congruity while allowing for early mobilisation. Kirschner wires and AO compression screws have been used with varying degrees of success. Kirschner wires do not offer compression at the fracture site and require subsequent removal [7]. Fixation with compression screws irritates the cartilage of the radial head, as the metal head protrudes from the articular surface. Cannulated screws introduced posteriorly through the humerus into the capitellum avoid this problem [9]. However, if the osteochondral fragment is small the screw may split it.

Accurate reduction and stable fixation of the fracture and early postoperative mobilisation has been reported to provide good results [3, 7, 18, 19]. Herbert screws allow rigid fixation at the fracture site, provide fracture site compression through variable thread pitch design and need not be removed later. These screws can be used both in anteroposterior and posteroanterior directions [3, 7, 18–20]. In all of our patients Herbert screws were used from posterior to anterior. In addition, miniscrews were used and buried in articular cartilage in cases of comminution.

Avascular necrosis is uncommon after open reduction and internal fixation of these fractures [4, 8]. The reported incidence of avascular necrosis is 0–30% [7]. No patient in our series had avascular necrosis. Mehdian et al. recommended that encountering a free capitellar fragment should not discourage the use of internal fixation [21]. In our series, we encountered two cases of type IV pattern injury in which there was no soft tissue attachment. The fragments were replaced and fixed. Both the patients have functional elbows with sound radiological union and no signs of avascular necrosis. McKee et al. reported one patient of post-traumatic osteoarthritis in his series of six patients [4]. In a large series, Lansinger et al. found no case of osteoarthritis of the elbow [22]. We also did not find osteoarthritis in any of our patients and believe that if

reduction is anatomical with minimal damage to articular cartilage, post-traumatic osteoarthritis should not occur.

Traditionally, in delayed diagnoses or old fractures, excision of the fragment is recommended because of the risk of osteonecrosis [13, 23]. Three fractures in our series were more than six months old and had been treated conservatively before presenting to us. They were treated by open reduction and internal fixation with augmentation bone graft. All eventually showed good union and functional results. Careful dissection and gentle handling of fragments help to achieve better congruity in such cases. It has been reported that articular cartilage can heal after anatomical reduction and stable internal fixation and joint mobilisation [24]. None of these patients have shown any signs of osteonecrosis despite the fact that there was little or no soft tissue attachment or substantial bony support to revascularise the fragments. Literature suggests that if osteonecrosis does not occur within one year, it is unlikely to occur [25].

We recommend open reduction and internal fixation with Herbert screws for the treatment of capitellar fractures, because this procedure leads to minimal articular damage and rigid fixation, as well as early mobilisation. Encountering a free capitellar fragment and non-union should not discourage the use of internal fixation as avascular necrosis is less likely to occur with good fixation and early mobilisation.

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