

Treatment of Coronal Shear Fractures of Distal Humerus that includes Capitellum and Whole of the Trochlea

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Abstract:

Background: This fracture is rare. This paper presents the diagnosis and treatment of coronal shear fractures of distal articular surface that includes capitellum and whole of the trochlea.

Material and methods: Four cases were treated from 2012 to 2014 for type IV capitellar fractures involving whole of the anterior distal humeral articular surface involving capitellum and trochlea in one piece. There were three females and one male, all adult with average age 30 years. No patient underwent CT scan. Under tourniquet, using extended lateral approach, open reduction and internal fixation was done using 4mm partially threaded cannulated cancellous screws under vision from posterior to anterior direction from the posterior aspect of lateral condyle of humerus and one screw from small poster-medial approach avoiding articular penetration except in one patient, Herbert screws were used. All were due to fall on outstretched hand. There were two right and two left side involvement.

Results: Results were evaluated using Grantham scale. All the fractures united uneventfully. At the end of one year follow-up, all had excellent elbow function with no signs of AVN or arthritis.

Conclusion: Double arc sign on lateral X-rays of the elbow is important for diagnosis and analysis of type IV capitellum fracture. Fixation with cannulated cancellous screws or Herbert screws using extended Kocher's lateral approach and small posteromedial approach has given good results. CT would have been helpful in exact pre-operative evaluation

Keywords: Capitellum & trochlea fracture, type 4 capitellum fracture, coronal shear fractures, cancellous screw

Introduction

Capitellum fractures are uncommon, only 3-4% of all distal humerus fractures [1,2]. Often the fractures are more complex with extension into trochlea, posterior comminution, and involvement of lateral epicondyle. These are more common in females, may be because of more carrying angle. These are rare in children [3,4]. 20% of these have an associated radial head fracture.

These fractures occur because of shear force following fall on outstretched hand or directly on the elbow. The capitellar center of rotation is 1-1.5 cm anterior to humeral shaft, rendering it vulnerable to fracture by shear force.

Treatment modalities vary in form of closed reduction and immobilization [5,6]. Fragment excision [6,7], to open reduction and fixation with K wires, and 4mm partially threaded screws or Herbert screws [8,9]. As open reduction and internal fixation maintains articular congruity, it helps in early mobilization, preventing stiffness of elbow and subsequent degenerative arthritis [10,11].

This fracture is in common in children and is difficult to diagnose due to un-ossified center before 8-9 yrs of age [12]. Extension of fracture into trochlea is described as type IV. The fragment is usually without any attachments and if not treated properly results in malunion interfering with flexion of elbow. Of these fractures involving wall of the anterior half of lower end of humerus including capitellum and trochlea (Coronal shear fractures) [10,11] form a separate entity. The fragment has to be anatomically stabilized to prevent articular incongruity and late onset arthritis [13]. A different strategy of surgical treatment is necessary for fixation of this fracture. Aim of this paper is to describe a different approach to fixation of these fractures and report the results at one year follow up.

Material and methods

Four cases were treated from 2012 to 2014 for type IV capitellar fracture involving whole of the anterior distal humeral articular surface involving capitellum and trochlea in one piece, as marked with red colour in bone model; Fig 1 (A,B,C,D,E). All were adults (23, 28, 33, 36yr), one males and three females. All were due to fall on outstretched hand. There were two right and two left side involvement.

Diagnosis: A lateral X-ray showed double arc sign. A double arc sign was the finding in lateral x-ray of all four patients. Three patients had proximal displacement of fragment with subluxation of elbow. All patients were diagnosed on day one. No patient underwent CT scan for economical reasons.

Surgical Procedure: All patients were operated under

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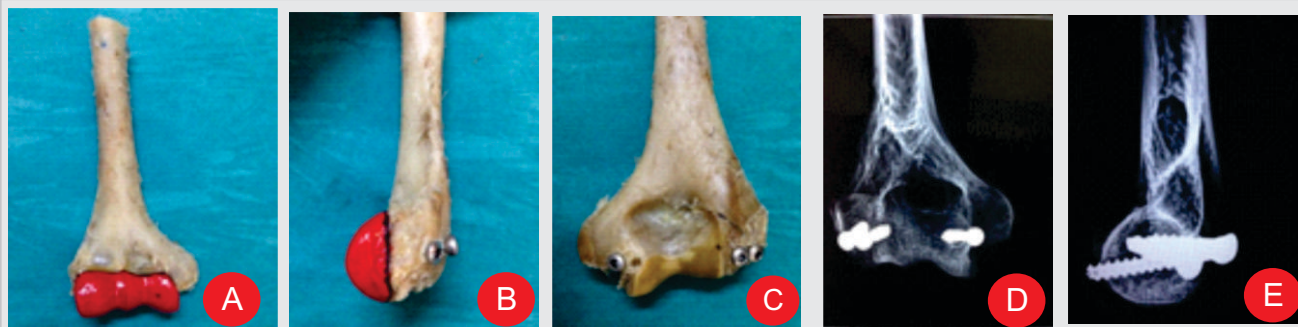


Figure 1: A- 32 Year male patient presented with swelling over right wrist. B, C- Magnetic resonance imaging (MRI) of right wrist with forearm showed soft tissue mass contiguous with flexor digitorum superficialis, extending from volar to dorsal aspect, probably a ganglion cyst or giant cell tumour of tendon sheath

Kocher's approach. The extensor origin was elevated subperiosteally including extensor carpi radialis longus. The origin of lateral ligamentous complex from lateral epicondyle was not disturbed. The exposure was extended distally between anconeus and extensor carpi ulnaris. Keeping the forearm pronated the extensor carpi ulnaris is elevated anteriorly. This allowed the surgeon to reflect the soft tissues to keep the bone levers over the medial column. The extensive exposure aided in keeping a bone lever over medial aspect of distal humerus, thus helping in visualization of entire articular surface of distal humerus to visualize the fracture; (Fig 2A).

The fracture was reduced by visualising anterior articular surface and held reduced with smooth K wires and/or with help of retractor and artery forceps (Fig 2B).

Definitive stabilisation was done with two 4.0 mm cannulated cancellous screws over guide wire from posterior to anterior direction from posterior aspect of lateral condyle (Fig 2C). Since articular surface was visible completely, penetration by screw threads was avoided under vision. For fixation of medial flange of trochlea, an additional small posterior-medial incision was taken behind medial epicondyle (Fig 2D) and ulnar nerve was retracted medially and guide wire is passed through groove between medial flange of trochlea and medial epicondyle from posterior to anterior and one partially threaded 4.0 mm cancellous screw was passed from posterior to anterior, keeping anterior exit of guide wire under vision through lateral incision to avoid thread penetration into joint surface (Fig 3).

In one patient, Herbert screws were used from posterior to

screws (Fig 4). The joint was irrigated and small fragments and grit was removed. Wound was sutured in layers over suction drain. Pressure bandage was given.

A plaster of paris slab was given in all cases with elbow at 90 degrees of flexion and forearm in neutral rotation. The patients were mobilized out of posterior slab after three weeks. Range of motion exercises were started under supervision of physiotherapist from three weeks and gradually increased to six weeks (Fig 5). Radiological follow up was done at six weeks, three months, six months and one year.

At one year follow up the elbows were tested for range of movements and instability and radiological assessment for avascular necrosis, arthritis, heterotrophic ossification.

Assessment was done by Grantham elbow assessment method based on stability, pain and range of movements, which is easy to follow [14]. Excellent - normal stability, no pain and full range of movements, good - less than 10° of instability, mild pain and less than 40° restriction in range of movements, fair 10-15° of instability, moderate pain or 40-60° of loss in range of motion, poor - 15° or greater instability, troublesome pain, or 60° or more of loss in range of motion.

Observations and results

All four fractures united well. At final follow up all patients had full flexion. However two patients had fixed flexion deformity of 10 degrees at the end of one year. None of the patients had instability. None of the patients had avascular necrosis, arthritis, heterotrophic ossification at the end of one year. None of the four patients developed ulnar

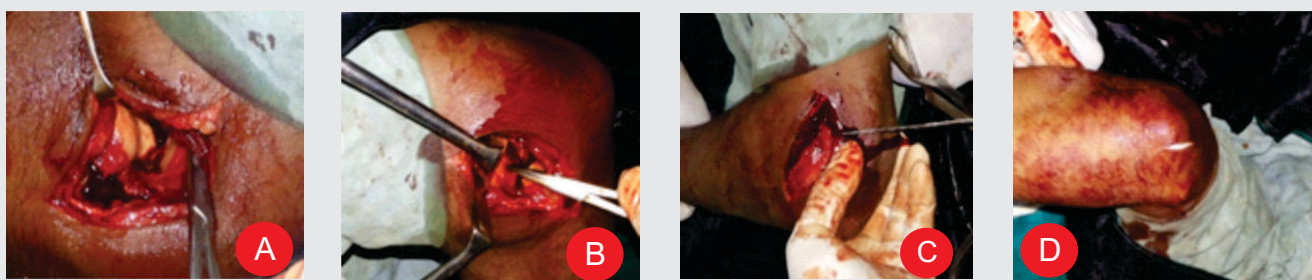


Figure 2 A-Lateral exposure showing the fracture. B - Lateral exposure showing reduced Capitellar Fragment and held with artery forceps and retractor. C- Guide wire for Cannulated cancellous Screw from posterior to anterior. D- Medial incision for passing medial cannulated cancellous screw from posterior to anterior.

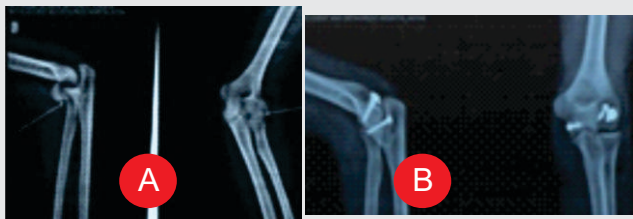


Figure 3: A-Pre-op x-ray and B-post-op x-rays showing fixation of the fracture with 4mm cannulated cancellous screws



Figure 4: A-Pre-op x-ray and B-post-op x-rays showing fixation of the fracture with Herbert screws.



Figure 5: Six week clinical follow up showing flexion of elbow

neuritis.

Discussion

Fractures of the capitellum are rare injuries [1,4]. Reportedly, fracture is more common in females with male to female ratio 1:3 [11], three out of four cases in present series were females. 20% of capitular fractures have an associated radial head fracture [15].

In present series mechanism of injury is usually fall on outstretched hand imparting a shearing force on Capitellum. Maximum force transmission through the radial head to the Capitellum occurs at zero to thirty degrees of elbow flexion [15].

Proper visualization of capitular fragment is sometimes not possible in routine radiographic views of the elbow and a radial head capitellum view may help in better delineation of fracture personality [16]. As per Fowls and Kassab, properly positioned lateral view is necessary for diagnosis with the fracture easily missed if the view is slightly oblique [7]. A capitellum fracture is often missed in emergency setting as the outline of the lower end of humerus is intact. In present series, three patients had subluxation so, the diagnosis was obvious. Only one patient had undisplaced fracture which was diagnosed on day one, no fracture was missed at first encounter.

A comparative view of opposite elbow or CT scan will help in diagnosis. A CT scan delineates the fracture more clearly [12] and helps the surgeon to plan the approach since, if the fragment is displaced medially, another medial approach may be needed for reduction. No patient in present series underwent x-ray of opposite elbow or CT scan. Author feels that high index of clinical suspicion is necessary to come to correct diagnosis. A properly taken lateral x ray will show anterior and superior displacement of fragment which gives rise to characteristic 'double arc' sign. The sub-chondral bone of trochlea creates a double arc and if present, it signifies that part of trochlea is also involved [10]. In present series this sign was present in all four cases.

Extension into medial flange of trochlea was an intraoperative finding. However preoperative CT scan can give this information so that preoperative planning for a

medial screw can be done. No patient underwent CT scan in present series. However, author has planned for CT scan with 3-D reconstruction in further cases.

Radiological diagnosis is difficult in a child as capitellum is not fully ossified before age of 9-10 years [4]. In these cases an oblique radiograph or an arthrogram may be done. All cases in present series are adult, so this problem was not relevant.

Some authors advocated conservative treatment or excision of fragment [1]. Ochner reported, in 1996, successful outcome of closed reduction of closed fractures in nine cases with long term follow up [5]. In none of cases of present series closed reduction was attempted. Closed reduction of fracture can lead to early arthritis, loss of motion, or instability of elbow because of nonanatomical reduction [11].

Excision of fragment can lead to instability of elbow. Excision to prevent avascular necrosis is suggested by few authors [12]. Fragment excision due to fear of avascular necrosis or redisplacement can lead to radiohumeral osteoarthritis or instability of elbow. Alvarez² advocated excision in 10 of 14 cases. In present series, none of the patients developed avascular necrosis, osteoarthritis or instability of elbow. Author feels that fear of these complications should not obviate the surgeon from anatomically reducing this fracture and rigidly fixing it.

Approaches described include lateral approach (modified Kocher approach) 9,12. Posterior approach with olecranon osteotomy⁹ by Sano for proper visualization of trochlea. He feels this approach is useful if fixation of trochlea is also needed. In present series only lateral approach was used with medial retraction with a lever on medial column visualized whole of anterior aspect including trochlea very well.

Fixation of the fractures involving whole of the trochlea could be very well done through lateral approach and a small posteromedial approach to retract ulnar nerve was advocated by author which led to good fixation.

Screws inserted from posterior to anterior (PA) direction have more biomechanical stability than anteroposterior screws and this prevents damage to articular cartilage¹⁹. Moreover, purchase of screws is more in PA directed screws, and splintering of the subchondral bone due to countersinking is less¹⁹. In present series all screws were

passed from posterior to anterior. Lateral ligament has to be preserved during the procedure. 20. In present series this care was taken in all four patients and none developed varus instability.

Various fixation methods have been described, including K wires¹, 4 mm cancellous screws¹², Herbert screws^{10,12}, absorbable polyglycide pins²¹, plate fixation²⁰, Kirschner wires do not provide enough stability for fracture healing and also damage the articular cartilage¹. The better functional outcome of operative fixation is documented. 22 Headless screws have problems if patients develop AVN or chondrolysis, because erosion of radial head is a possibility due to exposed implants¹. This problem is obviated by 4 mm cancellous screws which can be easily removed through stab incisions. Reports of avascular necrosis of capitellum are very rare^{23,24}. In present series none of the patients developed avascular necrosis. In all patients (except one fixed with Herbert screws) 4mm cannulated cancellous screws were used which had advantage of drilling, tapping and screw passing over guide wire. These had additional advantage of compression at fracture site as the screw is tightened once the threads cross the fracture. This advantage was not there for patient treated with Herbert screws.

All patients in present series had excellent results as per Grantham elbow assessment method¹⁴.

Articular damage is thought to be the reason for residual extensor lag in spite of anatomical reduction and early

mobilization.¹ In present series two patients had restricted extension.

Author feels, an additional medial screw had fixed the medial flange of trochlea along with two lateral screws gives good fixation. Though this is new concept, and the number of cases is small, also the level of evidence is Level V, author feels that this can be used routinely as it gave good intraoperative stability and good postoperative results. The flaw was, it was not decided preoperatively. Author has planned for compulsory preoperative CT scan in further part of study so that preoperative planning for this fracture would be possible.

Conclusion

Type IV capitellar fractures are less due to rarity of injury. The importance of noting "double arc sign" on x ray preoperatively and importance high index of clinical suspicion is well emphasized. The incorporation of CT scan as important investigation in future part of study is also emphasized. The importance of involvement of whole of trochlea and an additional medial screw fixation technique is described. The results of fixation with cannulated 4 mm cancellous screws through extended lateral Kocher's approach and additional posteromedial approach are good.

The report is presented though there is no long term follow up to document post traumatic arthritis.

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