

Reconstruction of the coronoid process with iliac crest bone graft in complex fracture-dislocation of elbow

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Abstract A 36-year-old man sustained posterior dislocation of left elbow joint with olecranon fracture, comminuted coronoid fracture and subluxation of proximal radioulnar joint. We reconstructed the coronoid process with autogenous iliac crest bone graft and reduced the olecranon fracture with internal fixation. In addition, we also repaired the medial collateral ligament, annular ligament and anterior capsule during the operation. He received immobilization of the left elbow for 3 weeks after surgery and started range of motion exercises. The radiographic bone union was found 2 months after operation. The range of motion of the elbow was full at 12 months after operation. The latest 2-year follow-up, the functional result of the elbow was excellent.

Introduction

Coronoid process of ulna plays an important role in the bony stability of ulnohumeral articulation, especially in flexion-extension arc. At the extremes of ulnohumeral movement, the coronoid process may lock into its corresponding fossa and add additional stability from contraction of muscle and ligamentous structures [13].

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Fracture of the coronoid process is an uncommon injury in the fracture-dislocation of elbow. It has been described in association with 2–10% of dislocations of the elbow [12]. The treatments of comminuted coronoid fracture with concomitant complex fracture-dislocation of the elbow were seldom reported.

In this paper, we presented our experience of complex fracture-dislocation of the elbow with concomitant comminuted coronoid fracture in one patient. We used iliac crest to reconstruct the comminuted coronoid process and also emphasized the important of the anterior capsule and ligamentous structures in providing the stability of the elbow.

Case report

A 36-year-old man injured his left elbow when he sustained a motor vehicle accident. He was transferred to our emergency department immediately. Deformity and moderate swelling of the left elbow were found at that time. The distal neurovascular supply was intact. An attempt at closed reduction of his deformed elbow was unsuccessful, and the patient was treated with a long-arm splint. Roentgenograms revealed a large intra-articular and displaced fracture of the coronoid process, a transverse fracture of the olecranon with concomitant complex dislocation of the left elbow joint (Fig. 1). A re-attempt at closed reduction was unsuccessful.

In view of the elbow condition, we performed an immediate surgical intervention. The patient was placed in supine position with the injured elbow on a hand table under general anesthesia. We firstly used medial incision and carefully dissected periosteum of



Fig. 1 Plain films of left elbow revealed fractures of the olecranon, comminuted fracture of the coronoid process, dislocation of proximal radioulnar joint, and posterolateral dislocation of the elbow

the upper third of the ulna to approach its anterior aspect and olecranon. We performed open reduction and internal fixation for fractured olecranon with tension band wires. Then we reduced the ulnohumeral joint and used one temporary Kirschner's pin fixation to hold it at the 90° flexion of the elbow. The comminuted coronoid process fragment was 2.5 cm in length and displaced proximally. The brachialis tendon was found attached to the coronoid process fragment. Due to the coronoid process, was so comminuted that it was unable to be reduced and fixed well. We reconstructed the coronoid process with autogenous iliac bone graft; 2 cm in length, 1 cm in width and 1 cm in height; which was harvested from the patient's left iliac crest. This structural bone graft was fixed at the original coronoid process with one 2.5 mm cancellous screw and washer. Then we performed pull-out suture with two non-absorbable sutures beside the bone graft to reattach the torn anterior capsule and brachialis tendon to the anterior aspect of proximal ulna. We also repaired the disrupted medial collateral ligament and closed the medial incision of the elbow with retention of an aspiratory drainage.

We used Kocher incision and found acute tear of annular ligament and dislocation of the proximal radioulnar joint. We firstly reduced the proximal radioulnar joint and fixed it with one 2.0 mm Kirschner's pin at neutral position of the patient's forearm (Fig. 2). Then we repaired the torn annular ligament with absorbable sutures. The wound was closed and an aspiratory drainage was left. Ultimately, the temporary Kirschner's pin for ulnohumeral joint was removed. The

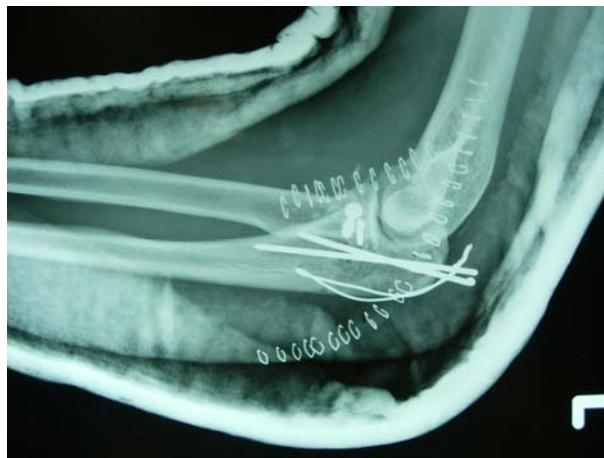


Fig. 2 Initial postoperative lateral view of left elbow showed the iliac crest bone graft was fixed to the original coronoid process with cancellous screw

elbow was immobilized for 3 weeks at 90° of flexion by a long arm posterior splint. Then he started passive and active range of motion exercises.

Radiologic union of the "reconstructed" bone graft and olecranon were found 2 months after operation. We removed the Kirschner's pin for holding proximal radioulnar joint and the stable elbow was found at the same time. The patient returned to his job at 3 months after the injury. The range of motion of the left elbow was 5°/130° in flexion-extension arc. The tension band wiring for the olecranon was removed at 12 months after injury. The 1-year postoperative radiographs showed no evidence of post-traumatic arthritis or myositis ossificans. (Fig. 3) The range of motion of the left elbow at this time was 0°/140° in flexion-extension arc (Fig. 4a, b) and the forearm was full in supination-pronation (Fig. 4c, d). According to the mayo elbow performance index, the functional result was "excellent" (100 points). He was able to work full-time in his previous occupation.

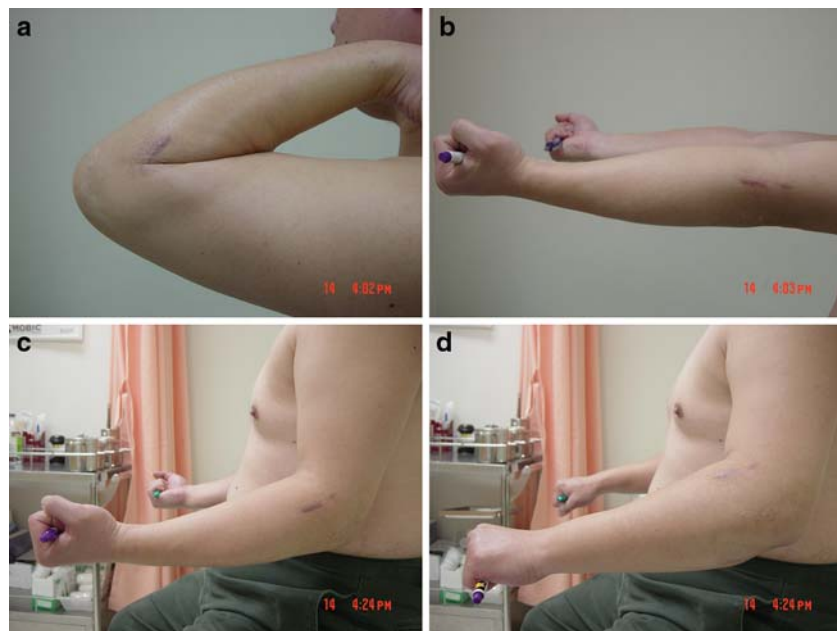
Discussion

Fracture-dislocation of the elbow with comminuted coronoid fracture and olecranon fracture is a troublesome injury. Comminuted fractures of the coronoid process reflected severe trauma to the elbow. The coronoid process plays an important role in the stability of elbow; including congruency of the elbow joint, acts as anterior bony buttress and provides attachment for anterior bundle of the medial collateral ligament and the middle third of the anterior portion of the capsule [1, 20, 21]. Displacement of a large fragment of the

Fig. 3 Radiographs of left elbow at 12-month follow-up showed good alignment and bony union of the elbow. There were no evidences of arthritis or heterotrophic ossificans



Fig. 4 **a, b** At the 12 month follow-up, range of motion of the left elbow was 0°/140° in flexion-extension arc. **c, d** At the 12 month follow-up, range of motion of the forearm was full in supination-pronation arc



coronoid has been associated with recurrent dislocation of elbow.

Fractures of the coronoid combined with olecranon fracture and elbow dislocation had usually poor result without operative fixation [14, 19, 20]. In the 1970, DePalma mentioned that these dislocations could be manually reduced and immobilized in as much flexion as possible. But the results of non-aggressive methods are poor [3]. In the 1989, the non-operative treatment of coronoid fractures reported by Regan and Morrey

has been drastically reconsidered in recent years [14] because the ulnohumeral joint would sublux posteriorly as the elbow is flexed past 60° without reconstruction of the large coronoid process [20, 22]. At present the treatments of coronoid fractures are based on the classification of Regan and Morrey [14]. They classified coronoid fractures based on the size of the fragment as type 1, avulsion fracture; type 2, more than a fleck and less than 50% of the height of the coronoid; and type 3, between 50 and 100% of the height of the coronoid.

Type I fractures do not affect elbow stability and can be treated conservatively [1]. Type II fractures, which are associated with instability, can also be treated conservatively. Cobb and Morrey have designated type IIB fractures associated with initial instability [2]. Type IIB and type III coronoid fractures require surgical management to regain the stability of elbow [1, 4, 14, 23].

Regan and Morrey reported that the result of treatments of type III coronoid fractures had a poor result (80%) secondary to stiffness, pain, and recurrent elbow instability [14]. The mean range of motion was 39°–100°. Two of the four patients with plaster immobilization also complained of instability. Regan and McKee MD therefore recommended that repair or reconstruction of a type III coronoid fracture reduces the risk of both valgus and posterior instability [7, 14].

There were different literatures to demonstrate various techniques to treat fracture-dislocation of the elbow with coronoid fracture. When the coronoid process is too comminuted to allow reconstruction, alternatives should be considered. The use of iliac crest as a bone graft to reconstruct the coronoid was described [4–6, 10]. Using the tip of olecranon as a bone graft was reported [11, 17]. But in cases of both olecranon and coronoid fractures, it was not advised to use olecranon tip for a graft. The radial head fragment use as a graft in cases of concomitant radial head fracture was recommended [4, 15]. Structural allograft bone is another alternative for a deficient coronoid process and a persistent unstable elbow, but the outcome is unpredictable [24]. Cobb and Morrey recommended distraction arthroplasty for persistent instability due to large unstable fractures of the coronoid process [2]. The mean arc of flexion before surgery was 33°; after surgery, the arc increased to 88°.

In view of the elbow condition, we chose the use of an autogenous iliac crest bone graft to reconstruct our patient's coronoid process. Ultimately, he had a full range of motion of the elbow at 1 year.

Morrey BF indicated that anterior capsule played a very important role in providing stability to the elbow joint. Anterior capsule, a secondary stabilizer, provides approximately 55% of the stabilizing contribution to valgus stress at 90° of flexion, 13% to varus stress at 90° of flexion, 30% to valgus stress in full extension, 32% to varus stress in full extension and 85% to resist the distraction in full extension [13]. In addition, medial collateral ligament accounts for 78% of the resistance to distraction in full extension. Lateral collateral ligament complex (LCLC) is defined as the lateral collateral ligament and annular ligament. The LCLC was found to be a primary stabilizer to pathologic external forearm rotation (PEFR). So repair or reconstruction

of the anterior capsule and ligamentous structure are very important in providing the stability to the elbow joint. Terada et al. also reported that the repair of the anterior capsule could reduce joint instability [23]. In our case, we used pull-out suture technique with non-absorbable sutures to reconstruct torn anterior capsule of the elbow. We thought that it was helpful to stabilize the elbow joint. Using anchor sutures to repair anterior capsule may be another alternative.

There were some reports about posterior, lateral, and medial approaches to the coronoid in the English literatures [8, 17, 21]. Fractures of the tip of coronoid process could be treated through a lateral exposure, whereas fractures involving the medial facet may be approached through a medial exposure [16]. We used separate medial and lateral incisions sequentially in the patient. The election of surgical incision depended on the concomitant injuries.

Prolonged immobilization following an acute episode of elbow instability was associated with poor results [14]. This patient received postoperative immobilization for 3 weeks. He started passive and active range of motion exercises 3 weeks after injury. We thought early range of motion exercises of the injured elbow with proper internal stabilization could regain early range of motion. Longer duration of immobilization would cause elbow stiffness and it is not necessary.

In summary, we thought that reconstruction of the coronoid process in the presence of unstable complex fracture-dislocation of the elbow is possible by use of an autogenous iliac crest graft and would produce the stable joint. We also emphasized that it was important to reconstruct the anterior capsule and ligamentous structures for providing the stability to the elbow joint. And the stability gains early, the range of motion of elbow gains early.

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