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Treatment of Delayed Humeral Intercondylar Fracture Associated with Severe Bone Defects by Iliac Bone Autografting Reconstruction

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Abstract

Objective: We report a case of delayed humeral intercondylar fracture associated with severe bone defects treated with iliac bone autografting reconstruction.

Methods: A 3-months deleyed case of humeral intercondylar fracture associated with severe bone defects and stiffness was treated by arthrolysis, olecranon osteotomy, internal fixation with parallel plates and iliac bone autografting reconstruction.

Results: 4 months later, the patient recovered with full range of motion and bone healing. There was no bone fragment displacement, implant loosening, or internal fixation breakage.

Conclusions: For delayed distal humeral intercondylar fracture with severe bone defects, we can successfully treat by arthrolysis, internal fixation with parallel plate, and iliac bone autografting reconstruction. Iliac crest bonegrafting is a good method to reconstruct the bone loss.

Keywords: Fracture; Humerus; Delayed; Arthrolysis; Bone defect; Reconstruction; Internal fixation

Introduction

Distal humeral intercondylar fractures are usually treated by open reduction and rigid internal fixation as early as possible to reach a better function [1]. However, In China, for some open cases with severe bone defects, many surgeons will only debride and close the wounds, and fix the elbow by cast to prevent infection after internal fixations. So these cases will be deleyed when they were transferred to the trauma centres several months later. Bone nonunion and defects may deleteriously affect elbow function and make further reparative treatment difficult. For the elder patients, we can choose total elbow replacement. But for the younger and active patients, we have to reconstruct the distal humeral part by autografting and internal fixation.

Materials and Methods

Patient

A 26 year-old male patient suffered an open distal humeral fracture with severe bone loss 3 months ago, no radial nerve injury and other associated injuries. He was treated only by debridement and close the wound, fixed by cast in the local hospital. 3 months later, when the wound was healed, and the CRP and ESR are normal, he was transferred to our hospital, Beijing Jishuitan Hospital.

The patient was overweight (over 130 Kg) (Figure 1). Preoperative anteroposterior and lateral X-ray radiographs (Figure 2) and 3D-CT (Figure 3) revealed severe bone defects at the supracondylar part and comminuted articular surface. According to Association for

Figure 1: The patient was overweight (over 130 Kg).

Figure 2: Preoperative anteroposterior and lateral X-ray radiographs revealed severe bone defects at the supracondylar part and comminuted articular surface.

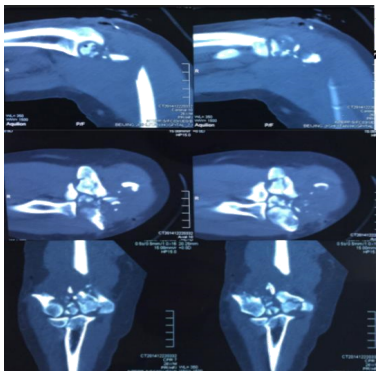

Figure 3: Preoperative 3D-CT showed severe comminuted articular surface.

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Osteosynthesis/ Association for the Study of Internal Fixation (AO/ ASIF) criteria the humeral condylar fracture was type C3. All these caused a stiff elbow, pseudarthrosis at the fracture site and make further reparative treatment difficult.

Surgery

After induction of general anesthesia, a straight incision was made along the midline of the posterior aspect of the elbow medially curved at the olecranon tip. The ulnar nerve was dissected carefully and protected by a rubber strip, and then a V-shaped osteotomy was made in the proximal olecranon, and the proximal bone fragments and triceps muscle were turned upward to expose the distal part of the humerus.

Then we removed all the scar tissue, fibrous tissue, and anterior and posterior capsules to release the elbow. Inactive dead bones and redundant callus were debrided until fresh bone was evident, and the bone callus were kept for grafting. The trochlea groove area was comminuted, free bone fragments and adhesive fibrous tissue were removed from the articular cavity, and the original articular cartilage was protected, the medullary canal was opened by 3.5 mm drilling bit.

After the fracture site was cleared, a cylindrical iliac crest fragment about 5 mm width was inserted into the trochlear groove defect to reconstruct the distal part width, with the cortical bone directed towards the articular cavity and 2 mm proximal to the cartilage (Figure 4). The trochlear articular surface of the distal humerus was aligned with the olecranon articular surface for reduction. Then we fixed the distal part by K-wires (Kirschner wires) temporarily including the small fragments. After reduction of the articular surface, the intracondylar fracture was converted to a supracondylar fracture. Next, reduction of the humeral shaft and condyles was carried out. Supracondylar bone defects were about 3 cm at the medial column and 5 cm at the lateral column. So the supracondylar fracture site was 2 cm shortened. Then, 2 pieces of bone harvested from the iliac crest were trimmed according to the size and shape of bone defects to reconstruct the medial and lateral columns which were fixed by K-wires temporarily. Cortical bone was directed outward and cancellous bone inward and between the fragments. The total bone loss were estimated by measuring humeral length.

Then internal fixation of the humeral shaft and condyles was performed using parallelled anatomic locking plates to optimize anatomic reconstruction and compressive fixation between the bone fragments. Several K-wires were leaved to fix the tiny articular fragments. After internal fixation, the elbow joint was flexed and extended to reach the full range of motion (Figure 5). The left iliac bone and callus were cut into several strip-shaped bone chips, and implanted around the supracondylar fracture site. Finally, the olecranon osteotomy was reduced and fixed by tension band wires. Ulnar nerve was fixed by soft tissue sling to prevent directly contact with the hardware. Musculature and deep fascia were sutured carefully to cover the bone grafts and internal fixators. The donor site was closed by direct suture. During and after the surgery, standard anteroposterior and lateral radiographs of the elbow joint were obtained to evaluate the reconstruction and fixation (Figure 6).

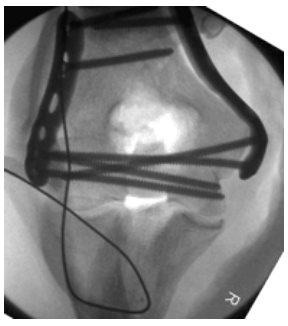

Figure 4: The diagram show a iliac fragment was inserted into the trochlear groove defect to reconstruct the distal part width, with the cortex 2mm proximal to the cartilage.

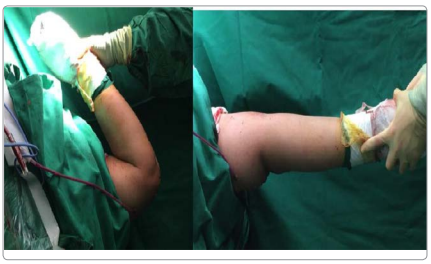

Figure 5: The intra-operative pictures show the extension-flexion function.

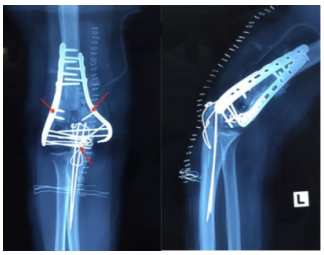

Figure 6: Postoperative AP and Lateral View after parallel plating fixation, the three arrows are the three iliac fragments to reconstruct the articular part and both columns. The K-wires were leaved to fix the tiny articular fragments.

Figure 7: 4 months later follow-up show full range of motion, with excellent extension-flexion and pronation-supination motion.

Postoperative management

Drainage was maintained for 24 hours after surgery. Flexion and extension exercises of the hand and wrist, and isometric contraction of the biceps and forearm muscles, and active and progressive elbow flexion and extension exercises were initiated on the second day after surgery.

Follow-up and Results

The patient was follow-up and standard anteroposterior and lateral radiographs of the elbow joint were obtained every 4 weeks after the surgery to monitor bone healing and elbow function.

4 months later, the patient recovered with full range of motion and bone healing, 130° elbow flexion and 0°extension, 90°supination

and pronation each, final follow-up MEPS score was 100, excellent (Figure 7). Anteroposterior and lateral radiographs show the presence of continuous callus bone passing through the fracture line. There were no bone fragment displacement, no implant loosening or internal fixation breakage, no abnormal movement. No other complications, such as delayed ulnar neuritis, olecranon nonunion, or donor site pain, occurred.

Discussion

The delayed distal humeral fractures with severe bone loss were very difficult to deal with. We successfully treated this young and active patient by arthrolysis, internal fixation with parallel plate, and iliac bone autografting reconstruction, in combination with early postoperative functional exercise. But there are still a lot of controversies in the treatment of these cases.

Approach

Numerous approaches for the distal humeral fractures have been described.

These all employ a posterior skin incision with various strategies of working through or around the triceps muscle, include the paratricipital (Alonso-Llames) [2], triceps-reflecting (Bryan-Morrey) [3], Triceps-Reflecting Anconeus Pedicle (TRAP) [4], triceps-splitting [5], and olecranon osteotomy techniques [6]. But for the delayed cases with a comminuted articular surface, adequate surgical exposure is critical for anatomic reduction of the articular surface as well as successful internal fixation. So we think the best exposure is through a chevron-shaped olecranon osteotomy which will be fixed by tension band wiring.

Fixation

There are two popular techniques for internal fixation of distal humeral fractures which are parallel-plating [7] and classic AO orthogonal plating technique. Our prefer for such complex case is the parallel-plating internal fixation. Biomechanical studies [8] have shown the superiority of the parallel-plate technique, especially when bone contact is compromised.

Structural iliac bone autograft

Several approaches [9,10] are used to deal with bone nonunion and bone defects including vascularized fibular grafting, autologous iliac bone grafting, allografting. Autogenous iliac bone contains both cancellous and cortical bone surfaces. During surgery, iliac bone can be cut and shaped to fill a bone defect. We suggest that use of iliac grafts can facilitate optimal anatomic reconstruction of bone in the humeral condyle and columns. Comminution of the central aspect of the distal humeral articular surface require structural bone-grafting which does not reach the joint surface to prevent excessive joint-space narrowing, incongruence, and arthritis.

Metaphyseal shortening

Bone loss at the supracondylar level may be addressed successfully with a moderate bone shortening. Humeral shortening of up to 2 cm has minimal impact on elbow biomechanics [11], and union is more likely with bone contact in compression. But the olecranon and coronoid fossa should be recreated.

Ulnar nerve

Controversy [12] remains regarding the ideal management of the ulnar nerve. We favor subcutaneous transposition to prevent contact with the medial plate.

Early postoperative exercise

We believe that this was an important factor to improve ROM function after rigid fixation, because postoperative exercise can prevent intra-articular adhesion and muscle adhesion around the joint, stiffness of the elbow joint, osteoporosis, muscle atrophy, and joint fibrosis. Our case is limited by short-time follow-up, but usually the patient's function will not deteriorate after 4 months exercise. So we believe the delayed distal humeral intercondylar fracture with severe bone defects can be successfully treated by arthrolysis, internal fixation with parallel plate, and iliac bone autografting reconstruction. Iliac crest bonegrafting is a good method to reconstruct the bone loss.

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