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Treatment of comminuted olecranon fractures with olecranon plate and structural iliac crest graft

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Severely comminuted olecranon fractures are challenging injuries. Commonly used tension band wiring exerts excessive compressive forces causing olecranon shortening, joint incongruity and humeral trochlea subluxation.

We report a retrospective study of 3 patients who underwent surgery for a severely comminuted olecranon fracture, with open reduction and fixation with a bridging rigid locking plate and intercalary tricortical structural iliac bone graft. Joint stability was restored allowing early mobilization and good functional outcome. Patients' mean age was 54 years. Mean follow-up was 23 months (range 19 to 27). Mean time to fusion was 14 weeks (range 11 to 18).

Results were excellent/good in all three patients according the Broberg and Morrey scoring system, and Mayo Elbow Performance Index. Mean range of flexion was 115°, with an average loss of 20° of extension. Average pronation was 71°, and supination 80°.

Keywords : fracture ; comminuted ; olecranon ; intercalary bone graft ; iliac crest ; tricortical ; plate and screws ; locking plate.

INTRODUCTION

Olecranon fractures are common due to its superficial anatomical location (*14*). Lister in 1873 was first to report internal fixation to treat these injuries with a silver needle (*6*). Highly comminuted fractures have poorer functional outcomes (*10,21*), and there is no clear consensus on their management (*3*). Cast immobilization, resection of the olecranon, open reduction and internal fixation with various devices, as well as closed reduction and external fixation have been advocated (*5*).

Non operative treatment and resection techniques of the olecranon are known to cause loss of range of motion and weakness. Tension band wiring causes fracture collapse, articular incongruity and early posttraumatic arthritis. Open reduction and internal fixation requires the use of a bridging plate.

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Table I. — Epidemiological data

Case	Follow-up (months)	Sex	Age	Side	Cause	Mayo Classif.	Open Fracture	Comminuted proximal olecranon remnant	Coronoid fracture	Associated lesions
1	27	F	68	L	Casual fall	II-b	No	No	Yes	Fx radial head
2	24	M	52	L	Casual fall	II-b	No	Yes	No	None
3	19	M	42	L	Motorcycle accident	III-b	Yes	Yes	Yes	None

R : Right ; L : Left ; M : Male ; F : Female.

Disadvantages of this procedure are the extent of the necessary soft tissue dissection and the prominence of the implant which frequently requires removal after bone healing (*7,10,22,24*).

Structural intercalary bone grafts can be used to reconstruct segmental bony defects (*11*). We report 3 cases of olecranon fractures with gross comminution and bone loss which were treated with an intercalary tricortical iliac crest autograft and an olecranon locking plate.

Surgical technique

We retrospectively reviewed the three cases of grossly comminuted olecranon fractures that underwent open reduction, internal fixation with locking olecranon plate and segmental iliac crest bone grafting. Two fractures (Patients 1 & 2) were displaced, stable, comminuted II-b type fractures according to the classification of the Mayo Clinic (*14*) ; the third fracture (Patient 3) was an open (Gustilo grade II), unstable, comminuted, displaced III-b type fracture (Table I). The injury was on the non dominant left side in all cases. Patient's mean age was 54 years. Mean follow-up was 23 months (Fig. 1).

The cause of the fracture was a fall from one's own height in 2 cases, and a motorcycle accident in the third case. Two patients had a comminuted proximal olecranon remnant (Patients 2 & 3). One patient had an associated Mason type I radial head fracture and a comminuted and sagittal fracture of the coronoid process (Patient 1) ; another patient had a fracture involving the coronoid (type III) as the major fragment (Patient 3). No fracture was associated with vascular or nerve injury.

Fig. 1. — Comminuted, displaced, unstable, olecranon fracture. Preoperative radiograph.

For the definitive surgical treatment, patients were placed in the supine position under general anaesthesia, with the shoulder and elbow both flexed to 90° and the antecubital fossa lying over a T-bar support. We used the Bryant-Morrey dorsal approach (*14*) under tourniquet ischaemia. The unreconstructable comminuted bone fragments were excised and the olecranon was restored to its original length with an autologous tricortical bone graft block harvested from the iliac crest. The graft was shaped and fitted under compression in the olecranon defect with the cortex facing towards the articular surface and the cancellous side facing dorsal. The trochlea of the humerus was left to articulate with the central portion of the interposition iliac crest graft (Fig. 2a-c). The graft could be buried into

Fig. 2. — Drawing of the technique described : Open reduction and reconstruction of the olecranon. An autogenous structural bone graft from the iliac crest fills the bone defect and restores the original length. Final fixation with an olecranon plate with locking screws.

the proximal ulna to improve stability of the construct. Securing the narrower interposition graft in the right position was a technically demanding procedure. Two provisional parallel 1.6 mm Kirschner wires were carefully inserted from the tip of the olecranon, through the bone graft and into the shaft of the ulna. An olecranon locking plate with locking screws (Acumed®, Hillsboro, Oregon, USA) was then used to bridge the fracture. Associated coronoid fractures were secured with lag screw or wire cerclage. Distraction of the shortened olecranon by the interposition graft facilitated subsequent reduction of the coronoid process.

Patients were evaluated according to the clinical and functional criteria of the Broberg and Morrey (*2*) scoring system and the Mayo Elbow Performance Index (*1*). The Broberg and Morrey scoring system is a 100-point system, which summarizes data from four sections : motion (40 points), strength (20 points), stability (5 points) and pain (35 points). The outcome is excellent with a score of 95-100 points ; good with 80-94 points ; fair with 60-79 points and poor when the score is ≤ 60 points. The Mayo Elbow Performance Index considers pain (45 points), ulnohumeral motion (20 points), stability (10 points) and the ability to perform five functional tasks (25 points). The total score ranges from 5 to 100 points, with higher scores indicating better function. Total scores between 90 and 100 points are considered excellent ; good between 75 and 89 points ; fair between 60 and 74 points and poor when less than 60 points.

Data collection also included preoperative, postoperative and follow-up radiographic evaluation, the presence of associated injuries, the presence of post-operative complications, and a questionnaire on satisfaction with treatment received.

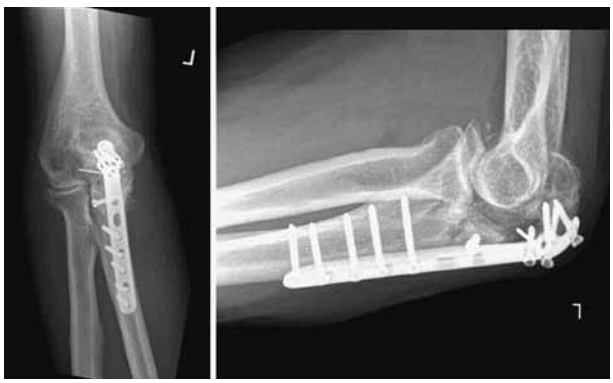

Fig. 3. — Final follow-up radiograph

RESULTS

Radiographic evaluation showed satisfactory reduction of the fracture in all three patients. Follow-up radiographs were taken at 4-week intervals. We did not observe degenerative radiographic changes at final follow up (Fig. 3). The mean range of flexion was 115°, with an average loss of 20° of extension. The mean pronation was 71° and the mean supination 80°. Based on the clinical and functional criteria of Broberg and Morrey, the result was excellent/good in all patients. The degree of satisfaction according to the Mayo Elbow Performance Index Score was good/excellent in all

Table II. — Results

Case	Pain	Flexion	Extension	Pronation	Supination	Complic.	Reoperation
1	None	120º	-15º	70º	80º	No	No
2	None	130º	-15º	75º	85º	No	No
3	Occasional discomfort	95º	-30º	68º	75º	No	No

three patients. None of the patients reported continuous pain, instability or difficulties with activities of daily living. Only one patient (Patient 3) complained of occasional mild discomfort without subjective loss of strength. No complications or later re-interventions were required (Table II).

DISCUSSION

Comminuted olecranon fractures are challenging injuries . Experimental studies (*15,19*) have shown that the major determinant of elbow stability is the congruence of the ulnar-humeral articulation, emphasizing the importance of restoring the dimensions of the ulnar trochlear notch and a correct alignment of the radio-capitellar joint (*9,23*). It is well known that incongruity of articulating surfaces is an important factor in the development of post-traumatic osteoarthritis (*24*). However, in cases of severe comminution, anatomic reduction is an ideal that may not always be clinically attainable.

In the elderly, comminuted olecranon fractures have been historically treated by excision of the comminuted fragments followed by triceps advancement and reattachment (*14*). Resection of a significant part of the olecranon compromises elbow stability. Triceps advancement leads to increased contact stress within the joint (*15*) and should be avoided in the active, working population. It is contraindicated in the presence of coronoid process fracture, unstable olecranon fractures (Mayo Clinic classification type-III), or in case of serious damage to the anterior soft tissues (*11,16,24*).

Tension band wiring is the most common operative technique for the treatment of displaced and minimally comminuted olecranon fractures (*3,4,7*). In the presence of severe comminution with bone loss, tension band wiring shortens the distance between the coronoid process and the tip of the olecranon, causing collapse of the articular surface and early posttraumatic arthritis (*11,14*).

The AO-ASIF Foundation (*17*) recommends a careful reconstruction of the articular surface and the use of bolted plates to secure the reduction of severely comminuted and complex fractures. Furthermore, active early motion provided by this type of rigid fixation is essential for successful treatment (*7,11*). Hume and Wiss (*10*) reported better results with posterior plate fixation than with tension band wiring of displaced intra-articular olecranon fractures.

Ikeda *et al* (*11*) have published their experience of 10 patients with comminuted olecranon fractures treated with cerclage wire and autologous bone graft from the iliac crest. Their results compare favourably with others reported in the literature, demonstrating the use of bone grafting as an effective alternative for articular surface reconstruction of the severely comminuted olecranon fractures. Furthermore in the presence of a comminuted olecranon tip, the ability to achieve a solid fixation between the ulnar shaft, the interposition graft, and the olecranon remnant may be compromised using tension band wiring. Under these circumstances we advocate the use of an olecranon locking plate. Anatomical olecranon locking plates facilitate fracture reduction, and are able to act as a tension-band in the presence of a structural intercalary bone graft even with limited fixation to the proximal fragment (*7*). Our technique allows for the interposition graft to be partially buried inside the proximal ulnar metaphysis, adding further stability.

The use of a heavy suture to secure the distal triceps tendon to the fixation plate has been reported recently. This technique reduces the pull of the extensor mechanism and can be effective when

secure fixation of the olecranon tip is not achievable (*12*).

To conclude, in patients with severely comminuted olecranon fractures, osteosynthesis with a structural intercalary graft and olecranon locking plate can achieve secure fixation and allow early range of motion exercises with good short term functional outcome.

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