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Corrective osteotomy and in situ fusion for late-presenting nonunion of lateral condyle fractures of the humerus in adults

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Background: Late presentation of lateral condylar fractures of the humerus is not an uncommon problem in children, and to lesser extent, in adults. The various surgical interventions for repairing the fracture, correcting the deformity, or even performing anterior transposition of the ulnar nerve as a single procedure or in combination, especially in adults, is still a controversial topic, with a paucity of literature regarding this. There is a risk of loss of the available preoperative range of motion, nonunion, and avascular necrosis.
Methods: In 19 patients with late presentation of lateral humeral condyle fracture, we assessed the results of only corrective osteotomy and internal fixation with lateral incision without anterior transposition of the ulnar nerve with regard to deformity correction, union, and functional results using the Mayo Elbow Performance Score with at least 24 months of follow-up. All patients (14 men, 5 women; average age, 29.1 years) had Milch type 2, 18 patients presented with cubitus valgus deformity, 1 presented with cubitus varus deformity, and 8 patients had tardy ulnar nerve symptoms.
Results: Late-presenting lateral condylar fractures could be managed surgically with our procedure alone even if they have a tardy ulnar neuritis, with excellent results in 17 patients and good results in 2 patients.
Conclusion: In situ fusion, deformity correction, and internal fixation is a valuable method for the management of late-presenting lateral condylar fractures in adults.
Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Lateral condyle humerus; nonunion; surgical management; fixation; adults; fracture

Lateral condylar fracture in children is quite common and, unfortunately, is an injury that can be frequently missed.[2] Neglected fracture of the lateral condyle in children is known to lead to functional loss of elbow range of motion because it is considered an intra-articular fracture. By contrast, the functional range of motion is almost maintained in adults, which creates a difficulty in deciding whether to operate or not, owing to the fear of complications.[3]

Cubitus valgus deformity is often present in late-presenting lateral condylar fractures, while uncommonly, some patients may develop a cubitus varus.[12] Patients with cubitus valgus, especially manual workers who are used to repeatedly flexing and extending their elbows, commonly present with tardy ulnar symptoms.[4]

There is a consensus in the literature about the unreliable results of surgical intervention of these late-presenting fractures after skeletal maturity, with a long list of complications that include cubitus varus and valgus deformities,

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osteonecrosis, nonunion and malunion, heterotrophic ossification, and loss of motion.[3,4,7,12,16]

Our study presents the results of operative management of 19 lateral condyle fractures of the humerus in adults who presented after more than 15 years of the initial trauma.

Materials and methods

This prospective case series included 19 patients (14 men, 5 women) aged 19 to 41 years. Of these, 12 patients presented after failed conservative management in other hospitals of a more recent trivial traumatic event in the form of a posterior above-elbow slab for more than 12 weeks. The traumatic events as described by the patients were mostly injuries occurring during sports participation or an inexpedient fall caused by slipping on the ground.

There were 16 left elbow fractures and 3 right elbow fractures, mean age of injury was 4.37 years, and mean age of presentation was 29.1 years, with a mean delay of 24.73 years. All fractures showed the same radiologic picture of nonunion of the lateral condyle with fish tail deformity of the lower humerus, which represents a Milch type 2 fracture configuration. A cubitus valgus deformity was present in 18 of the 19 patients, and 1 presented with cubitus varus (Fig. 1). Pain, deformity, apprehension, and ulnar nerve palsy manifestations were the main complaints of the patients' neglected lateral condylar fractures (Table I).

Patients presented with associated ulnar nerve symptoms in the form of elbow discomfort medially along with tingling and numbness along the medial one and half fingers with no motor symptoms. The electrodiagnostic study results were positive in these patients, with delayed sensory nerve latency greater than 4 msec.

Surgical technique

In situ fixation after refreshing of the fracture site was planned for all patients. A formal written and informed consent was taken before surgery. All patients were placed supine and operated on under general anesthesia, and a tourniquet was used. A lateral approach to the elbow was used in all cases.

The fragment was often mildly displaced, the articular surface was adapted to the radial head (congruent), and abundant fibrous tissue was present between the fracture fragments (Fig. 2). The fibrous nonunion was excised, and refreshing of the fracture site as well as thorough irrigation to remove the fibrinous debris was performed.

Careful anterior dissection of the fracture was made, and posterior attachments were saved to avoid violating the posterior blood supply and to minimize the risk of avascular necrosis. The lateral condylar fragment was reduced under direct visualization, often with the aid of a reduction clamp. We used 1.6-mm-diameter Kirschner wires for temporary fixation until the application of plate and screws.

A supracondylar varus extension osteotomy was performed in 18 patients with cubitus valgus deformity, and a supracondylar valgus

Figure 1 Ununited lateral condylar fractures with fishtail deformities with **(A)** fish tail appearance in xray, **(B)** cubitus varus deformity (notice arrested medial physis), (**C**) non united lateral condyle, and (**D**) cubitus varus deformity.

Table I Patient demographics

Patient	Sex	Age at presentation (yr)	Age at injury (yr)	Side	Dominance	Presenting symptoms
1	M	20	5	L	R	Pain, deformity, apprehension
2	M	31	5	L	R	Pain, deformity.
3	F	22	4	L	L	Pain, deformity, ulnar nerve dysfunction
4	M	24	3	R	R	Pain, deformity, ulnar nerve dysfunction
5	M	37	5	L	R	Apprehension, deformity
6	F	38	3	L	R	Pain, deformity
7	M	22	6	L	R	Pain, deformity
8	M	39	4	L	R	Pain, deformity
9	M	41	6	L	R	Pain, deformity
10	M	24	5	L	R	Pain, deformity
11	F	19	3	L	L	Pain, deformity, ulnar nerve dysfunction
12	M	24	3	R	R	Pain, deformity, ulnar nerve dysfunction
13	M	30	4	L	L	Pain, deformity, ulnar nerve dysfunction
14	F	32	4	L	R	Deformity
15	M	37	3	L	R	Pain, deformity
16	M	26	4	L	R	Pain, deformity
17	M	25	4	R	R	Pain, deformity, ulnar nerve dysfunction
18	M	33	7	L	R	Pain, deformity
19	F	29	5	L	R	Pain, deformity

M, male; *L*, left; *R*, right; *F*, female.

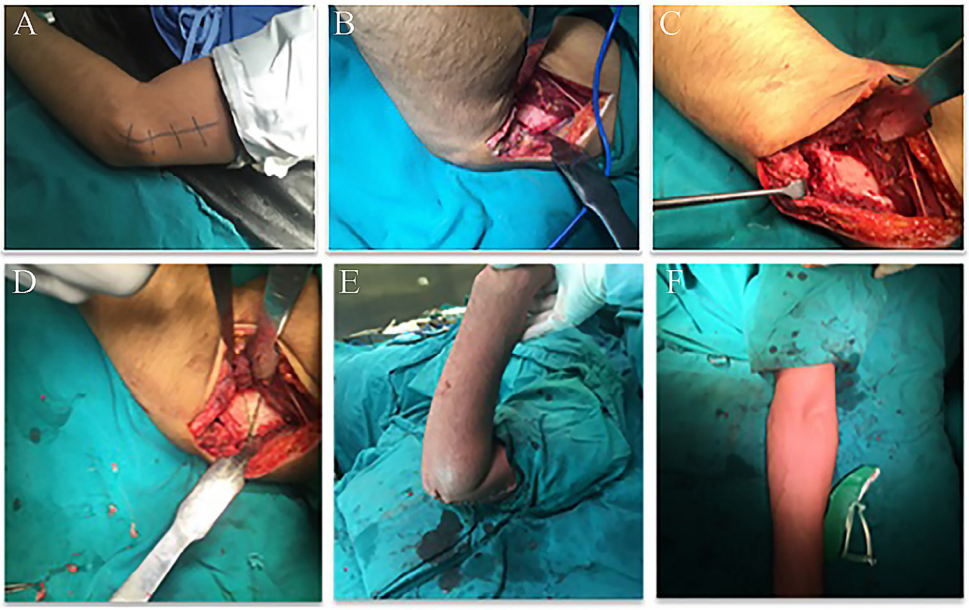

Figure 2 Operative details: **(A)** incision site, **(B)** fibrous nonunion at the fracture site, **(C)** débridement and refreshing of the fracture site, **(D)** planned supracondylar varus extension osteotomy, (**E**) nearly full flexion, and (**F**) full extension after application of plate and screws.

extension osteotomy was performed in 1 patient with cubitus varus deformity. The bone removed from the closing wedge was used as a graft for any defects left between the bony fragments.

An 8-hole locked angular stable reconstruction plate was applied to the lateral column in all patients to repair the lateral condylar fragment and the supracondylar osteotomy without any incisions, fixation, or manipulations medially, thereby decreasing the operative time, hardware used, manipulation to the ulnar nerve, and risk of postoperative heterotrophic ossification, even in patients with tardy ulnar nerve.

Immediately postoperatively, all patients underwent a common protocol of full range of motion exercises in a hinged elbow brace as tolerated to reach a full range at 6 weeks. At 1 year, the final assessment was done on the basis of the Mayo Elbow Performance Score (Table II).[16] Anteroposterior and lateral radiographs of the elbow were used to assess malunion, nonunion, avascular necrosis, and

Table II Evaluation of treatment outcomes in humeral lateral condyle injuries with the Mayo Elbow Performance Score

Mayo Elbow Performance Score	Points
Pain (45 points)	
None	45
Mild	30
Moderate	15
Severe	0
Motion (20 points)	
Arc to 100°	20
Arc 50°-100°	10
Arc 2°	0
Stability (20 points)	
Stable	20
Moderate instability	10
Gross instability	0
Daily function (25 points)	
Combing hair	5
Feeding oneself	5
Hygiene	5
Put on shoes	5
Put on shirt	5
Maximum possible score	100

heterotrophic ossification. Postoperative follow-up was maintained for 3 years. Union was said to have occurred when the fracture site was obliterated by the trabeculae or the callus; clinically, it was by the disappearance of pain and tenderness at the fractures site.

Results

The 19 patients included in the study had fractures that were classified as type 2 according to the Milch classification and were a result of trauma that had occurred between 3 and 6 years previously. The fractures in 8 patients were missed after a general practitioner consultation, 7 had been treated conservatively, and 4 had not consulted anyone and had tried home remedies. The mean carrying angle in the fractured elbow was 29° (standard deviation [SD], 6.7°) in all cubitus valgus cases and 15° of varus in 1 patient.

The flexion–extension range of motion had significantly improved postoperatively; mean range of flexion was 99° (SD, 7.59°) preoperatively and 125° (SD, 9.06°) postoperatively, and mean extension lag was 35° (SD, 4.6)° preoperatively and 7° (SD, 3.75°) postoperatively, with significant improvement in extension lag ($P < .001$) and in flexion ($P < .001$; Fig. 3).

Union occurred in all 19 patients within 6 to 13 weeks, with an average of 8 weeks, except for 1 case of delayed union of the osteotomy site that took 5 months.

According to the Mayo Elbow Performance Score, the functional results were excellent in 18 fractures, and very good in 1 fracture, with a significant improvement from a mean of 47.36 preoperatively to a mean of 97.3 postoperatively ($P < .001$).

Carrying angle improved from an average of 29° of valgus in 18 patients and 15° of varus in 1 patient to an average of 7° postoperatively.

Ulnar nerve symptoms were much improved 3 to 6 months after surgery according to the patient questionnaire and clinical examination. Further electrodiagnostic studies were considered of no value.

Statistical analysis was constrained by the small size of the sample because we were unable to access enough patients with this specific condition.

Discussion

Acute fractures of the lateral condyle of the humerus are not uncommon in daily orthopedic practice. Although early surgical treatment of the displaced fracture is generally agreed upon, surgical treatment of delayed fractures, especially in adults, is debatable. Neglected untreated fractures are difficult to manage due to disfigurement of the condylar fragment, incongruent articular surface, and possible avascular necrosis.

Lagrange and Rigault[10] stated that the vascular supply to the lateral condyle enters by its soft tissue attachments, particularly posteriorly at the common origin of the long extensors, and disruption of this will harm its blood supply, leaving the condyle ischemic.

The surgical technique used should not be hostile to or disturb the condylar vascularization, and to control the intra-articular reduction, it may be necessary to dissect some parts of the capsule and the synovia.[6,13] There is a general agreement that surgical intervention in old, established nonunions should be avoided because osteosynthesis may reduce the range of motion of the elbow or the bone may not unite. Hence, operative treatment for such patients has not been popular.[9,15]

Many scientific research papers have discussed the results of treatment of lateral condylar fractures in children, but few discuss late-presenting lateral condylar fractures in adults; further, even those that are available discuss in situ fusion with wedge osteotomy alone and not added extension osteotomy, as in our study.[1,7,8,11,14]

In a study by Gong et al[5] in 2017, 11 adults with nonunion fracture of the lateral condyle were treated by medial closing wedge osteotomy and fixation with ulnar nerve transposition. They reported 1 superficial infection and 1 radial nerve temporary neuropraxia. Pain, ulnar neuritis, and functional outcomes (modified An and Morrey, mean 7.1 point improvement) improved significantly. However, the combined range of motion decreased by a mean of 11.4°.[5]

All of the patients in our study reported for treatment more than 15 years after the initial injury. As expected, all of these patients had a good functional range of motion at presentation, especially in flexion, but most desired an increase in range in extension of the elbow to meet their job requirements. In all patients with cubitus valgus deformity, we therefore performed a supracondylar varus extension osteotomy to the side; however, a valgus extension osteotomy was performed in 1 patient with cubitus varus deformity.

Figure 3 (**A**) Preoperative X-ray; (**B**) Post-operative X-ray; (**C**) pre-operative deformity; (**D**) pre-operative extension range; (**E**) pre-operative flexion ROM; and (**F,G**) post-operative ROM.

Our study supports the hypothesis that lateral condylar fractures with a delayed presentation in adulthood, despite being more difficult to repair than fresh fractures and presenting the challenge of retaining a good functional range of motion in the elbow, can still be managed operatively with excellent-to-good results.

Limitations to our study include the small sample size, which can be attributed to the relative rarity of this condition.

Conclusion

Open reduction and internal fixation with corrective osteotomy for ununited lateral condyle fracture in adults is a challenging but effective treatment method with good-to-excellent outcome.

Disclaimer

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