

Original Research Article

Functional and radiological outcomes of plate osteosynthesis for comminuted olecranon fractures: a prospective observational study of 30 patients

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ABSTRACT

Background: Comminuted olecranon fractures disrupt the greater sigmoid notch and are subjected to the deforming pull of the triceps brachii. Tension band wiring does not reliably maintain length or articular alignment when the dorsal cortex is fragmented. This study was performed to determine the functional recovery and radiological union achieved when such fractures are stabilised with plate osteosynthesis, and to define the tempo at which that recovery occurs.

Methods: Thirty skeletally mature patients with comminuted olecranon fractures treated by open reduction and internal fixation with dorsal plating at a tertiary care teaching hospital were enrolled in a prospective observational study over 18 months. Gustilo-Anderson type 3C injuries were excluded. All underwent a standardised posterior approach with pre-contoured or reconstruction plating. Function was assessed with the mayo elbow performance score (MEPS) at 6 weeks, 3 months and 6 months; union was assessed on serial radiographs.

Results: Mean age was 40.93 (SD 13.06) years and 21 patients (70.0%) were male. Mayo type IIB was the commonest pattern (18, 60.0%). Union was achieved in 30 of 30 patients (100%) at a mean of 10.00 (SD 0.98) weeks. Mean MEPS rose from 54.00 (SD 5.2) at 6 weeks to 77.70 (SD 6.1) at 3 months and 96.20 (SD 8.9) at 6 months, when 24 patients (80.0%) scored a maximum 100.

Conclusions: Plate osteosynthesis produced universal union at approximately 10 weeks and excellent 6-month elbow function, with the steepest functional gain occurring between 6 weeks and 3 months.

Keywords: Olecranon fracture, Comminuted fracture, Plate osteosynthesis, Mayo elbow performance score, Fracture union, Functional outcome

INTRODUCTION

Olecranon fractures account for approximately 10-20% of all upper limb fractures and represent roughly 37% of fractures about the elbow, making them among the most frequently encountered intra-articular injuries of the proximal forearm.^{1,2} The olecranon process forms the posterior prominence of the proximal ulna, provides the insertion of the triceps brachii, and constitutes the dominant bony element of the greater sigmoid notch. Its subcutaneous position renders it vulnerable to direct

trauma, while its function as the lever arm of elbow extension exposes it to indirect avulsion forces.³ The Mayo classification separates non-displaced (type I), displaced-stable (type II) and unstable (type III) injuries, with the B subtypes denoting comminution.^{4,5} Comminuted patterns, principally Mayo types IIB and IIIB, behave very differently from simple transverse fractures. They arise most often from high-energy mechanisms, frequently carry associated coronoid and radial head injury, and present the surgeon with multiple articular fragments whose relationships must be restored if post-traumatic

arthrosis is to be avoided.^{6,7} Tension band wiring, popularized by Weber et al and Vasey et al, elegantly converts the tensile force of the triceps into compression across a transverse fracture line.⁸ That biomechanical premise fails when the dorsal cortex is fragmented: without an intact buttress the construct shortens, articular congruity is lost, and K-wire migration and reoperation rates rise.⁹⁻¹¹ Plate osteosynthesis, particularly with anatomically pre-contoured locking compression plates, provides fixed-angle multiplanar stability that is largely independent of bone quality and accommodates irregular fragment geometry.¹²⁻¹⁴ Contemporary series accordingly report union in 93-100% of cases and mean MEPS values between 87 and 95.¹⁵⁻¹⁷

What is less well characterised in the Indian literature is the tempo of recovery how much function is regained by 6 weeks, how much by 3 months, and how much is still to come at 6 months. That trajectory matters for counselling patients and for timing return to work. This study was therefore designed to document functional and radiological outcomes at fixed intervals after plate fixation of comminuted olecranon fractures, using the mayo elbow performance score and serial radiographic union as the principal endpoints.

METHODS

Study design and setting

This was a prospective observational study conducted in the Department of Orthopaedics of a tertiary care teaching hospital over 18 months. The study was approved by the Institutional Ethics Committee and written informed consent was obtained from every participant before enrolment.

Participants

Thirty skeletally mature patients presenting with comminuted olecranon fractures and managed operatively by open reduction and internal fixation with plating were enrolled by purposive sampling. Inclusion criteria were a fused olecranon epiphysis, a comminuted olecranon fracture with or without associated peri-elbow injury, and open fractures of Gustilo-Anderson types 1, 2, 3A and 3B. Gustilo-Anderson type 3C injuries, in which neurovascular deficit dictates a different management priority, were excluded, as were pathological fractures.

Initial assessment and management

On arrival, patients were resuscitated as required and the injured limb was immobilized in an above-elbow posterior plaster of Paris slab with elevation. A detailed history recorded the interval since injury and whether the mechanism was direct or indirect violence. Clinical assessment followed a fixed sequence of inspection, palpation, assessment of active and passive elbow flexion-extension and forearm rotation compared with the

contralateral side, measurement of elbow circumference, and documentation of distal neurovascular status and associated injuries. Routine haematological, biochemical and cardiorespiratory work-up preceded anaesthesia. Radiographs in anteroposterior and lateral projections were obtained of the elbow with forearm, forearm with wrist, arm with elbow, and shoulder with arm, to confirm the diagnosis and characterise the fracture. Fractures were classified by the Mayo, AO/OTA and Gustilo-Anderson systems.

Surgical technique

Positioning was dictated by the chosen approach, most often lateral decubitus with the elbow flexed over a support. A midline posterior incision was used and the fracture exposed by elevating the anconeus and the triceps aponeurosis laterally. All fragments were identified and their articular relationships restored, with provisional Kirschner wire fixation; impacted articular fragments were elevated and supported with bone graft where necessary. After anatomical reduction, a plate was selected from one-third tubular, 3.5 mm reconstruction, pre-contoured olecranon and locking compression options. The plate was applied to the dorsal or posterolateral surface of the ulna with its proximal end contoured to wrap around the olecranon tip, increasing the working length and improving proximal purchase. At least two proximal screws achieved bicortical purchase, lag screws were placed outside the plate where individual fragments required interfragmentary compression, and a minimum of six cortices were engaged distal to the fracture. Locking screws were used in osteoporotic bone. Reduction, plate position and screw length were confirmed under image intensification.

Postoperative protocol

Where fixation was judged stable, mobilisation began at 3 to 5 days. For comminuted or unstable configurations, a posterior splint was retained for 2 weeks before range of motion exercises were started. Strengthening was deferred until radiographic union. All patients were counselled about the possibility of symptomatic hardware and elective implant removal after union.

Outcome assessment

Patients were reviewed at 6 weeks, 3 months and 6 months. The primary functional outcome was the mayo elbow performance score, a 100-point instrument combining pain, arc of motion, stability and activities of daily living. Secondary assessment comprised pain on a visual analogue scale, elbow stiffness, swelling and tenderness; activities of daily living including combing hair, eating and personal hygiene, together with return to work; range of flexion, extension, supination and pronation compared with the uninjured side; and radiographic union on serial films. Union was defined as bridging trabeculae across the fracture with absence of tenderness on direct palpation.

Statistical analysis

Data were summarised descriptively. Continuous variables are presented as mean with standard deviation and median categorical variables as frequency and percentage. Given the single-arm observational design and the sample size, no comparative inferential testing was undertaken.

RESULTS

Baseline profile

Thirty patients completed the 6-month follow-up with no loss to attrition. Mean age was 40.93 (SD 13.06) years with a median of 38.00 years and a range spanning the third to seventh decades the single largest group, 9 patients (30.0%), fell between 21 and 30 years. Twenty-one patients (70.0%) were male. The right elbow was involved in 19 patients (63.3%). Road traffic accidents caused 12 injuries (40.0%), falls of all kinds a further 12 (40.0%) and assault 6 (20.0%). Surgery was performed within 3 days of injury in 24 patients (80.0%), the mean interval being 3.00 (SD 2.64) days with a single outlier operated at 13 days (Table 1).

Fracture morphology

Twenty-three fractures (76.7%) were closed 6 (20.0%) were Gustilo-Anderson type 1 and 1 (3.3%) type 2 open

injuries. By the Mayo system 18 fractures (60.0%) were type IIB, 9 (30.0%) type IIIB and 3 (10.0%) type IIIA, confirming that the cohort comprised displaced comminuted and unstable patterns throughout. AO/OTA 2U1B1 was the commonest subtype in 10 patients (33.3%), followed by 2U1C3 in 9 (30.0%) (Table 2).

Radiological union

All 30 fractures united; there were no cases of delayed union or non-union. The mean time to union was 10.00 (SD 0.98) weeks with a median of 10.00 weeks and a range of 8 to 12 weeks. Union occurred at 10 weeks in 11 patients (36.7%) and at 9 weeks in 9 (30.0%) 21 of 30 patients (70.0%) had united by 10 weeks (Table 3).

Functional outcome

Mean MEPS was 54.00 (SD 5.2) at 6 weeks, 77.70 (SD 6.1) at 3 months and 96.20 (SD 8.9) at 6 months. The absolute gain of 23.70 points between 6 weeks and 3 months exceeded the gain of 18.50 points between 3 and 6 months, locating the steepest phase of recovery in the second and third postoperative months. At 6 weeks no patient exceeded a score of 60 and 16 (53.3%) scored exactly 50. By 3 months 16 patients (53.3%) had reached 80. At final review 24 patients (80.0%) achieved a maximum score of 100, 3 (10.0%) scored 90, and 3 (10.0%) remained below 90 (Table 4).

Table 1: Baseline demographic and injury profile (n=30).

Variables	Category	N	%
Age group (in years)	21-30	9	30.0
	31-40	7	23.3
	41-50	7	23.3
	51-60	4	13.3
	>60	3	10.0
Mean age, years (SD), median		40.93 (13.06); 38.00	
Sex	Male	21	70.0
	Female	9	30.0
Side of injury	Right	19	63.3
	Left	11	36.7
Mechanism of injury	Road traffic accident	12	40.0
	Fall down	9	30.0
	Assault	6	20.0
	Fall down (domestic)	3	10.0
Trauma to surgery interval	0-3 days	24	80.0
	4-7 days	5	16.7
	>7 days	1	3.3
Mean interval, days (SD), median		3.00 (2.64); 2.50	

Table 2: Fracture morphology by classification system (n=30).

Classifications	Category	N	%
AO/OTA	2U1B1	10	33.3
	2U1C3	9	30.0
	2U1C2	5	16.7

Continued.

Classifications	Category	N	%
	2U1C	4	13.3
	2U1A2	1	3.3
	2U1B1 (variant coded 2UB1)	1	3.3
	Type IIB	18	60.0
Mayo	Type IIIB	9	30.0
	Type IIIA	3	10.0
Gustilo-Anderson	Closed	23	76.7
	Open type 1	6	20.0
	Open type 2	1	3.3

Table 3: Time to radiological union (n=30).

Time to union (in weeks)	N	%
8	1	3.3
9	9	30.0
10	11	36.7
11	7	23.3
12	2	6.7
Mean 10.00 weeks (SD 0.98); median 10.00; union rate 30/30 (100%)		

Table 4: Mayo elbow performance score at each review (n=30).

Reviews	Score	N	%
6 weeks	45	1	3.3
	50	16	53.3
	55	1	3.3
	60	12	40.0
	Mean (SD); median	54.00 (5.2); 50.00	
3 months	60	2	6.7
	75	10	33.3
	80	16	53.3
	90	2	6.7
		77.70 (6.1); 80.00	
6 months	<90	3	10.0
	90	3	10.0
	100	24	80.0
		96.20 (8.9); 100.00	

DISCUSSION

The central finding of this study is that plate osteosynthesis of comminuted olecranon fractures delivered union in every patient at a mean of 10 weeks and a mean mayo elbow performance score of 96.20 at 6 months, with 80% of patients scoring a perfect 100. Equally informative is the shape of the recovery curve: the largest single increment in function occurred between the 6-week and 3-month reviews, the period in which splintage ends and active mobilisation is established.

Demographic pattern

The mean age of 40.93 years, male predominance of 70% and preponderance of high-energy mechanisms are consistent with the younger limb of the recognised bimodal distribution of olecranon trauma, in which young

adults sustain comminuted patterns from high-energy impact while elderly patients sustain simpler fractures from ground-level falls.^{3,18} Amis et al and Miller et al showed in impact experiments that olecranon fractures characteristically follow a direct blow with the elbow near 90 degrees of flexion, whereas radial head and coronoid injuries arise at lesser flexion angles, which accords with the direct-trauma predominance seen here.¹⁹ The concentration of injuries in economically active men, and the fact that 40% arose from road traffic accidents, gives these fractures a socioeconomic weight beyond their anatomical extent.

Union

A 100% union rate at a mean of 10 weeks compares favourably with the published record. Tankshali et al comparing fixation methods, recorded mean radiographic

healing at 8 weeks for tension band wiring, 10 weeks for olecranon plating and 12 weeks for cannulated cancellous screws, with universal union by 6 months.²⁰ Buijze et al and Kloen et al reported excellent union with contoured locking compression plates for comminuted fractures, although their mean time to union was longer at 4.3 months.¹³ The consolidation observed here supports the principle that anatomical reduction combined with the rigid, fixed-angle stability of a pre-contoured dorsal plate provides the mechanical environment for reliable healing, and that non-union, which remains under 2% in modern plating series, is a rare event even in fragmented articular injuries.^{15,16}

Functional recovery and its tempo

The mean 6-month MEPS of 96.20 sits at the upper end of comparable series. Bailey et al reported a mean MEPS of 89 after plate fixation with 23 of 25 elbows rated good or excellent, Anderson et al reported 92% good or excellent results with congruent elbow plating and Park et al recently reported a mean MEPS of 95.4 where embedded subchondral Kirschner wires were used alongside plating to secure free articular fragments.^{12,21,22} That such consistency emerges across differing implants and populations argues that the determinant of outcome is the restoration of the greater sigmoid notch and the stability that permits early motion, rather than any particular plate design.

The interval data add a dimension seldom reported. A mean score of 54.00 at 6 weeks represents a functionally restricted elbow, and patients told only that plating yields excellent results may be discouraged at that first review. The subsequent rise to 77.70 by 3 months, and only then to 96.20, indicates that the decisive functional window follows the cessation of protective splintage. This reinforces the biomechanical justification for plating in comminuted patterns: the value of a fixed-angle construct lies less in the union rate itself, which tension band wiring can also achieve in simple fractures, than in its capacity to tolerate early active and passive motion and so prevent the capsular contracture that underlies post-traumatic stiffness.^{10,14,23} Three patients remained below 90 at 6 months, a reminder that a minority of severely fragmented articular injuries do not recover a full arc within this timeframe.

Clinical implications

Two practical points follow. First, in Mayo IIB and IIIB injuries the operative goal should be a construct stable enough to permit motion by the end of the second postoperative week, since it is the following six weeks that generate most of the functional gain.^{24,25} Second, patients should be counselled that the elbow at 6 weeks is not the elbow they will retain, and that continued participation in supervised mobilisation through the third month is the principal determinant of their final score.

Limitations

The sample of 30 patients recruited by purposive sampling is small, and subgroup comparison between Mayo IIB and IIIB injuries or across Gustilo-Anderson grades would be underpowered. The 6-month follow-up is adequate to document union and early functional recovery but cannot capture late outcomes such as progressive ulnohumeral arthrosis or delayed implant-related problems. As a single-arm observational study without a randomised comparator, it cannot establish the superiority of plating over alternative constructs, and no inferential comparison is offered.²⁶⁻²⁸ Finally, the Mayo elbow performance score, while validated and widely used, incorporates self-reported components and is known to correlate imperfectly with terminal extension deficit, so a residual loss of terminal extension may be underrepresented by a maximal score.

CONCLUSION

In this prospective series of 30 comminuted olecranon fractures, plate osteosynthesis achieved union in every patient at a mean of 10 weeks and a mean Mayo Elbow Performance Score of 96.20 at 6 months, with 80% of patients scoring 100. Recovery was not linear: the greatest functional gain occurred between the 6-week and 3-month reviews. Plate fixation, by providing stability sufficient for early mobilisation, remains the appropriate treatment for Mayo type IIB and IIIB injuries, and patients should be counselled that meaningful function continues to accrue well beyond the first postoperative review.

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