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Functional outcomes of plate fixation in comminuted fractures of olecranon: A case series

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Abstract
Objectives: To report and evaluate the functional outcome of plate fixation in comminuted olecranon fractures (Mayo types IIB and IIIB).
Method: 16 patients with comminuted fractures of the olecranon presented to our unit, were operated on with a locking Olecranon plate. Main outcome measurements included radiographic healing, postoperative range of motion, complications, outcome score and patient satisfaction measured at 1 year follow up.
Results: Our study included six females and ten males with a mean age of 48(18–67). Nine were Mayo type IIB and seven were Mayo type IIIB. Fourteen patients had no complications post-operatively with good outcomes with a mean oxford score of 44, full rotational ROM and mean flexion arc of 20-130 deg. Two patients had a range of motion between 40-90 deg with full rotational ROM and a mean oxford score of 28. No patients required hardware removal. No non-unions were noted in our series.
Conclusion: Plate fixation of complex olecranon fracture is an effective, reliable treatment method with a low risk of non-union. Restoration of a functional flexion arc of movement can be expected with the use of correct technique and early post-op mobilization.

Keywords: Plate fixation, comminuted fractures, olecranon

1. Introduction
Olecranon fractures are fairly common. Olecranon fractures account for 5-7% of elbow fractures in adults but are much rarer in children [1]. Its subcutaneous location makes it vulnerable to direct trauma. It can be as simple as non-displaced fractures or complex fractures with dislocation of the elbow joint. Plain X-rays, in particular, the lateral x-ray, help to confirm the diagnosis and plan the management. CT scan may be helpful, in some cases, to assess the severity of the injury and to plan fixation, especially when comminution is present [2]. Fixation with Locking Plate and screws is the standard treatment for comminuted fractures of the olecranon, fractures associated with dislocations and oblique fractures with distal extension affecting the coronoid [3, 4]. Good recovery is anticipated with surgical fixation. The final outcome may depend on the intra-articular nature of the injury, multiple fracture fragments and the extent of the soft tissue injury.
We evaluated locking plate fixation of comminuted olecranon fractures in terms of bone union, surgical complications and patient's satisfaction.

2. Materials and Methods
We prospectively studied 16 patients with comminuted fractures of the olecranon. The mean follow-up period was 12 months ranging from 8 to 20 months?
There were six females and ten males with a mean age of 48 years [range, 18-67 years. The 16 patients had an open reduction and internal fixation using plates and screws. We used the Mayo classification system, which classifies these fractures based on the stability, the displacement and the comminution of the fracture [6]. It comprises three types, and each type is divided into comminuted and non-comminuted subtypes. According to The Mayo classification system; nine patients had Mayo type IIB and seven had Mayo type IIIB. The surgeries were performed under a regional block. The mean tourniquet time was 64 mins. The fracture was exposed through a posterior straight midline incision while the patient was in a lateral position.

The postero-lateral approach was used to gain access to the olecranon. The C-arm was used intra-operatively to assess the reduction and the congruency of the joint. Care was taken to protect the ulnar nerve throughout the procedure. Cefotaxime was used intravenously, with 1g injected intra-operatively and 1g injected after 8 and 16 h. None of the patients developed a wound infection postoperatively.

All the patients were put in a broad arm sling post-operatively. They were allowed wrist and hand exercise immediately post-operatively. Patients were seen two weeks after the surgery in the outpatient clinic, had a wound check and started gentle elbow exercise.

The outcome was assessed with regard to clinical and radiological findings. We utilized The Oxford elbow scoring system, which has twelve components with five answer options each. Each answer is scored zero to four, with zero corresponding to greater severity. Underlying the twelve components are three spheres: Elbow pain, Elbow function and Social-psychological. Scores are converted to a metric of zero-48 (a lower score corresponding to greater severity) [6]. Anterior-posterior and lateral elbow radiographs were used during follow-up to evaluate the reduction, union and failure of hardware.

3. Results

These fractures were deemed to be unsuitable for Tension band fixation by virtue of their fracture configuration. There were no infections, wound leakages or wound break-downs reported on any of these cases. The full union was observed in all patients during the follow-up period.

One patient had a grade II open fracture that was debrided and fixed internally at the same time. All operations were performed within seventy-two hours from the initial injury. The majority (15 cases) were performed within 48 h.

A congruent Ulno-humeral articulation was achieved in all the patients; the reduction obtained during surgery was maintained in all cases when seen for follow-up. There were no implant failures.

No complications were noted postoperatively in 15 patients with a mean oxford score of 46. One patient (out of 16), had a transient neuropraxia of the ulnar nerve, which was diagnosed preoperatively and had resolved fully within the first six weeks.

Two patients had a range of motion between 40-90 deg with a full rotational ROM and a mean Oxford score of 28. None of the patients needed hardware removal. The first, a 57 years old female with a Mayo type IIB, developed stiffness with a flexion arc of 45–85 and an oxford score of 23. The second patient was a 34 years old male with a Mayo type IIIB. He was managed with long-term physiotherapy. These two patients had significant comminution of the articular surface. The articular surface fragmentation involved more than 50% of the joint surface. We found these two, in particular, to have more than two, smaller and comminuted intervening fragments in addition to the major fragments and these were not seen in the other 14 patients who did well after the surgery.

After reduction, one patient had a closed comminuted fracture with a 4.7 mm articular defect. At 24 weeks, the fracture had healed fully with a flexion arc of 110 deg and full rotational movements.

4. Discussion

All olecranon fractures are intra-articular and present a challenge when they are multi-fragmented. The outcome of the surgical treatment always depends directly on the precision of the joint reduction, restoration of mechanical stability that permits prompt mobilization, respect for the soft tissues, and maintaining an intact extensor mechanism [2, 4].

Surgery aims to achieve adequate stability to the fracture and to reconstruct the joint surface to enable range-of-motion exercises in the early postoperative period [7]. A considerable number of the published literature have described positive results with locking-plate in fragmented olecranon fractures [8–10].

Fyfe *et al*. conducted a biomechanical study on methods of fixation of olecranon fractures and concluded that fragmented osteotomies had the best stability when fixed using the contoured plates [9]. Following that, Gordon *et al*. performed a cadaveric study comparing plating methods on comminuted olecranon fractures [11]. The study concluded that plate fixation along with an intramedullary screw had the most attainable stability when fixing these fractures. Ramazan *et al*. retrospectively studied 18 cases of comminuted olecranon fractures, type IIB and IIIB, all underwent locking plate fixation [12] although those with type IIB fractures had slightly better results when compared with the type IIIB group, the difference was not statistically significant. They recommended an osteosynthesis system for fragmented fractures to guarantee more secured fixation, to provide better joint restoration and to guard against loss of elbow range of motion.

Hardware irritation is often reported with plate fixation and hardware removal rates are reported to be 0% to 20% in the literature [13–15]. Painful hardware is more frequent in tension-band wiring than plate fixation and our literature search revealed rates to be from 9% to 91% for the tension band technique [16–22].

Hume and Wiss in 1992 studied the outcomes of plate fixation against tension band wiring in variable patterns of olecranon fractures and found superior results clinically and radiologically with lower complication rate in the plate fixation group [23]. Bailey *et al*. in 2001 evaluated the functional outcome of plate fixation in twenty-five cases of complex olecranon fractures (Mayo type II and III) at an average of thirty-four months follow-up. Again, they reported a good or excellent outcome in 94% of patients with a mean DASH and MEPS to score of 10 and 89, respectively [24]. Wilson *et al*. conducted a biomechanical study in 2011 that revealed a considerably greater compression using locking plates than tension band wiring in the fixation of transverse olecranon fractures, both over the whole fracture and specifically at the articular side of the fracture, suggesting a lower risk of post-traumatic osteoarthritis [25]. Bujijze and Kloen evaluated the results of pre-contoured locking plate and intramedullary screw fixation for an acute fragmented olecranon fracture in sixteen patients. At a minimum of twelve months, over ninety percent of the patients had a good or excellent outcome [26]. Anderson *et al*. reported a mean MEPS score of 89, with also over ninety percent good or excellent results, and a mean DASH of 25 at a mean 2.2 years following locking plate fixation for the fixation of comminuted and non-comminuted olecranon fractures. Their study reported the mean flexion contracture was 13.5 deg [27].

Based on the previous biomechanical studies and the published case series, we believe that Plate fixation is mandatory in fragmented, unstable olecranon fractures. Using the pre-contoured locking plates helps to maintain the olecranon height and restore the articular arc, which is very important to avoid flexion-extension stiffness and enable

commencing early movements. Furthermore, low-profil pre-contoured plates reduce the need for hardware removal. We have mostly used a spanning type of fixation construct, but in some complex fractures, we have used sub-articular screws to buttress the articular surface. We found that; fractures with multiple small and comminuted intervening fragments in addition to the major fragments, they may not do well after surgery. Thus, further detailed imaging and planning before the surgery might help get better results.

The limitations of our study include its retrospective nature, the small number of patients and the relatively short duration of follow-up.

5. Conclusion

Plate fixation should be considered as the method of choice in comminuted olecranon fractures where the tension band wire technique will not provide the required reduction and stability. The plate acts as a posterior buttress/template, supporting the articular fragmentsuntil complete fracture consolidatione. Plate fixation is an effective and reliable way of treatment with a very low risk of non-union

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