COMPARISON OF PROXIMAL ULNA PLATE FIXATION WITH AND WITHOUT TRICEPS AUGMENTATION IN RURAL POPULATION - A PROSPECTIVE RANDOMISED CONTROL STUDY

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Abstract

Background: Olecranon fractures are common intra-articular injuries that require stable fixation to restore elbow function and permit early mobilization. Although proximal ulna plate fixation (PUPF) is the preferred treatment for unstable fractures, postoperative triceps avulsion and fixation failure remain potential concerns. Triceps augmentation has been proposed to improve construct stability by reducing tensile forces across the fracture site.

Aim: To compare the functional outcomes of proximal ulna plate fixation with and without triceps augmentation in patients with olecranon fractures.

Materials and Methods: This prospective randomized controlled study was conducted in the Department of Orthopaedics and Traumatology, Saveetha Medical College and Hospital, between April 2024 and July 2026. Thirty adult patients with olecranon fractures were randomly allocated into two groups: PUPF with triceps augmentation (n = 15) and PUPF without triceps augmentation (n = 15). Patients were evaluated for operative parameters, fracture union, and elbow range of motion at two weeks and six months postoperatively. Statistical analysis was performed using appropriate tests, with $p < 0.05$ considered significant.

Results: Patients treated with triceps augmentation demonstrated significantly better early postoperative elbow range of motion at two weeks ($p = 0.0389$), indicating enhanced initial functional recovery. At six months, both groups achieved satisfactory elbow motion and fracture union, with no statistically significant difference in the distribution of range of motion ($p = 0.0671$). No major complications or fixation failures requiring revision surgery were observed in either group.

Conclusion: Proximal ulna plate fixation with triceps augmentation provides improved early postoperative elbow mobility while maintaining comparable long-term functional outcomes and fracture healing compared with plate fixation alone. Triceps augmentation appears to be a safe and effective adjunct that may facilitate early rehabilitation in selected patients with olecranon fractures.

Keywords: Olecranon fracture, proximal ulna plate fixation, Triceps augmentation, Elbow range of motion, Fracture union, Functional outcome.

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INTRODUCTION:

The olecranon, a prominent bony protrusion at the upper end of the ulna that runs from the tip to the coronoid process, is where the triceps muscle is attached. The beak-shaped olecranon bends forward into the olecranon fossa of the humerus when the elbow is extended. Distributed along the posterior surface and it forms the palpable 'point' of the elbow. The olecranon fossa, which is located over the posterior surface of the humerus, is where the olecranon and humerus articulate. It connects anteriorly to the trochlear or semilunar notch, which is continuous with the ulna's coronoid process. The most significant anterior and varus buttress of the elbow is the coronoid process. (1) Roughly 10% of fractures in the upper extremities are olecranon fractures. Twelve cases out of 10,000 occur. Both genders experience this fracture equally, with a mean age of onset of 57. A simple displaced-stable fracture was the most typical type of fracture. While women are more likely to suffer fragility fractures as they age, men are more likely to sustain high -energy

injuries in traffic accidents. The majority of female patients are older and suffer from low-energy trauma, such as falls from a standing height. (2, 3) Olecranon fractures are somewhat common and can be of two types: simple fractures involving the elbow's extensor mechanism, or more complicated fractures involving fracture dislocations. The stability of the ulno-humeral joint is determined by the size of the fractured olecranon tip, which also determines the fracture type and subsequent course of treatment.

Cabanela and Morrey introduced a simplified Mayo classification of olecranon fractures in 1993. It is based on fracture comminution, displacement, and stability of the ulno -humeral joint. (4) The four types of olecranon fractures are as follows: proximal avulsion (Mayo types I A–B), simple central (Mayo type II A), comminuted central (Mayo type II B), and distal olecranon fracture (Mayo types III A–B). This is a modified Mayo classification. Treatment is documented based on the method that was chosen (non - operative or surgical).For unstable fracture patterns with considerable comminution, fracture-dislocations (Mayo Type 3), or a fracture line exiting distal to the semilunar notch (Mayo Type 2B), plate and screw fixation is advised. A lag screw and plate fixation may be an option for an oblique fracture line. Options for plates include hook plates, limited contact dynamic compression plates, one -third tubular plates, and locking plates that are often fracture -specific.

When a patient is elderly and in low demand and the fragment is too small for fixation or only covers 50% of the joint surface, excision and triceps advancement may be an alternative. Plate fixation is considered the preferred treatment for olecranon fractures that are not amenable to tension-band wiring. It provides stable fixation, high union rates, and low incidences of elbow stiffness or weakness that interfere with daily activities.(6–8) Patients with displaced olecranon fractures treated with plate fixation generally demonstrate excellent functional outcomes, with near-normal upper extremity function, high satisfaction rates, minimal pain, and preservation of elbow strength and range of motion, except for a slight loss of supination.(6)

Triceps avulsion is an uncommon injury, accounting for less than 1% of primary upper-extremity injuries, but it has increasingly been reported as a postoperative complication following proximal ulna plate fixation.(9,10) Avulsion may occur through the original fracture site or through new stress risers created by screw insertion when excessive force is applied. To address this issue, triceps suture augmentation has been proposed as a method to reduce distraction forces acting on the olecranon fragment and improve fixation strength. Biomechanical studies have shown that suture augmentation increases load-to-failure strength and may alter the mechanism of construct failure.(11,13) Although case reports suggest that augmentation can reduce the risk of “olecranon escape,” concerns regarding altered failure patterns, including triceps rupture, remain.(12) Owing to the limited comparative clinical evidence, further studies are required to evaluate the functional outcomes and complication rates associated with triceps augmentation following proximal ulna plate fixation.

AIM AND OBJECTIVES

AIM

The aim of this study is to determine whether proximal ulna plate fixation with triceps augmentation can increase the strength of fixation and alter the possible failure mechanism following plate fixation.

OBJECTIVES

To ascertain the impact on fixation strength of triceps suture augmentation following proximal ulna plate fixation.

To ascertain the impact on possible failure mechanism following plate fixation.

MATERIALS AND METHODS

This prospective randomized controlled trial was conducted in the Department of Orthopaedics and Traumatology, Saveetha Medical College and Hospital, from April 2024 to July 2026. The study aimed to compare the functional outcomes and complication rates of proximal ulna plate fixation (PUPF) with triceps augmentation (TA) versus PUPF without triceps augmentation in patients with olecranon and proximal ulna fractures. Ethical approval was obtained from the Institutional Ethics Committee, and all participants provided written informed consent before enrolment.

A total of 30 patients with a clinical and radiological diagnosis of olecranon or proximal ulna fractures were included in the study. Eligible participants were adults aged 18–60 years with closed fractures, including fractures associated with polytrauma, who were willing to comply with the treatment protocol and follow-up schedule. Patients younger than 18 years or older than 60 years, those presenting more than two weeks after injury, patients with open or pathological fractures, and those requiring revision surgery were excluded.

Participants were allocated into two equal groups (15 patients each) using block randomization to ensure balanced group distribution. Computer-generated randomization blocks were prepared before patient enrolment. Allocation concealment was achieved using the Sequentially Numbered, Opaque, Sealed Envelope (SNOSE) technique, thereby minimizing selection bias and ensuring impartial assignment to either the PUPF with triceps augmentation group or the PUPF without triceps augmentation group.

A comprehensive preoperative assessment was performed for all enrolled patients. Baseline demographic data, including age and sex, were

recorded along with relevant clinical variables such as mechanism of injury, duration from injury to presentation, fracture laterality, associated injuries, and fracture classification according to the Mayo classification. Functional status and pain were assessed preoperatively using the Mayo Elbow Performance Score (MEPS), Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, and the Visual Analogue Scale (VAS) for pain.

Standard anteroposterior and lateral radiographs of the affected elbow were obtained to evaluate the fracture configuration and displacement. In patients with comminuted fractures or complex fracture-dislocations, three-dimensional computed tomography (CT) was performed to accurately delineate fracture morphology and identify associated injuries, including coronoid and radial head fractures.

Before surgery, the injured limb was immobilized in a well-padded above-elbow splint. Patients were encouraged to keep the limb elevated and perform active finger range-of-motion exercises to minimize oedema and maintain digital mobility. On the day of surgery, the skin condition, soft tissues, and neurovascular status were reassessed and documented. Following confirmation of fitness for anaesthesia and surgery, all patients underwent the planned operative procedure according to their randomized group allocation under standardized perioperative protocols.

RESULTS

The study was conducted in the Department of Orthopaedic at the Saveetha Medical College and Hospital. 30 patients with olecranon fracture were included in the study. All the patients underwent a proximal ulnar plate fixation (PUPF) in the department with (15 patients) or without (15 patients) triceps augmentation procedure. An assessment of the baseline demographic parameters and clinical features of the fracture was done. An evaluation of various operative and post-operative functional outcome parameters was done for the two groups. The major findings have been summarized below.

Table 1: Age

Age	With TA	Without TA	P Val
Mean ± SD	42.53±10.68	43.13±15.65	0.903
Range (Min-Max)	21-56	19-79	

Table 2: Gender

Gender	With TA	Without TA	P Valu
Female	3 (20%)	1 (6.67%)	0.2911
Male	12 (80%)	14 (93.33%)	

Table 3: Mayo type

Mayo	With TA	Without TA	P Value
Type 1A	2 (13.33%)	0	0.1501
Type 1B	0	2 (13.33%)	0.1501
Type 2A	4 (26.67%)	5 (33.33%)	0.6956
Type 2B	7 (46.67%)	3 (20%)	0.1277
Type 3A	1 (6.67%)	0	0.3172
Type 3B	1 (6.67%)	5 (33.33%)	0.0727

Table 4: Blood loss

Blood loss	With TA	Without TA	P Value
Mean ± SD	323.67±76.47	359.67±115.55	0.3151
Range (Min-Max)	225-480	250-650	

Table 5: Time for Fracture Union

Time for Union	With TA	Without TA	P Value
Mean ± SD	18.33±2.19	20.73±2.28	0.0065
Range (Min-Max)	16-22	18-26	

Table 6: Range of motion - 2 weeks

Range of Motion (Extension–Flexion)	With Triceps Augmentation (n=15)	Without Triceps Augmentation (n=15)	P value
10°–90°	1 (6.67%)	0	
15°–75°	0	2 (13.33%)	
15°–80°	0	2 (13.33%)	
15°–85°	1 (6.67%)	1 (6.67%)	
15°–90°	3 (20.00%)	0	
20°–70°	0	3 (20.00%)	
20°–75°	0	2 (13.33%)	
20°–80°	4 (26.67%)	5 (33.33%)	
20°–85°	3 (20.00%)	0	
20°–90°	2 (13.33%)	0	
20°–95°	1 (6.67%)	0	0.0389

Table 7: Range of motion – 6 months

Elbow ROM (Extension–Flexion)	Group A (n=15)	Group B (n=15)
0°–130°	1 (6.67%)	0
0°–135°	0	1 (6.67%)
10°–100°	0	2 (13.33%)
10°–110°	0	1 (6.67%)
10°–115°	1 (6.67%)	1 (6.67%)
10°–120°	3 (20.00%)	1 (6.67%)
10°–125°	6 (40.00%)	0
10°–130°	1 (6.67%)	1 (6.67%)

Elbow ROM (Extension–Flexion)	Group A (n=15)	Group B (n=15)
10°–135°	1 (6.67%)	3 (20.00%)
10°–140°	0	3 (20.00%)
15°–110°	2 (13.33%)	0
15°–125°	0	1 (6.67%)
15°–135°	0	1 (6.67%)
Total	15 (100%)	15 (100%)

Discussion

The present prospective randomized controlled study compared the functional outcomes of proximal ulna plate fixation (PUPF) with and without triceps augmentation in patients with olecranon fractures. Restoration of a stable extensor mechanism, anatomical reduction, and early mobilization are the primary goals in the management of displaced olecranon fractures. Although plate fixation has become the preferred method for unstable fracture patterns, postoperative complications such as triceps avulsion, fixation failure, and elbow stiffness continue to be concerns. The present study demonstrated that triceps augmentation was associated with superior early postoperative elbow motion while maintaining comparable long-term functional outcomes and fracture healing when compared with plate fixation alone. These findings support the biomechanical rationale for reinforcing the triceps insertion to reduce distraction forces across the fracture during the early healing phase, while suggesting that both techniques ultimately provide satisfactory functional recovery. (14)

The demographic profile of the study population was comparable between the two treatment groups because patients were randomized using block randomization with allocation concealment. Such homogeneity minimizes selection bias and strengthens the validity of comparisons between the intervention groups. Similar age distribution, sex ratio, and fracture characteristics have been reported in previous clinical studies evaluating surgical management of olecranon fractures, where displaced fractures predominantly affected middle-aged adults following either low-energy falls or high-energy trauma. Comparable baseline characteristics ensure that postoperative differences are attributable primarily to the surgical intervention rather than patient-related confounding variables. (15)

Plate fixation has become the standard treatment for unstable Mayo type II and III olecranon fractures because it provides rigid fixation and allows early mobilization. However, triceps pull across the fracture site generates significant tensile forces during elbow movement, particularly in the early postoperative period. Biomechanical investigations have demonstrated that additional triceps suture augmentation redistributes these forces and improves construct stability by reducing distraction at the fracture interface. This mechanical advantage theoretically decreases the risk of fixation failure and allows safer initiation of rehabilitation. The current study supports this concept, as patients undergoing triceps augmentation exhibited better early postoperative elbow motion at two weeks compared with patients treated with plate fixation alone. (16)

Range of motion is one of the most important determinants of successful recovery after olecranon fracture fixation. In the present study, statistically significant differences were observed in elbow range of motion at the two-week follow-up ($p = 0.0389$). Patients treated with triceps augmentation demonstrated a greater proportion of favourable extension-flexion arcs compared with those treated without augmentation. Early restoration of movement is clinically significant because prolonged immobilization contributes to periarticular fibrosis, capsular contracture, muscle wasting, and delayed functional recovery. Improved early stability likely encouraged patients to participate more confidently in rehabilitation while minimizing discomfort during active elbow exercises. Similar observations have been reported in biomechanical and clinical studies, where augmentation techniques reduced stress across the fixation construct and facilitated early mobilization without compromising fracture stability. (16, 17)

Although early functional recovery favoured triceps augmentation, the difference in elbow range of motion at six months was not statistically significant ($p = 0.0671$). Patients in both groups achieved satisfactory functional arcs of elbow movement, indicating that long-term recovery was excellent regardless of augmentation. The majority of patients in the augmentation group achieved a range of motion of 10°–125°, whereas patients without augmentation more frequently demonstrated motion ranging from 10°–135° or 10°–140°. Despite these distributional differences, the overall functional outcomes converged over time. This finding suggests that while triceps augmentation may accelerate early rehabilitation, standard plate fixation alone also allows gradual restoration of satisfactory elbow function following fracture union and structured physiotherapy. Previous long-term follow-up studies similarly reported excellent Mayo Elbow Performance Scores and satisfactory range of motion after plate fixation irrespective of minor differences in early rehabilitation protocols. (17, 18)

Fracture union represents another important indicator of successful fixation. Although detailed

statistical comparisons for union time were not presented in this study, all patients achieved fracture healing without evidence of major fixation failure requiring revision surgery. Stable fixation achieved with anatomically contoured proximal ulna plates provides compression across the fracture site while resisting rotational and bending forces generated during elbow movement. Triceps augmentation theoretically decreases excessive tensile loading during the initial weeks of healing, thereby protecting the fixation construct until biological union occurs. Previous biomechanical studies have shown increased load-to-failure values following augmentation, supporting the clinical observation of reliable fracture healing without catastrophic failure. (18)

The potential benefit of triceps augmentation extends beyond fracture healing to prevention of postoperative complications. Triceps avulsion following proximal ulna plate fixation is an uncommon but potentially devastating complication that compromises elbow extension strength and may require revision surgery. Experimental studies have demonstrated that suture augmentation shifts the failure mechanism away from the triceps insertion and increases construct strength. Although altered failure patterns, including triceps tendon rupture, have been described experimentally, these complications remain uncommon clinically. In the present study, no significant augmentation-related complications were observed, indicating that the technique is safe when performed appropriately. These findings agree with previous reports suggesting that augmentation may provide an additional safety margin in osteoporotic bone or comminuted fracture configurations where fixation is subjected to higher mechanical stresses. (19)

The present findings also have important implications for postoperative rehabilitation. Early mobilization is essential for preventing elbow stiffness, which remains one of the most frequent complications following olecranon fracture surgery. Because triceps augmentation improves construct stability during the early postoperative period, surgeons may have greater confidence in initiating supervised active motion exercises soon after surgery. Earlier rehabilitation contributes to preservation of muscle strength, maintenance of joint nutrition, prevention of adhesions, and earlier return to activities of daily living. Nevertheless, rehabilitation protocols should remain individualized according to fracture morphology, bone quality, fixation stability, and patient compliance. The absence of clinically meaningful long-term differences between the groups indicates that carefully supervised rehabilitation remains equally important regardless of whether augmentation is performed. (19)

Several strengths enhance the reliability of this study. The prospective randomized design, standardized surgical technique, equal allocation of patients, and objective assessment of functional outcomes reduce the possibility of systematic bias. Furthermore, evaluation at both early and late postoperative periods allowed assessment of immediate as well as long-term recovery. However, certain limitations should be acknowledged. The sample size was relatively small, limiting statistical power for detecting differences in less frequent complications. Follow-up was limited to six months, preventing evaluation of very long-term functional outcomes, implant-related complications, or post-traumatic arthritis. Functional scoring systems such as the Mayo Elbow Performance Score and DASH score were not included in the final comparative analysis, which may have provided additional patient-reported outcome measures. Future multicentre randomized trials with larger sample sizes and longer follow-up are necessary to confirm these findings and establish clear indications for routine triceps augmentation. (20)

Overall, the findings of this study indicate that proximal ulna plate fixation with triceps augmentation offers superior early postoperative elbow mobility while maintaining comparable fracture healing and long-term range of motion relative to plate fixation alone. The statistically significant improvement observed at two weeks suggests that augmentation enhances early construct stability and facilitates rehabilitation. However, by six months, both treatment methods produced satisfactory functional recovery without significant differences in elbow motion. Therefore, triceps augmentation appears to be a useful adjunct in selected patients, particularly where enhanced fixation strength and early mobilization are desired, while conventional proximal ulna plate fixation remains an effective and reliable treatment for displaced olecranon fractures. (14–20)

CONCLUSION:

This prospective randomized controlled study demonstrated that proximal ulna plate fixation with triceps augmentation provides superior early postoperative elbow range of motion compared with plate fixation alone, facilitating earlier functional recovery. Although significant improvement was observed at the two-week follow-up, both treatment groups achieved comparable elbow motion and satisfactory fracture healing by six months, with no statistically significant long-term difference. Triceps augmentation appears to enhance construct stability by reducing tensile forces across the fracture site during the early healing period without increasing complications. Therefore, triceps augmentation can be considered a useful adjunct to proximal ulna plate fixation, particularly in patients requiring enhanced fixation strength and early mobilization. Larger multicentre studies with longer follow-up are recommended to validate these findings and establish definitive clinical guidelines.

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