

Comparative study between olecranon osteotomy and triceps sparing approaches in supracondylar intercondylar humerus fractures fixation

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Background

Open reduction and internal fixation is the standard of supracondylar intercondylar (SCIC) humerus fracture treatment and several approaches described to achieve best fractures visualization and anatomical reduction.

Objective

To compare functional outcome of SCIC humerus fracture managed by the olecranon osteotomy and triceps sparing approach.

Patients and methods

We conducted this prospective interventional study on patients presented with SCIC humerus fracture. Outcome measures were evaluated with Mayo Elbow Performance Score. Serial plain radiographies were used for radiological evaluation.

Results

Twenty patients in the study were randomly divided into two groups of 10 (50%) patients each. Mean age of group A was 44 ± 19.17 years and that of group B was 28.4 ± 10.25 years. In group A 70% of patients had satisfactory outcome and 30% of patient had unsatisfactory outcome. In group B 60% of patients had satisfactory outcome and 4% of patient were unsatisfactory.

Conclusion

Olecranon osteotomy provide better visualization specially in cases associated with comminuted articular surface while triceps sparing considered enough in cases associated with simple articular fracture.

Keywords:

olecranon osteotomy, supracondylar intercondylar humerus fracture, triceps sparing

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Introduction

Fractures of distal humerus, which are rather infrequent with an annual incidence of 5.7 per 100,000 people, have two peaks in the age distribution of these injuries; one induced by high energy trauma in young males and the other by low-energy trauma in elderly females over 60 [1].

Distal humerus fractures are mainly divided into three types under the AO/OTA classification: extra-articular (type A) fractures; intra-articular single column (type B); and intra-articular both-column (type C) that is called supracondylar intercondylar (SCIC) humerus fracture. The fracture's location and degree of comminution differentiate the subtypes (Fig. 1) [3].

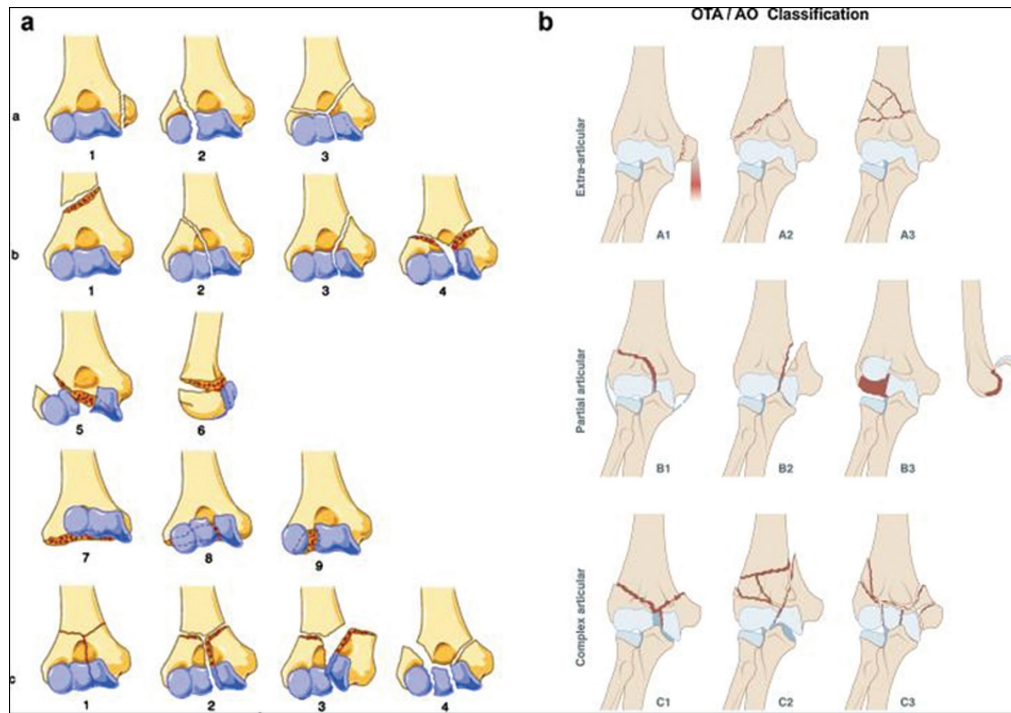
Many approaches, which published in the literatures—all of them—tried to achieve anatomical reduction and intraarticular fracture line visualization; triceps-splitting, paratricipital (AlonsoLlames), tricepsreflecting anconeus pedicle, and transolecranon osteotomy are all possible options [4].

Transolecranon osteotomy is enhancing articular visibility and enabling precise reduction. But recommendations for alternative exposure methods have been raised by significant osteotomy problems [5]. On the other hand, any disruption with the triceps reduces extension power so techniques that spare the triceps may sustain elbow strength because they protect the integrity of the elbow joint [6].

Transolecranon osteotomy is indicated for intra-articular fracture reconstruction, it also provide good exposure for anterior capitulum and trochlea, so it is more helpful in coronal plain fractures. But alternative approaches [i.e. triceps sparing (TS) or reflecting] are enough for simple fracture [7].

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Figure 1



SOFCOT (a) and AO/OTA classification systems (b) [2].

We introduce a comparative study of the functional outcome between TS and transolecranon osteotomy approach.

Patient and methods

This prospective interventional study was conducted on 20 patients with SCIC humerus fracture between March 2021 and September 2022. The 20 patients randomly divided into two equal groups by computer. Patients in group A were managed by open reduction and internal fixation via TS approach while group B were done via transolecranon osteotomy approach. There was no difference in surgical procedure except that of approach. The index surgery was done at our institute with the following inclusion criteria; more than 18 year old, closed fracture and recent trauma (less than 3 weeks). Exclusion criteria; patients with immature skeleton, old trauma, open fracture, and immunocompromised patient.

All patients underwent following preoperative evaluation: (1) history of trauma, (2) neurovascular examination, (3) radiological examination; plain radiography antero-posterior, lateral view, and also computed tomography.

Surgical technique

All patients had 2 gm of first generation cephalosporines 30 min before skin incision. Sixteen patients had general anasethia and four patients had regional anasethia.

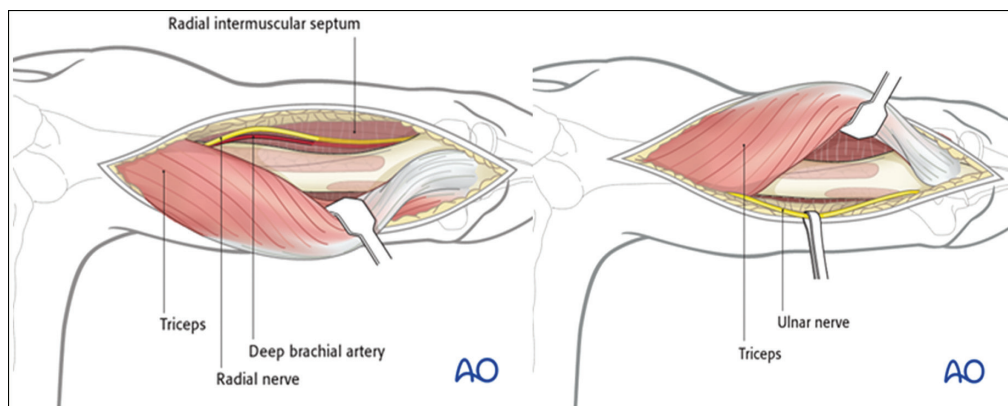
They all were positioned in a lateral decubitus position with the afflicted arm and elbow lying over a support and the forearm hanging freely.

Group A: after creation of a full-thickness fasciocutaneous flap involved a posterior midline incision. The ulnar nerve was dissected and protected from danger.

The medial and lateral windows were formed by identifying and separating the triceps muscle's medial and lateral boundaries from the corresponding intermuscular septum. Both windows were joined and the triceps muscle was detached from the back of the distal humerus by blunt dissection. The fat pad from olecranon fossa was excised. These two windows provided adequate visualization of the posterior aspect of articular surface of the distal humerus from the medial and lateral side [8] (Fig. 2).

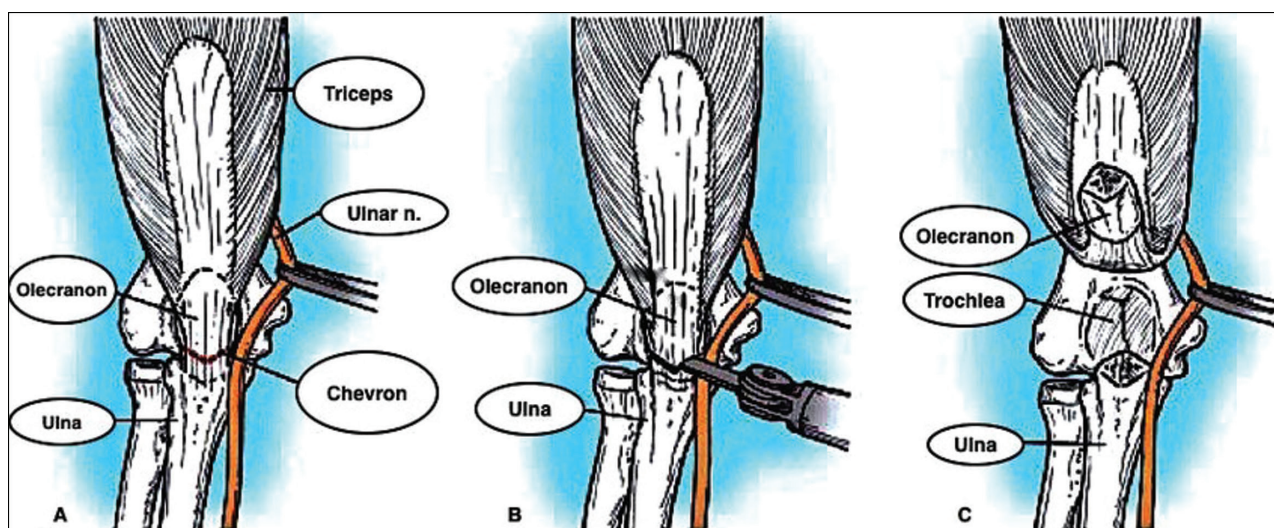
Group B: after creation of a full-thickness fasciocutaneous flap involved a posterior midline incision, the ulnar nerve was dissected and protected during all operation steps. Fracture fixation was done via transolecranon osteotomy. At the olecranon, 2 cm from its tip, a V-shaped osteotomy with the apex oriented distally. As the bone was separated, it was almost completely cut through. The triceps was lifted from the back of the humerus and also the soft-tissue attachments of the medial and lateral sides of the olecranon that had been osteotomized were freed and retracted proximally. All surfaces of the distal humerus

Figure 2



Radial and ulnar windows of triceps sparing approach [9].

Figure 3



Olecranon osteotomy approach. A, Olecranon osteotomy is marked in shape of shallow V or chevron. B, Thin-blade oscillating saw is used to start osteotomy. C, Osteotomized proximal olecranon fragment is elevated proximally; ulnar nerve is isolated, mobilized, and protected [11].

were exposed, with the exception of the anterior surface [10] (Fig. 3). Olecranon osteotomy (OO) reduction and fixation was done by tension band wires or cancellous screw 6.5 mm partially threaded.

As regard fixation, we applied the two plates at a 90° angle to one another. Lateral plate was precontoured small locked plate. Medial plate was precontoured reconstruction plate. That all was done after the initial screw fixation of the articular fragments in accordance with the recommendations made by AO/ASIF [12]. Skin closure was done under positive suction vacuum that removed second day postoperative. The intraoperative recorded data were surgical time, blood loss, and neurovascular complication.

Early postoperative program for patient was keeping affected limb in above elbow slap for 2 weeks then using arm sling for 4 weeks with active flexion, extension,

pronation, and supination during this period. After those 6 weeks, patient started physiotherapy. Patients discharged on the second day postoperative day and were followed up on 2 weeks, 4 weeks, 6 weeks, 3 months, and 6 months postoperatively. We used Mayo Elbow Performance Score (MEPS) for final functional outcome assessment [13] and radiography radiology.

Statistical analysis

The collected data were revised, coded, tabulated, and introduced to a PC using Microsoft excel. All statistical analysis was performed using SPSS 25. Data were presented and suitable analysis was done according to the type of data obtained for each parameter. One sample *T* test was used to compare the measurement of the scale and population value paired sample *t*-test was used to compare the measurement of the scale over time for MEPS score. Pearson correlation was used to quantify the strength of the relationship

between continuous variables. *P* value less than 0.05 is statistically significant.

Results

Twenty patients with SCIC humerus fracture were enrolled in our study. There was an equal gender distribution between the two groups. As regard mode of trauma 50% of cases in group A were due to fall from height and 50% of cases were due to motor car accident. In group B, there were 20% of cases of fall on ground, 20% of cases of fall on out-stretched hands, and 60% cases of motor car accident. All cases included in both groups are neurovascularly intact.

Patients in group A had no comorbidities. Meanwhile, 10% of patients in group B had diabetes mellitus and 20% of patients had hypertension. As regard smoking, 20% cases were smokers of group A versus 40% in group B (Table 1). Regarding AO classification, in group A 50% of cases were type C1, 40% were type C2, and 10% were type C3. But in group B, 30% of cases were type C1, 50% were type C2, and 20% were type C3. Time between trauma and surgery was 9.5 ± 4.5 days for cases in group A while it was 11.5 ± 6.5 days for group B. The average

of estimated operative time for group A was 130.4min and for group B it was 164.5 min; that was statistically difference (*P* greater than 0.01). Tourniquet was used for 70% of cases in group A and 60% of cases in group B. We used tourniquet with low fracture and when plainning for short plate but not with high fractures. But 30% of patients in group A were done without tourniquet with average blood loss 160.72 ml, and also 40% of patient in group B were done without tourniquet with 260.34ml average blood loss; that was statistically difference.

Final functional outcome between two groups regarding MEPS score (Figs. 4, 5) as followed; 50% of cases in group A had excellent score, 20% good, 20% fair, and 10% poor score. While MEPS score in group B was 30% of cases had excellent score, 30% good, 20% fair, and 20% poor score; mean flexion-extension range for group A $97^\circ \pm 18.16^\circ$ versus $89^\circ \pm 15.33^\circ$ for group B, regarding mean pronation-supination range; group A $141.7^\circ \pm 20^\circ$ and group B $139.6^\circ \pm 18^\circ$, as regard complications, we recorded that there were one case in group A and two cases in group B were early complicated by early postoperative infection. Infection subsided within 2 months after daily dressing and antibiotic according to culture and sensitivity for pus. There was one case in group A had radial neuritis that resolved after 4 months and another one case had ulnar neuritis resolved spontaneously after 3 months. In group B, there were two case had ulnar neuritis one of them resolved spontaneously within 3 months and the other case did not improve where the nerve conduction and electromyography show partial ulnar nerve injury but patient refused anymore intervention (Table 2).

Regarding elbow stiffness; five cases in group A (50%) had lost of all range of motions that improved with intensive course of physiotherapy. Seven cases in group B had elbow joint stiffness, whereas 50% had lost all range of motions. One of them improved with intensive course of physiotherapy, but the other two cases did not improve. Where the fractures of these two cases were severely intra-articular comminuted, due to delay of postoperative mobilization, age, and comorbidity.

Table 1 Demographics of patients

	(Group A)	(Group B)
	Mean \pm SD/N (%)	Mean \pm SD/N (%)
Age (years)	44 \pm 19.17	28.4 \pm 10.25
Sex		
Female	5 (50)	4 (40)
Male	5 (50)	6 (60)
Comorbidity		
DM	1 (10)	0
HTN	2 (20)	0
Smoking	4 (40)	2 (20)
Mood of trauma		
FFH	0	5 (50)
FOG	2 (20)	0
FOOSH	2 (20)	0
MCA	6 (60)	5 (50)
AO classification		
C1	5 (50)	0
C2	5 (50)	8 (80)
C3	0	2 (20)
Neurovascular		
Intact	10 (100)	10 (100)
Co-injuries		
Ankle B	1 (10)	0
Ipsilateral humerus	0	1 (10)
Mid shaft femur	0	2 (20)
Pelvis B and ipsilateral olecranon	0	1 (10)
Segmented femur and calcaneus	0	1 (10)

DM, diabetes mellitus; FFH, fall from height; FOG, fall on ground; FOOSH, fall on out-stretched hands; HTN, hypertension; MCA, motor car accident.

Discussion

Management of SCIC humerus fracture remains a challenging problem and there are multiple controversies in every step of surgical management starting from selection of the appropriate approach that is optimal for anatomical reduction of articular surface as TS approach only allow a view of the posterior part of the trochlea and capitulum, while the OO also allows a view of anterior part of the trochlea and the capitulum [7] and whether to use double parallel plates or orthogonal for best option of stabile fixation. In these

Figure 4



A 37-year-old male patient presented with left supracondylar intercondylar humerus fracture type C2.

Figure 5



An 18-year-old female patient with left supracondylar intercondylar humerus fracture type C2.

types of fractures especially the comminuted ones, to achieve normal postoperative elbow range of motion and function, the early postoperative mobilization is recommended which it may be impossible in elderly patients with osteoporosis and weak anchoring of the internal fixation. The aim of this study is to compare

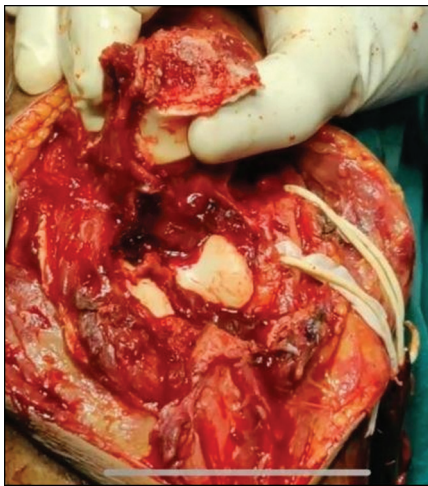
between transolecranon osteotomy and TS approach in SCIC humerus fractures.

In our study, 20 patients with SCIC humerus fracture were treated surgically. Mean MEPS score of group A cases was 82.5 ± 10.34 and group B 79.5 ± 13.63 ,

Table 2 Postoperative data

	Group A, N (%)	Group B, N (%)
Pain		
No	10 (100)	10 (100)
MEPS score		
Excellent	3 (30)	5 (50)
Fair	2 (20)	2 (20)
Good	3 (30)	2 (20)
Poor	2 (20)	1 (10)
Complications		
Postoperative infection	2 (20)	1 (10)
No	7 (70)	7 (70)
Radial palsy	1 (10)	0
Ulnar palsy	1 (10)	2 (20)

MEPS, Mayo Elbow Performance Score.

Figure 6

Transolecranon osteotomy approach.

Figure 7

Triceps sparing approach.

However Chen *et al.* [14], reported MEPS score was 84.5 ± 15.5 for group OO and 82.8 ± 18.4 for group TS. Our study mean flexion-extension rang $97^\circ \pm 18.16^\circ$ for group A versus $89^\circ \pm 15.33^\circ$ for group B. But Ansari *et al.* [15] reported in his that mean flexion-extension rang

Figure 8

Screw prominence.

$94.3^\circ \pm 17.1^\circ$ for group (OO) vs. $94.5^\circ \pm 18.2^\circ$ for group (TS). Our study, mean rotation; group A $141.7^\circ \pm 20^\circ$ and group B $139.6^\circ \pm 18^\circ$. But Zhang *et al.* [16] reported in his study, the mean rotation; group (OO) $134.58^\circ \pm 6.90^\circ$ and group (TS) $140.97^\circ \pm 7.79^\circ$ (Table 3).

As regard surgical approach we found that there is no significant difference in MEPS score between group A and group B; however, transolecranon osteotomy approach gives good visualization of articular surface and optimal for comminuted articular fracture for better reduction accessibility (Figs. 6, 7). But it is associated with more blood loss as average blood loss for group B with 260.34ml versus 160.72ml for group A, longer time of operation as mean time for group B 154.5min versus 130.4 for group A, induction of more morbidity to patient in form of OO results in additional injury, also osteotomy fixation has complications related to prominence (Fig. 8).

Our reported results as regard OO are similar to the other literature that recorded disadvantage of OO as migration of hardware, displacement, prominence, and nonunion of osteotomy and triceps weakness [17].

TS approach has advantage that no excess damage of elbow joint flexion and extension function. We recorded less blood loss and less operative time in group A cases in comparison to group B. Moreover, Lu *et al.* [18] reported that group (OO) associated with more blood loss than group (TS). We contribute this to decrease post-operative complications and preserve triceps muscle power. As regarding ulnar nerve neuritis, we reported that 20% of cases in group B had ulnar neuritis that improved spontaneously within 3 months except one case had partial ulnar nerve injury and patient refused anymore intervention. But in group A 10% of cases had ulnar nerve neuritis that improved spontaneously within 3 months. However,

Table 3 Comparison between functional results of our study and other studies

Study	Number of cases	Mean MEPS score	Mean flexion–extension range	Mean forearm pronation–supination range
Chen <i>et al.</i> [14]	33 (OO)	84.5 ± 15.5	111.5 ± 23.8	143.3 ± 20.5
	34 (TS)	82.8 ± 18.4	107.3 ± 29.7	140.4 ± 21.2
Zhang <i>et al.</i> [16]	33 (OO)	85.56 ± 3.48	103.61 ± 14.32	134.58 ± 6.90
	31 (TS)	87.71 ± 4.78	108.71 ± 12.51	140.97 ± 7.79
Ansari <i>et al.</i> [15]	28 (OO)	83.57 ± 10.96	94.3 ± 17.1	140.6 ± 20.2
	32 (TS)	86.56 ± 10.66	94.5 ± 18.2	141.8 ± 23.2
Our study	10 (OO)	79.5 ± 13.63	89 ± 15.33	139.6 ± 18
	10 (TS)	82.5 ± 10.34	97 ± 18.16	141.7 ± 20

MEPS, Mayo Elbow Performance Score; OO, olecranon osteotomy; TS, triceps sparing.

Chen *et al.* [14] reported that 12% of cases of TS group had ulnar nerve neuritis versus 6% of cases of OO group, so we recommend ulnar nerve to be kept away from the medial plate with gentle manipulation to prevent neuritis. Regarding ulnar neuritis, there was no statistical difference between two groups. This is mostly due to dissection and manipulation.

Each fracture of SCIC humerus type C has its own configuration and characters that need good radiology and planning to choose the most suitable approach and plating technique for fracture and patient.

Conclusion

In SCIC humerus fracture (type C), we found that, reduction and fracture fixation were easier in cases with OO and took much less time, while it was hard to reduce articular surface fracture of type C3 in cases with TS. So OO provides better visualization specially in cases associated with comminuted articular surface while TS considered enough in cases associated with simple articular fracture with less tissue violation.

Limitations

- (1) Few numbers of cases.
- (2) Many surgeons with different experiences, head of department, lecturers, assistant lecturers, and seniors resident.
- (3) Lack of cases compliance on physiotherapy that result in elbow stiffness and some cases lost follow up.

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Conflicts of interest

No conflicts of interest.

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