



Original Article

Comparative Outcomes of TRAP Approach and Olecranon Osteotomy in Intra-Articular Distal Humerus Fractures

Dr. Vikram Pratap Singh¹, Dr Rahul Raja², Dr Ravikant Jain^{3*}

¹MBBS, MS, Associate Professor, Department of Orthopaedics, Saraswati Medical College, Unnao, Uttar Pradesh

²MBBS, MS, Assistant Professor, Department of Orthopaedics, Saraswati Medical College, Unnao, Uttar Pradesh

^{3*}MBBS, MS, Assistant Professor, Department of Orthopaedics, Saraswati Medical College, Unnao, Uttar Pradesh

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Corresponding Author:

Dr Ravikant Jain

MBBS, MS, Assistant Professor,
Department of Orthopaedics,
Saraswati Medical College, Unnao,
Uttar Pradesh

Email: rkjvmmc@gmail.com

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ABSTRACT

Background: Intra-articular fracture of the distal humerus can be managed using various techniques and technologies as TRAP approach and olecranon osteotomy. However, the comparison of two technique in Indian context is scarce.

Aim: The present study was aimed to comparatively evaluate the functional outcomes of triceps-lifting approach (TRAP) and olecranon osteotomy in the management of intra-articular distal humeral fractures.

Methods: The present study assessed 40 subjects divided into two groups of 20 subjects each where subjects from Group I were managed with olecranon osteotomy and Group II subjects with triceps-lifting approach (TRAP). In the two groups, subjects were comparable at baseline for degree of fracture comminution, duration of injury, gender, and age. The results in two groups were compared concerning complications, range of motion, hospital stay, and operative time. Functional evaluation was done utilizing the MEPS (Mayo elbow performance score) and were followed for 1 year.

Results: The study results showed that fracture was united at or before 4 months in all subjects except for 2 subjects from Group II where fracture union was seen at 7 months. Mean time for union was comparable in two groups. Mean union time in two groups was statistically comparable with $p > 0.05$. In Group I, mean extension loss and degree of flexion was 12 ± 4.68 and 118.23 ± 4.92 , whereas, in Group II, it was 11 ± 3.82 and 118 ± 7.31 respectively. Mean range of motion was comparable in two groups and non-significant difference was seen MEPS with $p = 0.551$. Overall rate of complications was 30% in olecranon osteotomy and 40% in TRAP.

Conclusion: The present study concludes that intra-articular distal humerus fracture necessitates its surgical fixation for attaining best functional outcomes. Despite being technically challenging, TRAP exposure is comparable in efficacy to olecranon osteotomy approach with both the techniques depicting no significant differences concerning functional and clinical results for the management of intra-articular distal humerus fracture.

Keywords: Intraarticular distal humerus fracture, MEPS, Olecranon osteotomy, TRAP.

INTRODUCTION

Intra-articular distal humerus fractures are rarely seen in the adult subjects with high variability in the incidence of fracture based on the gender and age of the affected subjects. Among all the fractures in the human body, the incidence of distal humerus fracture is nearly 0.5-2% and in all cases of distal humerus fractures, intraarticular fractures constitute to 30% of total fractures. The management of these fractures is challenging to even the experienced surgeons owing to the limited subchondral bone, multiple fracture fragments, and complex anatomy of the elbow. The outcomes in distal humerus fracture are largely dependent on age, gender, type of fracture, choice of implant, and the surgical procedure. Intraarticular distal humerus fracture, for its management, need early mobilization, rigid fixation, and anatomic reconstruction to attain good

functional outcomes and best management of these fractures is open reduction and internal fixation. However, results reported still remains controversial.¹

Bicolumnar fixation of these fractures using two plates and following a 90-90 pattern is an efficacious way of management that use 2 plates placed orthogonally. Different approaches used in these types of fractures are olecranon osteotomy, triceps sparing, triceps splitting, and triceps lifting (Campbell's approach). There are various associated benefits and disadvantages associated with each approach. The most commonly used in all these approaches is olecranon osteotomy as it provides effective articular reduction and maximum exposure with good functional outcomes being reported. However, this method has associated complications as non-union of the osteotomy site, delayed union, and prominent hardware.²

Considering these limitations, an alternative approach was suggested in the year 2000 by O' Driscoll et al known as TRAP (Triceps Reflecting Anconeus Pedicle) approach using midline incision for exposure of the fracture. This approach spares the osteotomy related complications and provide the same exposure and has added benefit of retention of whole olecranon to utilize it as a template against which articular fragments of the trochlea can be joined. Also, it preserves the neurovascular supply of the anconeus maintaining the elbow stability. Other approaches such as Triceps-sparing approach use limited extensibility and less exposure and Triceps-splitting approach has limited exposure of the fracture. Literature data suggest less surgical duration, complications, and better outcomes with TRAP compared to olecranon osteotomy.³

However, few studies in existing literature report no statistical difference for function outcomes with either with TRAP or olecranon osteotomy with few data reporting conflicts concerning the choice of ideal approach.⁴ The present study was aimed to comparatively evaluate the functional outcomes of triceps-lifting approach (TRAP) and olecranon osteotomy in the management of intra-articular distal humeral fractures.

MATERIALS AND METHODS

The present comparative clinical study was aimed to comparatively evaluate the functional outcomes of triceps-lifting approach (TRAP) and olecranon osteotomy in the management of intra-articular distal humeral fractures. The study was done at Department of Orthopaedics, Saraswati Medical College, Unnao, Uttar Pradesh. Verbal and written informed consent were taken from all the subjects before study participation.

The present study assessed 40 subjects in the age range of 18-70 years that reported to the institute within the defined study period with intraarticular fracture of the humerus. These 40 subjects were divided into two groups of 20 subjects each where subjects from Group I were managed with olecranon osteotomy and Group II subjects with triceps-lifting approach (TRAP). The inclusion criteria for the study were subjects with grade 1 open fractures, Type C (AO/ASIF classification), no associated fracture in the same limb, no neurovascular involvement, and fresh fractures < 3 weeks. The exclusion criteria for the study were subjects with associated ipsilateral upper limb fractures, >3 weeks old fractures, associated neurovascular deficit, grade 2 & 3 open fracture, and medically unfit for surgery.

After preoperative routine investigations and preanesthetic check-up, subjects were taken for surgery. All subjects underwent surgery under general anesthesia in lateral decubitus position using arm support. A digital pneumatic tourniquet was applied in most proximal part of the arm and preoperative antibiotics were given. Under strict aseptic protocol, 14-16 cm midline skin incision was given curving over the tip of the olecranon. Lateral and medial full-thickness flaps were raised and ulnar nerve was identified and tagged using infant feeding tube. Nerve dissection was done from proximal to distal from mesial edge of tendon to first motor branch to the flexor carpi ulnaris muscle followed by further dissection.

In Group I, preserving the triceps insertion on olecranon, muscle elevation was done from medial to lateral intermuscular septa. Artery or sponge was put across articular surface for preservation. Intra-articular distally oriented chevron (reverse V) osteotomy was performed using an oscillating saw to the subchondral bone. Osteotome was then used for osteotomy completion and olecranon was raised using triceps off the posterior aspect of the humerus extraperiosteally.

In Group II, TRAP approach was used following O Driscoll et al in 2000 to expose the fracture. The approach started laterally between anconeus and extensor carpi ulnaris identical to Kocher approach. Precaution was taken to not cut the anular ligament and lateral collateral ligament. Sub-periosteal dissection was done for anconeus and it was raised with posterior capsule and triceps to expose distal humerus.

In both the groups, first articular reduction was done using a pointed clamp and fixed provisionally with k- wire that was replaced later using 4mm cannulated cancellous screw. The lateral or medium column was fixed then using an articular fragment and then remaining column. Medial column was fixed to medial surface and lateral column on posterior surface using reconstruction plate or pre-contoured locking anatomical plate. Care was taken to allow proper fit of the plates to the bony surfaces. Intraoperative imaging was done to confirm proper plate placement and confirm reduction. Valgus stability test, extension to check motion arc and varus, and flexion done for elbow stability.

In Group I, tension band wiring was done using 2 k-wire for olecranon osteotomy and in Group II, triceps were sutured to olecranon using drill holes with interrupted suture. Tourniquet was released and homeostasis was attained before closing the wound in layers over suction drain. Aseptic drainage and posterior slabs were applied.

For postoperative care and follow-up, in all subjects, posterior slab was kept in place in 90-degree flexion for prevention of oedema and limb was kept elevated for 2 days. Subjects were discharged on 5th postoperative day and were recalled for suture and splint removal at 2 weeks. This was followed by initiation of a physiotherapy program using passive gentle range of motion exercise that increased gradually. For subjects that underwent TRAP, active elbow extension was restricted for 6-8 weeks and was started after 2 weeks in osteotomy group.

All subjects were followed at 2 weeks postoperatively after removal of sutures and splint and based on the condition of the wound. At 6 weeks, 12-, and 18-weeks subjects were followed sequentially followed by recall after every 2 months till 12 months. At each follow-up, subjects were assessed for any unpleasant symptom as ROM at the elbow, signs of infection, swelling, and pain. Lateral and AP view of affected elbow was taken at each follow-up. At final follow-up of 12 months, MEPS (Mayo's elbow performance score), triceps strength, and elbow range of motion was calculated.

The data gathered were statistically analyzed using chi-square test, Fisher's exact test, Mann Whitney U test, and SPSS (Statistical Package for the Social Sciences) software version 24.0 (IBM Corp., Armonk, NY, USA) using ANOVA, chi-square test, and student's t-test. The significance level was considered at a p-value of <0.05.

RESULTS

The present comparative clinical study was aimed to comparatively evaluate the functional outcomes of triceps-lifting approach (TRAP) and olecranon osteotomy in the management of intra-articular distal humeral fractures. The present study assessed 40 subjects divided into two groups of 20 subjects each where subjects from Group I were managed with olecranon osteotomy and Group II subjects with triceps-lifting approach (TRAP). The mean age of the study subjects was 37.43 and 43 years in groups I and II. There were 10 males and 10 females in Group I and 6 males and 14 females in Group II. The involved side was left in 14 subjects and 6 had right side involved in Group I. In group II, left and right side was involved in 12 and 8 subjects respectively. Fracture type was C1, C2, and C3 in 6, 12, and 2 subjects from Group I and 8, 8, and 4 subjects from Group II respectively. Time from trauma to surgery in Groups I and II was 5.03 and 5.53 days respectively (Table 1).

Table 1: Demographic and fracture data in two groups of study subjects at baseline

S. No	Characteristics	Group I	Group II
1.	Mean age (years)	37.43	43
2.	Gender		
a)	Males	10	6
b)	Females	10	14
3.	Side		
a)	Left	14	12
b)	Right	6	8
4.	Fracture type		
a)	C1	6	8
b)	C2	12	8
c)	C3	2	4
5.	Time from trauma to surgery (days)	5.03	5.53

It was seen that for comparison of range of motion and outcome variables in study subjects, range of motion showed pronation of 77-degrees in group I and 80.73 degrees in Group II with a non-significant difference with p=0.225. similar non-significant difference in two groups for supination, extension loss, and flexion with p=0.675, 0.443, and 0.88 respectively. For outcome variables, MEPS and fracture union was comparable in two groups with p=0.551 and 0.65. however, stay duration and surgery time was significantly higher in Group II compared to Group I with p=0.0001 and 0.004 respectively (Table 2).

Table 2: Comparison of range of motion and outcome variables in study subjects

S. No	Variables	Group I (olecranon osteotomy)	Group II (TRAP)	p-value
1.	Range of motion (degrees)			
a)	Pronation	77	80.73	0.225
b)	Supination	71	72.23	0.675
c)	Extension loss	12	11	0.443
d)	Flexion	118.23	116	0.88

2.	Outcome variables			
a)	MEPS	86.23	84.23	0.551
b)	Fracture union (weeks)	12.83	13.03	0.65
c)	Stay duration (days)	5.43	9.83	0.0001
d)	Blood loss (ml)	200	224	
e)	Surgery time (minutes)	111.23	119.3	0.004

The study results showed that for comparison of postoperative complications in two groups of study subjects, extensor weakness was seen in 2 subjects from Group II and no subject from group I, delayed union at osteotomy in 2 subjects from Group I only, ulnar neuropathy in 2 subjects from Group II, hardware prominence in 2 subjects from Group I, and superficial infection in 2 subjects from Group I and 4 subjects from Group II respectively. Non-union and deep infection was not seen in any subject from either group (Table 3).

Table 3: Comparison of postoperative complications in two groups of study subjects

S. No	Complications	Group I	Group II
1.	Extensor weakness	0	2
2.	Delayed union at osteotomy	2	-
3.	Ulnar neuropathy	0	2
4.	Hardware prominence	2	0
5.	Non union	0	0
6.	Deep infection	0	0
7.	Superficial infection	2	4

Concerning the comparison of MEPS, for olecranon osteotomy, MEPS grading was excellent, good, fair, and poor in 40% (n=8), 40% (n=8), 10% (n=2), and 10% (n=2) study subjects respectively. In TRAP group, MEPS grading was excellent, good, fair, and poor in 50% (n=10), 40% (n=8), 10% (n=2), and 0 subjects respectively. In overall, MEPS grading was excellent, good, fair, and poor in 45% (n=18), 40% (n=16), 10% (n=4), and 5% (n=2) subjects respectively (Table 4).

Table 4: MEPS grading results in two groups of study subjects

S. No	Technique	Excellent n (%)	Good n (%)	Fair n (%)	Poor n (%)
1.	Olecranon osteotomy	8 (40)	8 (40)	2 (10)	2 (10)
2.	TRAP	10 (50)	8 (40)	2 (10)	0
3.	Total	18 (45)	16 (40)	4 (10)	2 (5)

DISCUSSION

The present study assessed 40 subjects divided into two groups of 20 subjects each where subjects from Group I were managed with olecranon osteotomy and Group II subjects with triceps-lifting approach (TRAP). The mean age of the study subjects was 37.43 and 43 years in groups I and II. There were 10 males and 10 females in Group I and 6 males and 14 females in Group II. The involved side was left in 14 subjects and 6 had right side involved in Group I. In group II, left and right side was involved in 12 and 8 subjects respectively. Fracture type was C1, C2, and C3 in 6, 12, and 2 subjects from Group I and 8, 8, and 4 subjects from Group II respectively. Time from trauma to surgery in Groups I and II was 5.03 and 5.53 days respectively. This was comparable to the previous studies of Jain R et al⁵ in 2023 and Wilkinson JM et al⁶ in 2001 where authors assessed subjects with humerus fracture and demographic and disease data comparable to the present study in their studies.

The study results showed that for comparison of range of motion and outcome variables in study subjects, range of motion showed pronation of 77-degrees in group I and 80.73 degrees in Group II with a non-significant difference with p=0.225. similar non-significant difference in two groups for supination, extension loss, and flexion with p=0.675, 0.443, and 0.88 respectively. For outcome variables, MEPS and fracture union was comparable in two groups with p=0.551 and 0.65. however, stay duration and surgery time was significantly higher in Group II compared to Group I with p=0.0001 and 0.004 respectively. These results were consistent with the findings of Mckee MD et al⁷ in 2000 and Mckee MD et al⁸ in 2004 where results reported by the authors for range of motion and outcome variables after olecranon osteotomy and TRAP were comparable to the results of the present study.

It was seen that for comparison of postoperative complications in two groups of study subjects, extensor weakness was seen in 2 subjects from Group II and no subject from group I, delayed union at osteotomy in 2 subjects from Group I only, ulnar neuropathy in 2 subjects from Group II, hardware prominence in 2 subjects from Group I, and superficial infection in 2 subjects from Group I and 4 subjects from Group II respectively. Non-union and deep infection was not seen in any subject from either group. These findings were in agreement with the results of Atalar AC et al⁹ in 2009 and Pankaj A et

al¹⁰ in 2007 where complications of olecranon osteotomy and TRAP similar to the present study were also reported by the authors.

For the comparison of MEPS, for olecranon osteotomy, MEPS grading was excellent, good, fair, and poor in 40% (n=8), 40% (n=8), 10% (n=2), and 10% (n=2) study subjects respectively. In TRAP group, MEPS grading was excellent, good, fair, and poor in 50% (n=10), 40% (n=8), 10% (n=2), and 0 subjects respectively. In overall, MEPS grading was excellent, good, fair, and poor in 45% (n=18), 40% (n=16), 10% (n=4), and 5% (n=2) subjects respectively. These results correlated with the findings of Chen G et al¹¹ in 2011 and Zhang C et al¹² in 2014 where results reported by the authors for comparison of MEPS for olecranon osteotomy and TRAP were comparable to the results of the present study.

CONCLUSION

Within its limitations, the present study concludes that intra-articular distal humerus fracture necessitates its surgical fixation for attaining best functional outcomes. Despite being technically challenging, TRAP exposure is comparable in efficacy to olecranon osteotomy approach with both the techniques depicting no significant differences concerning functional and clinical results for the management of intra-articular distal humerus fracture.

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