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Indian Journal of Orthopaedics Surgery

Journal homepage: <https://www.ijos.co.in/>

Original Research Article

Comparison of TRAP (triceps reflecting anconeus pedicle approach) v/s olecranon osteotomy approach for treatment of intercondylar fracture humerus

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ARTICLE INFO

Article history:

Received 06-10-2021

Accepted 22-10-2021

Available online 01-12-2021

Keywords:

Olecranon osteotomy

TRAP (triceps reflecting anconeus pedicle approach)

Intercondylar fractures

Mayo elbow performance score

ABSTRACT

Introduction: Distal humerus fractures constitute 2 to 7% of all the elbow fractures. Young males are most commonly affected due to high energy trauma and secondly seen in elderly women due to osteoporosis. Due to complex anatomy and neurovascular network nearby, the treatment is very difficult. Anatomical reconstruction is the key for successful functional outcome. We compared the TRAP and olecranon osteotomy approach for the management of intraarticular fractures of the humerus in terms of functional, clinical and radiological outcome.

Materials and Methods: The study was conducted in the Department of Orthopaedics & Traumatology, MGM Medical College and MY Hospital, Indore from August 2019 to August 2021 on 30 patients with intra-articular fractures of humerus. 15 patients were treated with olecranon osteotomy and 15 patients were treated with TRAP approach, on patients fulfilling all the inclusion, but none of the exclusion criteria. The functional outcome was measured using Mayo Elbow Performance Score (MEPS) and radiographs were used for evaluating the bone union time.

Results: There was a male predominance. Assault, fall and road traffic accidents were the modes of injury. 13-B2, 13-C1 and 13-C3 were commonly seen fracture types. Mean MEPS was significantly better in TRAP ($P < 0.05$) and full triceps strength was achieved in 86.7% patients by 3 months in TRAP and by 6 months in olecranon osteotomy group. The mean blood loss and duration of surgery was significantly longer in olecranon group ($P < 0.05$). The bone union time and hospital stay were comparable between the groups ($P > 0.05$). 73.3% patients of TRAP and 64.3% patients of olecranon osteotomy group achieved excellent outcome by 6 months.

Conclusion: TRAP approach is comparatively better than osteotomy approach. Both the methods provide a stable fracture fixation, but complications are more in osteotomy in comparison to TRAP and we found TRAP to be functionally better.

Abbreviations: TRAP-triceps reflecting anconeus pedicle approach, MEPS-Mayo Elbow Performance Score, DASH-disabilities of the arm, shoulder and hand, POP-plaster of Paris

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1. Introduction

Approximately, 2% to 7% of all adult fractures involve the elbow are distal humeral fracture. The most common, pattern is, an extra-articular fracture accounting for 40%. Bicolumnar or complete intraarticular fractures, are the

second most common accounting for 37%. These injuries occur in a bimodal distribution, with an early peak in young males, twelve to nineteen years of age as a result of high-energy trauma. A second peak in elderly women, with osteoporotic bone, as a result of simple fall. This fractures of elbow are the most difficult one to treat due to poor assessment of the this fractures with traditional approach and its complex anatomy and passing by neurovascular

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bundles.¹ Anatomical reconstruction of the articular surface and stable internal fixation are the key factors for successful functional outcomes. Adequate exposure of the articular surface is a prerequisite for anatomic reconstruction and stable fixation of these fractures.²

To better visualize the articular surface, olecranon osteotomy, Bryan-Murrey (triceps reflecting), triceps splitting and triceps-reflecting anconeus pedicle (TRAP) approaches have been used. TRAP approach, as defined by O'Driscoll et al.³ This approach is a combination of modified Kocher and Bryan-Morrey, mobilizes the triceps and anconeus muscle of the posterior humerus and proximal ulna, and also provides adequate exposure of distal humerus.

Olecranon osteotomy is well described approach for complex intra-articular distal humeral fractures. But it has potential complications related to prominence/migration of hardware, displacement/nonunion of osteotomy and triceps weakness. Triceps-reflecting anconeus pedicle (TRAP) approach avoids the olecranon osteotomy without compromising the operative exposure.⁴

The indications and superiority of these two techniques are a question of debate. In the literature, there are limited numbers of studies on this issue. The current study aimed to compare the TRAP approach with olecranon osteotomy regarding their effects on the functional results of intercondylar humerus fractures treated with open reduction and internal fixation (ORIF).

2. Materials and Methods

The present prospective, comparative study was conducted on 30 patients with intercondylar fracture humerus during a study period from August 2019 to August 2021 fulfilling the inclusion and exclusion criteria. The approval for the conduct of the study was obtained from the Institutional Review Board. Also prior to the inclusion of any patient in the study, a voluntary written informed consent was obtained from each patient.

2.1. Inclusion criteria

Patient with age more than 18 years and less than 70 years); 2) Patient with partial or complete intra-articular fracture of distal humerus (13B and 13C); 3) Patient with closed fracture; and 4) Patient with fracture less than 2 weeks.

2.2. Exclusion criteria

1) open fracture; 2) vascular injury; 3) a fracture more than 2 weeks old; 4) patient of age less than 18 years and more than 70 years; 5) Having associated ipsilateral, comminuted fractures extending into elbow joint in the same limb; 6. Patient with co-morbid conditions like uncontrolled diabetes mellitus, etc.

Olecranon osteotomy in the treatment of comminuted distal fractures of the humerus which involve the articular surface has been found to be valuable. But by doing this, the complexity of the procedure increases and also has its own complications.⁵

In our study, patients were randomized to either groups – TRAP or osteotomy based on odd and even method of randomization for any type (13B, 13C) intraarticular fracture humerus.

2.3. Surgical technique

All the patients and/or his/her legally acceptable representative were explained about the study in detail in their own language. After obtaining a verbal consent for participation in the study, a voluntary written informed consent was obtained from them. All study related procedures were conducted after obtaining the voluntary written informed consent.

All the patients underwent routine physical and clinical examination. Preoperative hematological examinations and anesthetic checkup was done prior to the surgery. All surgeries were done under general or regional anesthesia. Surgery was performed in lateral position and under sterile tourniquet.

2.4. Triceps reflecting anconeus pedicle (TRAP)

A straight posterior incision is made lateral to the olecranon tip, approximately 10cm proximal and 8cm distal. Medial and lateral skin flaps were raised to expose the supracondylar ridges on either side of the distal humerus. The ulnar nerve was initially localized proximally, where it emerged beneath the triceps tendon. To increase the mobility of ulnar nerve, the distal aspect of intermuscular septum was released. Anconeus triceps flap was detached from its distal attachment. Reduction of intra-articular component was done, followed by reduction of reconstituted condylar block and was fixed to the medial and lateral columns using Kirschner wires and precontoured anatomical plating done. Additional fixation was given by placing the long lag-screws from the medial or lateral epicondyles. To confirm the adequacy, intraoperative photographs were taken. Triceps and anconeus were reattached with sutures and holes were drilled through the bone in the region of olecranon.

2.5. Olecranon osteotomy

The surgical steps followed in olecranon osteotomy are same as triceps reflecting anconeus pedicle approach, with an additional osteotomy. The site of osteotomy was identified after incising the medial capsule after retracting the ulnar nerve or lateral capsule, after elevating the part of anconeus muscle and finding the center of trochlear notch. Osteotomy was performed 2cm distal to the tip

of olecranon using an oscillating saw. Osteotomy was completed using osteotome by levering the osteotome proximally. This causes in cracking of subchondral bone and uneven surface is created that facilitated reduction. After incision of posterior elbow capsule, joint was reached. Fragments reduction was done using temporary K-wires and precontoured anatomical plating done. Proximal fragment of the olecranon was repositioned. Fixation was obtained using a tension band over 2 Kirschner wires and wound was closed. We had preferred Chevron osteotomy as it provides stable bony contact during the repair of the olecranon reduction. The bone healing improved because of larger surface and shape improved the rotational stability.

After successful surgery and stabilization the patients were discharged home with instructions to review on regular follow-ups.

During the postoperative period, patients followed the protocol given below:

1. Above elbow POP slab was applied in 60 deg flexion for 2 weeks in TRAP patients and 90 deg flexion in olecranon osteotomy patients.
2. Check x-rays were taken and stitches were removed after 2 weeks.
3. Patients were not allowed to do full extension for 4 weeks.

The Mayo Elbow Performance Score was used for evaluating the functional outcome at 2 weeks, 4 weeks, 3 months and 6 months postoperatively. At each follow-up anatomical reduction, union time, functional outcome and complications were evaluated. Anteroposterior and lateral view radiographs were taken at each follow-up till bony union was achieved.

Mayo Elbow Performance Score (MEPS) and complications were the outcome measures.

The Mayo Elbow Performance Score (MEPS) used 4 subscales - pain; range of motion (arc of motion of the art. humeroulnaris); stability and daily function to evaluate the limitations caused by pathology of the elbow during performing the activities of daily living (ADL). And is rated on a scale of 100. A score of <60 is poor; 60-74 is fair; 75-89 is good and above 90 is excellent.⁶

The statistical analysis was carried out using GraphPad and Epi Info. The comparison of mean within the groups was done using Paired 't' test and association between two non-parametric variables was done using Pearson Chi-square test. A p value of < 0.05 was taken as statistically significant.

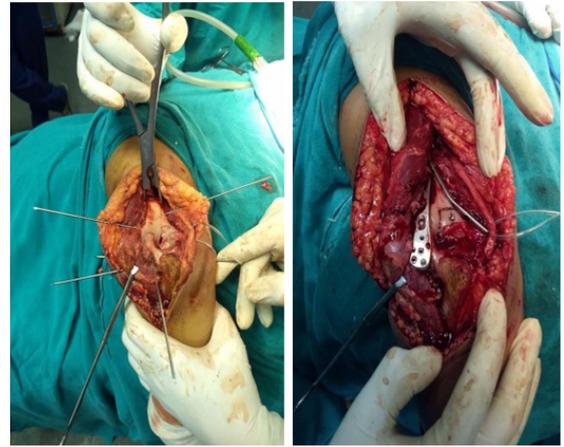


Fig. 1: Intraoperative view of a patient after plating using TRAP approach in which olecranon fully skeletonized

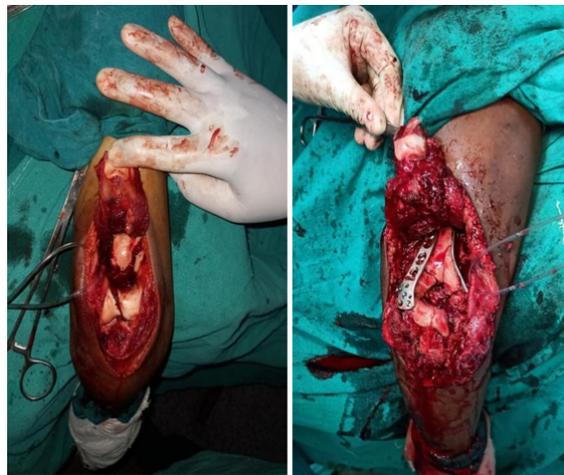


Fig. 2: Intraoperative view of a patient shows chevron-shaped osteotomy and after plate application



Fig. 3: Preoperative and post operative radiograph using TRAP approach (X Ray 1&2)



Fig. 4: Preoperative and postoperative radiograph using olecranon osteotomy approach

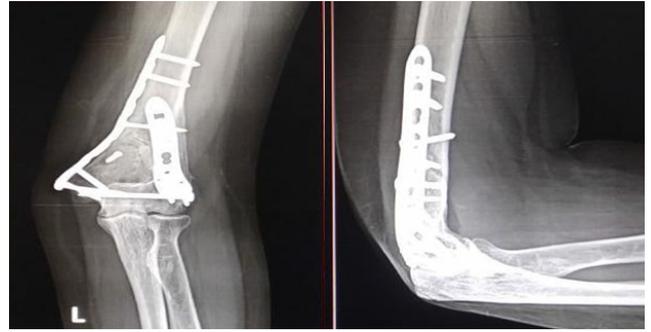


Fig. 7: Follow-up radiograph at 6 months also showing bone union



Fig. 8: Clinical photograph of the patient showing range of motion in extension and flexion



Fig. 5: Follow-up radiograph at 2 weeks



Fig. 9: Follow-up radiograph at 2 weeks

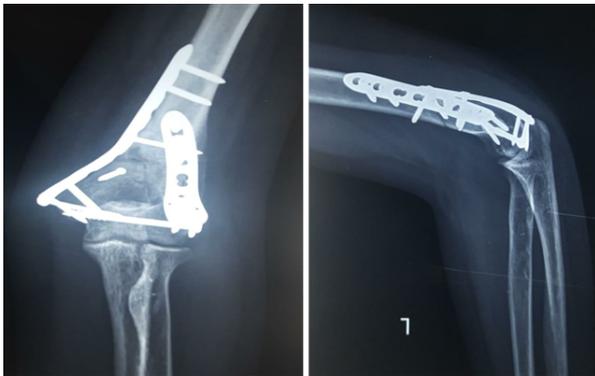


Fig. 6: Follow-up radiograph at 3 months

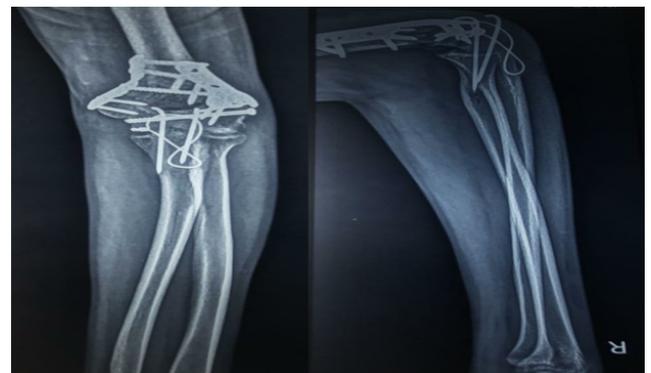


Fig. 10: Follow-up radiograph at 3 months



Fig. 11: Follow-up radiograph at 6 months also showing bone union

2.6. TRAP (Triceps Reflecting Anconeus Pedicle Approach) radiographs (Figures 5, 6, 7 and 8)

2.7. Olecranon osteotomy radiographs (Figures 9, 10 and 11)

3. Results

There were 15 (50%) patients in olecranon osteotomy group and TRAP group respectively and case selection was by odd and even method. Majority of the patients in both the groups were in 41-60 years. The mean age 40.13 ± 11.87 years in olecranon osteotomy group and 43.73 ± 13.71 years in TRAP group. (Table 1)

Table 1: Age wise distribution

Age	Olecranon osteotomy		TRAP	
	No.	%	No.	%
18-20 years	1	6.7	0	0.0
21-40 years	5	33.3	7	46.7
41-60 years	9	60.0	8	53.3
Total	15	100.0	15	100.0

There were 5 (33.3%) females and 10 (66.7%) males in olecranon osteotomy group; and 8 (53.3%) females and 7 (46.7%) males in TRAP group. In both the groups males were predominant.

In olecranon group, in majority of the patients assault (33.3%) was main mode of injury, followed by fall from swing (26.7%), fall in bathroom (20%) and fall on ground (20%). In TRAP group, in majority of the patients fall from 2 wheeler (40%) was the main mode of injury, followed by fall on ground (26.7%); road traffic accident (2 wheeler vs. 2 wheeler) (20%) and assault (13.3%).

In the olecranon group, 4 (26.7%) patients had 13-B1 fracture, 4 (26.7%) had 13-C1 fracture, 1 (6.7%) had 13-C2 fracture and 6 (40.0%) had 13-C3 fracture. In the TRAP group, 6 (40.0%) patients had 13-B2 fracture, 6 (40%) had 13-C1 fracture, 2 (13.3%) had 13-C2 fracture and 1 (6.7%) had 13-C3 fracture.

There was a significantly higher blood loss in olecranon osteotomy group in comparison to TRAP group (390.00 ± 78.74 ml vs. 220.00 ± 25.35 ml, $P=0.001$), similarly the duration of surgery was also significantly longer in olecranon osteotomy group (1.92 ± 0.16 hours vs. 1.41 ± 0.15 hours, $P=0.001$).

The mean total of MEPS was significantly higher in TRAP group at 2 weeks (8.33 ± 5.56 vs. 29.00 ± 4.71 , $P=0.001$) and at 4 weeks (32.67 ± 2.58 vs. 48.67 ± 8.12 , $P=0.001$), while it was comparable between the two groups at 3 months (64.67 ± 9.72 vs. 68.00 ± 8.62 , $P=0.329$) and at 6 months (83.67 ± 12.60 vs. 86.67 ± 9.39 , $P=0.466$).

Triceps strength was evaluated at 4 weeks, 3 months and 6 months. In TRAP group, by 4 weeks, 1 (6.7%) patient had Grade 2, 7 (46.7%) had grade 3 and 7 (46.7%) had grade 4 triceps strength. At 3 months, 1 (6.7%) had Grade 2, 1 (6.7%) had grade 4 and 13 (86.7%) had grade 5. At 6 months, 1 (6.7%) had Grade 3, 1 (6.7%) had grade 4 and 13 (86.7%) had grade 5.

In olecranon osteotomy group, 10 (66.7%) patients had Grade 2, 5 (33.3%) had Grade 3 triceps strength. At 3 months, 7 (46.7%) had grade 3 and 8 (53.3%) had grade 4. At 6 months, 1 (6.7%) had Grade 3, 1 (6.7%) had grade 4 and 13 (86.7%) had grade 5. (Table 2)

The mean hospital stay was comparable between TRAP and olecranon osteotomy groups (4.13 ± 0.99 vs. 4.13 ± 0.99 days, $P=1.000$), while the mean suture removal was comparable between the two groups (15.67 ± 1.45 olecranon osteotomy vs. 14.67 ± 1.49 TRAP group, $P=0.073$).

The mean bone union time was comparable between the TRAP group (10.87 ± 0.99 weeks) in comparison to olecranon osteotomy group (10.87 ± 0.99 weeks), $P=1.000$.

According to MEPS, in the olecranon osteotomy group, 1 (7.1%) patient had poor and fair outcomes respectively, 4 (26.7%) had good outcome and 9 (60.0%) had excellent outcome. In the TRAP group, 1 (6.7%) had fair outcome, 3 (20%) had good outcome and 11 (73.3%) had excellent outcome. (Table 3)

In olecranon osteotomy group, 6 patients had complications. 1 (6.7%) patient each had elbow stiffness, infection, implant impingement and TBW failure, respectively. 2 (13.3%) patients had triceps weakness. In TRAP group, complications were seen in 3 patients. 1 (6.7%) patient each had elbow stiffness, triceps weakness and implant impingement, respectively. (Table 4)

Table 2: Comparison of MEPS

Follow-up	Olecranon osteotomy [Mean±SD]	TRAP [Mean±SD]	't' value	P value
2 weeks	8.33 ± 5.56	29.00 ± 4.71	-10.985, df=28	0.001*
4 weeks	32.67 ± 2.58	48.67 ± 8.12	-7.272, df=28	0.001*
3 months	64.67 ± 9.72	68.00 ± 8.62	-0.944, df=28	0.329, NS
6 months	83.67 ± 12.60	86.67 ± 9.39	-0.739, df=28	0.466, NS

Table 3: Comparison of final outcome based on MEPS

Final Outcome	Olecranon osteotomy		TRAP	
	No.	%	No.	%
Poor	1	6.7	0	0.0
Fair	1	6.7	1	6.7
Good	4	26.7	3	20.0
Excellent	9	60.0	11	73.3
Total	15	100.0	15	100.0

Table 4: Comparison of complications

Complications	Olecranon osteotomy		TRAP	
	No.	%	No.	%
None	9	60.0	12	80.0
Elbow stiffness	1	6.7	1	6.7
Infection	1	6.7	0	0.0
TBW failure	1	6.7	0	0.0
Triceps weakness	2	13.3	1	6.7
Implant impingement	1	6.7	1	6.7
Total	15	100.0	15	100.0

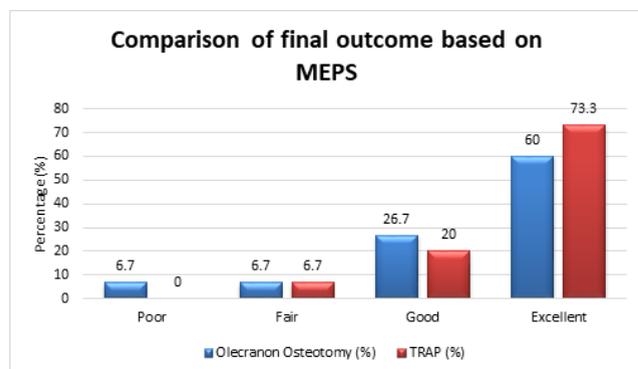


Fig. 12: Comparison of final outcome based on MEPS

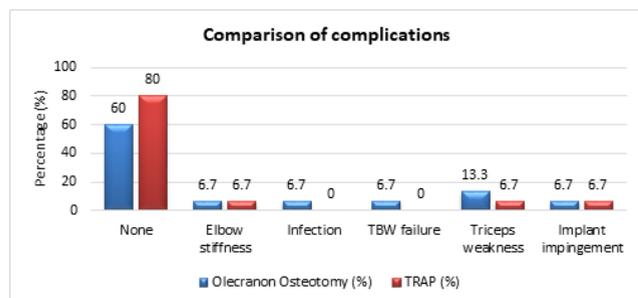


Fig. 13: Comparison of complications

4. Discussion

The present study showed that Triceps Reflecting Anconeus Pedicle (TRAP) method is better than olecranon osteotomy in terms of overall Mayo Elbow Performance Score (P<0.05) as well as all its subscales were better in TRAP method in comparison to olecranon osteotomy (P<0.05).

We had included 30 patients in the study, of 15 patients (5 females, 10 males) underwent TRAP and 15 (4 females and 11 males) underwent olecranon osteotomy. There was a male predominance in both the groups. The mean age 40.13 ± 11.87 years in olecranon osteotomy group and 43.73 ± 13.71 years in TRAP group (P>0.05). Azboy et al³ in their study also reported a male predominance in both the groups.

In the olecranon group, fracture type 13-C3, 13-B1 and 13-C1 and in TRAP group 13-B2 and 13-C1 were the most commonly seen.

Significantly higher blood loss, longer surgery duration and longer hospital stay was seen in olecranon osteotomy in comparison to TRAP group (P<0.05). Ansari et al⁷ had included all patients with fracture type 13-C2 and reported a significantly lower operative time in triceps sparing in comparison to olecranon osteotomy (77 ± 4.64 vs. 93.11 ± 8.78 min, P<0.05), which is comparable to our study findings, through the operative time was slightly longer in both the groups in our study. Verma et al⁸ in their study

reported a significantly lower operative time in olecranon osteotomy in comparison to TRAP (1.92 ± 0.16 hours vs. 1.41 ± 0.14 hours, $P < 0.05$), which is contradictory to our findings.

The mean suture removal time was comparable between the two groups ($P > 0.05$).

The mean MEPS was significantly higher in TRAP group at 2 and 4 weeks ($P < 0.05$), while it was comparable between TRAP and olecranon osteotomy group at 3 months and 6 months ($P > 0.05$). Ansari et al⁷ reported significantly better MEPS score in triceps sparing group in comparison to olecranon osteotomy group (86.56 ± 10.66 vs. 83.57 ± 10.96 , $P < 0.05$), which is comparable to our study findings.

While Azboy et al³ found no significant difference between mean MEPS between the two groups ($P > 0.05$), similarly another study done by Jain et al⁹ also reported no significant difference in the mean MEPS between the two groups ($P = 0.318$), which is contradictory to our study findings.

Full triceps strength was achieved in 86.7% of TRAP group patients by 3 months, while it took 6 months for 86.7% patients of olecranon group to achieve full triceps strength. The mean bone union time was comparable between TRAP group and olecranon osteotomy groups ($P > 0.05$). Mittal et al¹⁰ in their study reported a mean bone union time at or before 6 months in majority of their patients, and in some patients, they found union at 9 months; while in our study the union was achieved in both the groups by 11 weeks, that is earlier than that reported by Mittal. Another study by Pankaj et al⁴ reported mean bone union time of 3.2 ± 1.6 months, which is comparable to our study findings.

According to MEPS in the olecranon group, good to excellent outcome were seen in 13 patients, while it was seen in 14 patients of TRAP group. We found slightly better MEPS outcome in TRAP group. Ansari et al⁷ reported higher prevalence of excellent outcome in triceps sparing group (16) in comparison to olecranon osteotomy group (12), which is similar to our findings. And the study done by Verma et al⁸ found excellent outcome in slightly more number of patients of TRAP group in comparison to olecranon osteotomy group, but the comparison was found to be statistically not significant ($P > 0.05$), which is contradictory to our findings.

In olecranon group, complications were seen in 6 patients, triceps weakness was seen in 2 patients, while elbow stiffness, infection, TBW failure and implant impingement were seen in 1 patient each. While in TRAP group only 3 patients had complications, which were elbow stiffness, triceps weakness and implant impingement. Delay in postoperative rehabilitation was seen in 1 patient each in both the groups. Azboy et al³ reported higher complication rate in olecranon osteotomy group in comparison to TRAP group. Jain et al⁹ showed complication rate of 41.17% in TRAP group and 56.26% in the olecranon osteotomy

group. Verma et al⁸ reported significantly higher prevalence of complications in the TRAP (11.11%) in comparison to olecranon osteotomy group (50%), $P = 0.011$. All the studies showed a higher prevalence of complications in olecranon osteotomy group, which corroborates with our findings, but complications rates reported by Jain is much higher than the present study.

The Triceps Reflecting Anconeus Pedicle (TRAP) was found to be better in comparison to olecranon osteotomy for the management of intercondylar fracture humerus.

The limitation of the study is that we had included only 15 patients in each group, a larger sample population would have provided a better picture of the outcome. But from the available data, we feel that for the management of intercondylar fracture humerus, Triceps Reflecting Anconeus Pedicle (TRAP) is better.

5. Conclusion

Triceps Reflecting Anconeus Pedicle (TRAP) is better in comparison to olecranon osteotomy approach for the management of intercondylar fracture humerus, with lower blood loss and operative time. While the hospital stay and bone union time were comparable. Mayo Elbow Performance Score is comparatively better in TRAP in comparison to olecranon osteotomy. Both the methods provide a stable fracture fixation, but complications are more in osteotomy in comparison to TRAP and we found TRAP to be functionally better. We highly recommend the use of TRAP for the management of intercondylar fracture humerus.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Cite this article: Sharma DK, Banodha L, Goyal RL. Comparison of TRAP (triceps reflecting anconeus pedicle approach) v/s olecranon osteotomy approach for treatment of intercondylar fracture humerus. *Indian J Orthop Surg* 2021;7(4):291-298.