

# To Assess the Results of Surgical Management of Distal Humerus Fracture In Adults Using Triceps Reflecting Anconeus Pedicle (TRAP) Approach And Olecranon Osteotomy Approach: A Prospective Study

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## ABSTRACT

**Background:** Distal humerus fractures remain some of the most difficult injuries to manage despite of advances in techniques and implants. The intricate anatomy of elbow with three distinct articulation, proximity of neurovascular structures, meagre skeletal support of articular surfaces and lack of soft tissue attachments make management challenging, leaving limited option for internal fixation. The distal humerus fracture is commonly multi fragmented, occur in osteopenic bone and have complex anatomy. A painless, stable and mobile elbow joint is desired as it allows the hand to conduct the activities of daily living most notably personal hygiene and feeding. Therefore, it needs a systemic approach to achieve this goal. The present study is aimed to compare the efficacy, advantages and disadvantages of triceps reflecting anconeus pedicle approach (TRAP) and olecranon osteotomy (OO) approach in the management of distal humerus fractures.

**Methods:** The present study was conducted in the department of Orthopedics, Government Medical College, Barmer, Rajasthan, India. 33 patients were admitted in the department of orthopaedics with closed fractures of distal humerus. 17 patients were managed by open reduction and internal fixation with the plates and screw through triceps reflecting anconeus pedicle approach (TRAP) and 16 patients through olecranon osteotomy approach.

**Results:** Road traffic accident was the most common mode of injury accounting for (TRAP -50%, OO-60%) of cases, followed by this fall on ground and fall from height was the common mode of injury. Most common type of fracture was AO type C2 accounting for (TRAP-43.75%, OO-53.33%) of the cases. Average range of motion at elbow joint was (TRAP - 97.18°, OO - 107.66°). The Mayo elbow performance index (MEPI)

criteria was used in our study to evaluate final results. In present study we observed excellent result in (TRAP -12.5%, OO-19.99%), Good results (TRAP-56.25%, OO-53.32%); fair results in (TRAP-25%, OO-19.99%) and poor results in (TRAP-6.25%, OO-6.66%) cases.

**Conclusion:** It can be concluded that functional results of olecranon osteotomy (OO) approach and triceps reflecting anconeus pedicle (TRAP) approach are almost similar in management of fracture distal end humerus in adults. Both approaches have excellent articular surface visualization with limited complications. In olecranon osteotomy approach complications associated with an osteotomy including prominence/migration of hardware, displacement/non-union /delayed union of osteotomy site. Where as in TRAP approach, there is a risk of triceps dehiscence and extensor weakness.

**Keywords:** Triceps Reflecting Anconeus Pedicle (TRAP), Olecranon Osteotomy (OO), Mayo Elbow Performance Index (MEPI), Complications.

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## INTRODUCTION

Intra articular fractures of distal humerus constitute 0.5%-7% of all fractures and 30% of elbow fractures.<sup>1</sup> The frequency varied by gender and age with a higher incidence seen in males in the 12-19 year age groups while a higher incidence is seen in middle aged and elderly females.<sup>2</sup> In the younger age group distal humerus fractures occurs due to high energy trauma such as

motor vehicle collisions, fall from height, sports injuries, industrial accident and firearms. In contrast, greater than 60% of fractures in the elderly occur from low energy injuries, such fall from standing height.<sup>3</sup> The conservative treatments like closed reduction and plaster of paris (POP) immobilization, hanging arm cast and traction usually results into stiffness, malunion and non-union.

Severe comminution, bone loss and osteopenia predispose to unsatisfactory results. In the last few decades, the popularity of internal fixation of this fracture is growing fast.<sup>4</sup>

In 1913, Albin Lambotte challenged the leading opinion of conservative management for distal humerus fractures and advocated aggressive approach that consisted of open reduction & internal fixation.<sup>5</sup> He described the principles of osteosynthesis and believed anatomic restoration correlated with better return to function. Olecranon osteotomy first described by Mac Ausland<sup>6</sup> and compared with other posterior approaches. Olecranon osteotomy provides the best visualisation of the distal humerus articular surface.<sup>7</sup> The disadvantages of olecranon osteotomy approach is difficult to visualize very anterior articular fractures (AO type B3) and complications associated with an osteotomy including prominence/migration of hardware, displacement/ non-union of osteotomy and triceps weakness.

Triceps reflecting Anconeus pedicle approach (TRAP) described by Shawn W. O. Driscoll (2000). Involve completely detaching the triceps from proximal ulna with the anconeus muscle.<sup>8</sup> This approach provides good exposure to the posterior elbow joint while protecting the neurovascular supply to the anconeus muscle. The TRAP approach also avoid the complication of an olecranon osteotomy and allow the use of trochlear sulcus as a template to assist with articular reduction of distal humerus.<sup>8</sup>

## SUBJECTS AND METHODS

This study was conducted in the department of orthopaedics, Govt. Medical College, Barmer, from August 2017 to July 2019. 33 patients were admitted in the department of orthopaedics with closed fractures of distal humerus. 17 patients were managed by open reduction and internal fixation with the plates and screw through triceps reflecting anconeus pedicle approach (TRAP) and 16 patients through olecranon osteotomy approach were included in the present study. All patients were subjected to a detailed history and clinical examination with particular emphasis on mode of injury, time of injury, interval between injury and reporting and nature of treatment taken prior to admission. Clinical examination

included general, systemic, local examination of injured part and for associated injuries like head, chest-visceral injuries and other associated skeletal injuries. Depending on nature of injuries, relevant radiological examination was done and whenever required computed tomography (CT) Scan of part was also done for planning the treatment.

### Inclusion Criteria

- All closed, intra articular fracture distal humerus.
- Patients aged > 18 years.
- Duration of injury < 3 weeks.

### Exclusion Criteria

- All Open fractures.
- Associated skeletal injury of ipsilateral limb.
- Associated head injury.
- Associated active infection.
- Pre-existing disease leading to joint stiffness e.g. rheumatoid arthritis, ankylosing spondylitis, old healed septic arthritis etc.



Figure 1: Injured limb position

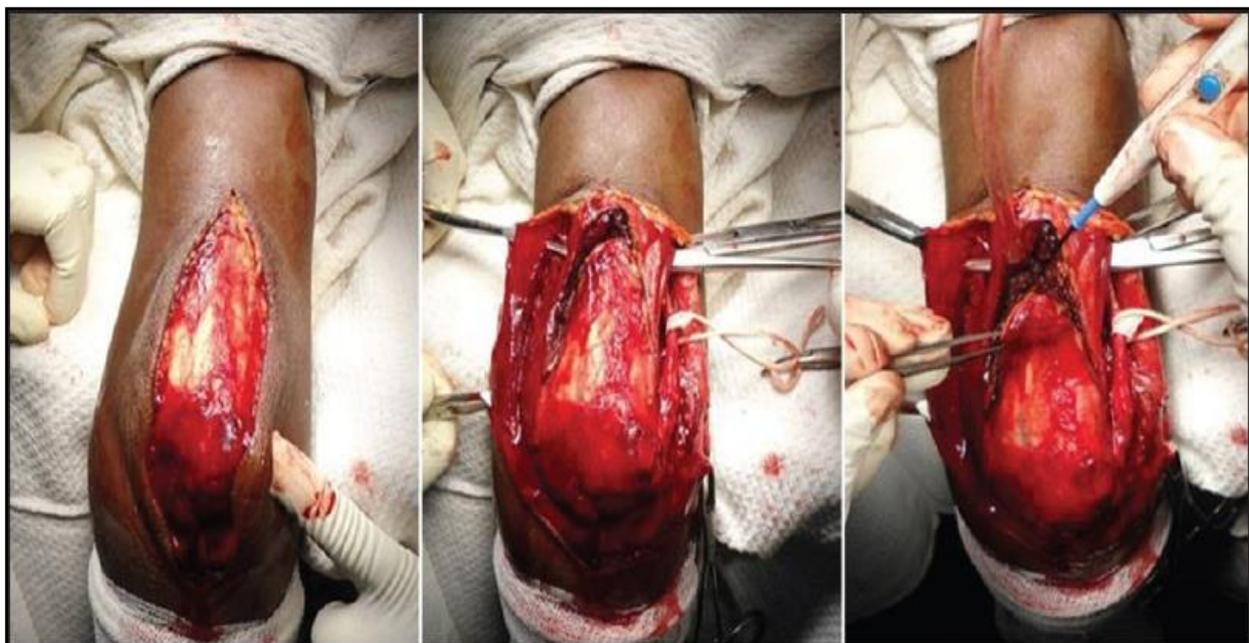


Figure 2: TRAP Approach

At the time of admission, all patients were evaluated preoperatively with standard radiographs, including AP and lateral view of elbow with lower ¾ arm. Radiograph of opposite healthy limb were also taken for comparison. Non-contrast CT of the injured elbow were made for all intra articular fracture patients. CT scan helpful to study the pattern of the fracture in greater detail. It helps in planning for reduction of fracture fragments in proper position and fixation. After preanesthetic check-up and fitness, patients were operated under regional or general anaesthesia as per protocol. All patients operated as early as possible i.e. preferably within 48 hrs.

Operations performed in lateral position with the injured limb hanging by the side of the table on a padded armrest with elbow flexed at 90°. In this position posterior surface of arm and elbow faces the surgeon. Tourniquet was applied in all cases. Selection of implants used in reconstruction procedure was done according to the type and comminution of the fracture. Implants made of 316-L stainless steel of Indian company were used. Surgical technique used either TRAP or olecranon osteotomy (OO) approach. On the basis of technique patients were divided into two groups i.e. TRAP group and OO group. Postoperatively limb was kept elevated for 48 hrs. Active finger movements were encouraged as early as possible. First postoperative dressing was done on the 3<sup>rd</sup> post-operative day. Injectable antibiotics were given once intra-operatively and then same night and next

morning postoperatively along with analgesics. The patients were discharged on average 4 postoperative day with oral antibiotics and analgesics and asked to report after 9 days for stitch removal and appropriate instructions regarding exercise program. In presence of infection or cases where infection suspected, patient was not discharged and kept in hospital till stitch removal and start appropriate antibiotics according to culture and sensitivity of discharging fluid. Depending upon the tolerance of pain and cooperation of patient gentle active and / or assisted exercises of elbow joint were started after stitch removal with the advice to keep the extremity in removable splint in between exercise. Vigorous stretching exercises were discouraged. Patients were followed up at regular intervals. After stitch removal next follow-ups were done at 3 weeks and 6 weeks postoperatively while all subsequent follow-ups were done at an interval of 4 weeks up to a minimum of 6 months. At 6 weeks splints were discarded and patient advised to keep limb in triangular sling in between exercise during day time. At every follow up a detailed clinical and radiological assessment of patient was done. A minimal follow up of 6 months was done before assessment of final results. The final results of patients were assessed as per criteria laid down by Mayo elbow performance index<sup>9</sup>.

The Mayo elbow performance index (MEPI) is one of the most commonly used physician-based elbow rating systems. This index consists of four parts:

**Table 1: Mayo elbow performance index (MEPI) scale**

Variable	Definition	No. of points
<b>PAIN (Max. 45 points)</b>	<b>None</b>	45
	<b>Mild</b>	30
	<b>Moderate</b>	15
	<b>Severe</b>	0
<b>RANGE OF MOTION (Max. 20 points)</b>	<b>Arc &gt; 100 degrees</b>	20
	<b>Arc 50 to 100 degrees</b>	15
	<b>Arc &lt; 50 degrees</b>	5
<b>STABILITY (Max. 10 points)</b>	<b>Stable</b>	10
	<b>Moderately Unstable</b>	5
	<b>Grossly unstable</b>	0
<b>FUNCTION (Max. 25 points)</b>	<b>Able to comb hair</b>	5
	<b>Able to feed on self</b>	5
	<b>Able to perform personal hygiene tasks</b>	5
	<b>Able to put on shirt</b>	5
	<b>Able to put on shoes</b>	5

The total score ranges from 5 to 100 points with higher scores indicating better function. If total score is included between 90 and 100 points, it can be considered excellent; between 75 and 89 points, good; between 60 and 74 points, fair; less than 60 points, poor.

## RESULTS

The mean age in TRAP group was 35.12 yrs (range 18-70 yrs) while in OO group was 35.6 yrs (range 25-62 yrs). Majority of patients were male (TRAP-56.25%, OO-73.26%) as they were more involved in outdoor activities & exposed to vehicular trauma.

Road traffic accident was the most common mode of injury accounting for (A-50%, B-60%) of cases, followed by this fall on ground and fall from height was the common mode of injury. In present study most common type of fracture was AO type C2 accounting for (A-43.75%, B-53.33%) of the cases. Average loss of extension in the present study was about (TRAP-16.25°, OO-12°). Most of cases (TRAP-93.75%, OO-86.58%) had no pain or only mild pain at final follow up in our series. Average range of motion at elbow joint was (TRAP- 97.18°, OO-107.66°). In present study most of the patients (TRAP-93.75%, OO-93.34%) had a stable elbow.

In TRAP group 56.25% had mean functional capacity score  $\geq 20$  and in OO 66.6% had mean functional capacity score  $\geq 20$ . In our study we observed excellent result in (TRAP -12.5%, OO-19.99%), Good results (TRAP-56.25%, OO-53.32%); fair results in

(TRAP-25%, OO-19.99%) and poor results in (TRAP-6.25%, OO-6.66%) cases. Most common complication in OO group was discomfort due to hardware protrusion (3cases). In TRAP series extensor weakness is most common complication.

**Table 2: Comparative results of two groups (TRAP GROUP) and Olecranon osteotomy (OO) group**

S.NO	OBSERVATION	TRAP group	OO group
1	The mean age	35.12 yr	35.6 yr
2	Male: female ratio	1.28:1	1.14:1
3	RTA	50%	60%
4	Right: Left ratio	1.28:1	2:1
5	Type:		
	C1	31.25%	26.66%
	C2	43.75%	53.33%
	C3	25%	20%
6	The average duration between injury and surgery.	3.56 days	3 days
7	Mean duration of hospital stays	7.37 days	7.4 days
8	Average loss of extension	16.25°	12°
9	Pain-No/mild	93.75%	86.58%
10	Average range of motion at elbow joint	97.18°	107.66°
11	stable elbow	93.75%	93.34%
12	mean functional capacity score $\geq 20$	56.25%	66.6%
13	Final result:		
	Excellent	12.5%	19.99%
	Good	56.25%	53.32%
	Fair	25%	19.99%
	Poor	6.25%	6.66%
14	COMPLICATIONS:		
	Hardware protrusion	0	3
	Superficial infection	1	2
	Deep infection	1	1
	Ulnar neuropathy	1	1
	Implant failure	1	1
	Extensor weakness	3	0
	Nonunion at osteotomy	0	1

## DISCUSSION

The incidence of Intra-articular fracture of distal humerus are on rise due to increase in elderly population and road traffic accidents. The improved surgical techniques and newer implants have increased the reliability of operative stabilization and maintenance of intra-articular congruency of distal humerus thereby allowing early mobilization of elbow which is the key to success in the management of intra-articular fractures. The posterior surgical approach provides optimal exposure of intra-articular aspect of distal part of humerus. Triceps splitting, triceps reflecting & olecranon osteotomy are the most common posterior surgical approaches to the adult elbow. In present study the maximum number of patients (75%-TRAP, 86.58%-OO) were in the age group of 21-40 years with the mean age of (35.12% TRAP, 35.6% OO) years (range 18-70 years). Other study also found similar observations eg. Ibrahim A et al<sup>10</sup> (mean age TRAP-37.8 yrs, OO-35.4 yrs), Pankaj A et al<sup>11</sup> (mean age of 32 years)

and Puneet Mishra et al<sup>12</sup> (mean age of 31.8 years). Most common mode of injury in our study was road traffic accidents (50% TRAP, 60% OO) followed by fall on ground (25% TRAP, 20% OO). This observation is quite different to, observation of Ibrahim A et al<sup>10</sup>, in which fall (TRAP-72.7%, OO -50%) was most common mode of injury followed by RTA (TRAP-13.6%, OO-35%) and was comparable with the study of M.D. Mckee et al<sup>13</sup> and J.L. Bassi et al.<sup>14</sup> These observations may be due to incidence of RTA are more in our country due to overcrowded traffic on roads, bad conditions of roads, non-following traffic rules, rash and drunk driving. All the 33 cases in our series were classified as per AO classification (Muller et al.).<sup>15</sup> Ibrahim A et al<sup>10</sup> in their study found, type 3 (TRAP-45.45%, OO-45%) was most common types followed by type 2 (TRAP-36.36%, OO-31.81%). Type 1 was least common. Pankaj et al<sup>11</sup> and Ozer H et al<sup>16</sup> were also observed similar type of fracture in their study.

Table 3: Type of fracture

S.No	Type of fracture	TRAP(A)	OLECRONAN OSTEOTOMY(B)
1	C1	5(31.25%)	4(26.66%)
2	C2	7(43.75%)	8(53.33%)
3	C3	4(25%)	3(20%)

Average duration between injury and surgery in our study was about (TRAP-3.56 days, OO-3 days) which is similar to the observations of other studies eg. Ibrahim A. et al<sup>10</sup> (TRAP-3.8, OO-3.1) days, Jupiter et al<sup>17</sup> 3.7 days and V.K. Sharma et al<sup>18</sup> 3.2 days. Two cases were operated 1 week after injury. Out of these 2 cases, one which had poor outcome was operated 8 days after injury, reason for delay was due to late reporting of patient to the hospital and management of associated cardiovascular problem by physician and another patient which had fair outcome operated 11 days after injury, because of associated chest injury managed by surgeon.

In present series (TRAP-81.25%, OO-93.33%) were having loss of extension (flexion contracture) of up to 30°, only (TRAP-18.75%, OO-6.66 %) patients were having loss of extension of > 30°. Average loss of extension in the present study was about (TRAP-16.25°, OO-12°) which is comparable to finding of R Krishna et al<sup>19</sup> (TRAP-12°, OO-13°) and relatively higher than the observation of Ozer H et al<sup>16</sup> (average loss of extension was about 8.64°), Pankaj A et al<sup>11</sup> (average loss of extension was about 5.25°) and Puneet Mishra et al<sup>12</sup> (average loss of extension was about 10.41°).

In TRAP approach 9 (56.25%) patients had range of motion between 50° to 100° arc i.e. score = 15; 6 (37.5%) patients had range of movements > 100° arc (i.e. score of 20). Only one (6.25%) patient had their range of motion arc < 50°. The average range of movement in the TRAP group was about 97.18° which is comparable with the observation of R Krishna et al<sup>19</sup> (average range of movement 103°) and Puneet Mishra et al<sup>12</sup> (Average range of Motion 101.53°). A relatively better range of motion was noted by other study Ibrahim A et al<sup>10</sup> (Average range of Motion 108°), Ozer H et al<sup>16</sup> (Average range of Motion 110.36°) and Pankaj A et al<sup>11</sup> (Average range of Motion 118.4°). Where as in OO group 5 (33.3%) patients had range of motion between 50° to 100° arc i.e. score = 15; 9(59.94%) patients had range of movements > 100° arc (i.e. score of 20). Only (6.25%) and one (6.66%) patient had their range of motion arc < 50°. The average range of movement in the olecranon osteotomy group was about 110.66° which is quite better than the observation of R. Krishna et al<sup>19</sup> (average range of movement 97.5°), by Ibrahim A et al<sup>10</sup> (Average range of Motion 98°) and by Puneet Mishra et al<sup>12</sup> (Average range of Motion 101.53°) and Relatively compatible with range of motion was noted by Ozer H et al<sup>16</sup> (Average range of Motion 110.36°) and Pankaj A et al<sup>11</sup> (Average range of Motion 118.4°). In present study lack of physiotherapy is the reason for relatively higher incidence of loss of extension compare to other studies. Since most of the patient belongs to rural area where facility for physiotherapy not available.

Most of cases (TRAP-93.75%, OO-86.58%) had no pain or only mild pain at final follow up in present study. Only one patient (OO) had moderate pain of elbow at final follow up and two (TRAP-1, OO-1) of the patients had severe pain which impair his / her functional activity. Similar observations were found in other study

eg. Ozer H et al<sup>16</sup> in their study observed no pain or only mild pain at final follow up in 90.90% cases and Puneet Mishra et al<sup>12</sup> in their series observed no pain or only mild pain at final follow up in 86.67% cases.

In present study most of the patients (TRAP-93.75%, OO-93.34%) had a stable elbow at final follow up which is quite similar with the study of Ozer H et al<sup>16</sup>, Pankaj A et al<sup>11</sup> and Puneet Mishra et al.<sup>12</sup> Only two patients (TRAP-1, OO-1) had grossly unstable elbow because of severe osteoporosis and type C3 fracture in these patients. The MEPS criteria was used in our study to evaluate final results as it takes into account the subjective evaluation of pain, objective evaluation of range of motion and stability and functional evaluation of patient at final follow up. As per above mentioned criteria in our study we observed excellent result in (TRAP -12.5%, OO-19.99%), Good results (TRAP-56.25%, OO-53.32%); fair results in (TRAP-25%, OO-19.99%) and poor results in (TRAP-6.25%, OO-6.66%) cases. In the TRAP approach good to excellent results were observed in 68.75% cases which is relative less with the results of other study. Ibrahim A et al<sup>10</sup> (TRAP-81.81%)<sup>37</sup>, Ozer H et al<sup>16</sup>, Pankaj A et al<sup>11</sup> and relatively comparable to results of Dr. Puneet Mishra et al.<sup>12</sup> Where as in olecranon osteotomy approach good to excellent results were observed 73.33% cases which is comparable with the results of other workers Ibrahim A. et al<sup>10</sup> (OO-77.77%).

In TRAP approach 3 patient have extensor weakness and no patient have hardware problem, one has ulnar neuropathy which recover within 2 months. One has superficial infection and another one patient have deep infection. In OO approach 3 patients have hardware protrusion and one patient have osteotomy site non-union and second surgery was done for non-union. No patient has extensor weakness, one has ulnar neuropathy which was recover in three months. Ibrahim A. et al<sup>10</sup> and R. Krishna et al<sup>19</sup> in their study also found similar complications.

## CONCLUSION

In the present study the functional results of olecranon osteotomy approach and TRAP approach are almost similar in management of fracture distal end humerus in adults. Both approaches have excellent articular surface visualization, but have potential complications. In olecranon osteotomy approach complications associated with an osteotomy including prominence/migration of hardware, displacement/non-union / delayed union of osteotomy site. Where as in TRAP approach, there is a risk of triceps dehiscence and extensor weakness.

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