

SURGICAL MANAGEMENT OF INTRA-ARTICULAR FRACTURES OF DISTAL HUMERUS IN ADULTS USING TRICEPS REFLECTING ANCONEUS PEDICLE APPROACH (TRAP)

Bhatia C.*

Tiwari A.**

Goel R.***

ABSTRACT

Introduction: Intra-articular fractures of distal humerus constitute 0.5% - 0.7% of all the fractures and 30% of elbow fractures. Exposure of distal humerus via posterior approach is dependent on the triceps mobilization and there are many other modifications e.g. olecranon osteotomy, triceps splitting, triceps reflecting, paratricipital.

Aim: To evaluate functional outcome of fixation of displaced intra-articular distal humeral fractures with use of triceps-reflecting anconeus pedicle approach.

Materials and Methods: 28 patients (16 males and 12 females) of closed intra-articular fractures of distal humerus were treated by open reduction and internal fixation with plate and screws using TRAP approach. Fractures were classified using A.O. classification. Mean age of the patients was 37 yrs(18-62 yrs). All open fractures, injuries older than 3 weeks, associated bony injuries of ipsilateral limb were excluded from the study. Passive and active Elbow mobilization exercises were started after stitch removal. Patients were advised to keep the extremity supported in a splint in between exercises which was discarded after 6-8 weeks. Average period of follow up was 9 months. Patients were evaluated using Mayo Elbow performance index.

Results: As per Mayo index results were excellent in 9 patients, good in 13 patients and fair in 4 patients and poor in 2 patients. Average arc of motion at elbow was 101.300. None of the patients had weakness of triceps. Most common complication was discomfort because of hardware prominence.

Conclusion: TRAP approach allows adequate fracture visualization of distal humerus for stable fixation of intra-articular fractures without creating an iatrogenic fracture of olecranon and its associated complications.

Keywords: Humerus, intercondylar fracture, Triceps-reflecting anconeus pedicle approach

INTRODUCTION

Intra-articular fractures of the distal humerus constitute 0.5%-7% of all fractures and 30% of elbow fractures.¹ The distal humerus fracture is commonly multifragmented have complex anatomy.^{2,3} Hence, Distal humerus fractures

demand technically difficult operative treatment, often with relatively high morbidity.⁴

The preferred treatment for displaced, intra-articular, intercondylar fractures of the distal part of the humerus is open reduction and internal fixation.⁵ Adequate exposure of the articular

* Resident Surgical Officer
** Professor
*** Professor & HOD

Address for correspondence:
Dr. Chirag Bhatia,
Department of Orthopaedics,
Govt Medical College,
Kota, Rajasthan, India

surface of the distal humerus and elbow joint is required for operative stabilization of bicolumnar distal humerus fractures. Generally intrarticular fracture of the distal humerus are accessed by the posterior approach which gives excellent exposure of the articular fragments of the distal humerus.^{6,7,8} Distally intrarticular exposure is dependent on the triceps mobilization and there are many modifications in posterior elbow surgical approaches eg. Olecranon osteotomy, triceps splitting, triceps reflecting, triceps reflecting anconeus pedicle, paratricipital approaches.^{6,7} The transolecranon approach, which provides complete posterior visualization and access to the distal humerus, is the most commonly used surgical approach.⁹ An olecranon osteotomy has risks and possible complications such as prominence/migration of hardware, displacement/nonunion of osteotomy and triceps weakness.

Triceps reflecting Anconeus pedicle approach (TRAP) described by O' Driscoll et al in 2000 and involves completely detaching the triceps from proximal ulna with the anconeus muscle.¹⁰ 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 & allow the use of trochlear sulcus as a template to assist with articular reduction of distal humerus.¹⁰

The purpose of our study was to determine the functional outcome of fixation of displaced intra-articular distal humeral fractures with use of triceps-reflecting anconeus pedicle approach.

MATERIALS AND METHODS

28 patients (16 males and 12 females) of age 18-62 yrs of intra-articular distal humerus fractures were managed using TRAP approach from January 2012 to July 2014. Standard antero-posterior and lateral views were obtained of the injured elbow. CT scans were obtained to evaluate comminuted fractures.

All fractures were classified using A.O. classification suggested by Muller.

- Type A : Extra-articular
- Type-B : Partial articular
- Type-C : Complete articular (Figure 1)

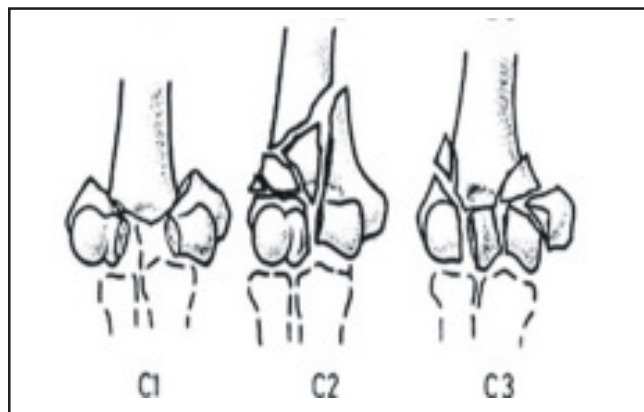


Figure 1 : Type C distal humerus fractures

Patients of age 18 yrs or greater with duration of injury less than 3 weeks were only included in the study. All closed, displaced fractures which were A.O. type C were included in the study.

Patients with associated skeletal injury of same limb, or with active infection or any preexisting disease like Rheumatoid arthritis were excluded from the study.

Implants used to fix the fracture were 3.5 mm Reconstruction plate, 3.5 mm One third tubular plate, 3.5 mm cortical screws, 4.0 mm cancellous screws (partially / fully threaded), K-Wire 1.6 mm. plates were applied in orthogonal fashion in all the cases.

All patients were operated under regional or general anesthesia in lateral decubitus position with the injured limb hanging by the side of the table on a padded armrest with elbow flexed at 90°. High tourniquet was applied in all the cases.

The TRAP approach incorporates a modified Kocher approach on the lateral side and a triceps-reflecting approach on the medial side, with the two approaches converging distally at the tip of the anconeus.

SURGICAL TECHNIQUE

After painting and draping a superficial

curvilinear posterior skin incision was made. The incision was approximately 15 cm long and was placed just lateral to the tip of the olecranon. Medial and lateral skin flaps were raised to expose the supracondylar ridges on either side of the distal humerus. The ulnar nerve was first identified and was carefully preserved.

The modified Kocher approach on the lateral side, commencing distally in the interval between the extensor carpi ulnaris (ECU) and the anconeus was used to elevate the anconeus muscle and develop the distal lateral portion of the flap. The muscle fibers and tendon of the anconeus was dissected off the annular ligament, lateral collateral ligament complex and capsule. The posterior capsule was incised and the dissection was carried proximally between the triceps and posterior humerus. The deep fibers of the triceps were dissected off the posterior humerus by blunt dissection.

On medial side triceps-reflecting approach performed by reflecting the triceps laterally off the posterior distal humerus in continuity with the periosteal sleeve over the olecranon and proximal ulna. Starting at the distal tip of the anconeus, an incision was made in the periosteum along the edge of the ulnar origin of the flexor carpi ulnaris (FCU) muscle to the medial tip of the olecranon and then it was continued proximally along the medial border of the triceps. The proximal ulna was exposed subperiosteally, then the Sharpey's fibers at the insertion of the triceps on the tip of the olecranon was released carefully by sharp dissection. This critical portion of the exposure was performed carefully to maintain continuity of the triceps and periosteal sleeve. After dissecting slightly more than halfway across the tip of the olecranon, a marking suture was placed in the Sharpey's fibers precisely where this part of the tendon was reattached to the olecranon at the completion of the procedure. The marking suture was essential for anatomic reattachment of the triceps tendon and prevention of shortening, lengthening, or medial and lateral displacement. The dissection was continued laterally beneath the

triceps and anconeus until it joins the previous plane of dissection in the modified Kocher approach from the lateral side.

Once the modified Kocher and triceps-reflecting approaches was performed medially and laterally, respectively, a continuous plane of elevation exists beneath the sleeve of triceps, anconeus, and periosteum (indicated by fingers beneath the tissues). The final step was detachment of the periosteum from the subcutaneous border of the ulna at the distal end of the anconeus and the reflection of the triceps proximally.

The exposure (Figure 2) was almost equivalent to that provided by olecranon osteotomy, with the exception of a portion of the anterior trochlea, which could be visualized by looking in the lateral ulno-humeral articulation while retracting the ulna gently with a blunt retractor.

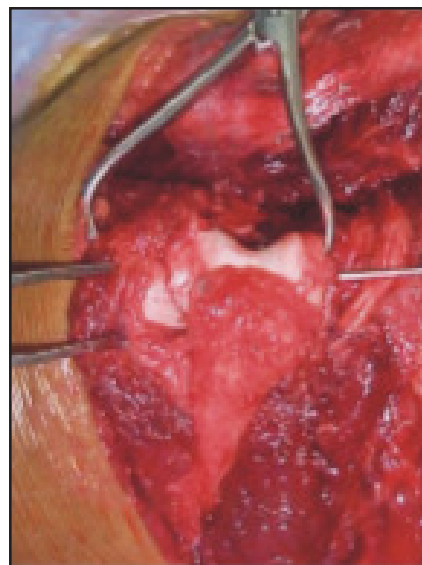


Figure 2 : Exposure of the fracture

Adequate fixation of intercondylar components and both the columns done with plate and screws (Figure 3). The triceps was reattached with interrupted number-2 braided polyester sutures, with use of drill-holes through bone in the region of the olecranon. A vacuum suction drain was placed on the triceps fascia and subcutaneous



Figure 3 : Both column fixation done reduction with TRAP approach with plate and screws

tissue and skin was closed in layers. Sterile dressing and above elbow POP slab was applied in 90° flexion.

Post-operatively gentle active and active-assisted range-of-motion exercises were started after stitch removal i.e. 10-12 days with the advice to keep the extremity in removable splint in between exercises. Active extension was prohibited until 6 weeks postoperatively to avoid undue stress on the extensor mechanism repair. At 6 weeks splints were discarded and patient advised to keep limb in triangular sling in between exercise during day time.

Patients were followed up at regular intervals. After stitch removal next follow-ups were done at 3 week and 6 week postoperatively while all subsequent follow-ups were done at an interval of 6 week up to minimum of 6 months. Average period of follow up was 9 months(6-12 months).

The final results of 28 patients were assessed as per criteria laid down by Mayo elbow performance Score (MEPS) (Table 1).

Table 1
Mayo elbow performance score

Function	Points	Definition	Points
Pain	45	None	45
		Mild	30
		Moderate	15
		Severe	0
Motion	20	Arc > 100°	20
		Arc 50-100°	15
		Arc < 50°	5
Stability	10	Stable	10
		Moderate instability	5
		Gross instability	0
Function	25	Comb hair	5
		Feed	5
		Hygiene	5
		Wear shirt	5
		Wear shoes	5

Total score = 100, Excellent Result = >90,
Good Result= 75-89, Fair Result = 60-74,
Poor Result = <60

ILLUSTRATIVE CASE REPORTS

Case 1: 48 yr old female of type C1 distal humerus fracture treated by ORIF with plate and screws using Trap approach. (Figure 4 and Figure 5). Final range of motion was 100-135°. Final result- excellent (Figure 6).



Figure 4 : Pre-operative radiographs



Figure 5 : At final follow up showing good union



Figure 6 : Final outcome- Excellent

RESULTS

Out of 28 patients 16 were males, 12 were females. Mean age of the patients was 37 yrs, most common age group being 21-40 yrs.

Most common mode of injury was RTA which was more common in young age group while fall on ground(trivial trauma) was more common in

older age groups. Right side was more commonly involved.

Most common type of fracture encountered was of type C2 (Table 2).

Table 2
Types of fractures encountered

Type of Fracture	No. of Patients	Percentage
C1	10	35.71%
C2	12	42.86%
C3	6	21.43%

85.71% of patients were having loss of extension = 300, only 2 patients (7.14%) had loss of extension more than 400 (Figure 7). Average loss of extension was about 18.750. Average arc of motion at elbow was 101.30.

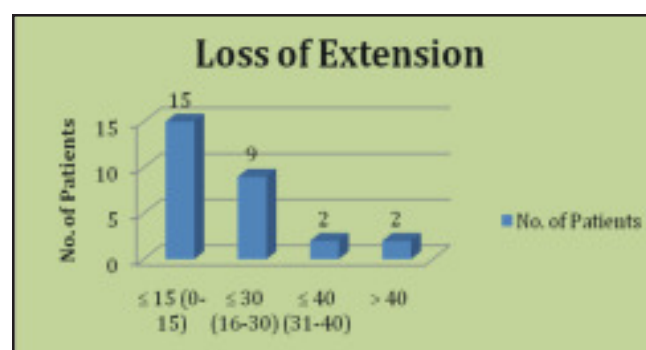


Figure 7 : Loss of extension

Final results as per Mayo index were 78.57% of the cases achieved excellent to good results whereas only 7.14% patients had poor results. (Table 3). Mean score in our study was 89.

Table 3
Final results as per Mayo index

Result	No. of Patients	Percentage
Excellent	9	32.14%
Good	13	46.43%
Fair	4	14.29%
Poor	2	7.14%

Majority of the excellent results (6 out of 9) belonged to fracture type C1 whereas two poor results belonged to fracture type C3. Majority of the good results (7 out of 13) were associated with fracture type C2. (Figure 8)

Triceps strength was normal in all the patients. There was no extension lag in any of the cases.

All patients had a stable elbow with no residual pain. Average time of fracture union was 14 weeks.

Most common complication in our series was discomfort due to hardware protrusion, seen in 5 cases but it had no effect on functional outcome. Superficial infection occurred in 3 cases which was managed by antibiotics and regular dressings. There were no deep infections.

DISCUSSION

Triceps mobilization is important for exposure of distal intra-articular humerus for which many modifications have been mentioned in literature

viz. olecranon osteotomy, triceps splitting, triceps reflecting, triceps reflecting anconeus pedicle, anconeus flap transolecranon (AFT) & paratricipital approaches.^{6,7}

Olecranon osteotomy first described by Mac Ausland¹¹ is the gold standard against which other approaches are compared. Olecranon osteotomy provides the best visualisation of the distal humerus articular surface.⁷ However its drawbacks like delayed or non-union of osteotomy, hardware complications (prominence/migration) and triceps weakness have led to other avenues of dealing with the extensor mechanism.¹²

Paratricipital approach avoids these complications but the disadvantage is the limited visualization of the articular surface of distal humerus therefore approach is usually inadequate for fixation of type C3 fractures.

Triceps-splitting or peeling approaches have postulated a negative effect on muscle strength on the basis of the potential for weakened reattachment, direct muscle injury with resultant

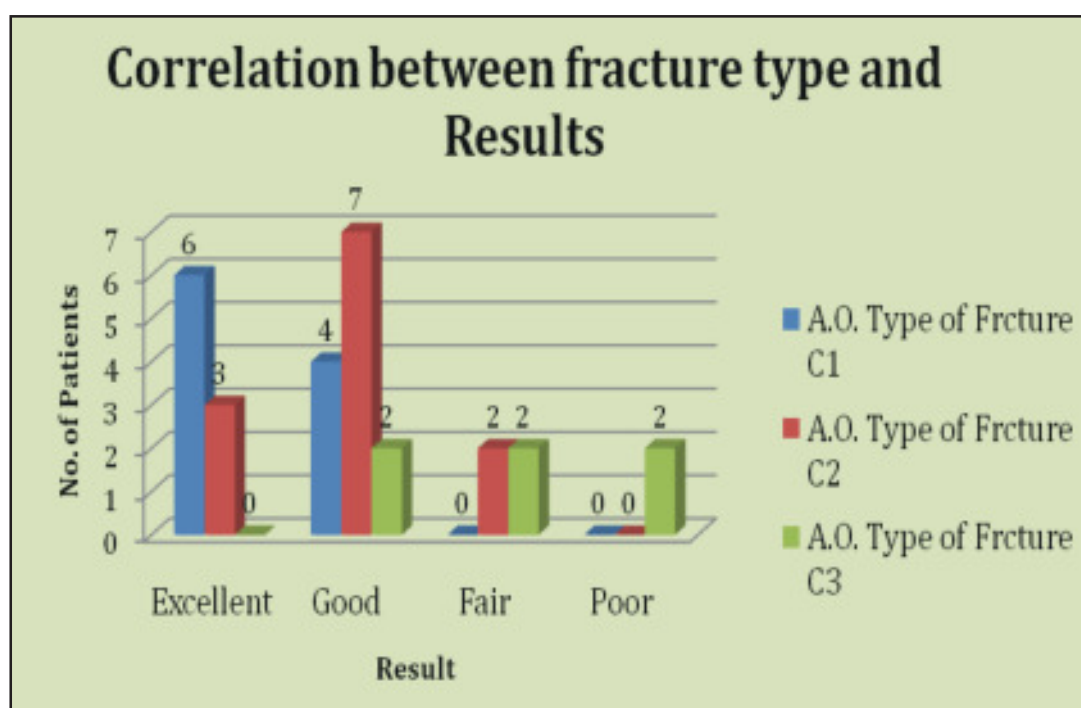


Figure 8 : Correlation between fracture type and Results

fibrosis and injury to intramuscular nerve branches.¹³ In the TRAP approach the dissection is in the internervous planes and hence muscle injury and injury to intramuscular nerve branches are avoided with this approach. It protects the nerve supply to the anconeus which is an important lateral stabilizer of the elbow.³ Moreover, extensor mechanism repair following TRAP approach is easy and strong enough to early aggressive elbow rehabilitation.^{14,15}

Olecranon osteotomy exposes more articular surface than other approaches but was not significantly greater than the triceps-reflecting approach.⁷ Extreme flexion of elbow allows visualization of most of the anterior articular surface of the humerus. TRAP avoids all the complications of an osteotomy and an intact olecranon acts as a template around which critical intra-articular reduction is afforded and also prevents inadvertent interfragmentary over compression in the intercondylar region.¹⁶

A review of previous studies on TRAP shows that our results were quite comparable (Table 4).

The reasons for poor result in two cases in our study were late reporting to the hospital, both were type c fractures and lack of supervised physiotherapy as both the patients belonged to rural background.

TRAP has given better functional outcome than olecranon osteotomy. B. Garg et al¹⁷ compared TRAP approach from olecranon osteotomy for distal humerus fracture and found that final ROM was higher in TRAP approach and

5 patients with olecranon osteotomy needed removal of hardware due to its complications. There was no difference in triceps power in both approaches.

To conclude Triceps reflecting anconeus pedicle (TRAP) approach is extensile enough to provide good exposure of distal intra-articular humerus for a stable fixation, without creating an iatrogenic fracture of olecranon and preserving the nerve supply to the anconeus as well. Easy and strong extensor mechanism repair allows early rehabilitation without any untoward effect on triceps strength.

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Table 4
A review of other studies

Series	Results in % of Total Cases as per Mayo index			
	Excellent	Good	Fair	Poor
Ozer H et al.	9.09	81.82	9.09	0
Pankaj A et al.	0	87.5	10	2.5
Dr. Puneet Mishra et al.	40	26.67	33.33	0
Current study	32.14	46.43	14.29	7.14

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