International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2017; 3(2): 526-533

www.orthopaper.com
Received: 20-02-2017
Accepted: 21-03-2017

Dr. Jayanta Mondal
MS. Medical College and Hospital, Kolkata, West Bengal, India

Dr. Chaitanya Krishna
MS. Medical College and Hospital, Kolkata, West Bengal, India

Dr. Ritwik Ganguli
MS. Medical College and Hospital, Kolkata, West Bengal, India

Dr. Kanchan K Sabui
MS. Medical College and Hospital, Kolkata, West Bengal, India

Correspondence
Dr. Chaitanya Krishna
Department of Orthopedics, PGIMS, Rohtak, Haryana, India

Paratricepital approach for fixation of distal humerus fracture in adults - A good alternative

Dr. Jayanta Mondal, Dr. Chaitanya Krishna, Dr. Ritwik Ganguli and Dr. Kanchan K Sabui

DOI: http://dx.doi.org/10.22271/ortho.2017.v3.i2e.50

Abstract
Objective: Distal humerus fractures most commonly managed by surgical approaches that disrupt the extensor mechanism of elbow. Paratricepital posterior approach for distal humerus fracture fixation done by orthogonal or parallel plate construct.
Methods: 30 cases of distal humerus fractures are taken. Bicolumnar fixation done by elevating and retracting the triceps of the distal humerus keeping triceps insertion undisturbed by orthogonal or parallel plate construct. Early active-assisted range of motion initiated within limits of pain. Age group was 15 to 60 years. Among all patients 10% of fractures were Type C1, 6.66% of fractures were Type C2, Type A 50% and Type B fractures is 33.33%.Radiograph (x-ray) and functional evaluation was done by MEPS (Mayo Elbow Performance Score), DASH (Disability of Arm Shoulder and Hand) questionnaire.
Results: All thirty fractures healed primarily. The median arc of elbow motion was 115^0 (range 70^0 to 140^0) with standard deviation of 1.33. Average score is 91(range 80-105) with standard deviation of 1.66, indicating excellent result.
Conclusions: Paratricepital posterior approach results in excellent healing, a mean flexion extensor arc of more than 100 degree, maintenance of almost normal elbow extensor strength.
Implication: Paratricepital posterior approach should be considered whenever distal humerus fracture are to be fixed especially in Type A and Type B fractures.

Keywords: Para-tricepital approach, distal humerus fracture, posterior approach

Introduction
Intra-articular distal humerus fractures are a considerable challenge to even the most experienced surgeon [1]. Distal articular humerus fractures are preferably treated by open reduction and internal fixation [2]. The surgery is technically demanding and an adequate exposure of the distal humerus articular surface is important for the surgery. The olecranon osteotomy approach has been the gold standard amongst surgical approaches for fracture fixation of the distal articular surface of humerus [2, 3, 4]. It is the most commonly used surgical approach and provides good visualisation of the fracture [4].
Complications of this approach include hardware migration and prominence, delayed union and non-union [5, 6].
Surgical approaches to elbow joint that dissociate the triceps from olecranon have distinct disadvantages like triceps avulsion, triceps weakness, wound healing problem etc. Such complications necessitate more surgery and predispose to infection [7]. To avoid these complications an extensor mechanism sparing paratricepital posterior approach to distal humerus through midline posterior incision was suggested by Schildhauer *et al* [8].
The bilaterotricepital approach (triceps sparing or triceps-on) was first reported by Alonso-Llames in 1972. This approach involves creation of surgical windows along medial and lateral side of triceps muscle and tendon without disrupting its insertion on olecranon [9].
The paratricepital approaches have several advantages: complications of olecranon osteotomy can be avoided, triceps tendon insertion not disrupted, allows early range of motion. This approach also preserves innervations and blood supply of anconeus muscle [9, 10] which provides dynamic postero-lateral stability of elbow. Finally if further exposure required paratricepital approach can be converted to olecranon osteotomy and if further proximal exposure is required for associated fracture shaft humerus, lateral side paratricepital approach can be converted into the Gerwin *et al* [11] approach.

The disadvantage of paratricepital approach is the limited visualisation of articular surface of distal humerus, therefore this approach is usually inadequate for fixation of type C3 fractures. The several advantages of this approach certainly indicate its use for AO/OTA types A2, A3, B1, B2 and possibly C1 and C2 fractures [8, 12]

The aim of our study is to prospectively evaluate the results of paratricepital approach in terms of adequacy of exposure of distal humerus for fixation of different types of distal humerus fractures, and ultimately the functional outcome of elbow.

The specific objectives are -

a) To determine adequacy of exposure of distal humerus in respect to dissection of soft tissue and extensor mechanism of elbow, for fixation of different types of distal humerus fracture in AO/OTA classification.
b) Time taken for surgery
c) Rate of complications
d) To evaluate post- operative range of motion& functional outcome by Visual analogue score for pain and Mayo elbow performance score (MEPS) [13].

Materials and Methods

A study of 30 cases of supracondylar and intercondylar fracture of humerus was conducted in the Department of Orthopaedics surgery, Medical College and Hospital, Kolkata between January 2011 to June 2012. There were 17 female patients and 13 were male. Left elbow was involved in 21 cases and right were involved in 9 cases. Most common mode of injury was road traffic accident (66.67%), then fall from height (20%), then simple fall (13.33%). Injury-operation interval in all cases were <1 week. X-Ray was used for post-operative follow-up and Fluoroscopy was used intra-operatively.

- **Inclusion criteria**

Displaced supracondylar and intercondylar fracture of distal humerus in age group 15-60 years.

- **Exclusion criteria**

a) Undisplaced distal humerus fracture which can be managed conservatively
b) Open fracture of distal humerus
c) Patients with medical co morbidities, not fit for anaesthesia
d) AO Type C3 fractures

Surgical Technique

Anesthesia - Regional anesthesia

Position of the patients – Patient were positioned in lateral decubitus with a bolster placed between arm and chest and the entire upper extremity draped free.

All cases were operated with tourniquet applied over upper arm. If operative time exceeded more than 1hrs 45mins tourniquet was deflated.

Surgical Exposure – Posterior approach to distal humerus was followed

Surgical steps

Bony landmarks are marked including olecranon process, subcutaneous border of ulna, medial and lateral epicondyles.

Incision – A posterior mid-line longitudinal incision was made over lower arm and extended distally beyond the elbow joint. Just above the tip of olecranon the incision was curved laterally. It was continued 5 cm distal to tip of olecranon.

Fig 1: Posterior Midline Longitudinal skin Incision.

Superficial surgical dissection: - Deep fascia incised in the mid line and full thickness skin flaps are developed. These are kept as thick as possible, with deep plane consisting of triceps fascia and epitendon proximally and forearm fascia and ulnar periosteum distally. Apo neurosis of the triceps exposed. Ulnar nerve palpated on the back of medial epicondyle. Fascia over the ulnar nerve incised to expose the ulnar nerve. When more proximal exposure of humerus was required ulnar nerve was followed further until it pierces the intermuscular septum coming from the anterior compartment. Distally it was released from cubital tunnel and dissected to its first branch. Articular branch of the ulnar nerve may be sacrificed.

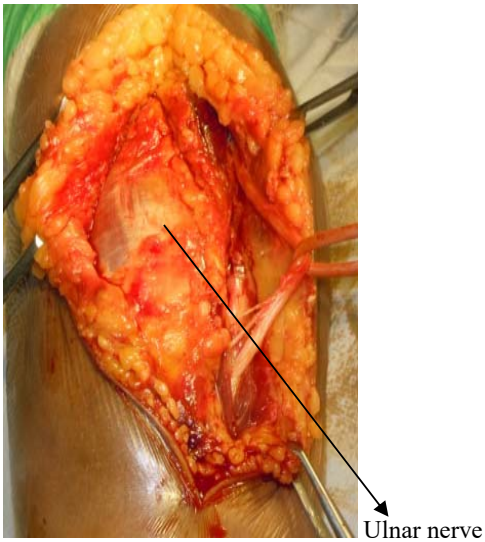
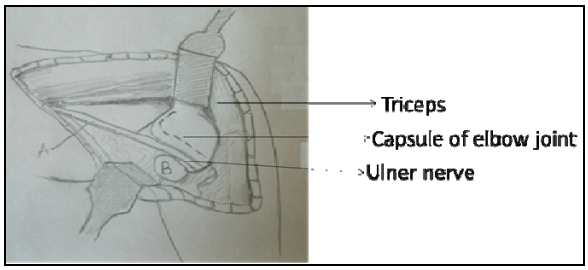
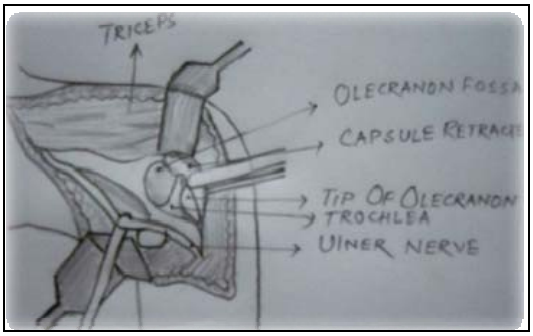
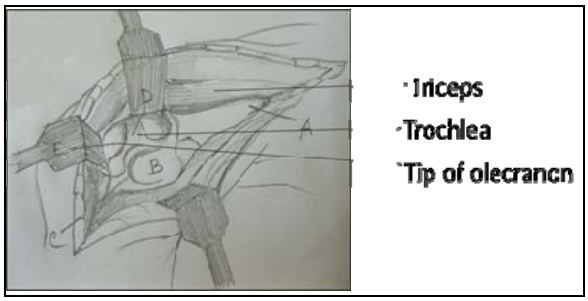


Fig 2: Full thickness skin flap developed. Ulnar nerve exposed.







Deep surgical dissection*:* Dissection was continued to lateral and medial triceps borders at their respective interfaces with posterior aspect of intermuscular septum. The distal lateral dissection was continued anterior to the anconeus muscle, allowing the muscle to be elevated along with the triceps and preserving its neurovascular supply The posterolateral humeral shaft approached by elevating the triceps and anconeus muscle from posterior periosteum and by retracting it medially. Medial paratricepital dissection along with posterior border of intermuscular septum exposed the posteromedial aspect of distal humerus. The intra-articular fat pad was excised. This provided Visualization of the entire posterior articular surface, comprising roughly 50% of the overall articular surface of the distal part of the humerus. Retracting triceps muscle medially and laterally exposes both column. Trochlea can be visualized by flexing elbow more than 90 degree. A sponge or 0.25-inch (0.6cm) Penrose drain was placed into the ulno-humeral joint to allow distraction of the joint by pulling distally on the olecranon via the sigmoid notch to aid in Visualization and facilitate the reduction through ligamentotaxis.

The distal part of the humerus was anatomically reduced with direct Visualization posteriorly and indirectly with fluoroscopy. The intact sigmoid notch was used as a template for reduction.

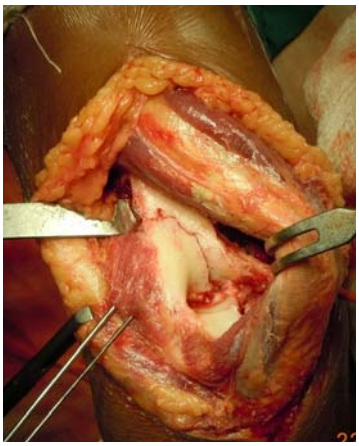
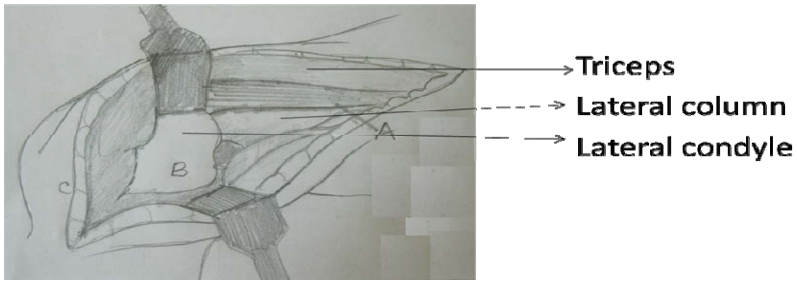


Fig 3: Retracting triceps medially laterally to expose distal humerus with articular surface.



Techniques of Fracture Reduction

- Articular fragments are reduced and provisionally fixed with guide wire.
- Definitive fixation of intraarticular part is done by 4 mm cannulated cancellous screws
- Care must be taken not to narrow the trochlea with a lag screw when there is bone loss.
- Once intraarticular part is fixed, intercondylar fracture is converted into supracondylar fracture.
- This is provisionally fixed with kirschners wire and converted with definitive fixation with either parallel plate or orthogonal plate construct.
- Fixation stability and motion arcs were assessed prior to closure.

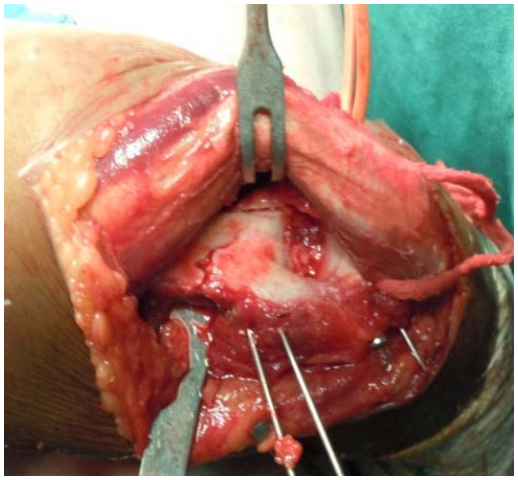


Fig 4: Fracture provisionally fixed with k wires

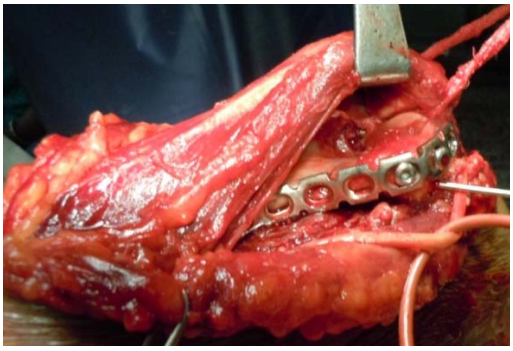


Fig 5: Fracture fixation done with plates and screws.

Technical Objective for Fixation of Fractures

- Every screw should pass through a plate.
- Each screw should engage a fragment on the opposite sides that is also fixed to a plate.
- As many screw as possible should be placed in distal fragments.
- Each screw should be as long as possible.
- Each screw should engage as many articular fragments as possible.
- Plate should be applied such that compression is achieved at the supracondylar level for both columns.
- Plates used must be strong and stiff enough to resist breaking or bending force before union occurs at the supracondylar level [14]

Closure

- The Ulnar nerve was not anteriorly transposed in any case.
- Implants were covered with soft tissue to prevent Ulnar neuritis.
- Triceps attached with intermuscular septum.
- A negative suction drain was given.
- Bulky dressing around elbow done.

After Treatment

- Plaster of Paris back slab applied.
- Drain was removed at 48 hrs
- Out of 30 cases, 26 cases were operated under tourniquet control. In rest, tourniquet had to be released intraoperatively as operative time exceeded more than 1hrs 45mins.
- Blood loss in cases operated with tourniquet – measured by collected blood in suction drain.
- In 4 cases tourniquet had to be removed intraoperatively.
- Blood loss in such cases measured with numbers of mops required during surgery plus collection in drain - (one wet mop = 200 ml of blood approx)
- Wound inspection was routinely done on 5th postoperative day.
- Suture removal was done on 14th postoperative day.

Postoperative Rehabilitation

The patients were put through active elbow motion of flexion and extension, pronation and supination within limits of pain at 5th postoperative day.

Follow up

Patients were reviewed every 2 weeks for first 2 months, every month for next 6 months and then every 3rd month and were assessed for:

- Time taken for functional recovery
- Range of motion
- Any specific complaints
- Time taken for fracture healing.
- Functional outcome by Mayo Elbow Performance Score(MEPS)

Final follow up was done one month before the conclusion of the study and various scoring system and classification were used to analyze the results.

Results were analysed statistically using SPSS software system.

Results

All 30 patients were reviewed clinically and radio graphically (X-Ray). Follow up ranged from 6 months to 18 months, with an average of 12.6 months. 20 patients had an excellent result, 7 had good and 3 poor.

Time taken for functional recovery

Functional recovery is interval between injury and time of return to normal daily activities. Average time being 101.8 days. Type A fractures were immobilised for 2 weeks and earlier mobilisation of joint was done, which result in average Functional Recovery Time of 80 days with standard deviation of 1.65 While that of Type B Fractures was of 95 days with standard deviation of 1.57. Type C Fractures were immobilised for 3 weeks and guarded Range of Motion was started which leads to delayed Recovery Time of 105 days with standard deviation of 1.35.

Among all patients 10% of fractures were Type C1, 6.66% of fractures were Type C2, Type A 50% and Type B fractures is 33.33%.

Range of Motion: The median arc of elbow motion was 115^0 (range 70^0 to 140^0) with standard deviation of 1.33. Arc of motion $>120^0$ seen in 66.66% of patients, arc 90^0-120^0 present in 23.33% of cases, arc $<90^0$ seen in 10% of cases. Type A fractures had >120 degree range of motion of 12 patients out of 15 patients (80%), Type B fractures had > 120 degree of 8 patients out of 10 patients (80%). Type C1 fractures had none > 120 degree Range of Motion, 90-120 degree had 2 out of 3 patients (66.6%). Type C2 Fractures had < 90 degree Range of Motion in 2 out of 2 patients (100%).

Range of Motion

AO Group	A	B	C1	C2	Total
< 90 Degree	0	0	1	2	3
90-120 Degree	3	2	2	0	7
>120 Degree	12	8	0	0	20
Total	15	10	3	2	30

Mayo Elbow Performance score (MEPS): Average score is 91 average 80- 105 with standard deviation of 1.66, indicating excellent result. AO Group A showed average MEPS score of 101 with standard deviation of 1.69, AO Group B showed average score of 98 with Standard Deviation of 1.67, AO Group C1 showed average score of 95 with standard deviation of 1.53 and C2 showed average score of 80 with standard deviation of 1.25. So, AO Group A and B had excellent result with this approach, while Type C1 and C2 had little difficulty for articular surface reduction. For Type C fractures, olecranon osteotomy seems to be better approach as articular surface can be viewed directly.

Mayo Elbow Performance Score (MEPS)

Section 1: Pain Intensity

☉	None
☐	Mild
☐	Moderate
☐	Severe

Section 2: Motion

☐	Arc of motion greater than 100 degrees
☐	Arc of motion between 50 and 100 degrees
☐	Arc of motion less than 50 degrees

Section 3: Stability

☐	Stable
☐	Moderate instability
☐	Grossly Unstable

Section 4: Function (Tick as many as able)

☐	Can comb hair
☐	Can eat
☐	Can perform hygiene
☐	Can wear shirt
☐	Can wear shoe

Disability of Arm, Shoulder, and Hand (DASH) questionnaire

1.	Open a tight or new jar	☉	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
2.	Write	☐	No difficulty	☐	Mild difficulty	☉	Moderate difficulty	☐	Severe difficulty	☐	Unable
3.	Turn a key	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
4.	Prepare a meal	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
5.	Push open a heavy door	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
6.	Place an object on a shelf above your head	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
7.	Do heavy household chores (eg wash walls, wash floors)	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
8.	Garden or do yard work	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
9.	Make a bed	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
10.	Carry a shopping bag or briefcase	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
11.	Carry a heavy object (over 10 lbs)	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
12.	Change a lightbulb overhead	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
13.	Wash or blow dry your hair	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
14.	Wash your back	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
15.	Put on a pullover sweater	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
16.	Use a knife to cut food	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
17.	Recreational activities which require little effort (eg cardplaying, knitting, etc)	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
18.	Recreational activities in which you take some force or impact through your arm, shoulder or hand (eg golf, hammering, tennis, etc)	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
19.	Recreational activities in which you move your arm freely (eg playing frisbee, badminton, etc)	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable

20.	Manage transportation needs (getting from one place to another)	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
21.	Sexual activities	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	Unable
22.	During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?	☐	Not at all	☐	Slightly	☐	Moderately	☐	Quite a bit	☐	Extremely
23.	During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	☐	Not limited at all	☐	Slightly limited	☐	Moderately limited	☐	Very limited	☐	Unable
	Please rate the severity of the following symptoms in the last week										
24.	Arm, shoulder or hand pain	☐	None	☐	Mild	☐	Moderate	☐	Severe	☐	Extreme
25.	Arm, shoulder or hand pain when you performed any specific activity	☐	None	☐	Mild	☐	Moderate	☐	Severe	☐	Extreme
26.	Tingling (pins and needles) in your arm, shoulder or hand	☐	None	☐	Mild	☐	Moderate	☐	Severe	☐	Extreme
27.	Weakness in your arm, shoulder or hand	☐	None	☐	Mild	☐	Moderate	☐	Severe	☐	Extreme
28.	Stiffness in your arm, shoulder or hand	☐	None	☐	Mild	☐	Moderate	☐	Severe	☐	Extreme
29.	During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand?	☐	No difficulty	☐	Mild difficulty	☐	Moderate difficulty	☐	Severe difficulty	☐	So much I can't sleep
30.	I feel less capable, less confident or less useful because of my arm, shoulder or hand problem	☐	Strongly disagree	☐	Disagree	☐	Neither agree nor disagree	☐	Agree	☐	Strongly agree

Mean score was 32.36. AO Group A showed excellent result with mean score of 18 and standard deviation of 1.67, AO Group B had mean score of 20 and standard deviation of 1.56 while Group C1 had 29 with standard deviation of 1.17 and Group C2 had 35 with standard deviation of 1.06 (0 = perfect and 100 = complete disability). This again proves that Group A and B had excellent result with this approach while Group C had little difficulty, and results are not very good.

Strength of triceps: According to MRC grading mean strength was 4.64 (Max.5, Min.0) with range of 4.2 to 4.92. While all the groups showed almost equal grade but results are still better with Group A and B than Group C.

Complications

1. Symptomatic hardware. In Type C2 Fracture, 1 in Total 2 (50%) and in Type C1, 1 in 3 (33%) and 1 in Type B (10%) had hardware impinging on skin. This was due to less use of muscle in Type C fractures and so less muscle mass.
2. Superficial skin infection (13.33%) This was more at stitch site and was recovered easily with antibiotic course and did not required any implant removal or debridement.
3. Tourniquet palsy (3.33%). This is seen in 1 case of Type C1 fracture due to prolonged tourniquet time as there was difficulty in achieving reduction. Patient recovered uneventful.
4. Ulnar nerve neuropraxia. 2 cases were seen. 1 in C1 and 1 in Type C2. This was more likely due to inadequate exposure of ulnar nerve and articular surface and use of more forceful retractors causing ulnar nerve impingement and neuropraxia. Patient recovered without long term sequel.
5. Post-Traumatic Arthritis. Most common in Type C fractures.

Discussion

30 patients with distal humerus fractures treated with Paratricepital posterior approach and fixation done with either orthogonal or parallel plate construct. In this study fracture was more common in female patients (56.67%). Left elbow most commonly involved (70%), minimum age of the patient

of this study was 15 years, maximum was 60 years. Mean age of this fracture was 32.89 years. Most common mode of injury was road traffic accident (63.33%). All of these patients were operated within 1 week of injury (56.67%). Among all patients 10% of fractures were Type C1, 6.66% of fractures were Type C2, Type A 50% and Type B fractures is 33.33%.

Treatment of distal humerus fracture in adults by paratricepital posterior approach results in excellent healing, a mean flexion extensor arc more than 100 degree, maintenance of almost normal elbow extensor strength compared with contra lateral normal elbow. This approach can be an alternative to other triceps detaching approach, were the complications are more [2-4]. Though this approach can be easily used for fixation of type A,B,C1,C2 fractures according to AO classification, fixation of type C3 and multifragmentary fractures by this approach can be problematic where there need a lot of exposure. While this approach is Good for Type A and Type B fractures, with better functional outcomes, better Range of Motion. Functional Recovery Time is less with Type A and type B Fractures. MEPS Score and DASH Score are better with Type A and Type B Fractures, Type C fractures have not so promising result. Results are not so better with Type C fractures, as there is difficulty in exposure. Arcticular surface are better visualized with olecranon osteotomy.

Paratricepital posterior approach avoids disruption of the extensor mechanism, so no postoperative restrictions related to approach is required but the only disadvantage is limited visualization of the articular surfaces. The paratricipital (bilaterotricipital, triceps sparing, or triceps-on) approach was first reported by Alonso-Llames in 1972 [9] for the management of pediatric supracondylar fractures. The approach involves the creation of surgical windows along the medial and lateral sides of the triceps muscle and tendon without disrupting its insertion on the olecranon. The paratricipital approach has several advantages, including, avoidance of an olecranon osteotomy, therefore the risks of nonunion and symptomatic olecranon hardware are avoided. Additionally, the triceps tendon insertion is not disrupted, allowing early active range of motion [14-18]. This approach also preserves the innervation and blood supply of the anconeus muscle, which provides dynamic posterolateral stability to the elbow. Finally, if further articular exposure is required, the paratricipital approach can be converted into an olecranon osteotomy. If further proximal exposure is required for associated fractures of the humeral shaft, the lateral side of the paratricipital approach can be converted into the Gerwin *et al*. [11] approach. This approach involves reflection of the triceps muscle unit from lateral to medial to expose 95% of the posterior humeral shaft and the radial nerve. In distal humerus fractures deemed unrepairable, in which the intent is to proceed directly to total elbow arthroplasty, the paratricipital approach is preferred because it avoids the problems associated with osteotomies and extensor mechanism healing in triceps detaching approaches. The approach is also useful in cases in which an initial attempt at ORIF is planned and there is a possibility of an intraoperative convertion to total elbow arthroplasty should fixation be deemed unsuccessful.

The disadvantage of the paratricipital approach is the limited visualization of the articular surface of the distal humerus; therefore, the approach is usually inadequate for fixation of type C3 fractures. The several advantages of this approach certainly indicate its use for AO/OTA types A2, A3, B1, B2, and possibly C1 and C2 fractures [10-13].

The goal of treatment is anatomical restoration of the joint surface with stable internal fixation that allows early motion. Lateral or medial column fractures (AO/OTA type B) usually can be reduced through a direct approach and fixed with simple buttress plating. Intraarticular fractures (AO/OTA type C) vary greatly. Generally, the lower the transverse component, the more difficult is attaining stable fixation. Likewise, the greater the comminution, the more difficult is attaining an anatomical reduction.

There are various approaches which are described for reduction and fixation of distal humeral fractures. Most commonly, a posterior approach with an olecranon osteotomy has been used, but concerns about healing and symptomatic implants have led to more frequent use of a triceps-reflecting approach. The best fracture exposure is provided by an olecranon osteotomy approach. As more familiarity is gained with fracture patterns and reduction techniques, a triceps-reflecting (Paratricepital Approach) may be selected to reduce complications. With all posterior approaches, the ulnar nerve must be carefully dissected without excessive stripping and usually is transposed anterior to the medial epicondyle at the end of the procedure Olecranon osteotomy [19-21] is indicated for ORIF (Open reduction and Internal Fixation) for fractures involving columns and articular surface. There is good access to posterior articular surfaces for reconstruction but disadvantages are non-union, malunion and failure of fixation of osteotomy and poor anterior access to capitellum. Relative contraindications to an osteotomy are very anterior articular fractures (AO/OTA type B3), which can be difficult to visualize through an osteotomy and if a total elbow arthroplasty is planned as it may lead to problems with implant stability and osteotomy healing and fixation.

Triceps-splitting approach is indicated for ORIF/TER (Total Elbow Replacement) for fractures involving columns and articular surface. It avoids complications associated with olecranon osteotomy but disadvantages are poor access to articular surface for internal fixation and risk of triceps detachment.

There are certain limitations of this study as well. A larger sample population needed to be studied to reduce the "type II" or beta error of the study. A better method of randomization should have been adopted. The patients could not be followed up for a longer period. Trauma surgery interval needed to be minimized as far as possible. Patients older than 50years of age are also included. These elderly patients have osteopenic bones.

References

1. Nadim ASLAM, Keith WILLETT. Functional outcome following internal fixation of intraarticular fractures of the distal humerus (AO type C), Acta Orthop. Belg, 2004; 70:118-122
2. Muller ME, Allgower M, Schneider R. Manual of Internal Fixation. Inc Techniques recommended by AO Group. 2nd edition. New York: Springer, 1979, 71-87.
3. Jupiter JB, Neff U, Holzach P, Allgower M. Intercondylar Fractures of the Humerus: An Operative Approach. JBJS. 1985; 67A:226-39.
4. Zagorsk JB, Jennings JJ, Burkhalter WE, Uribe JW. Comminuted Intraarticular Fractures of the Distal Humeral Condyles. Surgical vs. Nonsurgical Treatment. Clin. Orthop. 1986; 202:197-204.
5. Bryan RS, Morrey BF. Extensive posterior exposure of the elbow. Clin Orthop Rel Res. 1982; 166:188-92.

6. Ring D, Gulotta L, Chin K, Jupiter JB. Olecranon osteotomy for exposure of fractures and nonunions of the distal humerus. J Orthop Trauma. 2004; 18:446-449
7. Zlotolow DA, Catalano LW, Barron A, Glickel SZ. Surgical exposures of the humerus. J Am Acad Orthop Surg. 2006; 14:754-765.
8. Schildhauer TA, Nork SE, Mills WJ, Henley MB. Extensor mechanism- sparing paratricipital posterior approach to the distal humerus. J Orthop Trauma. 2003; 17(5):3 74-378.
9. Alonso-Lames M. Bilaterotricipital approach to elbow. Its application in the osteosynthesis of supracondylar fractures in yhe humerus in children. Acta Orthop scand. 1972; 43(6):479-490.
10. Amstrong AD, Dunning CE, Faber KJ. Single strand ligament reconstruction of medial collateral ligament restores valgus elbow stability. J Shoulder Elbow surg. 2002; 11(1)65-71
11. Gerwin M, Hotchkiss RN, Weiland AJ. Alternative operative exposure of posterior aspect of humeral diaphysis with reference to radial nerve. J Bone Joint Surg Am. 1996; 78(11):1690-1695.
12. Whitcomb Pollock J, Kenneth Faber J, George Athwal S. Distal humerus fracture. orthop clin North Am, 2008; 39(2)187-200.
13. Morrey BF, An KN, Chao EYS. Functional evaluation of the elbow. In The Elbow and Its Disorders, edited by B. F. Morrey. Ed. Philadelphia, W. B. Saunders, 1993; 2:86-89.
14. Sanchez-Sotelo J, Torchia ME, O'Driscoll SW. Principle based internal fixation of distal humerus fractures, Tech Hand Upper Extrimity surg. 2001; 5;179.
15. Athwal GS, Goetz TJ, Pollock JW *et al*. Prosthetic replacement for distal humerus fractures. Orthop Clin North Am, 2008; 39(2):201-212:vi.
16. Cassebaum WH. Open reduction of T and Y fractures of the lower end of the humerus. J Trauma. 1969; 9(11):915-925.
17. Gainor BJ, Moussa F, Schott T. Healing rate of transverse osteotomies of the olecranon used in reconstruction of distal humerus fractures. J South Orthop Assoc. 1995; 4(4):263-268.
18. Mac Ausland WR. Ankylosis of the elbow: with report of four cases treated by arthroplasty. JAMA. 1915; 64:312-318.
19. McCarty LP, Ring D, Jupiter JB. Management of distal humerus fractures. Am J Orthop. 2005; 34(9):430-438.
20. Pollock JW, Faber KJ, Athwal GS. Distal humerus fractures. Orthop Clin North Am. 2008; 39(2):187-200:vi.
21. Wilkinson JM, Stanley D. Posterior surgical approaches to the elbow: a comparative anatomic study. J Shoulder Elbow Surg. 2001; 10(4):380-382.