“COMPARATIVE ANALYSIS OF FUNCTIONAL OUTCOME OF INTERCONDYLAR FRACTURE DISTAL HUMERUS BY PLATE OSTEOSYNTHESIS USING TRAP APPROACH AND OTHER POSTERIOR APPROACHES”

Dissertation submitted in partial fulfillment of the regulation for the award of M.S. Degree in Orthopaedic Surgery

Branch II

THE TAMILNADU

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CERTIFICATE

This is to certify that the work **"COMPARATIVE ANALYSIS OF FUNCTIONAL OUTCOME OF INTERCONDYLAR FRACTURE DISTAL HUMERUS BY PLATE OSTEOSYNTHESIS USING TRAP APPROACH AND OTHER POSTERIOR APPROACHES**" which is being submitted for M.S. Orthopaedics, is a bonafide work of **Dr.J.Sivaprashanth**, Post Graduate Student at Department of Orthopaedics, Madurai Medical College, Madurai.

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Madurai.

CERTIFICATE

This is to certify that this dissertation titled **"COMPARATIVE ANALYSIS OF FUNCTIONAL OUTCOME OF INTERCONDYLAR FRACTURE DISTAL HUMERUS BY PLATE OSTEOSYNTHESIS USING TRAP APPROACH AND OTHER POSTERIOR APPROACHES"** is a bonafide work done by Dr.J.Sivaprashanth, postgraduate student of Madurai Medical College, Govt Rajaji Hospital.

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CERTIFICATE

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Last but not the least, I express my gratitude to the patients for their kind co-operation.

DECLARATION

I, **Dr.J.SIVAPRASHANTH**, solemnly declare that the dissertation titled **"COMPARATIVE ANALYSIS OF FUNCTIONAL OUTCOME OF INTERCONDYLAR FRACTURE DISTAL HUMERUS BY PLATE OSTEOSYNTHESIS USING TRAP APPROACH AND OTHER POSTERIOR APPROACHES"** has been prepared by me. This is submitted to **"The Tamil Nadu Dr. M.G.R. Medical University, Chennai,** in partial fulfillment of the regulations for the award of M S degree branch II Orthopaedics.

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INTRODUCTION

An Intercondylar Fracture of the Distal Humerus is an uncommon injury. They comprise approximately 2% of all adult fractures and challenge for many Orthopaedic Surgeons. The complex shape of the elbow joint, the adjacent neurovascular structures and the sparse soft tissue envelope combine to make these fractures difficult to treat.

The most reliable method for restoring the normal alignment and contour of the distal humerus. However fracture fixation enables movement. In the early and middle parts of twentieth century, operative treatment was combined with devascularising exposure, inadequate fixation, and cast immobilization. The result was often elbow stiffness and delayed healing. As a result of this , non-operative treatments, such as the so-called ‘bag- of –bones’ technique (a short duration of immobilization in either a cast or a collar and cuff followed by mobilization as tolerated).

Restoration of painless and satisfactory elbow function after a fracture of the distal humerus requires anatomic reconstruction of the articular surface, restoration of the overall geometry of the distal humerus, and stable fixation of the fractured fragments to allow early and full rehabilitation.

Depending upon the frequency of communition and displacement, open reduction and internal fixation with Kirschner wires, 1/3rd tubular plates, Dynamic Compression Plates, Reconstruction plates, Locking Compression Plates or Double Tension Band Wiring can be done individually or in combination. The result of operative fixation of fractures of the distal humerus remained unpredictable until improved techniques for the fixation of small, articular fractures as developed by the AO (Arbeitsgemeinschaft f ür Osteosynthesefragen) or the ASIF (Association of the Study of Internal Fixation) and others were applied. On the basis of the results reported in the more recent series, fixation with two plates at 90 degrees angle with one another or parallel plate arrangement has become the standard against which all other treatments are measured.

A surgeon treating a healthy active patient with a fracture of distal humerus should make every attempt to reconstruct and preserve the distal humerus.

The quality of elbow function following intercondylar fractures is related to the degree to which normal anatomic relationships are restored. Residual elbow stiffness still remains the worst complication of intercondylar fractures as it is poorly tolerated because of lack of compensatory motions in adjacent joints.

AIMS AND OBJECTIVES

To assess and compare the functional outcome of intercondylar fracture distal humerus by plate osteosynthesis by TRAP approach and other posterior approaches

Objectives

1. To assess the functional outcome and to compare the results after surgical management of intra articular fracture of distal humerus using Mayo elbow performance index.
2. To assess the range of movements, functional outcome at end of 3months and 6 months and 12 months

REVIEW OF LITERATURE

Hippocrates stated that splinting is best for closed humerus fractures. Methods of splinting became more refined, with plaster of Paris replacing bandaging as the method of choice in the 19th century.

He stated that there can be little doubt that the worst treatment of comminuted inter-condylar fractures of the humerus is extensive operative reduction with internal fixation by tri-radiate plates, and many screws. Such operations by stripping the blood supply of the partly detached fragments and causing adhesion of muscles to bone cause serious stiffness.

He gave opinion that since it is a flexion injury with forward displacement, it should not be immobilized in acute flexion. He had advised manipulation and immobilization in a plaster slab in the mid-flexed position as the safest conservative measure. The plaster slab is removed in 2-3 weeks and the joint mobilized by the physiotheraphy

In 1932- Hitzrot, said that early motion within two weeks will give good range of movement in the elbow joint.

In 1937- Eastwood, advocated the original Hugh Owen Thomas method, where the fracture is manipulated and wrist is suspended from the neck by a collar and cuff sling with the elbow at right angles allowing gravity and the weight of the limb to maintain the traction on the fragments - “Bag of Bones” technique.

In 1941- Brown and Morgan, reviewed the results of the above method and reported an average of 70 degrees of motion. It is also significant that in the X-rays presented by both Eastwood and Morgan, good reduction was noted

In 1962- Betts, said conservative treatment for widely displaced 'Y' shaped fractures, gave better functional range of motion was more likely..

In 1987 – Gabel GT et. al, The best exposure provided by the posterior approach with extra-articular osteotomy of the olecranon and triceps reflecting anconeus pedicle aproach. This allows complete examination of the articular surfaces of the trochlea, capitellum, olecranon. It also gives free access to the medial and lateral supracondylar ridges.

Wilkinson et al. have compared the triceps split, TRAP, and olecranon osteotomy techniques in a cadaveric study. They have found that these techniques demonstrate the joint sur-faces at a rate of 35%, 46%, and 57%, respectively. The authors have stated that the best exposure was achieved with the olecranon osteotomy approach (57%)

In 1990 – Holdsworth and Mossad, reviewed 57 adult patients at an average of 37 months after early internal fixation for displaced fractures of the distal humerus. Fractures were classified according to müller's classification. A chevron olecranon osteotomy was used with

early active movements after the fixation. Results were good or excellent in 76% with average range of movements of 115°. They recommended early stable fixation and early active movement after the fixation for these fractures

In 1994 – Kun-Chung-Wang et al, They suggested routine ulnar nerve anterior subcutaneous transposition using a posterior approach to avoid the postoperative ulnar nerve compression syndrome

In 1994 - Caja VL, Moroni A, Vendemia V, Sábato C and Zinghi G, **Ozer et al.** have used TRAP approach in eleven patients with AO type C fractures. They have performed an isokinetic strength test of involved and uninvolved elbow. Peak torque deficits of the flexor and extensors on the operated and non-operated side were below 20%. They have found no significant impairment of elbow function

In 2000-rochestor ,Minnesota said TRAP approach provides almost the same exposure as an olecranon osteotomy, without the complications of the osteotomy

In 2002 - Pajarinen J and Bjorkenheim JM., conducted a study on a group of 18 patients with type C inter- condylar fractures of distal humerus treated with open reduction and internal fixation. Review of these cases showed good to excellent results with olecranon osteotomy

Pankaj et al. have used TRAP approach in AO type C distal humerus fractures (n=40). They have reported that thirty-five patients

(87.5%) had good triceps strength, four patients (10%) had fair strength, and one patient (2.5%) had poor strength with an extension lag of 10

In 2004 - Allende CA. et al., advocated that the type, number and location of osteosynthesis material must be selected according to the fracture pattern, bone quality and associated lesions with intercondylar fracture distal humerus.

In 2004 - Teng-Le Huanga. et al., concluded that open reduction and internal fixation with AO reconstruction plate is very useful and effective in the treatment of displaced fractures of the adult distal humerus with triceps reflecting anconeus approach.

In 2004 - Ibomcha Singh and Sanjib Waikhom, concluded that internal fixation is a good method of treatment for Type-C distal humerus fracture to get restoration of the articular surface anatomy, stable fixation and early mobilization exposed by olecranon osteotomy.

In 2005- McCarty LP, Ring D and Jupiter JB, suggested that fractures of the distal humerus are complex injuries that can be effectively treated with open reduction and internal fixation (ORIF). Exposure of a complex intra-articular fracture may best be achieved through a posterior approach with osteotomy of the olecranon process.

In **2005-ozer,solak** stated TRAP approach is extensile enough in treating these complex fractures however both articular reconstruction

and fixation can be easily managed without creating an olecranon fracture. No significant triceps weakness and dysfunction was observed after TRAP approach in the treatment of the intercondylar fractures of the humerus.

IN 2007-Amite pankaj,mallinath concluded The TRAP approach provides good visualization for fixation of intercondylar fractures of the humerus, without any noticeable untoward effect on triceps strength and postoperative rehabilitation; and one can avoid iatrogenic fracture of the olecranon and its associated complications.

In 2008- K Reising et al., concluded that open reduction and internal fixation with the triceps reflecting approach provides reliable, stable fixation allowing early functional mobilisation of the elbow joint, even in complex fractures and impaired bone quality, resulting in good outcomes for the majority of patients.

In 2009 – Tang XJ et al., concluded that the technique of dual steel plate for the treatment intercondylar fractures of the humerus through approach of osteotomy of olecranon offers many advantages, such as sufficient exposure easy, stable fixation and earlier exercise.

In 2009- Atalar et al, conducted a study on around 21 patients with distal end humerus fractures and functionally evaluated the outcome and concluded that results are satisfactory when fractures are treated with

stable osteosynthesis exposed by osteotomy approach that allows early motion, in congruence with other studies conducted around that time

In 2011 – Chen G et al, concluded that ORIF via the triceps-sparing approach confers inferior functional outcomes for inter-condylar distal humerus fractures in patients over the age of 60 years, for whom the olecranon osteotomy approach may be a better choice. However, for patients less than 60 years of age, especially those less than 40 years of age, either approach confers satisfactory outcomes

In 2014 - Lee SK et al., concluded that no significant differences were found between trap approach and osteotomy approach in terms of clinical outcomes, mean operation time, union time, or complication rates

In 2015-saurabh Sharma, mukesh tiwari concluded TRAP approach provides an excellent exposure as well as a good functional outcome as measured by DASH score and full range of motion at the elbow joint with return of almost complete power of the extensor apparatus in patients with intra-articular fractures of distal humerus.

In 2016 –azboy,bulut,ancar et al compared the fracture intercondylar humerus by TRAP approach with olecranon osteotomy and concluded as TRAP is a successful approach in the treatment of intra-articular distal humerus fractures that provides better arc of elbow motion, reduces complications and reoperation rates.

In 2017-vijay sharukte,ravi bhanushali stated tRAP is a better option as it avoids creating a new fracture and preserving the joint anatomy as compared to olecranon osteotomy with adequate exposure of the joint to carry out the fixation

ANATOMY OF THE DISTAL HUMERUS & ELBOW JOINT

The elbow joint or cubital joint is a hinge variety of compound synovial joint.

This includes two articulations:

1. Humero - Ulnar, between humeral trochlea and ulnar trochlear notch
2. Humero - Radial, between humeral capitulum and radial head.
3. Its complexity is increased by its continuity with the superior Radio- Ulnar joint within a continuous synovial cavity, this complex being the cubital articulation.

THE BONES:

A) THE DISTAL END OF HUMERUS:

The distal end of humerus is wide transversely and is divided intoroughly triangular medial and lateral components called the condyles. Eachcondyle has articular and non articular parts.The articular parts include, the lateral capitulum and the medial The capitulum is less than half a sphere and includes the anterior and inferior surfaces of the lateral

humeral condyle

The trochlea is like a part of a pulley, includes anterior, inferior and posterior surfaces of the medial humeral condyle and is separated laterally from the capitulum by a faint groove. It articulates with the trochlear notch ulna. In extension the infero-posterior trochlear circumference is in contact with ulna, but in flexion the trochlear notch slides on to the anterior aspect, The non articular parts of the condyle includes medial and lateral epicondyles, coronoid, radial and olecranon fossae.

Medial epicondyle, the non articulating part of medial condyle is ablunt projection, which is subcutaneous and visible in passive flexion. Its posterior surface is crossed by the ulnar nerve in a shallow sulcus it enters the forearm. Distally the anterior surface is by the attachment of superficial forearm flexors.

B) THE PROXIMAL END OF ULNA :

It consists of olecranon and coronoid processes and trochlea and radial notches articulating with the humerus and radius respectively.

The olecranon, more proximal is bent forwards at its summit like abeak, which enters the humeral olecranon fossa in extension. The posterior surface of olecranon is smooth, triangular and subcutaneous, its proximal border being the elbow's point. In extension it can be in the

same line the humeral epicondyles, the three osseous forming an isosceles triangle. The anterior surface of olecranon is the surface which forms the proximal part of trochlear notch. The base of olecranon is slightly constricted where it joins the shaft.

C) THE PROXIMAL END OF RADIUS :

The proximal end of the radius is expanded and includes a head, neck and tuberosity. The head is discoid and its proximal surface is a shallow the humeral capitulum. Its smooth articular periphery is vertically deeper medially, where it articulates with the radial notch of ulna. The neck is the constriction distal to the head, which overhangs it, especially on the lateral side. The tuberosity is distal to the medial part of the neck which is extra articular and has a rough posterior portion for the insertion of biceps tendon.

LIGAMENTS OF ELBOW JOINT :

The humero-ulnar and humero-radial articulations form a largely uni- axial joint. The ligaments include capsular and the collaterals namely, ulnar and radial collateral. The collateral ligments supplement the natural stability of the elbow joint.

a) THE ARTICULAR CAPSULE :

It is anteriorly broad and thin, attached proximally to the humerus

above the coronoid and radial fossae and to the front of medial epicondyle and distally to the edge of the ulnar coronoid process and annular ligament. On either sides it is continuous with the ulnar and radialcollateral ligament.

The synovial membrane lines the capsule's deep surface extending from the humeral articular margins, lines the coronoid, radial and olecranon fossae, the flat medial trochlear surface and the lower part of the annular ligament.

b) THE ULNAR COLLATERAL (MEDIAL CUBITAL) LIGAMENT : This is a triangular band consisting of thick anterior, posterior and inferior parts limited byintermediate fibres.

c) THE RADIAL COLLATERAL (LATERAL CUBITAL) LIGAMENT :

This is a fan shaped band, attached proximally to the lateral epicondylea nd distally to the annular ligament. Some of its posterior fibres cross the ligament to the proximal end of the ulnar supinator crest. It is intimately blended with the attachment of supinator and extensor carpi radialis.

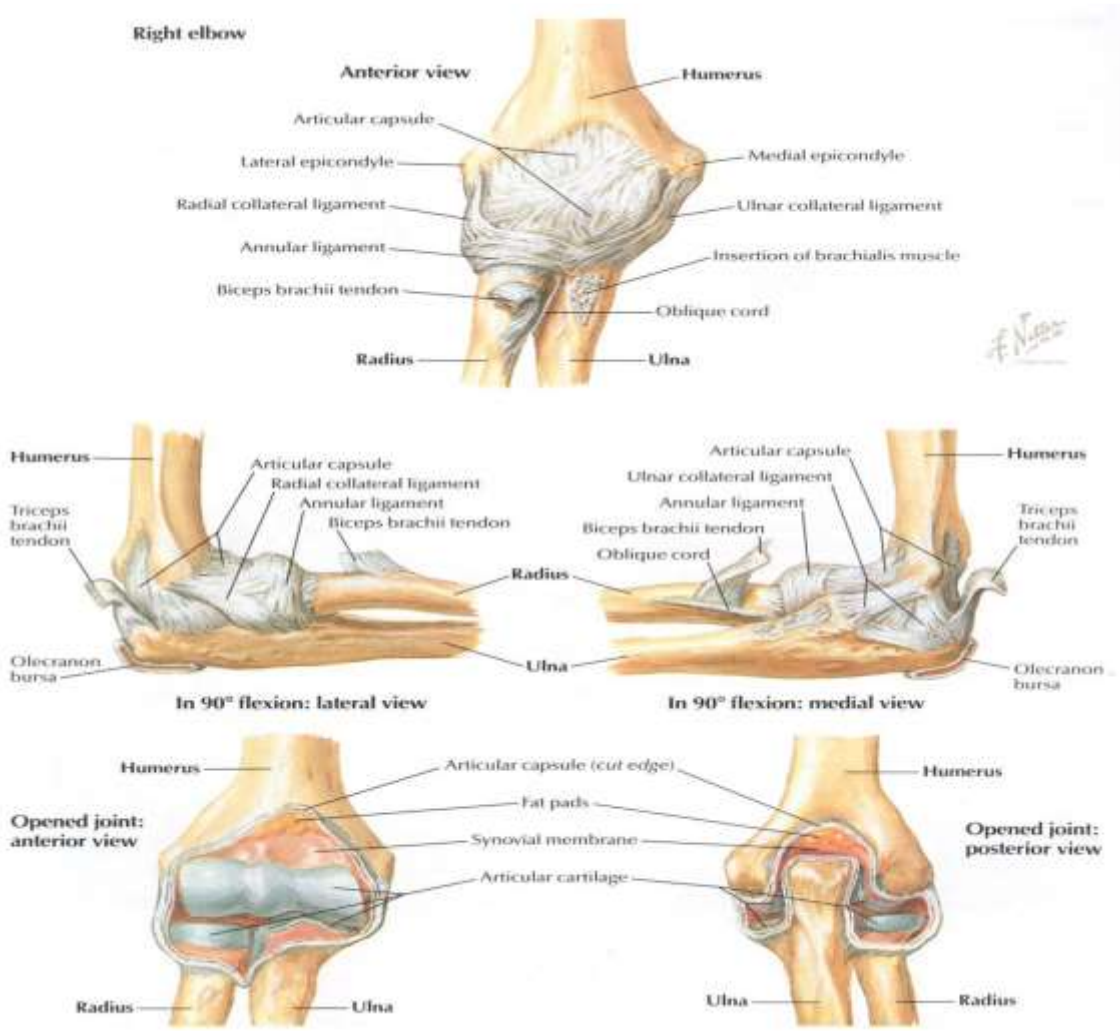
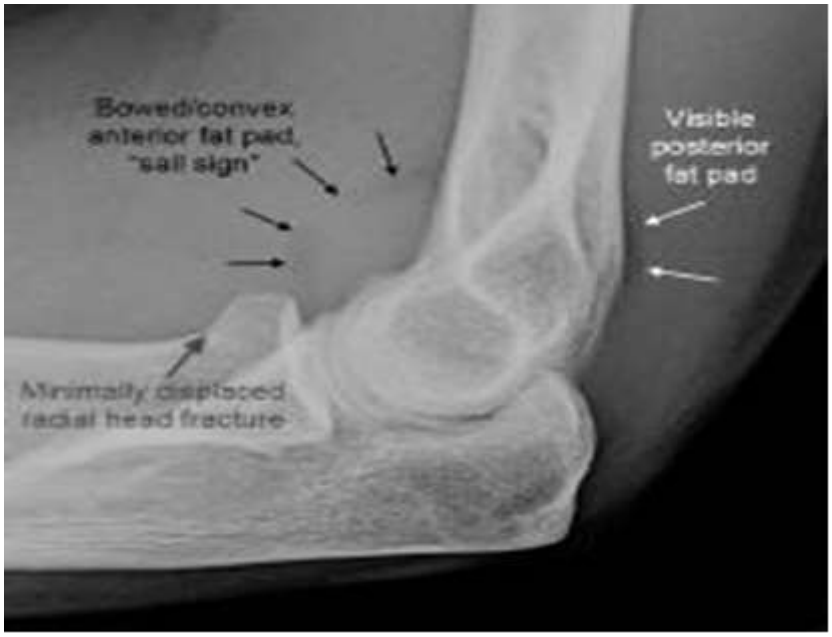


Figure 2 : Ligaments of Elbow

RADIOGRAPHIC ANATOMY :



Lateral Radiograph of Elbow Joint

"Fat pad sign" - is useful for occult intra-articular fractures. It is area of translucency posterior to distal humerus inlateral view. The normally not visible fat pad from olecranon fossa is displaced due to distension of joint as an effusion or hemarthrosis.

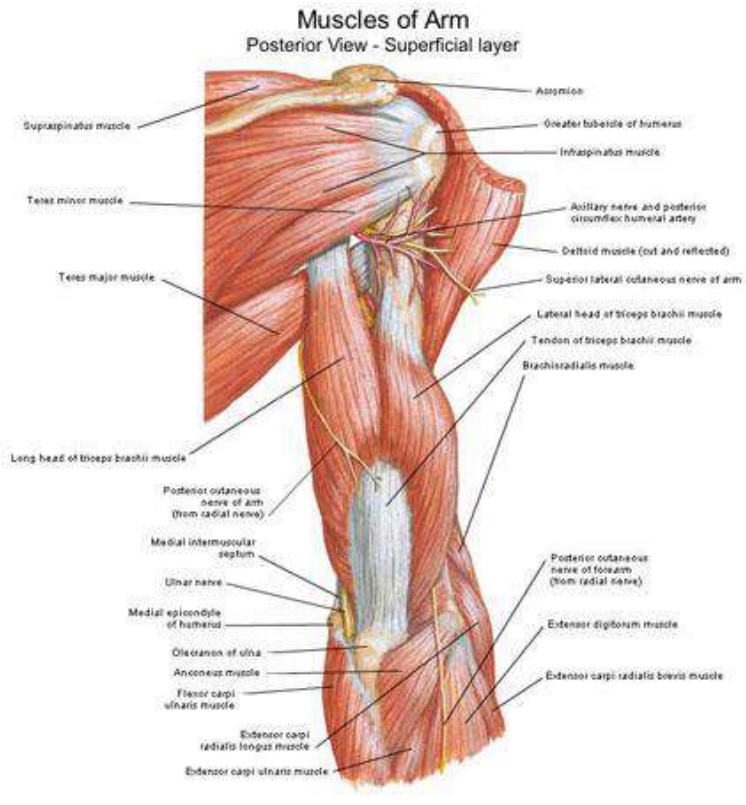
Since coronoid fossa is **:** shallow, anterior fat pad is not visualised in /normal elbows. Distension displaces it anteriorly and superiorly.

MOVEMENTS :

Elbow joint being a uni-axial joint allows flexion and extension with ulna moving on the trochlea and radial head on capitellum. However, ulnar flexion extension is not a pure swing but accompanied by slight conjunct rotation, the ulna being slightly pronated in extension and

supinated in flexion. The extension is limited by tension in the capsule and muscles anterior to the joint and the entry of tip of the olecranon into the olecranon fossa. The flexion is limited chiefly by apposition of soft parts, with the rim of radial head and the tip of ulnar coronoid process entering the radial and coronoid humeral fossae respectively. Accessory movements of limited to slight ulnar screwing, adduction, abduction and anteroposterior translation of the radial head on the humeral capitellum.

MUSCLES PRODUCING THE MOVEM4ENTS



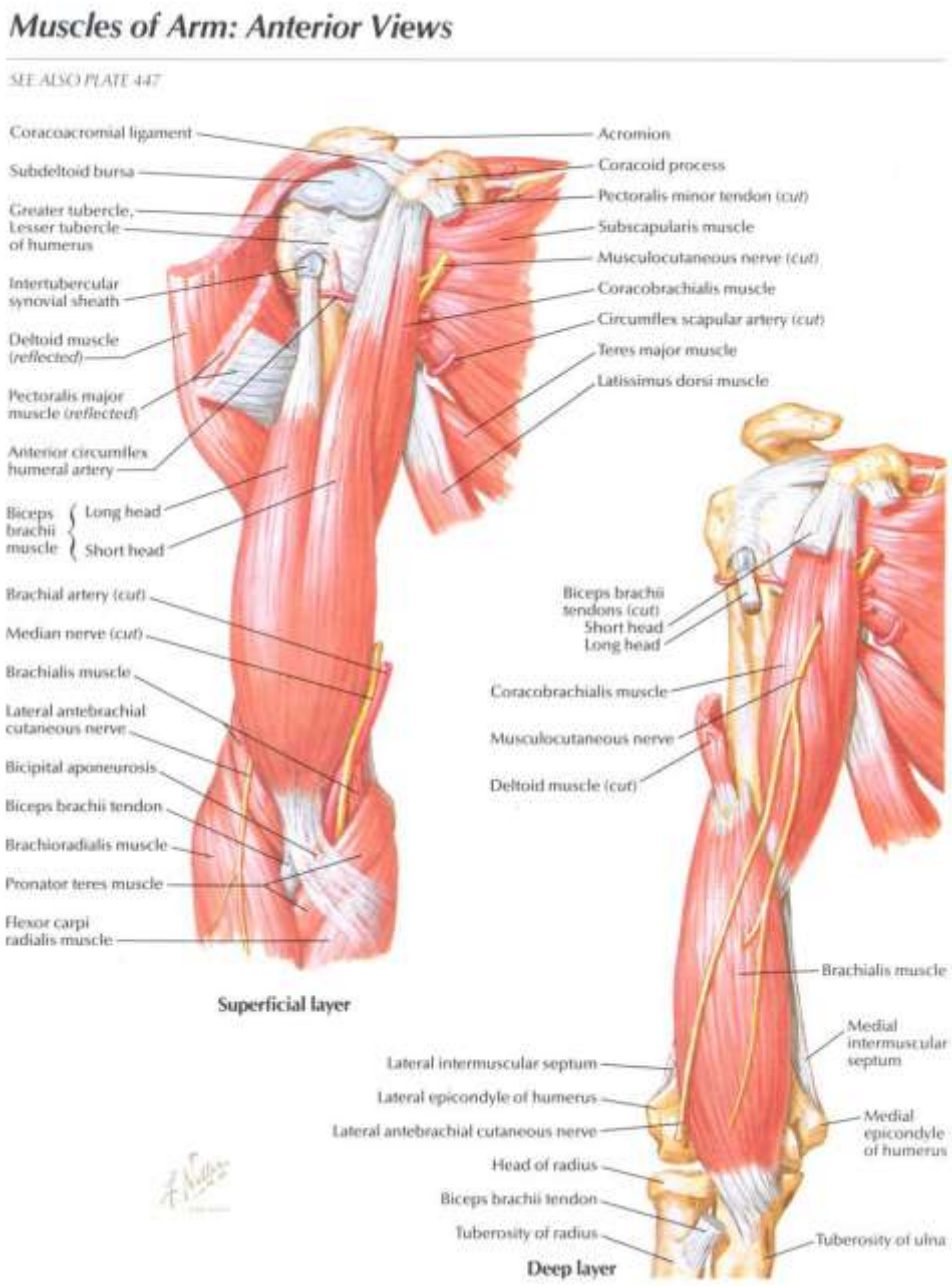


Figure 4 : Muscles of Arm (Anterior view)

THE SUPERIOR RADIO-ULNAR JOINT :

This is a uni-axial pivot between the circumference of the radial head and osseo-fibrous ring made by the ulnar radial notch and annular ligament. The annular ligament is a strong band that encircles the radial head holding it against the ulnar radial notch. It forms about four-fifths of

the ring and is attached anteriorly behind the posterior margin of radial notch. The proximal annular border blends with the cubital capsule reflected synovial membrane to attach loosely on the radial neck.

MOVEMENTS :

Movements of the radio-ulnar joint complex are pronation and supination the hand. In pronation the radius is carried antero-medially obliquely its proximal end remaining lateral and distal end becoming medial. In supination the radius returns to a position lateral & parallel to ulna. The hand can be turned thus through 140° -150° and with the elbow extended this can be increased to nearly 360° by humeral rotation and scapular movements.

MUSCLES PRODUCING THE MOVEMENTS :

Pronation : Pronator Quadratus, Pronator Teres and Flexor Carpi Radialis.

Supination : Biceps Brachii and Supinator .

BLOOD SUPPLY OF THE ELBOW JOINT :

The elbow joint is supplied by the articular branches from the anastomotic networks around the joint. The anastomosis is formed by:

a) Anterior descending and posterior descending branches of profunda brachii artery.

b) Radial recurrent branch of radial artery.

c) Inferior and superior ulnar collateral branch of brachial artery.

d) Anterior and posterior ulnar recurrent branches of ulnar artery.

NERVE SUPPLY OF THE ELBOW JOINT :

The elbow joint is supplied mainly from articular branches of musculocutaneous and radial nerves, but the ulnar, median and sometimes the anterior interosseous nerve also contribute. The articular branches from the musculocutaneous nerve arises from the nerve to brachialis and supply the anterior part of the capsule.

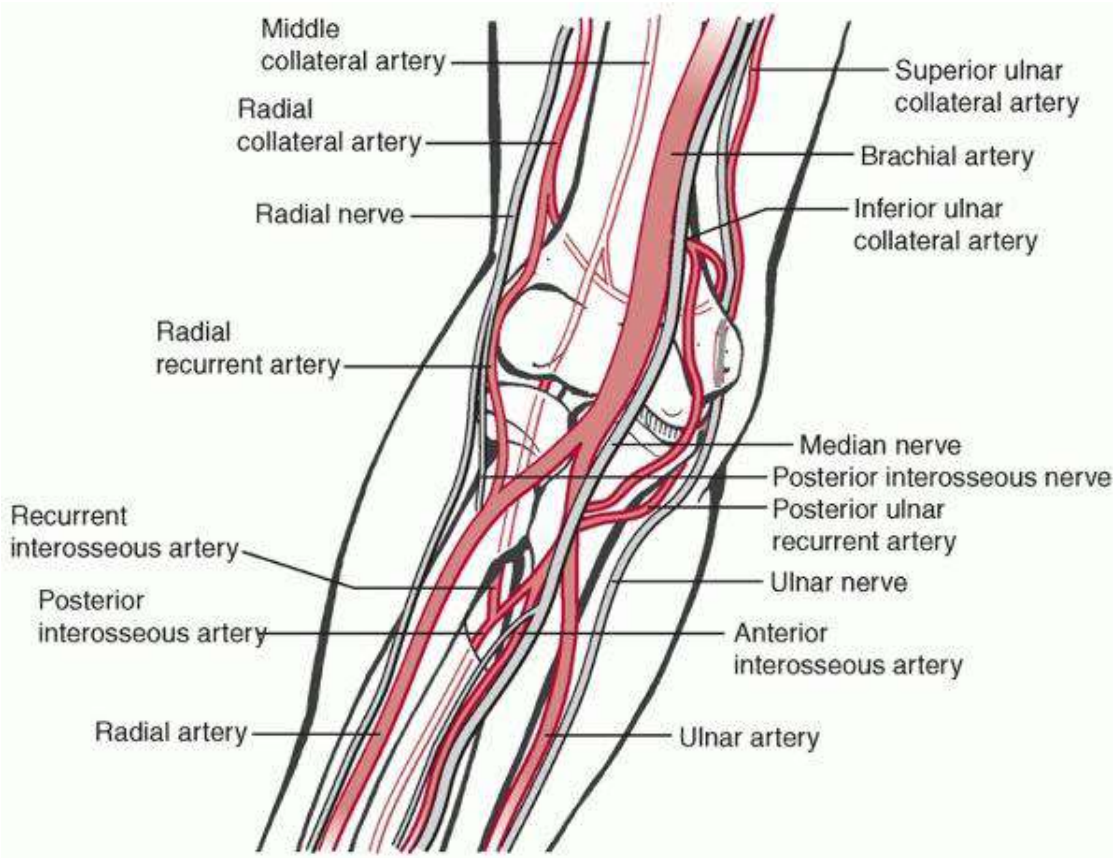


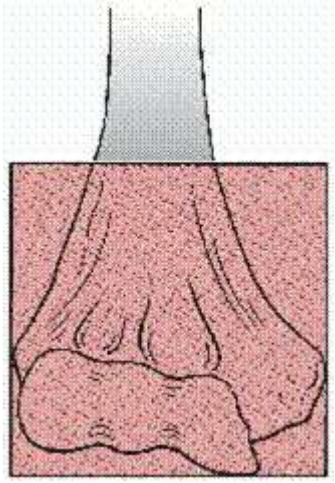
Figure 6 : Neuro- Vascular structures around the Elbow

Ossification centre	Appearance	Fusion
Capitulum	1 Year	14-16 Yrs
Head of Radius	4 Year	16-18 Yrs
Medial Epicondyle	4 Years (Female) 6 Years (Male)	16-18 Yrs
Trochlea	9 Years (Female) 10 Years(Male)	14-16 Yrs
Olecranon	10 Years	14-16 Yrs
Lateral Epicondyle	12 Years	14-16 Yrs

Table 1: Ossification centers around the Elbow

FUNCTIONAL ANATOMY:

The distal humerus consists of the expanded portion of the metaphysis, including the joint surfaces for



Distal Humerus Hypothetical Square considered to be metaphyseal if the major fragments are located within a hypothetical square, with sides equal the widest portion of the distal metaphysis. The columns and the trochlea are also anatomically the area of greatest bone mass, and serve as corridors in which internal fixation can be placed. The normal movement of the ulnotrochlear and radiocapitellar joints that accommodate the olecranon, coronoid, and radial head are not breached by the internal fixation. Although mechanically unimportant to the stability of the elbow, reconstruction of the anterior hemispheric surface at the distal part of the lateral column is connecting the medial and the lateralepicondyles, and both the trochlea andcapitellum project forward at an angle of approximately 40 degrees from the long axisof thehumerustrochlea is the medialmost part of thearticular segment and is intermediate in position between the medial epicondyle andcapitulum. This functions architecturally as a tie arch.

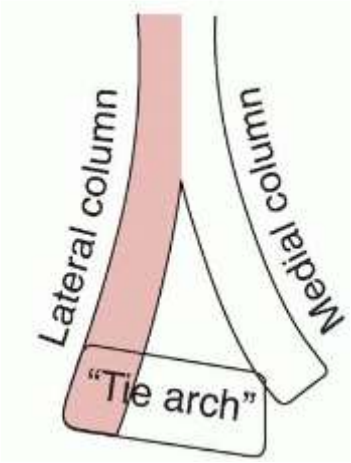


Figure 8 : Elbow as a Tie Arch

BIOMECHANICS OF THE ELBOW

Elbow joint is near equivalent of a mechanical hinge although not a perfect one. The predominant movements of the elbow joint are flexion and extension which are movements of forearm in respect of humerus as levers and elbow joint as the fulcrum.When the elbow is in full extension, the axes of the arm and forearm producecarrying angle, flexion it disappears. Elbow joint is considered in full extension when the long axis of the humerus and that of the ulna become collinear..found that most of the activities of daily living could be accomplished .

The axis of motion of elbow joint is transversely disposed and passes throughcentre of the capitulum and trochlea. This axis is inclined slightly upwards, backwardsand laterally, hence movement of ulna cannot be in same plane as humerus. Instant centre of motion of the elbow joint has been found to be a tight cluster of multiple points rather than a single centre. During early part of flexion, it is towards thecoronoid fossa and shift backwards towards the olecranon fossa during the last part of extension. The pattern of shifting of the contact point indicates that ulna some amount of adduction and axial rotation during flexion and flexion the elbow joint is not a uniplanar motion taking place in sagittal plane Rotation of the forearm takes place around an obliquely disposed longitudinal axis. Elbow joint is loaded by action of gravity (weight),

muscular forces and extra out of which 60% of the axial load is transmitted across the radiocapitular and 40% across the humero- ulnar articulation. Force transmitted isconstantly greater in pronation than in supination. Extensors of the elbow act on a lever arm shorter than the flexors, resulting in muscular force for elbowextension against gravity.

CLASSIFICATION

Fractures of the lower end of humerus are classified by –

A) Riseborough and Radin

- In 1969 classified inter- condylar fractures on the Radiographic appearance. It provides some guidance to management and prognosis. They are 4 types.
- Type- I : Non-displaced fracture between the capitulum and trochlea.
- Type- II : ‘T’ shaped fracture with separation of capitulum and trochlea
- without appreciable rotation of the fragments in frontal plane.
- Type- III : ‘T’ shaped fracture with separation of fragments with
- rotational deformity
- Type- IV : Severe comminuted articular surface with wide separation of
- humeral condyles.

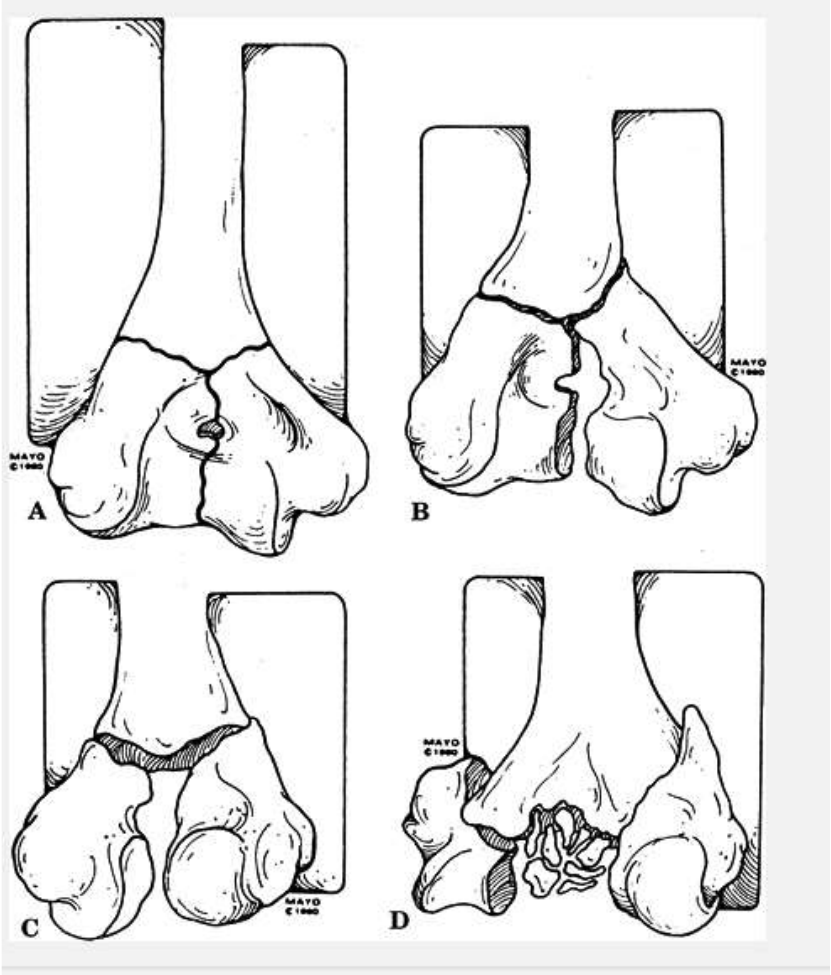


Figure 10 : Riseborough and Radin Classification

B) AO / ASIF Classification45 :

Here the fracture of distal humerus are basically classified into three types :

Type-A : Extra- articular fractures

Type-B : Intra- articular, uni- condylar or partial articular fractures

Type-C : Intra- articular, bi- condylar complete articular fractures.

C1 : Complete articular fracture, articular simple, metaphyseal simple.

C2 : Complete articular fracture, articular simple, metaphyseal multifragmentary.

C3 : Complete articular fracture, multi- fragmentary

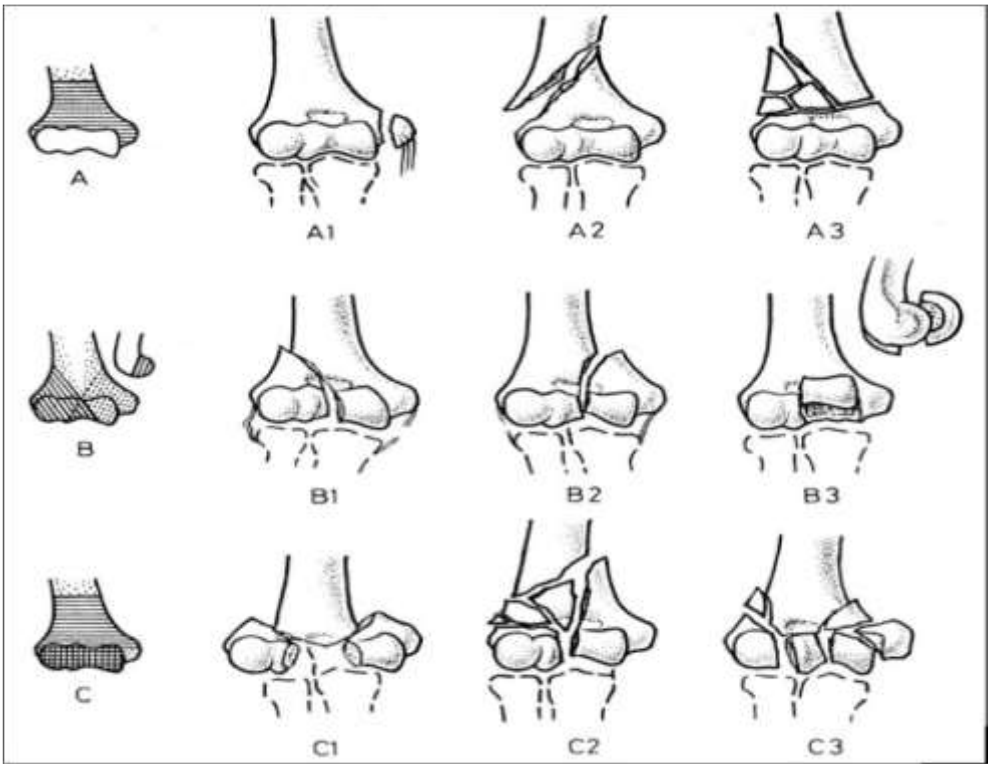


Figure 11 : AO- ASIF classification

MECHANISM OF INJURY

Extra- articular fractures that traverse both columns of the distal humerus most often the result of a fall. These fractures occur more commonly in children.Intra- articular fractures are probably caused by the impact of the proximalulna against the trochlea, forcing apart the condyles of the distal humerus. Thesefractures are associated with high-energy trauma, such as falls and motor vehicle accidents. Varus and

valgus movements, bone quality, and the energy of the injury influence the degree of comminution. Condylar fractures of the distal humerus can occur with adduction forces of the extended forearm, which concentrates these forces to one side of the distal humerus. This creates compressive forces on the articular surface. force applied to the posterior aspect of a flexed elbow can also produce a one condyle. A fracture of the capitulum usually results from shear forces. Fracture commonly results from a fall onto an outstreched hand. Isolated an epicondyle are more common in chfracture is commonly caused by a direct blow to the epicondyle.

There are two types of injury. One is “flexion type” where condyles are anterior to the humeral shaft. In the “extension type” , ulna is directed anterior against the posterior aspect of trochlea, separating the condyles action of biceps anteriorly and triceps posteriorly pull articular surface of Ulnaproximally. In an opposing fashion, the humeral shaft is forced distally between the rotated condyle

BIOMECHANICS OF FRACTURE FIXATION

Reconstruction of distal humerus can be done according to two rules

1. Reduction and fixation of the articular surfaces followed by attachment to the humeral shaft, or

2. Reduction and fixation of the medial or lateral condyle to the shaft, then reconstruction of the articular surface (advantageous when the

articular surface is comminuted), followed by fixation of contralateral condyle.

In 2001, Sanchez – Sotelo et al., in a study have described a few technical objectives for fixation of distal humerus fractures which can serve as guidelines. They are as follows :

1. Every screw should pass through a plate.

2. Each screw should engage a fragment on the opposite side that is also fixedto a plate.

3. As many screws as possible should be placed in the distal fragments.

4. Each screw should be as long as possible.

5. Each screw should engage as many articular fragments as possible.

6. Plates should be applied such that compression is achieved at the supracondylar level for both the columns.

7. Plates used must be strong and stiff enough to resist breaking or bending before union occurs at the supracondylar level.

METHODS OF TREATMENT

The various modes of treatment are non-operative and operative.

NON-OPERATIVE TREATMENT (Closed techniques) - can be divided into three

categories :

a) Cast or Posterior slab immobilization :

It is usually preceded by manipulation of the fracture. Watson Jones is a staunch supporter of this method. Here bicondylar pressure is applied while reducing and then the arm is flexed to 90° and long arm cast or slab is applied. The cast is well moulded while giving bicondylar pressure or a reinforcing medial or lateral slab is used over pads. As the swelling subsides, the bandages over the pads are tightened.

b) Traction (Skin, Gravity or Skeletal) :

It is one of the most popular technique among proponents of non-operative treatment.

Its use is to obtain reduction or maintain reduction achieved by manipulation. It is indicated for :

i) Riseborough and Radin Type-IV (severely comminuted) fracture

ii) Fracture with large open wound where contamination markedly increases the chances of infection with internal fixation.

iii) Lack of adequate surgical technique.

1) Patterson used a well-moulded long arm cast incorporating the ulnar pin.

2) Use of "icetongs"

Robert Jones modified Thomas arm splints to maintain traction and immobilisation. Michael used a hook type plaster traction.

But all of these were cumbersome and did not allow elbow motion.

c) Bag of bones technique :

Eastwood, who popularised this method in England in 1930s credited HughOwen Thomas as being its originator. It involves simply placing the arm in a collarand cuff sling in as much flexion as possible because exercise will improve extensionbut not flexion. The elbow is left hanging free, so that the effect of gravity in the dependant elbow is thought to enable fragments to settle into a more natural alignment.

shoulder motion begins at 7 to 10 days. As the swelling and pain subside, the patient isallowed to actively extend elbow gradually. The fracture usually unites in 6 weeks at which the sling is discarded. Intensive exercises increase the range of motion over 3-4 months

OPERATIVE METHODS :

These are -

1) Pins in plaster : This was originally called “blind nailing”52 by Miller. initially placed the upper extremity in traction with a Kirschner wire in the olecranon. The condyles were then manually reduced and transfixed percutaneously with a second K-wire. A third wire was likewise passed percutaneously through the proximal fragment. While the fracture was maintained in traction, a long arm cast was applied incorporating all the three kirschner wires. Bohler is a proponent of this technique.

The presence of at least two pins penetrating the fracture site greatly enhances the chances of infection and its resultant disability.

2) Limited open reduction and internal fixation : Two distinct methods have

In one method, this is followed by post-operative traction or closed manipulation andcasting of remaining supracondylar component. Motion was started at 4 weeks.

3) Open reduction and internal fixation : This seems to serve the perfect

Solution for accurate reduction and immobilisation of fracture. Mobilization (physiotherapy) can be started earlier and good results can be achieved

4) Total elbow replacement : Replacement surgeries in context to fracture of distal end of humerus is mainly used as a secondary procedure to treat elbow stiffnessand nonunion of distal end of humerus. . It is limited to a restricted group of patients older than 60-65 years with an extensively comminuted fracture that is not amenable to adequate and stable osteosynthesis.

The usual findings are –

(a) Severe comminution with multiple small fragments.

(b) Severely osteoporotic bone.

(c) Pre-existing joint damage in patients with rheumatoid arthritis or other inflammatory joint diseases.

5) Hemiarthroplasty : Another surgical option experiencing a renewed interest

POST-OPERATIVE CARE AND REHABILITATION :

The main aim is to provide stable fixation to allow early mobilisation. Active motion is started as soon as wound heals and swelling subsides. Passive motion delays rehabilitation and is not recommended.

COMPLICATIONS :

A) Early complications :

1) Nerve injuries : Neuropraxia of ulnar, median or radial nerves is seen most of which is temporary.

2) Vascular injuries : Usually is due to extensive antecubital swelling leading to ischaemic contracture of forearm muscles and ischaemic neuropathy. It is a permanent and worst complication.

B) Late complications :

1) Non union : Usually of the supracondylar portion occurs occasionally

2) Avascualr necrosis of the bony fragments is usually rare.

3) Malunion : Usually due to poor closed reduction or improper fixation

4) Calcification in soft tissues (heterotopic ossification) and even myositis ossificans

5) Elbow stiffness : This is one of the important complications.

6) Progressive ulnar nerve palsy : Especially in valgus angulation at

elbow due to malunion and very rarely due to entrapment in fracture callus especially in fractures of medial epicondyle.

7) Instability of the elbow : Due to collateral ligament injury, non-union, avascular necrosis of condyles and resection of capitellar fragments along with lateral trochlear ridge.

8) Infection : Due to initial compound injury with extensive soft tissue trauma and also due to implants used during ORIF.

9) Osteoarthritis of elbow .

10) Olecranon Osteotomy complications : These can present occasionally with non-union or delayed union of osteotomy site.

TABLE 57-6 Surgical Approaches Used for Treatment of Fractures of the Distal Humerus

	SURGICAL APPROACH	INDICATIONS	CONTRAINDICATIONS	ADVANTAGES	DISADVANTAGES
POSTERIOR	Olecranon osteotomy	ORIF for fractures involving columns and articular surface	TER	Good access to posterior articular surfaces for reconstruction	Nonunion and failure of fixation of osteotomy Poor anterior access to capitellum
	Triceps-splitting	ORIF/TER for fractures involving columns and articular surface	Previous olecranon osteotomy approach Patients at increased risk for healing problems	Avoids complications associated with olecranon osteotomy	Poor access to articular surface for internal fixation Risk of triceps detachment
	Triceps-reflecting	Fractures requiring TER	ORIF Previous olecranon osteotomy approach Patients at risk for healing problems	Avoids complications associated with olecranon osteotomy	Risk of triceps detachment
	Triceps-detaching	ORIF/TER for fractures involving columns and articular surface	Previous olecranon osteotomy approach Patients at risk for healing problems	Avoids complications associated with olecranon osteotomy	Poor access to articular surfaces for internal fixation Risk of triceps detachment
MEDIAL		Medial epicondylar fractures Medial column fractures			Lateral column inaccessible
	Koher	Lateral column fractures Lateral epicondylar fractures Capitellar fractures	Suspected more complex articular surface fracture	Radial nerve protected	Medial column inaccessible
LATERAL	Koeber				Risk of injury to radial nerve Medial column inaccessible
	Jupiter	Complex articular surface fractures	Significant involvement of the columns		Medial column inaccessible
ANTERIOR	Henry	Vascular injury	Requirement for plate fixation of columns or articular surface reconstruction	Good access to brachial artery	Limited access to columns

ORIF, open reduction and internal fixation; TER, total elbow replacement.
Modified from Robinson CM: Fractures of the distal humerus. In Bucholz RW, Heckman JD, Court-Brown CM, editors: *Rockwood and Green's fractures in adults*, ed 6, Philadelphia, 2006. Lippincott Williams & Wilkins.

Posterior Approaches :

The selection of a particular type of posterior approach depends on several factors, including: the degree of articular visualization required for anatomic reduction and internal fixation; the appropriateness of primary arthroplasty; patient factors(elderly, low demand); fracture characteristics (articular comminution); any associated injuries (i.e., triceps laceration or olecranon fracture) that may make one approach more favorable.

Trans- olecranon approach :

When compared with other posterior approaches, osteotomy of the olecranon provides the best visualization of the distal humerus articular surface. The main disadvantages of the approach are the complications associated with an osteotomy, including nonunion, malunion, and hardware irritation. Olecranon osteotomies are most commonly used for articular fractures requiring superior visualization of the articular fragments for anatomic reduction and internal fixation. An osteotomy can also be used for partial articular fractures, especially if they are comminuted. Relative contraindications to an osteotomy are very anterior articular fractures, 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.

Once the subcutaneous border of the proximal ulna is exposed, the nonarticular portion of the greater sigmoid notch (the “bare area”) between the olecranon articular facet and the coronoid articular facet should be clearly identified. This is done by subperiosteally dissecting along the medial and lateral sides of the olecranon to enter into the ulnohumeral joint. Dissection should not proceed distally as it places the collateral ligament insertions at risk. Medial and lateral retractors are then placed into the ulno- humeral joint to protect the soft tissues and to allow

direct visualization of the “bare area.” An apex distal chevron osteotomy entering into the bare area is then marked on the subcutaneous border of the ulna. A microsagittal saw is used to complete two thirds of the osteotomy. To avoid unpredictable propagation of the osteotomy, multiple perforations are carefully created through the remaining thirdusing a Kirschner wire (K-wire). Two osteotomes, placed into each arm of the chevron, apply controlled leverage of the olecranon fragment causing fracture of the remaining third. A chevron-shaped osteotomy provides rotation stability, increased surface area for healing, and protects the collateral ligament insertions. Typically, the anconeus muscle must be divided to reflect the triceps posteriorly which causes its denervation.

Anconeus muscle denervation can be avoided by reflecting the anconeus muscle posteriorly along with the olecranon fragment and triceps. Once the osteotomy is conducted, flexion of the elbow is used to maximize visualization of distal humerus articular surface. Fixation of the olecranon osteotomy can be achieved with tension band wiring, screw/tension band constructs, or compression plating.

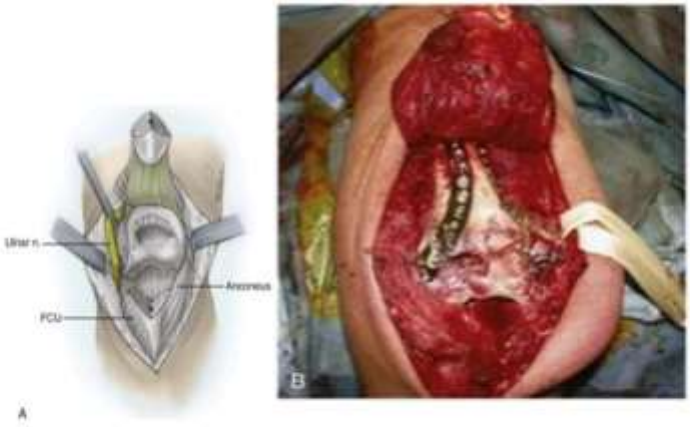
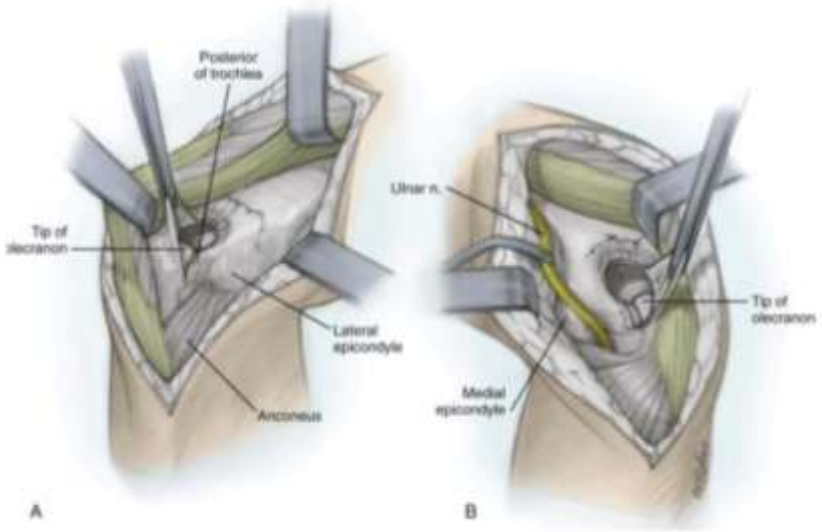


Figure :olecranon osteotomy approach

ParatricipitalApproach



The paratricipital (bilaterotricipital, triceps sparing, or triceps-on) approach was first reported by Alonso-Llames in 1972 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 approach starts with an extensile posterior skin incision and mobilization of the ulnar nerve. Along the medial side of the triceps, the interval between the triceps muscle and the medial intermuscular septum is developed and the triceps is elevated off the posterior aspect of the humerus . Laterally, the triceps is elevated off the lateral intermuscular septum and the posterior humerus in conjunction with the anconeus muscle. Distally, the paratricipital approach allows visualization of the medial and lateral columns, the olecranon fossa, and the posterior aspect of the trochlea

Advantages:

- Avoidance of an olecranon osteotomy and its complications.

- Triceps tendon insertion is not disrupted, allowing active range of motion.

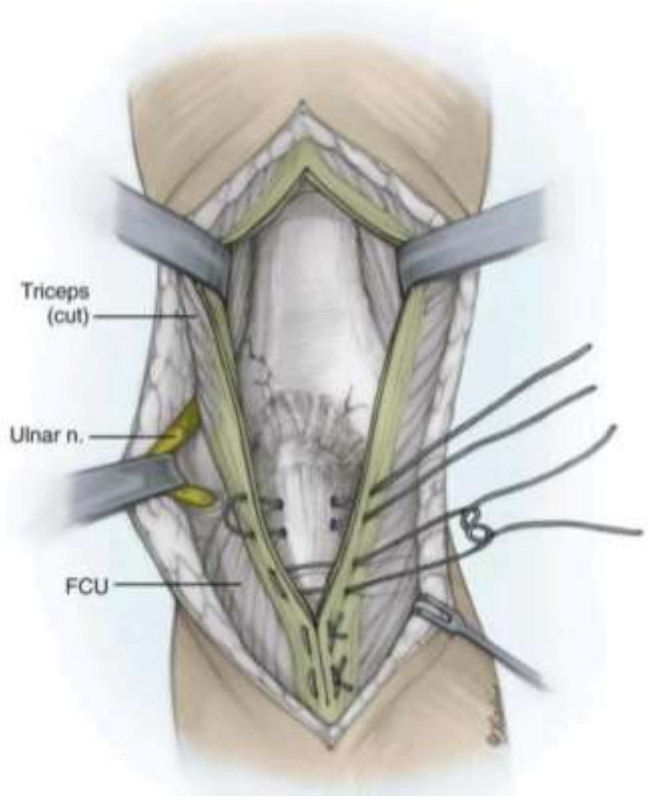
- Preserves the innervation and blood supply of the anconeus muscle, which provides dynamic posterolateral stability to the elbow.

approach.

Disadvantage :

- Limited visualization of the articular surface

Triceps Splitting Approach:



The triceps splitting approach described by Campbell involves a midline split through the triceps tendon. The medial and lateral columns are exposed with subperiosteal dissection starting from the midline and moving outwards. This approach can be extended proximally to the level of the radial nerve as it crosses the humeral shaft in the spiral groove. To expand the approach distally, the split can be extended through the triceps insertion to the subcutaneous border of the ulna. The triceps insertion is split midline, with release of Sharpey fibers creating medial and lateral fasciotendinous sleeves. At the conclusion of the procedure, the triceps tendon isrepaired to the olecranon via nonabsorbable braided sutures.

Advantages:

- Relative technical ease

- Ability to convert from open reduction and internal fixation to total elbow arthroplasty.

Disadvantages :

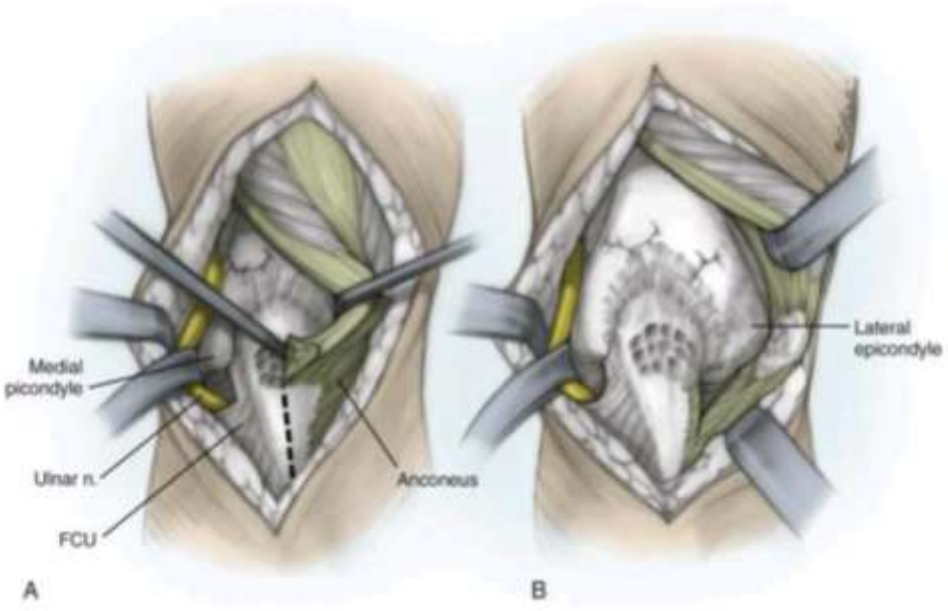
- Limited visibility of the articular surface,

- Disruption of the extensor mechanism requiring postoperative protection

- Risk of triceps dehiscence.

Triceps Reflecting Approaches :

Bryan- Morrey Approach:



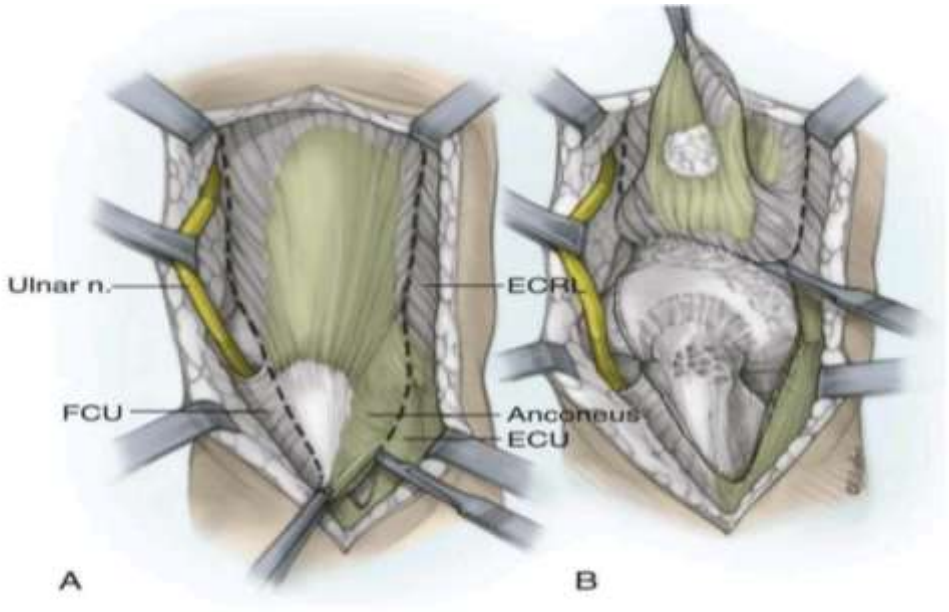
It is commonly used for total elbow arthroplasty. The approach can be used for ORIF of distal humerus fractures; however, exposure of the

lateral column for the application of fixation is limited. The approach has been termed “triceps-sparing” which has led to confusion. The approach does not “spare” the triceps, but rather detaches the triceps tendon in continuity with the ulnar periosteum and anconeus creating a large reflection or sleeve.

Extended Kocher Approach : The extended Kocher approach may be used for total elbow arthroplasty and is seldom used for ORIF of distal humerus fractures. The approach is analogous to the Bryan-Morrey in that the triceps is reflected; however, the direction of reflection is lateral to medial.

Triceps Dividing Approaches :

Triceps Reflecting Anconeus Pedicle Approach :



The triceps reflecting anconeus pedicle approach (TRAP) involves completely detaching the triceps from the proximal ulna with the

anconeus muscle. The approach is done through a longitudinal posterior skin incision after identification of the ulnar nerve. Kocher's interval is used to elevate the anconeus muscle and develop the distal lateral portion of the flap. The medial portion of the flap is created by subperiosteal dissection from the subcutaneous border of the ulna. The entire triceps-anconeus flap is then reflected proximally releasing the triceps muscle from the posterior aspect of the distal humerus.

Advantages :

- Provides good exposure to the posterior elbow joint
- Protects the neurovascular supply to the anconeus muscle.
- Avoids the complications of an olecranon osteotomy.
- Allows the use of the trochlear sulcus as a template to assist with articular reduction of the distal humerus.

Disadvantages :

- Triceps is completely released from its insertion
- Risk of triceps dehiscence and extensor weakness.

Van Gorder Approach (Triceps Tongue) :

This approach involves division of the triceps tendon at its musculotendinous junction. Most commonly used for total elbow arthroplasty and rarely for ORIF of distal humerus fractures. Transection of the triceps is done in the shape of a V, so thata V to Y plasty can be done if lengthening of the extensor mechanism is required. . This

approach is indicated for ORIF of distal humerus fractures when there is an associated complete or high grade partial triceps tendon laceration.

GRADING OF RESULTS

a) MAYO ELBOW PERFORMANCE SCORE :

MAYO ELBOW PERFORMANCE SCORE

Adapted from: Gill DR, JBJS 1998;80A:1327

Criteria	Points	Patient Score
Pain (45 points)		= 45
None	45	
Mild	30	
Moderate	15	
Severe	0	
ROM		
>100 degrees	20	= 20
50-100 degrees	15	
<50 degree	5	
Stability (10 points)		= 10
Stable	10	
Moderate instability	5	
Gross instability	0	
Daily function (25 points)		= 25
Combing hair	5	
Feeding oneself	5	
Hygiene	5	
Putting on shirt	5	
Putting on shoes	5	
	Patient Score=	100

> 90 points = excellent, 75 to 89 points = good, 60 to 74 points = fair, and less than 60 points = poor

Stable = no apparent varus-valgus laxity clinically, moderate instability = less than 10 degrees of varus-valgus laxity, and gross instability = at least 10 degrees of varus-valgus laxity.

Figure 14 : Mayo Elbow Performance Score

In this Study, we have used the Mayo Elbow Performance Score to evaluate the functional outcome.

MATERIALS AND METHODS

The present study includes 20 cases of intercondylar fracture of distal humerus admitted in government rajaji hospital, attached to Madurai medical college , between november 2015 to october 2017.

Method of collection of Data (including sampling procedure if any):

Collection of data for patients presenting with fracture of Distal humerus are as follows :-

- History by Verbal communication
- Clinical examination, both local and systemic.
- Radiological examination routine and other imaging modalities.
- Investigations- Baseline and others.
- Fracture anatomy assessed with X-rays.
- Diagnosis – Clinical and Radiological.
- Informed written consent will be taken for Surgical procedure.
- Surgery – Open reduction and Internal fixation
- Complications :-
- Follow up :-

Assessment at 6 weeks

- Clinical assessment of pain and stiffness
- Radiological assessment

Assessment at 12 weeks

- Assessment of Radiological and Clinical union.

Assessment at 6 months

- Assessment of Radiological and Clinical union and Functional ability of the elbow.

- Assessment of any complications.

- Assessment of function using Mayo Elbow performance score.

Inclusion and exclusion criteria :

Inclusion criteria :

• simple injury

• Patients above the age of 18 years

• Patients medically fit for surgery.

Exclusion criteria :

• Compound fractures of the distal humerus

• Old fractures of the distal humerus

• Patients not willing for surgery

• Patients medically unfit for surgery.

. The patients were then assessed clinically to evaluate their general condition and the local injury.

- Palpation revealed abnormal mobility and crepitus. Distal vascularity was assessed by radial artery pulsations, capillary filling, pallor and paraesthesia at finger tips.

- Radiographic study was done taking anteroposterior and lateral x-ray of theinvolved elbow. The limb was then immobilized in above elbow plaster of paris slab with sling.

Preoperative planning :

• Consent of the patient or relative was taken prior to the surgery.

• A dose of tetanus toxoid and antibiotic were given preoperatively.

• Preparation of the part was done a day before the surgery.

• The injured elbow was immobilised in an above elbow slab with sling during preoperative period.

• Instruments to be used were checked before hand and sterilised.

Position :

• All the patients were put in lateral position with arm supported and forearm hanging.

• Pneumatic tourniquet/ Esmarch tourniquet is recommended.

OPERATIVE PROCEDURE :

• Type of anaesthesia : General anaesthesia was used in 16 cases and brachial block in 4 cases.

• Pneumatic tourniquet/ Esmarch tourniquet was used in all cases

• Painting and draping of the part was done.

• The distal end of the humerus was approached using trans-olecranon approach.

• Elbow was exposed posteriorly through an incision beginning

approximately 5cm distal to the tip of the olecranon and extending proximally midline of the arm approximately 8cm above the tip of the olecranon.

• The skin and subcutaneous tissue were reflexted to either side carefully to expose the olecranon and triceps tendon.

• The ulnar nerve is isolated and fascia over the flexor carpi ulnaris is

longitudinally split over 5cm to enhance the nerve mobility. Then gently

retracted from its bed with a moist tape.

•Approach begins laterally at kocher interval between extensor carpi ulnaris and anconeus used to elevate anconeus and develop distal lateral portion of flap.Medial border created by subperiosteal dissection from subcutaneous border of ulna.Anconeus flap reflected proximally to expose triceps insertion which is also sharply released.Entire triceps anconeus flap reflected proximally releasing triceps muscle from posterior aspect of distal humerus

• The fracture hematoma was cautiously removed.

• Fragments of the humerus were assembled in the following ways

–

- Reduction and fixation of condyle together

- Fix the medial or lateral epicondylar ridge to the humeral

metaphysis, if

it is fractured. Reassembled condyles are fixed to the humeral metaphysis.

• Reduction and fixation of the condyles was done in the following ways

- Condyles were reduced and held with a bone holding clamp

- Reduced condyle was provisionally fixed with Kirschner wire.

- AO cannulated cancellous screw of 4mm was inserted across the reduced condyles.

• Reduction and fixation of the condyles to metaphysic was done in the following ways

- Reduction and temporary stabilization of the medial and lateral columns was done by using crossed Kirschner wire.

- Medial and lateral pillars were reconstructed using contoured 3.5mm reconstruction plate and screws.

- To enhance the mechanical strength the plates were placed either in the 90 – 90 degree fashion i.e orthogonal fashion or 180degree to each other i.e parallel arrangement.

• The stability of the internal fixation was tested by putting the elbow through a range of motion.

• At the completion of the fixation the elbow was again put through a range of motion to test the security of the internal fixation.

• The tourniquet was let down and haemostasis carefully secured and over a large suction drain the wound was closed in layers. Pressure bandage was applied and limb immobilized with above elbow plaster of paris slab.

After treatment :

Patients were instructed to keep the limb elevated and move their fingers and shoulder joint. Suction drain was removed after 24-48 hours. Wound was inspected after 3-4 days postoperatively. Antibiotics and analgesics were given to the patient till the time of suture removal. Suture/staples were removed on the 10^{th} postoperative day and check X-ray in anteroposterior and lateral views were obtained. Later patients were discharged with the forearm in an arm pouch advised to perform shoulder, elbow, wrist and finger movements. Patients advised not to lift heavy weight or exert the affected upper limb.

Follow-up :

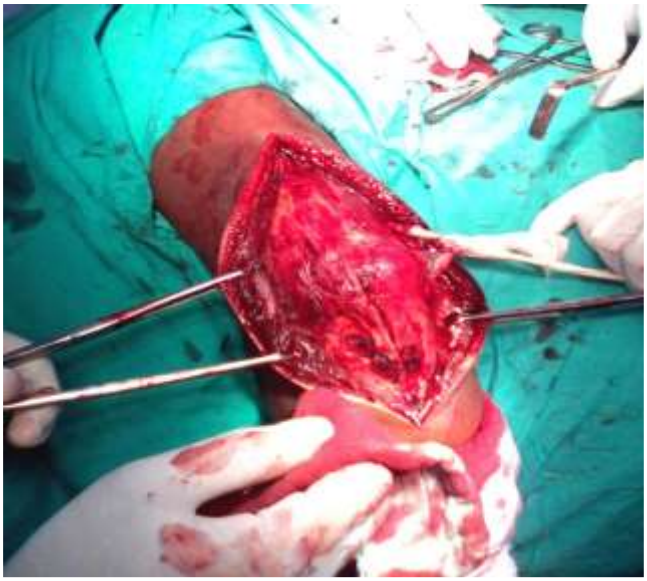
After discharge, patients were advised to report for follow up after 6 weeks 12 weeks and thereafter every 3 months. The results were assessed 3 months after the procedure. At follow up a detailed clinical examination was done and patients were assessed subjectively for the symptoms like pain, swelling and restriction of joint motion. Patients were instructed to carry out physiotherapy in the form of active flexion-extension and pronation-supination without loading.

The functional assessment of the patient was done according to Mayo Elbow Performance Score.

`Preparation of the Operative Site

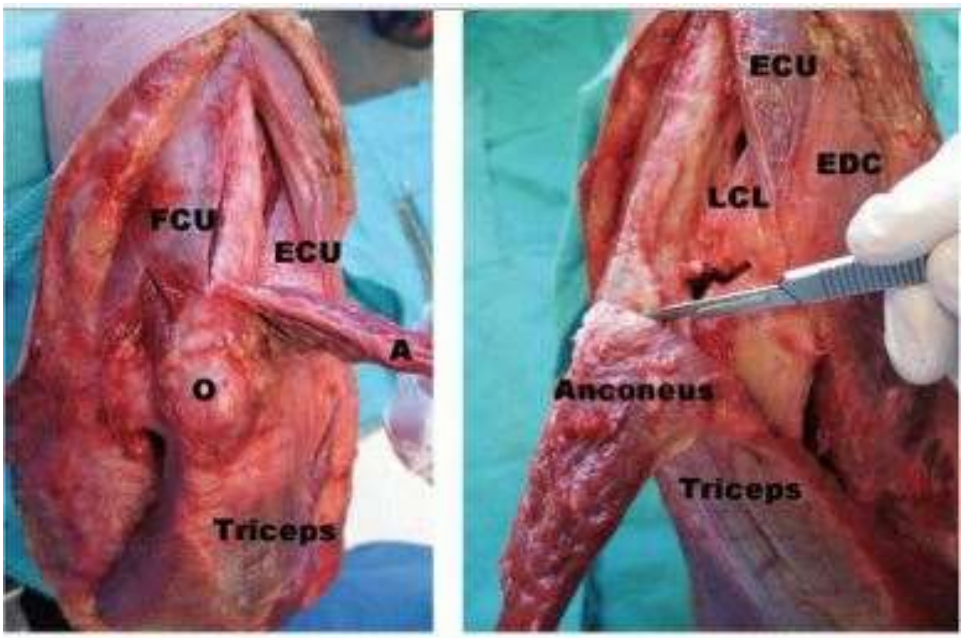
After Draping

Posterior midline incision

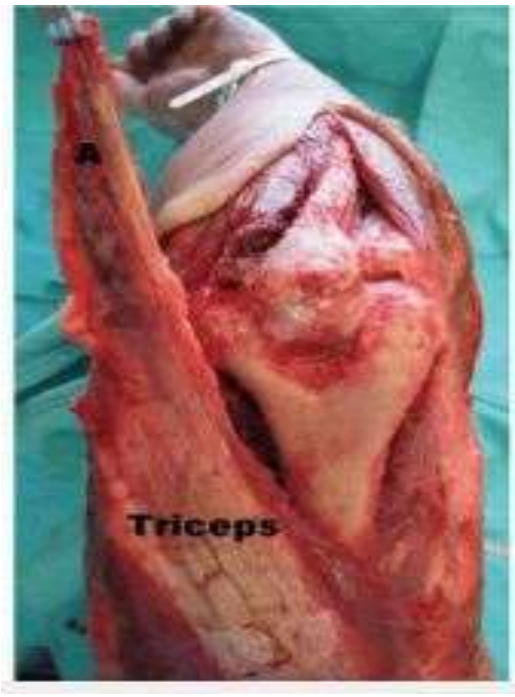


posterior midline

exposure of ulnar nerve



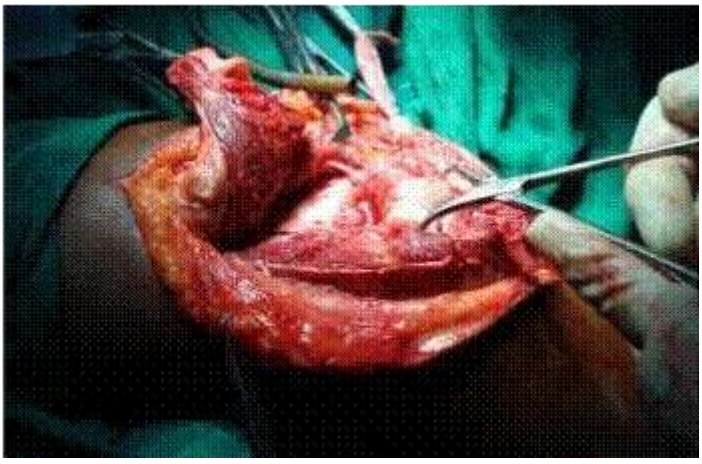
Identification of KOCHER INTERVAL between anconeus and extensor carpi ulnaris



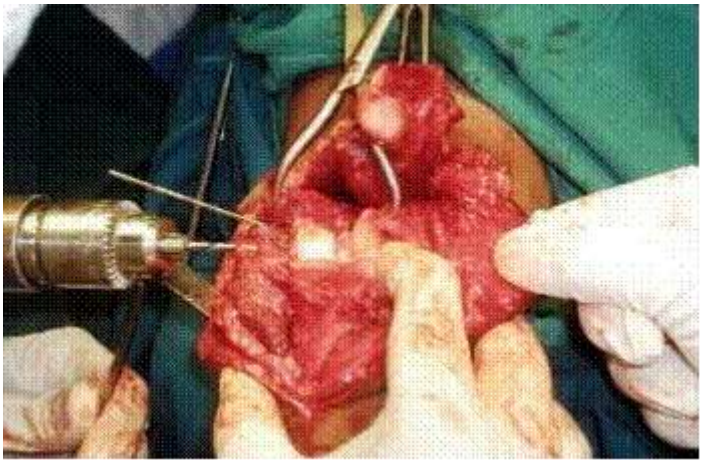
triceps reflected along with anconeues pedicle

Fracture Site exposed

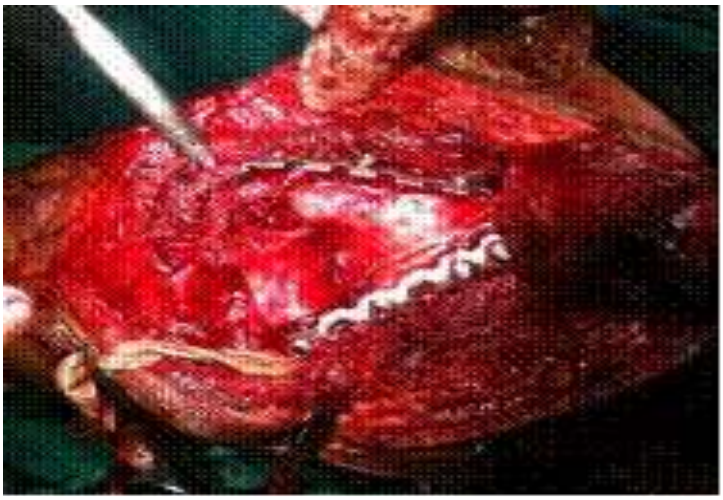
Condyles reduced and held with a



Clamp Condyles being drilled for Intercondylar

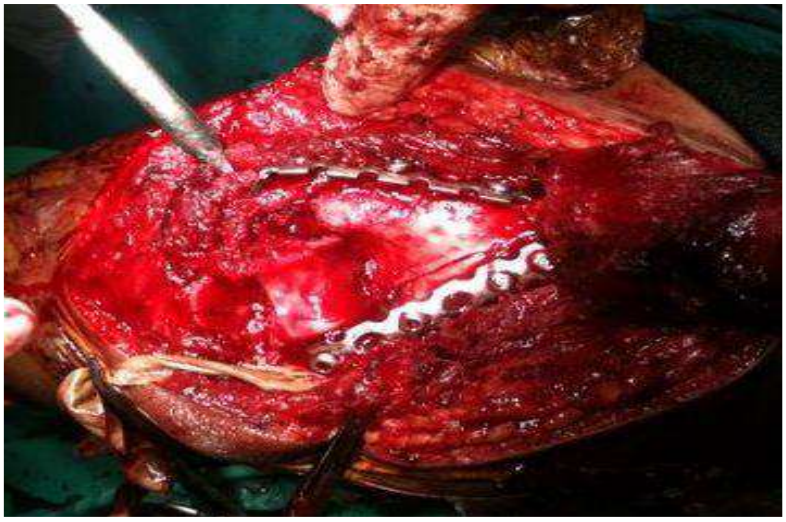


screw



Lateral pillar reconstructed using ec a

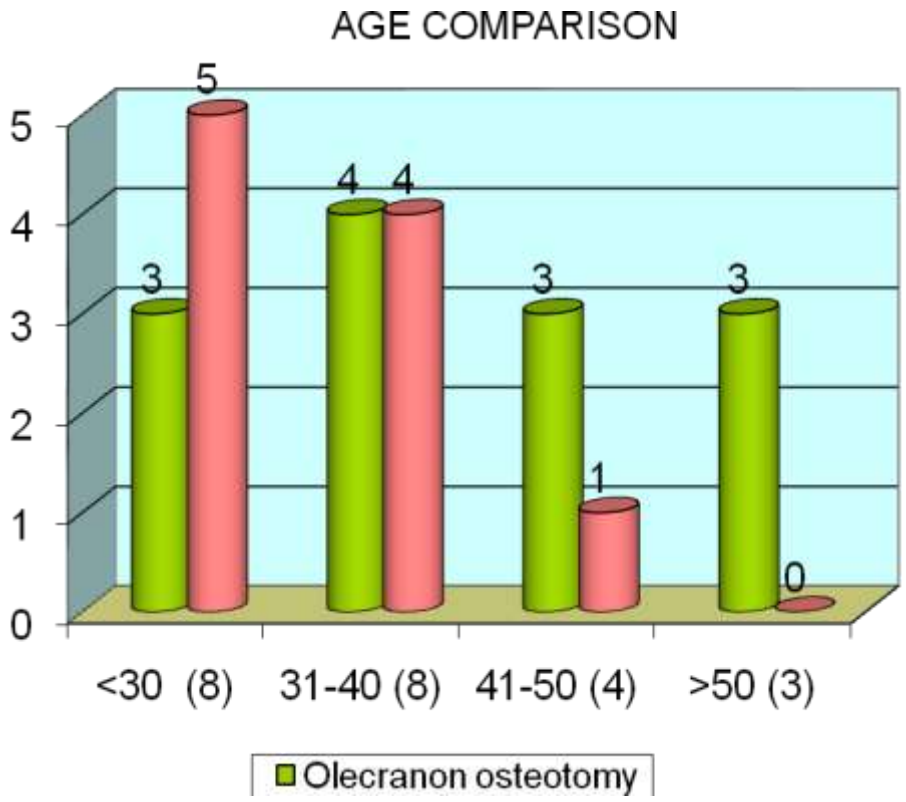
Medial pillar reconstructed



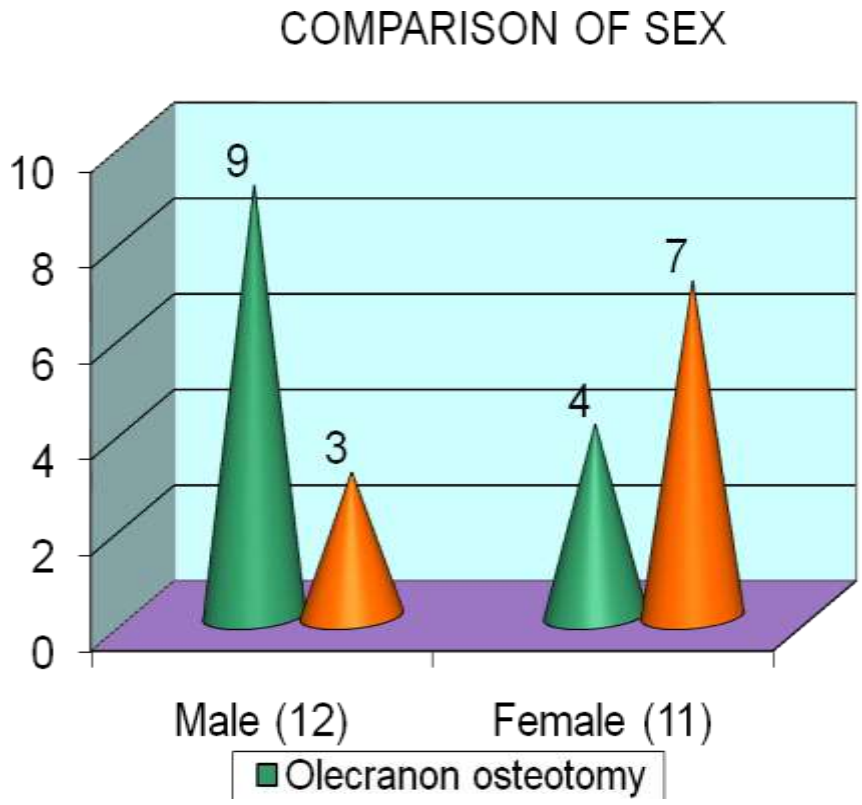
Wound Closure in layers

Skin closure with staples

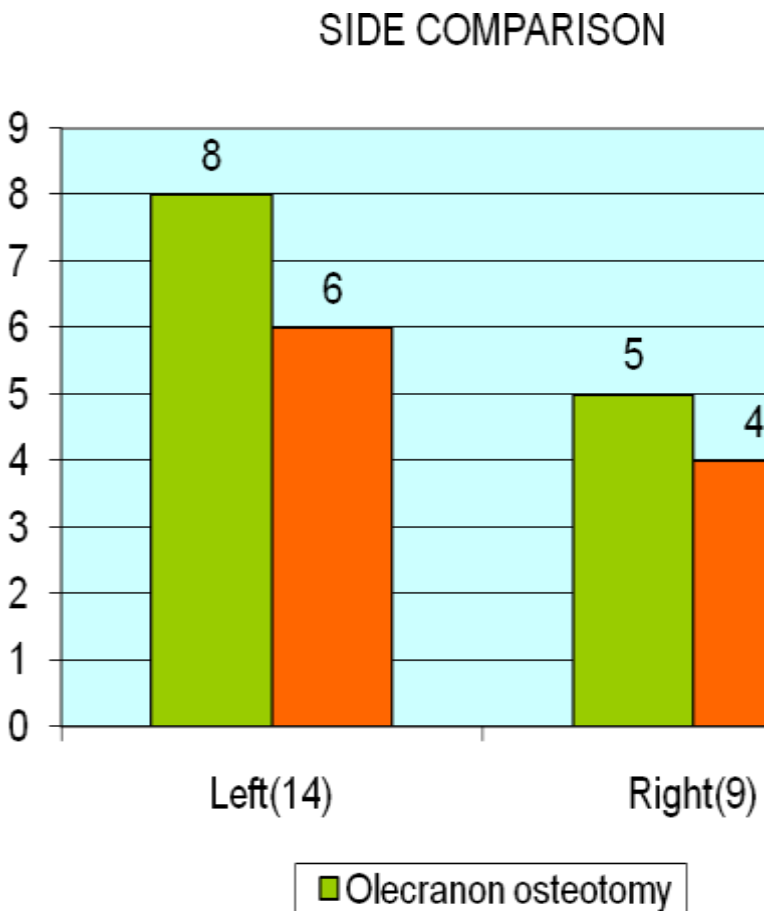
AGE	Olecranon osteotomy	TRAP
<30 (8)	3	5
31-40 (8)	4	4
41-50 (4)	3	1
>50 (3)	3	0
Total	13	10
Mean	40.61	32
Std	11.31	7.36
P'value	0.057 Not significant	



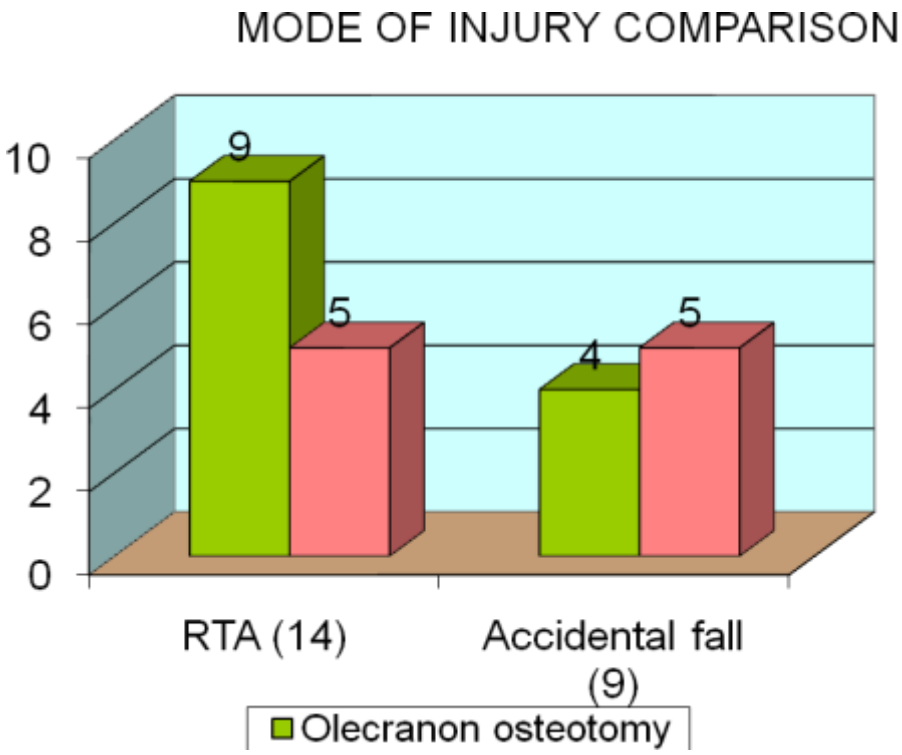
SEX	Olecranon osteotomy	TRAP
Male (12)	9	3
Female (11)	4	7
Total	13	10
P'value	0.052 Not significant	



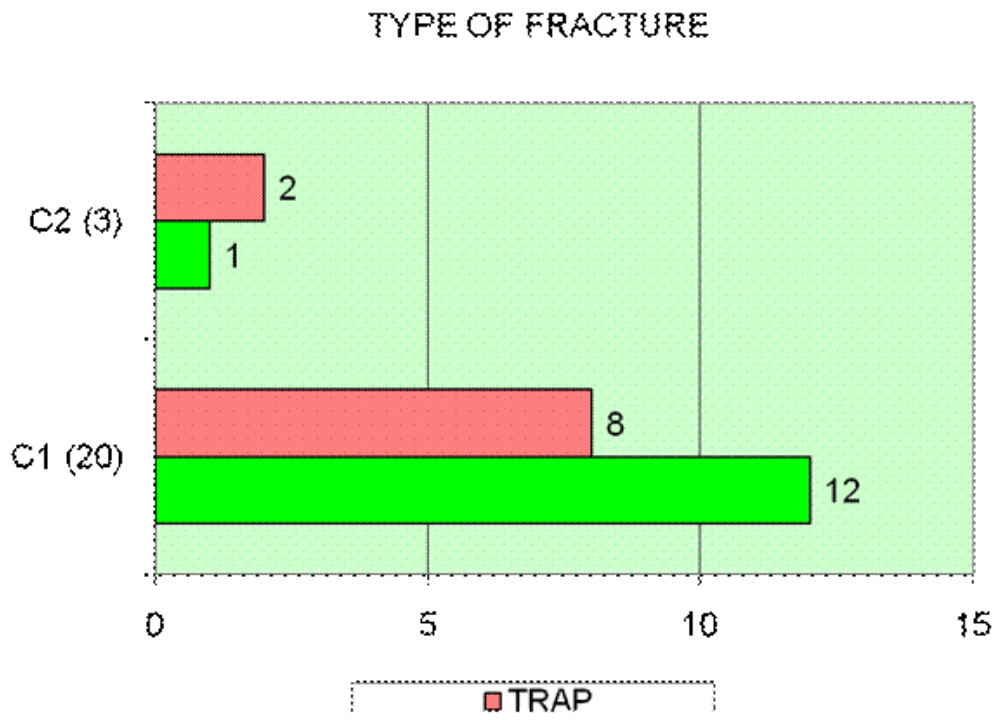
SIDE	Olecranon osteotomy	TRAP
Left(14)	8	6
Right(9)	5	4
Total	13	10



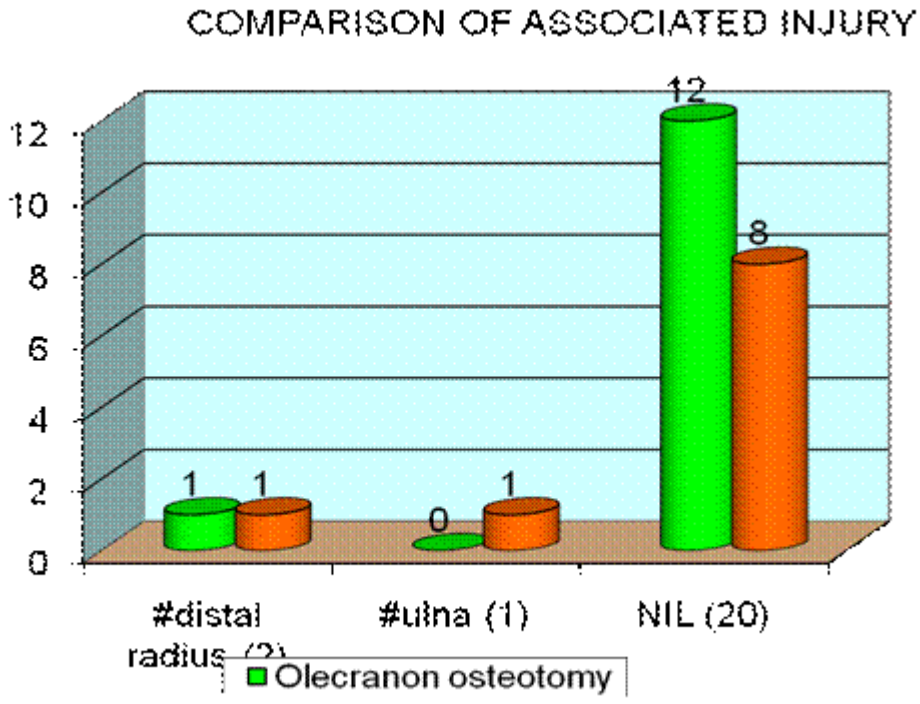
MODE OF INJURY	Olecranon osteotomy	TRAP
RTA (14)	9	5
Accidental fall (9)	4	5
Total	13	10



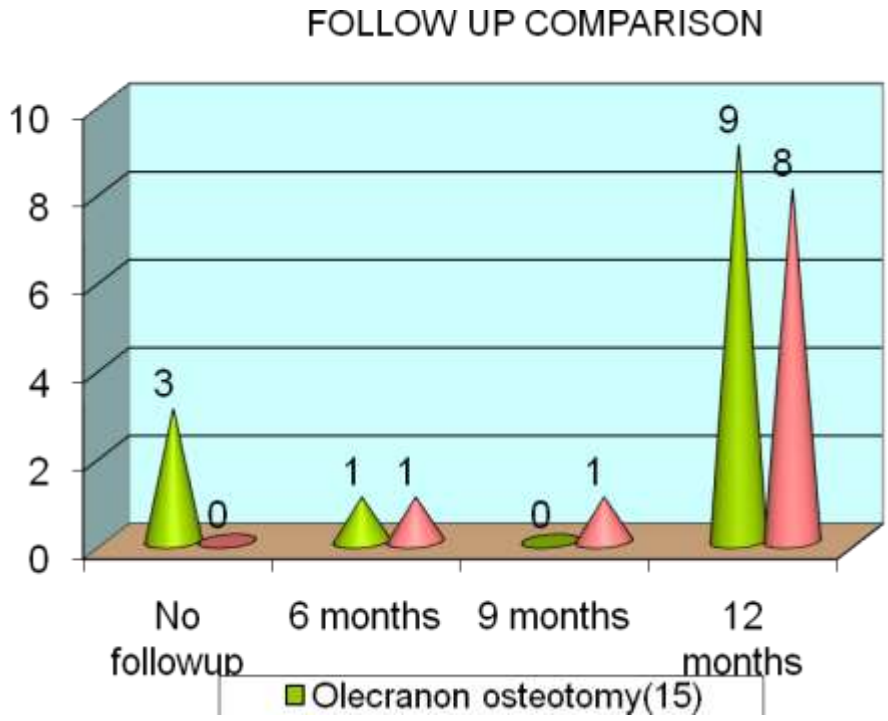
Type of fracture ao type	Olecranon osteotomy	TRAP
C1 (20)	12	8
C2 (3)	1	2
Total	13	10



Associated injury	Olecranon osteotomy	TRAP
#distal radius (2)	1	1
#ulna (1)	0	1
NIL (20)	12	8
Total	13	10

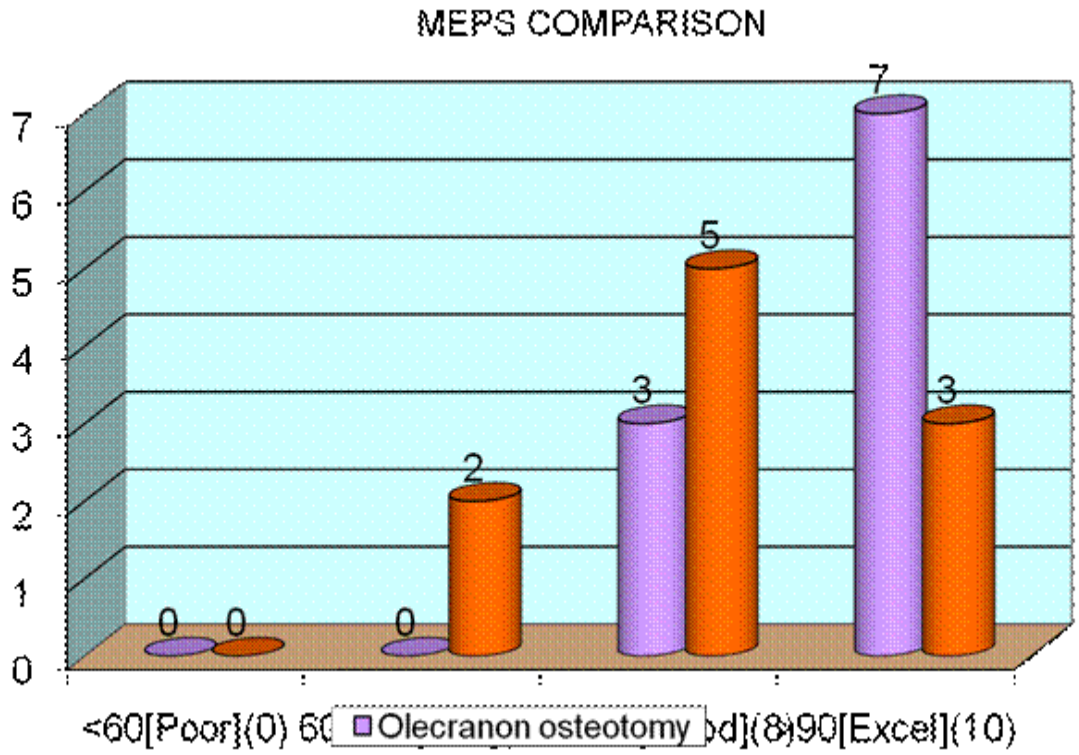


Followup	No followup	6 months	9 months	12 months
Olecranon osteotomy(13)	3	1	0	9
TRAP(10)	0	1	1	8
Total	3	2	1	17

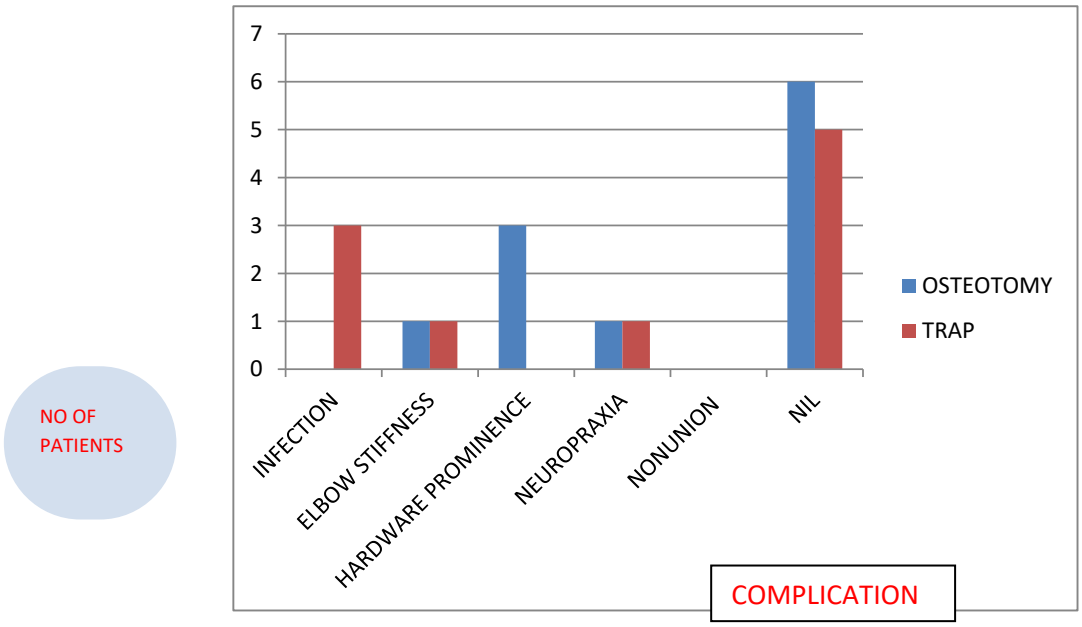


	TRAP APPROACH	**OLECRANON OSTEOTOMY**
MEPS	80	91
FLEXION EXTENSION ARC	97	103
PRONATION	72	75
SUPINATION	70	78
LOSS OF MOVEMENT	13	12

MEPS	Olecranon osteotomy	TRAP
<60[Poor](0)	0	0
60 - 74[Fair](2)	0	2
75 - 89[Good](8)	3	5
≥90[Excel](10)	7	3
Total	12	10
Mean	89.50	83.00
Std	4.97	8.23
P'value	0.047 Significant	



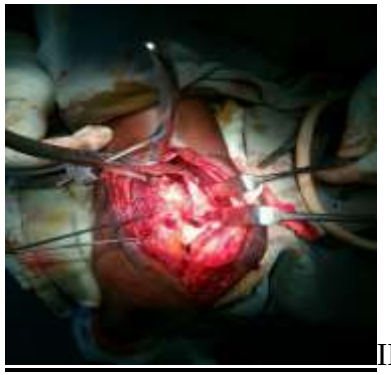
COMPLICATIONS	Olecranon osteotomy	TRAP
Infection (3)	0	3
Stiffness	1	1
Hardware prominence	3	0
Ulnar neuropraxia	1	1
Non union at osteotomy site	0	0
NIL (11)	5	6
Total	10	10



CASE 1 S.NO 1 AMALAMARY 30 /F AO C1

 AO C1	 INTRAOP	 3months
 6 months	 pronation	 extension
		**1)Approach =TRAP** **MAYO ELBOW PERFORMANCE =85** **GOOD**

CASE 2 S.NO 2 AYYANAR 28/M AO C1

 AO C1	 INTRAOPERATIVE	 INTRAOP
 6MONTHS	 FLEXIO	 EXTENSION
 Sup	 PRONATION	**2)APPROACH=TRAP** **MAYO ELBOW PERFORMANCE SCORE=90** **EXCELLENT**

CASE 3 S.NO 3 MENAKA 19/F AO C1

<table>
<tr>
<td>  AO C1</td>
<td>  INTRAOP</td>
<td>  3MONTHS</td>
</tr>
<tr>
<td>  6 MONTHS</td>
<td>  FLEXION</td>
<td>  EXTENSION</td>
</tr>
<tr>
<td>  SUPINATION</td>
<td>  PRONATION</td>
<td>3)APPROACH=TRAP
MAYO ELBOW PERFORMANCE SCORE=95

EXCELLENT</td>
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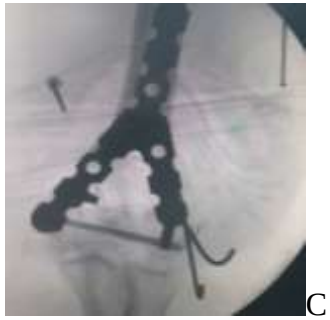
</table>

CASE 4 S.NO 4 ELIZABETH 45/F AO C1

 AO C1	 INTRAOP	 3MONTHS
 6MONTHS	 EXTENSION	 FLEXION
 FLEXION	 SUPINATION	**4)APPROACH=TRAP** **MAYO ELBOW PERFORMANCE SCORE=70** **FAIR**

CASE 5 S.NO 5 THENMOZHI 25/F AO C1

 AO C1	 INTRAOP	 3 MONTHS
 6MONTHS	 FLEXION	 EXTENSION
 SUPINATION	 FLEXION	**5)APPROACH=TRAP MAYO ELBOW PERFORMANCE SCORE-80** **GOOD**

 AO C1	 LAT	 INTRAOP
 C ARM	 6MONTHS	 EXTENSION
 SUPINATION	 PRONATION	**6)APPROACH=TRAP** **MAYO ELBOW PERFORMANCE SCORE=70** **FAIR**

CASE NO 7 **S.NO 7 CHOKKALINGAM 46/M AO C1**

<table>
<tr>
<td> 
AO C1</td>
<td>INTRAOP
  </td>
<td> 
6MONTHS</td>
</tr>
<tr>
<td> 
12 MONTHS</td>
<td>  EXTENSION</td>
<td>  PRONATION</td>
</tr>
<tr>
<td>  SUPINATION</td>
<td>  FLEXION</td>
<td>7)APPROACH=OLECRANON OSTEOTOMY
MAYOELBOW PERFORMANCE =90

EXCELLENT</td>
</tr>
</table>

CASE 8 S.NO 8 MUTHUVEL 20/M AO C1

 AO C1	 INTRAOP	 3MONTHS
 6MONTHS	 EXTENSION	 FLEXION
 PRONATION	 SUPINATION	**8)APPROACH=OLECRANON OSTEOTOMY** **MAYO ELBOW PERFORMANCE SCORE=90** **EXCELLENT**

CASE 9 **S.NO 9 THANGARAM 40/M AO C1**

<table>
<tr>
<td>  AO C1</td>
<td>  INTRAOP</td>
<td>  6MONTHS</td>
</tr>
<tr>
<td>  12 MONTHS</td>
<td>  EXTENSION</td>
<td>  PRONATION</td>
</tr>
<tr>
<td>  SUPINATION</td>
<td>  FLEXION</td>
<td>9)APPROACH=OLECRANON OSTEOTOMY
MAYO ELBOW PERFORMANCE SCORE-95

EXCELLENT</td>
</tr>
</table>

CASE 10 S.NO 10 PRITHVIRAJ 29/M AO C1

 AO C1	 CT	 INTRAOP
 INTRAOP	 6MONTHS	 6MONTHS
 FLEXION	 EXTENSION	**10)APPROACH=OLECRANON OSTEOTOMY** **MAYO ELBOW PERFORMANCE -80** **GOOD**

OBSERVATION AND RESULTS

- The following observations were made in our study.
- From November 2015 to October 2017 ,23 patients with distal humerus fractures underwent open reduction and internal fixation with plate osteosynthesis by posterior approaches in our institution..
- Of the 23 cases who fulfilled the inclusion criteria no one denied to take part in the study leaving 23 cases for the study.
- Twenty patients of distal humeral fractures were treated surgically with ORIF with plate osteosynthesis using either TRAP approach or olecranon osteotomy and analysed with an average follow up of 6 months.
- The mean age of the cases was 40.1 years (range 21 – 70 years). 70% of the patients were less than 50 years.
- There were 11 males & 9 females. Males dominated our study
- 14 fractures affected left side & 9on right upper limb
- 60 % fractures were due to RTA. 40% were due to accidental fall. Motor Vehicle accidents was a major form of injury in younger males.
- All types of fractures were simple (closed) fractures.

- The fractures were labelled according to AO-OTA fracture classification.
- 85 % fractures were C1 type, 15 % fractures contributed to C2 type (C1>C2)
- 3 patients had associated injuries . 3 had other skeletal injuries with two of them having # distal radius and one having #ulna
- None of them had fracture related pre-operative nerve injuries. None of them had preexisting elbow problems.
- Fractures were managed within an average of 13 days (9 to 18) days after injury.
- Most of the patients (60%) were operated by olecranon osteotomy approach (13 Patients). The remaining 10 patients were operated by Triceps Reflecting Anconeus Pedicle approach (TRAP)
- The average surgical time was 110 minutes ranging from 90 minutes to 2 hours.
- During the period of follow up Only 7 patients had mild pain. None of them reported severe elbow pain as per MEPS score.
- The mean flexion-extension arc was 107°. The Mean MEPS score was 86.25%. Based on that MEPS of 50 % (n=10) were rated as excellent, 40 % (n=8)were rated as good, 10 % n=2) as fair and no cases had poor functional outcome.

- Five Patients developed complications of which two had stiffness of elbow joint which were managed by regular physiotherapy. three had superficial wound infections which were treated with intravenous broadspectrum antibiotics for 3 weeks.
- Two patients had paraesthesia over ulnar sensory distribution post operatively which spontaneously relieved after 3 months
- None of them had distal humerus articular or supra condylar nonunion, there were no implant failure during follow up.
- Three patients were lost for follow up.
- In our study, solid radiologic union was achieved in a mean duration of 13 weeks (8 to 20 weeks) for all patients. Hardware failure did not occur in any patient.

DISCUSSION

The current study revealed that the olecranon osteotomy method was more successful than TRAP approach in terms of overall mean arc of elbow motion (p=0.047 significant). When MEPS scores were examined, it was observed that the results were better for the olecranon osteotmy group, statistically significant difference between the groups, (p=0.047)

(p=0.403) respectively.

- **a)Wilkinson et al.** have compared the triceps split, TRAP, and olecranon osteotomy techniques in a cadaveric study. They have found that these techniques demonstrate the joint surfaces at a rate of 35%, 46%, and 57%, respectively. The au-thors have stated that the best exposure was achieved with the olecranon osteotomy approach (57%), but no statisti-cally significant difference was detected between the TRAP approach
- **b)Azboy et** al compared the surgical exposures in intra-articular fractures of distal humerus and olecranon osteotomy approaches. He states that the exposure was better in the olecranon osteotomy group. He also observed that increasing elbow flexion provides sufficient exposure in the TRAP group, which enables restoration of articular surfaces and stabilization of fracture.

- c) **Pankaj et al**. have used TRAP approach in AO type C distal humerus fractures (n=40). They have reported that thirty-five patients (87.5%) had good triceps strength, four patients (10%) had fair strength, and one pa-tient (2.5%) had poor strength with an extension lag of 10.
- In our study, triceps rupture was not observed in any of the patients in which TRAP approach was performed. We found a transient decrease in the strength of the triceps in two and one patients in the TRAP and olecranon osteotomy groups, respectively.
- d)According to **O'Driscoll et al**. an ideal approach should provide adequate exposure, can be extended when required, the dissection should be in the plane between the nerves, any alternative surgical procedures done with the same exposure, should allow early rehabilitation, and the possible revision can be performed with the same incision if needed. The TRAP approach provides all these requirements. They have reported that TRAP approach provides sufficient exposure for open reduction and internal fixation, and also allows early rehabilitation. Furthermore, after TRAP exposure, there is a chance of total elbow prosthesis in the same session in cases in which the joint surface could not be restored.
- e)According to **Athwal et al** Restoration of elbow motion is one of the most important parameters in the treatment of intra-articular

distal humerus fractures. They compared the TRAP (n=12) and olecranon osteotomy (n=17) approach in the treatment of type C distal humeral fractures. They found no significant difference between both groups in terms of flexion-extension arc, elbow flexion, elbow extension, pronation, supination, MEPS or DASH score

- f) In a study by **Ozer et al**. Regarding range of motion of elbow following surgery, range of motion in Type C1 and C2 (n=9, 82%) had an average of 116° (range 95–140), and Type C3 (n=2, 18%) was 85°. In another study by **Pankaj at al.,** the average of range of motion was 118±7 degrees (range 80–140). In our study, the mean arc of motion was better in the olecranon osteotomy group (108° [range 70°–140°]) when compared to the TRAP group (98° [range 70°–115°]). The rate of type C3 fracture in our study was higher (45.4%, and 50% in the TRAP and olecranon osteotomy groups, respectively) than the study by **Pankaj at al**.(%20) and **Ozer et al**. (18%), which may explain relatively lower mean arc of motion in our study. It was suggested that union problems observed in olecranon osteotomies are mostly related to the transverse osteotomy technique (30%). Chevron shaped osteotomy reduced these complication.Chevron osteotomy increases contact surface that may promote healing, facilitate reduction and have inherent

translational and rotational stability due to interlocking of the proximal and distal fragments.

- G) **Sanchez-Sotelo et al** have reported excellent and good results (79%) using chevron type ostotomy in the treatment of complex distal humeral frac-tures. In the our study, an apex distal, chevron-shaped osteotomy was performed in the olecranon osteotomy group. Union was observed in all patients without any complications
- h) **Tak et al.** have used olecranon osteotomy in ninety-four patients and stated that all the un-satisfactory results (average and poor) were seen in those patients who developed complications related to the olecranon osteotomy (p=0.000, OR 103.2).

LIMITATIONS

1). Our Study comprises of relatively small number of patients.

2)Both parallel or orthogonal plating were used for fixation of distal humerus fractures in both groups.

3) comparison between TRAP and olecranon osteotomy could only be made

CONCLUSION

Even though both TRAP approach & olecranon osteotomy offer excellent functional results in surgical fixation of intercondylar fractures of humerus, olecranon osteotomy offers better visualization of intra articular fracture fragments and helps in restoring perfect articular congruity in a better way .The main drawbacks of olecranon osteotomy approach

a) Non union of olecranon osteotomy
b) Hardware prominence with olecranon bursitis
c) Increased operating time

TRAP approach is less extensile approach which also helps in restoring perfect articular congruity as shown in our series the complications of olecranon osteotomy are nullified .the post operative triceps weakness reported was transient and has recovered completely

TRAP approach is a better alternative to olecranon osteotomy approach in complex intercondylar fracture humerus

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COMPARITIVE ANALYSIS OF FUNCTIONAL OUTCOME OF FRACTURE INTERCONDYLAR HUMERUS BY PLATE OSTEOSYNTHESIS USING TRAP APPROACH AND OTHER POSTERIOR APPROACHES

NAME IP NO

AGE/SEX

OCCUPATION

DIAGNOSIS

DATE OF SURGERY

APPROACH

COMPLICATION

SECONDARY PROCEDURE

FOLLOWUP MAYO ELBOW PERFORMANCE SCORE

	6 WEEKS	12 WEEKS	6 MONTHS	12MONTHS
PAIN				
ROM				
STABILITY				
DAILY FUNCTION				

EVALUATION

TOTAL SCORE	6 WEEKS	12 WEEKS	6MONTHS	12 MONTHS
GRADE				

PATIENT PROFORMA

Consent form

FOR OPERATION/ANAESTHESIA

I_____ Hosp. No._____ in my full senses hereby give my full

consent for _____ or any other procedure deemed fit which is a diagnostic procedure / biopsy / transfusion / operation to be performed on me / my son / mydaughter / my ward_____age under any anaesthesia deemed fit. The nature,risks andcomplications involved in the procedure have been explained to me in my ownlanguage and to my satisfaction. For academic and scientific purpose theoperation/procedure may be photographed or televised.

Date:

Signature/Thumb Impression of Patient/Guardian

Name:

Designation Guardian Relation ship

Full address

MADURAI MEDICAL COLLEGE
MADURAI, TAMILNADU, INDIA -625 020
(Affiliated to The Tamilnadu Dr.MGR Medical University, Chennai, Tamil Nadu)

ETHICS COMMITTEE CERTIFICATE

Name of the Candidate	:	Dr.J.Sivaprashanth
Course	:	PG in M.S., Orthopaedics
Period of Study	:	2015-2018
College	:	MADURAI MEDICAL COLLEGE
Research Topic	:	Comparative Analysis of Functional outcome of intercondylar fracture distal humerus by plate osteosynthesis by TRAP approach and other posterior approaches
Ethical Committee as on	:	17.03.2017

The Ethics Committee, Madurai Medical College has decided to inform that your Research proposal is accepted.

Member Secretary Chairman Dean/Convenor

Prof Dr V Nagaraajan
M.D., MNAMS, D.M., Dsc.,(Neuro), Dsc (Hon)
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Madurai

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