FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PROXIMAL HUMERUS FRACTURES TREATED WITH PHILOS PLATE

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GOVT KILPAUK MEDICAL COLLEGE

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This is to certify that this dissertation entitled "FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PROXIMAL HUMERUS FRACTURES TREATED WITH PHILOS PLATE" is a bonafide and original work done by Dr.S.HariKaran, post-graduate student, under our direct supervision and guidance in the department of Orthopaedics, Government Royapettah Hospital, Chennai, in partial fulfilment of the regulations of The Tamil Nadu Dr. M.G.R. Medical University for the award of degree of M.S. Orthopaedics.

Prof. Dr.R.Balachandran M.S ortho D.ortho
Professor
Department of Orthopaedics
GRH, Chennai

Prof.Dr.S.Veerakumar M.S ortho
Head Of the Department
Department of Orthopaedics
KMC, Chennai

Prof Dr.P.Vasanthamani
M.D,DGO,MNAMS,DCPSY,MBA
DEAN
Govt Kilpauk Medical College
Chennai

CERTIFICATE II

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The Proposal is APPROVED.

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Kilpauk, Chennai-600 010.

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I, Dr.S.HariKaran, solemnly declare that this dissertation **"**FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PROXIMAL HUMERUS FRACTURES TREATED WITH PHILOS PLATE" is a bonafide work done by me at the Department of Orthopaedics, Government Royapettah Hospital, Chennai, under the guidance and supervision of my guide Prof. Dr. R. Balachandran, Department of Orthopaedics, Government Royapettah Hospital, Chennai. I also declare that this original work or a part of this work was not submitted by me or any other for any award, degree, diploma to any other university board either in India or abroad.

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Place: Chennai, Tamil Nadu

Date:

Signature of the candidate

(Dr.S.HariKaran)

III-year PG Graduate

Department of Orthopaedics

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December 2020 Dr. S.HariKaran

ABBREVIATIONS

AO	Arbeitsgemeinschaft fur Osteosynthesefragen
AP	Antero-posterior
ASIF	Association for the Study of Internal Fixation
AVN	Avascular Necrosis
BC	Before Christ
CT	Computed Tomography
DASH	Disabilities of the Arm, Shoulder, and Hand
DM	Diabetes Mellitus
ECG	Electrocardiogram
gm	Grams
IM	Intra-medullary
IV	Intravenous
LCP	Locking Compression Plate
mm	Millimeter
OPD	Outpatient Department
ORIF	Open Reduction and Internal Fixation
PHILOS	Proximal Humerus Internal Locking Osteosynthesis System
POP	Plaster of Paris

ROM	Range of Movement
GRH	Government Royapettah Hospital
TB	Tuberculosis

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INTRODUCTION

Proximal humeral fracture is a fracture occurring at or proximal to the surgical neck of the humerus. It is the commonest fracture affecting the shoulder girdle in adults, which ranks the third and the first and second being, hip and distal radius fractures respectively. Studies of approximately 50 years ago showed that proximal humeral fractures comprised 4% of all fractures and approximately one-half of all humerus fractures (1). The current fracture epidemiology shows that nowadays proximal humeral fractures account for almost 7% of all fractures and make up 80% of all humeral fractures. In patients above the age of 65 years proximal humeral fractures are the second most common upper extremity fracture and the third most common non-vertebral osteoporotic fracture after proximal femur and distal radius fractures.

CT scan can be useful in those difficult cases where the rotation of fragments or the amount of displacements are very difficult to determine on X rays.

Neer's classification is clinically applied to classify the fractures of proximal humerus which is based upon the angulation of the fragments more than 45 and or displacement >10 mm of fragments respect to one another. It has implications in the management and outcome of the fractures. According to

Neer's classification, 4-part fracture has poorer prognosis than 2- or 3-part fractures.

The proximal humerus fracture is an important cause of morbidity in the elderly that should be considered in the planning of the health care. About 80% of the fractures are undisplaced, which can be managed conservatively with POP/cuff and collar. The management of displaced fractures is controversial and challenging for the surgeon. Many authors have suggested that non-operative treatment can be given for 2-, 3-, and 4-part proximal humeral fractures in geriatric patients, but pain, stiffness & loss of function have been reported in a high percentage of patients after this treatment approach.

Based on the Arbeitsgemeinschaft fur Osteosynthesefragen (AO) or Association for the study of internal fixation (ASIF) principle of management of fractures, these fractures require acceptable reduction with stable fixation and early mobilization for better functional outcome (2). There are different types of fixation available for proximal humerus fracture like, K-wires, screw fixation, T-buttress plate, conventional plate, locking plate and prosthetic replacement. Every fixation has its own advantages and disadvantages. K-wires and screw fixation cannot be a stable fixation and needs prolonged immobilization. Open Reduction and Internal Fixation (ORIF) with conventional plates has been associated with loss of reduction, screw loosening, and osteonecrosis

Consequently, in recent years, angular stable plates have been evolved to maintain anatomic reduction with anchorage, especially in osteoporotic bone. Among them, the 3-dimensional anatomically adjusted Proximal Humerus Internal Locking Osteosynthesis System (PHILOS) plate provides a multidirectional locking system for its proximal part contacting the humeral head. These implants can withstand the physiological loads (muscular force) in the osteoporotic bone. Highly complex 3- & 4-part fractures can be reconstructed with rotator cuff sutural ties through the holes in the plate and thereby enhancing the functional outcome.

This study aims to analyze the functional and radiological outcome of fractures involving the proximal part of humerus treated with PHILOS plate in 20 patients.

AIM:

To determine functional and radiological outcome of proximal humerus fractures treated with PHILOS plate.

REVIEW OF LITERATURE

Proximal humerus fractures were first documented by Hippocrates in 460 BC (3). He described a method that bone healing can be promoted by weight traction. During the 18th century, the Hippocratic method of forceful extension and manipulation followed by bandaging and delayed splinting was used with inconsistent results (3). However, till the end of 19th century, there was limited knowledge about this fracture and its management.

In 1896 Kocher introduced a classification based upon the anatomical region of the fracture. It was not widely used due to its lack of precision and accuracy (4).

Pean in 1893 substituted the proximal part of humerus with a platinum and rubber. This intervention was not a successful one and it was removed due to TB infection (5).

In the 19th century, numerous methods (traction and abduction splints) of conservative management were developed such as Robert Liston bandage, Hamilton's bandage, Bardenhuer's apparatus, Hennequin's bandage, Desault's bandage, Velapeau's bandage and all these methods failed to achieve alignment and maintain the reduction.

Robert explained in 1932, that the treatment with simpler forms of fixation and early mobilization was more satisfactory than the conservative management and prolonged immobilization (6). Lane and Lambotte described the first systematic approach of surgical fixation of proximal humerus fracture (6).

Codman, during the year 1934, classified the fracture elements into four possible elements such as head, greater tuberosity, lesser tuberosity and shaft along the epiphyseal lines (7). Binary relationship (relationship between the fracture elements and fracture planes) is used and classified into two sets of two, three, four fragments.

In 1949, for transcervical fractures of proximal humerus, Wieden first used the intramedullary nailing and credited Palmer with the technique.

In 1950, Rush described his methods of intramedullary nailing for two parts and three parts fractures, which later became popular as rush pins (8). Implants were cheap and was a suitable alternative for fixing the fractures in geriatric patients.

In the early 1950s, humeral head replacement with metallic prosthesis was developed. The Charles Neer I prosthesis was developed in 1951. He replaced only the humeral head.

In 1955, Neer reported good results in use of metal humeral head prosthesis in 27 patients with dislocation (9,10). But patient often developed cartilage loss in the glenoid surface which warranted the need of replacing the glenoid surface (total shoulder replacement).

In 1970, Charles Neer described his 4-segment classification. It was based on the analysis of the radiograph and surgical findings of 300 patients treated in NewYork Orthopaedic Hospital-Columbia Presbyterian Medical Centre

between 1953 and 1967 (11). He proposed his classic 4-part classification based on Codman's 4 parts.

In the early 1970's, AO ASIF group popularized the use of AO plates and screws for displaced fractures and fracture dislocations.

In 1972, Bickel invented total shoulder prosthesis of the ball and socket type (12). In the same year, Stanmore designed total shoulder replacement (also a ball and socket design) for rheumatoid arthritis patients (12).

In 1973, the original Neer I prosthesis was made of vitallium. It had one stem size with head of 44 mm size and one hole in the lateral neck of prosthesis to stabilise the fragments and flattened head was used to avoid impingement. In 1973, he redesigned the prosthesis and it has same radius of 44 mm but with rounded edges to prevent encroachment on the glenoid component. Stem was used with or without cement. By then, Neer original prosthesis was modified as Neer II prosthesis, to improve the results (13).

Percutaneous pinning and minimal fixation had been used with poor outcomes in three 4-part fractures (34). To overcome the complications, a fixed rigid fixation is needed to provide stability and early motion. For which the fixed angle locking plates have been developed. It has multidirectional screw fixation on the osteoporotic head which provides stability.

Controversies still exist whether to do conservative or operative management. Various studies on the surgical management of proximal humerus fractures

which provide the essential information regarding the outcomes of the fractures and prove that surgical management is superior to conservative management.

A total of 72 patients were studied retrospectively by Bjorkenheim.et al (14). All of them treated with locking compression plate between Feb 2002 to Jan 2003.They were followed up for a period of 12 months. Constant score was used for functional outcome. Radiological assessment was made in all patients. Two fractures failed to unite, 3 patients had an avascular necrosis of the humeral head and 2 implant failures were occurred due to a technical error. Constant score was acceptable. Final interpretation was made that PHILOS plate was safe and can be advised for the treatment of these fractures in patient with osteoporosis.

In 2007, Charalambous et al (15) analyzed 25 cases of proximal humerus fracture treated with LCP. Twenty patients had fracture union with average neck shaft angle of 127.2^0 . Five patient needed revision surgery (failed to unite and failure of implant). This study concludes that PHILOS is effective for treating osteoporotic proximal humerus fractures with precautions on soft tissue handling and proper knowledge on techniques of plate fixation.

Fazal et al (16), in 2009, conducted a prospective analysis of 27 patients with proximal humerus fractures treated with PHILOS plate. All fractures were united except for one patient who had complications of screw penetration and avascular necrosis. This study concluded that PHILOS fixation is superior to all

fixations with less hardware problem and provides better stability with early motion.

Martinez et al (17), in 2009, did a retrospective analysis of 58 patients (31 males & 27 females) in the age group 36-73 (average 61) with displaced proximal humerus fractures treated with PHILOS plating. All patients were followed up for 1-1.5 years. All patients had satisfactory union except one patient who had varus malunion. Outcome was excellent in 13 patients, good in 36 patients, moderate in 8 patients and poor in one. Average Constant Murley score was 80. This study concluded that PHILOS is the appropriate management for proximal humerus fractures. Mohammed akram, dr. Abishekreview of literature dr.d.v.prasad, dr. Pareek, international journal of orthopaedic science

30 patients were managed surgically by Akram M and Abhishek and followed up ,out of 30 patients 24 healed satisfactorily, 2 cases had fracture collapse and 1 case developed non-union, 1 case had screw penetration of humeral head and 2 cases with Valgus 3 part fracture had Malunion. Dr. C.d.deepak, dr. Mahesh d.v., dr. Abdul ravoof

20 patients were managed surgically by Deepak CD et al of which 4 had excellent results, 10 had satisfactory and 5 had unsatisfactory results and 1 had failure.

Rose et al (18), in 2007, conducted the study of the use of PHILOS plates in 16 patients aged around 51 years. The study group consisted of 5 patients with two

part, 9 patients with three part and 2 patients with 4-part fractures. Out of the fractures that healed, good functional outcome was achieved (average elevation 132^0 , average external rotation 43^0) within an average follow up of one year.

In 2008, Crenshaw et al (19) in their study documented that in younger patients; open reduction and internal fixation with PHILOS plates were successful if damage to the blood supply of head of humerus is avoided by keeping the soft tissue stripping to a minimum. In young active patients with 4-part fractures, fixation with locking compression plate is the management of choice.

DEVELOPMENTAL ANATOMY

The Humeral ossification is from one primary ossification center and 7 secondary ossification centers. The one primary center appears in the middle of the shaft on the eighth week of gestation (20).

The proximal part ossifies from secondary ossification centers including one center for humeral head (first year), one center for greater tuberosity (second year) and one center for lesser tubercle (fifth year).These three centers altogether fuse and form humeral epiphysis at the age of six years. Later the epiphysis fuses with diaphysis at the age of 20 (21). This is represented by the epiphyseal line which encircles the lowest margin of humeral head. This part is the growing end of bone (22).

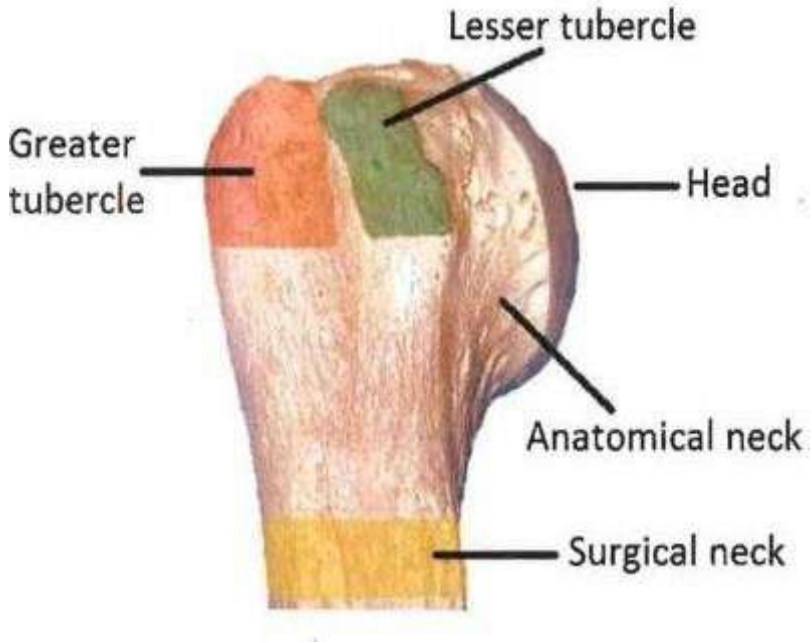
The Proximal Humerus (Upper End) consists of the followingHumeral head

- Greater Tuberosity

- Lesser Tuberosity
- Bicipital Groove (Intertubercular Sulcus)
- Proximal Humerus shaft

HUMERAL HEAD

The humeral head is a spheroidal bony structure (strictly ovoidal) and it is larger than the glenoid cavity. It has smooth articular surface lined by hyaline cartilage. In neutral position, it is directed medially, superiorly and posteriorly in relation to glenoid of the scapula. In contrast to glenoid humeral head central portion of articular cartilage is thickest, anterior border of articular cartilage is lesser tuberosity, lateral border is the greater tuberosity with intertubercular sulcus in-between. Along with the medial surface of the surgical neck of humerus, they are the sites for the ring of tendinous and ligamentous attachments. This ring is to stabilize the joint by centralizing the humeral head while tightening around the prominent articular surface.



GREATER TUBEROSITY

The greater tuberosity is a bony projection that forms the lateral part of upper end of humerus. Its posterior part being round has three impressions for the insertion of Supraspinatus, Infraspinatus, Teres minor from above downwards. The lateral surface of the greater tuberosity is convex and rough which presents with numerous vascular foramina. It is covered by the thick, bulky deltoid, which contributes to the normal spherical contour of the shoulder. A part of the subacromial bursa may cover the upper part of this area and separate it from deltoid.

LESSER TUBEROSITY

The lesser tuberosity is a bony projection, situated just anterior and beyond the anatomical neck. It faces medially and forward. There is an impression over

subscapularis muscle attachment. In its lateral margin it gives attachment for the transverse ligament of the shoulder joint.

INTER TUBERCULAR SULCUS

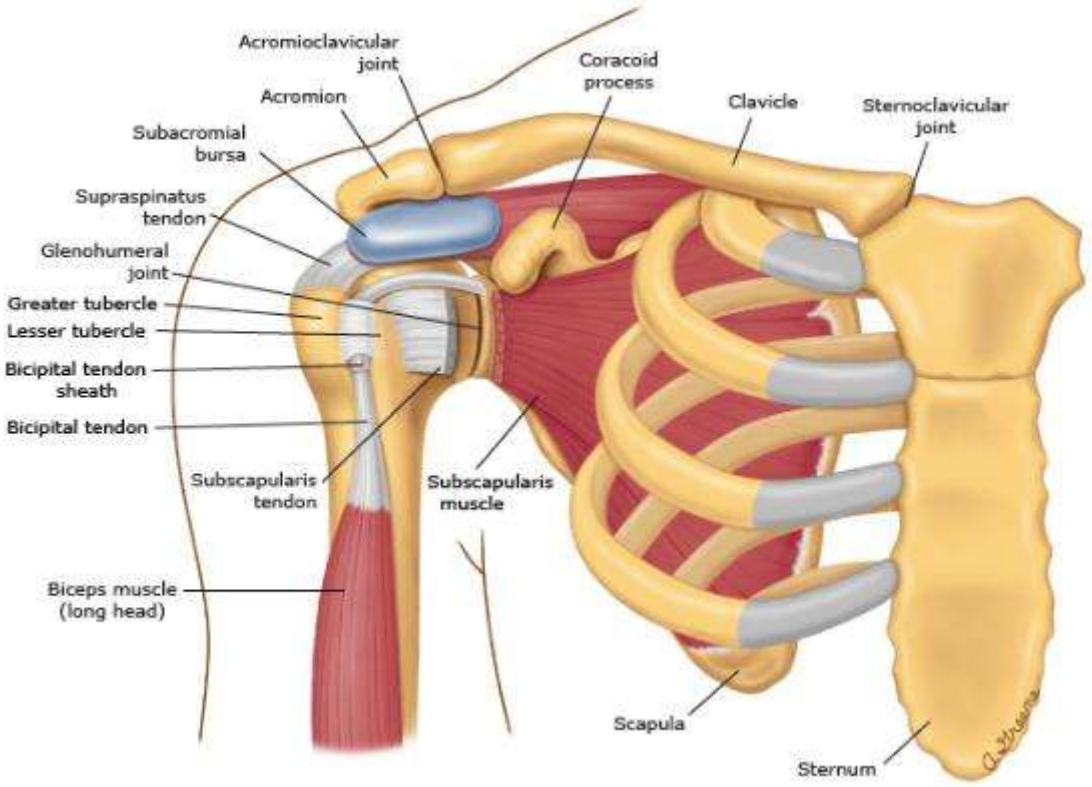
It lies 30^0 medial or .9 cm anterior to the central axis of the articular surface. It is otherwise called as bicipital groove which separates the lesser tuberosity medially from the anterior portion of greater tuberosity. The sulcus has a medial and lateral lip that is the representation of extension from both tubercles. The transverse ligaments bridges the lip proximally to act as a retinaculum for long head of biceps brachii, distally subscapularis forms the floor of the sheath. Medial lip has the insertion of Teres major (20,22). Lateral lip has bilaminar insertion of pectoralis major. The Latissimus dorsi inserted into the floor of the groove. Bicipital groove contains the long head of the Biceps brachii tendon and the ascending branch of anterior humeral circumflex artery which supplies the shoulder joint. Depth of intertubercular sulcus seems to play a major role in the pathogenesis of bicipital tendinitis.

ANATOMICAL NECK

It is an oblique constricted part of proximal humerus, which delineates the head from other parts of upper end of humerus. It is directed downwards from medial to lateral just below the circumference of humeral head. Boundaries are variable without a distinct line.

SURGICAL NECK

The narrow line separating the upper end of the humerus from the shaft is known as the surgical neck. It is a diaphyseal expansion ending in a metaphyseal flare just below the greater and lesser tuberosities. It is the common site for fracture.



The static stabilisers of the shoulder joint (23) are:

- Fibrous capsule
- Glenohumeral ligament
- Coracohumeral ligament
- Transverse humeral ligament
- Glenoidal labrum

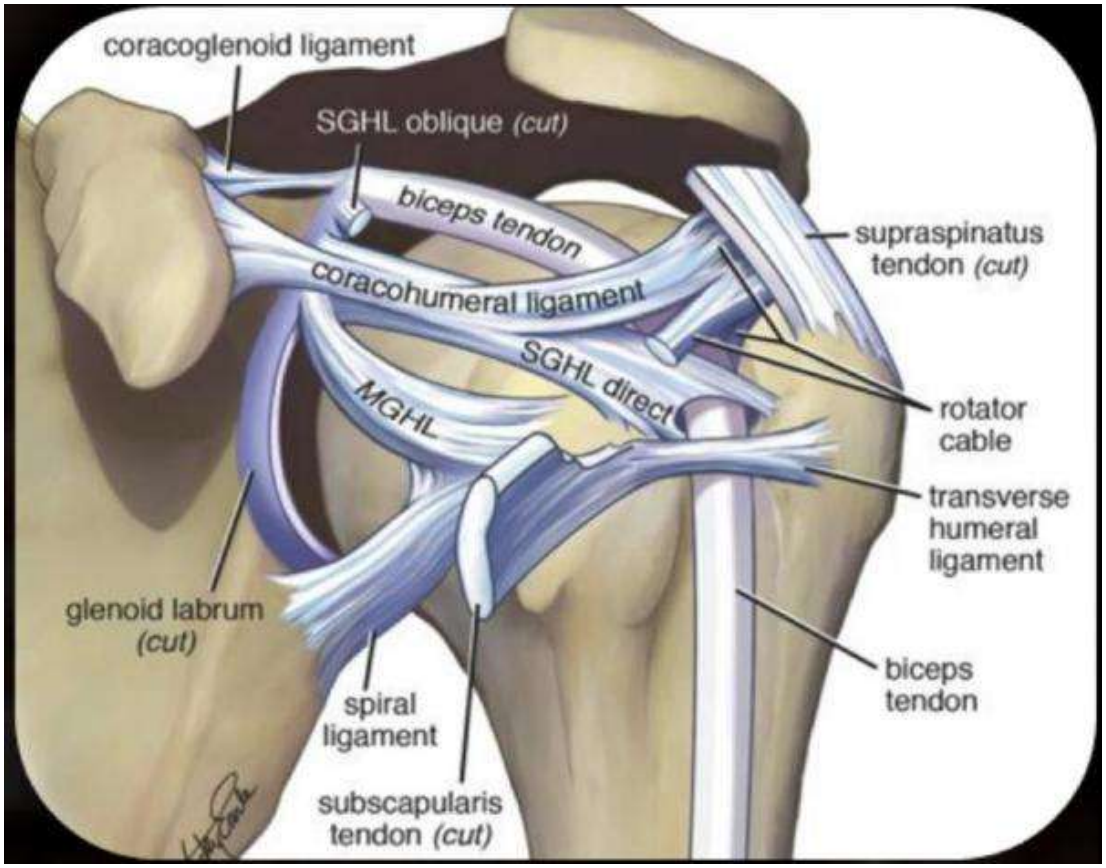
The dynamic stabilizers of the shoulder joint are:

- The musculotendinous cuff of the shoulder or the rotator cuff,
- Deltoid
- Trapezius
- Serratus anterior
- Lattissimus dorsi
- Rhomboids
- Levator scapulae

ANATOMICAL RELATIONSHIP

The proximal humerus is anatomically related to the shaft and its tuberosities as follows:

- Retroversion of head
- Inclination angle of head
- Translation of the head relative to the shaft
- The relationship of the head to the greater tuberosity



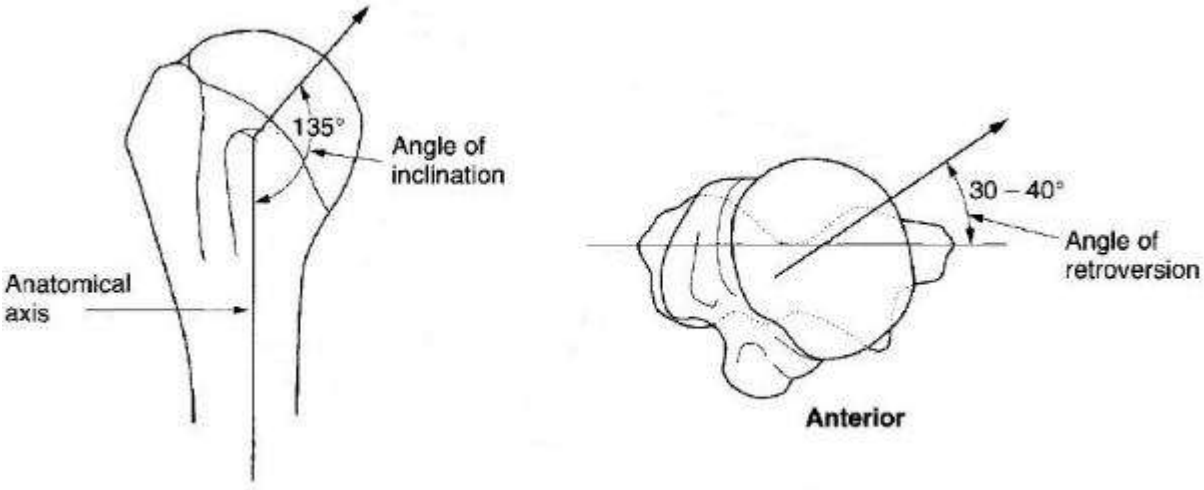
RETROVERSION OF THE HUMERUS

It is defined as the rotation angle of proximal humerus relative to Trans condylar axis. The articular segment is retroverted 30° relative to the arm. The

range is from 0-69° and can vary from one side to the other. Humeral retroversion angle decreases as the age advances (24,25)

INCLINATION ANGLE OF HEAD

Inclination of the articular segment also can vary. It ranges from 120-142°.The head segment can lie directly over the medullary canal but often is translated either posteriorly or medially.



Axillary artery and brachial plexus are just medial to coracoid process and precautions should be taken .it is safe to osteotomies on the lateral side than medial side which has neurovascular structures nearby.

By traversing the quadrangular space, the axillary nerve leaves the axilla. Then it winds around the surgical neck of humerus and enters posteriorly to deltoid about 7 cm from the tip of acromion process.

BLOOD SUPPLY OF PROXIMAL HUMERUS (23,26)

The main blood supply from the axillary artery through

1. Anterior circumflex humeral artery (85%)

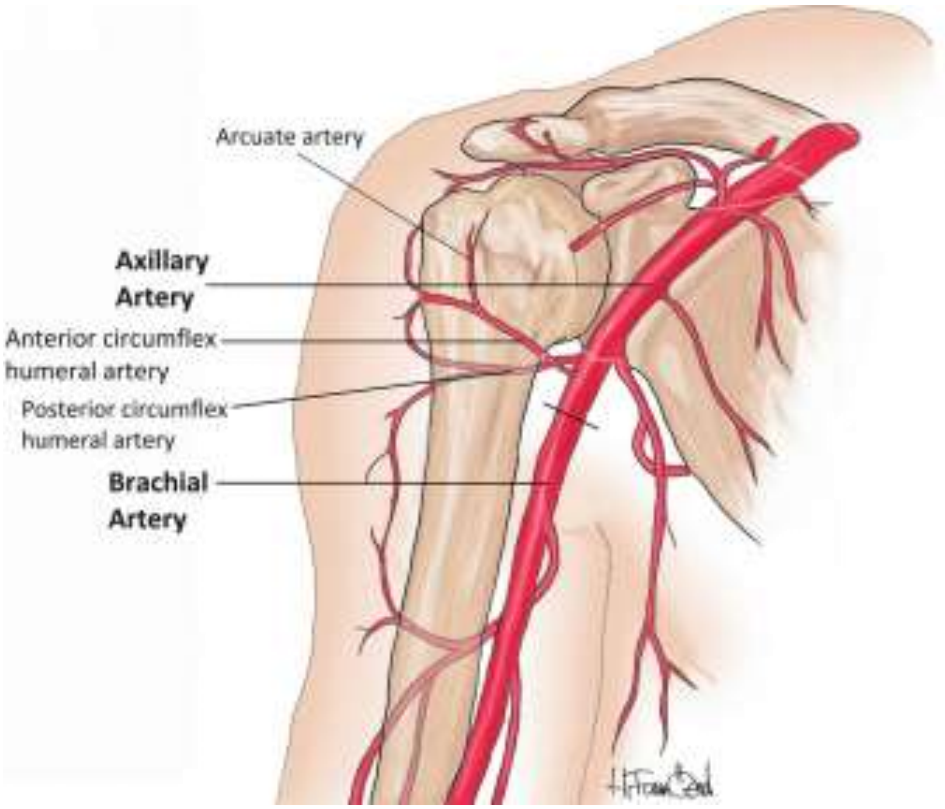
2. Posterior circumflex humeral artery (15%)

3. Suprascapular vessels

4. subscapular vessels

The axillary artery has its anastomoses in the following regions.

- medially in the quadrilateral space
- laterally in the area of the greater tuberosity
- in the humeral head through the rich network of interosseous anastomose



1. **Anterior Circumflex Humeral Artery** (a branch from third part of axillary artery) feeds the following region:

- Lesser tuberosity
- Majority of humeral head

through the following branches:

a. Ascending anterolateral branch (lies in bicipital groove)

b. Intraosseous arcuate branch (just below articular surface)

2. **Posterior Circumflex Humeral artery** feeds the following region:

- Greater tuberosity
- Posteromedial aspect of the head

It enters the head along the line of the capsular insertion in the anatomic neck posteriorly and inferiorly.

The prime source of vascularity to head is arcuate artery on medial aspect and it enters the bone through the intertubercular sulcus. The plexus includes anterior circumflex humeral artery, metaphyseal artery and arteries of greater & lesser tuberosities (27). The blood supply is usually compromised in case of 4-part fractures.

But in some special instances where posteromedial cortex is intact, such as impacted head of humerus and in valgus, the blood supply from posteromedial vessels is being retained. This is because the posteromedial cortex forms a bridge through which the vascularity of the head is maintained. Therefore, avascular necrosis of head of humerus becomes a rare incidence. But when

there is a discontinuity in the medial aspect of the neck, the chances of avascular necrosis are higher (28).

NERVE SUPPLY (29)

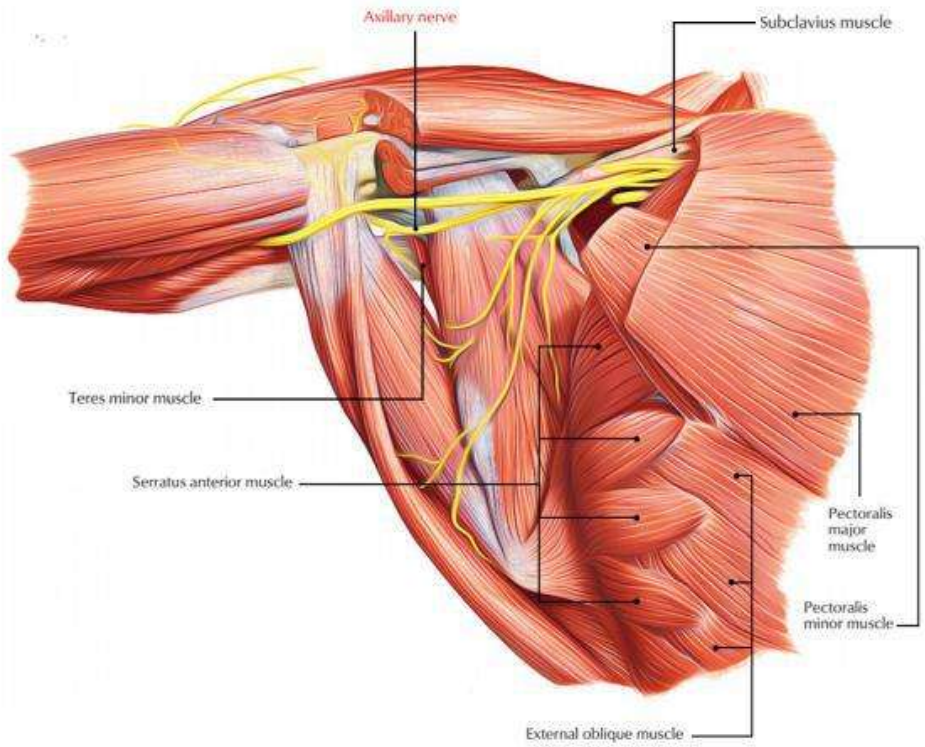
The main innervation is from the branches of the brachial plexus (C5-T1). It may be damaged by displaced fracture fragments or through traction injury. Conjoined tendons of the short head of biceps and coracobrachialis protects the trunks, divisions, cord & branches of brachial plexus during surgery. Conjoint tendon forms the medial extent of surgical exposure through the Deltopectoral approach.

Musculocutaneous nerve can be injured by prolonged traction during surgery. This pierces the conjoined tendon approximately 6 to 8 cm distal to the tip of the coracoid process.

The axillary nerve (C5-C6) is the main structure at risk during operative treatment of proximal humeral fractures. The nerve lies posterolateral to the lower subscapularis to enter the quadrilateral space, where it has an immediate inferior relation to the glenohumeral joint capsule.

Its posterior branch supplies the posterior deltoid and teres minor and provides sensation to the "badge area" of the upper arm.

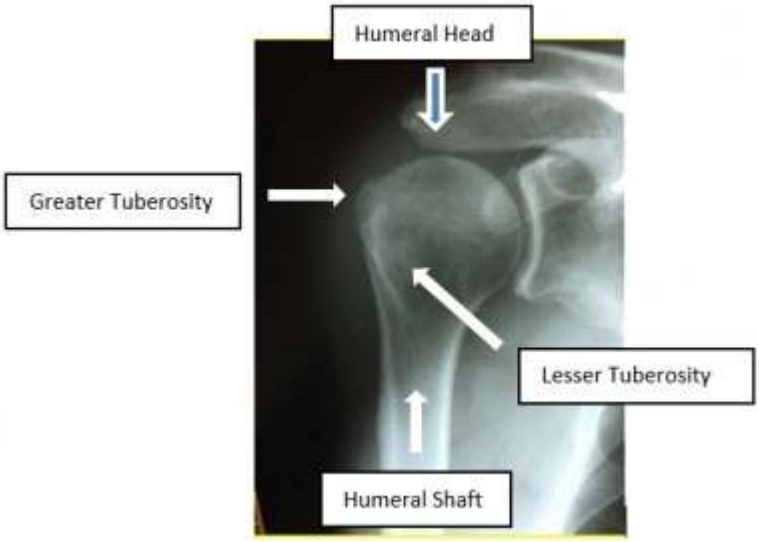
The anterior branch winds around the surgical neck deep to the deltoid muscle and has a somewhat variable course. It innervates the anterior and middle thirds of the deltoid but has no cutaneous branches.



Bone Density of the Humeral Head

The density of bone within the proximal humerus is not uniform. The bone density is higher proximal to the anatomical neck region and increases from central to peripheral region. So, these regions are most suitable regions to achieve fixation. In the medial calcar region, the density is high and lowest density is seen in the lateral humeral head adjacent to the greater tubercle and lesser tubercle. The bone quality is predicted by

1. Age of the patient,
2. Cortical thickness of the proximal diaphysis.



Bone quality can be predicted by humeral diaphysis cortical thickness. Cortical thickness of < 4 mm does not allow good screw purchase. Hence conservative treatment, hemiarthroplasty or Trans osseous suturing may be better choice of treatment.

CLASSIFICATION

A system of classification is more important and plays a vital role in managing the fractures. The classification should be comprehensive enough to encompass all factors and it should be specific enough to arrive at the diagnosis and ideal management. It should be reliable and reproducible

1. KOCHER'S Classification (30)

In 1896, Kocher first proposed his classification of proximal humerus fractures based on anatomical region involved, namely:

- Anatomic neck
- Epiphyseal region
- Surgical neck

Limitations:

- It does not account for multiple fractures at various sites.
- It does not differentiate displaced and undisplaced fractures, so treatment information cannot be obtained.

2. WATSON JONES Classification (31)

This system of classification is based on the mechanism of injury. It is divided into three types, namely:

- Abduction type

- Adduction type
- Contusion crack fractures

Limitations:

Depending upon the X-ray view, the classification varies. Hence, it is not reliable.

3. CODMAN Classification (32)

In 1934, Codman proposed that the proximal humerus fractures can be separated into 4 parts based on the lines of epiphyseal union. They are:

- Articular surface (humeral head)
- Greater tuberosity
- Lesser tuberosity
- Humeral shaft

This classification formed the basis of Neer's classification

Limitations:

It does not account for the biomechanics of displacements and their plan of management.

4. NEER's Classification

In 1970, Charles Neer described his four-segment classification. It was based on the analysis of the radiograph and surgical findings of 300 patients treated in

NewYork Orthopaedic Hospital-Columbia Presbyterian Medical Centre between 1953 and 1967. He proposed his classic 4-part classification based on Codman's 4 parts. When any of four fragments is displaced > 1 cm and or angulation more than 45^0 , then the fracture is considered displaced. It is classified as

- Undisplaced fracture
- 2-part fracture
- 3-part fracture
- 4-part fracture

NEER'S FRACTURE DISLOCATION

It is classified according to the direction of dislocation as follows:

- Anterior dislocation
- Posterior dislocation

It is classified based on the number of fracture fragments as follows:

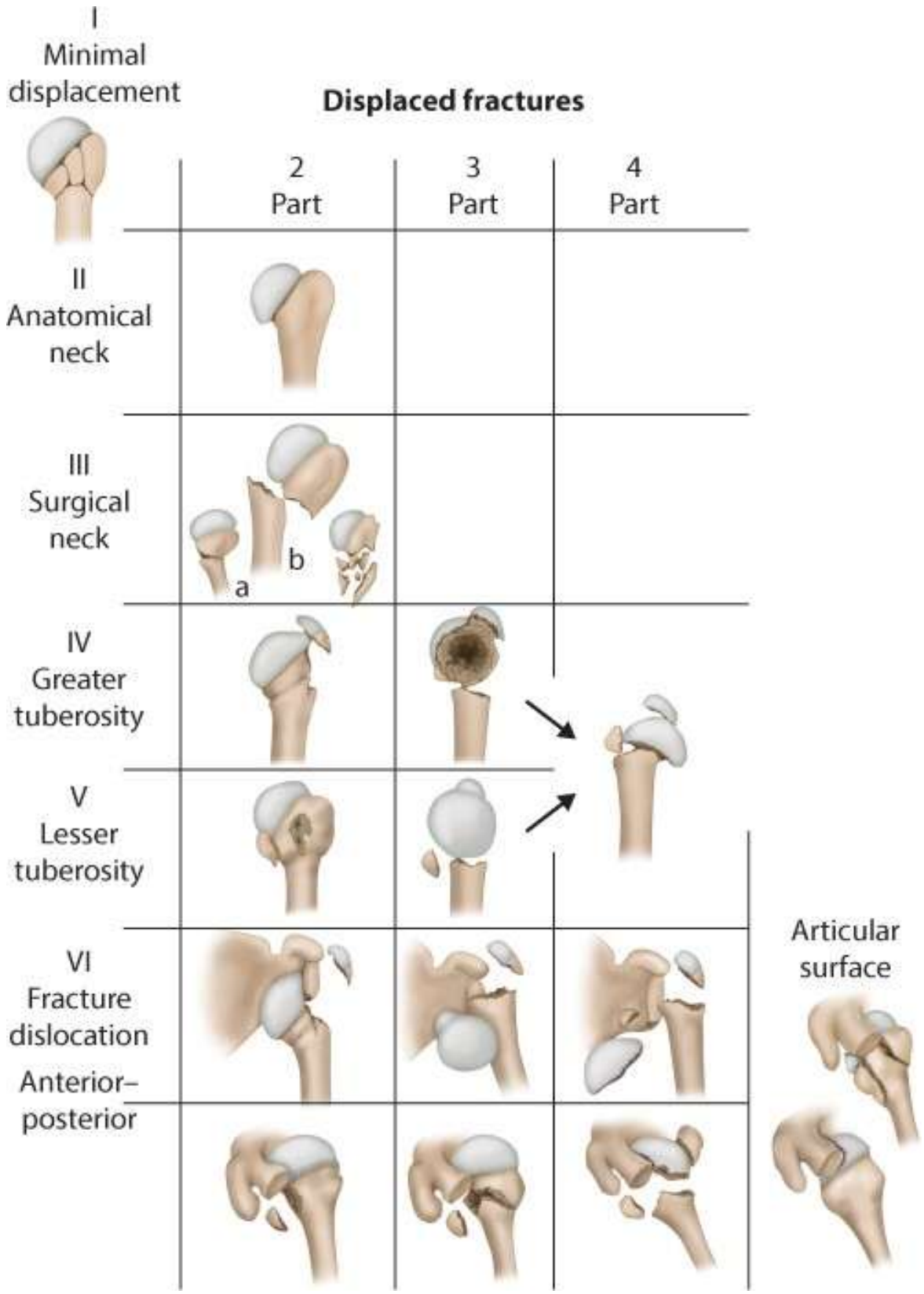
- 2-part fracture dislocation
- 3-part fracture dislocation
- 4-part fracture dislocation

Or classified as special fractures as follows:

- Head splitting fracture

- Impression fracture

- Valgus impacted fracture



AO CLASSIFICATION

AO-ASIF & Jacob et al group applied AO system of proximal humerus fractures. This system classifies the fractures into three types according to injury severity.

TYPE A

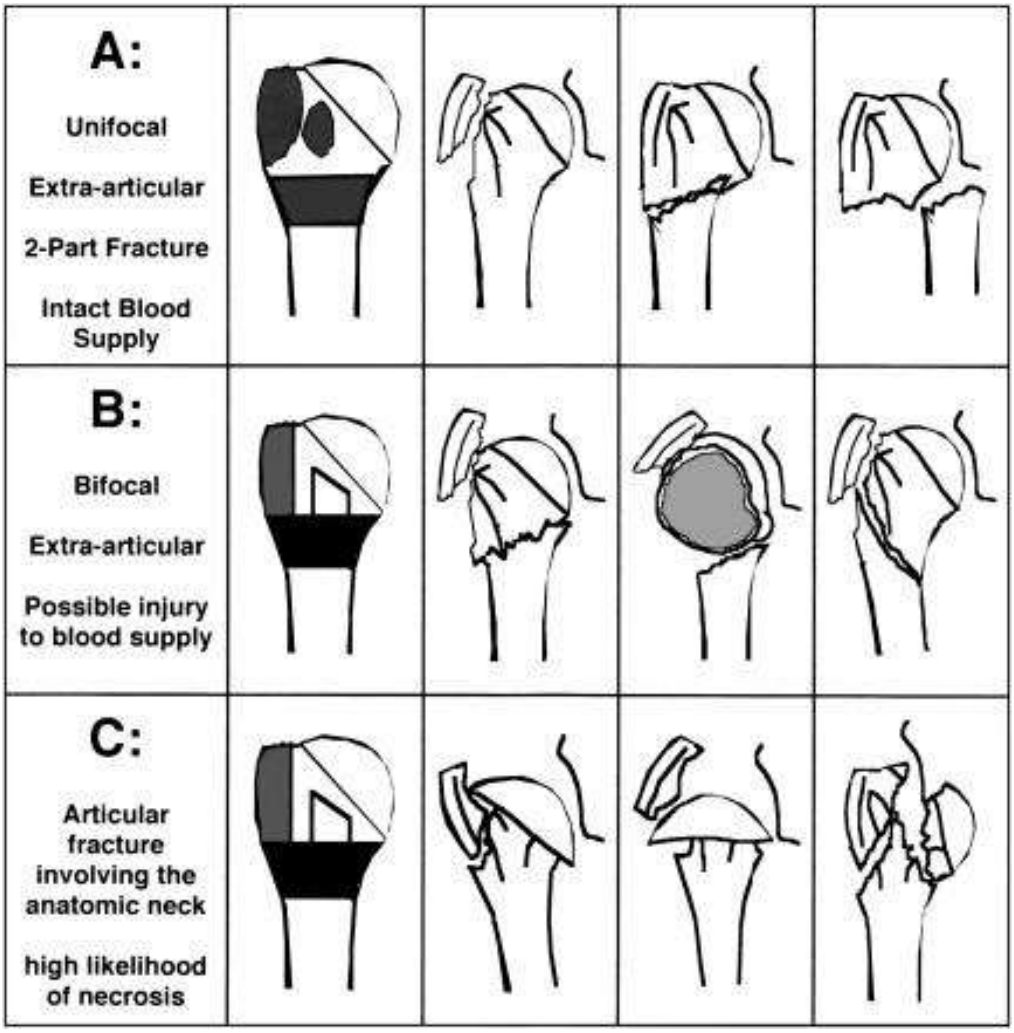
Extra articular, involves two of 4 parts, no vascular isolation of articular part, no risk of osteonecrosis & least severe.

TYPE B

Partial intra articular, involves 3- or 4- parts, low risk of AVN, partial vascular isolation of head & more severe.

TYPE C

Intra articular, involves all four parts, complete vascular isolation of segment, more risk of AVN & more severe. In addition, each alphabetical injury subdivided into three types. Higher the number indicates greater the severity.



Of all the classifications NEER's classification is widely used because of its implications on both treatment and the outcome (33,34,35,36). In our study, we have used Neer's classification.

MECHANISM OF INJURY

The common mode of injury is fall on an outstretched arm from the ground typically in geriatric osteoporotic female. The risk of fractures is increased in low bone mineral density people, a family history of osteoporotic fractures, frequent falls and evidence of impaired balance (1,37).

In middle age group with any risk factor such as alcohol abuse, drug/tobacco overuse, kidney disease, early menopause, low estrogenic status which results in low bone mineral density have the high risk of fractures. In young patients, frequent cause is violent trauma mainly from RTA, sports injuries, fall from height or gunshots. It is associated with significant soft tissue injury and poly trauma.

Other mechanisms of injury to shoulder include

- Abduction of shoulder beyond the limit in an osteoporotic individual, in which the increased rotation will cause fracture wherein the humerus locks against acromion which facilitates a fracture. It was described by Codman.
- Direct trauma, over proximal humerus
- Electrical shock or seizure. (Can cause bilateral fracture dislocation)
- Pathologic fracture of proximal humerus (metastatic deposits, primary bone tumour or infection).

FRACTURE MECHANISM

During the impact on the shoulder, the humeral head is impacted on the hard bone of the glenoid which acts as anvil. The interaction of external force during trauma with the internal forces generated by the pull of muscle around the shoulder and the mineral density of proximal humerus determine the fracture pattern and displacements. Depleted protective reflexes, delayed reaction time,

cognitive impairment, neuromuscular diseases, balance impairment raise the risk of fall directly on the shoulder (38,39).

The deforming forces of the muscular attachments to the fragments of the:

- Supraspinatus, infraspinatus, and teres minor tendons are attached onto the greater tuberosity contribute to the typical posterior and superior displacements. The rotator interval functions as a check post on the humeral head fragment and limits the displacement of 2-part fractures and most 3-part fractures.

- The pull of the subscapularis muscle tends to retract lesser tuberosity fragments medially. When the lesser tuberosity remains attached to the head fragment, the head fragment is rotated internally. Although the bone at the tendinous insertion tends to be very dense and strong, thus providing a potential site for fracture fixation.

- Pectoralis muscle is inserted on medial lip of bicipital groove, hence fractured shaft retracted medially.

- Deltoid insertion on the lateral surface of humerus will abduct the fractured proximal fragment.

CLINICO RADIOLOGICAL EVALUATION

HISTORY

A detailed history should be elicited such as patient's occupation, handedness, mode of injury and detailed medical history to find out whether patient has any significant comorbidity which results in osteoporosis/which may cause fracture such as seizure disorder.

CLINICAL PRESENTATION

Most patients present to trauma ward acutely with pain, swelling, painful restriction of movement, tenderness, crepitus if fractured fragments are in contact.

Within 24-48 hrs, Ecchymosis will be visible around the shoulder, chest and flanks.

Complete neurovascular evaluation including axillary nerve is mandatory,

IMAGING

Radiographs plays vital role in shoulder trauma to establish accurate diagnosis and proper management. Most of the time injuries were missed with radiographs obtained not in the plane of scapula. Hence three view right angled trauma series was evolved to overcome this error.

The 3 view right angled trauma series of X-rays were popularized by Charles Neer. Here the X-rays are taken in three separate perpendicular planes. They are

- **AP VIEW IN THE PLANE OF SCAPULA**

For this view, Posterior aspect of the injured shoulder is placed against X-ray plate and contralateral shoulder is rotated 40^0 out.

- **LATERAL VIEW IN THE PLANE OF SCAPULA**

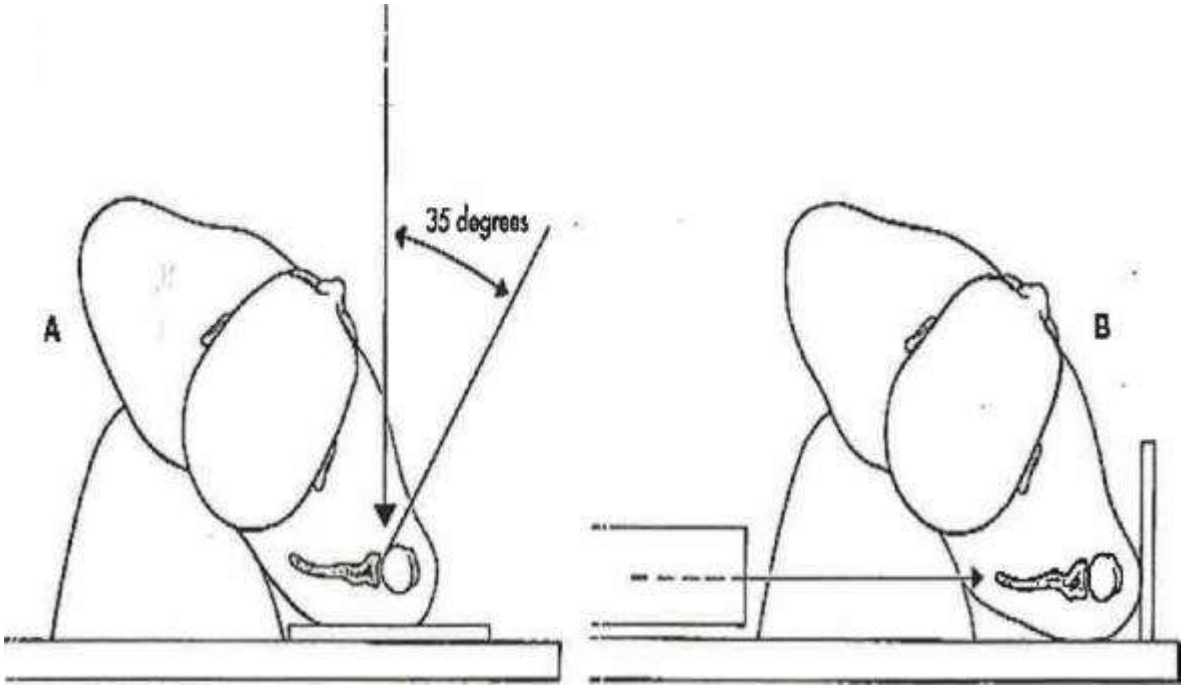
This view is obtained by placing anterior aspect of the injured shoulder over the X-ray plate and rotating contralateral shoulder 40^0 out. Now the X-ray tube is placed posteriorly, scapula appears as Y shaped with glenoid in centre and 2 upper limbs are acromion and coracoid with scapular body as vertical limb.

- **Axillary View**

This view helps in assessing the tuberosity displacements, articular surface of glenoid and relationship of humeral head to glenoid surface. This view is taken with 30^0 mild abduction with X-ray plate above the shoulder and X-ray beams goes from inferior to superior.

- **Velpeau Axillary View**

The advantage of this view is that it can be taken without sling removal. So, with minimal discomfort, X-ray can be taken in sitting/ standing/ prone position with patient tilted obliquely backwards 45^0 , the plate is placed on the table and X-ray beam is from above.



Special Views

Other special views are not routinely used. They are:

- Strip axillary lateral view (40)
- Trauma axillary lateral view (41)

- West point axillary view/Cuiollo supine axillary view with the arm in external rotation can delineate the anterior glenoid rim fractures
- The Bloom Obata Apical Oblique views (42) specifically to define posterior dislocation or fracture dislocation.

Tomograms

Tomograms can be useful in evaluating the articular surface incongruity/non-union but it is used seldom now.

CT-Scan

CT scan is ideal investigation of choice for evaluating the fractures. It helps to find:

- Degree of displacements and angulation
- Articular involvement
- Impression fracture
- Glenoid rim fractures
- Chronic fracture dislocation
- Non-union

Reconstruction CT Scan

In case of complex fracture patterns, 3D reconstruction CT is helpful in evaluating the fracture pattern and planning the treatment.

It is necessary to determine the head vascularity, quality of bone, implant choice and method of fixation before planning operative procedure.

METHODS OF TREATMENT

The main objective in treating the proximal humeral fractures is early return of function as nearly as normal. Various modalities of treatment are available for each fracture patterns. In-depth knowledge regarding the treatment modalities is mandatory to provide the ideal management for each pattern of fractures. The various methods are

- Conservative management (closed reduction with initial immobilisation and early mobilisation).
- Closed reduction with percutaneous pinning/IMIL nailing/minimally invasive plating.
- Open reduction and internal fixation with conventional plates/IMIL nail/ proximal humerus locking compression plates.
- Prosthetic replacement.

Non-Operative Treatment

Non-Operative management is preferable for:

- Osteoporotic geriatric patients
- Other severe co-morbid conditions like uncontrolled DM, Hypertension

- Minimally or undisplaced fractures
- Impacted fractures
- Surgically unfit patient
- Reducing highly comminuted or displaced fractures are difficult and often results are poor functionally.

Conservative treatment is achieved with a triangular sling or U-slab/cast for duration of 3 to 6 weeks. Movements of wrist & elbow are encouraged immediately so that the risk of stiffness and edema are minimized. After 2 weeks, Passive mobilization is allowed when there is reduction in pain and evidence of radiological union.

CLOSED REDUCTION

It has been a popular method for various patterns of proximal humerus fractures. It is essential to know that which fracture patterns are suitable, and which are not suitable.

Various types of reduction manoeuvres have been used with variable results. Watson and Jones prescribed a classical method of hyper abduction and traction to achieve a closed reduction.

Displaced lesser tuberosity fractures can be reduced by closed reduction if it is not blocking the internal rotation (43). Complex fractures cannot be treated by this method. Poor functional results are high in 3-part/4-part fractures.

OPERATIVE TREATMENT

In recent times, operative treatment of the fracture of proximal humerus is made safe and possible by better understanding of the fracture configuration and pattern and good knowledge of the implant profile.

Indications for surgery:

- Displacement of more than 1 cm of fracture fragment,
- Fracture fragments angulation is 45° or greater,
- If displacement is 5 mm or more in case of greater tuberosity fractures,
- Two-part surgical neck fracture with unstable reduction,
- Displaced 3- or 4-part fractures,
- In 20-40% of head impression fractures.

However, many other factors like quality of the bone, fracture orientation, and soft tissue injuries, patient age, co morbid condition and the skill of the surgeon in treating these kinds of injuries also have a great effect on indications of the surgical treatment.

Implants and Fixation Methods

1. Minimally invasive techniques

a. Screw fixation or Percutaneous Pinning

b. Intramedullary Nailing and Minimally invasive Plating.

2. Open reduction internal fixation techniques

a. Trans osseous suture fixation

b. Plate - LCP or conventional T-plate

c. Intramedullary Nail - polyaxial nail or Polarus

3. Replacement Arthroplasty

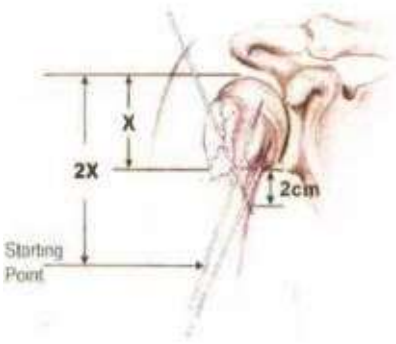
a. Reverse Shoulder Arthroplasty

b. Conventional Arthroplasty

PERCUTANEOUS PINNING

Advantage of this method is it has minimal soft tissue injury and vascularity injury to humeral head. It is less expensive. Jacob et al conducted a study on percutaneous pinning and outlined the satisfactory results which is seen in 35 out of 40 cases. But it demands good close reduction, lesser comminution, satisfactory bone stock and an intact medial cortex.

The complications like loss of purchase, infection of pin site and neurovascular damage are common. Metaphyseal comminution of fracture is the only contraindication.



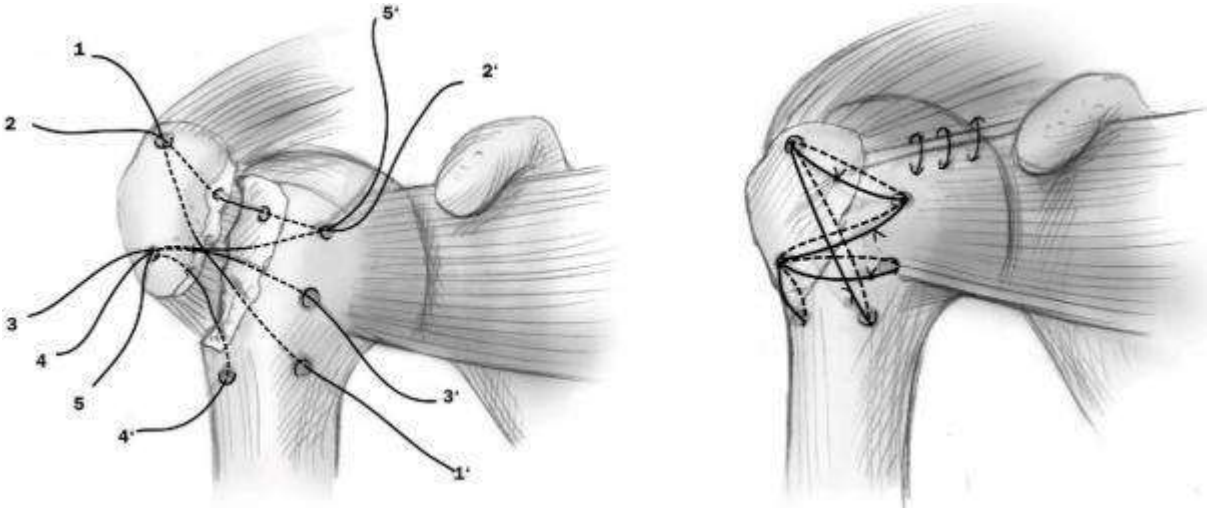
MINIMALLY INVASIVE PLATING AND INTRAMEDULLARY NAILING

It is similar to percutaneous pinning with same complications and advantages. Newer model of locked-plating and IM nailing systems are available now for percutaneous insertion through stab incisions.

This technique provides decreased chances of unstable fixation than the percutaneous screw/pinning. Polyaxial nail are available in the market with variety of jigs to accomplish easy fixation & polyethylene bushings to provide much stable construct and decreased chance of backing out of screws. Proximal and distal screw insertion can be performed percutaneously using custom-made jigs. It is reserved for minimally. displaced 2 parts surgical neck fractures with better bone stock, where reduction is easily obtained. However, while inserting it injures the rotator cuff. Absolute contraindication is fracture that involves medial cortex and tuberosities.

TRANS-OSSEOUS SUTURE FIXATION

It is ideal for isolated fractures of greater tuberosity with displacement of more than 5 mm. It is also advocated for 2-part surgical neck fractures and 3-part proximal humerus fractures.



Advantages:

- Less soft tissue injury,
- Chance of avascular necrosis reduced,

- Early joint passive mobilisation,
- Avoidance of expensive and bulky implant.

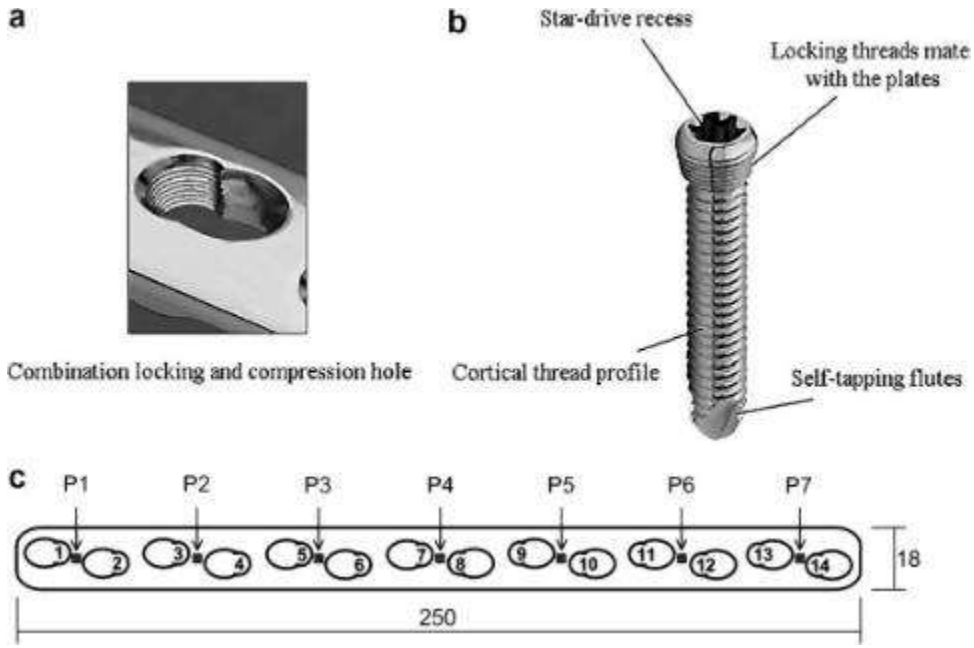
LOCKING COMPRESSION PLATE

The main advantages are:

➢ It keeps the fracture fragment more stable since it is a fixed-angle implant, and the screws alternatively converge and diverge providing the greater purchase and greater stability particularly in cases of more comminuted fracture patterns and in cases of osteoporotic bone;

➢ It provides the greater resistance against bending and torsional forces so that rehabilitation is achieved soon through early mobilization. There is less chance for dissection of soft tissue mainly rotator cuff;

➢ Reduced hardware related complications. The chances of implant removal are unlikely. In case of more complex fractures, the use of hemiarthroplasty can be avoided.



LCP Design

The 3.5 mm Locking compression Proximal Humerus Plate is a part of Small fragment LCP System. It is made up of either titanium or stainless steel. Stainless steel implants are produced from the implant quality 316L. It contains Iron 62.5%, Chromium 14.5%, Nickel 2.8%, Molybdenum and other alloys: Variable

- It is a Pre-contoured plate,
- It has ten small holes for purpose of suturing around the border of Proximal end,
- The Proximal locking holes will accept 3.5 mm Locking Screws,
- It has locked and fixed angle construct in humeral head.

There are 9 holes in the Head of the plate arranged in 5 rows as follows; A&E - 4 holes which are aligned in centre at 95°.

The distal shaft consists of 3 or 5 locking compression holes in the shaft, which includes 1 elongated hole to help in positioning of plate, in the threaded portion it accepts 3.5 mm Locking Screws and in the compression portion it accepts 4.0 mm Cancellous Screws 3.5 mm Cortex Screws and 4.0 mm Cortex Screws,

PROSTHETIC REPLACEMENT

In the early 1950's prosthesis replacement for proximal humerus was made. The original Neer's I prosthesis was developed in 1951. Neer documented the first case with fracture dislocation in proximal humerus treated with prosthesis. The Neer's I prosthesis was redesigned by himself in 1973.

Aim of the replacement is to provide humeral retroversion with proper myofascial sleeve tension. The prosthesis has two head sizes of 15 & 22 mm in thickness. The larger size will give better leverage, but the smaller size is required for coverage by rotator cuff. Three stem sizes 7, 9, 12 mm and two stem length 125 and 150 mm are available. Recently modular hemiarthroplasty has been used to provide greater flexibility.

Indications:

- Four-part fractures and fracture dislocation

- Three-part fractures and fracture dislocation in elderly/osteoporotic/comminuted
- Head splitting fracture/head impression fractures
- Anatomic neck fracture that cannot be reduced in adults
- Chronic dislocation with impression fracture greater than 40%
- Chronic cases of osteonecrosis of head
- Non-union surgical neck of humerus

In osteoporotic bones rigid and stiff implants will produce more damage. Load-sharing not load-bearing compound constructions are the aim. The key element in achieving the necessary load sharing is by obtaining the elastic buttressing.

Complications:

- Prosthetic loosening
- Malposition.
- Dislocation.
- Deep infection.
- Tuberosity detachment.
- Intra operative nerve injury.
- Intra operative fractures at tip.

MATERIALS AND METHODS:

STUDY POPULATION:

The study is a hospital based prospective case study, conducted in Govt Royapettah Hospital**,Chenna**i during the period of **June 2018 to November** 2020.20 patients (adults) presenting with proximal humerus fractures to the OPD at Department of Orthopaedics, or presenting to the Emergency Department, at GRH, Chennai,with a follow up period of minimum of 6 months and maximum of 18 months.

INCLUSION CRITERIA

1. Patients above 18 years of either sex
2. Closed proximal humerus fracture
3. Duration of injury less than 6 weeks.

EXCLUSION CRITERIA

1. Patients aged below 18 years,
2. Open proximal humerus fractures,
3. Patients medically unfit for surgery,
4. Pathological fractures other than osteoporosis,
5. Associated head injury/vascular injury
6. Infection

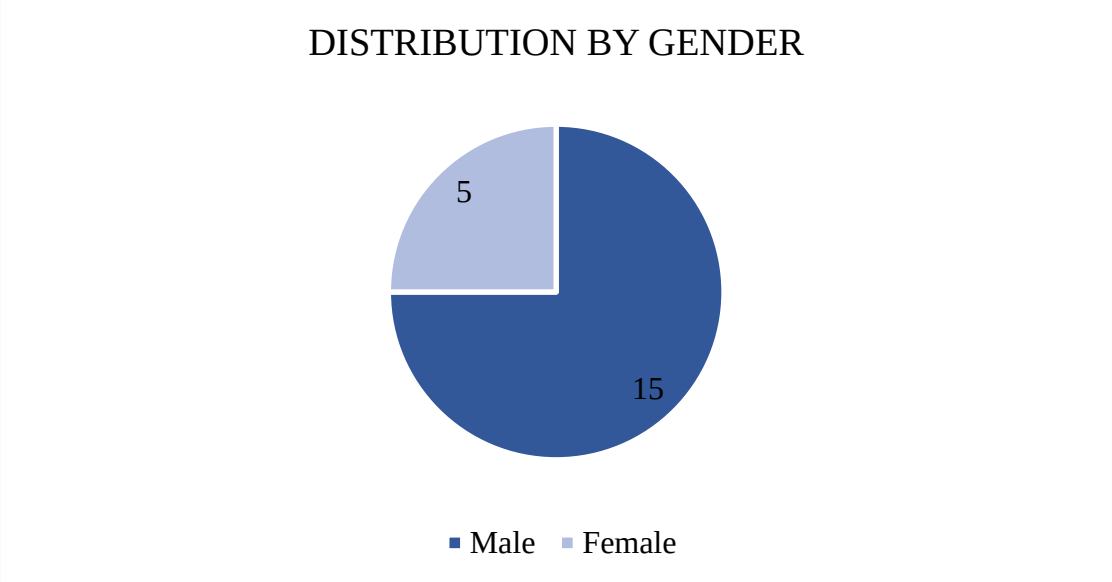
OBSERVATIONS AND RESULTS

A total of 20 patients visiting the outpatient department of our hospital with proximal humerus fractures were selected for this study.

DISTRIBUTION BY GENDER

Of the 20 patients, the gender distribution was as below.

GENDER	FREQUENCY (%)
Male	15 (75%)
Female	5 (25%)

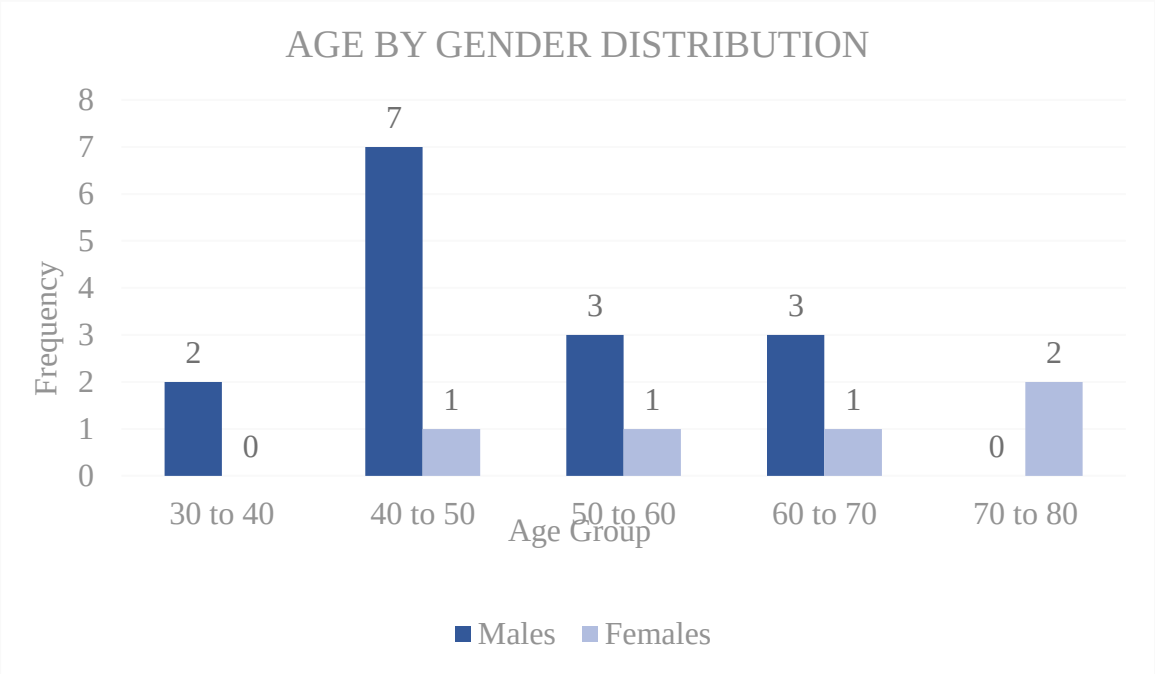


As shown in the chart above, fractures of the proximal humerus occurred more frequently in men (75%) than women (25%) in our cohort of patients.

Distribution by Age

The age distribution of the 20 patients enrolled to this study was as below.

AGE (YEARS)	FREQUENCY IN MALES	FREQUENCY IN FEMALES
30 to 40	2 (10%)	0
40 to 50	7 (35%)	1 (5%)
50 to 60	3 (15%)	1 (5%)
60 to 70	3 (15%)	1 (5%)
70 to 80	0	2 (10%)



The average age for the cohort of patients in this study was 54.4 years. As per the distribution chart by age, majority of the patients (60%) were in the age group of 40 to 60 years when they presented to the hospital with proximal humerus fracture. Thirty percent of the remaining patients were elderly in the

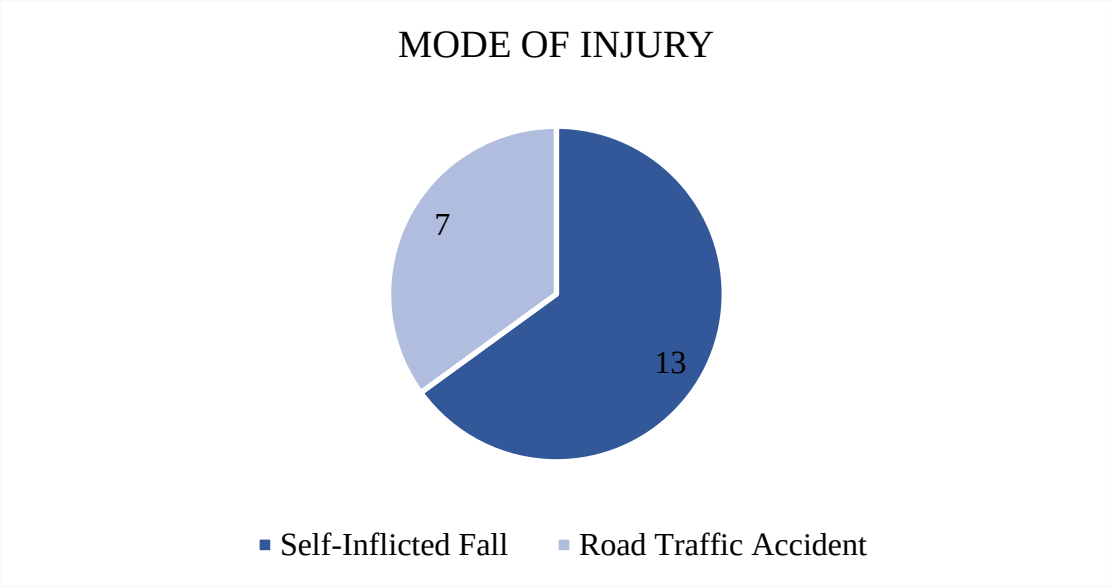
age group of 60 to 80 years, while fracture of the proximal humerus occurred in the age group of 30 to 40 years in the remaining 10% patients.

In our study, the number of females with proximal humerus fracture were lower in every age group except the age group of 70 to 80 years.

MODE OF INJURY

The 20 patients had various modes of developing the injury which led to the humerus fracture. These are summarized in the table below.

MODE OF INJURY	FREQUENCY (%)
Simple Fall	13 (65%)
Road Traffic Accident	7 (35%)



Most of the patients (65%) presenting to our hospital had a simple fall as the reason for their humerus fractures. The remaining 35% developed the fractures due to road traffic accidents.

LATERALITY OF THE FRACTURE

The laterality of the proximal humerus fracture in the 20 patients is presented below.

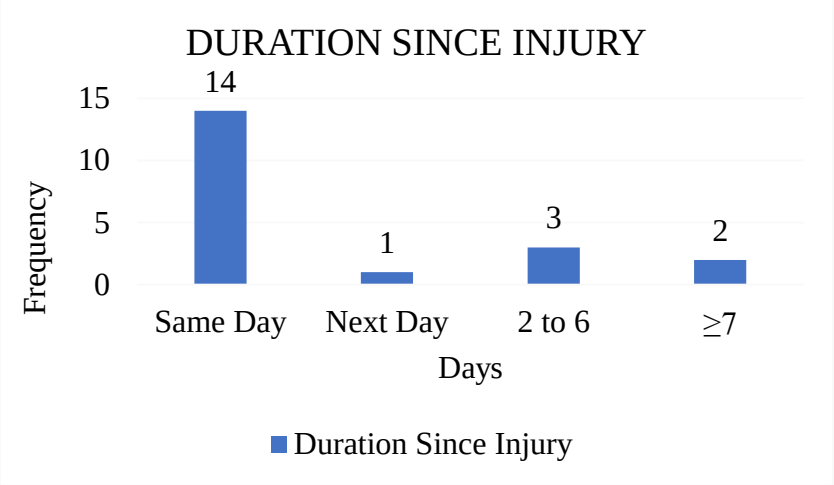
LATERALITY	FREQUENCY (%)
Unilateral	20 (100%)
Right	11 (55%)
Left	9 (45%)
Bilateral	0

Of the 20 patients with humerus fractures, none of the patients had fractures of both the humerus bones. Of these, 55% had right-sided humerus fracture, while the remaining 45% had left-sided proximal humerus fracture.

DURATION SINCE INJURY

The 20 patients with humerus fractures presented to our hospital at varying duration since the actual injury. Some of them also had history of native treatment in the form of massage, etc. This duration since injury is summarized below.

DURATION SINCE INJURY (DAYS)	FREQUENCY (%)
Same Day	14 (70%)
Next Day	1 (5%)
2 to 6	3 (15%)
≥7	2 (10%)



As evident from the graph above, most of the patients (70%) presented to our hospital on the same day of sustaining injury and were diagnosed with proximal humerus fracture. The remaining 10% patients presented 1 to 2 days (10%), 2 to 6 days (10%), and ≥7 days, each, after sustaining injury.

The 5 patients (25%) who presented greater than or equal to 2 days after sustaining injury and fracture took native treatment in the form of massage before presenting to the hospital.

COMORBIDITIES

Some of the patients who presented with the proximal humerus fracture also had comorbidities. The distribution of these comorbidities is as below.

COMORBIDITY	FREQUENCY (%)
None	15 (75%)
Type II DM	4 (20%)
Type II DM/SHT	1 (5%)

Key: DM=Diabetes Mellitus; SHT=Systolic Hypertension

Majority of the patients (75%) did not have a comorbidity, either from a fracture occurrence/treatment perspective, or from a fracture healing perspective. Twenty percent of the patients had type II diabetes mellitus (DM), while 5% had type II DM and systolic hypertension.

ASSOCIATED INJURY

Some patients also had other associated injuries in addition to proximal humerus fracture. These are summarized below.

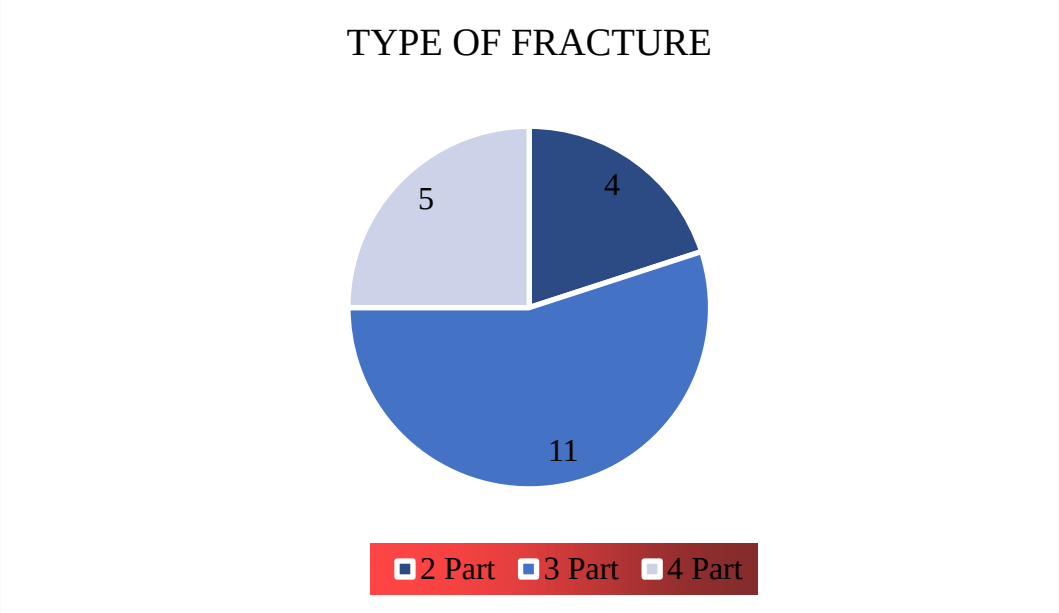
ASSOCIATED INJURY	FREQUENCY (%)
Distal Radius Fracture	2 (10%)
Elbow Dislocation	1 (5%)
Neck of Femur Fracture	1 (5%)
None	16 (80%)

Majority of the patients (80%) did not have an associated injury.

NEER'S CLASSIFICATION

All patients were evaluated with standard anteroposterior radiographs of the affected shoulder and most of them were further evaluated with Neer's three view trauma series which involves the AP, lateral view in the plane of scapula and axillary lateral view. Radiological evaluation of the fractures was done and were classified according to Neer's four-part classification system.CT was done for complex fractures.

NEER'S TYPE	FREQUENCY (%)
2 Part	4 (20%)
3 Part	11 (55%)
4 Part	5 (25%)



Based on Neer's system, 4 patients (20%) had 2-part fractures, 11 (55%) had 3-part fractures and 5 (25%) had 4-part fractures.

SURGERY AND POST-SURGICAL PHYSIOTHERAPY

All 20 patients underwent surgery to correct the fracture. The duration from injury to surgery is presented below.

DURATION FROM INJURY TO SURGERY	FREQUENCY (%)
< 2 weeks	19
> 2 weeks	1

Majority of the patients underwent surgical treatment for the proximal humerus fracture within 2 weeks of occurrence of injury. 1 patient underwent surgery after 2 weeks of injury.

All 20 patients were started on physiotherapy with passive mobilization on day 3 post-surgery.

METHODOLOGY

PRE-OPERATIVE ASSESSMENT

After initial assessment and resuscitation, detailed history and thorough clinical examination was made to rule out associated injuries .All patients were selected for the study based on NEER criteria and CT scan were done for complex fractures,patients were immobiliseld with U slab pre operatively after adressing any associated injuries.

Investigations

Routine blood investigations like complete hemogram, blood sugar, renal function test, serum electrolytes, blood grouping and typing, bleeding time and clotting time were done.

For anaesthesia evaluation, chest x ray and ECG were taken. Cardiologist fitness was obtained for patients aged above 50 years. Anaesthesia fitness was obtained for all patients.

Radiographs of affected shoulder were done, and diagnosis was made using Neer's classification.CT was done for complex fractures.

PROPHYLACTIC ANTIBIOTICS

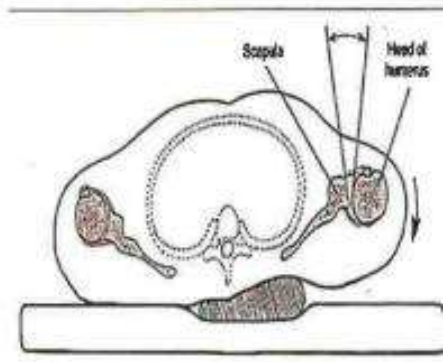
All patients received 1 gm of ceftriaxone IV thirty minutes before surgery.

CHOICE OF ANAESTHESIA

All patients were operated under supraclavicular and interscalene block/General anaesthesia.

POSITIONING THE PATIENT

All patients were positioned supine with a sandbag between the spine and medial border of the scapula of the affected side in order to push the joint forward and open the front of the joint. Image intensifier is placed on the opposite side.



SURGICAL APPROACH

All patients were operated using deltopectoral approach

OPERATIVE TECHNIQUE

An incision of size 10-15 cm is made from line of deltopectoral groove curved towards the shaft. After incising the skin, subcutaneous tissue, fascia and muscles, the conjoint tendon is retracted medially. Cephalic vein is retracted

medially. Fibres of deltoid muscle are retracted laterally and pectoralis muscle medially.

Short head of biceps retracted medially. Fascia over the conjoint tendon is incised to reveal the subscapularis muscle. By putting the shoulder into external rotation subscapularis muscle is stretched and it can be released from lesser tuberosity if needed.

Fragments were reduced and fixed with k wires temporarily. After obtaining appropriate reduction, the proximal humerus plate was placed 8mm inferior to greater tuberosity. Plate was placed lateral to long head of biceps. The humeral head fragments, metaphysis and shaft was aligned with plate and fixed with multiple locking and regular screws. Humeral head was fixed with cancellous locking screw of appropriate size and shaft was fixed with locking cortical screws. Of all screws, the oblique placement of infer medial screw **(calcar screws)** over the head is important and mandatory to prevent the secondary loss of reduction.

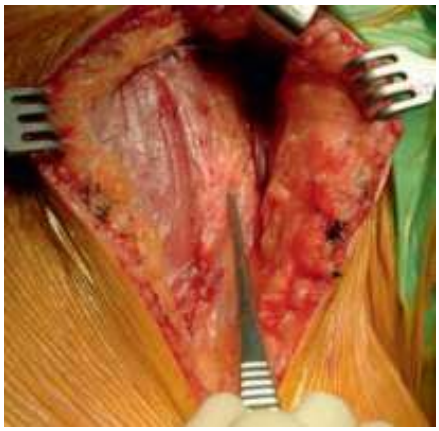
For 3-part or 4-part fractures/fracture dislocation or osteoporotic fragments, placing the sutures into the rotator cuff tendons which is attached to fractured fragments to facilitate the reduction.

The final position of implant and fracture reduction was checked with image intensifier in multiple planes. The shoulder was checked for range of movements and stability of fixation. None of the patients required bone

grafting. Suction drain was kept insitu and fascia and subcutaneous tissues and skin closed in layers.

Figure shows the position for proximal humerus fracture

Supine position with sand bag in the space between medial border of scapula and spine



POST-OPERATIVE MANAGEMENT

Postoperatively, the arm was immobilized using shoulder immobilizer for 1 patient and using cuff and collar for the remaining 19 patients. The suction drain was removed on 2nd post-operative day.

The time for commencement of shoulder physiotherapy was based on the stability of fixation, quality of bone, and compliance of patient. Passive range of movement exercises such as pendulums, passive forward elevation, external rotation generally was started on the first postoperative day provided that a stable reduction was achieved. Active ROM of the elbow, wrist, and hand was also started immediately.

The patient then progressed through a series of rehabilitation programs, consisting of early passive assisted exercises, active exercises starting at approximately 6 weeks postoperatively and strengthening or resistance exercises starting 10 to 12 weeks after surgery. Early passive assisted exercises help to avoid adhesion formation. Shoulder strengthening and resistance exercises were started after bony consolidation was confirmed on plain radiographs.

Post-operative x rays were taken after 24 hours of surgery to check the fracture alignment, reduction and fixation. Routine follow-up radiographs were taken after 6 weeks and every month for 3 months and then 6 and 12 months

postoperatively to evaluate the union and plate related complications such as screw penetration, screw cut out, avascular necrosis and implant loosening.

FUNCTIONAL OUTCOME ASSESSMENT

DASH score was used to assess the functional outcome of patients after 6 months post op. The QUICK DASH score is a questionnaire of 11 questions which the patient is asked to complete from which the functional outcome is calculated.

The DASH score was graded as follows:

Excellent 0-5 points

Good 6 to 15 points

Satisfactory 15-35 points

Poor >35 points

ANALYSIS AND RESULTS:

ANALYSIS OF FINAL OUTCOME:

The patients underwent a DASH scoring evaluation and the DASH scores have been provided in the table below. Based on the DASH scores, the final patient outcomes were assessed which are summarized as below.

DASH SCORE	FREQUENCY
0 to 5	1
6 to 15	7
15 to 35	10
>35	2

The following analysis was made from our study:

ANALYSIS OF RADIOLOGICAL OUTCOME

In the 20 patients, the neck-shaft angle at (Day 1) post op was in the range of 130^0 to 137^0 , with an average angle of 133.2^0 .

Post-surgery,after 3 weeks this neck-shaft angle reduced to the range of 124^0 to 132^0 (Day 21 follow-up), with an average of 128.5^0 .

Overall, the radiological outcome was favourable for all 20 patients.

The tip of the screw and joint distance when less than 4 mm led to screw penetration due to collapse in post of period and led to failure in 2 patients

COMPLICATIONS

Post-surgery, complications were encountered in some of the patients. The early and late complications that occurred are summarized separately below.

Of the 20, 2 patients (25%) developed early complications which are as follows.

EARLY COMPLICATIONS	FREQUENCY (%)
Superficial Skin Infection	2 (10%)
Screw Penetration	2 (10%)

Of the 20, 3 patients (15%) developed late complications as well, which are as follows.

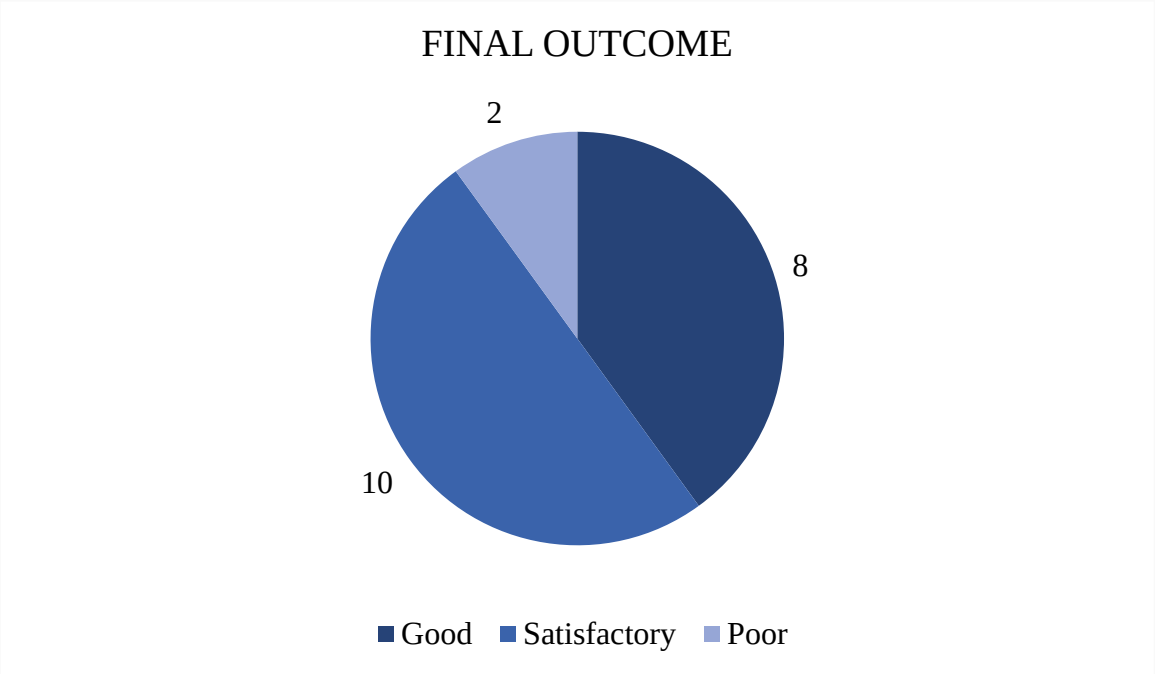
LATE COMPLICATIONS	FREQUENCY (%)
Osteonecrosis	2 (10%)
Joint Stiffness	1 (5%)

Majority of the patients (75%) did not experience either early or late complications post-surgery and had an uneventful recovery.

RESULT:

As previously highlighted in the section, the 20 patients were evaluated based on the DASH scores, the final patient outcomes were assessed as follows:

Of the 20 patients, 8(40%) patients had good final outcome based on the DASH score,



10 (50%) had a satisfactory outcome, while the remaining 2 (10%) had a poor outcome from the fracture surgery.

It was observed that people with age < 50 years had a better range of movement (eg. abduction and forward flexion of the shoulder joint) ranging over 120^0 . In patients aged > 50 years, the range of movement was restricted to an average of 100^0 .

Additionally, the overall DASH scores were better in the younger patients when compared with the elderly patients.

Longer subchondral screws closers to the joint resulted in failure

CASE ILLUSTRATIONS

Case 1 – 43/M – NEER'S 3 PART FRACTURE



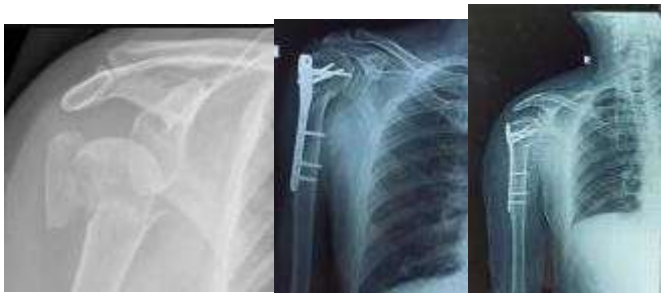



Case 2: - 49/M NEER'S 3 PART





CASE 3:65/M NEER'S 3 PART



CASE 4:43/M NEER'S 3 PART

CASE 5:47/M NEER'S 4 PART






DISCUSSION

The treatment of complex humeral 3- or 4-part fractures represents a challenge. The surgeon must obtain an exact anatomical reduction and stable fixation, and at the same time minimize the iatrogenic risk of screw penetration and avascular necrosis of the humeral head by maximal protection of the soft tissues surrounding the shoulder joint.

Poor results in these complex fractures are due to following causes:

1. Inadequate fracture reduction especially medial cortex
2. Unstable fixation
3. Incorrect positioning of the fixation devices

In this prospective hospital-based study, we have analyzed 20 cases of proximal humerus fractures treated surgically using PHILOS plates in our hospital.There was a male preponderance in our study 15 (75%) which was not in line with the conclusion of the study conducted by Hawkins & Bell (45) or Kumar et al (46), both of which had a female preponderance. In the study by Kristiansen et al (34) involving 565 proximal humerus fractures in 5,00,000 people, women were involved in 77% of fractures in all age groups. This is thought to be a direct result of advanced osteoporosis, but our study differs from the results of these studies.

In our study, the average age of the patients was 54.4 years which was corresponding to the reports by Hawkins and Bell, and Flatow et al (47) and Cornell et al (48).

In our study, the most common mode and mechanism of Injury was free fall at ground level and road traffic accident, which is comparative to the results of the study conducted by Flatow et al (47) as fall on the outstretched arm was the predominant mechanism of injury. Since Indian people have poor quality of bone stock, slight differences are expected.

Neer Classification is the most widely used scheme for proximal humeral fractures. It has gained universal clinical acceptance by orthopaedic surgeons and radiologists and is considered to have significant implications for both treatment options and outcomes. In our study also, we have followed Neer's 4-part classification.

In order to properly employ this classification, precise radiographic evaluation is of paramount importance (48). and it is found that Neer's 3 view trauma series to be of greatest value in evaluating these fractures. The importance of these series has been shown by Richard J, Hawkins S and R.L. Angel (49).

There was a predominance of 3-part fracture in our study in 11 patients (55%), of which greater tuberosity fracture were the most common.

Flatow et al (**Error! Bookmark not defined.**), in a series of 12 patients, reported 50% excellent results and 50% good results in patients treated by ORIF

with LCP for two part greater tuberosity fracture. In our study, the overall outcome was satisfactory in 50% of the patients and good in 40% of the patients.

Closed treatment of 3-part fracture is often associated with moderate pain, poor range of motion and disability. ORIF was associated with good to excellent results in more than 80% of patients in a report by Hawkins et al (**Error! Bookmark not defined.**) and recommended surgical treatment for healthy active individuals who have three part fractures of the proximal humerus. Cornell and Levine (**Error! Bookmark not defined.**) reported good results with screw tension band technique for 3-part fractures. Prosthetic replacement for 3-part fracture has been used by several authors.

In the treatment of 4-part fracture and fracture dislocations, less than 10% good or excellent results are obtained by open reduction and internal fixation (50,51). Isolated reports of revascularization of head of humerus following ORIF indicate satisfactory healing.

In the 20 patients, the neck-shaft angle at (Day 1) post op was in the range of 130^0 to 137^0 , with an average angle of 133.2^0 .

Post-surgery,after 3 weeks this neck-shaft angle reduced to the range of 124^0 to 132^0 (Day 21 follow-up), with an average of 128.5^0 and this did not make any difference in the final outcome (52)

It was observed that people with age < 50 years had a better range of movement (eg. abduction and forward flexion of the shoulder joint) ranging over 120^0 . In patients aged > 50 years, the range of movement was restricted to an average of 100^0 which corelates with the study done by Gracitell, Mauro Emilio Conforto et al (54)

In our study patient who had attended regular physiotheraphy sessions and who adhered to 3 phase rehabilitation protocol had better DASH score and range of movement than patient who did independent exercises at home .

Patients whose fracture were fixed earlier than 2 weeks had good and satisfactory outcome while in one patient when fracture was fixed later than 2 weeks had poor outcome in our study.

Inspite of most of the patients being operated early the number of patients with excellent functional outcome is less in our study because some of the patients did not come for regular physiotheraphy sessions which had direct impact on the final functional outcome.

The screw tip joint distance when less than 4 mm led to screw penetration and failure in 2 patients which is in accordance with the study done by Flether et al(55) where a distance of minimum of 8 mm is recommened

We have seen few complications in our study. All fractures united and the average time taken for union was approximately ten weeks. One patient with 4-part fracture went into varus malunion. One patient each with 3-part fracture

and 4-part fracture had screw penetration.Three of these 5 patients despite having malunion or screw penetration or infection had a satisfactory overall outcome, while the remaining 2 patient had poor overall outcome. There was no non-union deep infection in our study.

Finally, a prolonged closely monitored and well-defined program of rehabilitation was necessary to obtain the best functional results. We have followed the 3-phase rehabilitation protocol of Hughes and Neer (57) in our patients.

There are many pitfalls for the unwary patient and surgeon to avoid during the course of treatment. Emphasis is placed on complete and accurate diagnosis and formulation of safe and simple techniques for restoration of anatomical stability, fracture union, cuff integrity, range of motion and adequate muscle strength.

CONCLUSION.

- Accurate anatomical reduction and early fracture fixation are more important to get a good final functional outcome,
- Use of shorter screws than subchondral screws closer to the joint prevented failure
- Adherence to regular and graduated rehabilitation program is the key for good functional outcome.

ANNEXURE I:

PATIENT CONSENT FORM

Study detail : **"ANALYSIS OF FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PROXIMAL HUMARUS FRACTURE TREATED BY PHILOS PLATE– A PROSPECTIVE STUDY"**

Study Centre : GOVT ROYAPETTAH HOSPITAL, CHENNAI

Patients Name :

Patients Age :

Identification Number :

Patient may check (√) these boxes

1. I confirm that I have understood the purpose of procedure for the above study. I had the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ☐
2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ☐
3. I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ☐
4. I hereby make known that I have fully understood the use of above surgical procedure, the possible complications arising out of its use and the same was clearly explained to me and also understand treatment of polytrauma with fractures and this study ☐

is done to know the usefulness of the same in management of fractures in polytrauma patients.

5. I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well-being or any unexpected or unusual symptoms. ☐

6. I hereby consent to participate in this study. ☐

7. I hereby give permission to undergo complete clinical examination and diagnostic tests including hematological, biochemical, radiological tests. ☐

Signature/thumb impression:

Patients Name and Address: Place date

Signature of investigator :

Study investigator's Name Place date

ANNEXURE II:

நோயாளிஒப்புதல்படிவம்

ஆராய்ச்சியின்விவரம்:

ஆராய்ச்சிமையம்:

நோயாளியின்பெயர்: நோயாளியின்வயது:

பதிவுஎண்:

நோயாளிகீழ்கண்டவற்றுள்கட்டங்களை (✔)செய்யவும்

1. மேற்குறிப்பிட்டுள்ளஆராய்ச்சியின்நோக்கத்தையும்பயனையும்முழுவதுமாகபுரிந்துகொண்டேன். மேலும்எனதுஅனைத்துசந்தேகங்களையும்கேட்டுஅதற்கானவிளக்கங்களையும்தெளிவுபடுத்திக்கொண்டேன். ☐

2. மேலும்இந்தஆராய்ச்சிக்குஎனதுசொந்தவிருப்பத்தின்பேரில்பங்கேற்கிறேன்என்றும், மேலும்எந்தநேரத்திலும்எவ்விதமுன்னறிவிப்புமின்றிஇந்தஆராய்ச்சியிலிருந்துவிலகமுழுமையானஉரிமை உள்ளதையும், இதற்குஎவ்விதசட்டபிணைப்பும்இல்லைஎன்பதையும்அறிவேன். ☐

3. ஆராய்ச்சியாளரோ, ஆராய்ச்சிஉதவியாளரோ, ஆராய்ச்சிஉபயத்தாரோ, ஆராய்ச்சிபேராசிரியரோ, ஒழுங்குநெறிசெயற்குழுஉறுப்பினர்களோஎப்போதுவேண்டுமானாலும்எனதுஅனுமதியின்றிஎனதுஉன் நோயாளிபதிவுகளைஇந்தஆராய்ச்சிக்காகவோஅல்லதுஎதிர்காலபிறஆராய்ச்சிகளுக்காகவோபயன்படுத்திக்கொள்ளலாம்என்றும், மேலும்இந்தநிபந்தனைதான்இவ்வாராய்ச்சியிலிருந்துவிலகினாலும்தகும்என்றும்ஒப்புக்கொள்கிறேன். ஆயினும்எனதுஅடையாளம்சம்பந்தப்பட்டஎந்தபதிவுகளும் (சட்டபூர்வமானதேவைகள்தவிர) வெளியிடப்படமாட்டாதுஎன்றஉறுதிமொழியின்பெயரில்இந்தஆராய்ச்சியிலிருந்துகிடைக்கப்பெறும்முடிவுகளைவெளியிடமறுப்புதெரிவிக்கமாட்டேன்என்றுஉறுதியளிக்கின்றேன். ☐

4. இந்தஆராய்ச்சிக்குநான்முழுமனதுடன்சம்மதிக்கின்றேன்என்றும்மேலும்ஆராய்ச்சிக்குழுவினர்எனக்குஅளிக்கும்அறிவுரைகளைதவறாதுபின்பற்றுவேன்என்றும்இந்தஆராய்ச்சிகாலம்முழுவதும்எனதுஉடல்நிலையில்ஏதேனும்மாற்றமோஅல்லதுஎதிர்பாராதபாதகமானவிளைவோஏற்படுமாயின்உடனடியாகஆராய்ச்சிகுழுவினரைஅணுகுவேன்என்றும்உறுதியளிக்கின்றேன். ☐

5. இந்தஆராய்ச்சிக்குத்தேவைப்படும்அனைத்துமருத்துவப்பரிசோதனைகளுக்கும்ஒத்துழைப்புதருவேன்என்று உறுதியளிக்கின்றேன். ☐

6. இந்தஆராய்ச்சிக்குயாருடையவற்புருத்தலுமின்றிஎனதுசொந்தவிருப்பத்தின்பேரிலும்கயஅறிவுடனும்முழுமனதுடனும்சம்மத்திக்கின்றேன்என்றுஇதன்மூலம்ஒப்புக்கொள்கிறேன். ☐

நோயாளியின்கையொப்பம் / பெருவிரல்கைரேகை ஆராய்ச்சியாளரின்கையொப்பம்

இடம்: தேதி:

ANNEXURE III

PROFORMA

SERIAL NO.

DATE

PATIENT NAME

AGE/SEX

ADDRESS

CONTACT NO.

GENERAL EXAMINATION

Weight

Height

Medical History

Laterality of fracture

Mode of injury

Associated injury

Duration since injury

Native treatment YES/NO

If yes, details:

NEER classification

POST-SURGERY

Physiotherapy

Early complications

Late complications

Neck-Shaft angle (Day 1)

Neck-shaft angle (Day 21)

DASH Score

Final Outcome

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