A Prospective Study on

FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PROXIMAL HUMERAL FRACTURES TREATED WITH LOCKING COMPRESSION PLATES (PHILOS PLATES)

Dissertation submitted to

THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY

Chennai

In partial fulfillment of the regulations

for the award of the degree of

MS (ORTHOPAEDIC SURGERY)

BRANCH – II

KILPAUK MEDICAL COLLEGE

CHENNAI-600010

APRIL – 2014

CERTIFICATE

This is to certify that **Dr. V. Prabhu**, Postgraduate student, (2012-2014) in the **Department of Orthopaedic Surgery, Government Kilpauk Medical College Hospital** has done dissertation on- **A PROSPECTIVE STUDY ON FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PROXIMAL HUMERAL FRACTURES TREATED WITH LOCKING COMPRESSION PLATES(PHILOS PLATES)** under my guidance and supervision in partial fulfillment of the regulations laid down by **THE TAMIL NADU DR.M.G.R.MEDICAL UNIVERSITY, CHENNAI-32** for the MS (Orthopaedic Surgery) degree examination to be held in April 2014.

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DECLARATION

I, **Dr. V. PRABHU,** solemnly declare that this dissertation entitled **"A PROSPECTIVE STUDY ON FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PROXIMAL HUMERAL FRACTURES TREATED WITH LOCKING COMPRESSION PLATES (PHILOS PLATES)** is a bonafide work done by me at **Government Kilpauk Medical College And Hospital, Chennai-10** between **2012-2014** under the guidance and supervision of our respected **Head Of The Department and Unit Chief Prof. Dr. N. Nazeer Ahmed M.S.Ortho, D.Ortho.**

This dissertation is submitted to **"THE TAMILNADU DR.MGR MEDICAL UNIVERSITY" CHENNAI-32,** towards partial fulfillment of regulations for the award of **M.S. Degree Branch II in Orthopaedic Surgery.**

Place: Chennai

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ACKNOWLEDGEMENT

I express my utmost gratitude to **Prof. Dr. P.RAMAKRISHNAN, M.D., DLO., Dean**, **Government Kilpauk Medical College and Hospital** for providing me an opportunity to conduct this study and for permitting to use the hospital facilities for my study to the full extent.

I would like to express my sincere thanks and gratitude to my beloved **Chief Prof.Dr.N.Nazeer Ahmed, the Head Of The Department of Orthopaedics, Government Kilpauk Medical College And Hospital Chennai-10** who allotted me this topic and offered invaluable suggestions to make this study a successful one.

I would like to express my gratitude and reverence to our beloved **Chief Prof.K.Raju M.S.Ortho, D.Ortho** whose guidance and help has elevated me to this level to conduct this study successfully. I sincerely thank his expert guidance and constant encouragement to conduct this study.

I wish to express my sincere gratitude and heartfelt thanks to **Prof.N.O. Samson Jebakumar M.S.Ortho, D.Ortho, Prof.S.Anbazhaghan M.S.Ortho, D.Ortho, Prof.R.Balachandran M.S.Ortho, D.Ortho** for their encouragement.

I would like to thank all my Assistant Professors **Dr.Samuel Gnanam M.S.Ortho., D.Ortho, Dr.S.S.Sukumaran M.S.Ortho, D.Ortho Dr.G.Mohan M.S.Ortho, DNB.Ortho, Dr.K.Thanigaimani M.S.Ortho., D.Ortho., Dr.C.Anantharaman M.S.Ortho., Dr.S.Prabhakar M.S. D.Ortho, DNB Ortho** for their constant source of inspiration and who were very helpful and supportive right through my study.

I wish to express my sincere thanks to postgraduate colleagues, anesthesiologists, staff members, theatre staff and my family members for the help they have rendered.

I would like to thank all my patients for their full cooperation for this study without whom this study would not have been possible.

Above all it is the blessings of the Almighty that made this study a successful one and to Him I offer my sincere prayers.

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Assignment title	Medical
Author	221212154 - M.s.orthopaedics V.Prabhu
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Submission time	21-Dec-2013 02:56PM
Total words	13052

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INTRODUCTION Proximal humeral fractures account for about 4 to 5% of all fractures1,2,3,4,5,6. It account for up to 45% of all humeral fractures7. It is the third most common fracture after hip fracture and colles fracture in elderly patients8. It is important to recognize these fractures early. Numerous authors have suggested that non operative treatment9,10,11 can be acceptable for two, three and four part fractures of proximal humerus in elderly patients but pain, stiffness, loss of function and muscle power have been described in more percentage of patients following this conservative approach. Fractures of Proximal Humerus have gained more attention recently. Diagnosis has been...

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LIST OF ABBREVIATIONS

#BB FA	-	Fracture Both Bones Fore Arm
#DR	-	Fracture Distal Radius
#MC	-	Fracture Metacarpal
#NOF	-	Fracture Neck of Femur
#SOH	-	Fracture Shaft of Humerus
‘K’ wire	-	Kirschner Wire
ARS	-	Attempted Reduction & Splinting
DOA	-	Date of Admission
DOI	-	Date of Injury
DOS	-	Date of Surgery
DP	-	Delto Pectoral
DS	-	Deltoid Splitting

ER	-	External Rotation
FAG	-	Fall at Ground Level
FFH	-	Fall From Height
IR	-	Internal Rotation –Spine Level
LCP	-	Locking Compression Plate
MILD	-	Mild Pain
MOI	-	Mode of Injury
PHILOS	-	Proximal humerus internal locking
	-	Osteosynthesis system
POP	-	Plaster of Paris
PR	-	Pain at Rest
PUA	-	Pain with Unusual Activity
RTA	-	Road Traffic Accident
TBW	-	Tension Band Wiring

FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PROXIMAL HUMERAL FRACTURES TREATED WITH LOCKING COMPRESSION PLATES (PHILOS PLATES)

ABSTRACT

INTRODUCTION

Fractures of proximal humerus account for about 4 to 5% of all fractures. It is the third most common fracture after hip fracture and colles fracture in elderly patients. As the technology has advanced, the elderly people no longer need to be denied effective surgical treatment.

AIM OF THE STUDY

In this study we have analysed 20 cases of proximal humeral fractures treated surgically using (PHILOS) proximal humerus locking compression plates admitted at Department of Orthopaedics and Traumatology, Government Kilpauk Medical College And Hospital, Chennai from April 2013 to November 2013.

The aim of the study was to analyze the functional and radiological outcome and to assess the complications of proximal humeral fractures treated using locking compression plates.

MATERIAL AND METHODS:

Patients with proximal humerus fractures, who are skeletally mature and age more than 18 years satisfying Neer s criteria for operative displacement i.e. displacement of >1 cm between the major fracture fragments or angulation of the articular surface of >45 degrees and Neer s two,three and four part fractures were included in the study.

Patients with open fractures, pathological fractures, with associated neurovascular injury and associated head injury were not included. 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. CT Scan and 3D CT were taken if needed.

Radiological evaluation of the fractures was done and were classified according to

Neer's four part classification system. 12 patients (60%) had two part fractures, 7 (35%) had 3 part fractures and 1(5%) had four part fractures. Fracture dislocations were present in 2 patients.
The patients were operated by the standard anterior deltopectoral approach or deltoid splitting approach using proximal humerus locking plates.

All the patients were reviewed at two weeks interval, for first three months and later every month. During follow up, patients were clinically evaluated for pain and function. The minimum follow-up period was four months and maximum follow up period was 8 months. Radiological evaluation of fracture union was observed by serial x rays.

RESULTS AND OBSERVATION

Majority of injured patients were females (60%) and the highest number of patients were in their 5th decade (35%). Free fall at ground level was the most common mode of injury (50%) but one patient had post-epileptic fall causing the fracture. No case with bilateral fractures was reported. Neer's 2 part fracture is the most common type in 60% patients. Greater Tuberosity fractures were the predominant type in 2 part fracture. 4 part fractures accounted for only 5% of patients. Fracture dislocation were present in 2(10%) of patients. The average range of active elevation was 126.25 degrees. The average range of active external rotation 47 degrees. The average range of abduction 123.25 degrees. 17(85%) of patients had normal muscle strength in shoulder. Early complications like wound gaping, skin necrosis and deltoid atony were encountered. Late complications like malunion of greater tuberosity and joint stiffness were encountered.

Constant and Murley's score was used to assess the functional outcome of our patients. The average constant score in our study with 20 patients was 82.4.

CONCLUSION

Finally we concluded that displaced proximal humeral fractures when treated surgically produce greater range of movements (ROM), less pain and less stiffness. Functional outcome is better with isolated fractures than with fracture dislocations. Functional outcome of 2 part fractures is better than 3 part and 4 part fractures. Radiological outcome assessed by means of quality of reduction and union of fracture in two and three part fractures is better than in four part fractures.

KEYWORDS

Proximal humeral fractures, PHILOS plates, Neer's classification, Constant score.

INTRODUCTION

Proximal humeral fractures account for about 4 to 5% of all fractures[1,2,3,4,5,6]. It accounts for up to 45% of all humeral fractures[7]. It is the third most common fracture after hip fracture and colles fracture in elderly patients[8]. It is important to recognize these fractures early. Numerous authors have suggested that non operative treatment[9,10,11] can be acceptable for two, three and four part fractures of proximal humerus in elderly patients but pain, stiffness, loss of function and muscle power have been described in more percentage of patients following this conservative approach.

Fractures of Proximal Humerus have gained more attention recently. Diagnosis has been facilitated with adaptation of 3-right angled trauma series X-rays [2,12,13,14] supplemented with CT or MRI. With more standard use of Neer's 4-part Classification system for fracture and fracture dislocation, a protocol for management and comparison of long term outcome of similar injuries has been made possible[15, 16, 17].

Emphasis is placed on complete and accurate diagnosis and formulation of safe and simple standard techniques for fracture realignment, restoration of anatomic stability, fracture healing, cuff integrity, regaining movement and function.

There have been improvements in fixation techniques and in the understanding of the role of prosthetic replacement[19,20,21,22] to maximise anatomic restoration and minimising immobilisation time, during which period stiffness develops.

The elderly people no longer need to be denied effective surgical treatment, especially at a time in life, when the shoulders are often needed for ambulation with canes and crutches. Maintenance of good shoulder function will surely make a good difference to their independent life style.

In this study we have analysed the functional and radiological outcome of twenty (20) cases of proximal humeral fractures treated surgically using PHILOS plates. (proximal humerus internal locking osteosynthesis system)

AIM OF THE STUDY

1. To analyze the functional and radiological outcome of twenty patients with proximal humeral fractures treated using locking compression plates (PHILOS PLATES).
2. To assess the complications of proximal humeral fractures treated using locking compression plates (PHILOS PLATES)

REVIEW OF LITERATURE

Historical Review

Fractures of proximal humerus was first documented by Hippocrates[7] in 460 BC. He also described a method of weight traction that aided bone healing.

However, till the end of 19th century, knowledge about this fracture was less.

Kocher introduced an anatomic classification of proximal humerus fractures in 1896 in an attempt to improve the diagnosis and treatment but this was not descriptive enough and it lacks consistency.

In 1893 Pean described the first prosthetic arthroplasty of the shoulder joint. He replaced the proximal part of the humerus in a young man who had TB involving the Glenohumeral joint with a platinum and rubber prosthesis.

During the early 20th century, various methods of closed reduction, traction and abduction splints were developed to achieve and maintain alignment of these fractures with inconsistent results.

In 1932, Roberts reported that the use of conservative treatment and prolonged immobilization was less satisfactory than treatment with simpler

forms of fixation and early motion. During the same period open reduction and definitive fixation of severely displaced fractures and with dislocations gained importance in an effort to gain better anatomical alignment and functional restoration.

The first systematic approach of surgical fixation for proximal humerus fractures was described by Lane and Lambotte. Subsequently, other surgeons described many methods of surgical repair and fixation of proximal humeral fractures including percutaneous pins, blade plates, intramedullary nails , plate and screws and tension band fixation.

Codman during the year 1934 divided the fracture into four parts namely, Head, Greater Tuberosity, Lesser Tuberosity and Shaft along epiphyseal lines. This became the basis of Neer's classification of fractures of proximal humerus.

During the year 1949, Widen first reported on Intramedullary Nailing of transcervical fractures of proximal humerus and credited Palmer with the development of the technique.

In 1950, Rush described his methods of intramedullary nailing which later became popular as rush pins.

In the early 1950s, use of humeral head prosthesis was first described for fractures of proximal humerus. The original Charles Neer I prosthesis was designed in 1951.

In 1955, Neer reported good results with the use of metal humeral head prosthesis in 27 patients with dislocation[22,23]

In 1970, Charles Neer of Newyork proposed his classic 4 part classification based on Codman's 4 parts.

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

In 1972, Bichel designed a Total Shoulder Prosthesis of the ball and socket type[24]. In the same year, the Stanmore Total Shoulder Replacement, also a Ball and Socket design was developed for patients with Rheumatoid Arthritis[24].

In 1973, the original Neer I prosthesis was revised by Neer, as Neer II prosthesis, to improve the results.

Newer prosthesis like Grammont reverse shoulder prosthesis has been designed for even better function.

Percutaneous pinning and minimal fixation have now become the order of the day with principles of biological fixation.

Recently, a new concept has evolved in treating osteoporotic fratures. Fixed angle stable locking plates have been developed which lock screws to the plate and hence forms fixed angle construct.

Controversies still exist whether to do conservative or operative management. The recent trend is to surgically treat the patients with locking compression plates. Various studies have been done on this.

A total of 72 patients were studied retrospectively by Jan –Magnus Bjorkenheim. The patients were followed for a period of 12 months. All of them had fracture of the proximal humerus treated surgically with locking compression plate between February 2002 to January 2003. Constant Score was used and it was inferred that the final functional outcome was better even in geriatric patients. 2 patients had non union and 3 patients developed humeral head avascular necrosis. Two patients had failure of implants. The final interpretation was made that the PHILOS method was safe and can be advised for the treatment of these fractures in patients with reduced mineral density of bone[25].

C.P.Charalambous et al in 2007 analysed a total of 25 cases of fractures of Proximal humerus treated with Locking Compression Plates. 20 patients were found to have fracture union with an average neck shaft angle

of 127.2^{0}. Five cases needed revision surgery for failure to unite or failure of implant. Author concluded that Locking Compression Plate is effective for

giving fracture stabilization but knowledge of potential hardware complication is essential[26].

Kenmal A. Egol[27] (2008) conducted a retrospective analysis of 51 patients with fracture of proximal humerus managed with Locking Compression Plates between February 2003 and January 2006 with a minimum follow up of 6 months. Out of this, 12 patients (24%) developed complications with a success rate of 76%.

MA Fazal, FS Haddad (2009) conducted a prospective study of 27 individuals with displaced proximal humerus fractures managed with PHILOS plate fixation. All fractures were united except for one patient who developed a complication of screw penetration with subsequent failure to unite and avascular necrosis. The study concluded that fixation with PHILOS plate provided stable fixation, less hardware problem and helped to attain early range of motion[28].

AA Martinez (2009), conducted a retrospective study of 58 patients (31 males & 27 females) in the age group 36 to 73 (average 61) years with fractures of proximal humerus treated with PHILOS plates with a follow up of 1 to 1 1/2 years. All patients had satisfactorily healing of fractures. One

patient with a valgus 4 part fracture had malunion. Outcome was extremely good in 13 patients, good in 36 patients, moderate in 8 and poor in one. Average Constant Murley score was 80. The study concluded that PHILOS plate fixation was an appropriate treatment for Proximal humerus fractures[29].

Agarwal et al, 2010 conducted a prospective study of 56 cases having an acute fracture of proximal humerus treated with locking plate osteosynthesis with follow up for 2 years. 47 patients were evaluated by Constant Murley score. Final outcomes were excellent in 17% of patients, good in 38.5% of patients, moderate in 34% of patients and poor in 10.5% of patients. Constant Murley score was poorer for AO, OTA type 3 fractures. The study concluded that Locking plate osteosynthesis produced good functional outcome. Results were better than nonlocking plates in osteoporotic fractures of the geriatric age group[30].

Rose et al (2007) evaluated the use of PHILOS plates in 16 patients aged around 51 years. The study group consisted of 5 two part, 9 three part and 2 four part fractures. Out of the fractures that healed, good functional outcome was made out (average elevation 132 degrees, average external rotation 43 degrees) within an average follow up of one year[31].

In 2008, Andrew H.Crenshaw Jr, Edward A. Perez in their study concluded that in young patients, internal fixation with PHILOS plates are

successful if damage to humeral head blood supply is avoided by keeping soft tissue stripping to a minimum. In young, active patients with four part proximal humeral fractures, fixation with Locking Compression Plates is the management of choice[32].

ANATOMY OF THE SHOULDER JOINT

Developmental Anatomy

The ossification of humerus is from 1 primary centre and 7 secondary centres. The primary centre appears in the middle of the diaphysis during the eighth week of development[33]. The proximal humeral epiphysis is spherical in shape in infants.

The upper part ossifies from three secondary centres, one centre for the head (first year), one centre for the greater tubercle (second year), and one centre for the lesser tubercle (fifth year).These three fuse and form epiphysis during the 6 th year and this epiphysis in turn fuses with the diaphysis during the 20th year[34]. The epiphyseal line encircles bone in the level of the lowest margin of the head. This is the growing end of the bone (remember that the nutrient foramen is always directed away from end which grows).

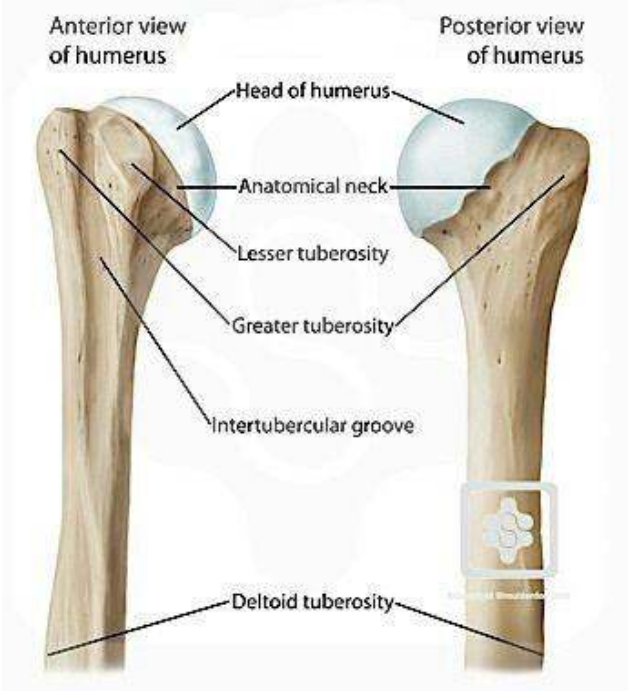
The lower part ossifies from four centres forming two epiphyses. The centres are as follows: one for capitulum and lateral flange of the trochlea (first year), one for medial flange of the trochlea (9th year), and one for lateral epicondyle (12th year). Three fuse during the 14th year forming an epiphysis, which fuses with the diaphysis around 16 years. The centre for

medial epicondyle appears at four to six years forming a separate epiphysis,and fuses with the diaphysis during the 20th year[35].

Relevant Anatomy

Understanding the anatomy of shoulder joint is very important because function of humeral joint depends on correct alignment and interaction of its anatomical structures.

Humerus is the longest and largest bone in the upper limb[35]. It has an expanded upper (proximal) end called "PROXIMAL HUMERUS", a shaft and a lower (distal) end.



The Proximal Humerus (Upper End) consists of the following

- ❖ Humeral head
- ❖ Greater Tuberosity
- ❖ Lesser Tuberosity
- ❖ Bicipital Groove (Intertubercular Sulcus)
- ❖ Proximal Humerus shaft

Head

The head is larger in size than the glenoid cavity and it forms about one third of a sphere. The head which is directed medially, backwards and upwards, articulates with the glenoid cavity of the scapula and forms the shoulder joint. Its articular surface is covered by hyaline cartilage.

Greater Tuberosity

It is a projection which is most lateral on the proximal end of humerus. Its posterior part has three impressions; upper, middle and lower into which muscles like supraspinatus, infraspinatus and teres minor are inserted correspondingly. It is covered by deltoid producing the rounded contourness of the shoulder.

Lesser Tuberosity

It is a projection on the anterior part of the upper end and the multipennate subscapularis muscle gets inserted into it.

Inter Tubercular Sulcus

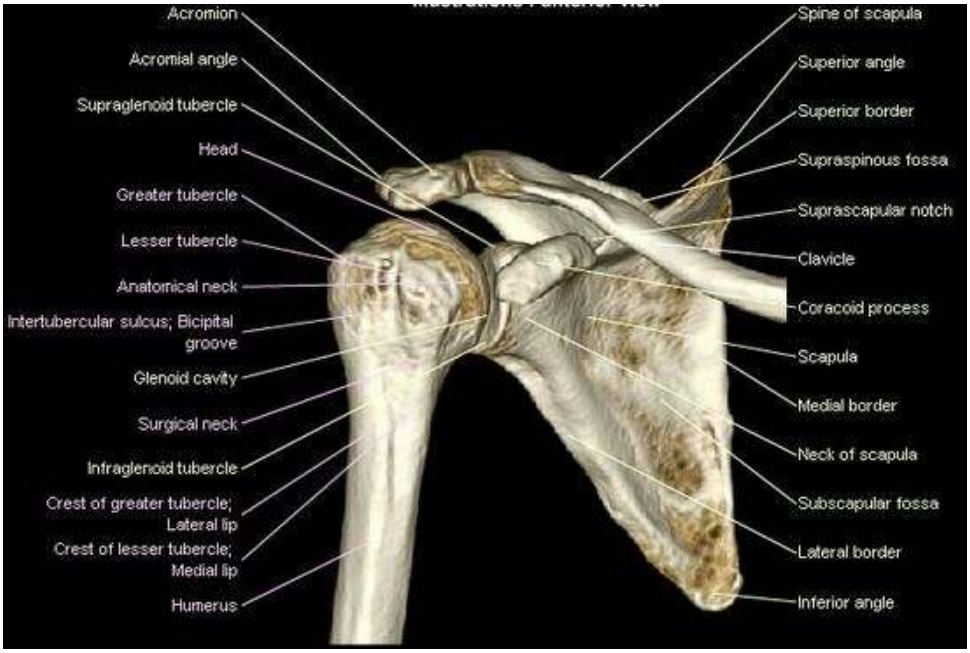
It is also known as bicipital groove. It separates lesser tubercle from the medial side from the anterior part of the greater tuberosity. The sulcus has medial and lateral lips that represent downwardly prolongated parts of the lesser and greater tuberosities. The pectoralis major is inserted into the lateral lip of the intertubercular sulcus. The insertion is bilaminar. The lattissimus dorsi is inserted into the floor of the intertubercular sulcus. The teres major is inserted into the medial lip of the intertubercular sulcus[33,35].The contents of the intertubercular sulcus are; the tendon of the long head of the biceps and its synovial sheath and the ascending branch of the anterior circumflex humeral artery. The tendon of long head of biceps is covered by transverse humeral ligament.

Anatomical Neck

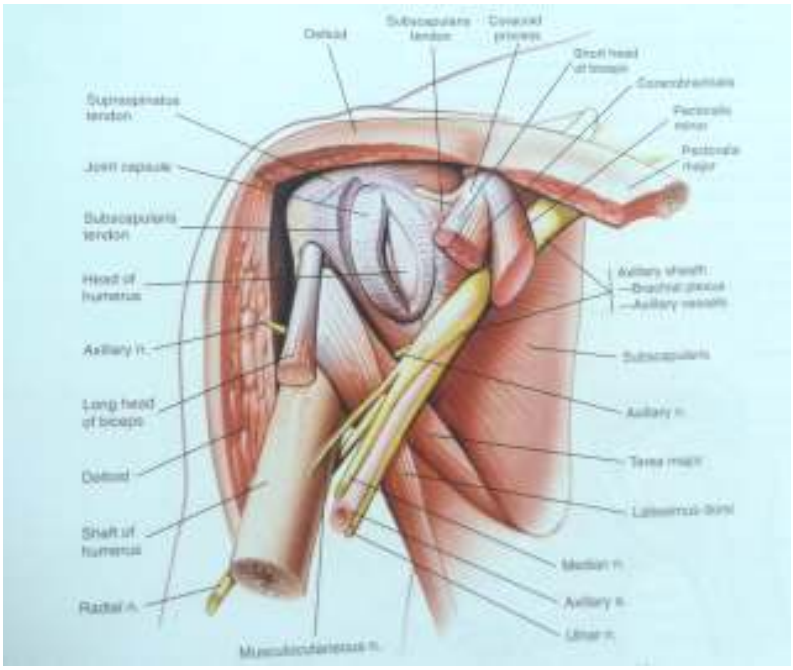
The line delineating the head from the other part of the upper end is known as the anatomical neck. It is a slight constriction, adjoining the articular surface, formed at the meeting point of head and tuberosities. The boundaries are variable without a distinct line.

Surgical Neck

The narrow line which separates the upper end of the humerus from the shaft is known as the surgical neck. It lies below the greater and lesser tubercles.



ANTERIOR VIEW OF THE SHOULDER



ANTOMY OF THE ANTERIOR PORTION OF THE SHOULDER

Glenoid

The Glenoid is a shallow, convex structure which is like an inverted "comma", approximately one third to one fourth of the surface area of the humeral head[36]. It articulates with the head of humerus and the glenoidal labrum and capsule gets attached to it.

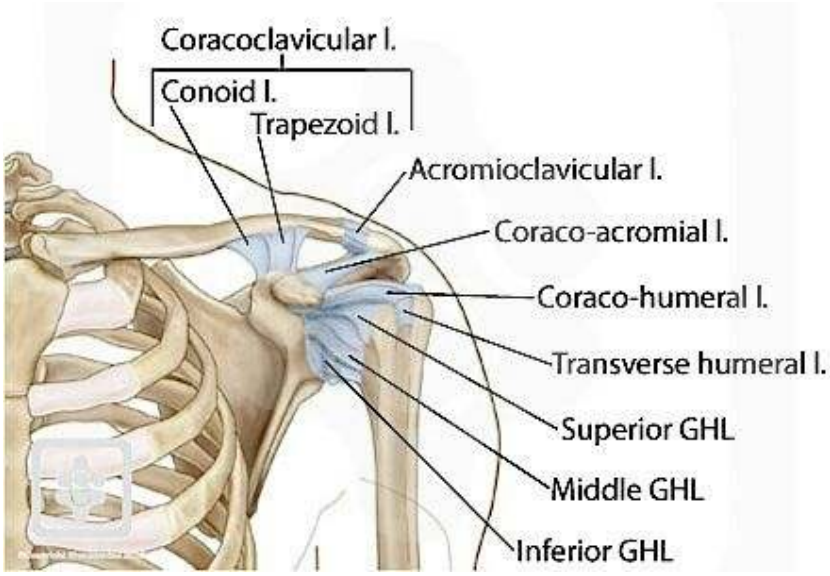
Glenohumeral Joint

The shoulder joint is a synovial joint of the ball and socket variety[37]. The joint is formed by articulation of the scapula and the head of the humerus.Therefore, it is also known as glenohumeral articulation.This joint has the greatest range of motion than any other joint in the body.

It is a weak joint structurally because of the small and shallow glenoid cavity which holds the humeral head in place. The humeral head size is four times larger than the size of the glenoid cavity. However this arrangement allows greater range of motion.

The following factors maintains the stability of the joint;

1. The coracoacromial arch or secondary socket for the humeral head.
2. The rotator cuff of the shoulder. (musculotendinous cuff)
3. The glenoidal labrum, helps in deepening the glenoid fossa. Additional stability is also provided by the long head of biceps, long head of triceps, pectoral girdle muscles and atmospheric pressure.



Stabilisers of the Shoulder Joint

The static stabilisers[42] of the shoulder joint are

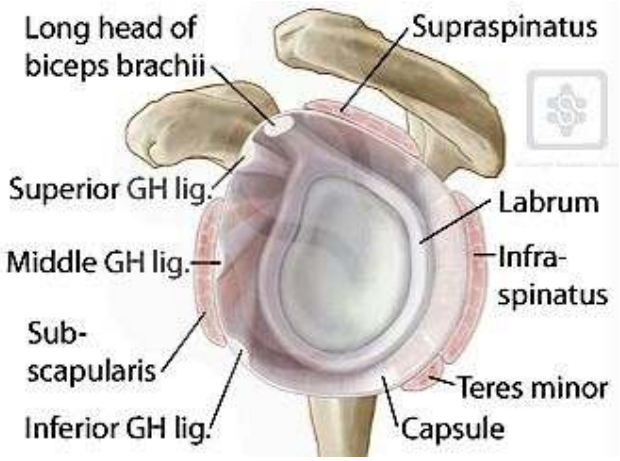
a. Fibrous capsule

b. Glenohumeral ligament

c. Coracohumeral ligament

d. Transverse humeral ligament

e. Glenoidal labrum



Stabilisers of the Shoulder Joint

The dynamic stabilizers of the shoulder joint are the musculotendinous cuff of the shoulder or rotator cuff,deltoid,trapezius,serratus anterior,lattissimus dorsi,rhomboids and levator scapulae

The 3 main factors that maintain the dynamic stability of fully developed shoulder joint[41]

1. Normal retrotilt of glenoid articular surface in relation to the axis of the scapula.
2. Optimum retrotorsion[38,39] of the head of the humerus in relation to shaft.
3. Balanced power of the horizontal steerers.

Rotator Cuff or Musculotendinous Cuff

This is a fibrous sheath formed by the four flattened tendons which blend with the shoulder joint capsule and strengthen it. The muscles which form the rotator cuff arise from the scapula and are inserted into the lesser and greater tubercles of the humerus. It is formed by Supraspinatus, Infraspinatus, Teres minor, and Subscapularis.

The rotator cuff muscles act to stabilise the head, which provide a fulcrum for abduction.

Surgical Anatomy

As the muscles of rotator cuff are attached to the tuberosities, it is vital to know the direction of pull of their fibers, because this facilitates an understanding of displacement of the fractured tuberosity fragments.

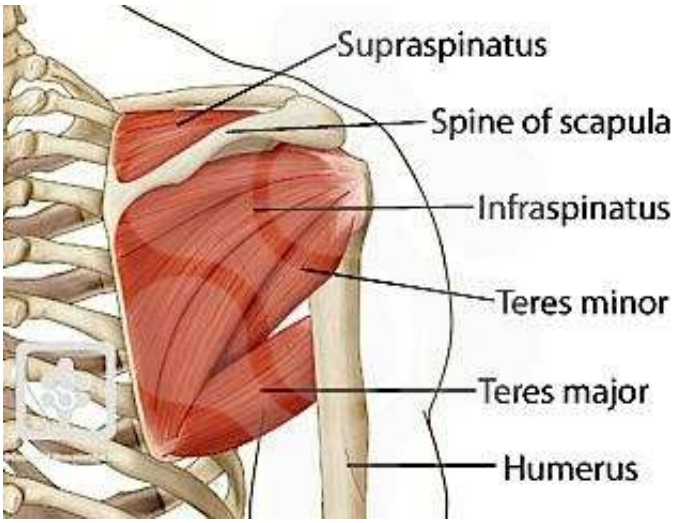
In fractures of greater tuberosity, the fragment will be pulled superiorly and posteriorly because of supraspinatus, infraspinatus and teres minor insertion. Reduction can be achieved by slight abduction and a tension band fixation neutralises initial displacement forces.

In fractures of lesser tuberosity, the fragment will be pulled anteriorly and medially by the subscapularis muscle. Horizontal fixation best neutralises these fractures.

During closed reductions the long head of biceps acts as a tether and blocks reduction. Also during surgical procedures, it is a crucial landmark from which rotator interval is identified, so that fracture fragments are properly identified and muscles of rotator cuff are preserved. Also adequate tension in long head of biceps is used to assess alignment in prosthetic replacement.

The deltoid inserting into the deltoid tuberosity can cause displacement of fracture of shaft at the surgical neck of humerus.

The pectoralis major inserting into the lip of inter tubercular sulcus (bicipital groove) can displace the proximal humeral fracture medially, as usually seen in surgical neck fractures.



Posterior view of right Shoulder

The axillary artery and brachial plexus brachial plexus are just medial to coracoid process and precaution should always be taken to avoid injury when osteotomising coracoid for better exposure. It is always wise to remember that the lateral side is the best side and the medial side is not safe when osteotomising coracoid.

Axillary nerve leaves the posterior wall of axilla by penetrating the quadrangular space. Then it winds around the humerus and enters the deltoid muscle posteriorly about seven cm from the tip of acromion process. Hence care should be taken during dissection of deltoid.

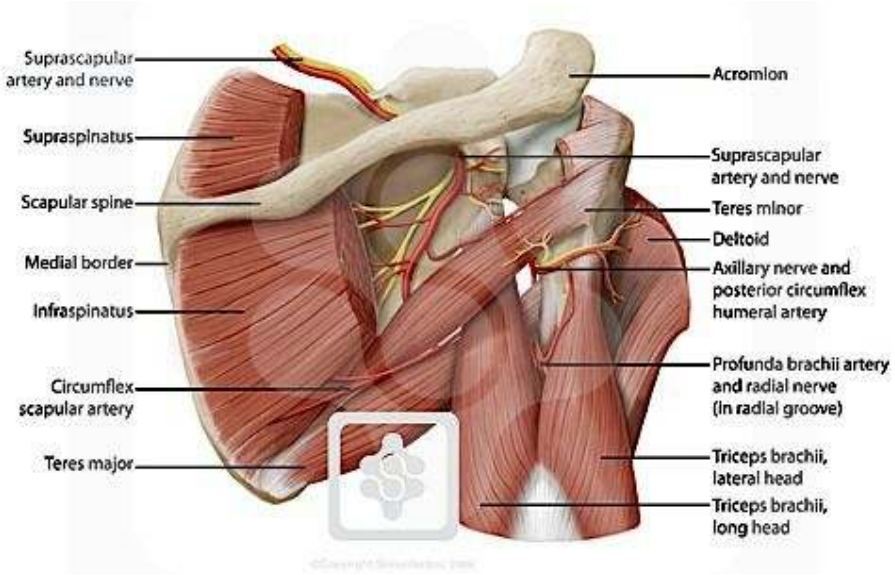
Blood Supply

1. Anterior circumflex humeral vessels
2. Posterior circumflex humeral vessels
3. Suprascapular vessels
4. Subscapular vessels

The major blood supply to the humeral head is from anterior circumflex humeral artery, a branch of third division of axillary artery. Laing was the first to describe the arcuate artery[42,43] which is a continuation of ascending branch of anterior circumflex humeral artery. This supplies blood to a large portion of head of the humerus. It enters the bone in the area of intertubercular sulcus.

Contribution also comes from the branches of posterior circumflex humeral artery entering the posteromedial aspect of the proximal humerus, metaphyseal vessels and vessels of the greater and lesser tuberosities[44] and small vessels entering through the rotator cuff insertion.

When the anterior circumflex humeral artery is injured close to its entrance to humeral head, it is more likely that the blood supply to the head will be compromised resulting in avascular necrosis of head of humerus[45].



Neuro Vascular Anatomy of Shoulder Joint

Nerve Supply

1. Axillary nerve
2. Musculocutaneous nerve
3. Suprascapular nerve

The shoulder joint is richly supplied by branches from the axillary, musculocutaneous and suprascapular nerves following the Hiltons law[46].

BIOMECHANICS

The glenohumeral joint is the least stable but has the greatest range of mobility than any other joint in the body.

It is a load bearing joint with significant forces acting across glenohumeral articulation. When the arm is held in 90° of abduction, the joint reaction force equals 90% of body weight[2,47].

The shoulder joint is exactly not located in the sagittal or coronal plane of the body. Its axis of motion begins on the curved chest wall, 35^0 to 45^0 away from the saggital plane of the body.

The humeral head is retroverted 30° to 40° to articulate with the scapula and the average adult humeral head has a radius of curvature of 44mm[2,,38,39]. At any particular time, only 25% to 30% of humeral head articulates with the glenoid cavity. The presence of glenoidal labrum increases the area of contact.

The intact humeral head is the fulcrum through which the rotator cuff and the long head of biceps act. The resulting force coupled with the action of deltoid muscle provides elevation of the arm while fixing the head within the glenoid cavity. When the humeral head that acts as a fulcrum is

damaged or destroyed by fracture, dislocation, avascular necrosis or surgical resection rotator and elevator movements of the shoulder joint are lost.

Avulsion of greater tuberosity is pathognomic of concomitant rotator cuff tear[2]. This will destabilize the shoulder and allows superior subluxation to occur with attempted elevation. There is also loss of lever arm and loss of active power. Also this will lead to subacromial impingement with loss of normal gliding motion of shoulder[36].

Thus pain, poor motion, loss of strength and endurance can result after Proximal humeral fracture if proper anatomy is not restored.

CLASSIFICATION

A system for the classification of Fractures occupy a central role in the practice of Orthopeadic surgery. The classification must be comprehensive enough to encompass all the factors, yet specific enough to allow accurate diagnosis and ideal management. It must be flexible enough to accommodate variations and allow logical deductions for treatment. It should also be both reliable and reproducible.

Kocher's Classification

This was devised in 1896 based on the different anatomic levels of the fracture namely,

a. Anatomic neck.
b. Epiphyseal region.
c. Surgical neck.

Limitations

- It does not account for multiple fractures that occurs at various sites.
- It does not differentiate between displaced and undisplaced fractures.

Watson-Jones Classification

This classification is based on the mechanism of injury and it is divided into three types namely,

a. Abduction type
b. Adduction type
c. Contusion Crack Fractures

Limitations

Depending on whether X-rays are taken in internal rotation or external rotation, fracture can become either an abduction or adduction fracture and hence not very reliable.

Codman

In 1934 Codman made a vital contribution to the understanding of proximal humeral fractures by proposing that proximal humerus fractures can be separated into four distinct fragments occurring roughly along the anatomic lines of epiphyseal union. These are as follows:

a. Anatomic head
b. Greater tuberosity
c. Lesser tuberosity
d. Shaft

This formed the basis of future NEER'S classification.

Limitations

It does not describe about biomechanical forces causing displacement or plan for treatment.

Neer's Four Part Classification

In 1970 Charles Neer of New York proposed the first truly comprehensive system that considered the anatomy and biomechanical forces and related it to diagnosis and treatment. It is based on Codman's four parts. When any of the four major fragments is displaced >1cm or angulated more than 45° then the fracture is considered displaced. It is classified as

a) Undisplaced fracture
b) 2 part fracture
c) 3 part fracture
d) 4 part fracture

Neer's Fracture Dislocation

A fracture dislocation exists, when the head is dislocated outside the joint space, not simply rotated and there is, in addition, a fracture.

It is classified according to the direction of dislocation as

a) Anterior Dislocation
b) Posterior Dislocation

Based on number of fracture fragments as

a) 2 part Fracture Dislocation

b) 3 part Fracture Dislocation

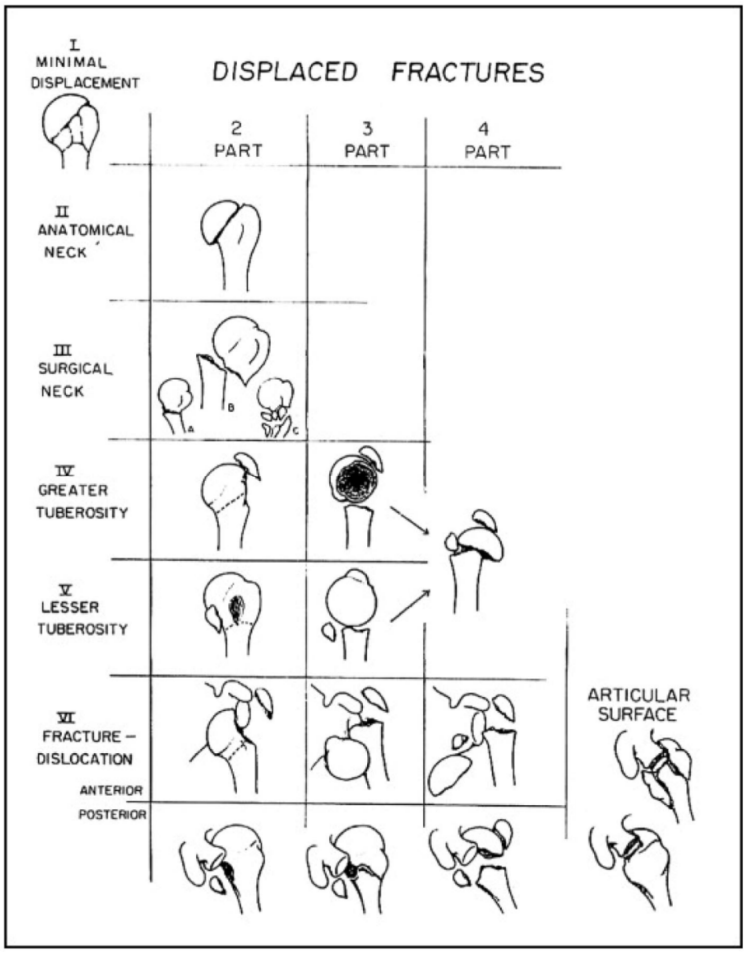
c) 4 part Fracture Dislocation

Or as special fractures as

a) Head splitting fractures

b) Impression Fracture

c) Valgus impacted fracture



<u>Neer Classification Of Proximal Humeral Fractures</u>:

AO Classification

Jacob & Colleagues and AO-ASIF group have applied AO System to Proximal Humeral fractures. This system is divided into 3 types according to increasing severity of injury.

Type A

Extra articular

Involves two of the 4 fragments

No vascular isolation of articular segment

No avascular necrosis

Least severe.

Type B

Partial intraarticular

Involves three of four fragments

Low risk of avascular necrosis

Partial vascular isolation of head More severe

Type C

Intraarticular

Involves all four fragments

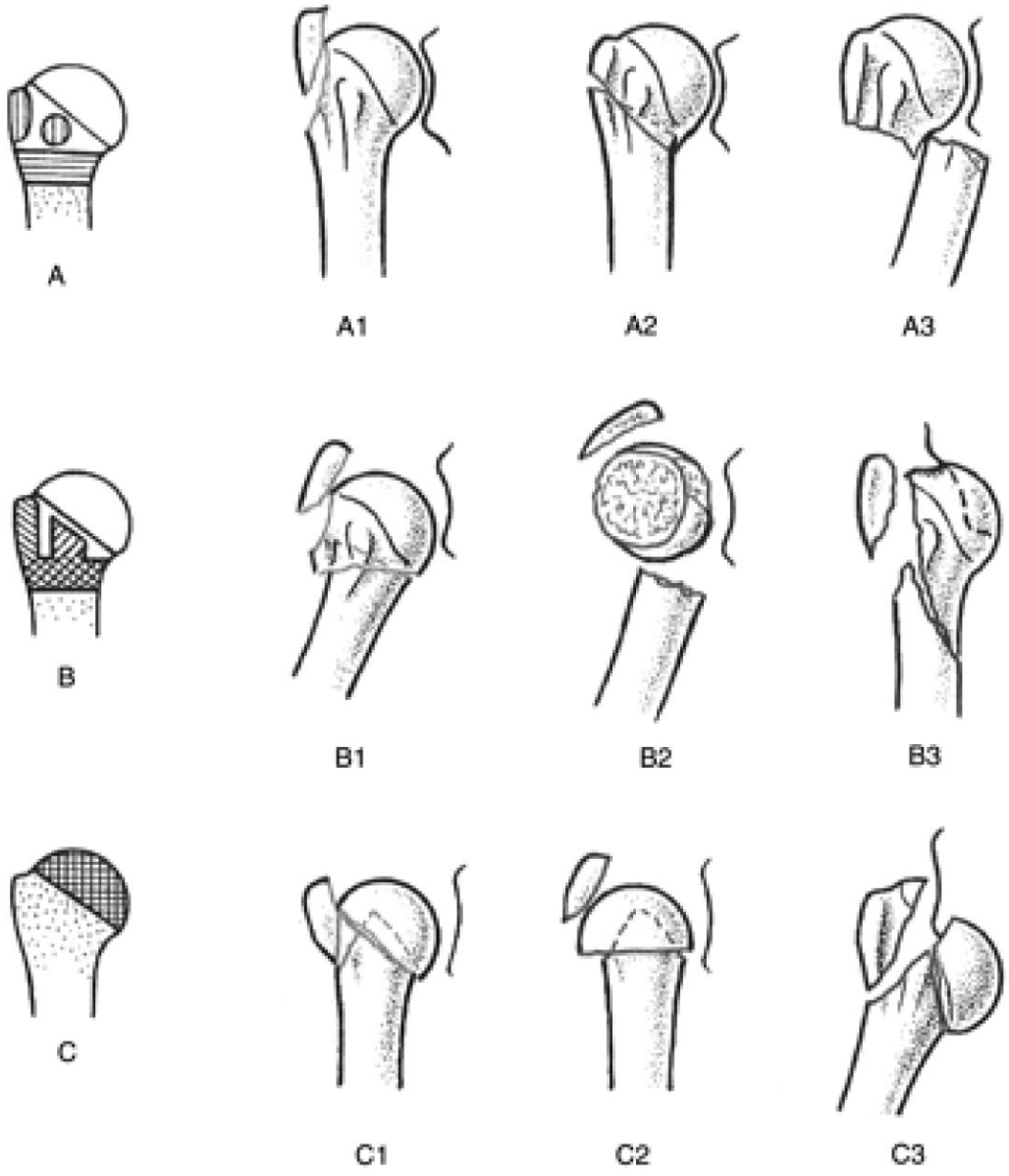
Complete vascular isolation of articular segment

More risk of avascular necrosis

More severe

In addition each alphabetical injury is subdivided numerically with higher numbers indicating greater severity.

AO classification of proximal humeral fractures



Of all, the Neer's classification has stood the test of time and still the most commonly followed the world over. It has important implication for both treatment options and outcomes [48,49,50,51].

We also have followed the Neer's classification in our study.

MECHANISM OF INJURY

Fractures of the proximal humerus have a bimodal age distribution. Fractures in adolescents and younger adults are usually produced by high energy injuries, mainly from road traffic accidents (RTA), sports injuries, falls from height or gun shot wounds. In these patients it is often associated with significant soft tissue injury and poly trauma. However these are much less common than fractures in the elderly, which are usually low energy osteoporotic injuries. More than three quarters follow low energy domestic falls and the risk of fracture is increased in sedentary people with low bone mineral density (BMD), a family history of osteoporotic fractures, frequent falls and evidence of impaired balance[52,53].

Middle aged patients who sustain low energy fractures frequently have a predisposing medical comorbidity or are physiologically older through the effects of alcohol, drug or tobacco overuse. Any other condition that produces osteoporosis at an earlier age will also increase the risk of fractures; in females, an early menopause is probably the most common of this.

During impact on the shoulder, the head of the humerus is thought to fracture on the hard packed bone of the glenoid, which acts as an anvil. The interaction of this external force with the forces generated by the intrinsic

shoulder musculature, and the quality of the proximal humeral bone stock, determines the initial fracture configuration and any ensuing displacement. Elderly patients, with advanced osteoporosis or with medical comorbidities, are more likely to have displaced fractures.

A proximal humeral fracture may occur from direct impact to the shoulder or indirectly by transmission of forces from a fall on to the outstretched arm. Depleted protective neuromuscular responses, because of a delayed reaction time, cognitive impairment, neuromuscular disorders, impaired balance, or acute intoxication, raise the risk of a fall directly on to the shoulder[54,55].

The non dominant arm is also affected in up to three quarters of cases, suggesting an association with reduced strength of neuromuscular coordination. Diminished protective responses are an indirect measure of poor physiologic status, and this may explain why patients who sustain proximal humeral fractures from direct impact on the shoulder tend to be frailer than those who sustain wrist fractures, where the arm is outstretched to break the fall.

A fracture that occurs after little or no trauma may be pathologic from metastatic tumour deposits, or rarely caused by a primary bone tumour or infection. In contrast, persistence of shoulder pain after a significant injury may be caused by an occult fracture (typically of the greater tuberosity),or a rotator cuff injury. This may be detectable using ultrasound or magnetic resonance imaging (MRI).

Another mechanism of injury described by Codman, is increased rotation of the arm particularly in the abducted position when a fracture occurs. Moreover the humerus locks against the acromion producing a pivotal position, facilitating a fracture.

Fractures of proximal humerus can result from a direct blow to the side of the shoulder. But the indirect mechanism is usually associated with greater degree of Fracture displacement than the direct mechanism[56].

An often ignored etiology for fracture dislocation of Proximal Humerus is electric shock or convulsive episode. They may have bilateral fracture dislocation.

CLINICO-RADIOLOGICAL EVALUATION

History

A detailed history should include patient's health, handedness, occupation and details of injury. A good understanding of patients general health (i.e. whether he or she has osteoporosis or metabolic disorder or seizures) is of critical importance as it will predict the outcome of surgical fixation.

Clinical Presentation

Most patients with proximal humeral fractures present acutely and hence the most common clinical features are pain, swelling and tenderness around the shoulder joint especially in the region of greater tuberosity.

Ecchymosis usually becomes visible within 24-48 hrs and may spread to chest wall, flanks and distally down the extremity.

Associated crepitus may be present with motion of the fracture fragments, if they are in contact.

A complete neurovascular evaluation is always necessary in all patients with proximal humerus fractures.

The most common nerve that is injured with these fractures is Axillary nerve and hence sensation over deltoid insertion must be checked for. Motor function is tested by asking the patient to attempt shoulder abduction against the examiner's hand while the deltoid muscle belly is palpated for contractions.

Imaging

Precise radiographs are critical in estabilising an accurate diagnosis in shoulder trauma. Most often injuries are missed with radiographs obtained in the plane of body rather than in the plane of scapula. To overcome this limitation, 3 view right angled trauma series was introduced. In addition CT scan, 3D CT Reconstruction, Arthrography, and MRI all allow the shoulder injuries to be more precisely defined.

Trauma Series

The 3 view Right angled Trauma Series was popularised by Charles Neer. Trauma series view still remains the best initial method of diagnosing fractures of Proximal Humerus as it allows assessment of fracture in three (3) separate perpendicular planes, so that accurate assessment of the fracture displacement can be obtained. It consists of the following:

a) AP VIEW IN THE PLANE OF SCAPULA

For scapular plane AP View, the posterior aspect of the injured shoulder is placed against X ray plate and the contralateral shoulder is rotated out approximately 40°. This allows visualisation of Glenohumeral joint space without any bony superimposition.

b) LATERAL VIEW IN THE PLANE OF SCAPULA

The lateral view in scapular plane is obtained by placing the anterior aspect of the injured shoulder against X ray plate and rotating the contralateral shoulder out approximately 40°. The X ray tube is then placed posteriorly along the spine of the scapula. Here scapula appears 'Y' shaped with the glenoid in the centre and the 2 upperlimbs of the 'Y' formed by acromion and coracoid with vertical limb formed by scapular body. This provides a true lateral view of the shoulder.

This view clearly demonstrates the displacement of the tuberosities and direction of dislocation.

c) AXILLARY VIEW

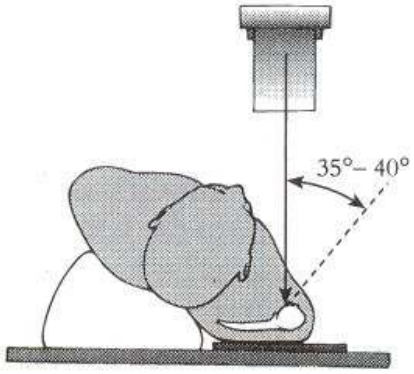
This allows for assessment of the shoulder in the axial plane and is vital for assessing the degree of tuberosity displacement, articular surface of the glenoid and relationship of humeral head to the glenoid.

Here the arm is held in mild abduction of 30° and the X ray plate is positioned above the patient's shoulder. The X ray beam goes inferior to superior.

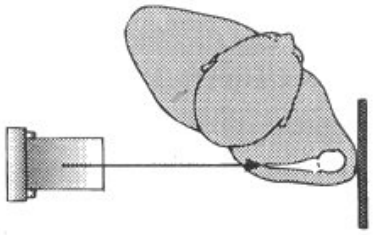
Another method is VELPEAU AXILLARY VIEW[57] where the arm is not removed from sling. The patient is seated and tilted obliquely backward 45°. The plate is placed on the table and X ray beam is shot from above.

The advantage of these views is that it can be taken without removing the sling from patient's arm. They can be done in either sitting, standing or prone position with minimal discomfort to the patient.

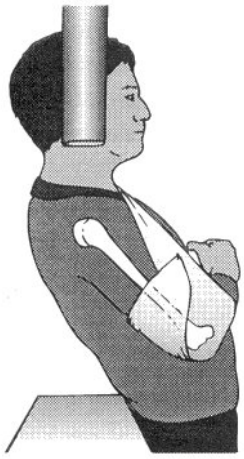
TRAUMA SERIES – RADIOGRAPH POSITIONS



Anteroposterior View in the Plane of Scapula



Lateral View in the Plane of Scapula



Velpeau Modified Axillary View

Special Views

Stripp axillary lateral[58] and the Trauma axillary lateral[59] view are described as special views.

Anterior glenoid rim fractures or ectopic calcification in many anteroinferior glenoid labral detachments with instability can be delineated with West Point Axillary View or alternatively, the Cuiollo Supine Axillary View with arm in external rotation.

The Bloom Obata Apical Oblique View[60] is specifically for defining whether there is a fracture dislocation or posterior dislocation.

Screening Views

There are 5 standard Radiographic projections[14] which are helpful in screening patients with shoulder complaints.The first three (3) views are Anteroposterior views in

1) Internal Rotation
2) External rotation
3) 100 degree Abduction.

The remaining 2 views are the Axillary and Bicipital Groove views. Single contrast Arthrography is invaluable in diagnosing full thickness tears of rotator cuff, adhesive capsulitis and lesions of the biceps. It is also useful

in determining deep surface incomplete cuff tears and occasionally anterior instability.

Tomograms

Tomograms can be useful in evaluating Proximal Humerus fracture for Nonunion or articular surface incongruity but this is largely replaced by CT scan.

CT Scan

CT scan is now the investigation of choice for evaluating Proximal Humerus fracture. It helps to find

a) Displacement of tuberosity fragments
b) Degree of articular involvement with head splitting fractures
c) Impression fracture
d) Glenoid rim fracture
e) Chronic fracture dislocation.

Reconstruction CT

Though not available in all centres, it is extremely valuable to get a 3D Reconstruction model of the fracture, which helps in planning treatment, especially in complex fracture patterns.

MRI

MRI is useful in showing relation of tuberosity fragments to rotator cuff tendons. It also helps in assessing associated rotator cuff injuries.

METHODS OF TREATMENT

The ultimate goal in the treatment of all fractures is making the patient return to usual daily activities as soon as and to as nearly as normal an extent as possible. Various modalities of treatment of Proximal Humerus Fractures have been advocated through the years creating a great deal of controversy and at times confusion. Sound judgement is required to determine the appropriate treatment for each fracture.

The various methods that are available are:

a) Closed Reduction
b) Initial Immobilization and early motion
c) Percutaneous pinning and external fixation
d) Plaster splint and cast
e) Skeletal traction
f) Open reduction and internal fixation
g) Prosthetic replacement

a. Closed Reduction

For years this has been a popular method of management for various types of Proximal Humerus Fractures. However, it is essential to distinguish between those fractures, which are suitable and those which are not.

Forcible and repeated attempts at closed reduction may complicate a fracture by causing further displacement, angulation, fragmentation or neurovascular injury.

Various types of reduction manouveres have been used with mixed results.

Watson and Jones described a classic technique of hyperabduction and traction to achieve a closed reduction.

Displaced lesser tuberosity fractures can be treated by closed reduction if it does not block internal rotation[61].

Three and four part fractures are unstable and difficult to treat by closed reduction. Recent literature has reported poor results with closed reduction, with more incidence of pain, malunion and avascular necrosis.

b. Initial Immobilisation and Early Motion

Initial immobilisation and early motion has been described with varying degrees of success for minimally displaced fractures. The shoulder joint has a large capsule, allowing a wide range of motion that can compensate for even moderate amounts of displacement. The arm is held by a sling at the side as in Velpeau position. Gentle range of motion exercises

are usually started by 7 to 10 days, when pain has reduced and patient is less apprehensive.

c. Plaster Splints & Casts

Older literature suggested that reduction in an abducted and flexed position was essential for proper alignment of the fractures and advocated shoulder spica casts and braces to maintain reduction, which were extremely cumbersome and uncomfortable for the patient.

The use of hanging arm cast for fracture of Proximal Fracture should be avoided, because of the tendency for distraction at the fracture site leading to non-union or mal-union.

d. Percutaneous Pins

Percutaneous pinning may be used after closed reduction if reductionis unstable. Jacob and co- workers have outlined the technique and reported satisfactory results in 35 of 40 cases.

Though this method of treatment is technically demanding it offers advantage of less soft tissue disruption and minimal fixation thus decreasingthe prevalence of avascular necrosis.

For unstable but reducible fractures of surgical neck, percutaneous pin stabilization remains a reasonable option.

e. Skeletal Traction

The use of traction is not commonly indicated but may be useful in the management of comminuted fractures.

The shoulder is flexed to 90° and elbow is also flexed to 90°. A threaded 'K' Wire or Steinmann pin is inserted in the ulna, and the forearm and wrist suspended in a sling. The goal is to try to hold the shaft fragments in a neutral position. When there is sufficient callus formation, the traction can be discontinued and the patient's arm placed in a sling or spica cast.

f. Open Reduction & Internal Fixation

Closed reduction and external fixation has been unable to correct deformity and maintain reduction sufficiently and hence open reduction and internal fixation has gained popularity[62]. Non-operative treatment of 3-part and 4-part complex fractures often results in malunion and shoulder stiffness. In younger or active elderly patients, surgical treatment should be considered. Otherwise the articular joint surface may compromise long term shoulder function to a larger extent[59]. The aim of internal fixation should be anatomical reduction and stable fixation allowing for early range of motion of the shoulder. The internal fixation of complex fractures of the Proximal

Humerus restores good shoulder function. The recent trend is towards limited dissection of the soft tissue around the fracture fragments and the use of minimal amount of hardware required for stable fixation.

Indications for ORIF

a) Displaced two part anatomic neck fractures in young adults.
b) Displaced two part surgical neck fractures with soft tissue interposition preventing closed reduction or if reduction is unstable.
c) Greater tuberosity fractures displaced more than 5 mm
d) Displaced isolated lesser tuberosity fracture especially if fragment is large and blocks internal rotation.
e) All displaced three part fractures
f) Displaced four part fractures
g) In 20% to 40% of head impression fracture

The choice of surgical approach is decided by the fracture pattern and includes an extended deltopectoral approach and superior deltoid-splitting approach[64].

In general,2-part, 3-part Fractures and 4-part Fracture in younger, active patients are treated with Open Reduction and Internal Fixation and 4-part Fracture in elderly, osteoporotic bone Hemiarthroplasty is

done[65]. Recently for 3 part & 4 part osteoporotic fractures, fixed angle stable locking plates are used with increasing results.

Implant Selection:

Two part anatomic neck fractures:

Two part anatomical neck fractures account for 0.8% of upper humeral fractures.

Fortunately anatomic neck fractures are rare. The prognosis for survival of head is poor, because it has been completely, deprived of its blood supply.

However several authors[49,66,67,68,69] recommend an attempt at open reduction and internal fixation with screws or locking compression plates if the patient is young and prosthetic replacement in older individuals.

Two part surgical neck fractures:

The surgical neck fractures are the most common type of the Proximal Humerus Fractures[3,5,6]. It occurs in all age groups. Displaced fractures can disrupt the function of the upper extremity. Displaced surgical neck fractures can be managed by various techniques; commonly used are percutanous pin fixation, antegrade and retrograde insertion of

intramedullay nails, combination of Ender's nail and suture techniques, plate and screw fixation and External fixation[4,69].

Two part greater tuberosity fracture:

Represents 3% of proximal humeral fractures. 15-30% anterior dislocations are associated with greater tuberosity fractures. Greater tuberosity fractures displaced greater than 5 mm require open reduction and internal fixation, because the posterior and superior displacement of the fragment will cause impingement beneath the acromion.

Screws, tension band wiring, suture materials, plates and screws, percutaneous pinning, have all been proposed. The rent in the rotator cuff that occurs with displaced greater tuberosity fracture must be repaired. Timing and proper treatment of these injuries is crucial as malunion and rotator cuff dysfunction may lead to pain, loss of motion and subsequent disability.

Two part lesser tuberosity fracture:

Displaced isolated lesser tuberosity fractures are rare but requires internal fixation with non-absorable sutures or wires or screw if the fragment is large and blocks internal rotation.

Some authors have described a method of removal of bone fragment and suturing of subscapularis tendon to the cortical edge of fracture site.

Avulsion fracture of the upper part of the Lesser Tuberosity appears to have been caused by hyperextension and hyperexternal rotation of the shoulder.

Three –part fracture:

Three part fractures represent 13% to 16% of all proximal humeral fractures. Open reduction and internal fixation is the treatment of choice for displaced three part fracture of Proximal Humerus. It is important to avoid extensive exposure and soft tissue dissection of fragments which may compromise blood supply. Intramedullary nails is usually not adequate to neutralise deforming forces. The AO buttress plate gives good results but may require extensive soft tissue stripping.

Hawkins and Co-workers[66] reported good results in 14 of 15 patients treated with "figure of 8" wire for three part fractures. In osteoporotic bones, wire or non-absorbable suture can be passed through rotator cuff as well as bone of tuberosity and then attached to shaft. This gives sufficient stability to begin early motion. Tension Band Wiring (TBW) is an accepted method of treatment for three (3) part fractures.

Locking compression plates improves torsional resistance in the stabilization of 3-part Proximal Humerus Fractures. It has good torsional fatigue resistance and stiffness than blade plate[3].

Four part fracture:

It is about 5% of all Proximal Humerus Fractures[4], and 19% incidence of humeral head necrosis occurs in these fractures[71].

Open reduction and internal fixation of four part fractures with pins, rods, plates and screws can be done but the results usually are not promising. These fractures usually occur in elderly people in whom osteoporosis[96] and poor bone quality preclude any stable internal fixation. Prosthetic replacement offers a distinct advantage in these fractures permitting early motion and return to work. The recent concept of Locking Compression Plate (LCP) in these patients is gaining momentum.

In general, surgical treatment of 2-part and 3-part Proximal Humeral Fractures is difficult and needs familarity with more than one method of fixation. Poor bone quality stock, comminution, and the deformity forces of the rotator cuff on the tuberosities influence the choice of operative approach and fixation techniques. Closed reduction and percutaneous pinning offer the potential advantage of less soft-tissue dissection; however, good bone quality and minimal comminution are prerequisites[64].

Locking Compression Plate:

Proximal Humeral Fractures in older patients with osteoporosis present challenges to conventional plates and screws resulting in early loosening and failure. To overcome this difficulty, fixed angle locking plate is being used. It is also used in complex 3 part and 4 part fratures. Fixed angle locking plate provides stable screw fixation construct within the head. Angular stability is provided between the plate and the locking head screws, allowing the implant to act as internal fixator. Load transfer between the fragments occur over the implant. It provides great resistance against bending and torsional forces than conventional plates[9,11]. Additional holes permit fixation of rotator cuff with greater tuberosity. The Locking Compression Plate (LCP) is placed on the lateral side of humerus, approximately 5 mm below the tip of greater tuberosity. Temporary fixation of plate with 1.8 Kirschner wires is done. The proximal locking screws were inserted into the humeral head before the distal screws were inserted into the humeral metaphysis or diaphysis. The screws alternatively converge and diverge gaining greater purchase and superior screw pullout strength. Standard AO cortical screws were used to fix the plate to the shaft. Instead cancellous screws were used in severely osteoporotic bone. In Koukakis et al[91] study average Constant shoulder score was 76.1%. Only one patient had avascular necrosis. There were no cases of impingement

syndrome[6]. Locking compression plate improve torsional resistance in the stabilisation of the 3 part fractures [7,8].

Prosthetic Replacement:

In the early 1950 s, the use of humeral head prosthesis was first reported for proximal humerus fracture. The original Neer's I prosthesis was designed in 1951. In 1953, Neer reported the first use of this prosthesis for complex fracture dislocation of Proximal Humerus. The original prosthesis was revised by Neer in 1973 [Neer II] to a more anatomic surface design.

Aim is to establish ideal humeral head version and proper myofascial sleeve tension within the rotator cuff and deltoid musculature[11]. The prosthesis has two head sizes 15 & 22 mm in thickness. The larger size gives better leverage and mechanical advantage for forward elevation but the smaller size may be required for coverage by the rotator cuff. There are three stem sizes 7, 9.5 and 12mm and two stem length 125 and 150mm. Longer stem length are available, if needed to bridge a shaft fracture[21]. Recently modular hemiarthroplasty has been used in management of complex fractures of Proximal Humerus. The modular humerus design offers greater flexibility in head sizes, perhaps allowing more precise tensioning of soft tissues.

Moreover the ability to disassemble the component allows easier access to the glenoid if revision to a total replacement is contemplated later[72,73,74,75].

A new shoulder prosthesis design for Proximal Humerus Fracture has been developed. The rim of the articular component of this prosthesis has multiple holes to which the bone-tendon junction of the rotator cuff is fixed, to allow an anatomic reconstruction of the glenohumeral unit.

Indications for prosthetic replacement[76]:

a) Displaced anatomic neck fracture in adults
b) Extensive head impression, splitting or crushing fractures.
c) Three part fractures that are tenuous and unstable after attempted open reduction.
d) Unstable four part fracture dislocation
e) In chronic cases of avascular necrosis, malunion or nonunion[98] with joint incongruity.
f) Neglected chronic dislocation[99].
g) Greater than 40% head impression fractures
h) Non union of surgical neck of humerus

Prosthetic replacement is a likelihood treatment in osteoporotic patients with 4 part fractures, fracture dislocation, split fractures with

more than 40% articular surface involvement, anatomic neck fracture, dislocation present for longer than 6 months. Early prosthetic replacement of has better functional outcome than late reconstructive prosthetic replacement[11].

In osteoporotic bone bulky, rigid and stiff implants are inadequate and may lead to more damage. Load sharing, not load bearing compound constructions are the aim. Obtaining adequate elastic buttressing is the key element in achieving the necessary load sharing[77].

The functional outcome is governed by the security of tuberosity-muscle cuff repair, adequate protection after surgery and long term physiotherapy.

Constrained Replacement

Patients who require arthroplasty but do not have a functional rotator cuff mechanism will be benefitted from the use of constrained replacement. If, in addition, the acromion fulcrum and loss of deltoid is present, then there is a greater reason for constrained replacement.

The optimal prosthetic reconstruction of the shoulder is dependent on prosthetic design, soft tissues, postoperative healing and rehabilitation, and the long term biologic response to the implant.

SURGICAL APPROACHES

There are many approaches used for treatment of fractures of Proximal Humerus. An approach which allows greatest visualization for performing a repair or fixation with the least disruption of soft tissues should be chosen for better functional recovery[78].

The various approaches are

A. Anterior deltopectoral approach

B. Deltoid approach

C. Superior approach

D. Posterior approach

Only the approaches that we have used in our study has been dealt below.

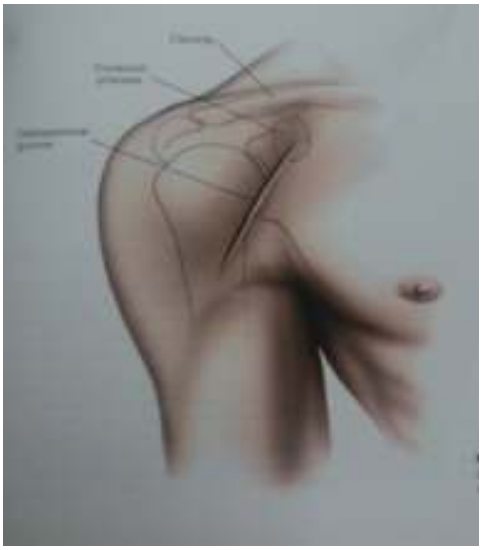
Position of the patient

Place the patient supine on the operating table. Place a sand bag between the spine and medial border of scapula to push the affected side forward while allowing the arm to fall backward thus opening up the front of the joint. Elevate the head of the table to 30° to 45° to reduce bleeding and to allow blood to drain away from the operative field.

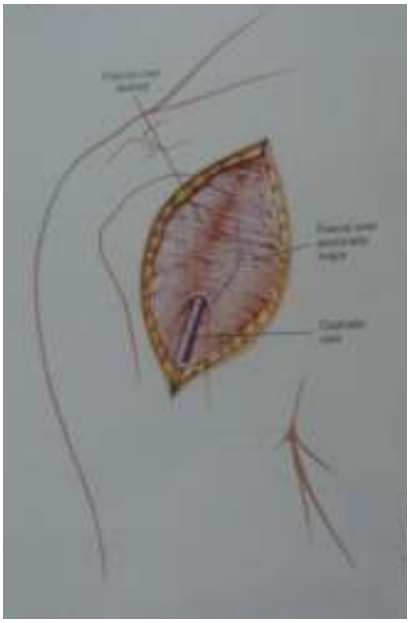
A. Anterior deltopectoral approach

A 15cm long incision is made from above the coracoid and carried distally in the line of deltopectoral groove to the deltoid insertion. The internervous plane lies between deltoid, which is supplied by axillary nerve and pectoralis major which is supplied by medial and lateral pectoral

nerves. The cephalic vein is preserved with retraction towards either the deltoid or pectoralis major.



Delto Pectoral Approach



Identifying Delto Pectoral Groove

1. Painting & Draping

2. Skin incision

3.Identifying Delto Pectoral Groove

Rarely it may be ligated. The clavipectoral fascia is incised. The muscles attached to the coracoid are retracted medially. With the arm abducted, anterior 1cm of deltoid is released and retracted laterally and retained with Richardson retractor. The long head of biceps, the key to anatomy of upper humerus is found under the insertion of pectoralis major. Palpate it as it proceeds upwards, but do not dissect it free, for fear of avascular necrosis. If lesser tuberosity is not fractured access is gained to the front of the joint by means of a directed subscapularis and capsular

longitudinal arthrotomy. Rarely coracoid osteotomy may be required for better exposure.

B. Deltoid splitting approach

Start the incision at the anterolateral tip of acromion and carry it distally over the deltoid muscle about 5 cm. Identify the tendinous interval 4-5 cm long between anterior and middle thirds of the deltoid, splitting the muscle here provides a fairly avascular approach to the underlying structures. Next, incise the thin wall of subdeltoid bursa and explore the rotator cuff and tuberosities.

Intra operative complications include:

a) Fracture of shaft of humerus from forceful manipulation.
b) Displacement of previously undisplaced fracture.
c) Poor holding of K wires and sutures in tuberosities in osteoporotic bone
d) Damage to deltoid with retraction
e) Damage to axillary artery
f) Damage to axillary nerve
g) Damage to brachial plexus
h) Torrential bleeding

Post-operative care and rehabilitation

Proper postoperative rehabilitation is necessary to obtain and maintenance of satisfactory range of motion, strength and shoulder function[70,78,79].

Rehabilitation should be custom tailored to the patient and the fracture pattern, and is easier, more comfortable and assured with stable internal fixation. If fracture fixation is stable, then physiotherapy can be initiated soon. The most accepted and useful rehabilitation protocol is the three-phase system devised by Hughes and Neer[80].

Application of this system is variable and depends on the fracture pattern, stability of fracture fixation and ability of patient to comprehend the exercise programme.

Phase I:

Phase I exercises are started early in the postoperative period, usually between 5th and 10th post-operative day. After stable surgical fixation, passive exercises can be started within 24-48 hours. The surgeon should start elbow flexion and extension. Then gently assist the patient with pendulum exercises. The next exercise is supine external rotation with a stick. Assisted forward elevation and pulley exercises are started after three weeks. Isometric exercises are initiated at four weeks.

Phase II:

This phase involves early active, resistive and stretching exercises. The first exercise is supine active forward elevation. During each session 3 sets of 10-15 repetitions are done regularly. This is followed by stretching for forward elevation on top of the door. The most important exercise to achieve abduction and external rotation is to place the hands behind the head with arm abducted and externally rotated.

Phase III:

Resistive strengthening exercises are started at three months during this phase. Arm is stretched higher on top of wall by leaning the ttunk onto the wall. Prone stretching for forward elevation is also useful. Light weight can be carried after three months. Weights are started at one pound and increased at one pound increments with the limit being 5 pounds. Strength can be achieved with effective functional activity.

A well supervised rehabilitation protocol is essential for the success of any fracture treatment. Even a perfect surgical repair will not achieve good results, without proper rehabilitation efforts[81].

MATERIALS AND METHODS

This prospective study is an analysis of functional outcome of 20 cases of surgically managed fractures of proximal humerus using proximal humerus (PHILOS)locking compression plates undertaken at Department of Orthopaedics and Traumatology, Government Kilpauk Medical College And Hospital, Chennai from April 2013 to November 2013. Of the 20 patients, 12(60%) were females and 8(40%) were males. (Table-I). The age of the patients ranged from 18-70 years. The mean age of the patients was 51 years.(Table- II).

METHODOLOGY (MATERIALS AND METHODS)

Study topic : Functional and Radiological outcome of proximal humeral fractures treated using PHILOS plates.

Study Design : Prospective Study

Study Venue : Department of Orthopaedics
Govt.Kilpauk Medical College And Hospital

Sample Size : Twenty (20)

Study Period : April 2013 to November 2013

Data Collection : Collection of data as per proforma with consent from the patients admitted in Orthopaedic ward, Kilpauk Medical College And Hospital.

Inclusion Criteria:

(i) Patients with proximal humerus fractures, who

(ii) Are skeletally mature and age more than 18 years

(iii) Satisfy Neer s criteria for operative displacement i.e. displacement of >1 cm between the major fracture fragments or angulation of the articular surface of >45 degrees.

(iv) Neer s two,three and four part fractures.

Exclusion Criteria:

Patients with

(i) Open fractures

(ii) Pathological fractures

(iii) Associated neurovascular injury

(iv) Associated head injury

Pre op assessment:

After initial resuscitation a detailed history was taken and thorough clinical examination done to rule out any other associated injuries. Distal neurovascular status was assessed.

Investigations:

Routine investigations like complete hemogram, blood sugar, renal function tests, serum electrolytes, blood grouping and typing, bleeding time, clotting time, chest x ray PA view, ecg were done. Radiographs of the affected shoulder were taken in AP, Lateral and Axillary views and fractures were classified according to Neer s classification. CT pictures were taken in selected patients with complex fracture patterns to know the articular involvement. Anaesthetic fitness was obtained for all the patients before surgery.

Prophylactic Antibiotics:

All patients received 1 gram of cefotaxime intravenously thirty minutes prior to surgery.

Anaesthesia:

Twelve patients were operated under supra clavicular and interscalene block. Combined general anaesthesia with inter scalene block was used in remaining eight patients in view of anticipatory increase in duration of surgery due to difficulty in fracture reduction.

Positioning the patient:

All patients were positioned supine on the table with a sand bag between the spine and medial border of the scapula in order to push the affected side forward and to open up the front of the joint.

Surgical Approach:

Sixteen patients were operated using standard deltopectoral approach. Four patients were operated using deltoid splitting approach.

Operative Technique:

After incising the skin, subcutaneous tissue, fascia and muscle, the conjoint tendon was retracted medially. The fragments were reduced indirectly and temporarily fixed with the help of 1.5 or 1.8 mm K wires under image intensifier control.

1. Temporary K wire fixation

2. C – Arm Image

After obtaining acceptable reduction, the PHILOS plate was placed atleast 8mm distal to the upper ened of the greater tuberosity. The long head of biceps tendon was identified and preserved. The plate was then placed lateral to the long head of biceps with out compromising its function. The humeral head fragment as well as the metaphyseal shaft was fixed with locking head screws. Standard length wires were inserted in to the humeral head through a guide and the length of screw determined by placing a measuring device over the protruding wire. The corresponding length locking screw was then inserted using a specifically designed screw driver. The final position of the implant was checked with image intensifier in multiple planes.The shoulder was checked for stability of fixation, range of movements and absence of impingement. None of our patients required bone grafting. Suction drain kept in situ and closure was with 2/0 vicryl to muscle, fascia and subcutaneous tissue , 2/0 ethilon sutures to the skin.

Fracture-Dislocation

In cases of irreducible fracture dislocation, the coracoid was predrilled and osteotomised and retracted with the tendon. Arm was externally rotated and blunt instrument passed between subscapularis and capsule and stay sutures applied. The same was divided one inch from its insertion and retracted. Capsule was incised longitudinally to open the joint and reduce the articular fragment.

Post op period:

Drain was removed on the second post operative day. Intravenous antibiotics continued till eighth post operative day. Sutures were removed on tenth post operative day.

Post op Xrays:

X rays are taken in the immediate post op period to document the fracture alignment, reduction and fixation. There after X rays are repeated at every 3 to 4 weeks interval to monitor the fracture union and to detect any implant loosening, deviation screw penetration screw back out, impingement and failure.

Functional Outcome Assessment :

Post op functional outcome was assessed by using Constant and Murley Score.

Radiological Outcome:

Post op radiological outcome was evaluated by taking serial X rays at follow up documenting on quality of reduction, fracture alignment, restoration of articular congruity, fracture union, PHILOS plate deviation, screw penetration, backout, implant loosening and failure.

Instruments and Implants used:

1. Kirschner ‘K’ wire (1.5mm)
2. Kirschner ‘K’ wire (1.8mm)
3 Drill Sleeve (4mm)
4 Drill Bit (3mm)
5 Screw Driver (3.5mm)
6 Cortical Locking Screw (4mm)
7. Cancellous Locking Screw (4mm)
8 Philos Plates

Post-Op Rehabilitation

In all patients the arm was placed in an arm sling,cuff and collar or shoulder immobilizer.(Table XV). Prophylactic antibiotics which were started before surgery were continued for 48 and 72 hours postoperatively. In few patients ice packs were used to minimise the swelling. Passive elbow flexion and extension were started by 24-48 hrs. Sutures were removed by 10th post op day.

Phase I exercises consisting of pendulum exercises were started from the first week. Gentle passive forward flexion, internal and external rotation exercises were initiated by third week. Phase II exercises consisting of active range of motion exercises and resistive exercises were started by 4-6 weeks. Phase III exercises consisting of advanced stretching and strengthening exercises were started by 3 months. Lifting of light weight objects were started after 3 months.

RESULTS

TABLE – I

SEX DISTRIBUTION

S. No.	Sex	No. of Patients	Percentage
1.	Females	12	60
2.	Males	8	40

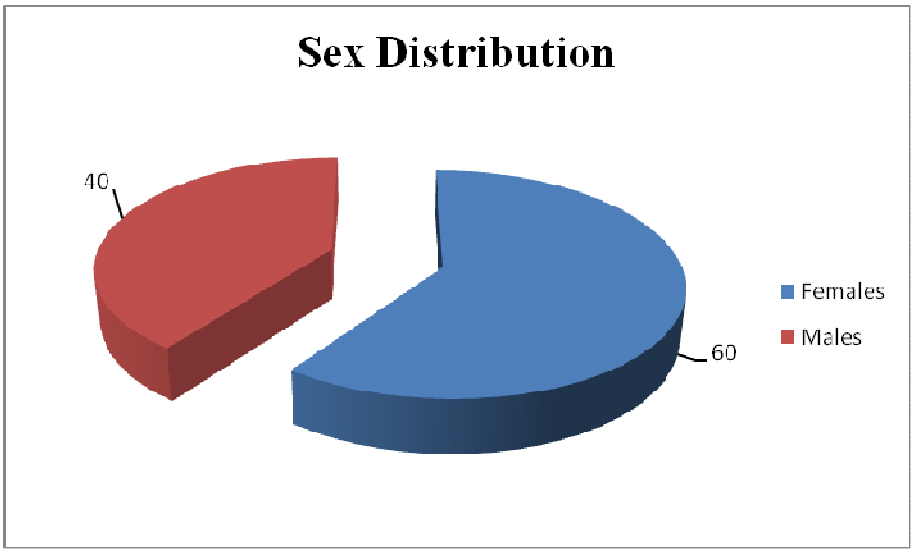


TABLE – II

AGE DISTRIBUTION

S. No	Age group	No. of Patients	Percentage	Males	Females
1	15-20	1	5	1	0
2	21-30	2	10	2	0
3	31-40	2	10	1	1
4	41-50	5	25	2	4
5	51-60	7	35	1	5
6	>61	3	15	1	2

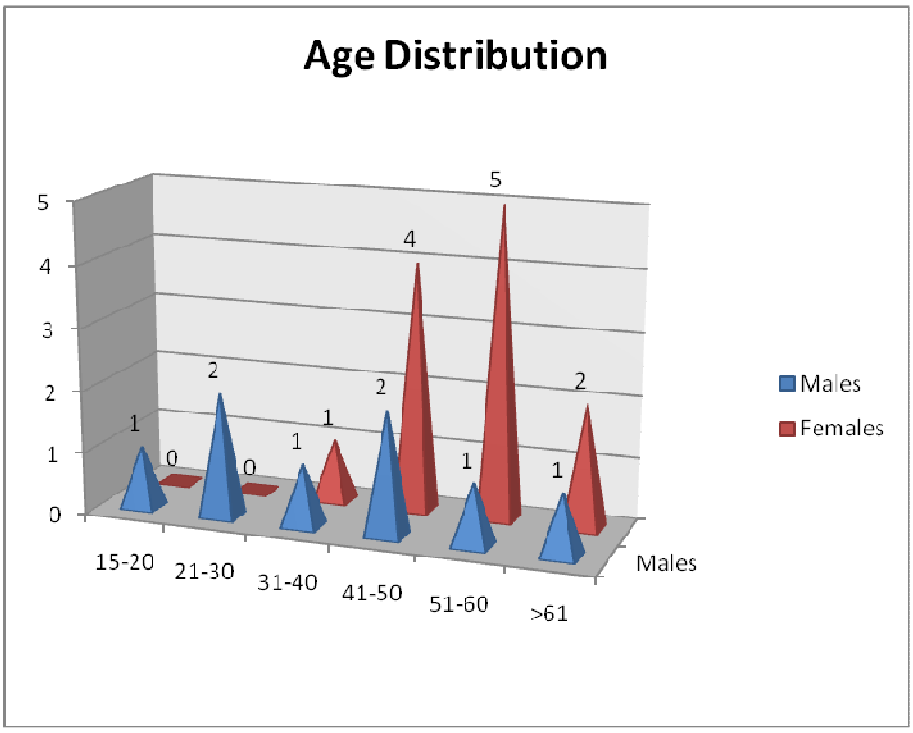


TABLE III

MODE OF INJURY

S. No.	Mode of injury	No. of Patients	Percentage
1	Fall at ground level	10	50
2	RTA	6	30
3	Fall from height	3	15
4	Epilepsy	1	5

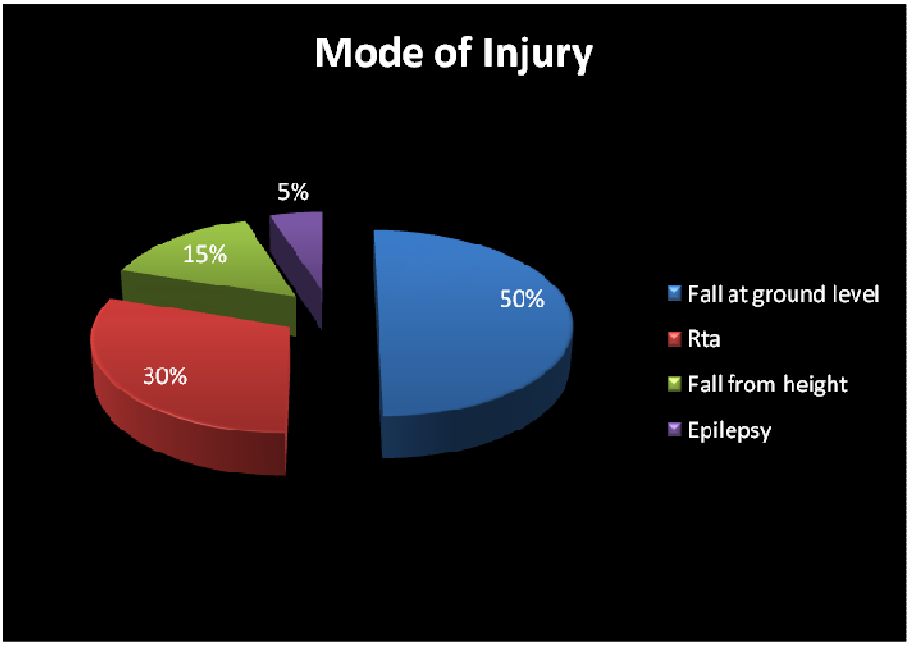


TABLE – IV

OCCUPATION

S. No	Occupation	No. of Patients
1	Labourer	5
2	House wife	6
3	Skilled worker	5
4	Professional	1
5	Student	1
6	Business	2

TABLE – V

S.No	Side	No. of patients
1	Unilateral	20
2	Bilateral	0

TABLE- VI

SIDE

S.No	Side involved	No: of patients
1	Dominant(Right)	15
2	Non-dominant(Left)	5

Sixteen patients presented to us within five days after injury,(Table-VII) and 5 patients had previous treatment either in the form of native splinting, massage or POP application. (Table -VIII)

TABLE – VII

DURATION

S. No	No of days Since injury	No. of patients
1	0-5 days	16
2	6-10 days	3
3	11-15 days	1

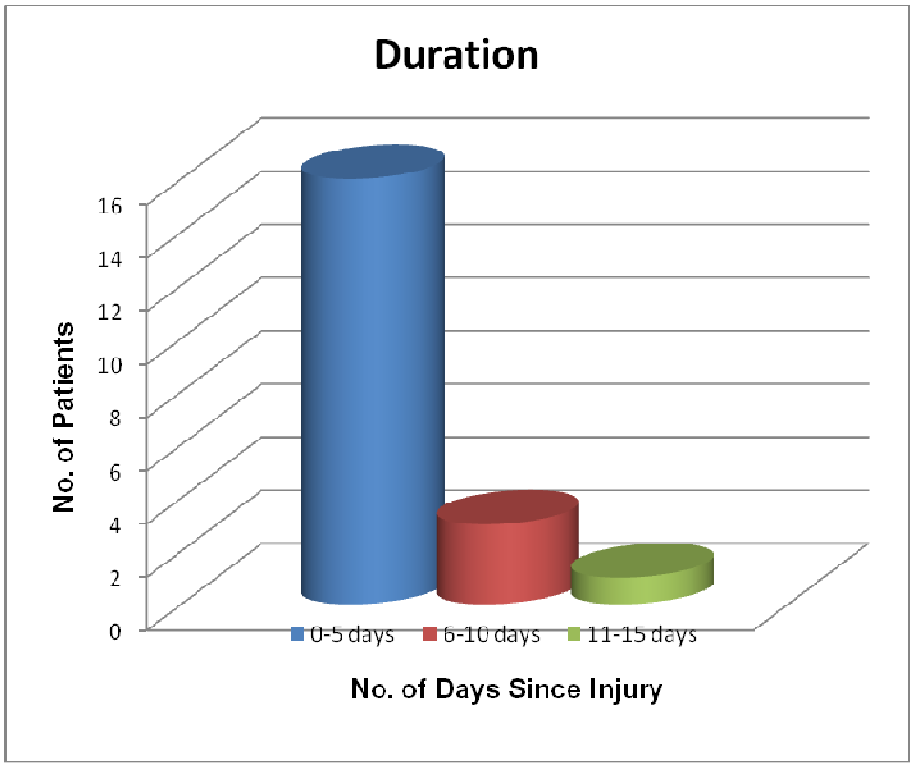


TABLE – VIII

PREVIOUS TREATMENT

S. No	Previous treatment	No. of patients	Percentage
1	Massage	2	10
2	Massage and splinting	0	0
3	Splinting	1	5
4	Attempted reduction with splinting	1	5
5	POP	1	5
6	No native treatment	15	75

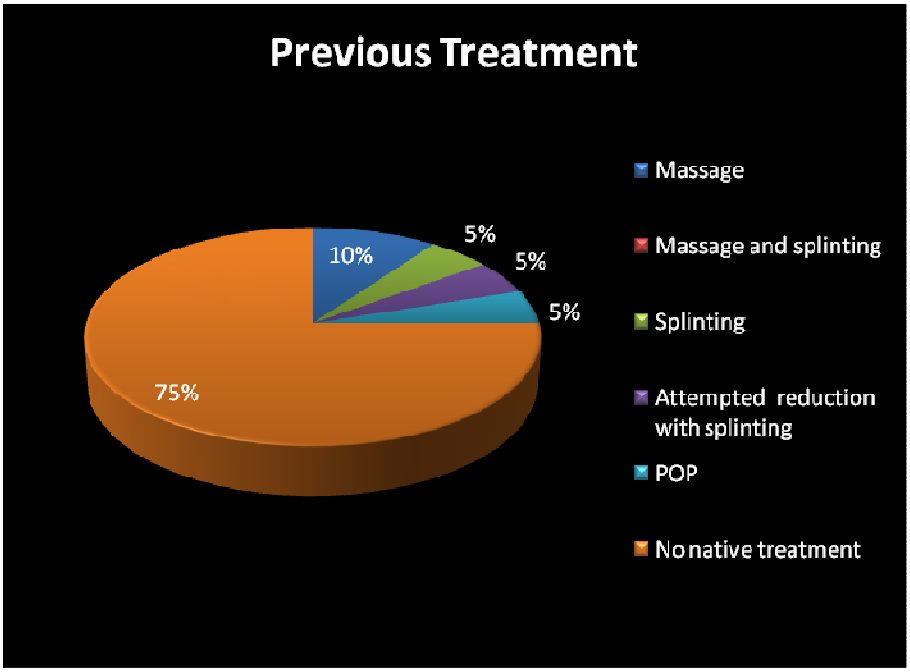


TABLE – IX

S. No	Fracture	No. of patients
1	Closed fracture	20
2	Open fracture	0

TABLE – X

S. No.	Associated injuries	No. of patients
1	Fracture metacarpal	2
2	Fracture patella	1
3	Fracture distal radius	2
4	Fracture SOH	1
5	Fracture NOF	1
6	Fracture BB Forearm	1

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. CT Scan was done in 5 patients with complex fracture dislocations, to delineate the fracture pattern and the direction of dislocation and for 3 patients 3D CT was taken to ascertain the position of the fragments (Table – XI).

TABLE – XI

IMAGING

S. No	Imaging	No. of patients
1	x-rays	20
2	CT Scan	5
4	3D CT	3
3	Bone scan	0

Radiological evaluation of the fractures was done and were classified according to Neer's four part classification system.

Based on Neer's sytem 12 patients (60%) had two part fractures, 7 (35%) had 3 part fractures and 1(5%) had four part fractures. (Table-XII) Fracture dislocations were present in 2 patients (Table-XIII).

TABLE – XII

TYPE OF FRACTURE

S. No	Neer's type	No. of patients	Percentage
1	2 part	12	60
2	3 part	7	35
3	4 part	1	5

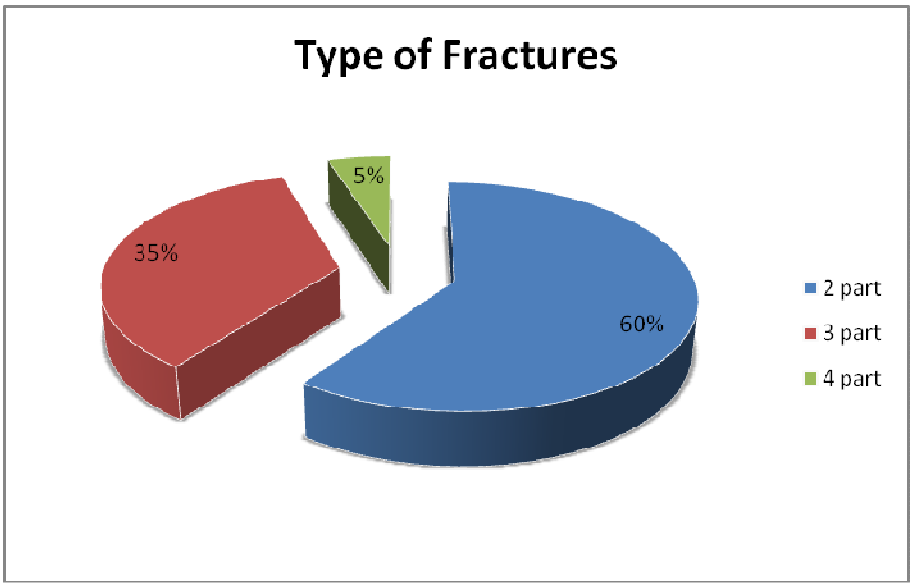


TABLE – XIII

FRACTURE DISLOCATION

S. No.	Dislocation	No. of patients	Percentage
1	No dislocation	18	90
2	Dislocation	2	10
	2 part	0	0
	3 part	2	10
	4 part	0	0

The indications for surgery were displacement of more than 1 cm between the fracture fragments and angulation of the articular surface more than 45°. Patients not satisfying these criteria were treated conservatively and not included in this study.

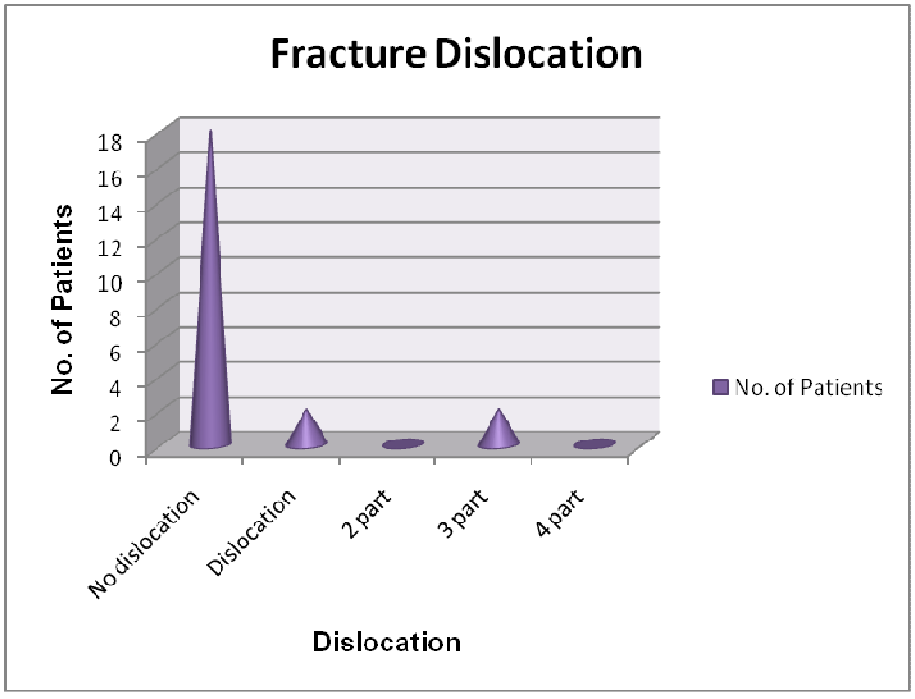


TABLE XV

POST-OP IMMOBILISATION

S. No.	Immobilisation	No. of patients
1	Post op POP	0
2	Arm sling	12
3	Shoulder Immobiliser	5
4	Cuff & Collar	3

All the patients were reviewed at two weeks interval, for first three months and later every month. During follow up, patients were clinically evaluated for pain and function. Radiological evaluation of fracture union was observed by serial x rays.

COMPLICATIONS

Early Complications

Early complications were encountered in 3 (15%) patients. [TableXVI].

1 patient with diabetes mellitus developed wound gaping requiring secondary suturing after glycaemic control.

1 patient with 3 part fracture developed skin necrosis which resolved with intravenous antibiotics.

1 patient had deltoid atony after surgery which improved with sling and strengthening exercises.

TABLE XVI
EARLY COMPLICATIONS

S. No	Complications	No. of Patients
1	Skin necrosis	1
2	Wound gaping	1
3	Deltoid atony	1

Late Complications

Late complications were encountered in 5(25%) of patients. [Table-XVII].

1 patient with 3 part fracture had malunion of greater tuberosity, restricting abduction above 90°.

The patient who had deltoid atony initially after surgery had mild inferior instability which was not incapacitating for the patient.

2 patients had joint stiffness. Both patients later required manipulation under general anaesthesia.

1 patient developed Heterotopic ossification with 3 part fracture, probably because the patient had exercised native treatment in the form of many attempted reduction, massage and splinting.

TABLE–XVII

LATE COMPLICATIONS

S. No	Late complications	No. of Patients
1	Malunion	1
2	Joint stiffness	2
3	Instability	1
4	Nonunion	0
5	Infection	0
6	Heterotropic Ossification	1

The patients were followed up at regular intervals every two weeks interval during the first 3 months and every 1 month thereafter. The minimum follow-up period was four months and maximum follow up period was 8 months.

The results were evaluated during follow up by taking into consideration the following factors:

1) Pain
2) Range of motion
3) Strength
4) Stability
5) Function
6) Radiological documentation of fracture union
7) Anatomic restoration

Constant And Murley Score;

Constant and Murley's score[82,83,84,85,86] was used to assess the functional outcome of our patients.

PAIN

Post op pain was recorded on a scale of 0-5points, where points were given according to the following criteria

TABLE - XVIII

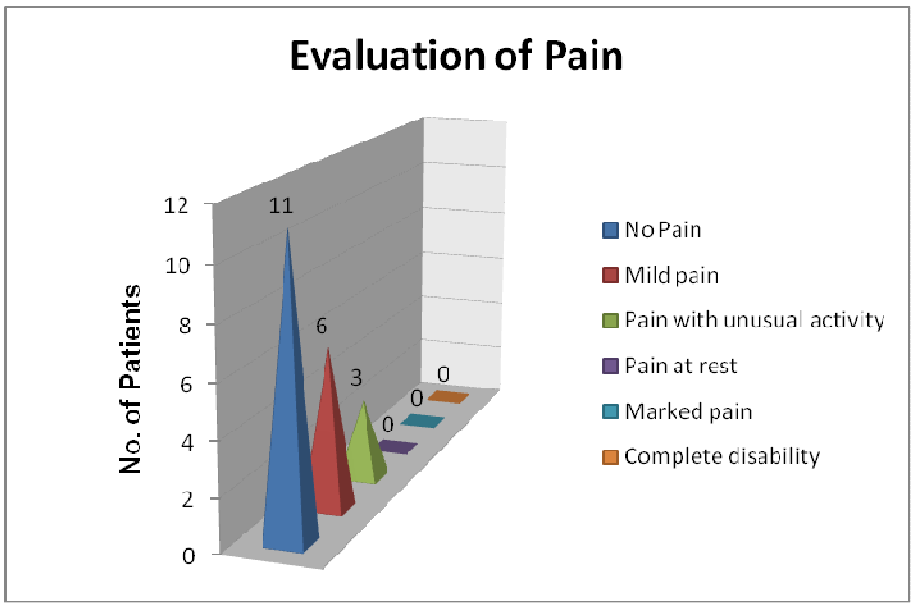
Pain scale	Points
No pain	5
Mild pain	4
Pain after unusual activity	3
Pain at rest	2
Marked pain	1
Complete disability	0

11(55%) patients said that may had no pain and 6(30%) patients had only mild pain, 3(15%) patients had pain after unusual activity . None of our patients had pain at rest or disabling pain. [Table-XIX]

TABLE–XIX

EVALUATION OF PAIN

Sl. No	Pain	No. of Patients
1	No Pain	11
2	Mild pain	6
3	Pain with unusual activity	3
4	Pain at rest	0
5	Marked pain	0
6	Complete disability	0



FUNCTIONAL OUTCOME

Functional outcome was evaluated with ability to perform day to day activities.

Points were given according to the following scale

4 – normal 3 – mild compromise

2 – with difficulty 1 – with aid

0 – unable NA – not available

Functional results were graded by following criteria:

Good functional result 3.5 – 4.0 points

Fair 2.5 – 3.4 points

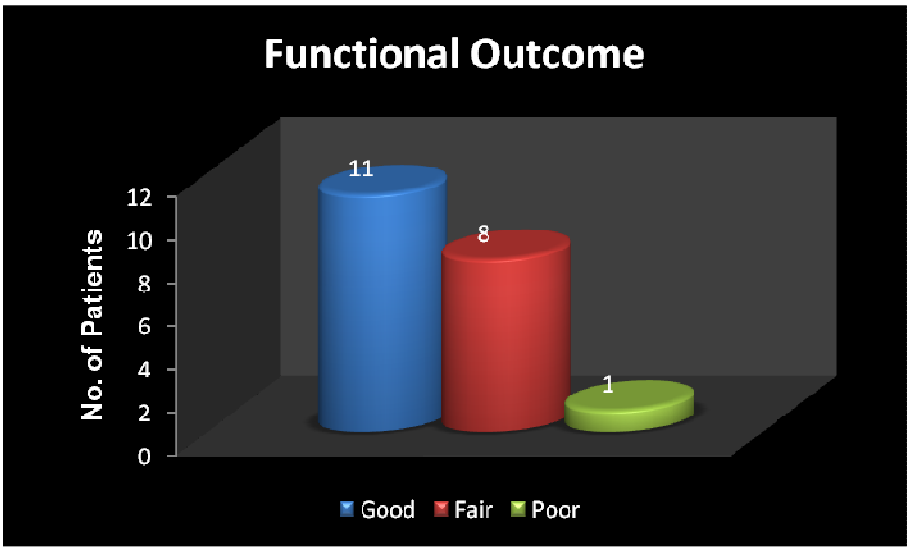
Poor < 2.5 points

11 (55%) of the 20 patients had good functional result, 8 (40%) had fair functional results and 1(5%) had poor functional result. [Table-XX]

TABLE–XX

FUNCTIONAL OUTCOME

S. No	Functional outcome	No: of patients
1	Good	11
2	Fair	8
3	Poor	1



Muscle Strength

Muscle strength was evaluated for the muscles around the shoulder and points allotted accorded to strength as follows;

Normal -5

Against Resistance -4

Against Gravity -3

With Elimination of Gravity -2

Flicker -1

Paralysis -0

17(85%) of patients had normal muscle strength in all the muscle groups evaluated and 2 (10%) patients had good muscle strength and 1 (5%) patient had fair muscle strength.

TABLE–XXI

MUSCLE STRENGTH

S. No	Muscle Strength	No: of patients
1	Normal	17
2	Against slight resistance	2
3	Against gravity	1
4	With elimination of gravity	0
5	Flicker	0
6	Paralysis	0

Range of Motion

Range of Motion was evaluated during each follow up and the improvement was recorded. The following table shows average range of motion (ROM) observed. Active forward elevation was defined as the angle between the humerus and the upper part of the thorax in the sagittal plane. External rotation was measured with the arm at patients side. Internal rotation was recorded as the posterior body segment that could be reached by the thumb with the elbow in a flexed position. [Table-XXII]

TABLE–XXII

ROM

S.No	Motion	Range in deg.	Average
1	Elevation	90-170	126.25
2	Abduction	70-160	123.25
3	ER	35-60	47
4	IR	T3-L4	T11
5	Extension	30-55	43
6	Flexion	80-120	93.85

Radiological Outcome:

Quality of reduction, fracture alignment, restoration of articular congruity, fracture union, PHILOS plate deviation, screw penetration, backout, implant loosening and failure were assessed radiologically during follow up. All fractures united and the average time taken for union was approximately ten weeks. One patient with three part fracture went for malunion. No cases of implant deviation, screw penetration, screw back out, impingement and failure was encountered.

Overall Results

The overall results were rated according to the following criteria: Maximum no: of points – 100 Excellent – more than 86.

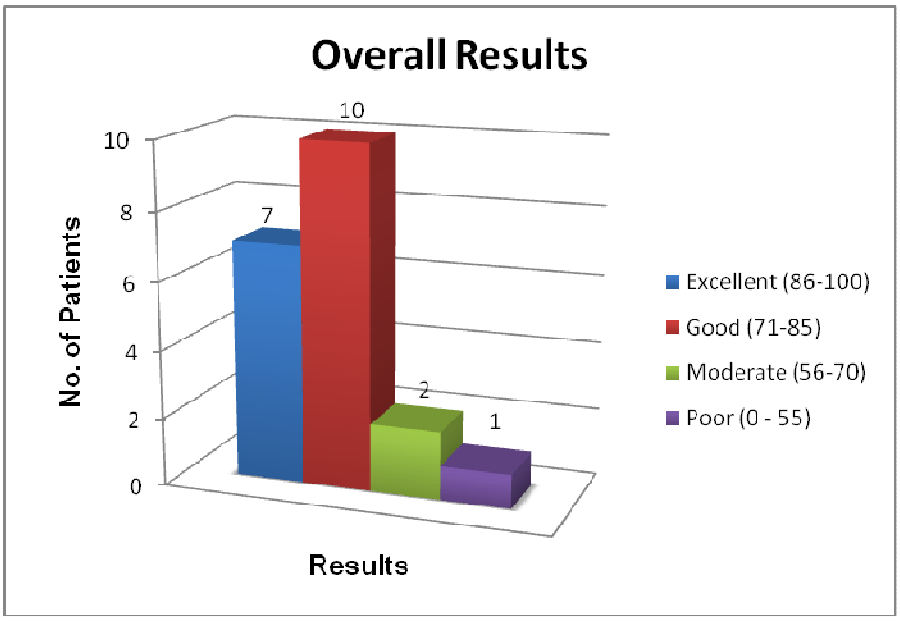
Good – 71-85 Moderate: 56-70; Poor : 0 - 55

Of the 20 cases 7(35%) patients had excellent result, 10(50%) satisfactory, 2(10%) unsatisfactory and 1 (5%) failure. [Table-XXIII]

TABLE–XXIII

OVERALL RESULTS

S.No	Rating	No: of Patients	Percentage
1	Excellent (86-100)	7	35
2	Good (71-85)	10	50
3	Moderate (56-70)	2	10
4	Poor (0 - 55)	1	5



OBSERVATIONS

- Majority of injured patients were females (60%).
- Highest number of patients were in their 5th decade (35%).
- Free fall at ground level was the most common mode of injury (50%)
- Post-epileptic fall caused fracture of Proximal Humerus in one patient.
- No case with bilateral fractures was reported.
- All were right handed persons and the dominant arm was involved in 15(75%) patients.
- Post menopausal osteoporotic females accounted for 50% of patients.
- 16(80%) patients reported to hospital within five days of injury.
- 25% of patients had undergone previous native treatment either in form of massage, splinting or attempted reduction and splinting.
- 8 patients had associated fractures.
- All the patients had closed injuries
- Neer's 2 part fracture is the most common type in 60% patients.
- Greater Tuberosity fractures were the predominant type in 2 part fracture.
- 4 part fractures accounted for only 5% of patients
- Fracture dislocation were present in 2(10%) of patients.

- None of our patients required post op immobilization with POP.
- Patients were taken up for surgery on an average of 6 days after admission.
- 60% patients did not have any pain during follow-up
- The average range of active elevation was 126.25 degrees
- The average range of active external rotation 47 degrees.
- The average range of abduction 123.25 degrees
- 17(85%) of patients had normal muscle strength in shoulder.
- Patients with 2 part fracture had better functional outcome than 3 and 4 part fracture.
- All fractures unite within an average period of ten weeks.
- No cases of implant loosening or failure were encountered.

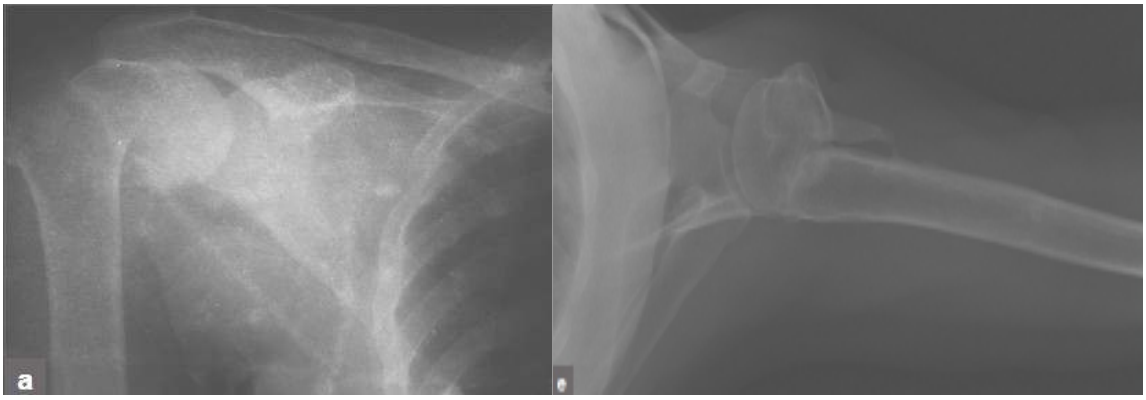
ILLUSTRATIVE CASES

CASE 1

A 49 yrs old, Mr. X, a right handed skilled worker sustained a history of self fall while going up a staircase without railing support and was diagnosed to had a four part fracture right proximal humerus with subluxation. He had fracture fifth metacarpal on the contralateral side. Patient reported to hospital two days after injury. Subsequently Neer s right angled trauma series X –rays, CT scan and 3D CT were taken to have complete view of fracture segments and complete understanding of anatomy. The patient underwent internal fixation with 7 holes PHILOS plate through a deltoid splitting approach after two days after injury.

Post-operatively, the patient was rehabilitated with 3 phase protocol of Hughes and Charles Neer.The patient was followed at monthly intervals.At 8 months followup,patient has satisfactory functional result with no pain and is able to attend his normal duty.

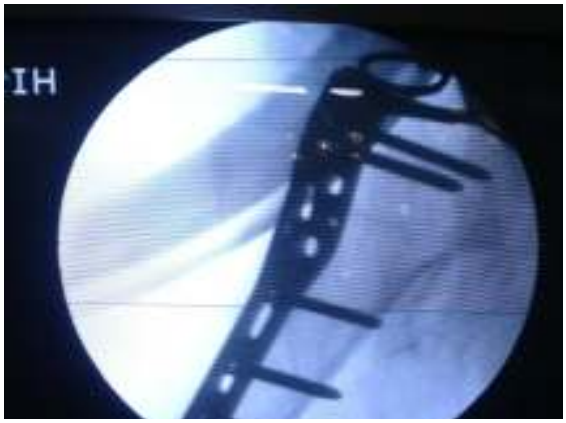
ILLUSTRATIVE CASE I PRE-OP



Pre op X - ray AP and Lateral views

CT PICTURES

Intra - OP Pictures



Immediate Post OP

Two Months follow-up

5 Months follow-up **8 Months follow-up**

ILLUSTRATIVE CASE I CLINICAL PICTURES

CASE- 2

A 65 years old female Mrs.Y, a right handed person, (house wife) sustained a comminuted two part fracture of surgical neck of humerus after she fall at ground level, in her residence. She was a known hypertensive and diabetic on regular treatment. She was referred from a private hospital with POP after 3 days of injury.

She underwent surgery on fourth day after admission with 5 hole PHILOS plate through deltopectoral approach.

Post-operatively, the patient was started on pendulum exercise from day 2 and supine external rotation exercises from 3rd week. Periodical functional and radiological assessment shows excellent range of movements and fracture union.She was able to perform her daily activities without any pain.

ILLUSTRATIVE CASE II

Pre op X - ray AP view

Intra - OP C-arm Image

Immediate Post OP X-ray

2 Months Post OP X-ray

4 Months Post OP X-ray

6 Months Post OP X-ray

ILLUSTRATIVE CASE II CLINICAL PICTURES

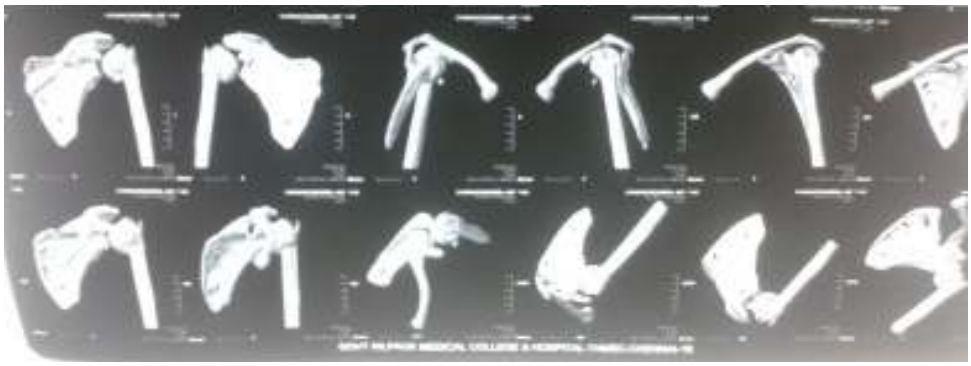
CASE - 3

Mr X, a 68 years old male who sustained a two part fracture of left proximal humerus after a fall at ground level in his residence got admitted in our hospital after three days of injury. He was a known diabetic on regular oral hypoglycaemics.s. He underwent internal fixation with 4 hole PHILOS PLATE through deltopectoral approach.

Post-operatively, the patient was rehabilitated with 3 Phase Rehabilitation protocol of Hughes and Neer.. The patient was followed up at regular monthly intervals. He was able to perform his day to day activities without any pain and restriction and he has excellent functional outcome.

Pre OP X - ray AP and Axillary Views

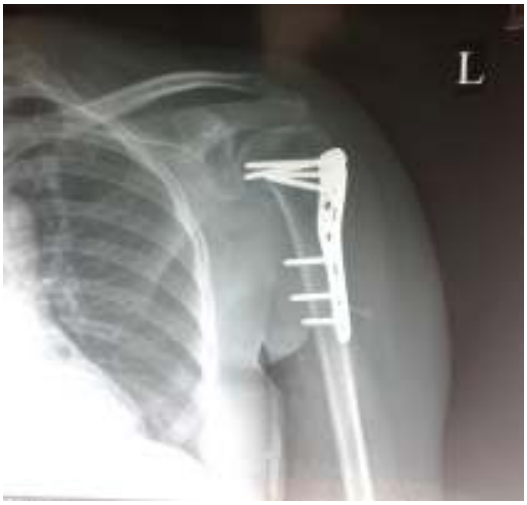
CT Pictures



Intra - OP Pictures

Immediate Post OP X-ray

Two Months Post OP X-ray



4 Months Post OP X-ray

7 Months Post OP X - ray

ILLUSTRATIVE CASE III

CLINICAL PICTURES

CASE- 4

Mrs .Y, a 53 years old female manual labourer fall from height while working and sustained a three part fracture of right proximal humerus. She also sustained fracture distal radius on the same side, got admitted on the day of injury. She is a known diabetic on regular treatment.

The patient underwent ORIF with Plate osteosynthesis with 5 hole PHILOS plate. Postoperatively the patient had wound gaping for which she required secondary suturing. The patient was Rehabilitated with 3 Phase Rehabilitation Protocol of the Hughes and Neer.

The patient was followed up every month till 7 months and she had satisfactory functional result.

Pre OP X - Ray AP Views

CT - Pictures

Immediate Post OP X- Ray **2 Months Post OP - Scapular 'Y' view**

4 months Post OP - AP View **7 Months Post OP - Scapular 'Y'view**

ILLUSTRATIVE CASE IV CLINICAL PICTURES

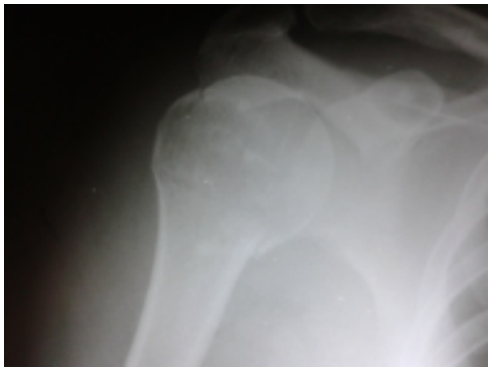
CASE - 5

Mr . X, a 48 years old bank employee met with an accident while he was going to his duty in a two-wheeler and sustained two part fracture of right proximal humerus. He got admitted on the same day of injury.

The patient underwent ORIF with Philos Plate through delto pectoral approach after three days of injury.

Postoperatively, the patient had no complications and the Rehabilitation started on from the 2nd day with pendulum exercises and continued with the Rehabilitation Protocol of Hughes and Neer. The patient was followed up regularly at monthly intervals. At the end of seven months patient had excellent functional result without any pain and he was able to perform his day to day activities efficiently.

Pre OP X - ray AP and lateral views



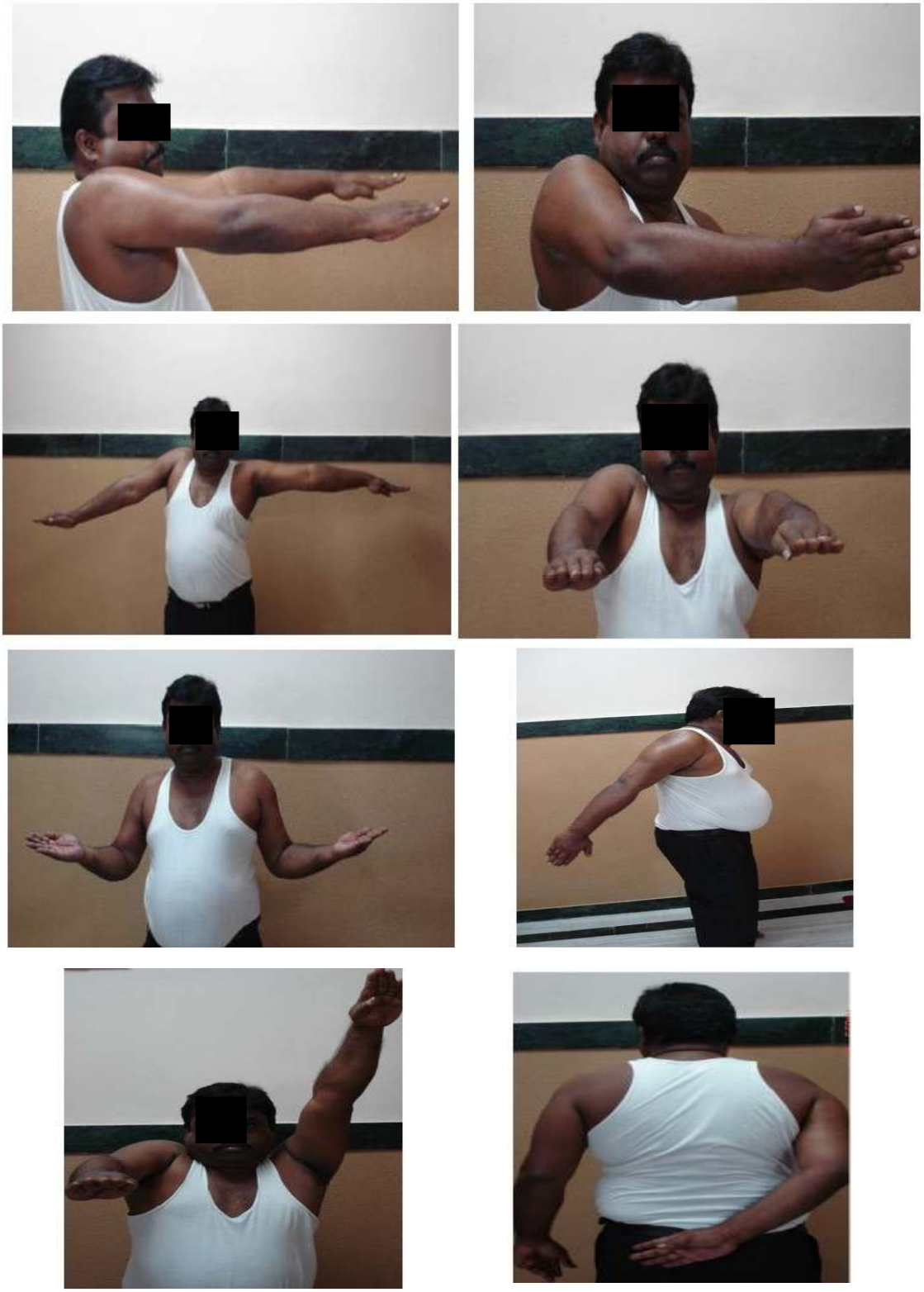
Intra OP Pictures

2 Months follow-up

5 Months follow-up

7 Months follow-up

Case - V Clinical Pictures



DISCUSSION

In this prospective study we have analysed twenty cases of Proximal Humerus Fractures treated surgically using proximal humerus locking plates (PHILOS) in our hospital. There was female preponderance in our study 12 (60%) similar to the conclusion of the study conducted by Hawkins & Bell involving fifteen (15) patients of Proximal Humeral Fractures. there was female preponderance. In Kristiansen et al study of 565 proximal humerus fractures in 5,00,000 people, women were involved in 77% of fracture in all age groups. This is thought to be a result of advanced osteoporosis.

In our study the average age of the patients was 51 years which was corresponding to the reports by Hawkins, Bell and Gurr[39] and Flatow et al[87] and Cornell CN, Levine D S, Pagnani M J[88].

In our study, the most common mode and mechanism of injury was free fall at ground level and fall on an outstretched hand free fall and average age is 51 years were much comparative to the results of the study conducted by Flatow et al[87] as fall on the outstretched arm was the predominant mechanism of injury and average age of the patient is (53) in their study. Since our people attain menopause at an earlier age and have poor quality of bone stock, the average age is little lower.

Also in our study, unusual mode of injury like seizures was present in one patient.

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, we also have followed the Neer's four part classification but several authors have reported low level of interobserver reliability. Sidor et al16 reported a reliability co-efficient of 0.48 for 1 viewing, 0.52 for 11 viewing and a reliability co efficient of 0.66.

In order to properly employ this classification, precise radiographic evaluation is of paramount importance[56]. We have found the Neer's three 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[76].

Computed tomographic scans were done in patients who had equivocal findings and also to find the direction of dislocation. Flatow et al[74] believed that sole reliance on standard AP radiograph may lead to under estimation of the amount of displacement of fragments.

There was a predominance of two part fracture in our study (60%), of which greater tuberosity fracture were the most common. Associated

dislocations were present in 40% of the patients. In the reduction of glenohumeral dislocation if tuberosity fragment remained displaced >1 cm or angulated more than 45°, ORIF was done. Repair in such patients restored the dynamic stability by reattachment of the muscles of the rotator cuff[74].

Flatow et al[74] in a series of 12 patients reported 50% excellent results and 50% good results in patients treated by ORIF with Locking Compression Plates (LCP) for two part greater tuberosity fracture.

Closed treatment of three part fracture is often associated with moderate pain, poor range of motion and disability. Open Reduction and Internal Fixation (ORIF) was associated with good to excellent results in more than 80% of patients in a report by Hawkins et al[56] and recommended surgical treatment for healthy active individuals who have three part fractures of the Proximal Humerus. Cornell and Levine[75] reported good results with screw tension band technique for 3 part fractures. Prosthetic replacement for three part fracture has been used by several authors.

In the treatment of four part fracture and fracture dislocations, less than 10% good or excellent results are obtained by open reduction and internal fixation[100,101]. Isolated reports of revascularization of head of humerus following open reduction and internal fixation indicate satisfactory healing.

Unfortunately, many of the cases referred in the literature often have not been true four part fractures with isolation of articular fragment and follow-up is not sufficient to rule out long term osteonecrosis. Hugg and Lundberg noted 74% AVN when ORIF was used for these fractures. AVN is reported to be as be as high as 90% in four part fractures and 3-25% in 3 part[4,77].

All authors agree that pain relief has been greater than 90% with prosthetic replacement, but there has been varying results with regard to function, motion and strength. Neer and McIlveen have reported nearly 90% excellent results with an improved technique utilizing long deltopectoral approach and better rehabilitation.

From the data presented in this study we have demonstrated that majority of the patients had no pain or only mild pain (85%) which is comparable to the study by Hawkins et al[56,102] and Flatow et al[74].

The average active elevation in our study in two part fractures was 126.25° and average external rotation was 47° which is comparable to the study by Flatow et al[74] in a study of 12 patients of two part fractures treated surgically.

The average elevation in our study with three part fracture was 124.25° and external rotation was 45.5° which is also comparable to the study by

Hawkins et al[56] of 15 cases of 3 part Proximal Humerus fractures treated surgically.

Of the 8 patients with 3 and 4 part fractures 8 patients (40%) regained atleast 90° abduction and elevation.

About 85% of the patients had full muscle strength which is also comparable to the study by Hawkins et al[56] and Flatow et al[74].

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 three part fracture went for malunion. No cases of implant deviation, screw penetration, screw back out, impingement and failure was encountered. Malunion of greater tuberosity fragment in a patient with 2 part fracture treated with PHILOS plate resulted in restriction of abduction and impingement. In this patient poor radiological outcome lead to poor functional outcome as well. Some patients despite having malunion may have a good functional capacity reflecting the fact that radiological outcome may not imply functional outcome.

Heterotopic ossification occurred in one patient with 3 part fracture, probably because the patient had exercised native treatment in the form of many attempted reduction, massage and splinting. Many authors have

reported an incidence of upto 10% of heterotopic ossification in proximal humeral fractures[79].

There was no non-union or radiographic evidence of avascular necrosis or 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 three phase rehabilitation protocol of Hughes and Neer in all our patients and this has provided good results.

LCP results: The average constant score in our study with 20 patients was 81.7 which is slightly better than the the study by Koukakis et al[78].

In summary fractures of Proximal Humerus may be extremely demanding. 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

- Displaced proximal humeral fractures when treated surgically produce greater range of movements (ROM), less pain and less stiffness.
- Earlier the surgery is done better are the results.
- Functional outcome is better with isolated fractures than with fracture dislocations.
- Results are best when operative method results in stable fixation that allows early passive mobilization.
- Functional outcome of 2 part fractures is better than 3 part and 4 part fractures.
- Radiological outcome assessed by means of quality of reduction and union of fracture in two and three part fractures is better than in four part fractures.

MASTER CHART - 1

S.no	Age	Sex	Occupation	DOI	DOA	DOS	MOI	Type	Dislocation	Side	Unilateral/ bilateral	Asso. Injury	Previous treatment	Open/closed		CT	3D CT
1	20	M	Student	17/04/13	17/04/13	19/04/13	RTA	2 part	No	L	UL			C	12		
2	39	F	Labourer	22/04/13	22/04/13	25/04/13	RTA	2 part	N	R	UL	# MC (L)		C	111		
3	49	M	Plumber	27/04/13	29/04/13	02/05/13	FAG	4 part	N	R	UL	#MC (L)		C		Y	Y
4	65	F	Housewife	29/04/13	01/05/13	04/05/13	FAG	2 part	N	R	UL		POP	C			
5	53	F	Labourer	06/05/13	06/05/13	10/05/13	FFH	3 part	N	R	UL	#DR	Massage	C		Y	
6	50	F	Teacher	09/05/13	12/05/13	15/05/13	FAG	2 part	N	L	UL			C			
7	56	F	Housewife	14/05/13	16/05/13	19/05/13	FAG	3part	N	R	UL		ARS	C		Y	Y
8	36	M	Tailor	19/05/13	22/05/13	25/05/13	RTA	2 part	N	R	UL	# Patella		C			
9	29	M	Plumber	24/05/13	27/05/13	29/05/13	FFH	2 part	N	L	UL			C			
10	44	F	Labourer	26/05/13	26/05/13	30/05/13	RTA	3 part	Y	R	UL		splinting	C			
11	30	M	Housewife	28/05/13	30/05/13	03/06/13	FAG	2part	N	R	UL			C			
12	62	F	Housewife	31/05/13	02/06/13	05/06/13	FAG	3 part	N	R	UL	# NOF	Massage	C		Y	Y
13	46	F	Labourer	03/06/13	09/06/13	13/06/13	FFH	3 part	Y	R	UL			C			
14	48	F	Teacher	04/06/13	09/06/13	15/06/13	Epilepsy	2 part	N	L	UL	# BB FA		C			
15	48	M	Bank employee	09/06/13	09/06/13	12/06/13	RTA	2 part	N	R	UL			C			
16	63	M	Labourer	12/06/13	17/06/13	22/06/13	FAG	2 part	N	R	UL	#SOH		C			
17	54	F	House-keeper	15/06/13	18/06/13	21/06/13	FAG	2 part	N	R	UL			C			
18	58	F	Housewife	17/06/13	22/06/13	27/06/13	FAG	3 part	N	R	UL	# DR		C		Y	
19	55	M	Business	18/06/13	24/06/13	26/06/13	RTA	3 part	N	L	UL			C			
20	53	F	Housewife	22/06/13	25/06/13	28/06/13	FAG	2 part	N	R	UL			C			

MASTER CHART - 2

Sl. No	Days int.to surgery	APPROACH	IMPLANT	Follow up	Elevation	Abduction	ER	IR	Extension	Flexion	Pain	Skin Necrosis	Wound Graping	Nonunion	Malunion	JT Stiffness	HET.Ossification	Deltoid Atony	Instability	Axilary nerve damage	Infection	Grade	Constant Score
1	3	DP	LCP	8	160	150	55	T 3	50	110													88
2	4	DP	LCP	8	165	150	55	T 4	50	110													80
3	6	DS	LCP	8	125	120	55	L 1	45	95	MILD												70
4	6	DP	LCP	8	145	120	50	L 4	45	105					Y								88
5	6	DP	LCP	7	95	100	45	L 4	35	80	PUA					Y	Y						82
6	7	DP	LCP	7	160	140	55	T 6	45	110													82
7	6	DP	LCP	8	125	125	40	L 1	40	90	PUA												72
8	7	DP	LCP	7	160	110	50	T 5	50	100													80
9	6	DP	LCP	7	165	140	55	T 4	50	100	MILD												88
10	5	DS	LCP	7	90	70	40	T 12	50	85	MILD							Y	Y				68
11	7	DP	LCP	7	145	110	50	L 2	50	100	MILD												88
12	6	DS	LCP	6	120	125	40	L 1	45	90	MILD												82
13	11	DP	LCP	6	125	130	50	T 10	45	90													82
14	12	DP	LCP	6	165	145	50	T 8	50	100		Y											80
15	6	DP	LCP	6	155	145	50	T 6	50	100													88
16	11	DP	LCP	6	160	135	50	L 1	45	95	PUA												88
17	7	DP	LCP	6	160	140	50	T 9	50	100													80
18	1	DP	LCP	6	130	135	40	L 2	30	80	MILD												80
19	8	DS	LCP	6	90	80	35	L 3	30	80			Y			Y							80
20	7	DP	LCP	6	160	145	50	T 8	45	100													88

EVALUATION FORM

CONSTANT SCORE TECHNIQUE

BACKGROUND

The **European Society for Shoulder and Elbow Surgery (ESSES)** adopted the scoring system of C Constant and A Murley. This scoring system consists of four variables that are used to assess the function of the shoulder. The right and left shoulders are assessed separately.

The subjective variables are pain and Activities of Daily Living (sleep, work, recreation / sport) which give a total of 35 points. The objective variables are range of motion and strength which give a total of 65 points.

SUBJECTIVE

Pain	15
ADL (sleep, work, recreation/sport)	20

OBJECTIVE

Range of motion	40
Strength	25

PAIN

Pain	Points
None	15
Mild	10
Moderate	5
Severe	0

ACTIVITIES OF DAILY LIVING (ADL)

Activity Level	Points
Full work	4
Full recreation/ sport	4
Unaffected sleep	2

Positioning	Points
Upto waist	2
Upto xiphoid	4
Upto neck	6
Upto top of head	8
Above head	10

RANGE OF MOTION

Active range of motion should always be measured as part of the Constant and Murley Score.

ESSES recommends measuring range of motion with the patient sitting on a chair or bed, with weight even distributed between the ischial tuberosities. No rotation of the upper torso is allowed during the examination.

In the case of active motion, the patient lifts the arm to a painfree level. The range of motion is determined by noting the number of degrees at which the pain starts. If one measures the active range of motion with pain, this should be stated. The Constant score cannot then be applied beyond the initiation of pain.

The most important thing is that range of active motion is performed and measured in a standardised way.

In the Constant score system there is precise information about how the points are calculated. Bear in mind that 150 degrees of flexion give 8 points, while 151 degrees give 10 points.

Forward flexion 10 points	
0-30°	0
31-60°	2
61-90°	4
91-120°	6
121-150°	8
151-180°	10

Abduction 10 points

0-30°	0
31-60°	2
61-90°	4
91-120°	6
121-150°	8
151-180°	10

External rotation 10 points (hand is not allowed	
Not reaching the head	0
Hand behind head with elbow	
Hand behind head with elbow back	2
Hand on top of head with elbow	
Hand on top of head with elbow back	2
Full elevation from on top of head	2

INTERNAL ROTATION

End of the thumb to lateral thigh	0
End of the thumb to buttock	2
End of the thumb to lumbosacral	4
End of the thumb to L3 (waist)	6
End of the thumb to T 12	8
End of the thumb to T 7(interscapular)	10

STRENGTH

Strength is given a maximum of 25 points in the Constant Score. The significance and technique of strength measurement has been and still continues to be the subject of much discussion.

The European Society for Shoulder and Elbow Surgery measures (ESSES) strength according to the following method:

- A spring balance is attached distal on the forearm.
- Strength is measured with the arm in 90 degrees of elevation in the plane of the scapula (30 degrees in front of the coronal plane) and elbow straight.
- Palm of the hand facing the floor (pronation).
- The patient is asked to maintain this resisted elevation for 5 seconds.

- It is repeated 3 times immediately after another.
- The average in pound (lb) is noted.
- The measurement should be painfree. If pain is involved the patient gets 0 points.
- If patient is unable to achieve 90 degrees of elevation in the scapula plane the patient gets 0 points.

***FUNCTION MUSCLE (M)**

0 Less than 1 kg
3 "1 kg - 2 kg"
5 "2 kg - 3 kg"
7 "3 kg - 4 kg"
9 "4 kg - 5 kg"
11 "5 kg - 6 kg"
13 "6 kg - 7 kg"
15 "7 kg - 8 kg"
17 "8 kg - 9 kg"
19 "9 kg - 10 kg"
21 "10 kg - 11 kg"
23 "11 kg - 12 kg"
25 "12 kg or above"

SCORING

0-55	Poor
56-70	Moderate
71-85	Good
>86	Excellent

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PROFORMA

Name :

Age / Sex :

IP number :

Address :

Contact Number :

Date of Admission :

Date of Surgery :

Date of Discharge :

Occupation :

Education :

Socioeconomic Status :

HISTORY:

1. Mode of injury : Road traffic accident / Fall at home / Fall from height / Assault
2. Presenting complaints :
    a. Pain – site / duration
    b. Swelling – site / extent
    c. Deformity
    d. Disturbances in function of shoulder and hand – movements / sensations
    e. Other associated injuries – head injury / limb injuries / spine injuries

3. Comorbid illnesses :

Diabetes mellitus		Hypertension		Coronary heart disease	
Renal disorder		Seizures /Neurological disorder		Hepatic disorder	
Dyslipidemia		Endocrine disorder		Tuberculosis	
Bronchial Asthma		Chronic Obstructive lung diseases		Neoplastic disorders	

4. Drug history : Steroids / Disease modifying anti-rheumatoid drugs / Immunosuppressants

PAST HISTORY:

- Any similar injuries
- Previous surgeries or hospitalisations
- Any major illnesses

PERSONAL HISTORY:

Diet	Vegetarian / Mixed
Marital Status	Married / Single
Bowel and Bladder habits	Regular / Altered
Habits	Smoking / Alcohol / Tobacco / Drug Addictions / Others

OBSTETRIC & GYNAECOLOGY HISTORY:

TREATMENT HISTORY:

FAMILY HISTORY:

CLINICAL EXAMINATION:

GENERAL EXAMINATION:

- Appearance :
- Built :
- Pallor :
- Icterus :
- Cyanosis :
- Clubbing :
- Pedal Edema :
- Lymphadenopathy :

VITALS:

1. Pulse :
2. BP :
3. Respiratory rate :
4. Temperature :

SYSTEMIC EXAMINATION :

- Cardiovascular system :
- Respiratory system :
- Abdomen :
- Central Nervous System :

REGIONAL EXAMINATION

RIGHT / LEFT ARM

OTHER INJURIES

X – RAY FINDINGS

3D CT RIGHT/LEFT SHOULDER JOINT (If needed)

INVESTIGATIONS

Hb%		TC		DC	P L B E M
ESR		BT/CT		RBS	
UREA		S.CREATININE		ELECTROLYTES	Na^+ K^+
HBsAg		HIV		VDRL	
CXR		ECG		URINE ROUTINE ALBUMIN SUGAR DEPOSITS	
Blood G & T					

FINAL DIAGNOSIS:

INITIAL TREATMENT GIVEN:

PLANNED SURGERY :

PROCEDURE NOTES

POST OP PERIOD

FOLLOW UP (After discharge)	CLINICAL FINDINGS	X–RAY FINDINGS	ADVICE
FIRST WEEK			
SECOND WEEK			
FIRST MONTH			
SECOND MONTH			
THIRD MONTH			
SIXTH MONTH			
SEVENTH MONTH			

OUTCOME:

PATIENT CONSENT FORM

Study detail:" A STUDY ON FUNCTIONAL AND RADIOLOGICAL OUTCOME OF PROXIMAL HUMERAL FRACTURES TREATED WITH LOCKING COMPRESSION PLATES (PHILOS PLATES)"

Study centre : KILPAUK MEDICAL COLLEGE, CHENNAI

Patients Name :

Patients Age :

Identification Number :

Patient may check (✓) these boxes

I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ☐

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. ☐

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. ☐

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. ☐

I hereby consent to participate in this study. ☐

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

நோயாளி ஒப்புதல் படிவம்

ஆராய்ச்சியின் விவரம்: மேற் கை பகுதியில் உள்ள எலும்பு முறிவிற்கு உலோக தகட்டை அறுவை சிகிச்சையின் மூலம் பொருத்தி அதன் பயன்களை அறியும் ஆய்வு அறிக்கை

ஆராய்ச்சி மையம்: அரசு கீழ்பாக்கம் மருத்துவக் கல்லூரி மருத்துவமனை

நோயாளியின் பெயர்: நோயாளியின் வயது:

பதிவு எண்:

நோயாளி கீழ்கண்டவற்றுள் கட்டங்களை (✔) செய்யவும்

1. மேற்குறிப்பிட்டுள்ள ஆராய்ச்சியின் நோக்கத்தையும் பயனையும் முழுவதுமாக புரிந்துகொண்டேன். மேலும் எனது அனைத்து சந்தேகங்களையும் கேட்டு அதற்கான விளக்கங்களையும் தெளிவுபடுத்திக் கொண்டேன். ☐

2. மேலும் இந்த ஆராய்ச்சிக்கு எனது சொந்த விருப்பத்தின் பேரில் பங்கேற்கிறேன் என்றும், மேலும் எந்த நேரத்திலும் எவ்வித முன்னறிவிப்புமின்றி இந்த ஆராய்ச்சியிலிருந்து விலக முழுமையான உரிமை உள்ளதையும், இதற்கு எவ்வித சட்ட பிணைப்பும் இல்லை என்பதையும் அறிவேன். ☐

3. ஆராய்ச்சியாளரோ, ஆராய்ச்சி உதவியாளரோ, ஆராய்ச்சி உபயத்தாரோ, ஆராய்ச்சி பொருளீட்டுரோ, ஒழுங்குநெறி செயற்குழு உறுப்பினர்களோ எப்போது வேண்டுமானாலும் எனது அனுமதியின்றி எனது உள்நோயாளி பதிவுகளை இந்த ஆராய்ச்சிக்காகவோ அல்லது எதிர்கால பிற ஆராய்ச்சிகளுக்காகவோ பயன்படுத்திக்கொள்ளலாம் என்றும், மேலும் இந்த நிபந்தனை நான் இவ்வாய்ச்சியிலிருந்து விலகினாலும் தரும் என்றும் ஒப்புக்கொள்கிறேன். ஆயினும் எனது அடையாளம் சம்பந்தப்பட்ட எந்த பதிவுகளும் சட்டபூர்வமான தேவைகள் தவிர வெளியிடப்படமாட்டாது என்ற உறுதிமொழியின் பெயரில் இந்த ஆராய்ச்சியிலிருந்து கிடைக்கப்பெறும் முடிவுகளை வெளியிட மறுப்பு தெரிவிக்கமாட்டேன் என்று உறுதியளிக்கின்றேன். ☐

4. இந்த ஆராய்ச்சிக்கு நான் முழுமனதுடன் சம்மதிக்கின்றேன் என்றும் மேலும் ஆராய்ச்சிக் குழுவினர் எனக்கு அளிக்கும் அறிவுரைகளை தவறாது பின்பற்றுவேன் என்றும் இந்த ஆராய்ச்சி காலம் முழுவதும் எனது உடல் நிலையில் ஏதேனும் மாற்றமோ அல்லது எதிர்பாராத பாதகமான விளைவோ ஏற்படுமாயின் உடனடியாக ஆராய்ச்சி குழுவினரை அணுகுவேன் என்றும் உறுதியளிக்கின்றேன். ☐

5. இந்த ஆராய்ச்சிக்குத் தேவைப்படும் அனைத்து மருத்துவ பரிசோதனைகளுக்கும் ஒத்துழைப்பு தருவேன் என்று உறுதியளிக்கின்றேன். ☐

6. இந்த ஆராய்ச்சிக்கு யாருடைய வற்புறுத்தலுமின்றி எனது சொந்த விருப்பத்தின் பேரிலும் சுயசுதந்திரத்துடனும் முழுமனதுடனும் சம்மதிக்கின்றேன் என்று இதன் மூலம் ஒப்புக்கொள்கிறேன். ☐

நோயாளியின் கையொப்பம் / பெருவிரல் கைரேகை: ஆராய்ச்சியாளரின் கையொப்பம்:

இடம்: தேதி:

INSTITUTIONAL ETHICAL COMMITTEE
GOVT.KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Ref.No.2318/ME-1/Ethics/2012 Dt:04.04.2013
CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "A Study on functional and radiological outcome of proximal humeral fractures treated with locking compression plates (Philo Plates)" – For Project Work submitted by Dr.Prabhu.V, MS (Ortho), PG Student, KMC, Chennai-10.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

GOVT. KILPAUK MEDICAL COLLEGE
29 MAY 2013
Kilpauk, Chennai-10.

29/5/13.
CHAIRMAN,
Ethical Committee
Govt.Kilpauk Medical College,Chennai