“FUNCTIONAL OUTCOME OF LOCKING PLATES IN PROXIMAL HUMERAL FRACTURES: BASED ON AGE AND FRACTURE PATTERN”

Dissertation Submitted to

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In partial fulfillment of the regulations for the Award of the Degree of

M.S. (ORTHOPAEDIC SURGERY)

BRANCH –II

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MAY 2018

CERTIFICATE

This is to certify that the dissertation entitled **"FUNCTIONAL OUTCOME OF LOCKING PLATES IN PROXIMAL HUMERAL FRACTURES: BASED ON AGE AND FRACTURE PATTERN"** is a bonafide work done by **Dr.M.RATHNA KUMAR, M.S ORTHOPAEDIC SURGERY BRANCH-II** at Government Kilpauk Medical College, Chennai-600010, to be submitted to The Tamil Nadu Dr.M.G.R Medical University, Chennai in partial fulfillment of the university rules and regulations for the award of M.S.Degree Branch-II Orthopaedic Surgery, under my supervision and guidance during the period from May 2015 to May 2018.

Prof.Dr.S.Veera Kumar,
M.S.Ortho,
Professor of Orthopaedics,
Department of Orthopaedics,
Govt.Kilpauk Medical College,
Chennai-600010.

Prof.Dr.S.Senthil Kumar,
M.S.Ortho, D.Ortho,
Professor and HOD,
Department of Orthopaedics,
Govt.Kilpauk Medical College,
Chennai-600010.

Prof.Dr.P.VASANTHA MANI,
MD, DGO. MNAMS. DCPSY, MBA,
DEAN,
Govt. Kilpauk Medical College,
Chennai – 600 010.

DECLARATION

I solemnly declare that this dissertation **"FUNCTIONAL OUTCOME OF LOCKING PLATES IN PROXIMAL HUMERAL FRACTURES: BASED ON AGE AND FRACTURE PATTERN"** is a bonafide work done by me at Govt. Kilpauk Medical College and Hospital, Chennai-10 during the period from May 2015 to May 2018 under the guidance and supervision of my unit Chief **Prof.Dr.S.VEERA KUMAR, M.S.Ortho,** Professor of Orthopaedic surgery, Govt. Kilpauk Medical College and Hospital, Chennai-10.

This dissertation is submitted to "THE TAMILNADU DR MGR MEDICAL UNIVERSITY", Chennai in partial fulfillment of the University regulations for the award of degree of M.S. BRANCH II ORTHOPAEDIC SURGERY.

Place :

Date : **Dr.M.RATHNA KUMAR**

INSTITUTIONAL ETHICS COMMITTEE

GOVT. KILPAUK MEDICAL COLLEGE, CHENNAI-10

Protocol ID. No.06/2016 Meeting held on 14/12/2016

CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval **"FUNCTIONAL OUTCOME OF LOCKING PLATES IN PROXIMAL HUMERAL FRACTURES: BASED ON AGE AND FRACTURE PATTERN"** submitted by Dr.M.Rathna Kumar.,Post Graduate in M.S.Ortho, Govt. Kilpauk Medical College, Chennai.

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.

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Lastly, I thank all the patients who wholeheartedly consented for the surgery for the betterment of science without whom this study would not have been possible.

CONTENTS

PART - A
INTRODUCTION

With progressively increasing incidence of Road Traffic Accidents, Assault and Occupational industrial accidents, occurrence of multiple fractures has become common. They form the major epidemic of modern era.

Proximal humerus account for 4-5% of all fractures.[1] Out of all humerus fractures it accounts for nearly 45%. In the Elderly patients it is the third most common fracture following fractures around proximal part of Hip and Colle's fracture. The increasing incidence is attributed to osteoporosis in aged population and higher velocity injuries in young patients. Various authors have suggested non operative treatment for proximal humerus fractures in elderly patients. But following conservative management complications like pain, joint stiffness, decreased function and muscle power have been documented in more percentage of patients[29]. 15% to 20% of displaced proximal humerus fractures may need surgical fixation for better results. The incidence of complications from operative treatment varies between 11% and 50%.

Over the last three decades, various modalities of fixation have evolved for the proximal humerus fractures. Of these Proximal Humerus locking plate is the implant of choice now for treatment of displaced fractures. Stable anatomical fixation can be achieved through surgery and hence permits early mobilization.

REVIEW OF LITERATURE

In ancient times, physicians advised bandaging and rest for closed proximal humerus fractures, and open fractures were usually considered fatal.[4] In 460 BC Hippocrates first documented a proximal humerus fracture and he treated it with traction which aided in bone healing. However till the end of 19th century, less was known about this fracture.

In 1896 Kocher, to improve the diagnosis and treatment devised an anatomic classification of proximal Humerus[4]. This Classification didn't gain significance as it was not descriptive enough and lacked consistency. Pean in 1893 described the first prosthetic arthroplasty for the shoulder joint.

Codman in 1934 devised a classification system based on epiphyseal lines that divided the proximal humerus into 4 parts. In 1970, Neer included anatomical, biomechanical, and treatment principles and expanded the classification on a 4 part concept.[31] Upto 1950, treatment modalities have included manipulation, traction and casting with an emphasis on early functional range of motion.[1]

A systematic approach to surgical fixation of proximal humerus was described first by Lambotte and Lane.[1]The concept of minimum fixation to preserve "The blood supply to the head and anterolateral

artery" was first described by Neer.[8] In 1970, the AO group published its "Manual of internal fixation". A three dimensional anatomically adjusted PHILOS plate provides a locking system for internal fixation of proximal humerus fractures in modern era.[12]

ANATOMY OF THE SHOULDER

The Humerus ossifies from one primary center and seven secondary centers. The primary ossification center appears in the middle of the humeral diaphysis during eighth week of development.[1,6] The upper part ossifies from 3 secondary centers. One Center for Head, one center for Greater tubercle and one center for Lesser tubercle. These three centers fuse and form the epiphysis. The Epiphysis then fuses with the diaphysis during the 20th year. The Epiphyseal line at the lowest margin of the head is the growing end of the bone.

The Lower end of Humerus ossifies from four centers and form two epiphyses. One center for Capitellum, Lateral Flange of Trochlea (1st Year). One Center for Trochlea medial flange (ninth year) and one center for Lateral Epicondyle of Humerus at twelfth year. These three centers fuse during the fourteenth year and form an epiphysis which inturn fuses with the diaphysis by 16 years. The ossification Center for Medial Epicondyle appears by 4-6 years, form a separate epiphysis which in turn fuses with the diaphysis during the twentieth year.

RELEVANT ANATOMY

To achieve a good reduction and correct alignment, it is important to understand the anatomy of shoulder joint. The Humerus is the largest and the longest bone of the upper limb. It has wide expanded upper part, a shaft and a lower end.

The upper end of Humerus consists of following parts.[6]

1) The Head
2) The Anatomical neck
3) The Greater tuberosity
4) The Lesser tuberosity
5) The Surgical neck
6) Intertubercular sulcus
7) Proximal Humeral Shaft

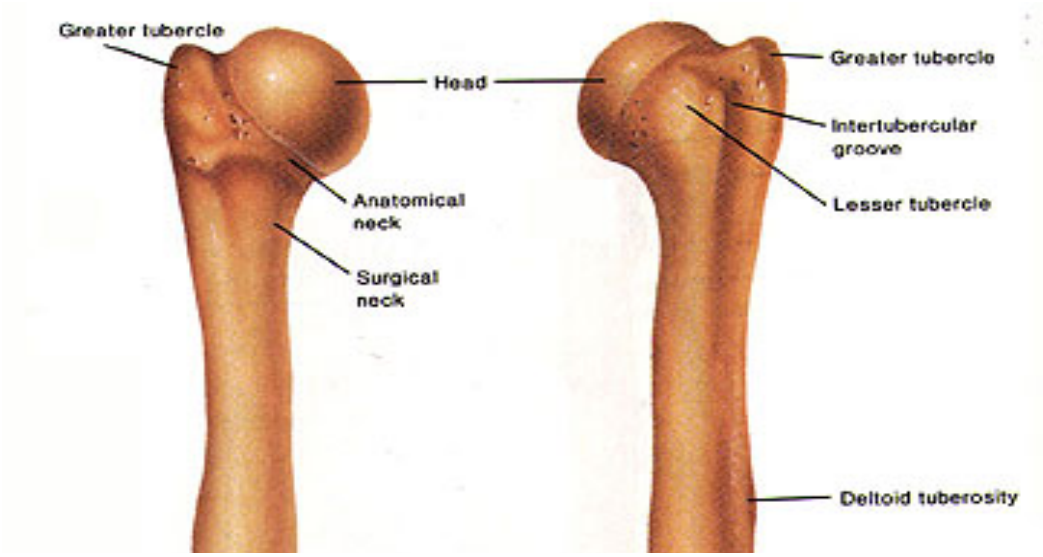
The Head

The head forms about one-third of a sphere and is larger in size than the glenoid cavity.[6]The head is directed medially, backwards and upwards. The diameter of curvature of the head is about 46mm on an average ranging from 37 mm to 57 mm.

The Humeral head articulation is in retroversion on an average of about 20^{o}. The inclination of humeral head in relation to the shaft averages 130 degrees.

The Anatomical Neck

Anatomical Neck is the line which separates the articular surface of the head from the rest of the proximal humerus. The articular capsule of the shoulder joint attaches to the anatomical neck.



The Greater Tuberosity

The greater tuberosity is an elevation that forms the lateral aspect of the proximal humerus.[6] The posterior part has three impressions, to which Supra spinatus, Infra spinatus, Teres minor attaches. The lateral surface of the greater tuberosity is convex and is covered by the Deltoid muscle which produces the rounded contour of the shoulder.

The Lesser Tuberosity

The Lesser tuberosity is an elevation present on the anterior aspect of the proximal humerus. It is directed medially and forward and the multipennate subscapularis muscle gets inserted to it.

The Surgical Neck

It is the constriction present between the tuberosities and shaft of humerus.

The Intertubercular Sulcus (Bicipital Groove)

The sulcus separates the lesser tubercle from the anterior part of the greater tubercle. Its contents are:

1) Long head of biceps
2) Branch of the anterior humeral circumflex artery.

Its upper part is covered with a thin layer of cartilage, lined by synovial membrane which prolongs from the synovial membrane of the shoulder joint. Its lower portion gives attachment to the insertion of Latissimus dorsi.[6]

ANATOMY OF THE ANTERIOR PORTION OF THE SHOULDER

Glenoid

The Glenoid is a convex, shallow structure and is like an inverted “comma” shaped structure. It is approximately one third to one fourth of the surface area of the humeral head.[1,6]It articulates with the head of the humerus and the glenoidal labrum and capsule gets attached with it.

Gleno humeral joint

The Shoulder joint is a synovial joint and is a Ball and Socket variety. It is formed by the articulation of the scapula and the head of the humerus. Hence it is also known as Gleno-humeral Articulation. Shoulder joint has the greatest range of motion than any other joint in the body.

The Shoulder joint is weak structurally because it has a small and shallow glenoid cavity that holds the humeral head in place. The Humeral head’s size is four times larger than the size of the glenoid cavity.[6] This arrangement allows greater range of motion.

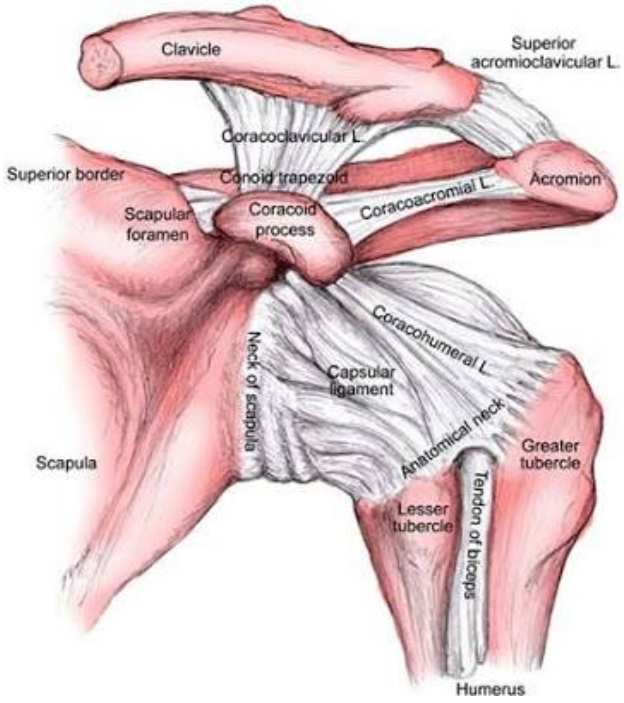
There are various factors that maintain the stability of the glenohumeral joint. They are as follows:[1,2,6]

1. The Rotator Cuff (Musculotendinous Cuff)
2. The Coracoacromial arch which act as the second socket for the humeral head
3. Glenoid Labrum-It helps in deepening the glenoid fossa.

Additional stability for the shoulder joint is also provided by other structures such as Long head of Biceps, Long head of Triceps, Pectoral muscles and atmospheric pressure.

The Static stabilizers of the shoulder joint are as follows:[1]

1. Fibrous Capsule
2. Coracohumeral Ligament
3. Glenohumeral Ligament
4. Transverse humeral Ligament
5. Glenoidal Labrum.



The Shoulder joint has also dynamic stabilizers which are

1.Musculotendinous Cuff or Rotator Cuff

2.Deltoid

3.Trapezius

4.Serratus Anterior

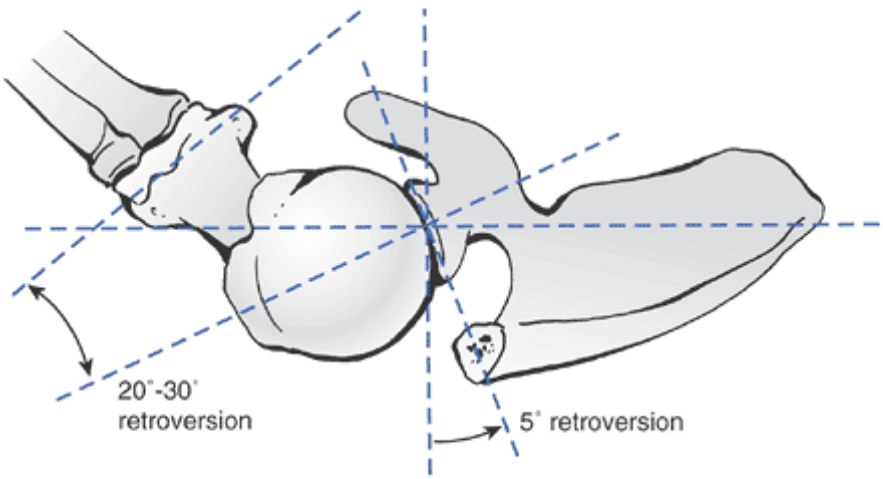
5 .Lattissimus dorsi

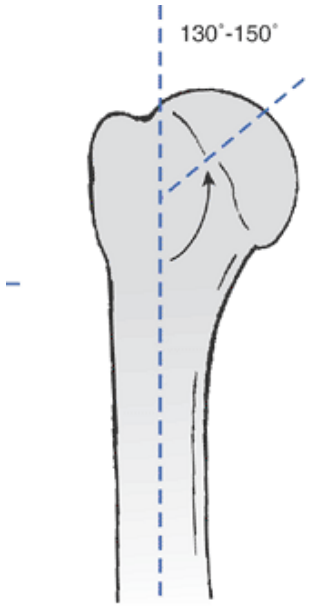
6.Rhomboids

7.Levator scapulae

The factors that maintain the dynamic stability of the Shoulder Joint are,[6]

1. Optimum Retrotorsion of the humeral head in relation to the humeral Shaft
2. Normal retrotilt of the glenoid articular surface in relation to the axis of the scapula.



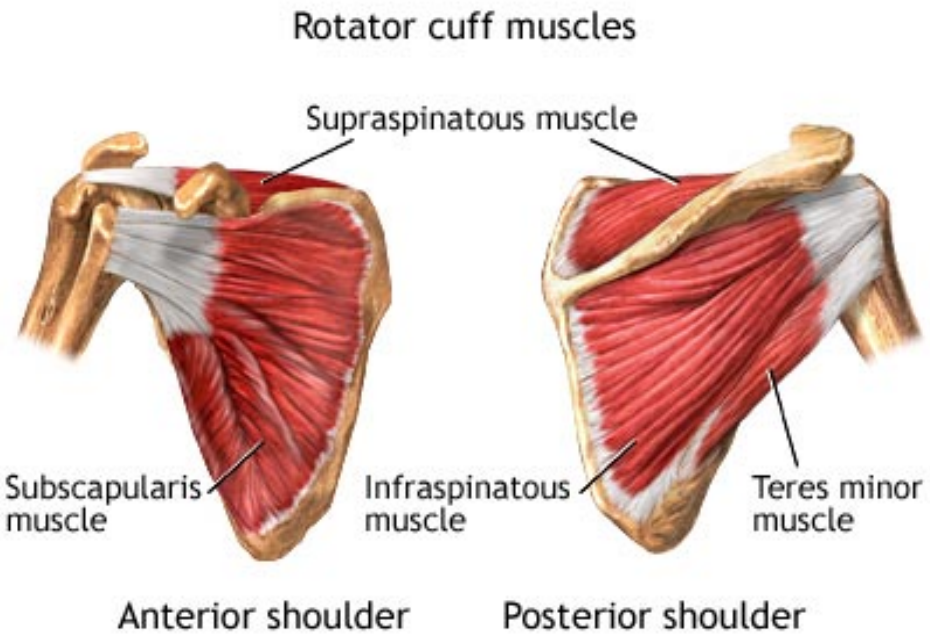


Rotator cuff

The tendons that gets attached to the greater and lesser tuberosity form the rotator cuff[6]. They are:

1) Supra spinatus
2) Infra spinatus
3) Teres minor
4) Subscapularis

The orientation of the rotator cuff attachment to the humerus is important to understand the displacement of tuberosities in proximal humerus fractures.[6,23]



Surgical Anatomy

The muscles of the Rotator cuff are attached to the greater and lesser tuberosities of the humerus. It is important to know the direction of pull of fibers to understand the displacement of fractured tuberosity fragments. In case of fracture of greater tuberosity, the fragment will be pulled superiorly and posteriorly because of the pull of supraspinatus and teres minor.[7,13]In case of fractures of Lesser tuberosities, the fragment will be pulled anteriorly and medially by the subscapularis muscle.

During closed reductions of the fractures, the long head of biceps act as a block for reduction and it is a landmark to identify the rotator cuff. The deltoid muscle which is getting inserted into the deltoid

tuberosity causes displacement of fracture of the shaft at the surgical neck of humerus.

The Pectoralis major which gets inserted into the lip of inter tubercular sulcus causes displacement of the fracture medially as seen in surgical neck of humerus fractures.

Neurovascular structures like Axillary artery and Brachial plexus are just medial to the coracoid process. Precautions should always be taken to avoid injury to this structures while coracoid is osteotomised for better exposure. Axillary nerve leaves the posterior wall of axilla and penetrates the quadrangular space, it then winds around the humerus and enters the deltoid muscle posteriorly about seven centimeters from the tip of acromion process.[1,6]So care should be taken to avoid injury to the nerve during dissection of the deltoid.

VASCULAR ANATOMY

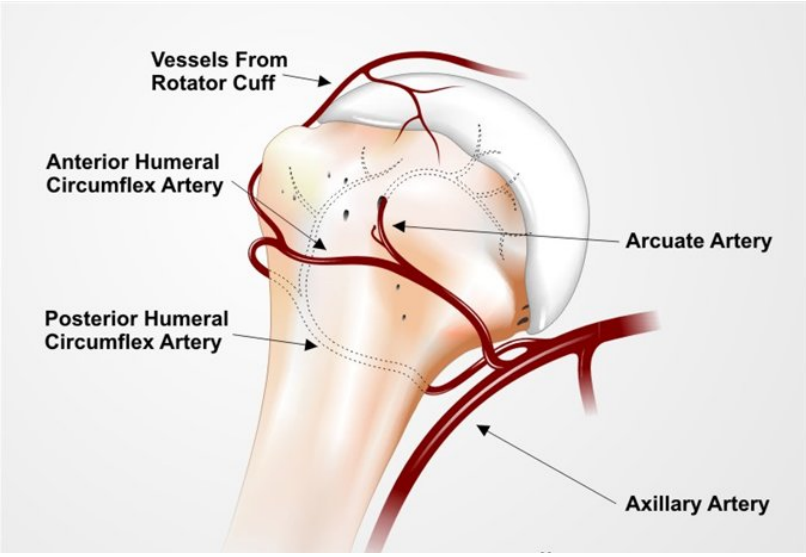
Proximal humerus gets its blood supply from the following vessels:[8,9]

1) Ascending branch of anterior humeral circumflex artery (main supply)
2) Branch from the posterior humeral circumflex artery
3) Vessels from the tuberosities
4) Metaphyseal vessels.

The major blood supply to the head comes from Anterior Circumflex Humeral artery which is a branch of third division of Axillary artery. Arcuate artery is a continuation of the ascending branch of Anterior Circumflex Humeral artery. This artery supplies a large portion of the head of the humerus. It enters the humerus in the area of the Intertubercular sulcus.

Posterior Circumflex Humeral artery enters from the posteromedial aspect of proximal humerus. Blood supply to proximal humerus is also contributed by Vessels of the greater tuberosity, Lesser tuberosity, Vessels entering through Rotator cuff insertion and Metaphyseal vessels.[8,9]

The articular necrosis of humeral head incidence is high in fracture involving anatomical neck, four part fracture with dislocation. The incidence of articular necrosis of humeral head is relatively low in fractures impacted in valgus position, articular segment with posteromedial spike.



BIOMECHANICS

Of all the joints in the body, the glenohumeral joint has greatest range of motion and has the least stability. The Shoulder joint is not located exactly either in the coronal or sagittal plane. The head of the humerus is in retroversion of about 30^{o} to 40^{o} to articulate with the glenoid.[6] The average Radius of curvature of the adult humeral head is 44 mm.

The humeral head at any given point has only 25% to 30% articulation with the glenoid cavity. The area of the contact was increased by the presence of glenoidal labrum. Majority of the proximal humerus fractures occurs as are sult of indirect force such as fall with an outstretched arm. Injury caused by a direct blow to shoulder are relatively less. The fracture pattern was determined by the muscular pull of adjacent tendon attachments on humeral fracture fragments.[13]

Displacements:

Greater tuberosity fragment → Posterosuperiorly (by supraspinatus and Infraspinatus)

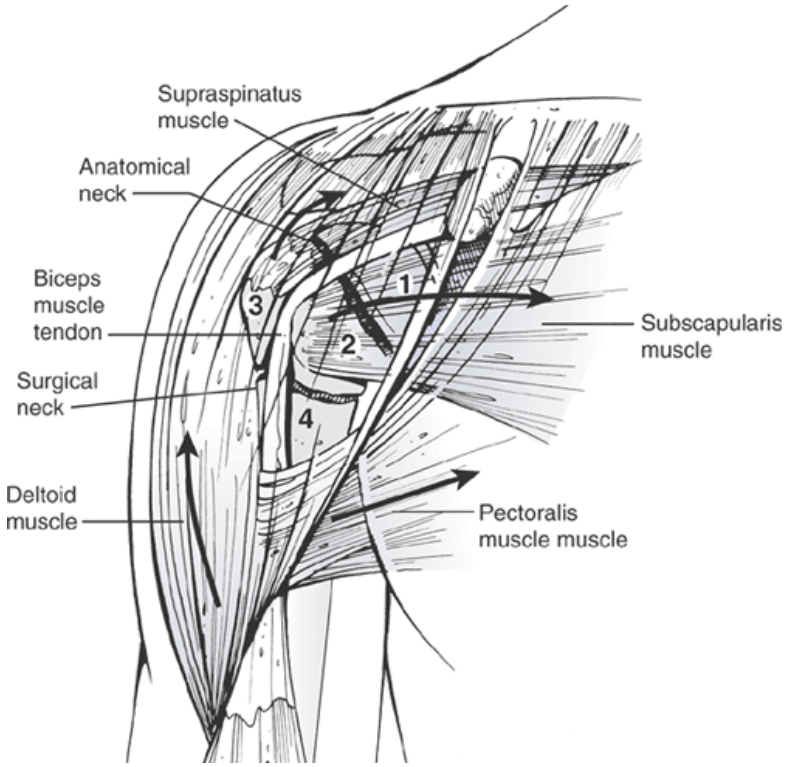
Lesser tuberosity fragment → Medially (by Subscapularis)

Shaft → Anteriorly and Medially (by Pectoralis major)

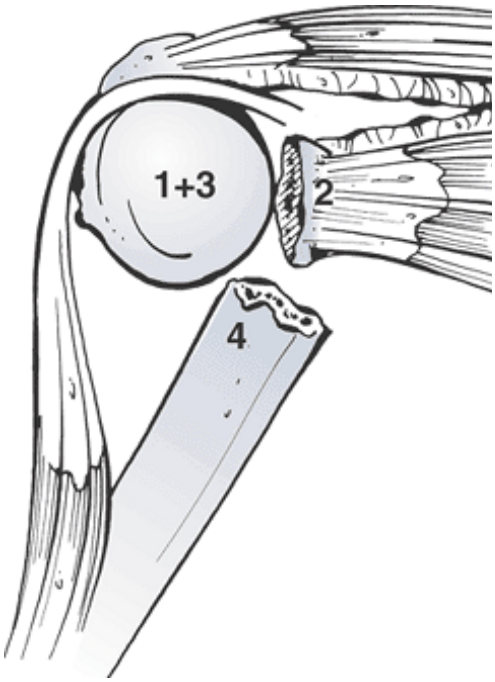
In case of three part fractures, if the greater tuberosity remains attached to the head, the articular surface faces anteriorly and faces posteriorly when the lesser tuberosity remains attached to the head.

Based on the bone quality,the patients can be divided into groups. In group I, the patients are young, with either minimally displaced fractures or more comminution. These group of individuals are suitable for rigid fixation because of good quality bone. In group II patients, the bone quality is osteoporotic because of older age, have most often displaced fragments than impacted. Fixation in these group of patients will be a challenging one because of the poor bone quality.

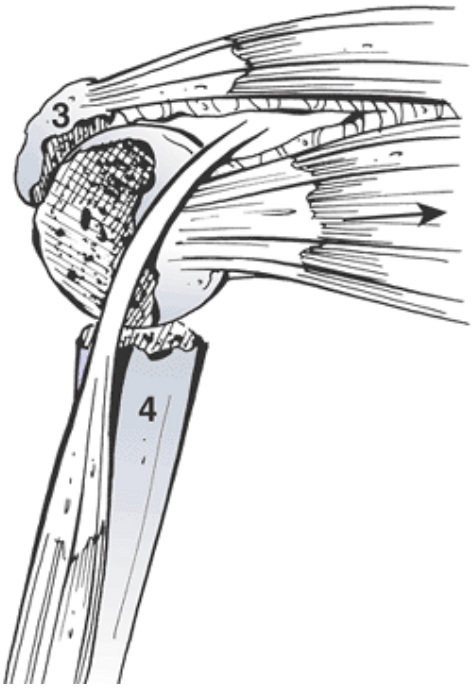
Displacement of fragments



Greater tuberosity - attached to the head



Lesser tuberosity - attached to the head

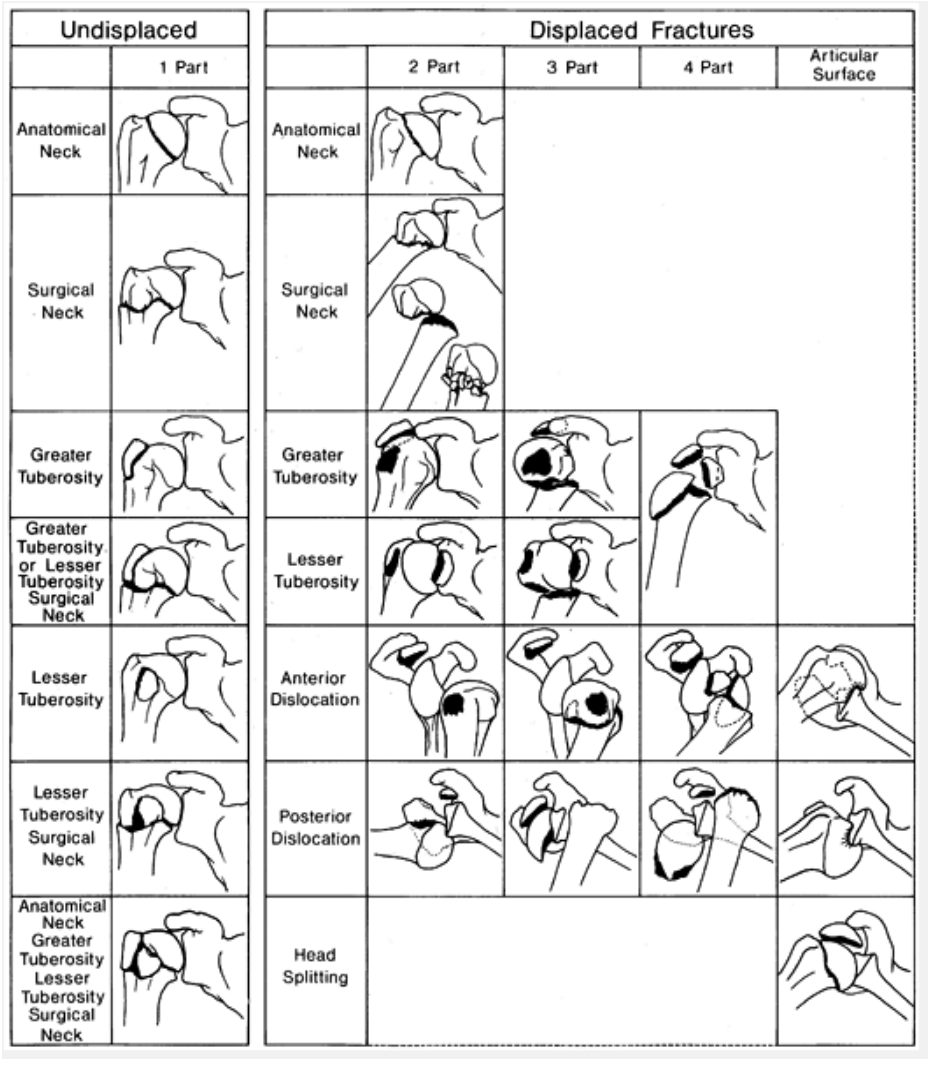


CLASSIFICATION

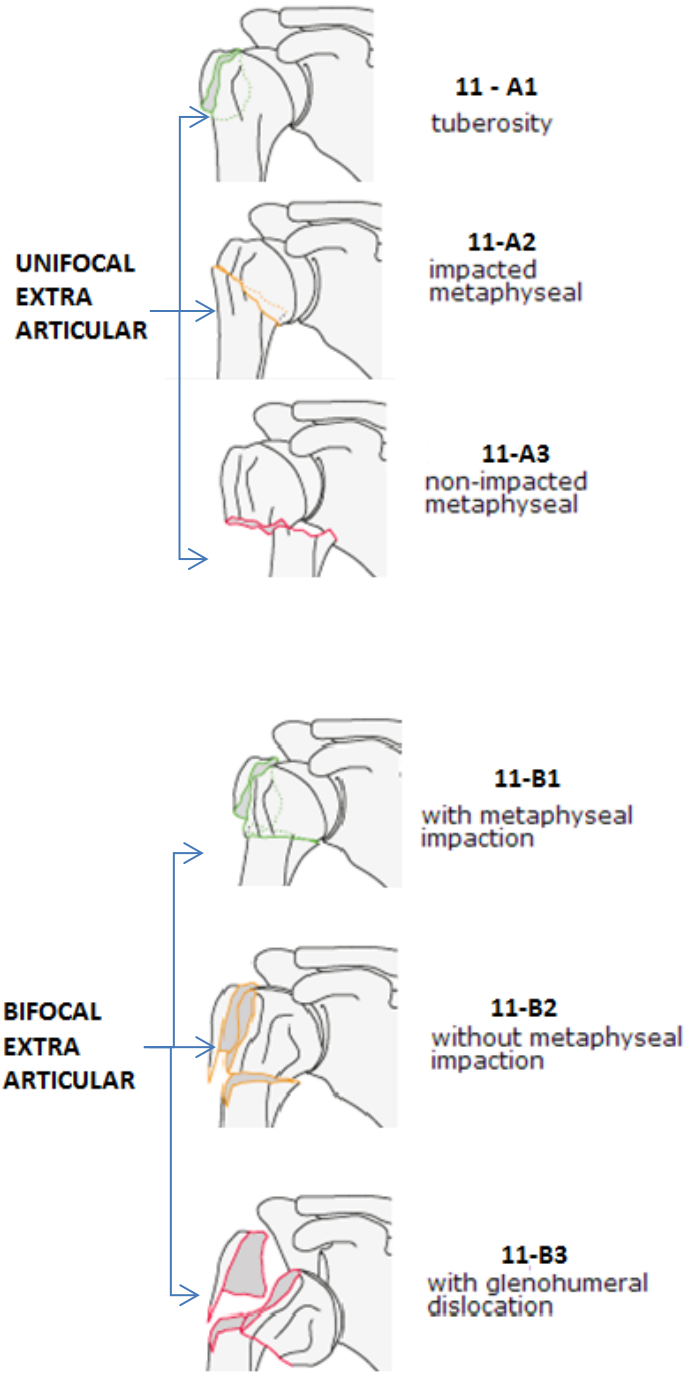
The most commonly used classification system for Proximal Humerus Fractures is Neer's classification.[31] The Classification is based on:

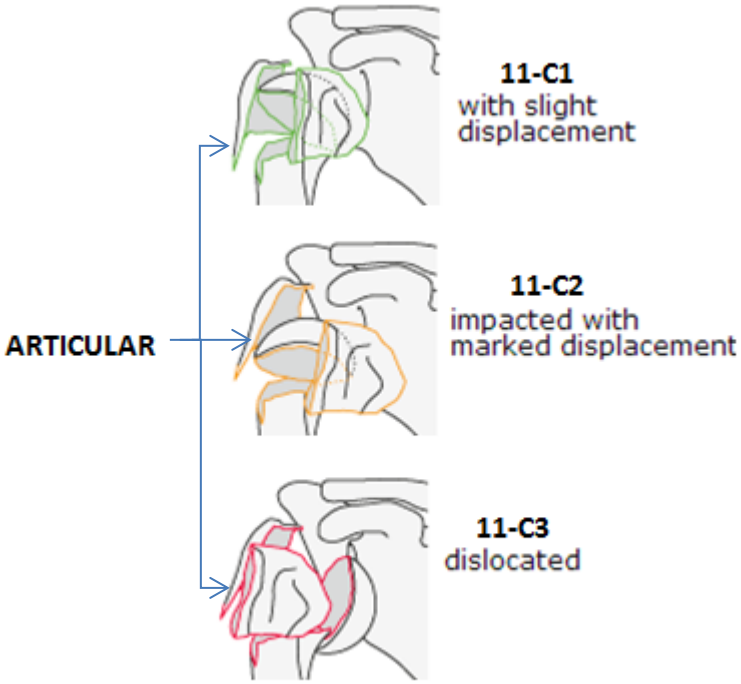
- Number of fragments
- Displacement of fragments

The criteria for displacement of fracture fragments are 45 degree angulation or more than 1cm displacement between the fracture parts.[1,13]



“AO” CLASSIFICATION SYSTEM





The other classification system available for proximal Humerus fractures are

1. Kocher's Classification
2. Watson –Jones Classification
3. Codman Classification.

MECHANISM OF INJURY

Fractures in younger adults and adolescents are produced by Road Traffic Accidents, fall from height, injuries sustained during sports or gunshot injuries. In elderly patients the fractures result mostly from low velocity injuries because of the osteoporotic nature of the bone. The risk of fracture is increased in people with familial history of osteoporotic fractures, low bone mineral density, frequent falls and impaired balance. Middle aged patients with preexisting co-morbid conditions or physiologically older because of use of tobacco, alcohol or drug may sustain fracture even from a low velocity injury. In females an early menopause is a cause for fractures.

When an impact on a shoulder occurs, a proximal humerus fracture occurs by a combination of external forces and intrinsic forces and bone quality of the proximal humerus. These forces determines the initial fracture pattern and the displacement of the fractures. Displaced fractures are likely to occur in patients with multiple medical comorbidities and patients with advanced osteoporosis.

Proximal humerus fractures occur either by a direct impact onto the shoulder or by an indirect forces transmitted to the shoulder, such as fall with an outstretched arm.[1,2] Fracture that occurs with little or no trauma

may be a pathologic fracture from metastatic tumour deposits or a primary bone tumour. Occult fracture may cause persistent pain after significant injury, which may be detectable by Ultrasound or Magnetic Resonance Imaging (MRI).

Codman, described that fracture may occur due to increased rotation of the arm especially in abduction, when the humeral head gets locked against the acromion producing a pivotal position, facilitating a fracture. Proximal humerus fracture dislocation are also reported to have occur in cases of Electric shock or Convulsive episodes, where they may be a bilateral fracture dislocation.

INVESTIGATIONS

History

A detailed history should be elicited from the patient including patient's health, handedness, occupation and details of the injury. Patient's general health condition should be understood, whether he or she has osteoporosis or metabolic disorders and is of critical importance, as this factors predict the outcome of surgery in these patients.

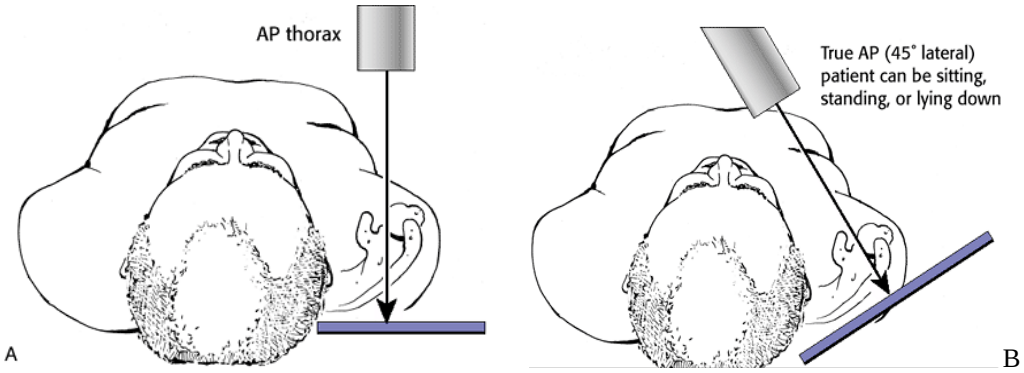
Imaging

Adequate radiographic evaluation is essential for accurate fracture classification and treatment decision. Most of the shoulder injuries are missed with radiographs taken in the plane of the body rather than in the plane of the Scapula. To avoid this limitation, a Trauma series Radiographs with 3 views was introduced. The radiographic views which are useful in making the diagnosis are,[1,2]

1) True Anteroposterior (AP) view of shoulder
2) Axillary view (or) Velpeau axillary view
3) Lateral "Y" view of the scapula

True anteroposterior view of shoulder:

For true AP view, the posterior aspect of the affected shoulder is placed against the X-ray plate and the contralateral shoulder is rotated out approximately 40^0.This view facilitates the visualization of the shoulder joint without any bony superimposition.



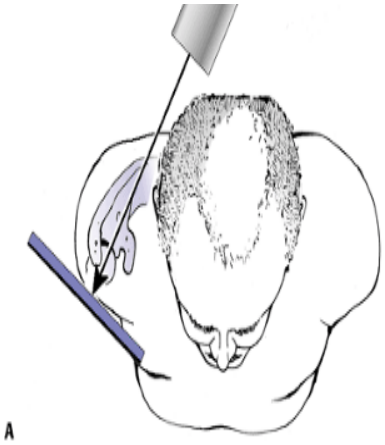
Axillary view

The arm is held in abduction of $70^o$to 90^o, X-ray plate is placed above the patient's shoulder. The X-ray beam is directed from inferior to superior. This view helps in assessing the degree of tuberosity displacement, articular surface of glenoid and relationship of humeral head to the glenoid.

Velpeau Axillary View

Lateral "Y" view of the scapula

The anterior aspect of the injured shoulder is placed against the X-ray plate and the contralateral shoulder is rotated out approximately 40^{o}.The X-ray tube is directed from posterior to anterior along the spine of scapula. In this view the scapula appears "Y" shaped with Glenoid in the center, the upperlimbs of the "Y" was formed by coracoid and acromion and the vertical limb was formed by the scapular body.



Computed Tomography

3-Dimentional reconstructive computed tomography are useful in evaluation of intraarticular fractures and aids in the preoperative planning and to assess the degree and nature of damage to articular surface. [11]

3D Reconstruction CT Scan

PRINCIPLES OF MANAGEMENT

The factors which determine the type of management and influencing the prognosis includes

1) Fracture Related:

   - Fracture pattern and number of fractured fragments
   - Displacement of greater and lesser tuberosities
   - Presence of posteromedial spike in articular fragment
   - Degree of comminution

2) Other Factors:

   - Bone Quality(Degree Of Osteoporosis)
   - Extent of soft tissue injuries
   - Associated neurovascular injuries
   - Presence of multiple trauma
   - Magnitude of joint involvements

Chance of Avascular Necrosis of the head of humerus is increased with increased number of fragments and dislocation of the articular segment. The presence of posteromedial spike in the articular fragment reduces the chance of avascular necrosis (AVN).[1,12] Degree of

osteoporosis and the extent of soft tissue injury will decide the implant to be used.

So the objectives of treatment of proximal humerus fractures in adults are :

1) To obtain and maintain satisfactory reduction
2) To treat the associated injuries
3) To regain the functional range of movements of shoulder joint.

METHODS OF TREATMENT

The main goal of treatment is to make the patient return to day to day activities as early as possible and to achieve a near normal function.The variable treatment options for treating an adult with a fracture proximal humerus are:

1) Conservative management
2) Surgical management
    1. Closed reduction and fixation with K-wires / cancellous screw
    2. Trans osseous suturing
    3. Tension band wiring
    4. Proximal humerus nail

5. ORIF with plate and screws
    a. Locking compression plate
    b. Blade Plate
    c. Conventional AO plate
6. Replacement surgery

Conservative management

In conservative management, fracture is immobilized in a sling or 'U' slab for 2-3 weeks. After 2 weeks, passive range of motion is allowed in case of one part fractures and impacted fractures.[17] It can be delayed upto 6-10 weeks in displaced four part fractures. Repeated and forced attempts at closed reduction may produce complications like fracture displacement, angulation or neurovascular injury.

The reduction is done by holding one hand anteriorly on the fracture site followed by forceful flexion of the arm combined with adduction. This is done to disimpact the posterior impaction and to relax the pectoralis major muscle. The proximal humeral shaft next to the fracture site is there by manipulated posteriorly and laterally.[26]

Watson and Jones described a reduction technique, that is done by hyperabduction and traction.[26]To treat three part and four part fractures by closed reduction is difficult. These fractures are unstable and the

incidence of pain, malunion and avascular necrosis is found to be high. Conservative management may be indicated in :

1) Elderly patients with co-morbid illness
2) One part fractures
3) Impacted fractures

Surgical management

In recent times surgical fixation of the fracture of proximal humerus is made safe and possible by better understanding of the fracture configuration and pattern, good knowledge of the implant profile, minimal soft tissue handling technique and preoperative antibiotics. The goals of operative treatment includes :

a) To achieve anatomical alignment (restoration of tuberosity anatomy)
b) To provide Stable fixation
c) To provide early functional rehabilitation of upper limb

Indications for surgery:[1,2]

- Fracture fragments with more than 1cm displacement
- Angulation more than 45^{o} between the fracture fragments
- Displacement of greater tuberosity more than 5 mm

- Two part, Three part displaced fractures
- Fracture dislocation

The choice of surgical approach is decided depending upon the fracture pattern. The surgical approach may be an extended Deltopectoral approach or Deltoid splitting approach.

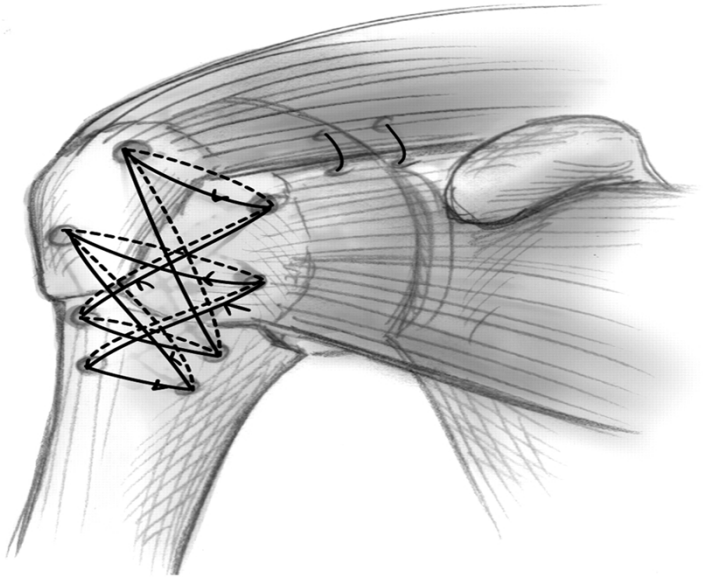
Preoperative planning:

When surgical management is indicated or decided for a patient proper preoperative evaluation and planning should be performed. This includes standard history taking, proper examination of the patient with a possible shoulder injury. Neurovascular assessment and full radiological examination of the patient should be done.

Trauma series X-ray evaluation should be done to assess the fracture pattern that aids in proper preoperative planning. The axillary view is useful in assessing head splitting fractures. It helps to visualize any posterior displacement of the greater tuberosity and to assess the relationship between the articular surfaces. Computerised Tomography scans with 3D reconstruction helps in providing good details about the fracture pattern,provides a three dimensional details about the fracture fragments,fragment displacement and angulations.

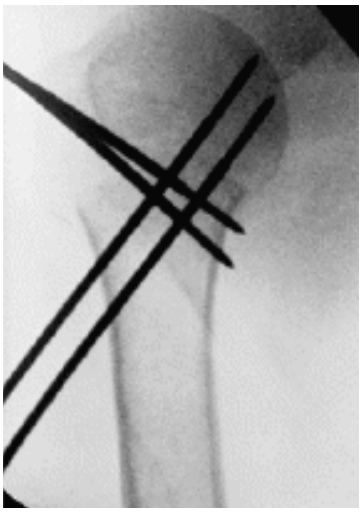
Trans Osseous Suture fixation[15]

Trans Osseous fixation can be done in two part surgical neck fractures and three part fractures. Four or five number sized nonabsorbable sutures are used for fixation. Drill holes are created in the humerus to secure anatomic reduction of the greater tuberosity fragments and the sutures are passed through supraspinatus tendon.



Percutaneous Pinning [19,21]

It can be used after closed reduction of the fractures when they are unstable. It avoids further damage to the soft tissue envelope and blood supply to the humeral head. The procedure is technically challenging and it is not a good choice for patients with mental problems or substance abuse problem. The complications include loss of fixation and pin tract infections.



Proximal Humerus Nailing [2,3]

Proximal Humerus Nailing provides a better fixation than percutaneous pinning but not better than locking plate fixation. The advantage of using intramedullary nails includes preservation of soft tissues around the fracture, advantages from biomechanical properties of a nail. Disadvantages is, insertion of intramedullary nail damages the rotator cuff and hence the patient has postoperative pain. Recently newer nail design with polyaxial screws have been introduced which provides more stability than earlier designs.

Replacement Surgery [5,22]

Indications for the replacement surgery in proximal humerus fractures

1) Fracture in Anatomical neck
2) Head splitting fractures involving more than 40% of the articular surface

3) 4 part fracture with complete dislocation of articular surface.

4) Nonreconstructable tuberosity fractures.

The options available are:

1) Shoulder Hemiarthroplasty
2) Total Replacement Arthroplasty

ORIF with Plate Osteosynthesis [1,2,10]

Open Reduction and Internal Fixation has gained popularity because closed reduction and external fixation were unable to correct the deformity and unable to maintain the reduction sufficiently. The aim of Open Reduction and Internal Fixation is to achieve anatomical alignment and provide a stable fixation. Various plates are used for the proximal humerus fracture fixation.

1. Conventional clover leaf plate
2. AO ‘T’ plate
3. Angled blade plate
4. Locking compression plate

ORIF with plate osteosynthesis has the following advantages:

- Provides stable fixation of the fracture with anatomical restoration of the tuberosity.
- Early mobilization of the joint.
- Because of the anatomical restoration of the tuberosities, future revision arthroplasty will be technically easy and functional output will be good.

COMPLICATIONS

Following operative treatment for proximal humerus fracture, the complications are relatively less common because of better surgical techniques and improved implants.

Complications of fractures:

i) Malunion
ii) Nonunion
iii) Associated vascular / nerve injury

Complications of operative treatment[1,2] :

i) Refractory Post traumatic shoulder stiffness
ii) Incomplete reduction (Restoration of tuberosity)
iii) Osteonecrosis of humeral head
iv) Secondary loss of fixation
v) Unstable fixation
vi) Heterotropic bone Formation
vii) Hardware problems
viii) Infections

Malunion :[1,2,14]

Malunion in proximal humerus fracture is not rare. It occurs in a failed closed reduction or failed ORIF where the normal anatomic relationships between the humeral head, shaft, tuberosities and glenohumeral joint is not restored. But often it does not result in

significant functional disability. Malunion of the tuberosity will compromise the range of movements. Superior displacement which encroaches upon the subacromial space will cause pain, weakness and result in a mechanical block to overhead elevation of the arm.

Posterior displacement of the tuberosities results in limitation of external rotation because of abutment with the posterior glenoid. Thorough preoperative counseling is essential to discuss reasonable expectations because the functional results are often modest.

Nonunion [2,18]

In general nonunion rate in proximal humerus is relatively less because of the cancellous bone and its vascularity. In proximal humerus fractures, nonunion occurs mostly in elderly patients with osteoporosis. It may occur in upto 23% in surgical neck fractures of elderly patients. Factors found to be associated with nonunion are soft tissue interposition, inadequate fixation, hanging arm casts and associated comorbid conditions like Diabetes Mellitus, alcoholism and smoking.

Neuro vascular injuries [1,2]

Neurovascular injuries are rare in proximal humerus fractures but in some cases iatrogenic injuries may occur. Axillary nerve and Anterior Circumflex Humeral artery are the common structures to be involved.

Misplaced pins, excessive dissection and mobilization of medial fragment are among the most common causes.

Stiffness [1,18]

It is one of the most common side effects of proximal humerus fractures. The factors found to be associated with shoulder stiffness are severity of injury at the time of presentation, duration of immobilisation, articular surface malunion and the compliance of the patient for rehabilitation after treatment. Prolonged immobilisation causes scaring between tissue planes and leads to stiffness. It can be avoided by stable fixation and early mobilization.

Hardware problems [1,12]

Problems with hardware are usually associated with other complications such as nonunion and neurovascular problems. Hardware related complications occurs depending upon the implant used. Incidence of infections is found high with K wire fixation. Impingement syndrome occurs with improperly placed plate during fixation. These problems are sometimes related to inappropriate use of rigid devices in poor bone.

Infections [1,2]

Infection is relatively less common in the shoulder joint owing to the rich blood supply and adequate soft tissue coverage. Pin tracts

infection is common in percutaneous pinning of fractures and K wire fixations. In the shoulder arthroplasty, “propionibacterium” is the frequent cause of infection nowadays. It causes persistent pain with stiffness of the shoulder.

Instability

True instability is rare after fracture fixation. But subluxation can occur due to haemarthrosis, Deltoid atony, Rotator cuff dysfunction.

Osteonecrosis [1,2]

The incidence of osteonecrosis is proportional to the complexity of the proximal humeral fractures, handling of soft tissues during surgery. With proper understanding of the anatomy of humeral head and proper preoperative planning these complications can be reduced. During surgery, screw penetration of the humeral head causes chondrolysis of the humeral head and lead to glenohumeral arthritis.

Osteonecrosis can occur either as complete humeral head collapse or as a partial involvement of the humeral head with or without articular collapse. In presence of severe pain and functional loss prosthetic arthroplasty is indicated.

IMPLANT PROFILE

Proximal part

The proximal part of the proximal humerus locking plate is anatomically shaped according to the shape of the humeral head and neck.

It accommodates following screw

- 4 mm cortical / cancellous locking screws

Distal Part

It has the shaft holes. It accommodates the following screws

a) 4 mm locking screws (cortical / cancellous)

b) 4 mm cancellous screws

c) 3.5 mm cortical screws

It is available in

a) pure titanium
b) stainless steel

Stainless steel implants are produced from the implant quality 316L. It contains

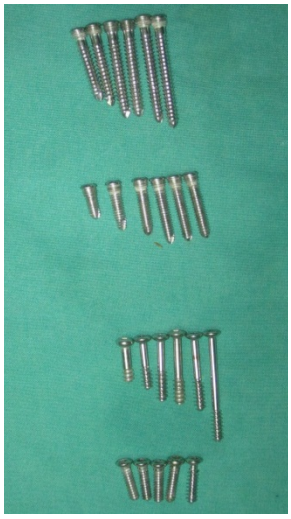
Iron – 62.5%
Chromium – 14.5%
Nickel – 2.8%

Molybdenum and other alloys – Variable

Locking Screws

- Self tapping screws
- Available from 20mm to 60 mm size

- 2.5mm Drill Bit
- 3.5mm Screw Driver
- Depth gauge
- 3.5 mmTap
- Screws



- 4mm Cancellous locking screws
- 4mm Cortical locking screws
- 4mm Cancellous screws
- 3.5mm Cortical screws

PROXIMAL HUMERUS LOCKING PLATE

EVALUATION OF OUTCOME

The functional outcome of fracture fixation was evaluated using Constant Murley scoring system.[34]This system takes into account the following parameters:

1. Pain – 15 (points)
2. Activities of Daily Living – 20
3. Range of Movements – 40
4. Strength – 25

Total –100

A. Pain

None	15
Mild	10
Moderate	5
Severe	0

B. Activities of Daily Living

Activity level	Points
Full work	4
Full recreation	4
Unaffected sleep	2

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

C. Range of Movements

Forward Elevation:	**Points**
$0 – 30^0$	0
$31^0 – 60^0$	2
$61^0 – 90^0$	4
$91^0 – 120^0$	6
$121^0 – 150^0$	8
$151^0 – 180^0$	10
Lateral Elevation:	**Points**
$0 – 30^0$	0
$31^0 – 60^0$	2
$61^0 – 90^0$	4
$91^0 – 120^0$	6
$120^0 – 150^0$	8
$151^0 – 180^0$	10

External Rotation:	**Points**
Hand behind head, Elbow held forward	2
Hand behind head, Elbow held back	2
Hand on top of head, Elbow held forward	2
Hand on top of head, Elbow held back	2
Full elevation from on top of head	2
Internal Rotation:	**Points**
Dorsum of hand to lateral thigh area	2
Dorsum of hand to buttock	2
Dorsum of hand to Lumbo Sacral Junction	4
Dorsum of hand to waist (L3)	6
Dorsum of hand to D12 Vertebra	8
Dorsum of hand to interscapular region	10

D. Strength

1st Pull	5
2nd Pull	5
3rd Pull	5
4th Pull	5
5th Pull	5

Total score: A + B + C + D[71]

Final Outcome

Results	**Score**
Poor	0 – 55
Moderate	56 – 70
Good	71 – 85
Excellent	86 – 100

The other scoring systems used for functional evaluation of proximal humerus fractures are:

a) DASH Scoring
b) Neer's Scoring
c) Rowe Scoring.

PART B

PREAMBLE

Proximal humerus fractures account for 2 to 4% of all upper limb fractures. The treatment modality depends upon many factors like mechanism of injury, patient's health and activity level, bone quality and initial fracture pattern. Fracture that are undisplaced or minimally displaced are treated conservatively and fractures that are displaced require surgical treatment. Seventy five percent of proximal humerus fractures occurs in older patients aged more than 60.[1,10] The mechanism injury in this patients are a Low energy trauma. The risk factors associated with fractures in older age group are osteoporotic bone quality, associated medical comorbid conditions, complex fracture pattern because of poor bone quality. Most of the fractures were treated conservatively or by semi rigid fixation. Recently with the increased use of proximal humerus locking plate the functional outcome of fixation of these fractures has improved a lot.

This series has 22 cases of proximal humerus fractures, all were fixed with proximal humerus locking plate. The outcome was analyzed by the pain, range of movements, ADL and stability (bony union) using the constant Murley scoring system.

AIM OF THE STUDY

- To evaluate the efficacy of a proximal humeral locking plates in proximal humerus fractures.
- To Analyze the outcome based on patients age (<60 years and > 60 years) and fracture pattern(AO Classification Type A,B,C) .

MATERIALS AND METHODS

This is a prospective study of 22 proximal humerus fracture cases treated surgically with Proximal Humerus locking plate fixation. The functional outcome of patients with proximal humerus fracture treated by locking plate fixation was evaluated in our study. In our study we also evaluate any significant difference in the functional outcome in patients with age less than 60 and more than 60 and between fracture types A,B,C classified using AO classification. The patients were explained clearly about the treatment modalities, post operative and rehabilitation protocols and consent was obtained for surgical procedure.

Study Design

Prospective Study

Study Period

February 2016 to September 2017

Study Population

22 cases were randomly selected with proximal humerus fractures admitted in Govt. Kilpauk Medical College.

Study Centre

Govt. Kilpauk Medical College & Hospital.

Inclusion criteria

- Closed Proximal Humerus Fractures (AO/Unifocal, Bifocal, Intraarticular).
- Acute Injuries
- Age >18 years
- Isolated Proximal Humeral Fractures

Exclusion criteria

- Age < 18 years
- Compound Fractures
- Head Splitting Fractures(>40% articular surface)
- Pathological Fractures
- Patients with Primary or Metastatic tumours
- Fractures with Nonunion.

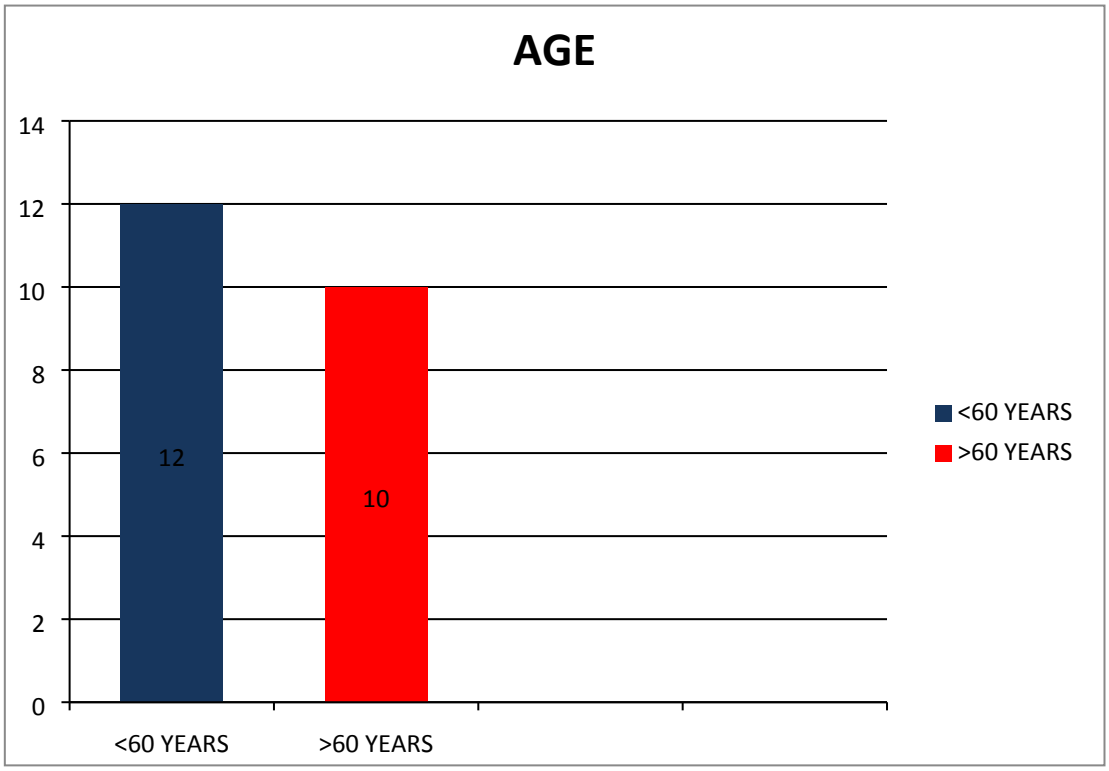
All the cases were analyzed under the following factors

1. Age Distribution
2. Gender Distribution
3. Side of Injury
4. Mode of Injury
5. AO Classification
6. Complications

I. AGE DISTRIBUTION

TABLE - 1

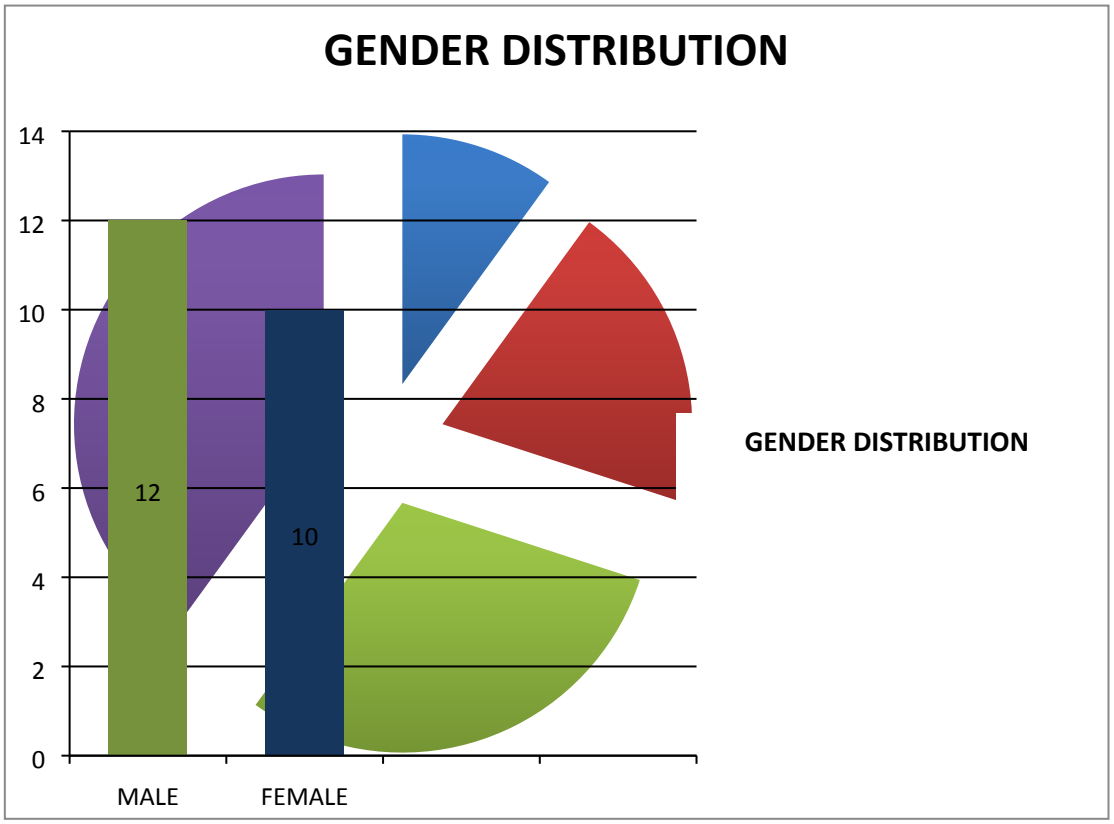
S.NO	AGE	NO	PERCENTAGE
1	<60	12	54.54
2	>60	10	45.45



II. GENDER DISTRIBUTION

TABLE - 2

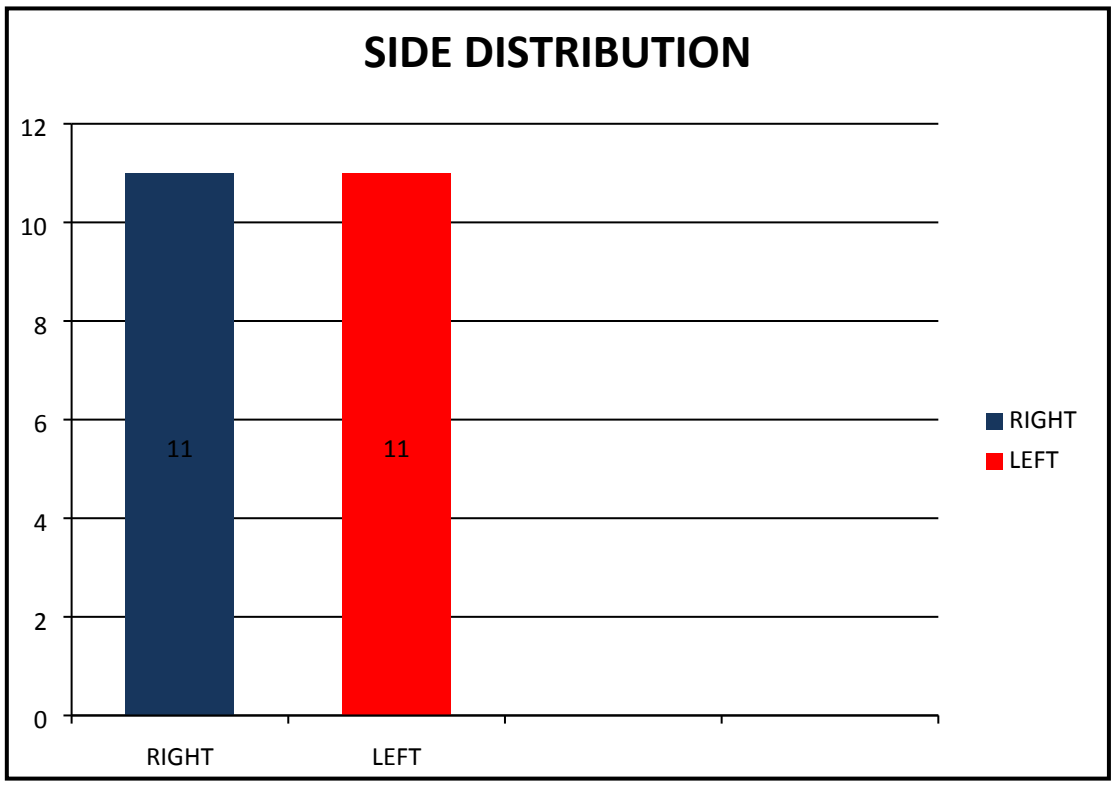
S.NO	SEX	NO	PERCENTAGE
1	MALE	12	54.54
2	FEMALE	10	45.45



III. SIDE DISTRIBUTION

TABLE - 3

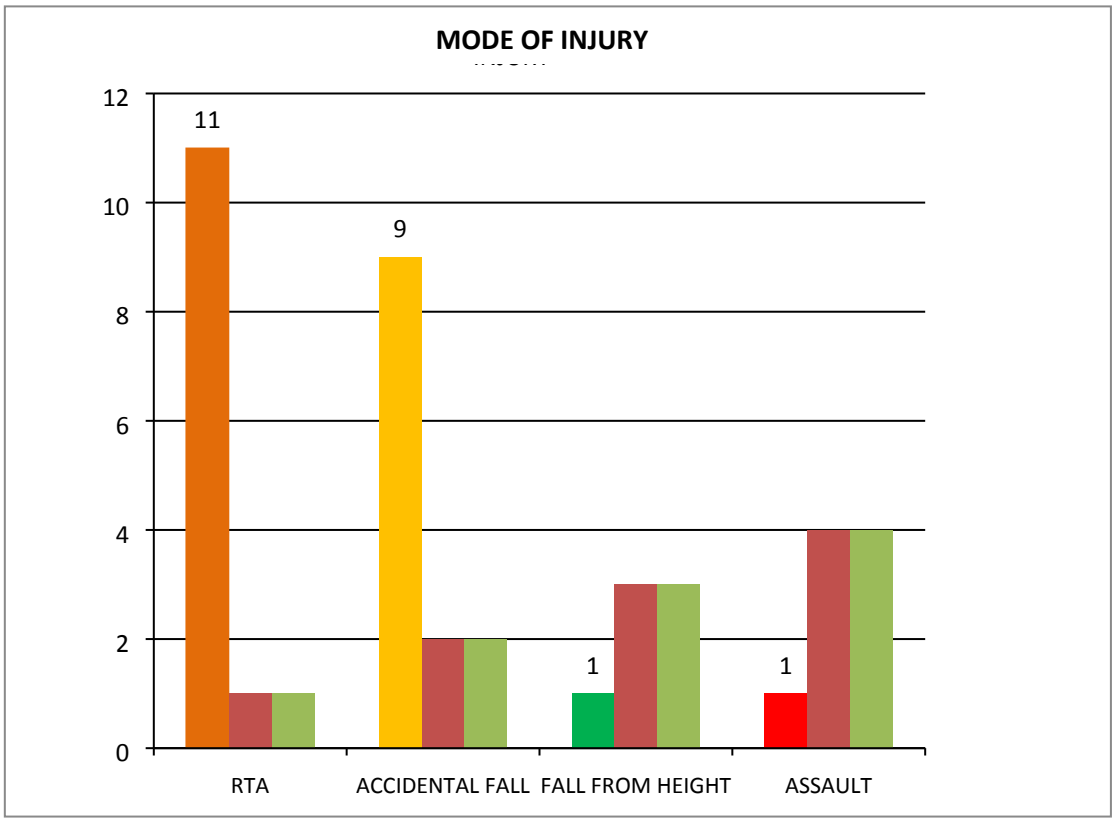
SL.NO	SIDE	NO OF CASES	PERCENTAGE
1	RIGHT	11	50
2	LEFT	11	50



IV. MODE OF INJURY

TABLE - 4

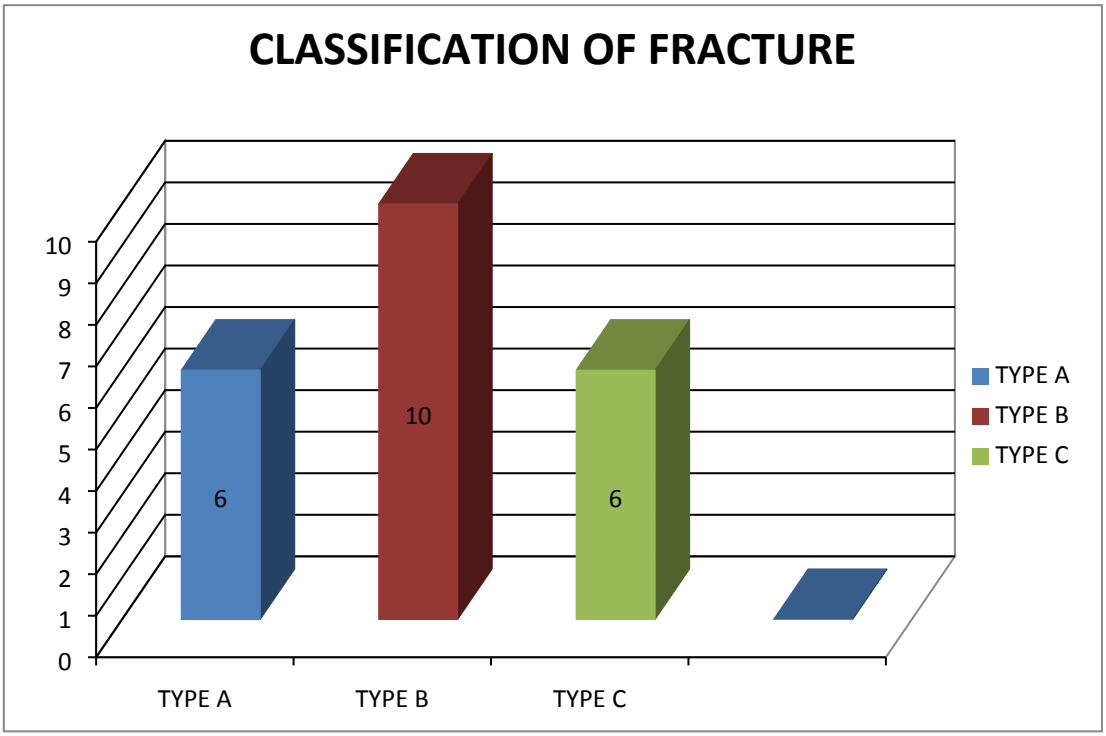
S.NO	MODE OF INJURY	NO	PERCENTAGE
1	RTA	11	50
2	ACCIDENTAL FALL	9	40.9
3	FALL FROM HEIGHT	1	4.55
4	ASSAULT	1	4.55



V. CLASSIFICATION OF FRACTURE

TABLE - 5

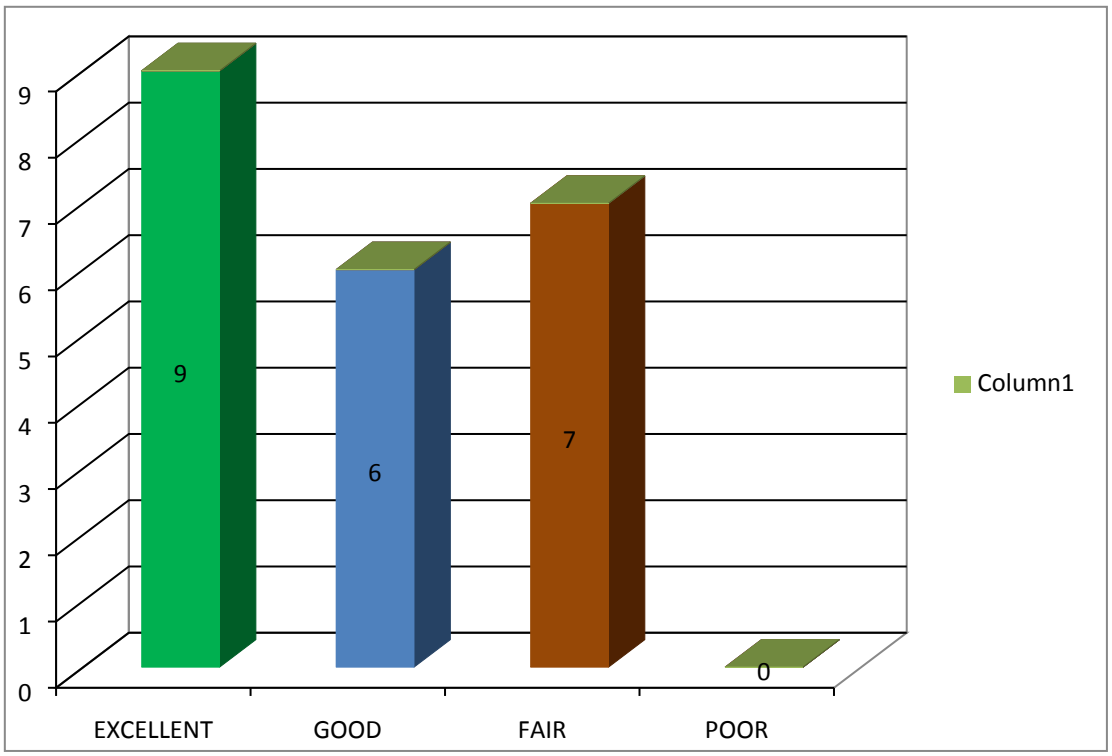
S.NO	TYPE	NO	PERCENTAGE
1	A	6	27.27
2	B	10	45.45
3	C	6	27.27



VI. CONSTANT MURLEY SCORE DISTRIBUTION

TABLE - 6

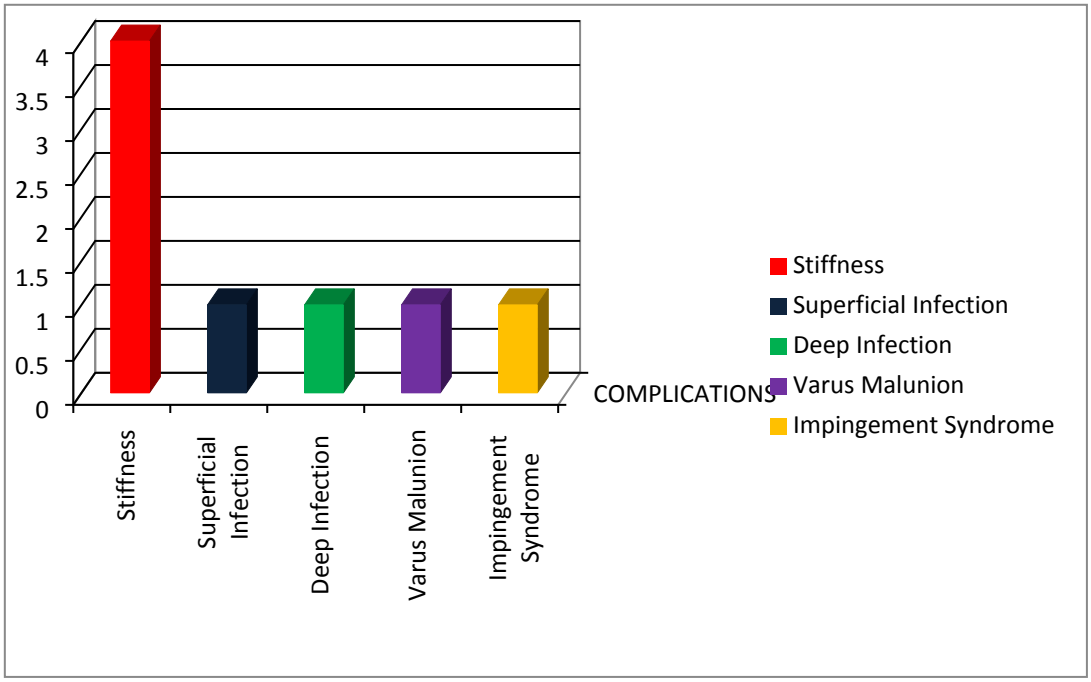
SL.NO	OUTCOME	NO OF CASES	PERCENTAGE
1	EXCELLENT	9	40.9
2	GOOD	6	27.27
3	FAIR	7	31.82
4	POOR	0	0



VII. COMPLICATIONS

TABLE - 7

S.NO	COMPLICATIONS	NOS
1	Stiffness	4
2	Superficial Infection	1
3	Deep Infection	1
4	Varus Malunion	1
5	Impingement Syndrome	1



Management of Complications

Four patients had shoulder stiffness which was managed through vigorous physiotherapy and rehabilitation protocols. One patient had Superficial Infection and found to be a stitch abscess on the 12^{th} postoperative period. It was managed with suture removal and with IV Antibiotics. One patient presented with deep infection at second postoperative follow up. It was managed with wound wash and antibiotics.

One patient had Varus malunion. It was evident only radiologically and the patient had no functional impairment. One patient had Impingement Syndrome, the patient had pain over 120^{o} degrees of abduction. The patient is on follow up and we have planned for removal of the plate after union. None of the patients had nonunion and all cases had radiological evidence of union.

PROCEDURE AND POST OPERATIVE PROTOCOL

All the patients were received in the casualty department and were resuscitated. Any associated major injuries were treated accordingly at first and after the general condition of the patient improved radiographs were taken. The fractures were reduced and “U” slab immobilization was given. The cases that met the inclusion criteria mentioned in our study were operated. Cases were taken for elective fixation after doing all investigation work up and after obtaining anaesthesia fitness and were operated within 1 week of injury.

Preoperative Preparation

- Informed Consent
- Injured shoulder, axilla were prepared
- Injection Cefotaxime 1 gram given intravenously 1 hour before surgery after proper administration of test dose
- Injection Xylocaine test dose was given.

Choice of Anaesthesia

Out of 22 cases, 14 cases were operated under Regional Anaesthesia (Interscalene / Supraclavicular block) and remaining 8 cases were operated under General anaesthesia.

Positioning of the patient

All patients were positioned supine on the operating table with a sand bag placed in the Interscapular Region.[2]It helps to push the affected side forward and to open up the front of the joint. Head end of the operating table is elevated 30^{o} to 45^{o} to reduce bleeding. It also allows the blood to drain away from the operative field.

Surgical Approach

All twenty two patients were operated with standard Deltopectoral approach.

Surgical Procedure

At first, the Deltopectoral groove was located and the incision was made from the coracoid process proximally and extended distally along the deltopectoral groove to the deltoid insertion for approximately 15cm.[32] In obese patients, deltopectoral groove can be located by abducting and externally rotating the shoulder. Deep fascia over the cephalic vein was opened and the vein lies between the internervous plane of Deltoid and Pectoralis major. The interval was developed, the deltoid was retracted laterally along with cephalic vein and the Pectoralis major was retracted medially. Any damage and ligation of the cephalic vein may produce significant edema and compromise in wound healing.

Since most of the feeder vessels enter from the deltoid side, the cephalic vein is retracted along with the deltoid muscle, but can also be retracted medially when this facilitates fracture visualization and reduction. The leading edge of the coracoacromial ligament may be resected in order to have superior visualization and to mobilize the fracture fragments. The tendon of pectoralis major may be released from its attachment to decrease its deforming force on the proximal shaft of humerus, which may complicate reduction of fragments.

Wide exposure is possible by transecting the muscle orginating from the coracoid process. Sometimes it may be necessary to transect the origin of the pectoralis minor muscle. Usually the insertion of the anterior fibres of the deltoid is erased subperiosteally which gives a better exposure of the operative field. The anterior circumflex vessels lie in the middle of the wound, just superior to the pectoralis major muscle. Adequate care was taken to avoid damaging the vessel.

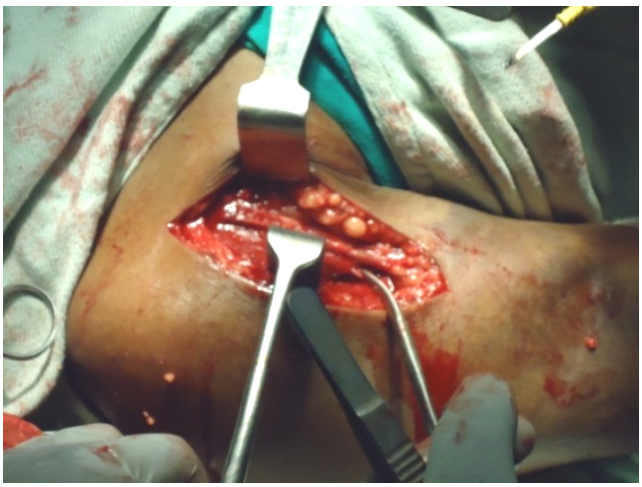
Biceps tendon was used as a landmark between the two tuberosities. The capsule of the shoulder joint was never opened. The reduction of articular surface was indirect using the image intensifier.[1,12] Soft tissue attachments to the fracture fragments were carefully preserved to prevent devascularisation of the fracture fragments. Kirshner wires (K wire) were used temporarily to hold the reduced fragments. Non

Absorbable suture materials (Ethibond 5) were used to restore the greater tuberosity anatomy. Plate was placed at least 5-8mm inferior to upper end of greater tuberosity to avoid subaromial impingement and 2-4mm lateral to the bicipital groove, ensuring that a sufficient gap was maintained between the plate and biceps tendon.

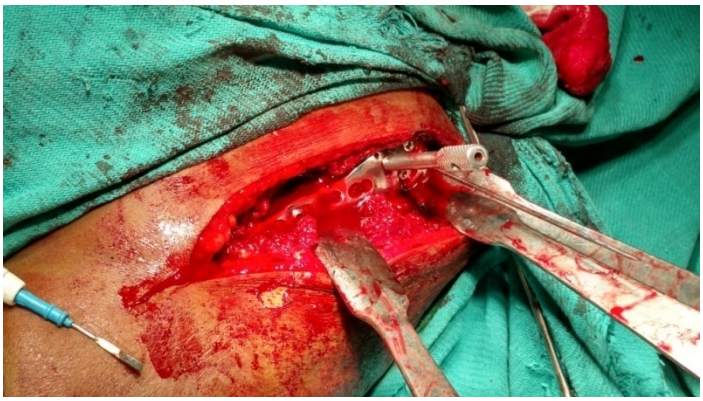
After reduction of fracture fragments, reduction was held with Kirschner Wires, plate is placed and holes are drilled in the humeral head using the drill sleeve. Screws are applied in different directions in the head for better stability and holding of the head fragment. The Calcar screw is then applied. Then the shaft screws were applied. 3.5 mm cortical non-locking screws were applied first in the shaft for better approximation of the plate to the bone. Finally, screw positions and stability of fixation was checked under image intensifier.

1. Draping of the patient

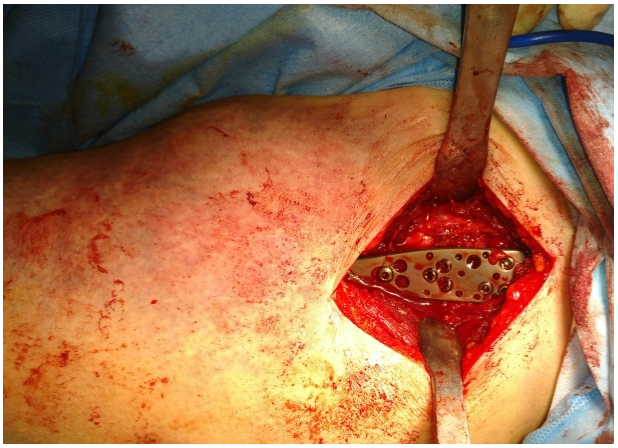
2. Skin incision and retraction of cephalic vein



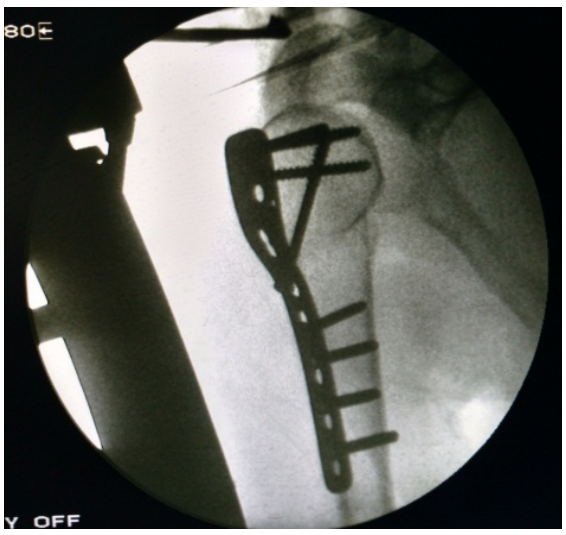
3. Plate held with K-Wire and screws applied

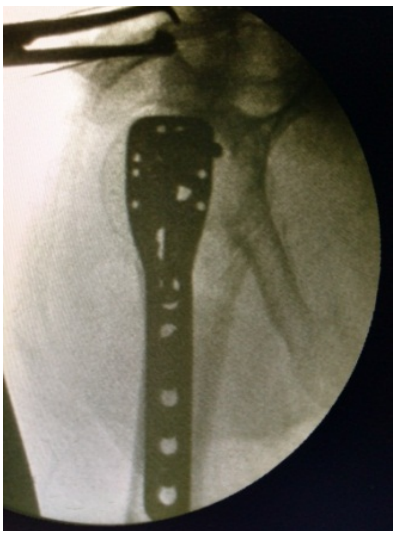


4. Positioning of the Plate



5. Reduction checked with image intensifier





POST OPERATIVE PROTOCOL

Following surgery, the operated arm was immobilized in a shoulder sling. The drain tube was removed on the second postoperative day. Suture removal was done on 12th postoperative day.

The factors which determine the timing of shoulder rehabilitation,

- ✓ Stability of fixation
- ✓ Bone Quality
- ✓ Fracture pattern
- ✓ Patient's compliance

Postoperative rehabilitation is important to achieve a optimal functional outcome. Adequate and stable fixation allows early rehabilitation and functional recovery. Hughes and Neer devised a three phased rehabilitation protocol.[33]The application of this protocol is variable and it depends upon factors such as stability of fixation, fracture pattern, and patient's compliance towards rehabilitation. Elbow, wrist and fingers active ROM exercises were started immediately after surgery.

PHASE 1[33]

This phase of rehabilitation is started early in the postoperative period usually started within 5th to 10th postoperative day. It includes,

1. Elbow flexion and extension
2. Shoulder pendulum exercises
3. Supine external rotation with a stick
4. Assisted forward elevation and pulley exercises

PHASE 2

In this phase early active, resistive and stretching exercises are started. The first exercise to start is supine active forward elevation. This is done by 3 sets of 10-15 repetitions during each session. The patient is then trained to place the hands behind the head to achieve abduction and external rotation. This is followed by stretching for forward elevation.

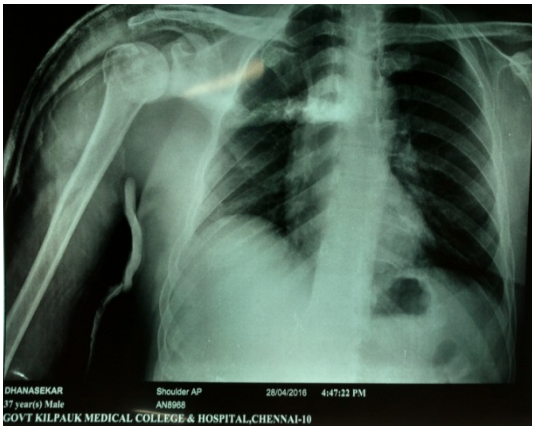
PHASE 3

In this phase resistive strengthening exercises are started at three months postoperative period. Arm is stretched higher on top of the wall. Prone stretching for forward elevation is also started. Lifting light weight objects is started after three months. Lifting weights is gradually increased from one pound with one pound increments to a limit of 5 pounds.

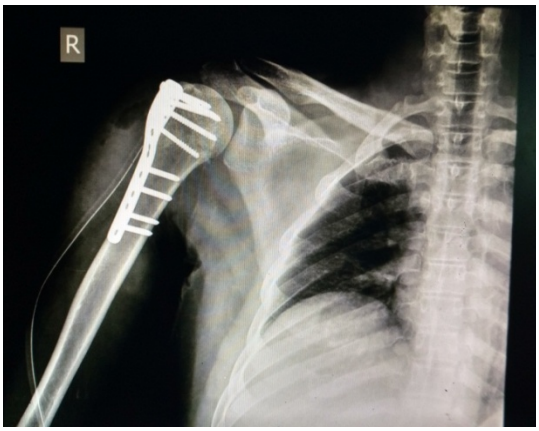
Standard radiological evaluation done periodically (3,6 and 12 weeks post operatively). Then again at $6^{th}$and 12^{th} month following surgery.

CASE ILLUSTRATIONS

CASE – 1



PRE OP

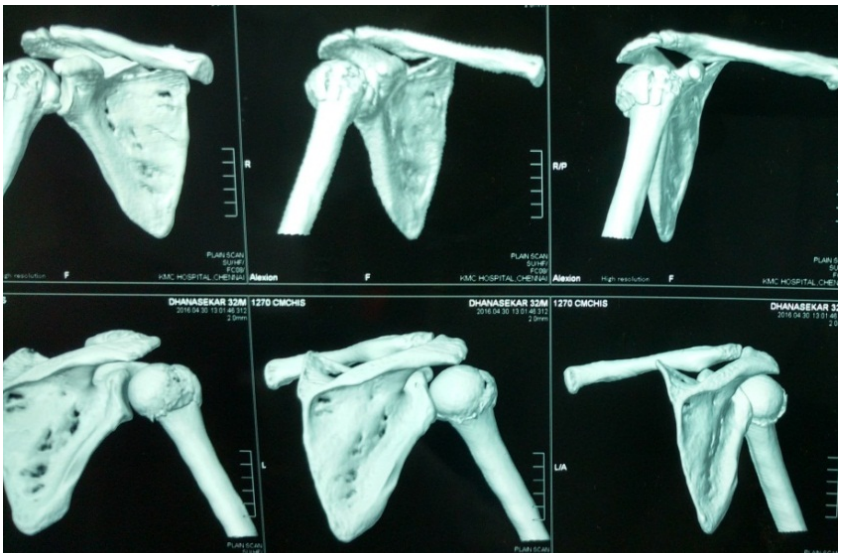


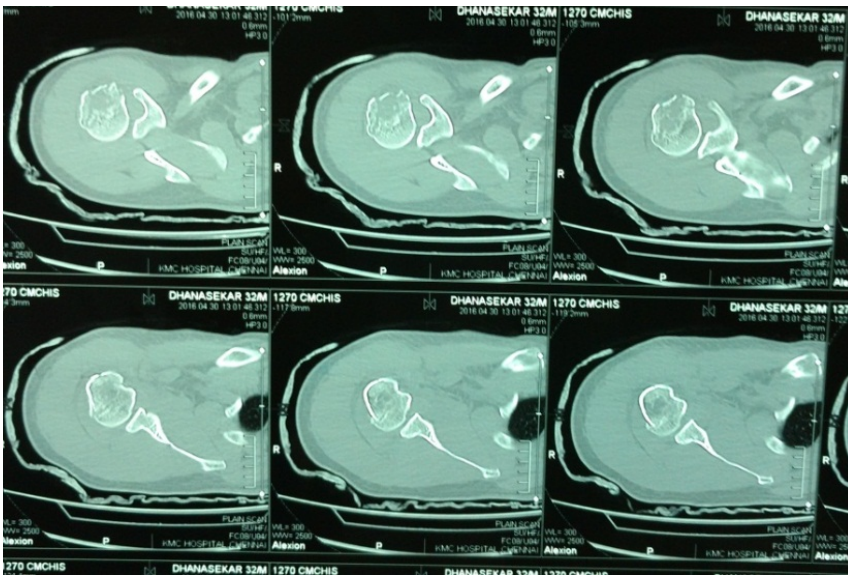
IMMEDIATE POST OP

3 MONTHS POST OP

1 YEAR FOLLOW UP

CT WITH 3D RECONSTRUCTION

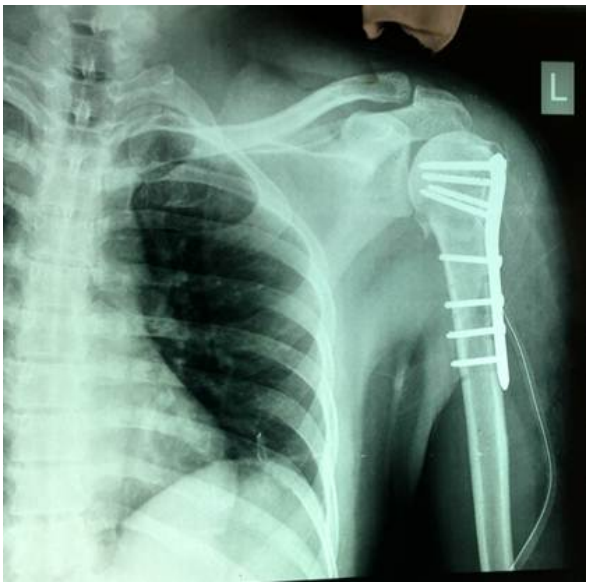




CLINICAL PICTURES

CASE - 2

PRE OP



IMMEDIATE POST OP

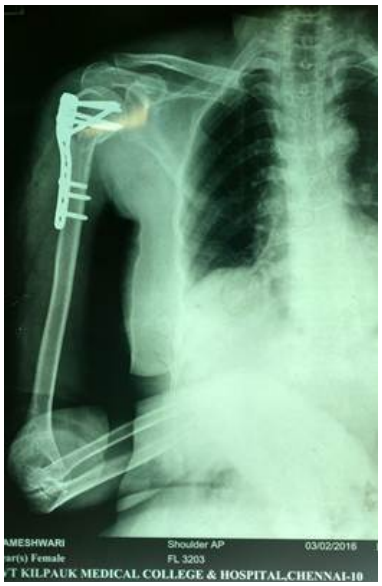
3 MONTHS FOLLOW UP

1 YEAR FOLLOW UP

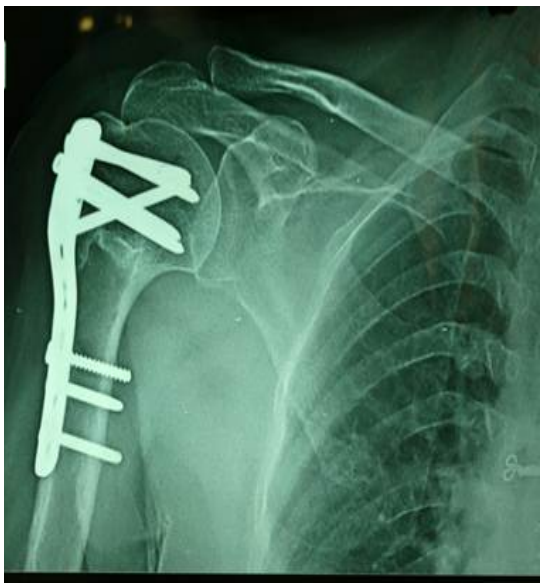
CLINICAL PICTURES

CASE - 2

CASE - 3



PRE OP **IMMEDIATE POST OP**



6 MONTHS FOLLOW UP **1 YEAR FOLLOW UP**

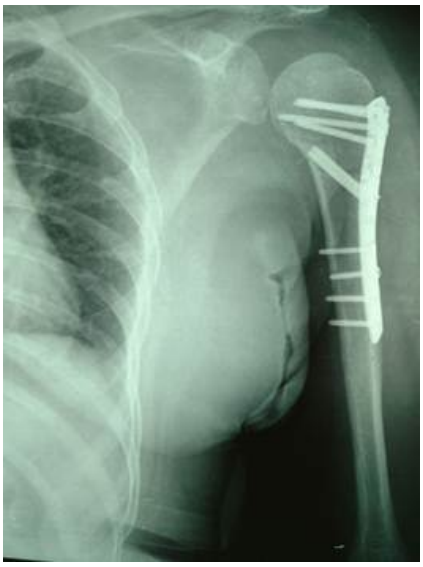
1.5 YEARS FOLLOW UP

CLINICAL PICTURES

CASE - 4

PRE OP

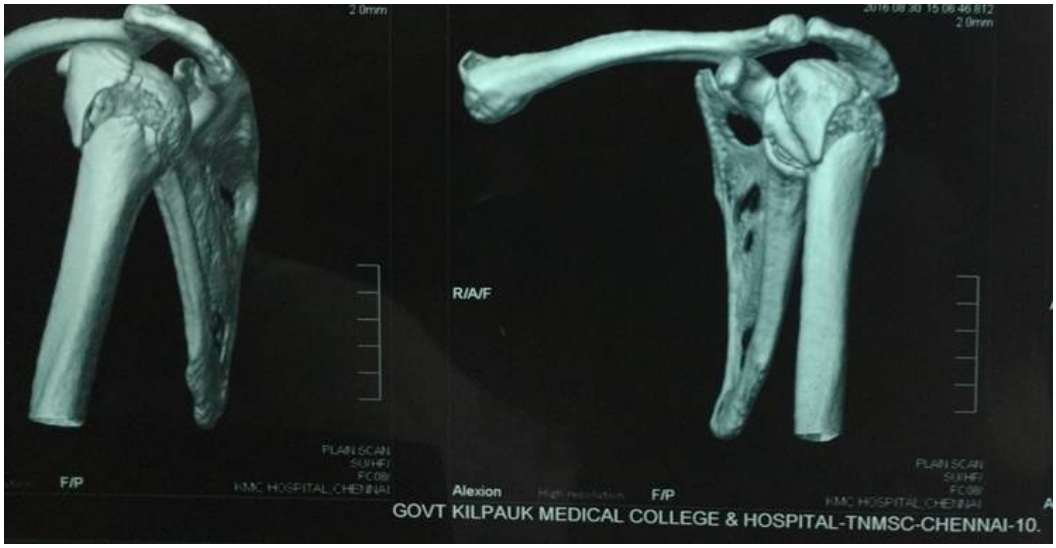
IMMEDIATE POST OP



3 MONTHS FOLLOW UP

9 MONTHS FOLLOW UP

CT SCAN WITH 3D RECONSTRUCTION



DISCUSSION

Recent studies shows that the incidence of proximal humerus fractures have increased to 7% of all fractures and 80% of all humerus fractures.[1]Variable treatment options are available for treating proximal humerus fractures. The treatment option depends upon many factors such as fracture pattern, patient's age, quality of the bone, patient's functional demand and associated comorbid conditions and patient's general wellbeing.

Many studies conducted in the past support nonoperative management of undisplaced proximal humerus fractures. The indications for nonoperative treatment patients with undisplaced or minimally displaced fractures, valgus impacted fractures,[17] patients not medically fit for surgery and elderly patients with low functional demand. But prospective studies conducted in the past reveals marked functional impairment may occur in the setting of fracture treated non operatively and this patients are reported to have chronic pain at the affected arm.

The outcome predictors which determine the results of treatment of a proximal fractures are Age of the patient and AO/OTA classification of fractures. Surgical treatment of proximal fractures are advised for displaced proximal humerus fractures and patients with high functional

demand. The main aim of the surgical fixation is to achieve anatomical reduction and stable fixation of the tuberosities, restore the rotator cuff mechanism and to give a functional outcome which is near normal to the preinjury status of the patient.

Open Reduction and Internal Fixation is the frequently used method of surgical treatment. It allows direct visualization of the fracture fragments and facilitates the direct reduction and aids in achieving anatomical reduction. It also helps in proper positioning of the implant. However dissection done during surgery may jeopardize the fracture biologically and may interfere with fracture healing and increases the risk of Avascular Necrosis of the humeral head.[1] Therefore careful and judiciary surgical dissection is advised during surgery.

Over the past five decades, fixation with compression plates and screws has been the standard treatment modality. Satisfactory healing rates and functional outcome after conventional plate and screw fixation have been reported in several studies especially in young individuals. But high rates of postoperative fracture displacement and varus collapse has been reported with conventional compression plate and screw fixation.[1] This is found especially in elder patients owing to the osteoporotic nature of the bone. This led to the advent and popularizing of locking plates.

Locking plates are precontoured and vary in terms of number of proximal locking screws and their arrangement and also vary with ability to place screws at different angles with regards to the plate.[1,20]Locking plates allows angular stability between screws and plates. Constructs using locking plates are biomechanically superior in strength and more resilient than constructs using nonlocking plates/screws, blade plates and Intramedullay nails. They help to prevent postoperative displacement and varus collapse of the fractures.

Osterhoff et al in a recent study emphasized about the use of calcar screws in the prevention of secondary loss of reduction. Calcar screws are applied tangentially to the medial curvature of the surgical neck of humerus. Previous studies report that use of calcar screws have complications like axillary nerve damage, screw cut out and avascular necrosis of humeral head especially when done percutaneously as in minimally invasive technique.

Loss of reduction and varus malunion results in short lever arm of rotator cuff and subacromial impingement because of decreased acromio humeral distance. In this study, they concluded that the placement of calcar screws prevents secondary loss of reduction by providing inferomedial support.

In our study, we have analyzed twenty two cases of proximal humerus fractures which were treated surgically using Proximal Humerus Locking plates in Govt. Kilpauk Medical College Hospital.

Out of 22 cases, 12 cases were males and 10 cases were females. In a study conducted by Hawkins and Bell involving 15 patients and in a study conducted by Kristiansen et al involving 565 patients with proximal humerus fractures shows female preponderance. This is attributed to advanced osteoporosis in elderly women.

The average age of the patients in our study is 52 years and this corresponds with reports of studies conducted by Hawkins, Bell and Gurr, Cornell CN, Pagnani M J and Flatow et al. Also in our study we studied the functional outcome of proximal humerus fractures based on patient's age.Patients who are less than 60 years and patients with more than 60 years age are divided into two groups and their outcome studied.

SEX

		Frequency	Percent	Valid Percent	Cumulative Percent
	M	12	54.5	54.5	54.5
	F	10	45.5	45.5	100
	Total	22	100.0	100.0	

In Recent studies it has been stated that in elderly patients aged more than 65 years the incidence of proximal humerus fractures was found to be more than 10% which ranks third next to proximal femur and distal radius fractures respectively. It is also stated that the incidence of fractures increases by 40 % every 5 years beyond the age of 40 for females and 60 years for males.

In our study, we had statistical significance in the constant scores between patients with age less than 60 and in patients with age more than 60 and this results were concurrent with study conducted by Agarwal et al. The mean functional scores in younger age group is 86.75 and mean value in elderly patients is 67.10 and the statistical significant value is (p-0.00). This may be due to osteoporotic bone quality, initial fracture pattern, associated comorbid conditions and patients poor compliance in post operative physiotherapy and rehabilitation protocols. Hence proper preoperative counseling should be given regarding the variable results and high surgical caution should be excised.

AGE

N	Valid	22
	Missing	0
Mean		52.50
Median		55.00
Minimum		22
Maximum		72

Mann-Whitney Test

Ranks

	Age	N	Mean	Mean Rank	p value
SCORE	< 60 yrs	12	86.7500	16.50	
	> 60 yrs	10	67.1000	5.50	.000
	Total	22			

In our study, the most common mechanism of injury is Road Traffic Accidents followed by accidental fall sustained at ground level. Other mode of injuries like direct injury caused by assault and fall from height were also present in our studies. Unlikely to the high incidence of proximal humerus fractures in the elderly patients we had 12 cases under 60 years owing to the nature of high energy trauma sustained by Road Traffic Accidents.

INJURY

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ACC FALL	9	40.9	40.9	40.9
	ASSAULT	1	4.5	4.5	45.5
	FALL FROM HEIGHT	1	4.5	4.5	50.0
	RTA	11	50.0	50.0	100.0
	Total	22	100.0	100.0	

In our study, the fractures are classified using AO/OTA classification of proximal humerus fractures. There were six patients in Type A fractures, 10 with Type B, 6 in Type C fractures. In our study, we found that there is statistical significance between the mean functional constant scores of the patients within Type A,B,C with a p value of 0.048.

CLASSIFICATION

		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	A	6	27.3	27.3	27.3
	B	10	45.5	45.5	72.7
	C	6	27.3	27.3	100.0
	Total	22	100.0	100.0	

Kruskal-Wallis Test

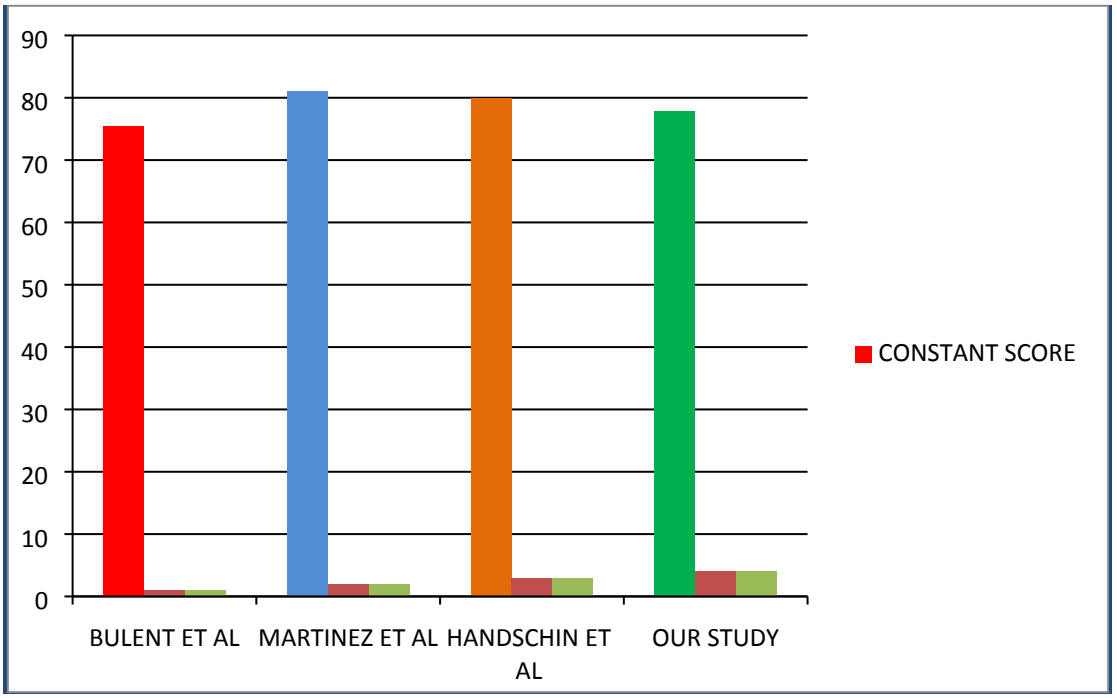
Ranks

	CLASSIFICATION RECODED	**N**	**Mean**	**Mean Rank**	**p value**
SCORE	A	6	85.1667	15.33	
	B	10	78.9000	12.30	.048
	C	6	68.6667	6.33	
	Total	22	77.8182		

The mean age of the patient with classification Type C is 61.5 years. Also type C fractures initially have more displacement of fracture fragments which makes reduction difficult intraoperatively and adversely affects the fracture stability. As already stated, initiation of rehabilitation phases depends upon many factors such as fracture pattern, stability of fixation and patients compliance, these factors cumulatively may have reduced the functional outcome of patients with type C fractures .We consider age as a confounding factor in this statistically significant association. The limitation of our study is small sample size and this association have to evaluated in further studies.

The average Constant Score in our study was 77.8 and this score was in concurrent with the results of similar studies conducted in the past.

Study	**Bulent et al 2008**	**Martinez et al 2009**	**Handschin et al 2009**	**Our study 2017**
Constant Shoulder Score	75.5	81	80	77.8


90
80
70
60
50
40
30
20
10
0
BULENT ET AL
MARTINEZ ET AL
HANDSCHIN ET AL
OUR STUDY
CONSTANT SCORE

CONCLUSION

- Proximal Humerus Locking Plate is the implant of choice for treating displaced proximal humerus fractures.
- This variable angle locking plate provides stable internal fixation, allows early mobilisation and prevents secondary loss of reduction and hence we recommend the use of proximal humerus locking plate in osteoporotic fractures.
- Anatomic restoration of tuberosities should be achieved for optimal functional outcome postoperatively.
- The use of Calcar screws prevents secondary loss of reduction by providing inferomedial support.
- The functional outcome was decreased in elderly individuals when compared to younger individuals.
- More complex initial fracture patterns have decreased functional outcome postoperatively, hence adequate stable fixation and appropriate physiotherapy and rehabilitation protocols should be followed to achieve the optimal functional demand of the patient.

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MASTER CHART

S.NO	NAME	AGE/ SEX	SIDE	MODE OF INJURY	CLASSIFICATION	WEEKS			COMPLICATIONS	CONSTANT SCORE
						ROM	UNION	REHAB		
1	DHANASEKAR	33/M	RT	RTA	11B1	3	9	12	NIL	90
2	SEKAR	55/M	LT	RTA	11B2	4	10	13	NIL	87
3	KUMARI	69/F	RT	ACC FALL	11C1	4	12	16	STIFFNESS	63
4	PARAMESHWARI	63/F	RT	ACC FALL	11A3	4	10	14	NIL	75
5	NANDHAKUMAR	40/M	LT	RTA	11A2	3	9	12	NIL	88
6	VICTORIA	37/F	LT	ACC FALL	11B2	2	9	12	NIL	90
7	NAGAMMAL	68/F	RT	ACC FALL	11B3	4	11	15	SUP INFECTION	63
8	ASHOKAN	48/M	LT	RTA	11B3	3	9	12	NIL	87
9	PAUL RAJ	27/M	LT	RTA	11B2	2	9	12	NIL	91
10	THIRUPURAM	70/F	LT	RTA	11B3	5	12	16	STIFFNESS	62
11	RAJENDRAN	55/M	RT	RTA	11B2	3	9	14	NIL	82
12	ABDUL RAHMAN	64/M	RT	ACC FALL	11B1	4	10	14	STIFFNESS	71
13	MUNIYAMMAL	70/F	LT	ACC FALL	11C1	5	12	16	DEEP INFECTION	62
14	MANIKANDAN	38/M	RT	RTA	11A3	3	9	12	NIL	90
15	NIRMAL RAJ	22/M	LT	RTA	11C1	3	10	14	NIL	78
16	RENGANAYAGI	72/F	RT	ACC FALL	11C1	5	12	15	NIL	68

S.NO	NAME	AGE/ SEX	SIDE	MODE OF INJURY	CLASSIFICATION	WEEKS			COMPLICATIONS	CONSTANT SCORE
						ROM	UNION	REHAB		
17	MENAGA	34/F	LT	RTA	11A3	3	9	12	NIL	89
18	KASTHURI	72/F	LT	ACC FALL	11C1	4	11	15	VARUS MALUNION	68
19	KASINATHAN	64/M	RT	FALL FROM HEIGHT	11C1	4	10	15	STIFFNESS	73
20	SHANMUGAM	43/M	RT	RTA	11A3	3	9	12	NIL	86
21	RAJALAKSHMI	65/F	LT	ACC FALL	11B3	5	11	16	IMPINGEMENT SYNDROME	66
22	BHASKARAN	46/M	RT	ASSAULT	11A3	3	9	13	NIL	83

KEY WORDS

Rt	-	Right
Lt	-	Left
RTA	-	Road Traffic Accident
ACC Fall	-	Accidental Fall
Sup. Infection	-	Superficial Infection
ROM	-	Range of Motion
REHAB	-	Rehabilitation