"STUDY OF FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF PROXIMAL HUMERUS FRACTURE TREATED WITH PHILOS PLATE''

By

DR. K VINAYAK SANTOSH

Dissertation submitted to
BLDE UNIVERSITY, BIJAPUR. KARNATAKA.

In partial fulfillment Of the requirements for the degree of

MASTER OF SURGERY
IN
ORTHOPAEDICS

Under the guidance of

DR. ASHOK.R. NAYAK M.S.(ORTHO)

PROFESSOR,

DEPARTMENT OF ORTHOPAEDICS

SHRI B. M. PATIL

MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE

BIJAPUR – 586103

2014

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled "STUDY OF FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF PROXIMAL HUMERUS FRACTURE TREATED WITH PHILOS PLATE''is a bonafide and genuine research work carried out by me under the guidance of DR. ASHOK.R.NAYAK, PROFESSOR OF ORTHOPAEDICS.

Date:

Place: Bijapur. **DR. K VINAYAK SANTOSH**

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **"STUDY OF FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF PROXIMAL HUMERUS FRACTURE TREATED WITH PHILOS PLATE''** is a bonafide research work done by **DR. K VINAYAK SANTOSH** in partial fulfillment of the requirement for the degree of M.S. in ORTHOPAEDICS.

DR. ASHOK.R.NAYAK **MS (ORTHO)**
PROFESSOR,
DEPARTMENT OF ORTHOPAEDICS
BLDEU's
Shri. B. M. Patil Medical College,
Hospital and Research Centre, Bijapur

Date:

Place: Bijapur.

ENDORSEMENT BY THE HOD

This is to certify that the dissertation entitled **"STUDY OF FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF PROXIMAL HUMERUS FRACTURE TREATED WITH PHILOS PLATE"** is a bonafide research work done by **DR. K VINAYAK SANTOSH** under the guidance of **DR. ASHOK.R.NAYAK** **M.S.(ORTHO),** Professor of Orthopaedics.

DR O.B. PATTANASHETTY **MS (ORTHO)**
PROFESSOR AND H.O.D.
DEPARTMENT OF ORTHOPAEDICS
BLDEU's Shri. B. M. Patil Medical College,
Hospital and Research Centre, Bijapur

Date:
Place: Bijapur.

ENDORSEMENT BY THE PRINCIPAL

This is to certify that the dissertation entitled "STUDY OF FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF PROXIMAL HUMERUS FRACTURE TREATED WITH PHILOS PLATE**"** is a bonafide research work done by **DR. K VINAYAK SANTOSH** under the guidance of **DR. ASHOK.R.NAYAK M.S.(ORTHO)**, Professor of Orthopaedics.

Dr. M.S. BIRADAR **MD**
Principal,
Shri. B. M. Patil
Medical College Hospital &
Research Centre, Bijapur.

Date**:**
Place**:** Bijapur

COPYRIGHT

DECLARATION BY THE CANDIDATE

I hereby declare that the BLDE University, Bijapur, Karnataka shall have the rights to preserve, use and disseminate this dissertation / thesis in print or electronic format for academic / research purpose.

Date: **DR.K VINAYAK SANTOSH**

Place: Bijapur

ACKNOWLEDGEMENT

On completion of my post graduation journey and this scientific document, I would like to acknowledge the immense help received from my mentors in the department of orthopaedics.

With privilege and respect I like to express my gratitude and indebtedness to my Guide, **Dr. Ashok.R.Nayak,** for his constant inspiration, extensive encouragement and loving support, which he rendered in pursuit of my post-graduate studies and in preparing this dissertation.

I am forever grateful to **Dr. O. B. Pattanashetty, HOD** of department of orthopaedics for his guidance and encouragement provided to me, to achieve new heights professionally over my course period.

I am very grateful to Dr. Shreepad Kulkarni, for his guidance, encouragement and inspiration.

I am thankful to Dr S.S. Nandi, Dr.Dayanand, Dr.Kiran Patil,Dr.M.A.Q. Ansari, Dr Sudhir Hasaraddi, Dr Avinash Kulkarni, Dr Haridas, Dr Jagadish Patil, Dr. Tanay Sharma for their great help.

I am extremely thankful to Prof. Dr. M. S. Biradar , Principal, of B.L.D.E.U'S Shri B.M. Patil Medical College Hospital and Research Centre, Bijapur, for permitting me to utilize resources in completion of my work.

My thanks to one and all staff of Library, Orthopaedics Department and Hospital for their co-operation in my study.

I am thankful to colleagues Dr.Natesh, Dr.Monish, Dr. Preetish Dr. Yogesh, Dr. Mithun, Dr. Gireesh, Dr.Vikrant, Dr.Bhimangouda, Dr.Rupali, Dr.Deepesh, Dr.

Mrutunjay, Dr. Mallikarjun, Dr. Mayur, for their advice, suggestions and co-operation in my journey.

I would also like to thank my juniors Dr. Aarviind, Dr. Sreedhar, Dr. Alaf, Dr. Harikrishnan, Dr. Sharath, Dr. Sandeep and Dr. Arshad for their help and co-operation.

I am deeply indebted to my parents for their blessings, which helped me to complete this dissertation.

Last but not the least; I convey my heartfelt gratitude to all my patients, without whose co-operation, this study would be incomplete.

As, a special mention, I would like to thank Preeti Net Zone for Computerizing my disseratation work.

Dr. K VINAYAK SANTOSH

ABSTRACT

TITLE OF DISSERTATION : "STUDY OF FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF PROXIMAL HUMERUS FRACTURE TREATED WITH PHILOS PLATE''

Introduction :

Proximal humeral fractures account for approximately 4% of all fractures and 26% of humerus fractures[1]. These fractures have a dual age distribution occurring either in young people following high energy trauma or in those older than 50 years with low velocity injuries like simple fall. Most of the proximal humeral fractures are non-displaced or minimally displaced and stable. These can be treated non-operatively successfully with early rehabilitation. But severely displaced and comminuted fractures warrant surgical management for optimum shoulder function.

Treatment of unstable displaced fractures of the proximal humerus has remained controversial. Various surgical treatment modalities for displaced proximal humeral fractures are pins, wires, heavy sutures, staples, rush nails, screws and plates, hemiarthroplasty, intramedullary nailing, retrograde nails and pins, external fixationand tension band wiring.

All these techniques have been associated with various complications including implant failure, loss of reduction, nonunion or malunion of the fracture, impingement syndrome, and osteonecrosis of the humeral head.

The osseous architecture of the humeral head with poor central cancellous bone stock particularly in the elderly patients,leads to a high risk of fixation failure with conventional plate n screw fixation.The PHILOS® plate has been introduced to reduce this complications but there are few studies have been published on the results of this device.

Therefore the present study will be carried out to assess and evaluate the surgical outcome of proximal humeral fractures treated with proximal humerus interlocking plate osteosynthesis system.

AIMS AND OBJECTIVES

To study the functional outcome of surgical management of proximal humeral fractures treated with proximal humeral interlocking osteosynthesis system.

MATERIALS AND METHODS

SOURCE OF DATA

1. All confirmed cases of proximal humeral fractures admitted in department of orthopaedics of Shri B.M.Patil Medical College hospital and Research Center, Bijapur,Karnataka.

2. Patient will be informed about the study in all respects and written and informed consent will be obtained.

3. Period of study will be from september 2012 to april 2014

4. Follow up period will be 3 weeks, 2 months,4 months.

METHOD OF COLLECTION OF DATA

- Patients will be selected on basis of history, clinical examination and radiography.
- All fractures will be classified as per NEERS system of classification of proximal humeral fractures.
- Follow-up and assessment will be performed using Neers criteria.

INCLUSION CRITERIA

1. All adults patients admitted with proximal humerus fracture.
2. Patients without any distal neurovascular deficits.

EXCLUSION CRITERIA

1. Skeletally immature patients
2. Pathological fractures,
3. Patients with distal neurovascular deficit,
4. Polytrauma patients with an Injury Severity Score > 16
5. Shaft humerus fractures with proximal extension
6. Immuno compromised patients like HIV.

INDEX

LIST OF TABLES

LIST OF GRAPHS

INTRODUCTION

The field of orthopedic surgery has been in the vanguard in creating new information, establishing new principles of treatment and solving both new and old problem of musculoskeletal system.

"Use adequate radiograms to understand the traumatic lesion, be careful denying older patients effective treatment, use safe and simple surgical approach, know the options for internal fixation, recognize the value of prosthetic replacement, avoid technical pitfalls, and thoughtfully supervise the postoperative patient care"

Cofield's[1] summary of treatment of proximal humeral fractures is an indication of the difficulty of treating these injuries, from first evaluation to final outcome much controversy and confusion still exist, and no single treatment protocol or algorithm has been proved to be universally effective. As indicated by Cofield areas still in question include radiographic diagnosis, operative, non operative treatment, consideration of patient age in treatment decision making, surgical approach, fracture fixation or hemiarthroplasty, type of internal fixation, and rehabilitation protocol.

Fractures of proximal humerus are still an unsolved problem in many ways. Disagreement exists regarding reliability of classification system. The indication for surgical management continues to be modified. Fixation techniques are myriad and none is ideal for all cases[2].

Fractures of proximal humerus are not uncommon especially in older age group. They represent no more than 3% of all upper extremity fractures[3]. Their overall incidence has

been reported to be73 cases per 100, 000 individuals per year[4]. About 85% fractures are minimally displaced and are effectively treated symptomatically with immobilization followed by early motion. The remaining 15% of fractures are displaced, unstable and may have disruption of blood supply. Treatment of these fractures is a therapeutic challenge. Displaced and unstable fractures are commonly treated by open reduction and internal fixation.

Various therapeutic options for displaced proximal humeral fractures are k wires, tension band wiring, humeral nails, anatomic plate osteosynthesis like PHILOS (Proximal Humerus Interlocking System) and PHLP (Proximal Humerus Locking Plate) and hemiarthroplasty[4,5]. The choice of technique and device depends on type of fracture, quality of bone, age and reliability of patients. Recently, open reduction and internal fixation (ORIF) with locked plating has demonstrated promise in the treatment of displaced, comminuted proximal humerus fractures. This approach offers several potential advantages compared with more traditional open techniques[6]. These benefits include improved fracture stability because of the fixed-angle construct, particularly in more comminuted fracture patterns and in osteoporotic bone; a short period of immobilization with the opportunity for earlier rehabilitation, lower risk of damage to the rotator cuff or need for implant removal, reduced hardware complications and in patients with more complex fractures, the potential to avoid the use of hemiarthroplasty[7].

Locked plating is becoming more common; precise knowledge of and experience with the surgical technique is required to maximize clinical outcomes. However the goal

of proximal humerus fracture fixation should be stable reduction allowing early mobilization.

This study is conducted to study the results and complications of proximal humeral fractures treated by anatomic locking compression plate (PHILOS- Proximal Humerus Interlocking Osteosynthesis System).

AIMS AND OBJECTIVES

To study the functional outcome and complications of surgical management of proximal humeral fractures treated with proximal humeral interlocking osteosynthesis system**.**

REVIEW OF LITERATURE

HISTORICAL REVIEW

A great deal of information has been published in recent decades as the new technique of fracture management has been developed and older once have been rediscovered.

Hippocrates (460 BC) is credited with documenting the first fracture of proximal humerus in 460 BC and describing a method of weight and traction which resulted in bone healing. However little was written concerning this subject until later part of 19th century[4].

In 1934 Codman made significant contribution by dividing proximal humeral fractures into four basic parts[4].

In 1937 Meyerding suggested the use of open reduction and early mobilization to improve alignment and avoid malunions that would limit motion. Suture materials, screws and wires were the types of earlier fixation[4].

In early 1970s the association of study of internal fixation (ASIF) group popularized osteosynthesis by plate and screws for the displaced fractures.

Neer II has made an outstanding contribution to proximal humeral fractures. He published two articles in 1970[8,9]. The first article deals with classification and evaluation of fractures and second article deals with treatment of displaced three part and four part fractures.

Kristiansen[10] in 1986 has reported 9(45%) satisfactory and 11(55%) unsatisfactory results out of 20 patients with two part, three part and four part fractures treated with AO Buttress plate. In their study 4 cases had infection, five cases had impingement of plate and two cases had loosening of plate. They concluded that Buttress plate offers satisfactory reduction and good stability with high risk of complications and hence internal fixation should be considered carefully in elderly and surgery should be performed by experienced hands.

Moda S K et al.[11] in 1990 treated proximal humeral fractures with plate and screws. This is an important series in India. This study illustrated the reasonable degree of effectiveness of rigid internal fixation for younger patients with proximal humeral fracture.

They used AO T plate in 15 patients and blade plate in 10 patients. Excellent or satisfactory results achieved in 21 of 25 (84 %).There were 4 (11.4%) un satisfactory results which were associated with rotator cuff damage. There were 2 patients who had severe stiffness and 1 patient had bicipital tendinitis. They concluded that AO T plate fixation is stable enough to mobilize immediately.

In 1994 Esser R D et al.[12] reviewed 31 patients who were treated between 1978-1992, age range 19-62 yrs and evaluated for average of 6 yrs and 7 months. 21 patients had 3 part fractures, 10 had four part fractures. 26 patients treated with modified cloverleaf plate and 5 with AO T- plate. They found that 23 (6.7 %) patients had good to excellent result, 2 (7%) had good result and 6(19%) had fair result. They concluded that open

reduction and internal fixation with plate is a successful treatment in many proximal humeral fractures especially in young patients.

In 1999 Hessman M et al.[13] concluded that functional results of plate osteosynthesis of unstable and displaced fractures in elderly are good to excellent in 70% of patients when treated with open reduction and internal fixation with plate.

Their study included 99 patients with two, three and four part fractures for which open reduction and internal fixation was done with Buttress plate using deltopectoral approach and they found that the incidence of osteonecrosis of humeral head and non union are rare with this technique.

PHILOS

In 2004 Jan, Magnus Bjorkenheim et al.[6] retrospectively reviewed 72 patients for 1 yr treated by Philos plate. In their study they had nonunion of two patients, osteonecrosis of 3 patients and two patients had implant failure. They concluded that treatment of proximal humeral fractures with PHILOS plate appears to be safe and recommended in patients with poor bone quality.

M Webb et al.[14] in 2005 evaluated the results of PHILOS plate fixation in 25 patients with a mean age of 49.5 (19-80). 22 for acute fractures, 2 for nonunion and 1 for malunion. They had 1 patient with infection, 1 with tuberosity failure and 1 fracture collapse. They concluded that PHILOS plate ostesynthesis is a suitable procedure for displaced and ununited fracture of proximal humerus.

In 2006 Koukakis et al.[15] studied 20 patients with proximal humeral fractures treated with PHILOS plate from Sep 2001 to Jan 2004.They proposed that the plate design provides stable fixation with good functional outcome and eliminates most hardware problems such as failure and impingement syndrome.

In 2008 Shahid R et al.[16]proposed their prospective review of 50 patients treated for proximal humeral fractures with PHILOS plate from September 2002 to September 2006. 11 patients had 2 part fractures 11 patients had 3 part and18 had four part fractures. Radiological union was achieved in 40 out of 41(5 patients died and 4 lost the follow up), complications noted in 4 patients. Their study has shown that PHILOS is the reliable implant for proximal humerus.

In 2009 Brunner F et al.[17] evaluated the incidence of complications and functional outcome after open reduction and internal fixation with PHILOS. Study was prospective, multicenter study between September 2002 to September 2005, with 158 fractures in157 patients. They had primary screw perforation of 14% and secondary screw perforation of 8% and avascular necrosis of 8%. They concluded that fixation with PHILOS plate preserves achieved reduction and a good functional outcome can be expected. More accurate screw length measurement and shorter screw selection should prevent primary screw perforation. Awareness of obtaining anatomic reduction of the tubercles and restoring the medial support should reduce the secondary screw perforation, even in osteopenic bone.

In 2009 Martinz A et al.[18] proposed the evaluation of efficacy of PHILOS plate fixation for proximal humerus. They reviewed 58 patients with age 36 to 73 (mean 61).

Indication was three, four part fractures with angulations of more than 45 degrees and displacement of more than 1 cm. All fractures healed satisfactorily except 1 who had malunion. There was no wound infection, osteonecrosis, vascular injury and loss of fixation. Functional outcome was excellent in 13 patients, good in 36, moderate in 8 and poor in 1. They concluded that PHILOS plate fixation is an appropriate treatment for proximal humerus fractures.

Liu XW et al.[19]in 2010 concluded that treatment of proximal humeral fractures in elderly patients with application of PHILOS plate combined with injectable artificial bone as satisfactory, especially suitable for osteoporotic and comminuted proximal humeral fractures. They studied 17 patients from March 2007 to March 2009 with an average age 71 yrs (66 to 81). The clinical outcome was excellent in 9 patients, good in 6, moderate in 2 cases.

ANATOMY

OSTEOLOGY

The humerus is the largest, most proximal long bone of the upper extremity[4]. The proximal humerus consists of humeral head, the greater tuberosity, the lesser tuberosity, the bicipital groove, and the proximal shaft. It is important to differentiate between the anatomical neck which is at the junction of the head and the tuberosities and surgical neck which is at the area bellow the greater and lesser tuberosities. The boundaries of later are variable without a distinct line.

The lesser tuberosity is the area of attachment of subscapularis muscle, lies on the anterior aspect of the humerus and is smaller than greater tuberosity .The greater tuberosity lies posterior and superior to humeral shaft and provides attachment for the supraspinatus, infraspinatus and teres minor muscles. The bicipital groove lies between the greater and lesser tuberosites and is on the anterior part of proximal humerus.There are considerable variations exists in height and depth of the bicipital groove. The biceps tendon lies in the bicipital groove and is covered by transverse humeral ligament.

The glenoid cavity is a shallow, concave structure with the shape of an inverted comma, approximately $1/3^{rd}$ to $1/4^{th}$ the surface of humeral head, with which it articulates. The glenoid cavity provides attachments to the rim of glenoid labrum and capsule.

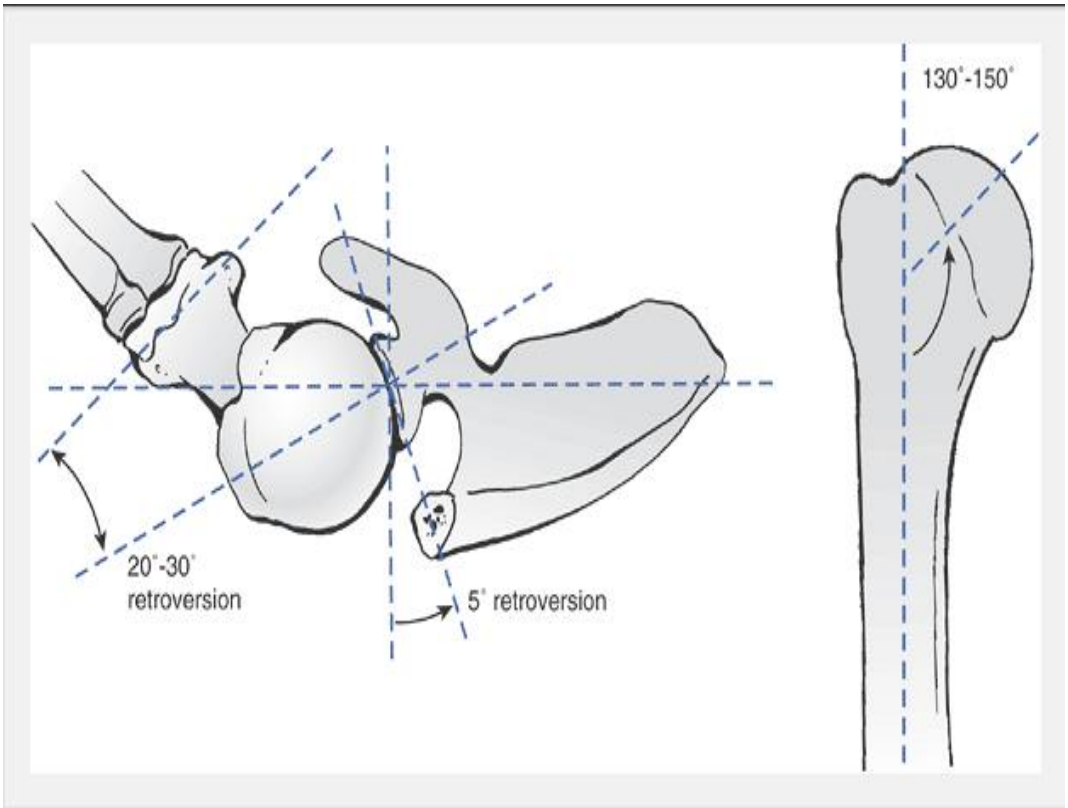
The proximal humerus can be considered to consist of three structural and functional regions; the head, the shaft and the tuberosities. The head is primarily composed of cancellous bone with two major systems of trabecular rays. A medial ray passes onto the

inferomedial region of the head; while the lateral ray runs vertically to the tuberosity and superolateral part of head. This arrangement provides poor osseous support for fixation. In contrast shaft exhibits dense cortical bone. The region of tuberosities represents a zone of transition, frequently deficient in both cortical and cancellous bone; often a cavity with a thin shell of cortex represents the greater tuberosity.

These osseous characteristics in combination with medial torsion of humerus in the region of upper epiphyseal plate account for fracture patterns of the proximal humerus.

There are important relationships of head segment with shaft and tuberosities which includes retroversion, inclination angle, and translation relative to shaft and the relationship to greater tuberosity.

There is 30^0 of retroversion of head relative to forearm ($0\text{-}70^0$), $120\text{-}140^0$ inclination of head segment to shaft (avg 145^0) and translation of articular head relative to tuberosity is (3-20 mm)[4,24,30]. Humerus is spheroid and it's radius of curvature is 2.25 cm.



Proximal humerus anatomy

From: Rockwood and Green's Fractures in adults,vol 1. 6th edition.

OSSIFICATION

Proximal humerus develops from three distinct ossification centers, one for humeral head and one each for lesser and greater tuberosities. The humeral head ossification center usually appears between fourth and sixth month of life. The ossification center of greater tuberosity appears during the third year of life and that of lesser tuberosity appears during fifth year of life. These tuberosities fuse together at fifth year of life and in turn, fuse with the humeral head seventh year of life. Head fuses with the shaft by nineteenth year. The fusion of ossification center creates a weakened area in the

construct, known as epiphyseal scar, making these regions of proximal humerus susceptible to fractures[4,24].

THE ACROMION

The acromion protects the superior aspect of the glenohumeral joint and provides origin and mechanical leverage for the deltoid muscle which is the prime abductor of the shoulder. It also forms the lateral component of acromioclavicular joint. Acromion together with the coracoacromial ligament and coracoid process forms the coracoacromial arch.

It is rather a rigid structure under which the proximal humerus, rotator cuff and subacromial bursa must pass. Displaced tuberosity may disrupt the smooth gliding of these strucures bellow the coracoaromial arch, which may result in impingement, and prevent normal glenohumeral motion[4].

THE SUBACROMIAL BURSA

It is a large synovial membrane[4]. The roof is adherent to the undersurface of the coracoacromial ligament, acromion and deltoid muscle laterally while the floor is closely adherent to rotator cuff and greater tuberosity. It also extends anteriorly and posteriorly around proximal humerus, creating gliding mechanism that facilitates the movement of the proximal humerus under coracoacromial arch.

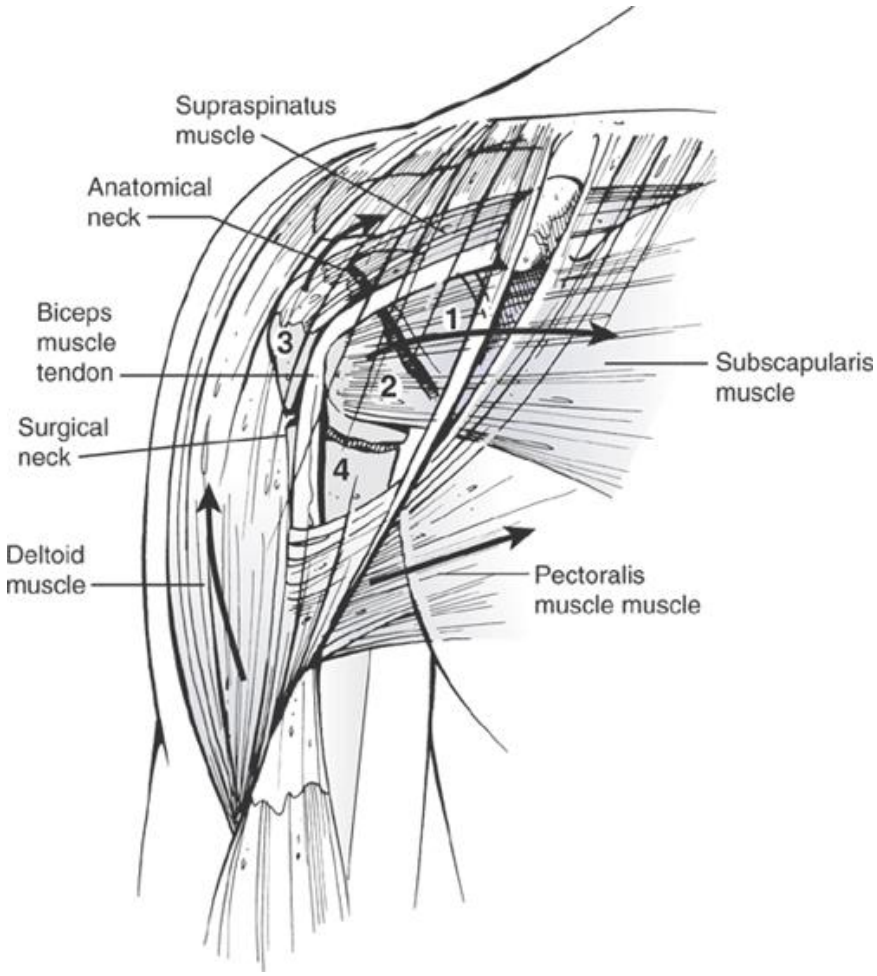
ROTATOR CUFF AND MUSCLES

The dynamic interplay of rotator cuff and deltoid muscle is essential for glenohumeral function. The rotator cuff consists of four muscles subscapularis, supraspinatus, infraspinatus and teres minor. The long head of biceps is also an important component of this complex. The subscapulris is an internal rotator while, supraspinatus is head depressor and in certain positions an internal rotator. The infraspinatus and teres minor are external rotators. These muscles work as a unit rather than individually to maintain dynamic glenohumeral stability.

Two other important muscles must be cosidered in relation to proximal humerus the deltoid and the pectoralis major. The deltoid is a prime mover of the shoulder and takes origins from lateral one third of clavicle, the acromion and the spine of the scapula. It inserts at deltoid tuberosity on lateral aspect of shaft of humerus and it can cause displacement of fractures of the proximal humerus. The pectoralis major is a large fan shaped muscle takes a broad origin from clavicle, the upper ribs and the sternocostal area. It inserts on the lower portion of lateral lip of bicipital groove and it can displace proximal humeral fractures medially.

The supraspinatus attaches to the greater tuerosity at the superior facet and superior half of middle facet. Avulsion type of forces from this muscle produces a short transverse fracture of greater tubrosity that displaces primarily superiorly. Reduction by abduction helps to reduce the fracture.

If the infraspinatus, which attaches to entire middle facet of the greater tuberosity is also involved the fracture fragment is larger and fragment displaces posteriorly and superiorly.The subscapularis inserts onto lesser tuberosity, this causes fractures of lesser tuberosity to displace anteriorly and medially.



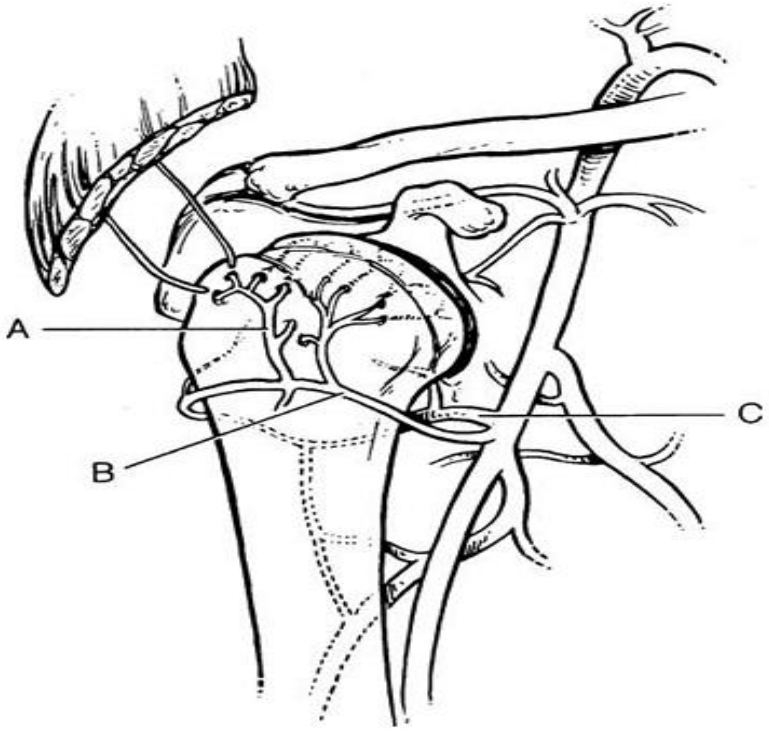
Displacement of fragments depends on the pull of rotator muscles and the pectoralis major.

From: Rockwood and Green's Fractures in adults,vol 1. 6th edition.

BLOOD SUPPLY

Vascular Anatomy

Laing et al.[25] studies showed that the anterior lateral branch of the anterior humeral circumflex artery is the primary blood supply to the proximal humerus. The anterior humeral circumflex artery arises from the lateral side of the third division of the axillary artery approximately 1 cm distal to the inferior border of the pectoralis minor muscle (just above the teres major muscle) and courses laterally behind the coracobrachialis to reach the surgical neck of the humerus at the lower border of the subscapularis. The ascending branch of the anterior humeral circumflex artery courses immediately lateral to the bicipital groove and is paramount in maintaining vascularity of the articular segment. This vessel enters the humeral head just below the articular surface to form the arcuate artery, which perfuses the majority of the humeral head. Laing noted inconsistent contributions to the humeral head from both the lesser and greater tuberosities. The posterior humeral circumflex artery arises closely juxtaposed to the anterior humeral circumflex artery and is much larger in diameter. Gerber found that the posteromedial vessels arising from the posterior humeral circumflex artery supplied the posterior portion of the greater tuberosity and a small posterior inferior part of the head. The vessels then form an anastomosis with the arcuate artery on and within the greater tuberosity and on the joint capsule. Brookes et al[28] demonstrated that these posteromedial vessels pass beneath the humeral capsular attachment (which at this site extends from 1 cm onto the surgical neck) and run toward the humeral head before entering the bone just below the articular margin.



The rich vascular anatomy of the proximal humerus: (A) The anterior lateral branch of (B) the anterior humeral circumflex artery is the primary blood supply. (C) The posterior humeral circumflex artery arises close to the anterior humeral circumflex and gives off posterior medial branches to help supply the head.

The study by Brookes[26] et al emphasized the importance of the intraosseous anastomoses and showed that the humeral head could be completely perfused after ligation of the anterior humeral circumflex artery at its entry site into the humeral head. They found large metaphyseal arteries that passed through the fused growth plate to anastomose with the arcuate artery in six of the eight normal and control specimens. In addition, significant intraosseous anastomoses occurred between the arcuate artery and

the posterior humeral circumflex artery through the posteromedial vessels described in the foregoing and the vessels of the greater and lesser tuberosities[27].

A classic four part fracture will lose the blood supply to the head from disruption of the anterior humeral circumflex artery, greater and lesser tuberosities, and any metaphyseal arterial anastomosis. Thus, a high rate of osteonecrosis is expected. Yet, Brookes et al. has shown that perfusion of the humeral head by the arcuate artery may continue if the head fragment includes part of the medial aspect of the upper part of the neck where the posteromedial arteries enter. The so called four part valgus impacted fracture with limited lateral displacement of the head fragment may retain its vascularity from the posterior medial vessels, thus accounting for the lower incidence of osteonecrosis reported compared with classic four part fractures[26]. The vascular anatomy also supports the observation that minimally displaced fractures of the anatomic neck, in which the fracture line is at the junction between the articular surface and neck, may be complicated by osteonecrosis as a result of disruption of both the extra and intraosseous blood supply[28].

Rarely, proximal humeral fractures with significant displacement of the humeral shaft can injure the axillary artery near the take off of the circumflex humeral artery.

Rothmann [29] has outlined the blood supply to the rotator cuff as routinely derived from six arteries the anterior humeral circumflex, the posterior humeral circumflex, the suprascapular, the subscapular, thoracoacromial and the suprahumeral artery.

NERVE SUPPLY

Injury to the nerves at the shoulder can occur with fractures. The brachial plexus and the axillary artery are medial to the coracoid process and can be injured in anterior dislocation of shoulder and violent trauma to proximal humerus. Isolated injury to major nerves innervating the muscles around the shoulder the axillary, supraspinatus and musculocutaneous nerve can also occur[4].

The innervations of the shoulder are derived from the C_5-T_1contribution of the brachial plexus. In the setting of displaced proximal humerus fractures and fracture and dislocations, the axillary nerve is the primary nerve at risk for injury as it courses through the quadrilateral space.

Axillary nerve is composed of fibers from C_5-C_6 roots and takes origin from the posterior cord at the level of axilla. Then it crosses the anterior surface of subscapularis muscle dips back posteriorly under its inferior border. It passes along the inferior border of capsule of glenohumeral joint then through quadrangular space. After emerging from the quadrangular space it gives off a branch to teres minor and divides into anterior and posterior branches.The posterior branch supplies posterior deltoid and gives off superior lateral brachial cutaneous nerve. Anterior branch supplies middle and anterior part of deltoid. Owing to its relative fixation at the posterior cord and deltoid, any downward motion of the proximal humerus can result into traction injury to this nerve.

Its relationship to inferior capsule makes it susceptible to injury from anterior dislocation and during open repairs for anterior fracture dislocation. The subscapular

nerve may be injured but this is less common .The two points of fixation of nerve are at its origin from the upper trunk and at suprascapular notch making it susceptible to traction injuries. Injury to musculocutaneous nerve is very rare but does occur due to blunt trauma as well as traction injuries.

CLASSIFICATION

Prior to Neer classification various other methods have been proposed including anatomical level or location of injury, mechanism of injury, amount of contact by the fracture fragments and degree of displacement.

1. Kocher(1896)[30] was the first to devise a classification of proximal humeral fractures based on anatomical levels
    a. Anatomical neck
    b. Epiphyseal region
    c. Surgical neck
2. Codman (1934)[31] first described the main fracture fragments and their attachments, which cause displacement.
    a) Greater tuberosity
    b) Lesser tuberosity
    c) Head
    d) Shaft
3. Watson-Jones (1955) [32]classified fractures according to mechanism of injury.
    a) Contusion crack fracture
    b) Impacted adduction fracture
    c) Impacted abduction fracture

Major disadvantage of this classification is that changes in humeral rotation alter the radiographic appearance of fracture.

4.Neer[8] classification:

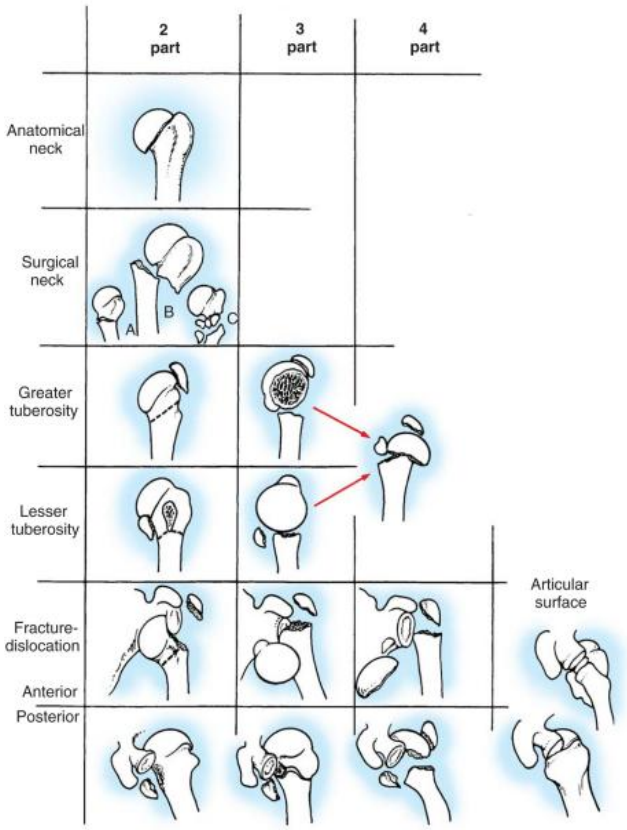
First described in 1970 and then simplified in 1975, was developed from retrospective review of 300 fractures.

Neer's classification scheme is the system most widely used by orthopaedic surgeons today. In this system the criteria for displacement are 45^0 of angulation or more than 1 cm displacement between fracture fragments.

Two part fracture means that only one segment is displaced, and the most common type is surgical neck fracture. Greater tuberosity fracture is another common fracture. Two part fracture that involve lesser and the anatomical neck are rare.

Three part fracture is one which involves displacement of the shaft and humeral head from either the greater tuberosity(most common) or the lesser tuberosity.

A four part fracture isolates the humeral articular segment from the tuberosities and the shaft. The typical scenario is dislocation of the humeral segment out of the glenoid with no remaining soft tissue attachments. The valgus impacted four part fracture which is described after Neer's classification is an important variant and it may have better prognosis than classic four part fracture.



The Neer classification of proximal humeral fractures

From: Campbell's operative orthopaedics. Vol III 2839pp, 12th edition.

AO Classification[4]

The AO group has modified the Neer classification, placing more emphasis on the vascular supply to the articular segment of the proximal humerus. Severity of the injury and risk of osteonecrosis forms the basis of the AO classification system. In this system, it is accepted that if either tuberosity or its attached rotator cuff remain in continuity with the articular segment, the vascular supply is probably adequate.

Proximal humerus fractures are separated into three types:

- Extraarticular unifocal
- Extraarticular bifocal

❖ Articular

Each of these types is further subdivided into different groups based on alignment, degree, and direction of the displacement; presence of impaction; and associated dislocation.

1) Type A: Extraarticular fractures and involve one of the tuberosities with or without a concomitant metaphyseal fracture.
    a) Group A1: Extraarticular unifocal tuberosity fractures
    b) Group A2: Extraarticular unifocal fractures with an impactedmetaphyseal fracture.
    c) GroupA3: Extraarticular unifocal fractures with nonimpacted metaphyseal fracture.

    Osteonecrosis is unlikely in type A fractures.
2) Type B: Extraarticular and involve both tuberosities with a concomitant metaphyseal fracture or glenohumeral dislocation.
    a) Group B1: Extraarticular bifocal fractures associated with an impacted metaphyseal fracture;
    b) GroupB2:Extraarticular bifocal fractures with a nonimpacted metaphyseal fracture
    c) GroupB3:Extraarticular bifocal fractures with glenohumeral dislocation.

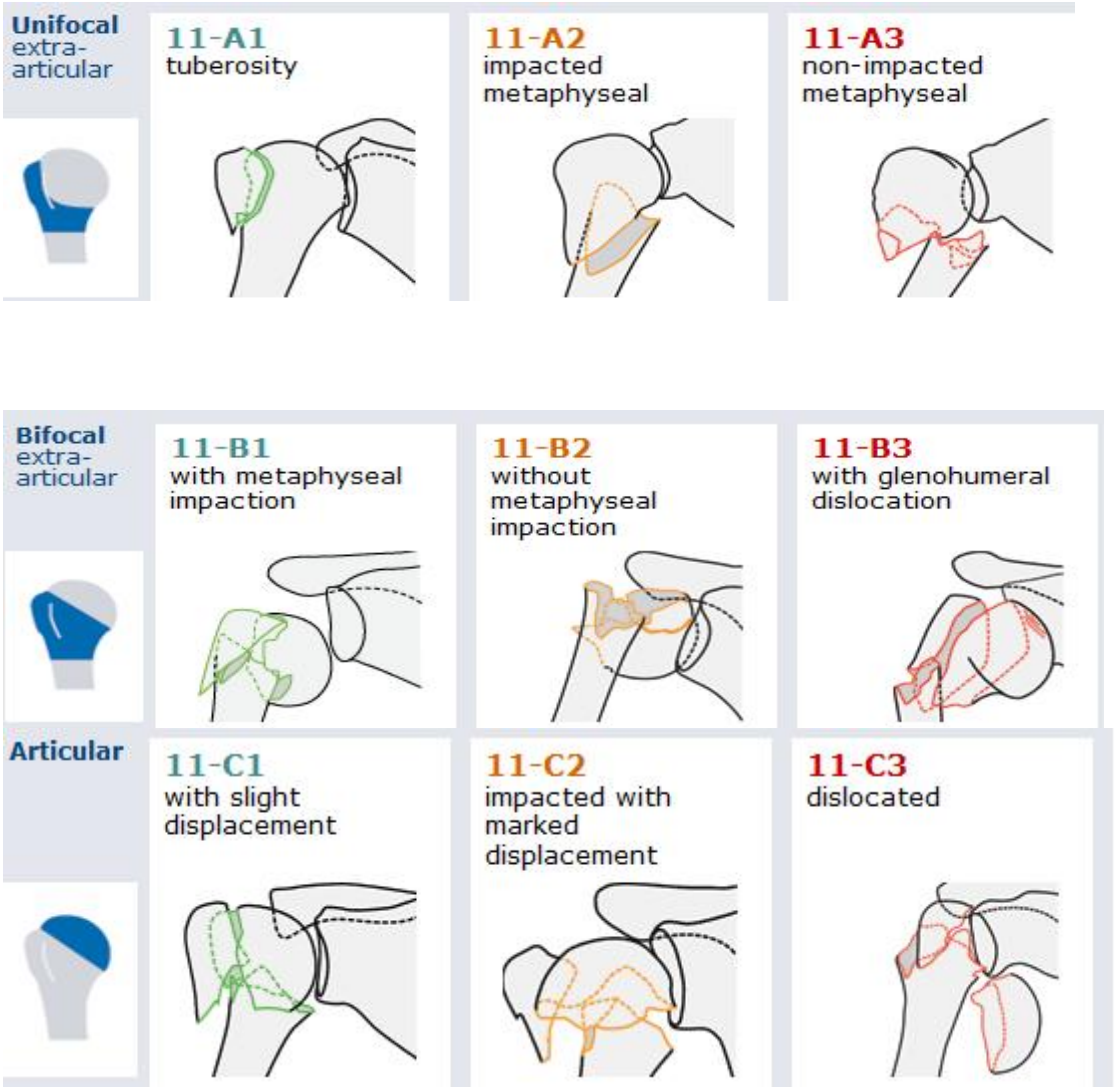
    There is a low risk for osteonecrosis in type B fractures.
3) Type C: Extraarticular fractures and involve vascular isolation of the articular segment.

a) Group C1:Extraarticular fractures with slight displacement

b) Group C2: Extraarticular impacted fractures with marked displacement

c) Group C3: Extraarticular fractures associated with a glenohumeral dislocation.

There is a high risk of osteonecrosis in this type.

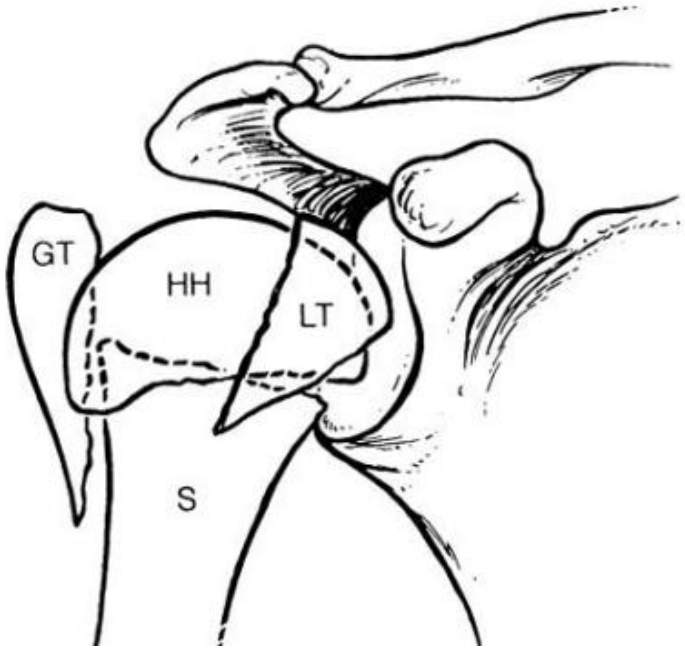


AO CLASSIFICATION

From: ao foundation.org

Valgus Impacted fracture[28]

There is a specific type of four part fracture described that is characterized by a valgus impaction of the humeral head and variable displacement of the tuberosities. This valgus impacted humeral head fracture pattern does not fit accurately into Neer's classification. The AO classification system classifies these fracture patterns as C2.1 and C2.2 type fractures. However, because of the lower rate of osteonecrosis and the more favorable outcome compared with classic four-part fractures Jakob et al[28] felt this fracture pattern required special consideration.



MECHANISM OF INJURY[4,5]

1. Fall onto outstretched hand this is the most common cause.
2. Excessive rotation of arm especially in abducted position as described by Codman.
3. The humerus locks in pivotal position and fracture can occur especially in older patients.
4. Direct blow to the side of the shoulder result in greater tuberosity fracture with communition.
5. A strong external rotation force when arm is at maximum external rotation and is about 60^0 abduction causes lesser tuberosity fracture.
6. Pathological fractures due to trivial trauma.
7. Resisted internal rotation may cause lesser tuberosity fracture.
8. Anterior dislocation of shoulder following abduction and external rotation force may cause greater tuberosity fracture.

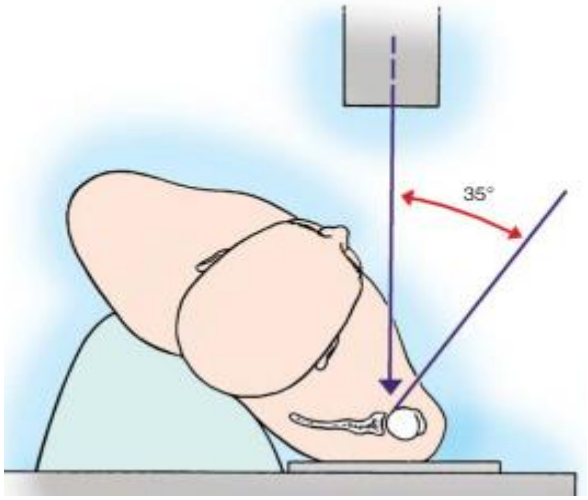
CLINICAL FEATURES[4,33]

- ❖ In most cases of proximal humerus fracture, there is significant swelling and pain which may worsen over several days after injury and are usually associated with ecchymosis.
- ❖ There may be anterior bulge below the coracoid process in cases of anterior dislocation.
- ❖ There may be posterior bulge and anterior sulcus seen in posterior dislocation.

- On palpation there will be tenderness around the shoulder.
- Sensation over the lateral aspect of the shoulder will give the information about the integrity of the axilary nerve.
- Ipsilateral shaft humerus, elbow, forearm, and wrist should be examined.

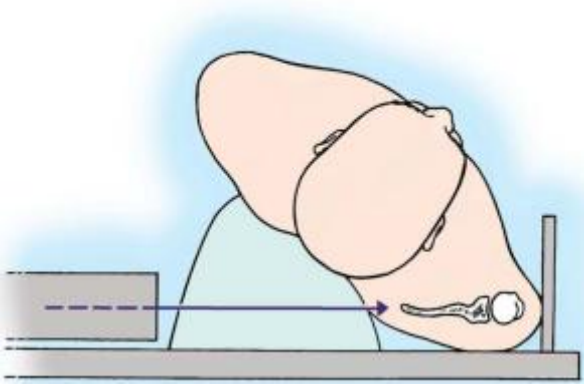
IMAGING STUDIES

- The most important diagnostic tool for proximal humerus fracture is the radiographic evaluation. Incorrect radiographic views or acceptance of poor quality radiographs can lead to errors in diagnosis and may allow selection of inappropriate treatment.
- The initial series selected to evaluate a patient with a possible proximal humerus fracture is the trauma series, which consists of anteroposterior and lateral x-rays in the scapular plane and an axillary view.
- The scapula sits obliquely on the chest wall. Therefore to achieve a true anteroposterior view, the beam of the x- rays must be tilted 35^0 to thorax. Similarly for the lateral view the x- ray beam should be parallel to the scapular spine while the body is tilted 40^0.



The scapular AP view

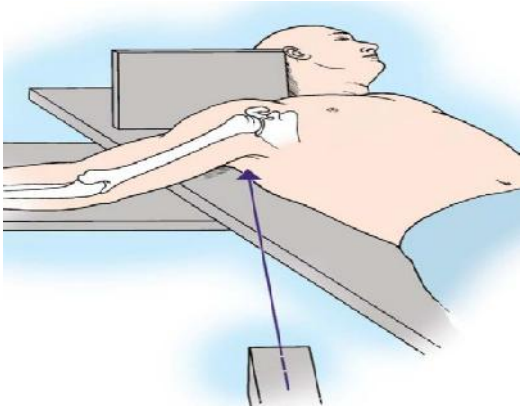
From: Campbell's operative orthopaedics. Vol III,2840 pg,12th edition



The scapular lateral view

From: Campbell's operative orthopaedics. Vol III,2840pg, 12th edition

The axillary view can be obtained by abducting the affected shoulder. The Veleau axillary view can be obtained without abducting the shoulder, allowing the arm to stay within the sling. In this view, the patient seated and tilted backwards 45^0.



Axillay view

From: Campbell's operative orthopaedics. Vol III, 2840pg,12th edition

- Use the anteroposterior view to assess fracture displacement of surgical neck (varus and valgus), the greater tuberosity when there is superior displacement, the lesser tuberosity when there is medial displacement.
- Additionally, the glenohumeral joint should be clearly visible. If it has overlapped then suspect dislocation. The lateral view is helpful in assessing flexion and extension of surgical neck and posterior displacement of the greater tuberosity fragment.
- Finally the axillary view helps to assess tuberosity fragments with anteromedial displacement of the lesser tuberosity and posterior displacement of greater tuberosity fragment. This view is critical in assessing greater tuberosity fragment, as superior displacement may be absent and the infraspinatus can be completely

avulsed with a posterior displaced fragment. Furthermore, dislocation of the head can be clearly defined on this view.

CT SCAN

Computed tomography scans of proximal humeral fractures and fracture dislocations may be indicated when the trauma series radiographs are indeterminate. CT scans have been recommended to evaluate the rotation of fragments, the degree of tuberosity displacement, as well as articular impression fractures, head-splitting fractures and chronic fracture dislocations. CT does not seem to improve interobserver reliability and fracture classification[34]. CT scans are most helpful in the evaluation of chronic fracture dislocations, specifically to identify the size and location of humeral head impression defects and the degree of secondary glenoid changes.

Another imaging modality to consider is Magnetic Resonance Imaging (MRI). MRI provides information about associated soft tissue injuries of the rotator cuff, biceps tendon, and glenoid labrum, which may be helpful in the management of these patients. However, cost benefit issues have to be considered carefully. Thus far, there have been no studies performed to support its routine use.

TREATMENT

The indication for operative versus non operative management of adult proximal humerus fracture is determined by numerous factors including the patient's physiologic age, arm dominance, associated injuries, fracture type, degree of fracture displacement and bone quality. The surgeon's knowledge and skill will greatly affect the functional outcome [35].

One-Part Fractures

Minimally displaced fractures account for over 80% of all proximal humerus fractures[8]. They are often referred to as one-part fractures, based on Neer's four-segment classification. Many of these fractures are impacted and with rotation of the humerus, the proximal humerus and shaft move together as one unit. These are stable fractures and an early range of motion program is appropriate. However, some minimally displaced fractures are not impacted and rotation of the humerus shows that the proximal segment and shaft do not move as a unit. These fractures are not stable and require a period of immobilization until sufficient healing has occurred.

Two Part Fractures

Two-part fractures involve displacement of one of the four segments. Therefore, four different fracture patterns are possible: anatomic neck, greater tuberosity, lesser tuberosity and surgical neck.

Anatomic Neck fractures

The problem with these fractures is the high risk of osteonecrosis because of disruption of the intra and extraosseous blood supply to the humeral head. These fractures are difficult to treat by closed reduction. Open reduction and internal fixation (ORIF) is preferred, with the goal of avoiding prosthetic replacement in young patients. If a displaced anatomic neck fracture occurs in an elderly patient, a choice has to be made between open reduction and internal fixation and primary hemiarthroplasty. If the articular surface is comminuted, then the fracture is similar to a head splitting fracture and primary hemiarthroplasty is preferred.

Lesser Tuberosity fractures [36,37,38,]

Two- part lesser tuberosity fractures in the absence of posterior dislocations are uncommon. These fractures are of minimal clinical significance unless the fragment is large and includes a significant portion of the articular surface. If a large fragment is involved, open reduction and

internal fixation with two 4 mm AO cannulated cancellous screw is indicated.

Greater Tuberosity fractures

Two-part greater tuberosity fractures are relatively common and can be the source of significant disability. About 7-15% of anterior shoulder dislocations are associated with greater tuberosity fractures[39,40,41]. Open reduction and internal fixation of the fragment and repair of the rotator cuff tear is usually the preferred treatment.

Although the criterion for displaced fractures is 1 cm, greater tuberosity fractures appear to be different from other proximal humerus fractures. Less than 1cm displacement may be problematic, particularly when the displacement is superiorly into the subacromial space. Open reduction and internal fixation has been generally recommended in patients when the displacement is >0.5cm[33]. Different options include open reduction and internal fixation with screws or suture fixation in younger patients in case of large fragments[42].

Surgical Neck fractures

Two-part surgical neck fractures are quite common in the elderly. Treatment depends on fracture stability and the displacement pattern.

Impacted fractures with less than 45-degree angulations may be treated nonoperatively with early motion. Impacted fractures with greater than a 45-degree anterior angulation may limit forward elevation. Therefore, disimpaction followed by reimpaction to achieve better alignment, should be considered in active patients. Also complete displacement of proximal fragment from the shaft is an indication for surgery[42]. Various options include closed reduction with or without percutaneous pinning, open reduction with minimal or rigid fixation with plates, IM fixation and fixation with heavy sutures.

Three-Part Fractures

The classic three part fracture as described by Neer involves either greater or lesser tuberosity[8,9]. Two types of three-part fracture patterns can occur. The first type is displacement of the greater tuberosity and shaft, with the lesser tuberosity remaining attached to the articular segment. This pattern occurs more commonly. The second and less commonly encountered type of three-part fracture is displacement of the lesser tuberosity and shaft segments with the greater tuberosity remaining attached to the articular segment. Due to rotational component of these fractures it is difficult to reduce these fractures through closed means thus, an open reduction is preferred.

Treatment options for open reduction and internal fixation include heavy sutures, IM device and proximal humeral locking plate which is preferred by most surgeons[42].

Four-Part Fractures

Classic Four Part Fractures[42]

By definition, a four part fracture is one in which the articular segment is isolated from both tuberosities and the shaft. In most cases an immediate hemiarthroplasty is indicated. In some cases of young individuals an immediate open reduction and internal fixation with a combination of plates, screws and sometimes heavy suture is perfomed. The key is to restore an anatomic relationship to humeral head and tuberosities, since osteonecrosis in this situation is well tolerated and later conversion to arthroplsty is much more successful.

Valgus impacted fracture[42]

This should be considered separately due to preserved medial soft tissue hinge, which preserves the vascularity to articular segment. Thus the risk of osteonecrosis is lower than the typical four part fractures. Both closed reduction with internal fixation and open reduction with internal fixation are well suited for this fracture.

COMPLICATIONS

Complications[42] are not uncommon after surgical treatment of proximal humerus fractures. This is usually due to errors in procedure selection and in surgical technique. Furthermore, many complications such as greater tuberosity displacement are typically missed on postoperative follow-up. This makes revision surgery more difficult.

A. Instability

True instability is rare after treatment of fractures and subluxation of the humeral head out of the glenoid is usually the consequence of hemarthrosis, deltoid atony, or rotator cuff dysfunction. This is usually transient as muscle tone returns and hemarthrosis is resorbed. In the setting of hemiarthroplasty, inferior subluxation can also be due to incorrect placement of the prosthesis at a level that is too low, so that the deltoid tension is insufficient to maintain the humeral head in the glenoid.

B. Hardware Problem

Problems with hardware are usually associated with other complications such as nonunion and sometimes neurovascular problems. These problems are sometimes related to inappropriate use of rigid devices in poor bone or placement of metallic implants with a poor construct that cannot withstand

the forces across the fracture. A thorough understanding of fracture geometry and bone quality is essential to avoid such problems.

C. Delayed Treatment and Missed Fractures

Delay in treatment, especially in the setting of missed fractures can lead to a poor outcome because heterotopic bone formation may ensue and soft tissue contractures may prevent the restoration of normal anatomy.

D. Neurovascular Problems

Although rare, neurovascular problems are unfortunately usually due to iatrogenic causes. Misplaced pins and excessive dissection and mobilization may be involved. Vascular injury in the case of marked fracture displacement has been reported and careful neurovascular examination is required in all patients with a fracture.

E. Malunion

Malunion in the case of proximal humerus fracture is not rare, but often it does not result in significant functional disability. Rotational deformities as well as angular deformities in the plane of motion of the joint are relatively well tolerated, but malunions of the tuberosity relative to the articular segment are less well tolerated. In cases of varus malunion, an angular osteotomy usually leads to an excellent outcome, whereas

osteotomy of displaced tuberosity fragments with or without arthroplasty, usually leads to weakness and a poor overall functional outcome.

F. Nonunion

Surgical neck nonunion is much more common than tuberosity nonunion. The incidence of surgical neck nonunion in the setting of conservative treatment has actually been reported to be as high as 20%. Surgical neck nonunion usually occurs in conjunction with tuberosity displacement, and reconstruction with hemiarthroplasty when performed in this setting usually leads to poor function. Isolated surgical neck nonunion has been successfully treated with blade plate or proximal humeral locking plate fixation. Bone graft can be either used as an intramedullary plug or placed along the nonunion.

G. Osteonecrosis

Osteonecrosis can occur either as complete humeral head collapse or as a partial involvement of the humeral head either with or without articular collapse. The extent of osteonecrosis depends on the fracture configuration and the associated fracture treatment, as iatrogenic osteonecrosis is associated with excessive stripping of the medial soft tissues that contain the residual vascularity to the articular segment.

In symptomatic osteonecrosis, hemiarthroplasty is usually indicated.

H. Stiffness and Arthritis

Stiffness may occur with or without operative treatment of a fracture and it is usually due to prolonged immobilization that leads to scarring between tissue planes. In general, this complication is less common with closed reduction and percutaneous fixation than with open reduction and percutaneous fixation.

Posttraumatic arthritis is usually associated with loss of motion as well and may or may not occur in the setting of joint incongruity with fracture malunion.

I. Infection

Infection is relatively rare in the shoulder, even after surgical repair using open methods. This is due to the rich vascularity to this region and the good soft tissue coverage. Pin tract infections have been implicated as a common complication in the setting of percutaneous pinning of fractures. Pins that protrude from the skin create an increased risk for pin tract infection. In the setting of arthroplasty, Propionibacterium infections appear to be much more frequent than previously believed, although the diagnosis may be difficult to make in the setting of a normal sedimentation rate, equivocal C-reactive protein tests, and no radiographic evidence of

loosening. Persistent pain with stiffness under these circumstances should raise concern of a possible indolent Propionibacterium infection.

MATERIALS AND METHODS

STUDY AREA AND STUDY POPULATION:

This is a prospective and retrospective study, conducted in the department of Orthopaedics in SRI B.M.PATIL MEDICAL COLLEGE Hospital and Research Center. All patients with displaced proximal humerus fractures admitted in this hospital from SEP 2012 to FEB 2014 were considered for the study if they fulfilled following criteria

INCLUSION CRITERIA:

1. All adults patients admitted with proximal humerus fracture.

2. Patients without any distal neurovascular deficits.

EXCLUSION CRITERIA:

1. Skeletally immature patients
2. Pathological fractures,
3. Patients with distal neurovascular deficit,
4. Polytrauma patients with an Injury Severity Score > 16
5. Shaft humerus fractures with proximal extension
6. Immuno compromised patients like HIV.

The study was approved by local ethics committee. There were 45 patients, 29 males and 16 females. The mean age of patients was 49.6 yrs (range 22-79). The right

shoulder was involved in 28 patients and left in 17 patients. 30 patients sustained fracture following RTA whereas 15 patients sustained fracture following a fall. The diagnosis was established by clinical evaluation and radiological examination in standard anteroposterior and lateral views and CT scan (occasionally).

The fractures were classified based on Neer's classification system. 10 patients had two part fracture, 26 patients had three part fractures and 9 patients had four part fractures.

A detailed history was obtained which included information related to the patient's health, activity level, and the specifics of the injury. The general history includes the patient's age, sex, hand dominance, occupation, hobbies, and how the injured extremity is used in daily life.The history of mechanism of injury (i.e. whether the trauma was mild, moderate or violent) obtained. A complete physical examination which included neurovascular assessment and assessment for other bony and visceral injuries was conducted. All fractures were initially immobilized with shoulder immobilizer till the time of surgery.

After the medical evaluation, the surgical procedure, type of anaesthesia, postoperative course, risks and the potential complications of surgery were explained to the patient prior to the surgery.

All patients were operated at mean 2days (range 2-4 days) delay after the injury.

INSTRUMENTATION:

1. PHILOS plate (Proximal Humeral Inter Locking Osteosynthesis System)

1) FEATURES OF PHILOS PLATE (PROXIMAL HUMERAL INTERLOCKING SYSTEM):

- Anatomically shaped
- Ten suture holes around the perimeter of the proximal end
- 9 Proximal locking holes accept 3.5 mm locking Screws
- Locked construct in humeral head
- Distal shaft consists of three or five combi-holes for 3.5 mm cortex screw, 4.0 mm cancellous screw and 3.5 mm locking screw.
- Available in stainless steel and titanium.

PHILOS PLATES

SCREWS:

The Locking Proximal Humerus Plate and PHILOS plates used with small fragment standard and locking head screws, included in the LCP 3.5 Implant Set.

3.5Locking head
Self tapping

3.5 cortex screw
Self tapping.

INSTRUMENTS OF PHILOS:

Philos Aiming Device

3.5 mm Locking Screw Sleeve

2.8 mm Drill Sleeve

Centering Sleeve for K-Wire

Direct measuring device

GENERAL PRINCIPLES OF SURGERY:

TIMING OF SURGERY:

The optimal time for surgery depends upon many factors including the type of fracture, the condition of soft tissue, other injuries, medical problems, operating room availability, cost and patient's social circumstances.

All patients were operated at mean 2. days (range 2-4 days) delay after injury. Early surgical treatment allows early rehabilitation, less hospital stay and more accurate reduction.

Surgery was delayed in some cases for reasons such as soft tissue swelling, medical problem and nonavailability of operating room.

PRE OPERATIVE EVALUATION:

The following routine investigations were done;

1) Radiographs: Scapular AP, Scapular lateral and axillary view. CT scan occasionally.
2) Pre operative investigations;
    - ❖ Routine blood investigations: CBC, Blood sugar,
      Sr creatinine, HIV, HBsAg and HCV.
    - ❖ Urine routine examination.
    - ❖ Blood grouping and Rh typing. Coagulation profile in some cases.
    - ❖ ECG to assess the myocardial status and in some cases
      2D ECHO.

PREPARATION OF PATIENTS:

1) Patients were kept nil orally for 6 hrs prior to surgery.
2) Intravenous fluids were given as needed.
3) Properly written, informed consent was taken.
4) Preparation of the part.
5) Intravenous antibiotic, usually Inj Cefotaxime 1 gm was administered 30 minutes before surgery.

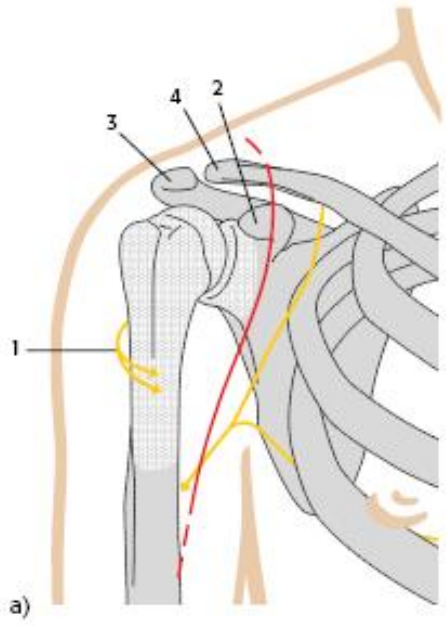
ANAESTHESIA AND PATIENT POSITIONING:

The operation is performed under general anesthesia. Patient is placed in supine position. Folded sheet is placed in interscapular region. The fluoroscopic imaging equipment is positioned at the head end of the bed and rotated over shoulder to allow optimal imaging intraopretively.

Patient positioning

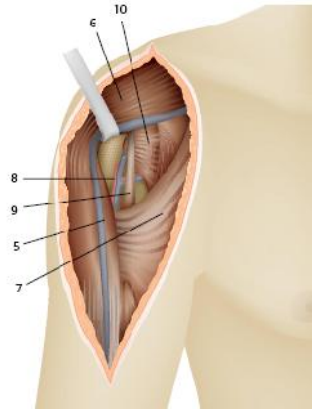
SURGIACAL APPROACH:

A deltopectoral approach was preferred. The skin incision is begun at the tip of the coracoid process proximally and is extended 10 to 15 cm distally to the deltoid tuberosity. Following exposure of the skin and the subcutaneous tissues, the cephalic vein, deltoid muscle, and pectoralis major muscle are identified. The cephalic vein marks the interval between the deltoid muscle laterally and the pectoralis major muscle medially. The cephalic vein is a major draining vein of the arm and should be preserved. It is retracted laterally to protect the many deltoid branches that enter on this side. Next, the internervous plane between the deltoid (i.e. axillary nerve) and the pectoralis major (i.e. medial and lateral pectoral nerves) is developed. Once through the interval, an extensive hematoma is usually encountered and is evacuated by aspiration or digitally to expose the fracture. Slight abduction of the arm relaxes the deltoid muscle and enables better access to the humeral head. The long head of the biceps tendon is identified at the upper border of the pectoralis major muscle, and its course is followed proximally. This tendon is important in orienting the anatomy of the proximal humerus because it runs in the intertubercular groove between the greater and lesser tuberosities. Thebiceps tendon is particularly useful for orientation in the presence of four part fractures, when anatomy can be significantly distorted.



The skin incision starts from the coracoids process and runs slightly convex towards the medial side, as far as the insertion of the deltoid muscle on the lateral humeral shaft. 1) Axillary nerve 2) coracoid process, 3) acromion, 4) lateral end of clavicle.

Deltopectoral groove exposed



Retraction of the deltoid muscle to the lateral side looking for the humeral head. 5) Cephalic vein, 6) deltoid muscle, 7) pectoralis muscle, 8) anterior circumflex humeral artery, 9) long head of the biceps muscle, 10) subscapularis muscle

Prior to attempted fracture reduction, the rotator cuff is generously tagged with nonabsorbable sutures anteriorly, posteriorly, and superiorly to assist with reduction of the fracture fragments and ultimately, to reinforce fixation of the fracture to the plate. Now the head fragment can be gently manipulated under direct visualization with a periosteal elevator introduced into the fracture gaps. The elevator is helpful in disimpacting the head from the humeral shaft. Excessive exposure of the fracture fragments should be avoided to prevent disruption of the blood supply. Indirect reduction can be achieved without force by means of longitudinal traction on the arm, abduction or adduction, rotation, and lateralization of the humeral shaft while pulling on the rotator cuff sutures. In the presence of varus tilt of the head fragment, the position can be corrected by pulling on the superior suture loop through the supraspinatus tendon while maintaining longitudinal traction on the arm. Tagged tuberosity fragments can be reduced to the humeral shaft and may also indirectly reduce a head fragment. Once the head

fragment has been reduced, the tuberosities are pulled together with the sutures and fitted via digital manipulation. Poor results have been shown with improper reduction of the tuberosities. In comminuted fractures, temporary fixation with K-wires is recommended to hold the fracture reduction. Care must be taken so that the wires do not interfere with subsequent plate positioning

After temporary fracture reduction is achieved, the precontoured anatomic locking compression plate is positioned approximately 8 mm distal to the upper edge of the greater tuberosity. Care should be taken to avoid placing the plate too high because this could increase the risk of subacromial impingement. However, care should also be taken to avoid placing the plate too low which could prevent optimal screw placement in the humeral head. Centre the plate laterally against the greater tuberosity, ensuring that a sufficient gap is maintained between the plate and the long bicep tendon.

Before placement of locking screws, a shaft that is lying medial brought lateral into a reduced position against the plate with a 3.5mm cortical screw

introduced into the first hole distal to the fracture site. Correct plate position checked and the adequacy of fracture reduction confirmed on fluoroscopic imaging. K-wires are temporarily inserted into the screw holes to hold the plate in place. With the plate appropriately positioned and the fracture reduced, proximal and distal screws are placed in the plate. All fracture fragments must be reduced and the plate correctly aligned before the locking screws are placed because these screws will prevent further compression or reduction of the fracture. An insertion guide can be used to facilitate placement of the proximal locking screws. When drilling the proximal screw holes into the humeral head, advance the drill bit in stepwise manner until it encounters resistance from subchondral

bone. Screw length is determined with a depth gauge and confirmed with fluoroscopy. The use of imaging in determining the screw length is particularly important in thin osteoporotic bone, in which drill depth cannot always be accurately detected by depth gauge alone. This confirmatory step decreases the risk of placing locking screws that protrude through the articular cartilage of the humeral head. To maximize construct stability, we use to place as many divergent locking screws in the humeral head as the plate will allow.

We prefer to insert the tip of each locking screw to a distance at least 5 mm short of the subchondral bone. This depth, in conjunction with the use of self-tapping locking screws, reduces the risk of screw penetration into the glenohumeral joint should impaction or collapse of the fracture occur.

The distal or shaft end of the plate has holes that may be filled with locking or nonlocking (i.e. compression) screws. Minimum of two bicortical screws should be used in shaft to prevent hardware failure.Three bicortical screws used in osteoporotic bone. To allow the plate to function as a bridging device, holes at the metaphyseal level not filled in the presence of metaphyseal comminution. The segment of plate that is not filled with screws allows absorption of bending moments, thus preventing implant breakage resulting from excess stress concentration at the bone implant interface. A longer plate used to manage fracture with a significant metaphyseal comminution.

Following reduction of a proximal humerus fracture,and provisional placement of the locked plate, correct plate position and the adequacy of fracture reduction confirmed on fluoroscopy. When all screws have been placed, the rotator cuff sutures are threaded through the small holes in the proximal end of the plate and tied down for additional

fixation. The indication for suture use should be generous because the added stability allows for early postoperative exercises and reduces the risk of loss of reduction and malunion.

With fixation complete, passive motion of the shoulder with direct fracture visualization, followed by fluoroscopic imaging, performed to check construct stability. Particular attention paid to the quality of the reduction, plate position, stability, and avoidance of penetration of the locking screws into the glenohumeral joint. Once adequate fixation is confirmed, the wound is irrigated and closed in layers. During wound closure, we placed a drain deep to the deltopectoral interval to close down any dead space.All patients received perioperative antibiotics. Adjuvant bone grafting not used.

Temporary plate fixation with k wires

Fixation of drill sleeves

Skin closure

Dressing applied

POSTOPERATIVE CARE:

Postoperatively, the arm is immobilized in a shoulder immobilizer. The drain is removed 48 hrs after surgery. The timing of shoulder rehabilitation is determined by fracture stability, bone quality, and patient compliance. The patient progresses through a three-phase rehabilitation program consisting of I) Passive or assisted exercises. II) Active exercises starting at approximately 4-6 weeks postoperatively. III) Strengthening or resisted exercises beginning 8 to10 weeks after surgery.

FOLLOW UP:

All the patients were followed up by clinical and radiographic assessment immediately after treatment and at 3weeks, 2 months and 4 months. Radiographic assessment was made by anteroposterior and lateral or axillary views taken immediately after surgery. Routine follow-up radiographs are taken at 3 weeks and 2months postoperatively, then again at 4 months following surgery. Union was defined with presence of bridge callus in two views and AVN was defined with loss of bony substance and presence of diffuse sclerotic area in the humeral head. Malunion was defined if there was displacement of more than 5mm or an angulation of more than 40 degree of any fragment.

DATA COLLECTION TECHNIQUES AND TOOLS:

16.ASSESSMENT OF RESULTS BY NEERS CRITERIA.

The maximum points are 100 units:

- Pain : 35 Units
- Function : 30 Units
- Range Of Movement : 25 Units
- Anatomy : 10 Units

1. Pain — Total 35 Unit
    a. No Pain — 35
    b. Slight or Occasional — 30
    c. Mild, No effect in ordinary activity — 25
    d. Moderate, tolerable, starting to affect ordinary activity — 15
    e. Marked, serious limitation of ordinary activity — 5
    f. Total Disablement — 0
2. Functional Ability — Total 30 Units

a. Strength		b. Reaching		c. Stability	
• Normal	10	• Above head	2	• Lifting	2
• Good	8	• Mouth	2	• Throwing	2
• Fair	6	• Belt buckle	2	• Carrying	2
• Poor	4	• Opposite axilla	2	• Pushing	2
• Trace	2	• Brassiere hook		• Hold over head	2
• Zero	0		2		

3. Range of Motion Total 25 Units

Flextion		Extension		Abduction		External rotation		Internal rotation	
• 180^0	6	• 45^0	3	• 180^0	6	• 60^0	5	• 90^0(T6)	5
• 170^0	5	• 30^0	2	• 170^0	5	• 30^0	3	• 70^0(T12)	4
• 130^0	4	• 15^0	1	• 140^0	4	• 10^0	1	• 50^0(L5)	3
• 100^0	2	• $<15^0$	0	• 100^0	2	• $<10^0$	0	• 30^0	2
• 80^0	1			• 80^0	1			• $<30^0$	0
• $<80^0$	0			• $<80^0$	0				

4. Anatomy Total 10 Units

Rotation, Angulation, Joint incongruity, Retracted Tuberosities, Non-union, AVN

- None 10
- Mild 8
- Moderate 4
- Severe 0-2

On overall scores, the patients were grouped into:

Results Score

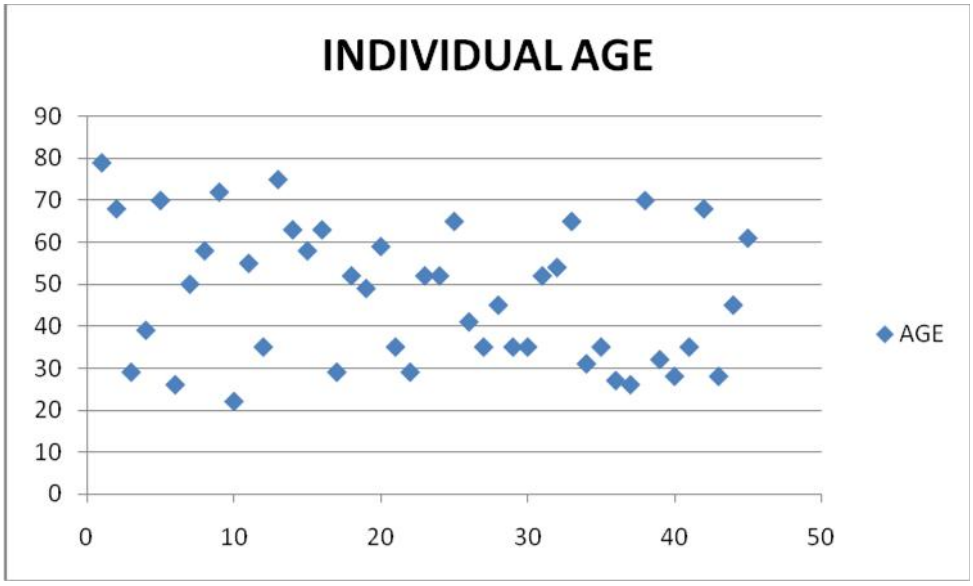
1. Excellent : > 89 units
2. Satisfactory : 80-89 units
3. Un-Satisfactory : 70-79 units
4. Failure : < 70

OBSERVATIONS AND RESULTS

OBSERVATIONS:

Total 45 patients were included in the study. Out of 45 patients only 43 patients were available for follow up. One patient lost the follow up due to unknown reason and another patient died due to the reason which was unrelated to the surgery. All the patients were followed up at the interval of 3 weeks, 2 months and 4 months. At the end of four months the functional assessment was done on the basis of the neers criteria. Patients were ranged from 22 to 79 years (mean age 49.6 yr) with 29 males and 16 females.

Graph 1 : Age distribution of patients with proximal humerus fractures.



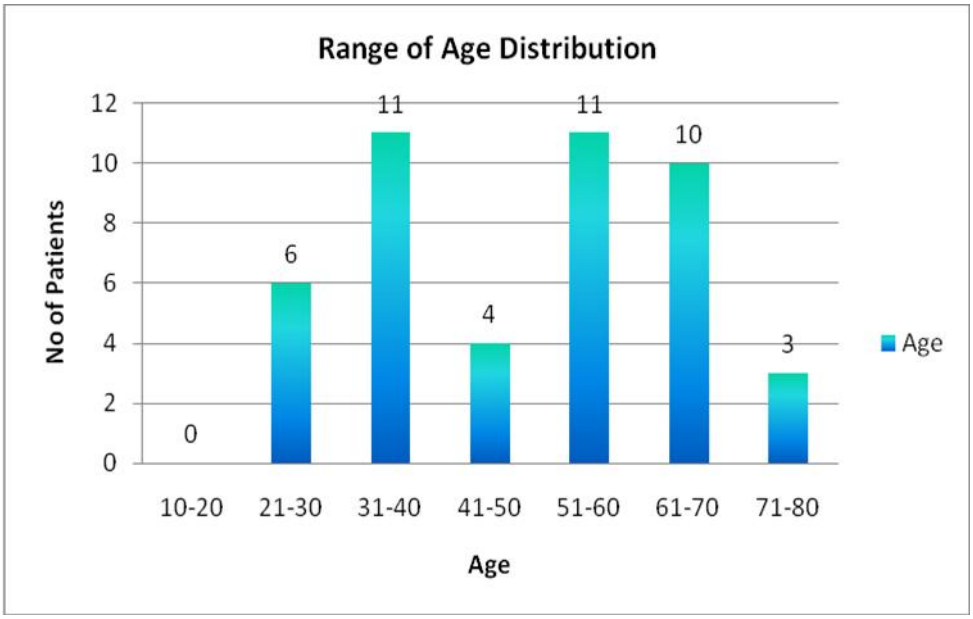
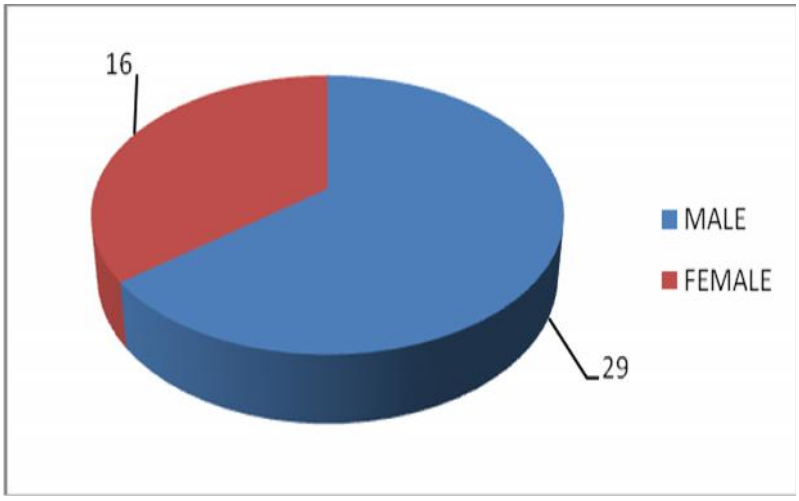


Table No 1 : Sex ratio of patients

MALE	FEMALE	TOTAL
29	16	45

Graph 2 :

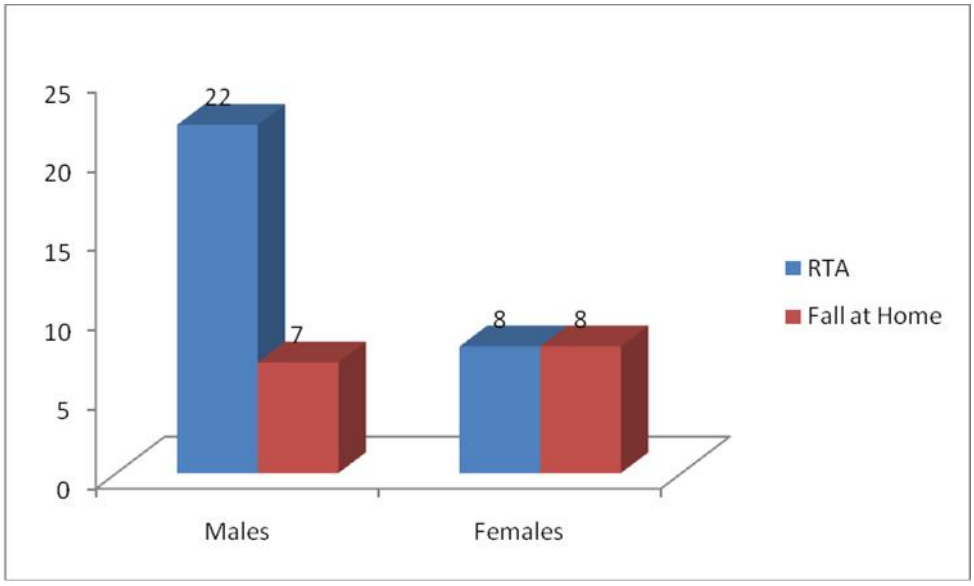


Mode of injury was high energy trauma (Road traffic Accidents) in case of 30 cases in which 22 were males and 8 were females and low energy trauma (Fall at Home) in 15 cases in which 7 were males and 8 were females .

Table No. 2 Mode of injury

	Males	Females
RTA	22	8
Fall at Home	7	8

Graph 3:

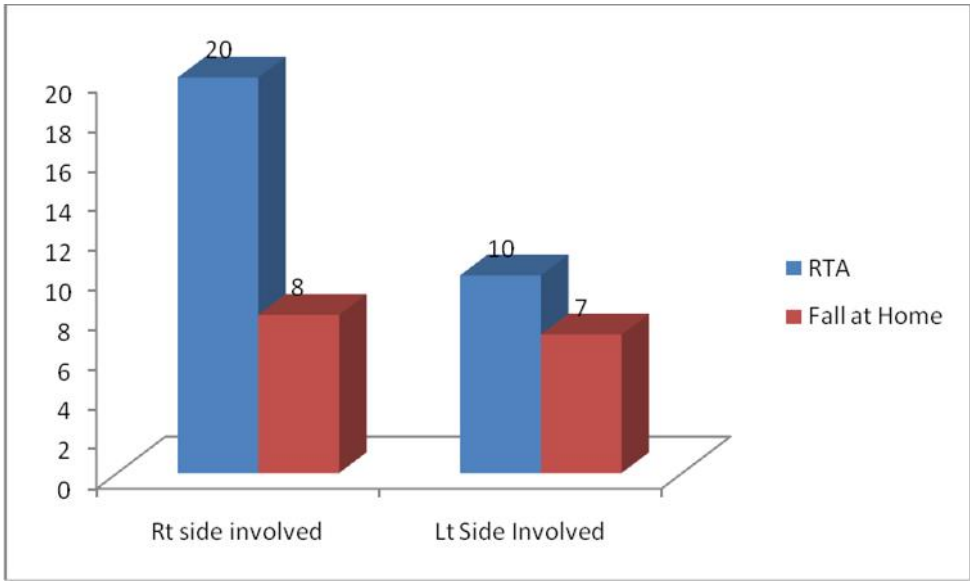


Mode of injury of patients with proximal humerus fractures Out of 30 patients sustaining RTA 20 patients were having Rt side involvement and 10 patients were having Lt side involvement. Out of 15 patients having fall at home 8 patients were having Rt side involvement and 7 Patients were having Lt side involvement.

Table No 3 : Side involved according to mode of injury

	Rt side involved	Lt Side Involved
RTA	20	10
Fall at Home	8	7

Graph 4:



Side involved in patients with proximal humerus fractures

According to Neer's classification, out of 45, 10 (22.22%) were two part fractures, 26 (57.77%) were three part fractures, 9 (20.00%) were four part fractures.

Table No. 4 Distribution of type of fracture

Type of fracture	Male	Female
2part	9	1
3 Part	14	12
4 Part	6	3

Graph 5

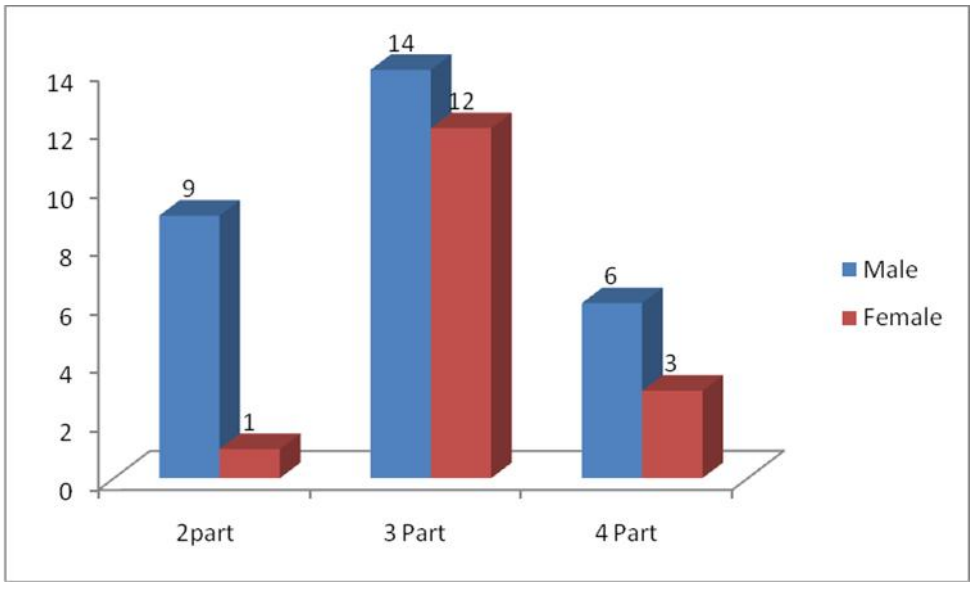
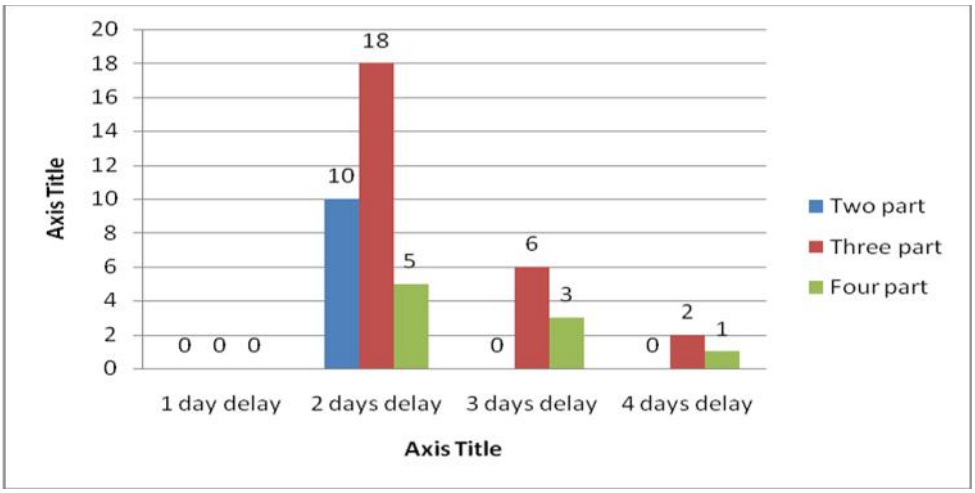


Table No. 5 : The mean delay from injury to surgery was 2.65 days (range 2-4 days)

	Two part	Three part	Four part
1 day delay	0	0	0
2 days delay	10	18	5
3 days delay	0	6	3
4 days delay	0	2	1

Graph 6



Out of 45 patients 33 were operated after 2 days delay, 9 were operated after 3 days delay, 3 were operated after 4 days delay.

- ❖ One patient had fracture dislocation.
- ❖ One patient had subluxation.
- ❖ Two patients had ipsilateral distal radius fracture.
- ❖ One patient had vertebral compression fracture of D 12 vertebrae.
- ❖ None of the patients had neurovascular complication.
- ❖ All fractures were closed fractures.

Out of 43 patients available for follow up in post operative period

- None of our patients sustained post op infections.
- All fractures united.
- At the end of 4 months functional assessment was done with Neers score. Out of 43 patients available for follow up
- 16 patients having Excellent results (8 are 2 part,8 are 3 part fractures)
- 24 patients having Satisfactory results (2 are 2 part, 18 are 3 part fractures,4 are 4 part)
- 3 patients had unsatisfactory results.

Table No. 6 : Results

	Excellent (>89)	satisfactory (80-89)	Unsatisfactory (70-79)	Failure (<70)	Mean
Two Part Fracture	8 (Mean 91)	2 (Mean 85)	0	0	89.5
Three Part Fracture	8 (Mean 90)	18 (Mean 82)	0	0	86
Four Part Fracture	0	4 (Mean 81)	3 (Mean 72)	0	76.5

Graph 7 :

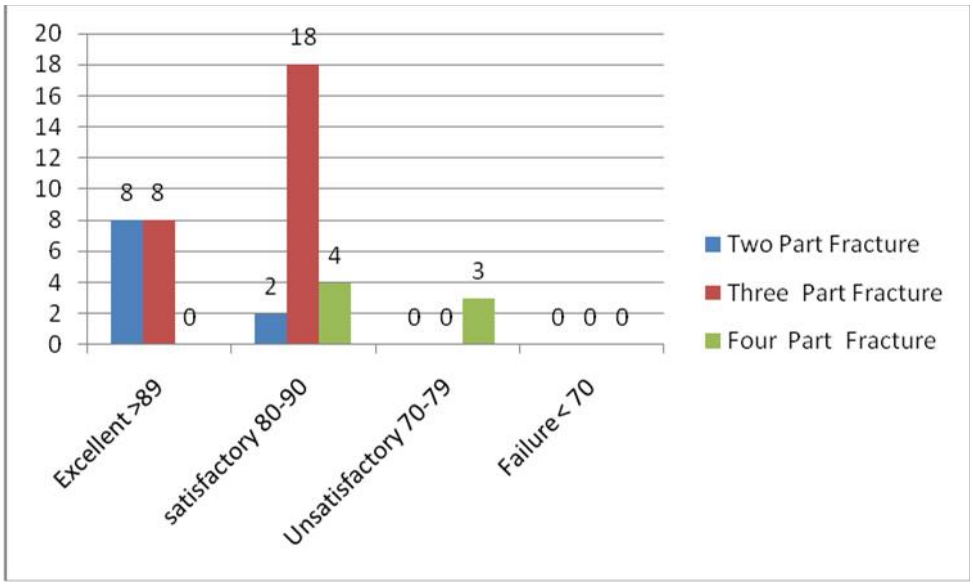
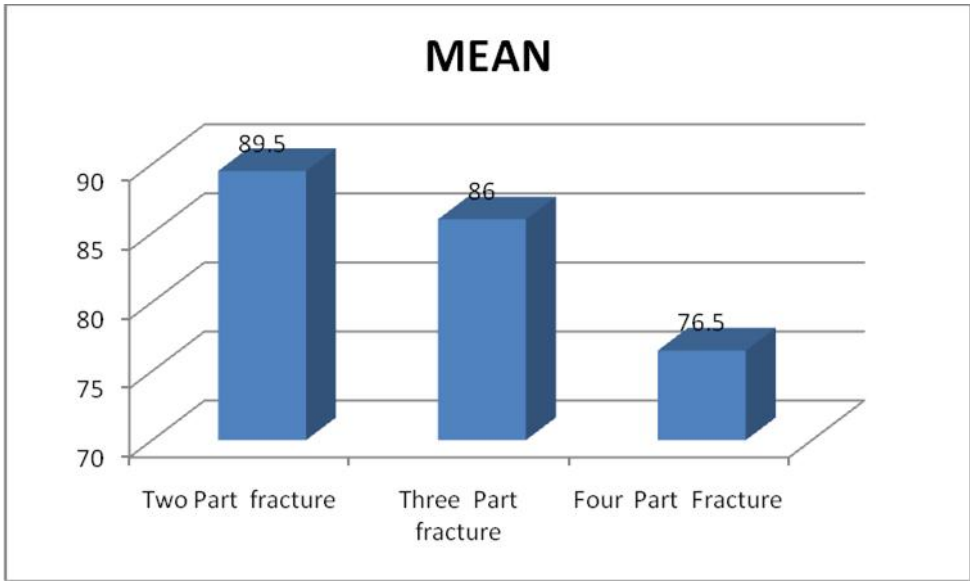


Table No. 7 Mean value for different type of fractures

	Mean
Two Part fracture	89.5
Three Part fracture	86
Four Part Fracture	76.5

Graph No. 8



The mean Neers score was 84

For two part fractures the mean Neers score was 89.5

For three part fractures the mean Neers score was 86

For four part fractures the mean Neers score was 76. 5

DISCUSSION:

Proximal humeral fractures represent an increasing challenge for health-care system because of the increasing proportion of elderly individuals in the population. The majority of patients with these fractures are more than 60 yrs old, and most these fractures are related to osteoporosis. Nevertheless, stable reduction is essential for healing of these fractures and for achieving early functional recovery of the shoulder. In patients with osteoporotic bones and/or comminuted fractures, operative stabilization is challenging and remains controversial.

During later part of last century and early part of this decade fracture fixation has undergone revolutionary changes in the form of concept, technique, and implants, as our understanding of fracture healing increased. Various techniques have been used to stabilize the proximal humerus fractures including intramedullary nails, percutaneous pin fixation, tension band wiring, plate and screws osteosynthesis and hemiarthroplasty. Successful outcome after plate osteosynthesis of proximal humerus fractures have been reported[13,43,44]. Open reduction and internal fixation of proximal humerus fractures with non locking plates and screws has been shown to provide strongest fixation in non-osteoporotic bone[44]. As the stability of osteosynthesis with non locking plates and screws, relies on the friction between the plate and the bone, the effectiveness of traditional plate and screw fixation decreases with bone quality.

Newer techniques involving the use of locking compression plates and screws with angular stability have been introduced in order to avoid complications associated with traditional plates. The anatomic locking compression plate (PHILOS: Proximal Humerus Interlocking System) is designed to maintain a stable fracture reduction even in

osteoporotic bone. Advantages of these plate include gentle fracture reduction with the use of indirect reduction manoeuvres, resistance to screw pull out even in patients with poor bone stock because of the combination of fixed –angle screw –plate locking and three –dimensional placement of screws in humeral head, and possibility of early exercise and a short period of immobilization because of high initial stability achieved[45].

Lill et al.[46] determined the in-vitro characteristics of five clinically used and newly developed implants for proximal humerus fractures under static and cyclic loading. Compared with the stiff implants(T-plates, intramedullary nail), the more elastic locking compression plates showed a low load decrease with a low load level and steady curve, which is promising for long term stability.

Many studies have shown that the displaced fractures of the proximal humerus have good functional outcome when treated with anatomic locking compression plates. Most authors have concluded that the plate design provides stable fixation with good clinical outcome and have recommended the use of locking plates for the treatment of proximal humeral fractures, especially in patients with poor bone quality [6,15,47,48]. This study reports our initial experience with anatomic locking compression plates designed specifically for proximal humerus.

We observed 43 patients (Total patients were 45 in the beginning but one lost the follow up and another died due to the cause unrelated to surgery) with follow up at 3 weeks,2 months,4 months.

AGE INCIDENCE:

- In our study 66.6% of patients were between 22 to 79yrs and average age being 52.5 yrs. Most common mode of injury in this age group was RTA.
- In Martinze et al study the age group was 36-73yrs in a study of 58 patients.
- The average age of incidence in Sudkamp et al study was 62.9+/- 15.7 yrs which constituted 187 patients.
- In Liu XW et al study of 17 patients the average age of incidence was 71yrs.
- The average age of incidence in Fazal et al study was 56 yrs which constituted 27 patients.

SEX INCIDENCE:

- In our present study 29(64.4%) patients were male and 16(35.6%) were female.
- In Martinze et al study there were 31(53.4%) male and 27(46.6%) female patients.
- In Sudkamp et al study of 187 patients, 52(27.9%) male and 135 (72.1%) female patients were present.
- In Liu XW et al study of 17 patients, 7(41.2%) were male and 10(58.8%) were female.
- In Fazal et al study of 27 patients, 6(22.3 %) were male and 21(77.7%) were female patients were present.

MODE OF INJURY:

- Major mode of injury in our study was high energy trauma (Road traffic Accidents) in case of 30 cases (66.6%) and low energy trauma (Fall at home) in 15 cases (33.4%).
- In Sudkamp et al study which constituted 187 patients, fall was the major cause leading to fracture in 162(87%) patients and RTA was the cause in 25(13%) patients.
- In Fazal et al study of 27 patients, 6 were due to RTA and 21 were due to fall at home**.**

SIDE AFFECTED:

- In our present study 28(62.2%) patients had right side affected whereas 17(37.8%) had left side affected.
- Sudkamp et al study right side was affected in 101(54%) and left side was affected in 76(40.6%) patients.

FRACTURE PATTERN AND METHOD OF TREATMENT:

- In our present study of 45 cases 10(22.2%) were two part fractures, 26 (57.8%) were three part fractures, 9(20.00%) were four part fractures.
- All patients were treated with open reduction and internal fixation with PHILOS plate.
- In Martinze et al of 58 patients, 33(56.8%) were 3 part and 25(43%) were 4 part fractures and all were treated with PHILOS plate.

- In Liu XW et al study of 17 patients, 9(52%) were 3 part fractures and 8(47%) were 4 part fractures and all were treated with PHILOS plate.
- In Fazal et al study which constituted 27 patients, 13(48%) patients were 2 part fractures,12(44%)were 3 part and 2(7%) were 4 part fractures and all were treated with PHILOS plate.

RESULTS:

- In our study at the end of 4 month the mean Neers score was 81.33 and out of 43 cases followed 16 patients had excellent and 24 patients had good results and 3 had fair results.

All fractures are united around 6-8 weeks. The mean Neers score was 81.33. For two part fractures the mean Neers score was 87.5, for three part fractures the mean Neers score was 84.5 and for four part fractures the mean Neers score was 72.0 Our results were comparable with other series using implants providing anguler stability with respect to union and functional outcome in terms of mean Neers score.

In order to obtain better and reproducible results, the AO ASIF has developed a special locking compression plate for fractures of the proximal humerus, Frigg[48] 2003, Ring and Jupiter 2003. According to our own findings, the main advantage of the new plate is apparent in elderly patients, since we had no failures of the internal fixation in this particular age group, and they could attain an activity level that was sufficient to satisfy their needs regarding independent daily living.

The functional outcome was better in the 2 and 3 part fracture group than in patients with 4 part fractures in our series. Although the follow-up time in our study was relatively short and it was not a randomized controlled study, the results demonstrate

several benefits of the proximal humerus locking plate. Most importantly, it is easy to use, it is biological in the sense that the blood circulation to the humeral head is not compromised, the plate does not need to be configured and the angular screw fixation ensures fixed-angle stabilization. Randomized long term studies will of course be needed in the future to validate the possible advantages associated with these implants.

SUMMARY

In our study which was conducted in the department of Orthopaedics in Shri B.M.Patil Medical College Hospital and Research Center, Bijapur, Karnataka included 45 patients with displaced proximal humerus fractures admitted in the hospital from Sep 2012 to feb 2014.

1) In our study patients were aged between 22 to 79 years with the average age being 49.6 years.
2) In our study 29 were male and 16were females.
3) Fracture occurred on right side in 28 patients and on left side in 17 patients.
4) The fractures were classified based on Neer's classification system. 10 patients had two part fracture, 26 patients had three part fractures and 9 patients had four part fractures.
5) Mode of injury was high energy trauma (Road traffic Accidents) in case of 30 patients in which 22 were males and 8 were females and low energy trauma (Fall at Home) in 15 patients in which 7 were males and 6 were females
6) All fractures were united around 6-8 weeks.
7) In our study no complications were observed.
8) The final results were evaluated using Neers Criteria.
9) The analysis of data was done to know the efficacy of open reduction and internal fixation of proximal humerus fractures treated with anatomic locking compression plates (PHILOS;Proximal Humerus Interlocking System).

CONCLUSION

The present study was done to evaluate the results, complications and functional outcome of proximal humeral fractures treated with anatomic locking compression plates (PHILOS:Proximal Humerus Interlocking System).

In our experience with anatomic locking compression plate, we were encouraged by performance of locking compression plates for various proximal humeral fractures. Proximal humeral fractures were common in middle aged patients in our study. Road traffic accident was the commonest mode of injury, followed by fall at home in our study. In our study males sustained the proximal humeral fractures more compared to females. Right side was more commonly involved in our study and it was the dominant side in most of our patients. Out of all fractures in our study Neer's 3 part fractures were the dominant group, followed by 2 part fractures.

Sound union was achieved in all patients .None of the patients had postoperative infection and loss of reduction. None of the cases had implant failure. The adequate stability provided by locking compression plates allowed us to initiate early rehabilitation programme which is necessary for good functional outcome and aids in the management of polytrauma patients. The range of movement and functional outcome at the end of Four months was satisfactory as assessed by NEERS CRITERIA. Although alternative techniques are available, only few have demonstrated excellent functional outcomes. Perhaps the additional fixation that locking plate offers especially in osteoporotic fractures allows earlier functional rehabilitation and in some way accounts for the better functional outcome.

This study is admittedly limited in that, the four months results may not be sufficient for drawing final conclusions regarding avascular necrosis of humeral head after these challenging fractures. There was no control group in the present study; therefore we cannot determine if another method of treatment would have led to better functional results. The numbers available are insufficient for detailed statistical analyses. However, within these limitations, the data generated are useful in evaluating the results, complications and the functional outcome of the implant and cases in which this implant may not be well suited.

In conclusion, the internal fixation of proximal humeral fractures with the use of anatomic locking compression plates yields reliable results when utilized correctly. We believe that, provided the correct surgical technique is used by competent surgeon, the anatomic locking compression plate is suitable for the stabilization of proximal humeral fractures and can lead to a good functional outcome.

BIBLIOGRAPHY

1. Cofield R H in: Complications of operative fixation of proximal humeral fractures in patients with rheumatoid arthritis, journal of Shoulder Elbow Surgery 14:559; 2005.
2. Gerald R Williams and Kirk L Wong2000: Two part fractures management of proximal and distal humerus fractures". Ortho Clin North Am, January 31(1): 1-21.
3. Lind T, Kronerk, and Jensen J: The epidemiology of fractures of proximal humerus.Arch Ortho Trauma Surg, 1989:108: 285.
4. Lous U, Bigiliani,Chapter 9 the Shoulder, vol 1 charles Rockwood, Fredericka. Fractures of proximal humerus. In Rockwood CA, Masten.Phildelphia: w.b. Sauders, 1990: p278-334
5. Scott E Powell, Robert W Chandler: Fractures of proximal humerus In: Textbook of operative techniques in upper extremity sports injuries. Frank W Jobe, Mosby, 1995: p313-340.
6. Björkenheim JM, Pajarinen J, Savolainen V: Internal fixation of proximal humeral fractures with a locking compression plate: A retrospective evaluation of 72 patients followed for a minimum of 1 year. Acta Orthop Scand 2004; 75:741-745.
7. Flores S, Merk BR: Two-part surgical neck fractures of the proximal part of the humerus: A biomechanical evaluation of two fixation techniques. J Bone Joint Surg Am 2006; 88:2258- 2264.

8. Neer CS. “Displaced proximal humeral fracture: Part I: Classification and evaluation.Journal of Bones and Joints Surg Am 1970; 52-A: 1077-89.
9. Neer CS. “Displaced proximal humeral fracture:Part II: Treatment of three and four part displacement”. Journal of Bone and Joints Surg Am 1970; 52-A: 1090-1103.
10. Kristiansen B and Cristensen SW: Plate Fixation of proximal humeral fractures, Acta Ortho Scand, 1986;57:320-323.
11. Moda S K, Chadha N S, Sangwan S S, Khurana D K, Dahiya A S, Siwach R C “Open reduction and internal fixation of proximal humeral fractures and fracture dislocations”. Jour Bone and Joint Surg 1990; 72-B 1050-1052.
12. Esser R D, Et al. “Open reduction and internal fixation of three and four part proximal humeral fractures”. Clin Ortho 1994; 299:244-251.
13. Hessmann M, Gehling H, Gotzenl, “Plate fixation of proximal humerus fracture with indirect reduction; surgical technique and results using the shoulder score”. Injury1999; 30: 453-462.
14. M Webb, L Funk
15. Koukakis, Athanasios MD; Apostolou, Constantinos D MD, PhD; Taneja,Tarun MS (Ortho); Korres, Dimitrios S MD; Amini, Alexander FRCS(Orth) Clinical Orthopaedics & Related Research: January 2006 - Volume 442 – Issue;pp 115-120.
16. Shahid R, Mushtaq A, Northover J, Maqsood M Acta Orthop Belg. 200 Oct; 74(5):602-8.

17. Brunner F, Sommer C, Bahrs C, Heuwinkel R, Hafner C, Rillmann P, Kohut G, Ekelund A, Muller M, Audigé L, Babst R. J Orthop Trauma.2009 Mar; 23(3):163-72.

18. Martinez AA, Cuenca J, Herrera A. J Orthop Surg (Hong Kong). 2009 Apr;17(1):10-4.

19. Liu XW, Fu QG, Xu SG, Zhang CC, Su JC, Wang PF, Zhao DF, Li YH Zhongguo Gu Shang. 2010 Mar;23(3):180-2.

20. Lill H, Hepp P, Rose T, König K, Josten C. Zentralbl Chir. 2004Jan; 129(1): 43-8.

21. Plecko M, Kraus A. Oper Orthop Traumatol. 2005 Feb; 17(1):25-50.

22. Agudelo, Juan Schürmann, Matthias Stahel, Philip Helwig, Peter Morgan, Steven J Zechel, Wolfgang Bahrs, Christian, ET al. Jour Of Ortho Traum Vol. 21 Issue 10.

23. Julie Y. Bishop, MD, and Christopher T. Donaldson, MD, 2009 by TheJournal of Bone and Joint Surgery, Inc.

24. Cristopher M Jobe, Gross anatomy of the shoulder. Chapter-2, In: The Shoulder, Vol 1, Charles A, Rockwood Jr, Frederick A, Mastein III,Philadelphia: W B Saunders company, 1990: p 34-97.

25. Laing PG. The arterial supply to the adult humerus. Jour Bone Joint SurgAm 1956; 38: 1105-1116.

26. Brookes CH, Revell WJ, Heatley FW. Vascularity of the humeral headafter proximal humeral fractures: an anatomical cadaver study. Jour BoneJoint Surg Br 1993; 75:132-136.
27. Gerber C, Lambert SM, Hoogewoud HM. Absence of avascular necrosis of the humeral head after posttraumatic rupture of the anterior and posteriorhumeral circumflex arteries: a case report. J Bone Joint Surg Am1996; 78:1256-1259.
28. Jakob RP, Miniaci A, Anson PS, Jaberg H, Osterwalder A, Ganz R. Four-part valgus impacted fractures of the proximal humerus. Jour Bone Joint Surg Br 1991; 73:295-298.
29. Rothmann T B and Mainab I, "The microvascular pattern of rotator cuff".Jour Bone Joint Surg Am1970; 52 B 540-553.
30. Hertel R, Hempfing A, Stiehler M, Leunig M. Predictors of humeral headischemia after intracapsular fracture of the proximal humerus. J Shoulder Elbow Surg. 2004;13:427-33.
31. Codman EA The shoulder: Rupture of the supraspinatus tendon and other lesions in or about subacromial bursa. Boston :Thomas Todd,1934
32. Watson and Jones R 1955 Fracture and joint injuries, 4th ed, livingstone, Edinbergh.
33. EL Flatow, F Cuomo, MG Maday, SR Miller, SJ McIlveen and LUBigliani The Journa**l of** Bone and Joint Surgery, Vo**l** 73, Issue 8 1213-1218.
34. Sallay PI, Pedowitz RA, Mallon WJ, Vandemark RM, Dalton JD, SpeerKP.Reliability and reproducibility of radiographic interpretation of proximal humeral fracture pathoanatomy. J Shoulder Elbow Surg 1997;6:60-69.

35. Cuomo F. Proximal humerus fractures in the elderly: instructional courseLecture 247. Presented at the American Academy of Orthopaedic Surgeons Annual Meeting, San Francisco, CA, February 14, 1997.
36. Paschal SO,Hutton KS, Whetherall PT.isolated avulsion fracture of thelesser tuberosity fractures in adolescents. Jour Bone Joint Surg Am1995; 77: 1427-1429.
37. Caniggia M, Maniscalco P, Picinotti A. Isolated avulsion fracture of thelesser tuberosity of the humerus. Report of two cases. Panminerva Med 1996;38(1):56-60.
38. van Laarhoven HA, te Slaa RL, van Laarhoven EW. Isolated avulsionfracture of the lesser tuberosity of the humerus. J Trauma 1995;39(5):997-999.
39. Cave EF. Shoulder girdle injuries. In: Fractures and other injuries. Chicago: Year Book, 1958.
40. Savoie FH, Geissler WB, Vander Griend RA. Open reduction and internalfixation of three-part fractures of the proximal humerus. Orthopedics1989;12:65-70.
41. Wentworth ET. Fractures involving the shoulder joint. NY State J Med 1940;40:1282-1288.
42. Rockwood and Green's Fractures in adults vol I; chapter 31;Fractures of Proximal Humerus: 6th Edition.
43. wanner G A, Romero J, Hersche O.Internal fixation of displaced proximal humerus with two one-third tubular plates.J Trauma 2003;54;536-44.
44. Wijgman AJ,Roolker W, Patt TW . Open reduction and internalfixation of three and four part fractures of the proximal humerus.Jour Bone Joint Surg Am 2002;84;1919-1925.

45. Palvanen M, Kannus P, Niemi S.Update in the epidemiology of proximal humeral fractures.Clin Orthop Relat Res .2006;442;87-92
46. Lill H, Hepp P, Korner J, Kassi JP.Proximal humeral fractures: how stiffshould an implant be? A comparative mechanical study with new implantsin human specimens. Arch Ortho Trauma Surg.2003;123:74-81.
47. Frankhauser F, Boldin C, Schippinger eplatG. A new locking plate for unstable fractures of proximal humerus. Clin Orthop Relat Res. 2005;430:176-81.
48. Kettler M, Biberthaler P, Braunstein V. Treatment proximal humeral fractures with PHILOS angular stable plate. Presentation of 225 cases of dislocated fractures Unfallchirurg ,German.2006;109:1032-1040.

ANNEXURE

B.L.D.E. UNIVERSITY'S

SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR-586 103

INSTITUTIONAL ETHICAL COMMITTEE

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 18-10-2012 *at* 3-30 pm *to scrutinize the Synopsis of Postgraduate Students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected & revised version synopsis of the Thesis has been accorded Ethical Clearance.*

Title "Study of functional outcome of surgical management of proximal humerus fracture treated with philos plate"

Name of P.G. student Dr. K. Vinayak Santosh

Orthopaedics

Name of Guide/Co-investigator Dr Ashok Nayak

Prof of Orthopaedics

DR.TEJASWINI. VALLABHA
CHAIRMAN
INSTITUTIONAL ETHICAL COMMITTEE
BLDEU'S, SHRI.B.M.PATIL
MEDICAL COLLEGE, BIJAPUR.

Following documents were placed before E.C. for Scrutinization
1) Copy of Synopsis/Research project.
2) Copy of informed consent form
3) Any other relevant documents.

SHRI B.M. PATIL MEDICAL COLLEGE, HOSPITAL AND RESEARCH CENTER, BIJAPUR-586103.

CONSENT FORM

TITLE OF RESEARCH: "STUDY OF FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF PROXIMAL HUMERUS FRACTURE TREATED WITH PHILOS PLATE"

Principle Investigator : Dr K.VINAYAK SANTOSH

P.G. Guide name : Dr ASHOK NAYAK M.S (ORTHO)

All aspects of this consent form are explained to the patient in the language understood by him/her.

1 Informed part

i. Purpose of study

I have been informed that this study will test the effectiveness of one particular method of open reduction and internal fixation of proximal humeral fractures. This method requires hospitalization.

ii. Procedure

I will be selected for the treatment after the clinical study of my age, type of fracture, condition of bone seen in radiograph and after study of fitness for anesthesia and surgery. I will be admitted immediately. I will have to attend follow-up to OPD regularly. I will be assessed in physiotherapy department also.

iii. Risk and discomfort

I understand that i may experience some pain and discomfort during the post-operative period. This condition is usually expected. These are associated with the usual course of treatment.

iv. Benefits

I understand that my participation in this study will have no direct benefit to me other than the potential benefit of treatment which is planned to heal my fracture in the shortest possible period and restore my function.

v. Alternatives

I understand that, the various alternative modes of treatment available to me in this fracture pattern with their merits and demerits have been explained to me.

vi. Confidentiality

I have been assured that all information furnished to the doctor by me regarding my medical condition will be kept confidential at all times and all circumstances except legal matters.

vii. Requires for more information

It has been clear to me that i am free at all time under any circumstances to touch based with doctor by directly approaching or otherwise to satisfy any query, doubt regarding any aspect of research concerns.

viii. Refusal or withdrawal of participation

It has been made clear to me that participation in this medical research is solely the matter of my will and also right to withdraw from participation in due course research at any time.

2 CONSENT OF PATIENT

I undersigned, have been explained by Dr ASHOK NAYAK in the language understood by me. The purpose of research, the details of procedure that will be implemented on me, the possible risks and discomforts of surgery and anesthesia have been understood by me. I have also been explained that participation in this medical

research is solely the matter of my will and also that i have the right to withdraw from this participation at any time in due course of medical research.

Signature of participant/patient: date: time:

Signature of witness: date: time:

ANNEXURE II

SHRI B.M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTER,BIJAPUR

PROFORMA

Name :

Age : Sex: I.P. No:

Occupation : D.O.A:

Address : D.O.S:

Date of injury: D.O.D:

1. COMPLAINTS: Pain,

Swelling,

Deformity.

2. HISTORY: Fall,

Vehicular accident,

3. PAST HISTORY:

5. FAMILY HISTORY:

5. GENERAL PHYSICAL EXAMINATION:

a. pallor: c. cyanosis:

b. pulse: d. B.P:

6. SYSTEMIC EXAMINATION:

a. C.V.S: c. R.S:

b. P.A: d. C.N.S

7. LOCAL EXAMINATION:

Inspection:

a. Attitude.

b.Swelling.

c. Deformity.

Palpation:

a. Tenderness.
b. Temperature
c. Crepitus.
d. Bony irregularity.

8.MEASUREMENTS:

a)Length of arm R L

b) Shortening or lengthening

9.MOVEMENTS:

a) shoulder: Abuction Adduction

Flexion Extension

Internal rotation External rotation

10.NEUROLOGICAL STATUS:

Axillary nerve.

11.VASCULAR STATUS:

Brachial pulse,

Radial pulse.

12.INVESTIGATION:

Blood: Hb%: TC: DC: ESR:

Urine: Albumin: Sugar: Microscopy:

BT: CT:

Blood grouping and typing:

RBS: Blood urea: Serum creatinine:

HIV: HbsAg:

X-ray A.P &Lat: NO: Date: Report:

13.MANAGEMENT:

Preliminary treatment on admission Plaster of Paris 'U Slab'

Distal pulse is checked.

Neurological status is checked.

Anti-inflammatory drugs,

Analgesic drugs.

Surgery: open reduction and PHILOS® plating under c-arm image intensifier.

Operative data :

Type of anaesthesia

Position

Approach

Procedure

Implant used

Distal pulse is checked.

Neurological status is checked.

Post Operative Data

Immobilisation

Antibiotics

Suture removal

Complications

Check X-ray: no: date: report:

14.FOLLOW UP:

After 3 weeks Check X-ray no: date: report:

Shoulder arm sling removed.

Clinical findings:

Pain,

Swelling,

Deformity,

Movements.

Physiotherapy advised

Shoulder range of motion.

After 2 months

Functional ability

Range of motions.

Check x-ray

After 4 months

Functional ability

Strength

Range of motions

Anatomy

Check x-ray

15.COMPLICATION:

Immediate: Vascular,

Neurological.

Delayed:

Infection,

Restricted ROM

AVN

Arthritis

16.ASSESSMENT OF RESULTS

BY NEERS CRITERIA.

The maximum points are 100 units:

- Pain : 35 Units
- Function : 30 Units
- Range Of Movement : 25 Units
- Anatomy : 10 Units

5. Pain — Total 35 Unit
    a. No Pain — 35
    b. Slight or Occasional — 30
    c. Mild, No effect in ordinary activity — 25
    d. Moderate, tolerable, starting to affect ordinary activity — 15
    e. Marked, serious limitation of ordinary activity — 5
    f. Total Disablement — 0

6. Functional Ability — Total 30 Units

a. Strength		b. Reaching		c. Stability	
• Normal	10	• Above head	2	• Lifting	2
• Good	8	• Mouth	2	• Throwing	2
• Fair	6	• Belt buckle	2	• Carrying	2
• Poor	4	• Opposite axilla	2	• Pushing	2
• Trace	2	• Brassiere hook	2	• Hold over head	2
• Zero	0				

7. Range of Motion Total 25 Units

Flexion		Extension		Abduction		External rotation		Internal rotation	
• 180^0	6	• 45^0	3	• 180^0	6	• 60^0	5	• 90^0(T6)	5
• 170^0	5	• 30^0	2	• 170^0	5	• 30^0	3	• 70^0(T12)	4
• 130^0	4	• 15^0	1	• 140^0	4	• 10^0	1	• 50^0(L5)	3
• 100^0	2	• $<15^0$	0	• 100^0	2	• $<10^0$	0	• 30^0	2
• 80^0	1			• 80^0	1			• $<30^0$	0
• $<80^0$	0			• $<80^0$	0				

8. Anatomy Total 10 Units

   Rotation, Angulation, Joint incongruity, Retracted Tuberosities, Non-union, AVN

   - None 10
   - Mild 8
   - Moderate 4
   - Severe 0-2

On overall scores, the patients were grouped into:

Results Score

6. Excellent : > 89 units
7. Satisfactory : 80-89 units
8. Un-Satisfactory : 70-79 units
9. Failure : < 70

MASTER CHART

PHOTO PLATES

CASE 30

Pre OP Xray

Post OP Xray

CASE NO 15

Pre OP Xray

Post OP Xray

CASE NO 6

Pre OP Xray

Post OP Xray

Xray Showing Union

ABDUCTION

ADDUCTION

EXTERNAL ROTATION

INTERNAL ROTATION

EXTENSION

CASE NO 14

Pre OP Xray

Post OP Xray

EXTENSION

FLEXION

EXTERNAL ROTATION

INTERNAL ROTATION

CASE 39

Pre OP Xray

Post OP Xray

ABDUCTION

FLEXION

EXTENSION

CASE NO 33

Pre OP Xray

Post OP Xray