

**Original article**  
**Orthopaedics**

**ASSESSMENT OF  
OUTCOME OF  
PROXIMAL HUMERUS  
FRACTURES  
TREATED WITH  
VARIOUS SURGICAL  
MODALITIES IN  
ELDERLY**

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**Abstract:**

Displaced proximal humeral fractures when treated surgically produce less pain, less stiffness and greater ROM. Earlier the surgery better are the results. In severely comminuted fractures where anatomy cannot be restored without extensive soft tissue dissection, fixation with K wires and screws gave better functional results. Results are better with fractures than with fracture dislocations. Results are best when operative method results in stable fixation that allows early passive mobilization. Functional outcome of 2 part fractures is better than 3 part and 4 part fractures. The patients were followed up at regular intervals preoperatively, immediate post operative and was followed up for the first 3 months after the procedure and evaluated 6 months later.

**Keywords:** Proximal humerus fractures, surgeries for proximal humerus fractures, displaced proximal humerus fractures

## Introduction

Fractures of Proximal Humerus are challenging for diagnosis and treatment. They are not uncommon, accounting for 4 to 5% of all fractures<sup>1-6</sup>. 80-85% of these fractures are minimally displaced or undisplaced and are effectively treated symptomatically with, immobilization followed by early motion<sup>4,7-9</sup>. Proximal Humerus Fractures are the third most frequent fracture in elderly patients after hip fracture and Colle's fracture<sup>10</sup>. It is important to recognize these fractures early. Results and Treatment of the most severely displaced Fractures of the Proximal Humerus have not been consistently satisfactory when treated with non-operative measures<sup>4,11,12</sup>. If neglected they may result in pain, stiffness, arthritis, loss of muscle power and function.

Fractures of Proximal Humerus have gained more attention recently. Diagnosis has been facilitated with adaptation of 3-right angled trauma series X- rays<sup>2,13,14,15</sup> supplemented with CT or MRI With more standard use of Neer's 4-part Classification system for fracture and fracture dislocation<sup>16,17,18</sup>, a protocol for management and comparison of long term outcome of similar injuries has been made possible.

Emphasis is placed on complete and accurate diagnosis and formulation of safe and simple techniques for fracture realignment, restoration of stability, fracture healing, cuff integrity, regaining motion and function. There have been improvements in fixation techniques and in the understanding of the role of prosthetic replacement<sup>19,20,21,22</sup>, to maximize anatomic restoration and minimizing immobilization time, during which stiffness develops.

The elderly no longer need to be

denied effective surgical treatment, especially at a time in life, when the shoulders are often needed for ambulation with canes and crutches. Maintenance of good shoulder function may make a good difference to their independent life style.

In this study we have analyzed the functional outcome of 20 cases of fractures of Proximal Humerus managed surgically in elderly patients.

## Aim Of The Study

- Prospective study of Functional outcome of fractures of the Proximal Humerus in the elderly managed surgically at the Department of Orthopaedics NRI Medical College & Hospital, Chinakakani between June 2015 and June 2017.
- To analyse the results in management of proximal humerus fractures with open reduction and internal fixation.
- To follow up the patients operated upon and note functional outcome and complications.

## Materials And Methods

All the cases attending either the outpatient department, orthopaedics emergency at NRI MEDICAL COLLEGE AND GENERAL HOSPITAL during the period of 2 years.

## Methodology

The patients will be evaluated as per the history, mode of injury. Necessary radiological investigations and hematology profile will be done on admission. Type of surgery and details are noted. The immediate post-operative x-rays are evaluated. All the cases are again evaluated through clinical and radiological methods

at 6 months for any morbidity and mortality.

## Implants Used For Fixation Of Proximal Fractures Of Humerus

1. Philos plate
2. 4mm Cancellous/ Cannulated cancellous screws.
3. 3.5 mm cortical screws.
4. Locking head screws 2.7 mm (head LCP 2.4) or standard cortex 2.4 mm screws for threaded holes of distal part of a dorsolateral DHP or medial DHP.
5. 3.5 mm locking head screws and standard cortex screws 3.5 mm for the LCP combi-holes of shaft of DHP.
6. K wires,
7. Bending templates and Bending Irons/Bending Pliers.
8. Instrumentation Set for insertion of screws (Drill, Drill bit, Drill sleeves, Tap, Screwdriver etc).
9. Cerclage Wire set

## Inclusion Criteria:

- Only proximal humerus fractures (Two part, Three part & Four part fractures)
- Age more than 50years
- Patient who gives consent for study

## Exclusion Criteria

- Undisplaced fractures
- Proximal humerus fractures not associated with diaphysis of humerus or distal humerus.
- Fractures associated with neurovascular injury
- Infection around the proximal humerus region

**Statistical Analysis: Data will be expressed in percentages.**

We found in our study are females are more prone for fractures of the proximal humerus i.e., 12 patients (60%) in contrast to males 8 (40%). The age of the patients ranged from 50-80 years. The mean age of the patients was 60.7 years. Maximum number of patients are in the 51-60 year age group (50%) followed by 61-70 years (30%). The mode of injury was fall at ground level in 9 (45%) patients, road traffic accident in 7 (35%) patients, fall from height in 3 (15%) patients, fall due to epilepsy in 1 (5%) patients.

In our study, 17 patients presented within 5 days of injury (85%), 1 patient (5%) presented with in 6-10 days of injury and 2 patients (10%) presented within 15 days of injury.

7 patients had previous treatment either in the form of native splinting, massage or POP cast. 13 patients (65%) did not take any form of native treatment before coming to the hospital.

A meticulous clinical examination was made in all patients with care to look for any associated injuries. 8 patients (40%) had associated ipsilateral skeletal injuries which were concomitantly treated. Standard anteroposterior radiographs of the affected shoulder were taken in all patients and most of them were further evaluated with Neer's three view trauma series which involves the AP View in the plane of scapula, lateral view in plane of scapula and axillary lateral view. CT Scan was done in 6 patients with complex fracture dislocations, to delineate the fracture pattern and the direction of dislocation and for 3 patients 3D CT was taken to ascertain the position of the fragments.

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

part classification system. Based on Neer's system 10 patients (50%) had two part fractures, 5 (25%) patients had 3 part fractures and 5 (25%) had four part fractures. (Table-9) Fracture dislocations were present in 8 patients (Table-10)

### Fracture-Dislocation

In irreducible fracture dislocations and head splitting fractures the coracoid was predrilled and osteotomised and retracted with the tendon. Arm was externally rotated and blunt instrument passed between subscapularis and capsule and stay sutures applied. It was divided one inch from its insertion and retracted. Capsule was incised longitudinally to open the joint and reduce the articular fragment.

In all patients, the rotator interval between anterior edge of supraspinatus and superior edge of subscapularis was closed with multiple interrupted sutures. The deltoid was reattached to the clavicle and wound irrigated and closed over suction drain.

### Post-Op Rehabilitation

In all patients the arm was placed in an arm sling and POP applied if fixation was not stable. Prophylactic antibiotics which were started before surgery were continued for 48 and 72 hours postoperatively. In a few, ice packs were used to decrease the swelling. Passive elbow flexion and extension were started by 24-48 hrs. Sutures were removed by 10th post op day.

Phase I exercises consisting of pendulum exercises were encouraged from the first week. Gentle passive forward flexion and internal and external rotation were started by third or fourth week. Phase II exercises consisting of active range of motion

exercises and resistive exercises were started by 4-6 weeks. Phase III exercises consisting of advanced stretching and strengthening exercises were started by 3 months. Light weight lifting were started after 3 months.

All the patients were followed up monthly, for first three months and later, every 3 months. During follow-up, patients were clinically evaluated for pain, function and rotation. Radiological evaluation of fracture union was observed by serial x-rays.

### Observations

1. Majority of injured patients were females (60%).
2. Highest number of patients were in their 5th decade (50%).
3. Free fall at ground level was the most common mode of injury (45%)
4. Post-epileptic fall caused fracture of Proximal Humerus in one patient.
5. There was no case with bilateral fractures.
6. All were right handed persons and the dominant arm was involved in 16 (80%) patients.
7. Post menopausal osteoporotic females accounted for 45% of patients.
8. 10 (50%) patients reported to hospital on day of injury.
9. 35% of patients had undergone previous native treatment either in form of massage or splinting.;
10. 8 patients had associated fractures.
11. All the patients had closed injuries
12. Neer's 2 part fracture is the most common type in 50% patients.
13. Greater Tuberosity fractures were the predominant type in 2

part fracture.

14. 4 part fractures accounted for only 25% of patients
15. Fracture dislocation were present in 8(40%) of patients.
16. Post operative immobilization with POP was used in 5 patients.
17. Patients were taken up for surgery on an average of 7.95 days after injury.
18. 5 patients underwent ORIF with Locking Compression Plate.
19. Among patients with 2 part fractures, 2 were treated with cancellous screws, 3 were treated with 'K' wires, and 1 with TBW.
20. Among patients with 2-part fracture dislocations, one was treated with TBW & Cancellous screws, 1 with IMIL Nail, 1 with LCP and 1 with 'K' wires.
21. 1 patient with 4 part fracture underwent Hemiarthroplasty
22. Follow-up period was 6 months
23. 55% patients did not have any pain during follow-up
24. The average range of active elevation in these patients was 127.75°
25. The average range of active external rotation 47°.
26. The average range of abduction 121.25°
27. 18(90%) of patients had normal muscle strength in shoulder.
28. Patients with 2 part fracture had better functional outcome than 3 and 4 part fracture.

## Complications

**Table-13**  
**Early Complications**

S.No	Complications	No. of Patients
1	Wound gaping	1
2	Axillary nerve damage	1
3	Deltoid atony	1

**Table-14**  
**Late Complications**

S.No	Late complications	No. of Patients
1	Non-union	0
2	Malunion	1
3	Joint stiffness	2
4	Heterotopic ossification	1
5	Instability	1
6	Infection	0

## Results

The patients were followed up at regular intervals preoperatively, immediate post operative and was followed up for the first 3 months after the procedure and evaluated 6 months later

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

1. Pain
2. Range of motion
3. Strength
4. Stability
5. Function
6. Roentgenographic documentation of fracture healing
7. Anatomic restoration

## Neer Score:

The results were graded by using Neer 100 units Rating System.

This Rating system consists of  
35 units for PAIN  
30 units for FUNCTION  
25 units for RANGE OF MOTION

10 units for ANATOMY

## Pain

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

**Table-15**  
**Pain Scale**

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

**Table-16**  
**Evaluation Of Pain**

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

11(55%) patients said that may had no pain and 5(25%) patients had only mild pain, 2(10%) patients had pain after unusual activity and pain at rest in 2(10%) patients. No patient had disabling pain.

## Function

Function was evaluated with ability to perform day to day activities. Points were given according to the following scale.

- 4 – normal
- 3- mild compromise
- 2-with difficulty
- 1 - with aid
- 0 – unable
- NA - not available

Functional results were graded by following criteria:-

Good functional result 3.5 - 4.0 points

Fair 2.5-3.4 points

Poor < 2.5 points

**Table-17**  
**Functional Outcome**

S. No	Functional outcome	No. of patients
1	Good	10
2	Fair	8
3	Poor	2

10 (50%) of the 20 patients had good functional result, 8 (40%) had fair functional results and 2(10%) had poor functional result.

**Muscle Strength**

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

Normal - 5

Against slight resistance- 4

Against gravity - 3

With elimination of gravity - 2

Flicker -1

Paralysis - 0

**Table-18**  
**Muscle Strength**

S.N.	Muscle Strength	No: of patients
1	Normal	18
2	Against slight resistance	1
3	Against gravity	1
4	With elimination of gravity	0
5	Flicker	0
6	Paralysis	0

18 (90%) of patients had normal muscle strength in all the muscle groups evaluated and 1 patient had good muscle strength and 1 patient had fair muscle strength.

**Range of Motion**

ROM was evaluated during each follow-up and the improvement and progress recorded. The following table shows average ROM observed. Active forward elevation was defined as the angle between the humerus and the

upper part of the thorax in the sagittal plane. External rotation was measured with the arm at patients side. Internal rotation was measured was recorded as the posterior body segment that could be reached by the thumb with the elbow in a flexed position.

S.N.	Motion	Range in deg.	Average
1	Elevation	90-170	127.75
2	Abduction	70-160	121.25
3	ER	35-60	47
4	IR	T3-L4	T11
5	Extension	30-55	41
6	Flexion	80-120	92.75

**Overall Results**

The results were rated according to the following criteria:

Maximum no: of points – 100

Excellent - 90-100

Satisfactory-80-89

Unsatisfactory - 70-79

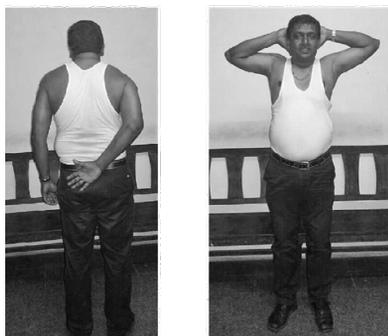
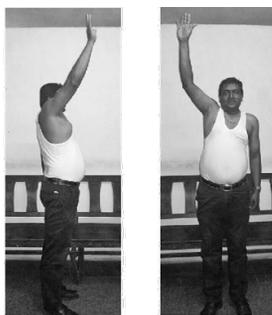
Failure - <70

S.N.	Rating	No: of Patients	Percentage
1	Excellent (90-100)	10	50
2	Satisfactory (80-89)	6	30
3	Unsatisfactory(70-79)	2	10
4	Failure< 70	2	10

Of the 20 cases 10 (50%) patients had excellent result, 6 (30%) satisfactory, 2(10%)unsatisfactory and 2 (10%) failure.



**PRE-OP      Immediate Post-OP      Follow Up At 6 Months**

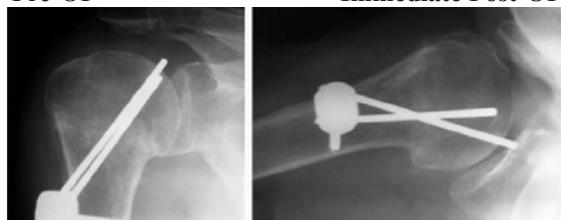


**Clinical Outcome - Range Of Movements**

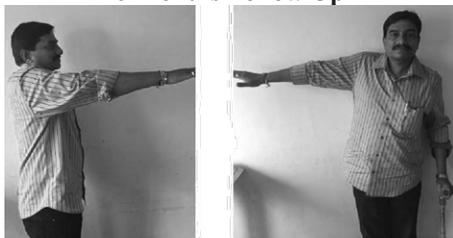


**Pre-OP**

**Immediate Post-OP**



**6 Months Follow Up**



**Able to perform her day to day activities**

**Discussion**

Proximal humerus fractures (PHFs) accounts for approximately 4-5% of all the fractures and are next to hip fractures and distal radius fractures in the elderly population. The incidence is approximately 3/10,000 persons a year and is rapidly increasing with age.<sup>23-25</sup> Women are affected twice as often as men.<sup>24</sup>

The patients attending the OPD and Inpatients attending the department of Orthopaedics NRI General Hospital are surgically treated for fractures of proximal humerus and their functional outcomes were analyzed.

In this study, we analyzed 20 patients managed surgically and the mean age of the patients is 60.7 years and there is a female preponderance (12 patients 60%) in concordance with the other studies.

An analysis of the Finnish trauma registry revealed that the incidence of proximal humerus fracture rose from 32 to 105 per 1,00,000 persons per year between 1970 and 2002, along with a rise in the average age of affected women, from 73 to 78.<sup>26</sup>

In Hungary, health insurance data from 1999-2003 reveal an incidence of 342 per 100 000 persons per year; in emergency rooms in the USA, there were 61 consultations for proximal humerus fracture per 1,00,000 persons in the year 2008.<sup>27-28</sup>

In Neer's original series of 300 fractures the average age of the patients was 55.6 years.<sup>29</sup>

Lind found that three fourth of his patients with proximal humerus fractures were over 60 years.<sup>30</sup>

Mayo clinic identified a predominance of proximal humerus fracture in women at ratio of 1.5:1 and Lind noted female to male ratio 3:1.<sup>4,31</sup>

Similarly, a study conducted by Hawkins & Bell involving 15 patients of Proximal Humeral Fractures there was female preponderance. In Kristiansen et al study of 565 PHF in 5,00,000 people 77% of fracture in all age groups involved were women. This is thought to be a result of advanced osteoporosis.

In the present study 9 patients (45%) presented with history of falls and 7 patients (35%) had road traffic accident as mode of injury. These findings were consistent with a study done by Aggarwal S, et al,<sup>32</sup> who reported falls in 55% of the patients and road traffic accident in 42.5%.

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

In this present study most of the patients presented with left fracture (60%). Similar fracture pattern was reported in a study by Gerber C, et al.<sup>33</sup>

In this study, patients with only 2-part, 3-part & 4-part fracture of proximal humerus were included based on Neer's classification. Accordingly the 2-part fractures were noted in most of the cases (55%) followed by 3-part (35%) and 4-part (10%).

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

There was a predominance of two part fracture in our study (50%), of which greater tuberosity fracture were the most common. Associated dislocations were present in 40% of the patients. In the reduction of glenohumeral dislocation if tuberosity fragment remained displaced >1 cm or angulated more than 45°, ORIF was

done. Repair in such patients restored the dynamic stability by reattachment of the muscles of the rotator cuff.

Flatow et al in a series of 12 patients reported 50% excellent results and 50% good results in patients treated by ORIF for two part greater tuberosity fracture.

Closed treatment of three part fracture is associated with moderate pain, poor motion and disability. ORIF was associated with good to excellent results in more than 80% of patients in a report by Hawkins et al and recommended operative treatment for healthy active individuals who have three part fractures of the Proximal Humerus. Cornell and Levine reported good results with screw tension band technique for 3 part fractures.

Kristiansen<sup>34</sup> in 1986 has reported 9(45%) satisfactory and 11(55%) unsatisfactory results for 20 patients with two-part, three-part, and four-part fracture treated with AO Buttress plate. In this study 4 cases developed infection, and in five cases impingement of plate was present and in two cases loosening of plate was present. They concluded that buttress plate offers satisfactory reduction and good stability at high risk of complications and hence the indications should be carefully considered in elderly and operation should be performed by experienced orthopedic surgeon.

In 1995 Zyto K, et al<sup>35</sup> their study of shoulder function after displaced fractures of proximal humerus, concluded that - it is difficult to consistently achieve success in patients with four-part fractures or fracture dislocations. However many of those with three-part fracture can be successfully treated. In their study out of thirty eight patients, 26 with 3-part, 12 with four part were followed

for 3 to 3½ year, 28(74%) patients were treated conservatively, 7(18%) underwent open reduction and internal fixation, 3(8%) had hemiarthoplasty. According to Neer score 4 patients with 3 part and 7 with four part were classified failure that is total 28% of failure were present.

In 2000 Hintermann B, et al.<sup>36</sup> studied 42 patients (34 three part, 8 four part) fractures treated using blade plate and deltopectoral approach. On final review (after average of 3.4 years). They found 13 patients with excellent result 17 patients with good result, fair in seven, poor in 1. They concluded that rigid fixation of displaced fractures of proximal humerus with a blade plate in elderly patient provides sufficient primary stability to allow early functional treatment.

In 2002 Wijnman AJ, et al.<sup>37</sup> assessed the intermediate and long-term results for sixty patients with a three or four-part fracture of the proximal part of the humerus who had undergone open reduction and internal fixation with cerclage wires or a T plate. The Constant score and a visual analog score for pain were calculated, and radiographs of the proximal part of the humerus were evaluated. After an average of ten years of follow-up, fifty-two patients (87%) had a good or excellent result on the basis of the Constant score whereas eight patients (13%) had a poor result. Fifty-one patients (85%) were satisfied with the result at the time of the most recent examination. Twenty-two patients (37%) had development of avascular necrosis of the humeral head, and seventeen (77%) of these twenty-two patients had a good or excellent Constant score. They concluded open reduction and internal fixation with cerclage wires or a T-plate yields good

functional results in most patients. This option should be considered even for patients with fracture-dislocation patterns that are associated with a high risk for avascular necrosis of the humeral head, as this complication did not preclude a good result.

In 2004 Bjorkenheim JM, et al.<sup>13</sup> retrospectively reviewed complication and functional outcome after minimum follow up of 1 year in 72 patients treated with locking compression plate. 2 fracture failed to unite, 3 patients developed avascular necrosis of humeral head, 2 implant failure. They concluded locking compression plate appears to be safe and recommended in patients with poor bone quality.

In 2004 Gerber C, et al.<sup>38</sup> treated 34 articular fractures of the proximal humerus with good bone quality in 33 patients by open reduction and internal fixation with various modalities (Plate screw/ percutaneous pinning/osteosuture). They achieved anatomical or near anatomical reduction in 30 patients. 32 patients obtained mean constant score of 78 points. They concluded that operative treatment of complex fractures of proximal humerus gives good result if anatomical or near anatomical reduction is achieved in a patient with good bone quality.

In 2005 Charalambous CP, et al.<sup>39</sup> treated 25 patients with proximal locking compression plate of which 20 went to union with mean neck shaft angle of 127.2°. five cases required revision surgery for non union or implant failure. Of 25 implants, 4 had screw protrusion into gleno humeral joint, 4 had screw loosening and backing out, and 1 plate broke without further trauma. They concluded proximal locking compression plate as effective system for fracture stabilization to bony union.

In 2007 Siwach R et al,<sup>40</sup> prospectively assessed the functional outcome and complications in 25 patients of proximal humerus fracture with osteoporosis treated with locking compression plate. Mean constant score was 80 points. According to constant score, 28% excellent outcome, 64% good functional outcome, 8% had moderate outcome. Varus malalignment and subacromial impingement were observed in 8% patients. Loosening of implant and loss of reduction were observed in 4%. superficial infection in 4%. they concluded locking compression plate is an advantageous implant in proximal humerus fracture due to angular stability particularly in osteoporotic bone and comminuted fracture.

In 2008 Shahid R, et al<sup>40</sup> prospectively reviewed 50 patients with proximal humerus fracture treated with proximal humerus locking compression plate from 2002 to 2006. Of which 11 patients had 2-part, eleven 3-parts, and 18 4- part fracture. Radiological union was achieved within 8 weeks in 40/41 fracture. They concluded locking compression plate as reliable implant. Increase in number of part of fracture did not affect final outcome.

From the data presented in this study we have demonstrated that majority of the patients had no pain or only mild pain (80%) which is comparable to the study by Hawkins et al<sup>56</sup> and Flatow et al<sup>4,33</sup>.

The average active elevation in our study in two part fractures was 127.75° and average external rotation was 47° which is comparable to the study by Flatow et al<sup>74</sup> in a study of 12 patients of two part fractures treated surgically.

The average elevation in our study with three part fracture was 124.0625° and external rotation was 45.3° which

is also comparable to the study by Hawkins et al<sup>41</sup> of 15 cases of 3 part Proximal Humerus fractures treated surgically. Of the 10 patients with 3 part and 4 part fractures 8 patients (80%) regained at least 90° abduction and elevation.

About 90% of the patients had full muscle strength which is also comparable to the study by Hawkins et al<sup>56</sup> and Flatow et al<sup>30</sup>.

We have seen few complications in our study. Malunion of greater tuberosity fragment in a patient with 3 part fracture treated with cancellous screw with 'K' wire resulted in restriction of abduction and impingement. Good functional results are seen reflecting the fact that radiological outcome may not imply functional outcome.

In 2008 Egol KA, et al<sup>42</sup> studied Early Complications in Proximal Humerus Fractures Treated with Locked Plates Fifty-one consecutive patients treated with a proximal humerus locking plate. A retrospective analysis was undertaken of a consecutive series of proximal humerus fractures treated with a locking plate between 2003 and 2006. Fracture union was identified in 18 male and 33 female patients with an average age of 61. All were treated with a similar protocol of open reduction internal fixation with the PHILOS plate followed by early range of shoulder motion. Fiftyone patients were available for minimum 6-month follow-up (mean, 16 months; range, 6 to 45 months). Radiographically, 92% of the cases united at 3months

after surgery, and 2 fractures had signs of osteonecrosis at latest follow-up. Eight patients (16%) had screws that penetrated the humeral head Early implant failure occurred in 2 patients; one was revised to a longer

plate, and one underwent resection arthroplasty. There was one acute postoperative infection. The major complication reported in this study was screw penetration, suggesting that exceptional vigilance must be taken in estimating the appropriate number and length of screws used to prevent articular penetration. Hence concluded although the device provides exceptional fixation stability, its indication must be scrutinized for each individual patient, taking the extent of trauma/fracture and age into consideration and carefully weighing it against other forms of treatment.

In 2009 Brunner F, et al<sup>43</sup> multicenter study in 8 trauma units (levels I, II, and III) with recruitment between 2002 and 2005. One hundred fifty-seven patients treated with Open reduction and internal fixation with a Philos plate. One-year follow-up rate was 84%. The incidence of experiencing any implant-related complication was 9% and 35% for non implant related complications. Primary screw perforation was the most frequent problem (14%) followed by secondary screw perforation (8%) and avascular necrosis (8%). After 1 year, a mean Constant score of 72 points (87% of the contralateral noninjured side), a mean Neer's score of 76 points, and mean Disabilities of the Arm, Shoulder, and Hand score of 16 points were achieved. Concluded that Fixation with Philos plates preserves achieved reduction, and a good functional outcome can be expected. However, complication incidence proportions are high, particularly due to primary and secondary screw perforations into the glenohumeral joint, with an overall complication rate of 35%. More accurate 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 incidence of secondary screw perforations, even in osteopenic bone.

In 2009 Martinez AA et al,<sup>9</sup> retrospectively reviewed 58 patients who underwent locking compression plate fixation for proximal humerus fracture between September 2004 to March 2006. All fractures healed satisfactorily, except in 1 patient with a valgus 4-part fracture who had malunion. Functional outcome was excellent in 13 patients, good in 36, moderate in 8, poor in 1. They concluded proximal humerus locking compression plate is appropriate treatment for proximal humerus fracture.

In 2010 Aggarwal A et al,<sup>44</sup> Over two and a half years, treated 56 patients with an acute proximal humerus fracture with locking plate osteosynthesis. 47 of these patients who completed a minimum follow up of 1 year were evaluated using Constant score calculation. The average follow up period was around 21.5 months. Outcomes were excellent in 17%, good in 38.5%, moderate in 34% while poor in 10.5%. The Constant score was poorer for AO-OTA type 3 fractures as compared to other types. The scores were also inferior for older patients (> 65 years old).

Complications included screw perforation of head, AVN, subacromial impingement, loss of fixation, axillary nerve palsy and infection. A varus malalignment was found to be a strong predictor of loss of fixation. They concluded locking plate osteosynthesis leads to satisfactory functional outcomes in all the patients. Results are better than non locking plates in osteoporotic fractures of the elderly

In 2009, Papadopoulos P et al.<sup>45</sup>

reported experience from the use of the Philos plate for the treatment of three- and four-part proximal humeral fractures and to investigate factors influencing the final outcome. He concluded that, internal fixation with the Philos plate seems to be a reliable option in the operative treatment of upper end humeral fractures, especially in osteoporotic bone. It allows secure fracture fixation and quick shoulder mobilisation, while quick and uneventful fracture healing and very satisfactory clinical results are achieved.

In 2012, Pawaskar AC, et al<sup>17</sup> studied 25 patients who underwent surgery for proximal humerus fracture with locking plate between 2008 to 2010. Measurement of neck shaft angle was done at immediate post op, 3 month post op and final follow up (8 to 17 months). He found mean loss in neck shaft angle in the first 3 months was 3.8° as compared to 1.3° in the period between 3 months and final follow up. This was statistically significant (p=0.002). He concluded proximal humerus locking plate maintains reliable radiographic results even in elderly population with proximal humerus fracture.

A study by Abdelrahman AA, et al<sup>46</sup> (2013) to evaluate the functional outcome after combined osteosynthesis and osteosuture for proximal humeral fractures enrolled 20 patients (eight men and 12 women) who underwent surgical treatment for proximal humerus fractures using proximal humeral locking plate for fixation (not original PHILOS plate). The mean age of the patients was 62.4 years. According to Neer, seven patients had three-part fractures, 11 patients had four-part fractures (one patient had fracture dislocation), and two patients had associated fracture

of proximal humeral shaft. Of the 20 patients, anatomic or near-anatomic reduction was obtained in 17 patients (85%). All fractures united in a mean of 3 months (range 2-5 months). None of the patients had avascular necrosis, implant failure, superficial or deep infection, or neurovascular injury. The mean constant score for all patients was 77. Study concluded that, the results showed that rigid fixation of the proximal humeral fractures using locking plate with preservation of the vascularity of the fracture fragments of the humeral head through minimal soft tissue dissection and preservation of soft tissue of fracture fragments were important in decreasing the complications following surgical treatment of the proximal humeral fractures.

Elgohary HS, et al<sup>47</sup> in 2013 evaluated 26 osteoporotic or osteopenic patients with three-part or four-part proximal humerus fractures according to the Neer classification who underwent surgical fixation with locked plates through the standard deltopectoral approach were included in the study. The clinical outcome was evaluated with the Constant-Murley score. The average Constant score corresponds to 76.5 points, and the mean patient age in this study was 61 years. The average Constant score for pain was 13 points, strength 17 points, activities of daily living 17.9 points, and range of motion 28.6 points. All 26 fractures healed with a mean time of 11.5 weeks (8-16 weeks) and were followed for an average of 17 months. Study commented that, locked plate fixation for three-part and four-part fractures of the proximal humerus in osteopenic or osteoporotic patients is a good and reliable method of fixation with limited complications.

Voos et al.<sup>48</sup> described their general

indications for hemiarthroplasty for proximal humeral fractures to include: displaced three- and four-part fractures, age > 70 years, severe osteoporosis, humeral head osteonecrosis, failure to maintain open reduction and internal fixation, head-splitting fracture, and fracture-dislocation. They also defined their indications for reverse total shoulder age > 70 years combined with low demands, a fracture with severe tuberosity and metaphyseal comminution, severe osteoporosis, cuff tear arthropathy, fatty infiltration of a massive rotator cuff tear, a failed hemiarthroplasty, and comorbidities that would affect tuberosity healing.

Keener et al.<sup>25</sup> followed 27 patients who were treated with closed or percutaneous reduction and percutaneous fixation of displaced two-, three-, and four-part proximal humeral fractures. They found that all fractures healed after the index procedure and the mean ASES score was 83 and the mean Constant score was 74.

Fenichel et al.<sup>26</sup> reviewed the outcomes of 50 patients with proximal humeral fractures treated with closed reduction and percutaneous pinning using threaded pins. They found that the average Constant score was 81, while fractures confined to the surgical or anatomical neck generally did better than those associated with a greater tuberosity fragment.

Reports of intramedullary nailing of proximal humeral fractures have generally demonstrated satisfactory outcomes in patients with two-part fractures, but less reliable outcomes in patients with three- and four-part fractures.<sup>41</sup> One recent report found no differences in the functional outcome of proximal humeral fractures treated with either a plate or an antegrade nail.<sup>30</sup>

In a multicenter study of 167 patients who had a hemiarthroplasty for three- and four-part fractures, Kralinger et al.<sup>32</sup> noted anatomical healing of the tuberosity significantly influenced the outcome as measured by the Constant score and subjective patient satisfaction. This finding was corroborated by another multicenter analysis on the functional outcome of shoulder hemiarthroplasty for fractures.<sup>33</sup>

A recent systematic review of the literature examining the role of hemiarthroplasty in the early management of proximal humerus fractures found a mean Constant score of 57.<sup>49</sup> No pain or only mild pain was experienced by most patients, but marked limitation of function persisted. Complications related to the fixation and healing of the tuberosities were observed in 11% of cases

Bufquin et al.<sup>50</sup> reported on the short term (mean 22 months) outcomes of 43 patients, noting mean active anterior elevation of 97° and mean active external rotation in abduction of 30°. They concluded that these outcomes demonstrated satisfactory mobility despite frequent (53%) migration of the tuberosities.

Cazeneuve et al.<sup>51</sup> reported the clinical and radiological outcome at a mean of 6.6 years for 36 fractures treated with reverse total shoulder arthroplasty. Fixation of proximal humerus fractures with plates and screws has been associated with complications such as pullout of screws in osteoporotic bone, subacromial impingement and avascular necrosis of the humeral head due to excessive periosteal stripping.<sup>52</sup>

Kristiansen and Christensen<sup>34</sup> have reported a high incidence of fixation failure following use of T-butress plates in fixation of proximal humerus

fractures. Wiggman et al.<sup>37</sup> have reported good intermediate and long-term results in 87% of patients who had three-and four-part fractures fixed with T-buttress plate.

Wiggman et al.<sup>37</sup> et al reported good to excellent results in 87% of their 60 patients with three or four part proximal humerus fractures operated with a T-buttress plate and cerclage wires.

Paavolainen et al.<sup>53</sup> reported satisfactory results in 74.2% of their 41 patients with severe proximal humerus fractures treated with plate and screw devices. However all these authors found poor results in 4 part fractures and recommended a prosthetic replacement in such patients.

MA Fazal et al,<sup>54</sup> retrospectively reviewed 27 patients who underwent locking compression plate fixation for proximal humerus fracture. All fracture were classified as 2 part (n=13), 3 part (n=12), 4 part (n=2). All fractures united expect one 3-part fracture in 78 yrs aged women in whom there was a collapse and screw penetration. The constant shoulder score was > 75 in 11 patients, 13 were scored between 50 to 75, and 3 below 50. They concluded philos plate fixation provided stable fixation, minimal metal work problem and enabled early range of motion exercises to achieve acceptable functional results.

Egol KA et al<sup>42</sup> in his retrospective analysis studied early complications in proximal humerus fractures treated with locked plates in 51 consecutive patients who were treated with a proximal humerus locking plate from 2003 to 2006. Radiographically, 92% of the cases united at 3 months after surgery, and 2 fractures had signs of osteonecrosis at latest follow-up. The major complication reported in this study was screw penetration, suggesting

that exceptional vigilance must be taken in estimating the appropriate number and length of screws used to prevent articular penetration. Authors concluded that, although the device provides exceptional fixation stability, its indication must be scrutinized for each individual patient, taking the extent of trauma/fracture and age into consideration and carefully weighing it against other forms of treatment.

Brunner F, et al.<sup>43</sup> 30 in his multicenter study from 8 trauma units enrolled 157 patients and treated with open reduction and internal fixation with a Philos plate. One-year follow-up rate was 84%. The incidence of experiencing any implant-related complication was 9% and 35% for non implant related complications. Primary screw perforation was the most frequent problem (14%) followed by secondary screw perforation (8%) and avascular necrosis (8%). After 1 year, a mean Constant score of 72 points (87% of the contralateral noninjured side), a mean Neer's score of 76 points, and mean Disabilities of the Arm, Shoulder, and Hand score of 16 points were achieved. They concluded that fixation with Philos plates preserves achieved reduction, and a good functional outcome can be expected. However, complication incidence proportions are high, particularly due to primary and secondary screw perforations into the glenohumeral joint, with an overall complication rate of 35%. More accurate length measurement and shorter screw selection should prevent primary screw perforation. Awareness of obtaining anatomic reduction of the tuberosities and restoring the medial support should reduce the incidence of secondary screw perforations, even in osteopenic bone.

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In summary fractures of Proximal Humerus may be extremely demanding. There are many pitfalls for the unwary patient and surgeon to avoid during the course of treatment. Emphasis is placed on complete and accurate diagnosis and formation of safe and simple techniques for restoration of disability, fracture healing and cuff integrity, motion and strength.

### Summary And Conclusions

- Displaced proximal humeral fractures when treated surgically produce less pain, less stiffness and greater ROM.
- Earlier the surgery better are the results.
- In severely comminuted fractures where anatomy cannot be restored without extensive soft tissue dissection, fixation with K wires and screws gave better functional results.
- Results are better with fractures than with fracture dislocations.
- Results are best when operative

method results in stable fixation that allows early passive mobilization.

- Functional outcome of 2 part fractures is better than 3 part and 4 part fractures.

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