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## A prospective study of functional outcome in displaced fractures of the proximal humerus managed surgically

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### Abstract

**Background:** The aim of the study is to evaluate the functional outcome of displaced fractures of the proximal humerus managed surgically.

**Methods:** A prospective analysis of the functional outcome of 20 cases under surgically managed displaced proximal humeral fractures were undertaken in our hospital. The indications of the surgery were displacement to more than 1 cm and angulation of more than 45°. The patients were operated by the standard anterior deltopectoral approach, deltoid splitting or percutaneous procedure depending upon the type of fracture and bone quality.

**Results:** The mean age of the patients was 44 years. The mode of injury was fall at ground level in 10(50%) patients, road traffic accident in 6(30%) patients, fall from height in 3(15%) patients, fall due to epilepsy in 1(5%) patients. 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. Greater Tuberosity fractures were the predominant type in 2 part fracture. Patients underwent the surgery on an average of 7.95 days after injury. The mean follow-up period in this study was 12.2 months.

**Conclusion:** Displaced proximal humeral fractures when treated surgically produce less pain, less stiffness and greater range of motion. Earlier the surgery better are the 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.

**Keywords:** Proximal humerus, greater tuberosity fractures, deltopectoral approach, anatomic restoration

### Introduction

Fractures of proximal humerus are challenging for diagnosis and treatment. They are not uncommon, accounting for 4 to 5% of all fractures [1, 2]. 80-85% of these fractures are minimally displaced or undisplaced and are effectively treated symptomatically with immobilisation followed by early motion [3, 4]. Proximal humerus fractures are the third most frequent fracture in elderly patients after hip fracture and Colles fracture [5]. It is important to recognise 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 [3, 6, 7]. 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 [2, 18] supplemented with CT or MRI. With more standard use of Neer's 4-part Classification system for fracture and fracture dislocation [9, 10, 11] 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 [12, 13, 14] to maximise anatomic restoration and minimising immobilisation 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.

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In this study we have analysed the functional outcome of 20 cases of displaced fractures of proximal humerus managed surgically.

### Materials and Methods

This prospective study is an analysis of functional outcome of 20 cases of surgically managed displaced Proximal Humeral Fractures, undertaken at Department of Orthopaedics, Vinayaka Mission Kirupananda Variyar Medical College & Hospital, Salem. Of the 20 patients, 12 (60%) were females and 8 (40%) were males. It was approved by institutional medical ethics committee. A written informed consent was obtained from all the patients.

### Inclusion criteria

1. Two part, three part & four part fractures of proximal humerus.
2. Adult 18 years & above included.
3. Angulation of more than 45\* or more than 1 cm displacement.
4. Patient fit for surgery.

### Exclusion criteria

1. Patient below 18 years.
2. Patient with undisplaced fractures according to NEERS classification (<45\* angulation or <1cm displacement).
3. Patients in whom functional demands are low.

### 4. Compound fractures.

The indications for surgery were displacement more than 1 cm and angulation more than 45°. Patients not satisfying these criteria were treated conservatively and not included in this study. The patients were operated by the standard anterior deltopectoral approach, deltoid splitting or percutaneous procedure depending upon the type of fracture and bone quality. Implants were selected according to the geometry of the fracture.

### Results and Observation

The age of the patients ranged from 18-70 years. The mean age of the patients was 44 years. Majority of injured patients were females (60%). Post-menopausal osteoporotic females accounted for 45% of patients. Highest number of patients were in their 5th decade (30%). The mode of injury was fall at ground level in 10(50%) patients, road traffic accident in 6(30%) patients, fall from height in 3 (15%) patients, fall due to epilepsy in 1 (5%) patients. There was no case with bilateral fractures. All were right handed persons and the dominant arm was involved in 16(80%). patients. Seventeen patients presented to us within a week after injury. 7 patients had previous treatment either in the form of native splinting, massage or POP cast. All the patients had closed injuries. These details are presented in Table 1.

**Table 1:** Details of the injury

Characteristics	No. of individuals percent	Percent
<b>Mode of Injury</b>		
Fall at ground level	9	45
Road traffic accident	7	35
Fall from height	3	15
Epilepsy	1	5
<b>Fracture side</b>		
Unilateral	20	100
Bilateral	0	0
<b>Duration from injury to reporting</b>		
0-5 days	17	85
6-10 days	1	5
11-15 days	2	10
<b>Previous treatment</b>		
Massage	2	10
Massage and splinting	0	0
Splinting	2	10
Attempted reduction with splinting	1	5
POP	2	10
No native treatment	13	65
<b>Associated injuries</b>		
Fracture metacarpal	2	25
Fracture scapula	1	12.5
Fracture distal radius	2	25
Fracture SOH	1	12.5
Fracture NOF	1	12.5
Fracture BB Forearm	1	12.5

A meticulous clinical examination was made in all patients with care to look for any associated injuries. 8 patients 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 sytem 10 patients (50%) had two part fractures, 5 (25%) patients had 3 part fractures and 5 (25%) had four part fractures. Greater tuberosity fractures were the predominant type in 2 part fracture. Fracture dislocation was there in 8(40%) patients. Patients with 2 part fracture had better functional outcome than 3 and 4 part fractures.

**Table 2:** Type of fracture

Neer’s type	No. of patients	Percentage
2 part	10	50
3 part	5	25
4 part	5	25
Dislocation	8	40

Patients underwent the surgery on an average of 7.95 days after injury. 4 patients underwent ORIF with Locking Compression Plate. Among 6 patients with 2 part fractures, 2 were treated with cancellous screws, 3 were treated with ‘K’ wires, and 1 with TBW. Of patients with 2-part fracture dislocations, one was treated with TBW & Cancellous screws, 1 with ‘T’ Buttress, 1 with LCP and 1 with ‘K’ wires. 1 patient with 4 part fracture underwent Hemiarthroplasty Average follow-up period was 12.2 months.

The patients were followed up at regular intervals every month during the first 3 months and every 3 months thereafter. The minimum follow-up period was 6 months and maximum follow-up period was 24 months. The mean follow-up period in this study was 12.2 months. The results were evaluated during follow-up by taking into consideration few factors like pain, range of motion, strength, stability, function, roentgenographic documentation of fracture healing and anatomic restoration.

**Pain**

Post op pain was recorded on a scale of 0-5points. 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.

**Table 3:** Functional outcome according to Constant and Murley’s score

Functional outcome	No: of patients
Good (3.5 – 4.0 points)	10
Fair (2.5 – 3.4 points)	8
Poor(<2.5 points)	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**

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**

Range of motion was evaluated during each follow-up and the improvement and progress recorded.

**Table 4:** Range of Motion

Motion	Range in degrees	Average
Elevation	90-170	127.75
Abduction	70-160	121.25
External rotation	35-60	47
Internal rotation	T3-L4	T11
Extension	30-55	41
Flexion	80-120	92.75

**Overall results**

**Table 5:** Overall results

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

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

**Discussion**

In this study we have analysed 20 cases of surgically managed proximal humerus fractures in our hospital. There was female preponderance in our study 12 (60%) 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 our study the average age of the patients was 46.3 years which was lower than reports by Hawkins and Gurr [15] and Flatow *et al.* [16] and Cornell CN, Levine D S, Pagnani M J [17].

Free fall at ground level was the most common mode of injury & fall on outstretched hand was the most common mechanism of injury & average age 46.3 years in our study, much in comparison with the study by Flatow *et al.* [16] as fall on the arm was the predominant mode of injury & average age of the patient (53 mean) in their study. Since our people attain menopause early and have poor bone quality the average age is lower. In our study, unusual mode of injury like seizures was present in one patient.

The Neer Classification is the most widely used scheme for proximal humeral fractures. We also have followed the Neer’s four part classification in our study but several authors have reported low level of inter observer reliability. Sidor *et al.* [10] reported a reliability co-efficient of 0.48 for 1 viewing and 0.52 for 11 viewing and reproducibility co-efficient of 0.66. In order to properly employ this classification, precise radiographic evaluation is of paramount importance [18]. We have found the Neer’s three view trauma series to be of greatest value in evaluating these fractures.

Computed tomographic scans were done in patients who had equivocal findings and also to find the direction of dislocation. 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 [16].

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.* [18] and recommended operative treatment for healthy active individuals who have three part fractures of the Proximal Humerus. Cornell and Levine [17] reported good results with screw tension band technique for 3 part fractures. Prosthetic replacement for 3 part fracture has been used by several authors but we have not used prosthetic replacement for three part fracture in our study. In the treatment of four part fracture and fracture dislocations, less than 10% good or excellent results are obtained by either closed or open reduction or internal fixation. Isolated reports of revascularization of humeral head following open reduction and internal fixation indicate satisfactory healing.

Unfortunately, many of the cases referred in the literature often have not been true four part fractures with isolation of articular fragment and follow-up is not sufficient to rule out long term osteonecrosis. Hugg and Lundberg noted 74% AVN when ORIF was used for these fractures. AVN is reported to be as high as 90% in four part fractures and 3-25% in 3 part [3, 19]. All authors agree that pain relief has been greater than 90% with prosthetic replacement, but there has been varying results with regard to function, motion and strength. Neer and McIlveen have reported nearly 90% excellent results with an improved technique utilizing long deltopectoral approach and better rehabilitation.

From the data presented in this study we have demonstrated that majority of the patients had no pain or only mild pain (80%) which is comparable to the study by Hawkins *et al.* [18] and Flatow *et al.* [16]. 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.* [16] 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.* [18] 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.* [56] and Flatow *et al.* [16]. 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.

Heterotopic ossification occurred in one patient with 4 part fracture dislocation, probably because the patient had exercised native treatment in the form of many attempted reduction and massage. Several authors have reported an incidence of upto 10% of heterotopic ossification in proximal humeral fractures [20]. There was no non-union or radiographic evidence of a vascular necrosis or deep infection in our study. Finally a prolonged closely monitored and well defined program of rehabilitation was necessary to obtain the best functional results. We have followed the three phase rehabilitation protocol of Hughes and Neer in all our patients and this has provided good results. For some patients this had taken as long as a year to achieve nearly full range of motion and function.

Locking compression plate results: The mean constant score in our study with 4 patients was 77.47 which is about equal to the study by Koukakis *et al.* [21]. 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.

### Conclusion

Displaced proximal humeral fractures when treated surgically produce less pain, less stiffness and greater range of motion. If the surgery is carried out at the earlier stages then better will be the results. In severely comminuted fractures where anatomy cannot be restored without extensive soft tissue dissection, fixation with K wires and screws give better functional results. Results are better with fractures than with fracture dislocations. Results are good 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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