# Internal Fixation of Proximal Humeral Fractures with Locking Proximal Humeral Plate (LPHP) - Outcome of 30 Patients

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***Abstract***- Background: Different operative techniques used for treating displaced proximal humeral fractures could result in malunion, non-union, osteonecrosis of humeral head, loosening of screw and loss of reduction particularly in comminuted and osteoporotic fractures. Locking compression plate (LPHP) has been proposed for open reduction and internal fixation of these fractures and is associated with less complication rate.

Materials and methods: Functional outcomes of 16 men and 14 women aged 18- 72 (mean 44.53) years who underwent locking compression plate fixation for proximal humeral fractures were observed after an average 12 months follow- up.

Results: According to constant score, 36.66% had excellent outcome, 46.67% had good functional outcome and 16.66% had moderate outcome. The shoulder range of movement was excellent in 11 (36.66%), moderate in 13 (43.33%), and poor in 6 (20%). In objective assessment it was observed that about 83% regain adequate power to perform activities of daily living and in subjective assessment it was found that 63.33% patients were able to perform activity of daily living without much problem. All fractures healed satisfactorily, except in one patient with a valgus 4-part fracture who had malunion. No wound infections, vascular injuries, avascular necrosis, or loss of fixation ensued. Two patients with axillary nerve palsy recovered spontaneously within 3 months.

Conclusions: Locking compression plate (LPHP) is an advantageous implant in proximal humeral fractures due to angular stability, particularly in comminuted fractures and in osteoporotic bones in elderly patients, thus allowing early mobilization.

***Index Terms***- Locking compression plate, Fractures fixation, Proximal Humerus fracture, Internal fixation, Osteoporosis

## I. INTRODUCTION

Fractures of the proximal humerus are an increasingly common injury, accounting for 4% to 5% of all fractures [11, 16] and 45% of all humeral fractures [19]. They are the third most common fracture in people older than 65 years, after hip and distal radius fractures [23]. The highest incidence occurs in women between the ages of 80 and 89 years [14]. As the number of osteoporosis-related fractures increases, a three-fold increase in the incidence of proximal humerus fractures over the next 30 years is projected. Eighty percent of proximal humerus fractures are neither displaced nor markedly unstable and are treated conservatively. In the remaining 20%, the fracture fragments are displaced, unstable, and may cause disruption to their blood supply. As proximal fragment is too small toaccommodate minimum of three screws, loosening ofscrews and loss of reduction may occur with conventionalimplants [2, 29]. Poor rotational and angular stability canlead to a partial loss of reduction into varus or retro flexion,resulting in an unsatisfactory functional outcome [13].The treatment of these fractures remains a challenging problem, with no consensus about the most appropriate management.

There are different techniques available for fixation of these fracture including bone sutures, cerclage wires, K-wires, tension band wires, T-plates, intramedullary devices, double tubular plates, the Polaris nail, conventional Plate and prosthetic replacements [20, 21, 24, 25, 26, 27, 30]. Many complications of proximal humeral fracture fixation have been reported. These include nonunion, malunion, avascular necrosis, and rotator cuff impingement and implant failure. The osseous architecture of the humeral head with poor central cancellous bone stock particularly in elderly patients, leads to a high risk of fixation failure with conventional plate-and-screw fixation [9, 10, 16]. Inorder to avoid the common problems associated withthis fracture, the AO-ASIF has recently developed a technique which aims to preserve thebiological integrity of the humeral head and to securean anatomical reduction with multiple locking screwswith angular stability [6, 22] with minimal soft tissue dissection and allow for early shoulder mobilization.

## II. MATERIAL AND METHODS

This was a prospective study performed at Department of Orthopaedics, MBS Hospital attached with Government Medical College, Kota between July 2005 and December 2007. A total of 30 patients (16 males and 14 females) with displaced proximal humeral fractures were operated using LPHP.

The inclusion criteria into the study were

1. Closed displaced two- part, three-part and four- part proximal humeral (fig 1) fractures in adults with osteoporosis.
2. Failed conservative treatment (unsatisfactory position).
3. Patients without neurological deficit.
4. Grade I–IV osteoporosis as per Singh's index [28].

Exclusion criteria were

1. Pathologic fractures from primary or metastatic tumours

2. Age under 18 years.

There were 39 patients meeting our inclusion and exclusion criteria. Four patients were lost to follow-up and 5 died leaving 30 patients (table I).

***Table 1: Age and Sex distribution of cases***

| Age | No. of patients | | % |
|---|---|---|---|
| | Male | Female | |
| 18- 20 | 2 | 0 | 6.66 |
| 21- 30 | 4 | 4 | 26.66 |
| 31- 40 | 3 | 1 | 13.33 |
| 41- 50 | 3 | 3 | 20 |
| 51- 60 | 3 | 2 | 16.66 |
| 61- 70 | 1 | 3 | 13.33 |
| >70 | | 1 | 3.33 |

All patients were followed up for a minimum of 12 months. All proximal humeral fractures met the indications for the operative treatment outlined by Neer [18] i.e. an angulation of articular surface of more than 45°, a displacement between the major fracture segments more than 1 cm, or a fracture with valgus impaction [8]. Mean age was 44.53 years (range 18– 72 years). Using plain radiographs, all fractures were classified according to Neer classification (fig 1).

**Fig 1: Roentgenogram of 47 years old female showing 4- part fracture in proximal end of humerus**

Antero-posterior radiographs of pelvis including both hips were assessed for grading osteoporosis. According to Neer's classification, 18 fractures were 2- part and 9 fractures were 3- part and 3 fractures were 4- part. The causes of injury were motor vehicle accidents (16), falls (13) and other like epileptic fits (1).

All patients received a prophylactic dose of 1.5gm cefuroxime intravenously preoperatively. The operation was done in supine position with small sand bag under shoulder, under general anaesthesia. Fracture was exposed through delto-pectoral approach. Fracture fragments were reduced without stripping periosteum to maximum possible achievable anatomical position and reduction was held with Kirschner wires. Reduction was checked under image intensifier. Definitive fixation with locking proximal humeral plate was done with plate positioned lateral to bicipital groove sparing tendon of long head of biceps. The plate was placed at least 1 cm distal to the upper end of greater tubercle. Plate was fixed with screw at longitudinal dynamic hole (fig 2).

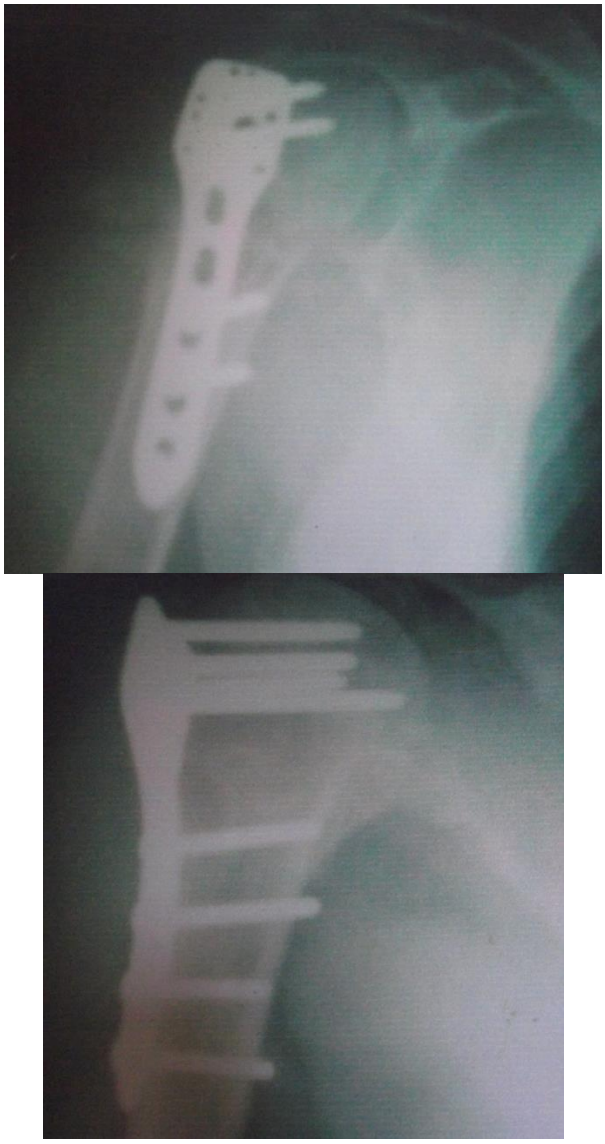

**Fig 2: Anteroposterior and lateral radiographs of same person in which the humerus fracture was stabilised with the LPH plate.**

After achieving near anatomical reduction, multidirectional screws were used to fix proximal fragments. Meticulous repairs of the rotator cuff, capsule and subscapularis muscle tears/avulsions were carried out, if found pre-operatively. Lesser tuberosity was fixed with a separate screw/wire if found avulsed. Range of motion of shoulder was checked on the table for impingement. Wound was closed under negative suction, which was removed after 24-48 hours depend on the drainage.

The patient were followed up at 5th day for dress check,12-15th days for stich removal, then monthly for 6 months, and then at 12 months for final evaluation. Standard anteroposterior and axillary radiographs were obtained and evaluated for bony healing, non-union, malunion, loosening of implant, loss of reduction and avascular necrosis of head of humerus. Comparing the immediate postoperative radiographs and those taken at the time of the final assessment assessed loss of reduction. Assessment and analysis of any complications including axillary nerve injury and impingement due to plate was done. Functional outcome was assessed according to Constant–Murley score [3].The Constant–Murley score was graded as poor (0–55 points), moderate (56–70), good (71–85), or excellent (86–100).

## III. Ethical considerations

Informed consent was taken from the patients prior to operation and for the inclusion to the study. The study was performed according to the Declaration of Helsinki, and the Institutional Ethical Board approved it.

## IV. Results

In present study, motor vehicle accident accounted for majority of fractures i.e. in 53.33 % patients, fall in 43.33% patients and other like epileptic fit accounted for 3.33% patients. Five cases also had associated injuries like 2 cases had fracture shaft femur, 1 had fracture shaft femur and fracture of both bone forearm, and one case had fracture calcaneum. Maximum no of patients (90 %) were operated with in first two weeks of injury. Patients were followed up for 12 months. All fractures healed in satisfactory position, except in one patient with a valgus 4-part fracture who had malunion. The humeral head was in a valgus and anteverted position, with the lesser tuberosity displaced internally and the greater tuberosity displaced superiorly. No wound infections, vascular injuries, avascular necrosis, or loss of fixation were noted. Two patients with axillary nerve palsy recovered spontaneously within 3 months. According to constant score, 36.66% had excellent outcome (fig 3), 46.67% had good functional outcome and 16.66% had moderate outcome.

**Fig 3: final functional result of same woman showing excellent results**

All fractures united with an average union time of 18 (16–23) weeks. The shoulder range of movement was excellent in 11 (36.66%), moderate in 13 (43.33%), and poor in 6 (20%). In objective assessment it was observed that about 83% regain adequate power to perform activities of daily living and in subjective assessment it was found that 63.33% patients were able to perform activity of daily living without much problem.

***Table 2: Functional outcome in different fracture types, presented as mean and range of the Constant score at 3, 6 and 12 months follow-up***

| Follow up | All (n= 30) | Constant score according to fracture type | | |
|---|---|---|---|---|
| | | 2- part (n= 18 ) | 3- part (n= 9 ) | 4- part (n= 3 ) |
| 3 months | 69 (60- 80) | 72 (60- 80) | 66 (61- 78) | 62 (58- 75) |
| 6 months | 75 (60- 86) | 78 (67- 86) | 73 (60- 84) | 68 (62- 78) |
| 12 months | 80 (66- 92) | 83 (71- 92) | 78 (66- 88) | 73 (60- 84) |

Tables 2and 3show functional outcome presented as Constant–Murley score at final follow-up according to fracture type and grades of osteoporosis, respectively. Mean Constant–Murley score was 80 points at one-year follow-up. When the results were related to fracture classification, two-part fractures had the higher average Constant–Murley score (83 points, range 71–92 points) as compared to three-part fractures (78 points, range 66–88 points) and four- part fracture (73 points, range 60-84). When the results were related to grades of osteoporosis, grade IV osteoporotic fractures had highest average Constant–Murley score (83 points, range 78–88 points), followed by grade III osteoporotic fractures (80 points, range 71–92 points), followed by grade II osteoporotic fractures (78 points, range 66–88 points). Patients in the younger age group had better outcomes than those in the older age group.

***Table 3: Functional outcome in different grades of osteoporosis presented as mean and range of the Constant score at 3, 6 and 12 months follow-up***

| Follow up | Constant score according to grades of osteoporosis | | |
|---|---|---|---|
| | II (n= 8) | III (n= 12) | IV (n= 10) |
| 3 months | 65 (55- 76) | 68 (60- 80) | 73 (66- 80) |
| 6 months | 72 (60- 82) | 75 (67- 86) | 78 (68- 86) |
| 12 months | 78 (66- 88) | 80 (71- 92) | 83 (78- 88) |

## V. Discussion

Displaced proximal humeral fractures in elderly patients pose a challenge to treatment when associated with osteoporosis and comminution [12]. Poor bone quality makes screw purchase and fixation less secure [2, 29]. The decreased healing capacity in osteoporosis is reflected in a dramatic increase in the rate of failure of implant fixation [8, 12]. In present study, LPHP has shown encouraging results in displaced proximal humeral fractures in osteoporotic bones. Sound union was achieved in all patients except one. No revision surgery was performed in our study due to implant failure. LPHP was associated with significant lower risk of screw loosening and secondary loss of reduction as compared to conventional plates in the present series. LPHP offers the advantage of locking head screws, which enter the humeral head at various angles in order to maximise purchase [12]. Fracture in a poor position is associated with poor functional results [7, 13]. Insufficient fixation of the screws may

cause partial loss of reduction with secondary displacement of the humeral head into varus position leading to unsatisfactory result. Whereas, a higher rate (12%) of varusmalunion was observed in conventional plate osteosynthesis [13]. We did not have any secondary varus deformity. Primary malunion can be prevented if fracture is fixed in near anatomical position at the time of fixation. We feel that near anatomical reduction must be achieved before applying multidirectional screws, as plate does not help in reduction of proximal fragments. Rather it fixes the proximal fragments wherever they are. With varusmalalignment, the plate must not be positioned too far cranially; otherwise there could be subacromial impingement. Meier et al. [17] did not recommend internal fixation with angled blade plate in unstable proximal humerus fractures due to high rate of complications (33%) including protrusion of blade into glenohumaral articulation (22%). Several authors showed satisfactory results with implants providing an angular stability [1, 5, 11,15]. Avascular necrosis of humerus has been reported to be 4–5% in other series [1, 15]. Only AO/ASIF type-C fracture or Neer's 4-part fracture had this complication. Our results are comparable with other series using implants providing an angular stability with respect to union, varusmalunion [1, 15]. This suggests that LPHP is associated with satisfactory results in both osteoporotic and non-osteoporotic fractures of proximal humerus. Although small no of patients in our series is a limitation, higher rate of secondary loss of reduction (12.5%) was observed in fractures with severe osteoporosis (Singh index grade II) as compared to fractures with mild osteoporosis (0%) (Singh index grade IV). This suggests that there is need for further improvement in management of osteoporotic proximal humeral fractures. The goal of surgical therapy is to obtain fracture reduction and stable fixation to enable immediate functional after treatment without the need for postoperative immobilization [13]. The LPHP demonstrated superior biomechanical characteristics compared with the proximal humeral nail [4]. Additional holes in the plate allow tension band fixation of the rotator cuff [1, 12]. Stable construct allows early mobilization and satisfactory functional outcome. Use of LCP is recommended in elderly patients with osteoporotic bone [1]. We are also of this view as elderly patients could attain an activity level that was sufficient to satisfy their needs regarding independent daily living. But, as expected, the mean Constant–Murley [3] score declined with increasing age. It is because after achieving a satisfactory functional result with a good range of motion, elderly patients usually discontinue exercise at home and often lose range of motion. Previous study had poor outcome in elderly patients. With the experience of both techniques, we have found locking proximal humeral plate an advantageous implant in communited 2-part fractures, 3-part fractures and 4- part fracture with osteoporosis in elderly patients. Fixed angular stability and meticulous rotator cuff repair leads to early mobilization and satisfactory functional outcome.

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