

A prospective study on Clinical and functional outcome of proximal humerus fractures treated with locking compression plate (LCP) among adults

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Abstract:

Introduction: Proximal humerus fractures are one of the commonest fractures occurring in the skeleton representing approximately 4% of all fractures and 26% of humerus fractures. Fractures that occur in the elderly usually result from a trivial fall on an outstretched hand or the side of the shoulder. Younger patients with these injuries are more likely due to high energy trauma following road traffic accidents and present with significant associated injuries. **Aim:** To evaluate the outcome of open reduction and internal fixation using locking compression plate for proximal humeral fractures.

Materials and Methods: This is a prospective study comprising of 30 patients with fractures of proximal humerus were treated by open reduction and internal fixation with locking compression plate were evaluated in the Department of Orthopedics, Tertiary Care Teaching Hospital from 2009- 2022. Clinical and radiological evaluation was done. Patients will undergo open reduction internal fixation with locking compression plate for the sustained fracture under general anesthesia.

Results: All the 30 patients of displaced proximal humerus were operated by open reduction and internal fixation using locking compression plate i.e. PHILOS (Proximal Humerus Inter Locking System). Among these 20 (66.7%) were males and 10 (33.3%) were females. At six months follow up out of 30 patients, 0 patients had poor (constant score 0-55), 12 had moderate (constant score 56-70), 15 had well (constant score 71-85) and 3 had excellent (constant score 86-100) outcome.

Conclusion: In conclusion, locking compression plate is an advantageous implant in proximal humerus fractures due to angular stability, particularly in comminuted fractures and in osteoporotic bones of elderly patients, which allows their early mobilization.

Keywords: Proximal humerus fracture, locking compression plate, Constant murley score, internal fixation, Open reduction.

Introduction

Proximal humerus fractures are one of the commonest fractures occurring in the skeleton representing approximately 4% of all fractures and 26% of humerus fractures. ^[1] They trail behind only femoral neck and distal radius as the third most common fracture in patients older than 65 years. ^[2]

Fractures that occur in the elderly usually result from a trivial fall on an outstretched hand or the side of the shoulder. Younger patients with these injuries are more likely due to high energy trauma following road traffic accidents and present with significant associated injuries. ^[3] They occur more commonly in elderly patients, after cancellous bone of the humeral neck has weakened by senility but these fractures are seen in patients of all ages. The most serious fractures and fracture dislocations are often seen in active, middle-aged patients. These fractures can be extremely disabling and their management often demands experienced surgical skills and judgment. ^[4]

Codman first recognized that proximal humerus fractures in adults occur along the lines of old physeal scars, with injury patterns involving four segments. Neer refined Codman's classification scheme by emphasizing the degree of displacement or angulations of an anatomical segment and was published in 1975. The AO/ASIF proposed a classification scheme based on vascular supply to the articular surface of the proximal humerus to predict the risk of avascular necrosis. ^[5] The final management decision should not be based solely on the presence of number of fracture fragments as dictated by the classification systems described. Instead, they must be individualized on the basis of age, associated injuries, and functional demands of the patient and fracture characteristics. In elderly patients, restoration of muscle power to the injured arm is not the prime objective. The main requirement is to achieve activities of daily living which do not need much strength, but require a reasonable range of movement. ^[6]

However, till now very limited prospective studies have been done describing the functional outcome, and complications following locking plate fixation of proximal humeral fractures in rural Indian population where fluorosis is endemic, which corresponds to the population in this study. ^[7]

Materials and Methods

This is a prospective study comprising of 30 patients with fractures of proximal humerus were treated by open reduction and internal fixation with locking compression plate were evaluated in the Department of Orthopedics, Tertiary Care Teaching Hospital from 2009-2022. The study purpose to include patients with proximal humerus fractures admitted and examined according to protocol, associated injuries noted. Clinical and radiological evaluation done. Fractures classified using Neers classification. A routine investigation carried out to get fitness for surgery. Patients will undergo open reduction internal fixation

with locking compression plate for the sustained fracture under general anesthesia. Postoperative physiotherapy followed according to protocol, to evaluate the functional outcome.

Inclusion criteria

Patients with two-part, three-part, four-part proximal humeral fractures, acute fracture, patients with age above 18 years and patients fit for surgery.

Exclusion criteria

Patients with associated humerus shaft fracture, associated neurovascular injury, acute infection, pathological fractures, old fractures and compound fractures. On admission of the patient, a careful history was elicited from the patients and/or attendants of injury and the severity of trauma. The patients were then assessed clinically to evaluate their general condition and the local injury. The general condition of the patient and the vital signs were recorded. The methodical examination was done to rule out fractures at other sites.

The local examination of the injured shoulder was done for swelling, deformity loss of function and altered attitude. Any nerve injury was also looked for and noted. The local neurologic deficit of axillary nerve was also assessed by looking for the anesthetic patch over the lateral aspect of the shoulder. Radiograph of proximal humerus was taken and fractures were classified according to Neer's classification. The patient was taken for surgery after routine investigation and after obtaining physician fitness towards surgery.

The investigations are as follows: Hb%, urine for sugar, FBS, blood urea serum creatinine, HIV, HBsAg, and ECG. The consent for surgery was also taken from the patient and attendants after explaining the procedure and possible complications. The limb was shaved from shoulder to hand including axilla 1 day before the surgery. Injection tetvac and antibiotics were given 1 hour preoperatively.

Surgical approach

Deltopectoral approach

Incision starts just above the coracoid process, which is palpated in deepest point in the clavicular concavity distally towards acromioclavicular joint. An 8 to 10 cm incision started from just above coracoid process advanced following the line of the deltopectoral groove. The Internervous plane is between the deltoid muscle which is supplied by axillary nerve and the pectoralis major muscle, which is supplied by the medial and lateral pectoral nerves. Retract pectoralis major medially and deltoid laterally, splitting the two Muscles apart. The vein is retracted either medially or laterally.

The short head of biceps and the coracobrachialis must be displaced medially before access can be gained to the anterior aspect of the shoulder joint beneath the tendons lie the transversely running fibers of the subscapularis muscle. Apply an external rotation to the arm to stretch the subscapularis, bringing the muscle belly into the wound and making its superior and inferior borders easier to define. Pass a blunt instrument between the capsule and the

subscapularis, then divide the subscapularis in from insertion onto to the lesser trochanter of the humerus. Incise the capsule longitudinally to enter the joint wherever the selected repair must be performed. [8]

Procedure

All patients received a prophylactic dose of 1 gm ceftriaxone + sulbactam intravenously preoperatively. The operation was done in the supine position with a small sandbag under shoulder, under general anesthesia. Through deltopectoral approach, the fracture was exposed and reduced with minimal soft tissue dissection. Briefly, the anatomical relationship between humeral head and greater tuberosity was reduced and fixed temporarily with K wires. In case of obvious rotation or displacement of the humeral head, a joystick technique was used. Then the shaft fragment was reduced by abduction, traction, and rotation of the arm.

The reduction was checked under image intensifier. Definitive fixation with locking plate was done with the plate positioned laterally to bicipital groove sparing tendon of long head of biceps and 1cm distal to the greater trochanter. The screws were chosen according to preoperative planning, and all the four head screws were supposed to be inserted into the head. The inferior screws supporting the humeral head were considered critical. Proximal locking screws were inserted to hold the humeral head. All proximal locking screws were placed in a uni-cortical fashion through an external guide and confirmed to be within the humeral head with intraoperative fluoroscopy. AP (internal and external rotation) views and axillary views 90 degrees to each other were used to visualize screw placement. The distal shaft screws were placed bi-cortically.

A minimum of three bi-cortical screws was used. Fluoroscopic images were taken to confirm satisfactory fracture reduction, plate positioning and proper length of screws in the humeral head. In case of severe comminution or instability, the rotator cuff, the greater tuberosity, and the lesser tuberosity were fastened to the plate using non-absorbable sutures. The range of motion of shoulder was checked on the table for impingement. Wound was closed under negative section, which was removed after 48 hours. [9]

Statistical analysis

The statistical analysis was carried out with SPSS VER. 18.0 Software. All the data were presented as mean, standard deviation, and percentage of efficacies. Chi-square and paired 't' test are used to evaluate the statistical significance ($P < 0.05$) is considered as significant.

Results

All the 30 patients of displaced proximal humerus were operated by open reduction and internal fixation using locking compression plate i.e. PHILOS (Proximal Humerus Inter Locking System). Among these 20 (66.7%) were males and 10 (33.3%) were females in table 1.

Table-1: Gender distribution of patients

Gender	No. of Patients	Percentage
Males	20	66.67
Females	10	33.33

Table-2: Age wise distribution of patients

Age in years	No of patients	Percentage
20-40	4	13.3
40-60	12	40.0
>60	14	46.7

Table-3: Injury related parameters.

Parameters	Number of patients	Percentage
Mode of injury		
RTA	20	66.7
Fall due to slip	10	33.3
Limb involved		
Right Side	21	70
Left Side	9	30
Co-morbidity		
None	13	43.4
Hypertension	8	26.6
Diabetes Mellitus	4	13.3
C.A.D	5	16.7

In the present study, the most common mechanism of injury was found to be road traffic accidents with a total of 20 (66.7%) patients and rest 10 (33.3%) were injured due to accidental fall on the ground. In the present study, the right side proximal humeral fracture occurred in 21 (70%) patients and left side proximal humeral fracture occurred in 9 (30%) patients respectively. Majority of the patients around 13 (43.4%) doesn't have any co-morbidities, a total of 17 patients had different comorbidities which includes; 8 (26.6%) had diabetes mellitus, 4 (13.3%) had hypertension, and 5 (16.7%) had coronary artery disease.

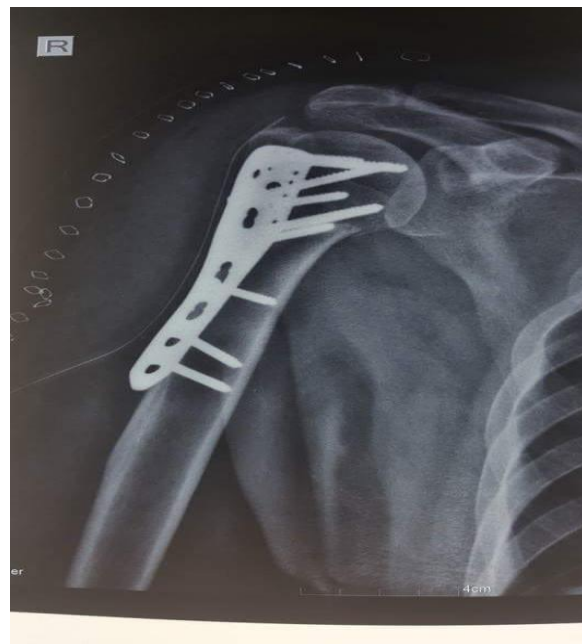
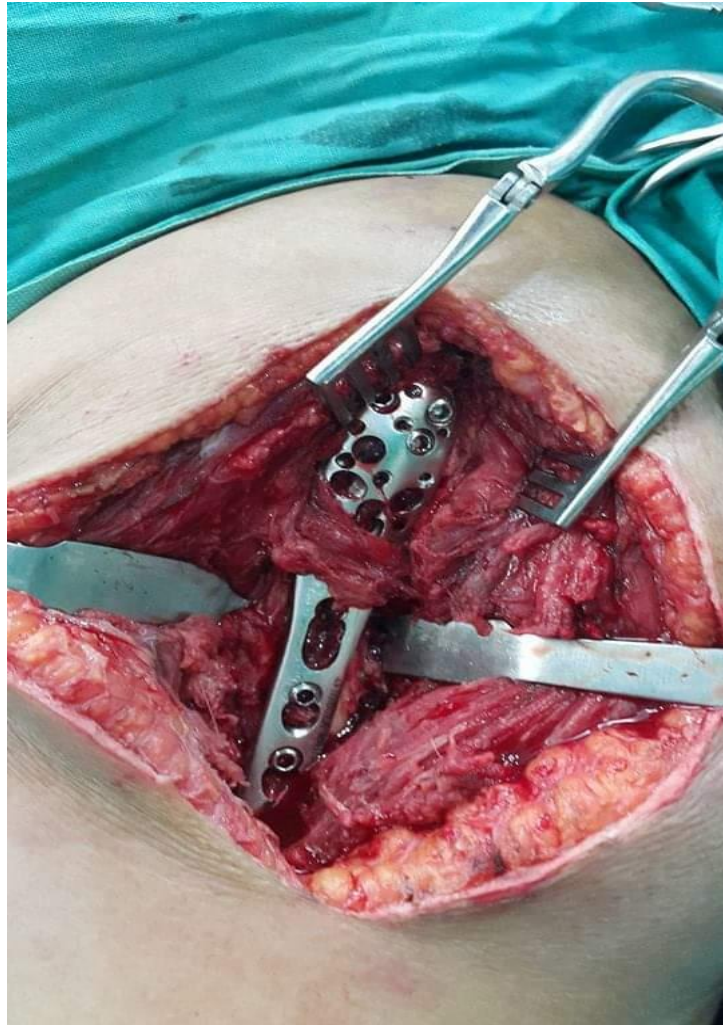






Table-4: Neer's classification wise distribution of fracture

Classification	Number of patients	Percentage
2 Part Fracture	13	43.3
3 Part Fracture	10	33.3
4 Part Fracture	7	23.4

All fractures were classified according to Neer's classification system. 13 (43.3%) patients were two-part, 10 (33.3%) were three-part and 7 (23.4%) were four-part in table 4.

Table-5: Time of injury of the patients

Time of injury	Number of patients	Percentage
Valgus displacement of the head	16	53.3
Varus displacement	12	40.0
Normal alignment	2	6.7
Total	30	100

Table-6: Shoulder functional outcomes.

Follow-up	N	CMS (Mean \pm SD)	p-value
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06 Weeks	30	30.24 ± 2.83	<0.0001
12 Weeks	30	49.37 ± 5.31	
06 Months	30	58.46 ± 5.75	

In table 6, the Constant -Murley score achieved at the end of study period (6months) was 58.46 ± 5.75. The Constant-Murley score was significantly improved (p<0.0001) over each successive follow-up period with the average improvement of around 19 scores between 1st and 2nd follow-up and around 15 score improvement between 2nd and 3rd follow-up.

Table-7: Constant-Murley score grading.

CMS Grading	Number of patients	Percentage
Poor (0-55)	0	0
Moderate (56-70)	12	40.0
Good (71-85)	15	50.0
Excellent (86-100)	3	10.0
Total	30	100

In table 7, at six months follow up out of 30 patients, 0 patients had poor (constant score 0-55), 12 had moderate (constant score 56-70), 15 had well (constant score 71-85) and 3 had excellent (constant score 86-100) outcome.

Discussion

The incidence of proximal humerus fractures has increased due to modern lifestyle changes and ever-increasing number of RTAs when compared with the previous decade. Treatment options for complex proximal humerus fractures are restricted to T-buttruss plates, K-wires, and bent ST-plates. Even if the injury is thoroughly analyzed and the literature is understood, treatment and fixation of these displaced fractures or fracture with dislocation is extremely difficult.^[10]

Locked plate techniques have become very popular and are being used to treat the open reduction and internal fixation (ORIF) of displaced fractures of the proximal humerus.^[11] Recent meta-analysis of the literature was unable to detect a clear advantage from internal fixation or arthroplasty for treatment of such complex fractures of the humerus. Most of the proximal humerus fractures which are un-displaced can be treated conservatively. Many studies have shown that the displaced fractures of the proximal humerus have a poor functional outcome when not treated because of severe displacement of fragments.^[12]

However, the best management in these injuries is still uncertain and debatable. Hatzidaki et al^[13] studied the outcomes of 30 patients who were treated with locked angular-stable intramedullary implant fixation for 2-part surgical neck fractures. He did a follow-up for a minimum period of 12 months. All fractures healed primarily. The mean Constant score was 71, which was a mean age-adjusted Constant score of 97%. In their study, patients could do an average forward elevation of 132° and Constant pain score was 13 (15 = no pain). In

their results, 37 (97%) of 38 patients had satisfactory score. Only four patients (11%) were reoperated. ^[14]

However, with the aim of getting anatomically accurate reductions, rapid healing, and early restoration of function, which is a demand of today's life, ORIF is the preferred modality of treatment. This goal is well achieved by locking compression plate as depicted in our study though data are small. The ideal treatment of complex fractures of the proximal humerus is still being debated and controversial. The fracture classification systems are prone to lots of errors. None of these give a clear prognosis and innovations for further outcome and treatment. Treatment of such fractures have resulted in satisfactory outcome by adopting ORIF techniques. ^[15]

If the fractures are well reduced and stabilized until healing has occurred, it will usually end up with satisfactory results. This depends on the type of fracture, the quality of the bone, and the technique of reduction and fixation. The experience and skill of the surgeon also count. ^[16]

We had moderate and poor results in five (25%) patients, out of which two patients had plate impingement with restriction of abduction beyond 90°. Two patients had stiffness with restriction of movements and with persistent pain of mild to moderate degree. Of the two patients, one had 2-part fracture with axillary artery rupture, which was repaired with fracture fixation; limb survived with stiffness and mild pain. All fractures got united in 3 months. There was one case of AVN in our study, who was advised hemi replacement. Our study is in agreement with other studies, with more than 75% patients having excellent to satisfactory results. ^[17]

A randomized controlled trial evaluated the results for a period of 2 years in which locking plate fixation vs non-operative treatment in elderly patients treated for a displaced 3-part fracture of the proximal humerus was studied. In this study, treatment with a locking plate resulted in superior functional outcome and health-related quality of life compared with non-operative treatment. However, 30% of the patients studied required additional surgery because of fracture complications. ^[18] It is important to note that the Constant score, the Disabilities of the Arm, Shoulder, and Hand (DASH) score, and the EQ-5D (EuroQol Group; Rotterdam, the Netherlands) score noted in the study were all superior in the locking plate group on all follow-up occasions. Even though the results were encouraging, it did not reach statistical significance. ^[19]

Sudkamp et al ^[20] evaluated the complication rate and functional outcome of 150 patients after ORIF of proximal humerus fractures using a locking proximal humerus plate. At 12 months follow-up, in the study group, average Constant score was 70.6, which was 85% of the contralateral side. The average active elevation was 132° and the external rotation of the limb was 45°. The overall complication rate was 34% (52 of 155), and the common complication (21 of 155) was intraoperative screw penetration into the humeral head. Twenty-nine of these patients (19%) required a reoperation.

In the study by Bahrs et al, ^[21] the Constant score and radiographic outcome in 50 patients with minimally displaced and/or impacted fractures of the proximal humerus treated with early immobilization were assessed. The fractures healed well, without nonunion, in all their patients. Imaging studies showed fracture displacement of less than 15° of angulation and/or less than 5-mm displacement of the greater tuberosity in 80% of their patients.

They also found a significant association between the final Constant score, age, AO classification, and original fracture displacement. ^[22] They concluded by saying that, earlier physiotherapy with a limited period of immobilization is sufficient in managing minimally displaced and/or impacted fractures of the proximal humerus.

In our study, use of proximal humerus locking compression plate resulted in favorable outcome in fractures of the humerus with displacement. Sound union was achieved in all patients. There was no incidence of implant failure which required reoperation. This locking compression plate has the advantage of locking head screws, which enter the head of the humerus at different angles.

Two patients had unsatisfactory results with stiffness, restriction of movements, and mild to moderate pain. One patient had AVN. Regular follow-up and compliance was poor in these patients. In our study, none of the cases had implant failure. Our study has similar results compared with other studies of surgical management of the proximal humerus. ^[23]

Proximal humerus fractures occur more commonly in the middle age group. Numerous age-related studies point toward this, and our study is consistent with this finding. In our study, majority of the patients, i.e., 7 (35%), were from age group of 41 to 50 years followed by 5 patients (25%) >50 to 60 years. The average age of the patients were 42.5 years (Table 7). Majority of the patients in our group are middle aged probably as it is the most active and working group of the population in general.

Further, as with other studies, our study showed a higher incidence of fractures in men than in women. The gender ratio was 19:1 (Table 8). This higher ratio can be explained by a higher involvement of males and the nature of work they do in day-to-day activities of life compared with females.

Major cause of fracture in our study was RTA in 17 cases (85%), and in 3 cases (15%) the mode of injury was falls (Table 9). Fazal and Haddad in their study have reported 21 cases (77.8%) of fall and 6 cases (22.2%) of RTA. Aggarwal et al ^[24] in their study of 47 patients of proximal humerus fracture accounted for 55% of fracture, RTA 42.5% and 1 fracture (2.5%) caused by seizure. In the study of Resch et al ^[25] of 30 patients with 3-part and 4-part fracture, 24 patients had history of high-energy trauma.

CMS was compared with other studies. Good results of our study were comparable with the studies of Bjorkenheim and Siwach ^[26] (Table 11) not many studies have been done on this topic in Indian patients with a medium sample size. Gerber et al did a study on PHILOS

plating but used a different score, and Charalambous et al had a small sample size.^[27,28] We had only one case of AVN of humeral head in PHILOS group, which was asymptomatic clinically (5%). It is much less than 6 to 10%. As we did not obtain magnetic resonance imaging routinely, the true prevalence of AVN and other complications may be difficult to assess.^[29]

Conclusion

Locking compression plate is an advantageous implant in fixing proximal comminuted and displaced fractures of the humerus. It is also useful in osteoporotic bones of the elderly patients. It allows early mobilization. Further randomized trials are the need of the hour to compare the outcome of conservative non-operative treatment with other surgical treatment options like ORIF and hemiarthroplasty.

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