

Original Research Article

Functional outcome in displaced proximal humeral fractures in adults treated by proximal humeral locking plates

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ABSTRACT

Background: The management of proximal humerus fractures (PHF) is a challenging task to any surgeon. Study was conducted to evaluate the clinical and functional outcome of the proximal humeral internal locking system in fixation of displaced proximal humeral fractures.

Methods: Study was conducted in the Department of Orthopedics, GSL Medical College. Informed written consent was taken from the study participants. All skeletally mature patients aged >18 years, presenting with displaced PHF according to Neer two, three and four part fracture were included in the study. Either deltopectoral or deltoid splitting approach was used for surgery, post-operative rehabilitation was started on day one.

Results: Twenty-five patients with PHF were enrolled in the study; five-holed proximal humerus locking plate (PHLP) was used for 18 patients, eight-holed PHLP for 05 and three-holed, ten-holed PHLP for 01 for one each. The Constant-Murley score was significantly improved ($p=0.000$) 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.

Conclusions: The proximal humeral locking plate is an adequate device for the fixation of displaced two-part, three-part and four-part PHF. Patient can regain good shoulder function, resume normal activities much earlier.

Keywords: Fracture, Patient, Humerus

INTRODUCTION

Fractures occurring at or proximal to surgical neck of humerus are described as proximal humerus fractures (PHF). The Incidence of trauma related skeletal injuries have been on the rise in recent years and PHF are one of the most common fractures occurring in the human body. Fractures of the proximal humerus represent approximately 4% of all fractures and 26% of humerus fractures.^{1,2} It is the most common type of fracture in an elderly population with osteoporotic bone, Three fourths of the fractures occur in older individuals with an occurrence three times more often in women than in men.

In patients above the age of 65 years proximal humeral fractures are the second most frequent upper extremity fractures, next to distal end radius fractures. The most serious fractures and fracture dislocations are often seen in active, middle aged patients.³⁻⁸

The management of PHF is a challenging task to any surgeon due to a wide variety of fracture patterns observed in these injuries. The injury is of great importance when it affects the young and middle age groups of the population. It leads to temporary disability and loss of working hours. Restoration of the function of the limb is of paramount importance. Multiple factors

related to patient, surgeon and fixation technique govern the outcomes of these injuries. Patient-related factors like age, co-morbidity, fracture pattern, bone quality, arm dominance, activity level, professional demands, ability to comply with postoperative rehabilitation protocol and more importantly the expectation of the patients from particular intervention were taken into account before proceeding with any appropriate intervention.⁹ Reduction of displaced PHF is a challenging task as various fracture patterns can occur owing to the complex anatomy.¹⁰ Surgical skills of the operating surgeon and knowledge of anatomy and biomechanics also play a significant role in the outcome of these injuries. These fractures can be extremely disabling and their management often demands experienced surgical skills and judgment. They can cause great morbidity. It is a challenge to treat unstable, displaced, and comminuted fractures of the proximal humerus.

The management of displaced PHF is controversial as many fixation techniques have evolved over the years claiming to be a better fixation device compared to the other. As numerous versatile surgical fixation techniques and implants are available in the market to treat PHF, it is of utmost importance to select the most appropriate fixation technique and implant to achieve good outcome.

One meta-analysis by Bhandari et al, concluded that there was insufficient evidence to determine the optimal treatment for patients with displaced fractures of the proximal humerus.¹¹ Hence the present study was conducted to evaluate the clinical and functional outcome of the proximal humeral internal locking system (PHILOS) technology in fixation of displaced proximal humeral fractures.

METHODS

This was a prospective observational study, conducted in the department of orthopedics, GSL Medical College from October 2015 to March 2017. Study protocol was approved by the institutional ethics committee; informed written consent was taken from the study participants.

All skeletally mature patients aged >18 years, presenting with displaced PHF according to Neer two, three and four part fracture, patients with associated dislocation of the shoulder, patients undergoing revision surgery for failure of other implants and failure of conservative treatment were included in the study.¹² Pathologic fractures from primary or metastatic tumors, patients age less than 18 years, open fractures and poly trauma, four part fracture in elderly, those not fit for surgery and with neurovascular deficits were not considered.

Patients presented to the emergency services with shoulder trauma were initially managed with shoulder immobilization (either with an arm sling or U-slab) and analgesics. 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 and the vital signs were recorded. Methodical examination was done to rule out fractures at other sides. The local examination of injured shoulder was done for swelling, deformity loss of function and altered attitude. Any nerve injury was also looked for and noted. Local neurologic deficit of axillary nerve was also assessed by looking for anaesthetic patch over lateral aspect of shoulder.

They were further evaluated with X-ray of the injured shoulder, the anteroposterior (AP) view, axillary and scapular Y-view was also obtained. CT scan was used in selected cases where the fracture line couldn't be made out through plain X-rays, also to evaluate the extension of fracture and to evaluate tuberosity displacement in comminuted fractures.

The patient was taken for surgery after routine investigation and after obtaining physician fitness towards surgery. Limb was shaved from shoulder to hand including axilla 1 day before the surgery. Pre-operatively prophylactic antibiotics given one hour before the surgery.

The patients were operated under general anesthesia. Either deltopectoral or deltoid splitting approach were used.^{13,14} All patients are immobilized in arm pouch with cuff and collar sling. Appropriate antibiotics and analgesics were used. Immediate post-operative radiographs were taken to determine the bone alignment and maintenance of reduction. Sutures removed by 10th day. Postoperative rehabilitation was started on day one onwards. Elbow and wrist active range of motion exercises were commenced initially, while the passive range of motion and pendulum exercises of the shoulder were encouraged as soon as the pain subsided. Active assisted and passive exercises of the shoulder were done during the first three weeks, after which active range of motion of shoulder was started along with muscle strengthening exercises. All post-operative rehabilitation was done under the guidance of an experienced physiotherapist.

The shoulder functions were assessed using standard Constant-Murley score proforma at postoperative six weeks, three months and six months.^{15,16} The protocol mentioned in the Danish version of modified Constant-Murley score was followed to measure individual parameters.¹⁷

Statistical analysis

Statistical analysis was done by using SPSS version 21.0. Chi-square test was used to assess the association among different categorical variables; $p < 0.05$ was considered statistically significant.

RESULTS

Twenty-five patients with proximal humeral fracture were enrolled in the study and they were treated by open

reduction and internal fixation with PHILOS plate; majority were <50 years (Table 1) with 1.77 male female ratio (Figure 1). Neer classification wise, 52%, 32% and 16% were respectively 2 part fracture, 3 part fracture and 4 part fracture (Table 2).

Table 1: Age distribution of the study participants.

Age (in years)	Number (%)
19-49	14 (56)
50-75	11 (44)
Total	25 (100)



Figure 1: Gender distribution of the participants.

Table 2: Distribution of the study participants as per Neer’s classification.

Fracture	Participants (%)
2 part	13 (52)
3 part	08 (32)
4 part	04 (16)
Total	25 (100)

Table 3: PHILOS plate size used for the participants.

PHILOS plate size	Participants (%)
Three holed PHILOS plate	01 (4)
Five holed PHILOS plate	18 (72)
Eight holed PHILOS plate	05 (20)
Ten holed PHILOS plate	01 (4)
Total	25 (100)

Table 4: CMS among the participants during follow up in weeks.

Follow up	CMS (mean±SD)	df	F	P
06	36.24±4.48	2		
12	55.44±7.37	72	130.61	0.00
24	69.84±9.41			

In this study, 72% (18) of the patients we used five-holed PHLP, followed by 20% (05) of patients we used eight-holed PHLP, 04% (01) of patients we used three-holed PHLP and remaining 04% (01) patients we used ten-holed PHLP (Table 3). The Constant-Murley score (CMS) was significantly improved (p=0.000) 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 4).

DISCUSSION

Displaced proximal humeral fractures are a challenge for orthopaedic surgeons. Un-displaced fractures can be treated conservatively. Prevalence of osteoporotic PHF is increasing in recent years as the elderly population is on the rise. A variety of options are available to manage these fractures. The goal of proximal humeral fracture fixation is to obtain a painless and functional shoulder. The current best treatment option for PHF is controversial. As so many fixation devices have evolved over time, the comparison between the studies is difficult because of differences in types of fractures included, patient age, sex, the length of follow-up, outcome parameter evaluation.

Locking plate technology is the most recent evaluation of devices which have been developed to overcome difficulty and complications faced by previous fixation methods, and it shows promising results in recent studies.^{9,18}

The age of the study participants was ranged between 22 to 62 years; mean age was 43.52±13.04 years, majority of the patients i.e., 14 (56%) were from age group of 19-49 years and 50–75 years age group has 11 (44%) respectively. The age of the patients was categorized into either 19–49 years or 50–75 years to assess differences in shoulder functional outcomes in younger and older individuals; as with old age, the function of the joint will deteriorate due to degenerative changes and it may impact the overall functional outcome of the study.

In this research, 64% (16) of the respondents were male and about 36% (09) of were female. Most of the patients had two-part (52%) followed by three-part (32%) and four-part (16%) PHF. This is in accordance with the results of epidemiological studies conducted by Court-Brown et al and Roux et al who stated that the most common displaced fracture pattern was 2-part fractures followed by 3 parts and 4 parts respectively.^{19,20} But this was in contrast to the findings of Vijayvargiya et al study; the authors reported that most of the fractures were three-part (46.1%) followed by four- part (34.7%) and two-part (19.2%) PHF were reported to be least.²¹ Similarly, Erasmo et al. observed a higher number of three-part fractures (40), compared to four- part (35) and two-part (2) among a total number of 81 patients with 82 proximal humeral humerus fractures.²²

In our study, road traffic accident was the most common mode of injury (72%) followed by simple falls (28%). This was in contrast to the earlier reports which stated that fall as the most common mode of injury.^{3,19,20} Vijayvargiya et al study reported also reported that fall

(53.8%) is the predominant mode of injury followed by road traffic accidents (46.2%).²¹

The average delay before surgery was two days which is similar to the study conducted by Menendez et al which states that the delay before surgery should not be later than three days to avoid inpatient adverse events, postoperative length of stay.²³ However, this study 24% got operated in 3–6 days of span after injury. The reasons behind the delay were due to their comorbid conditions patients were not fit for anaesthesia immediately. Thus, surgical fitness had to be ensured before surgery. On analysis, we found statistically significant correlation between delay in surgery and functional outcome at six months follow-up according to Spearman's Rho correlation test ($p=0.036$).

Bone graft or substitute was used in 3 patients to fill the metaphyseal defect at the time of reduction to prevent varus collapse and for augmentation, as suggested by Sinha et al, Euler et al.^{24,25} Bone cement, fibular strut graft, and allograft were used individually in these patients. However, one varus malunion and one valgus malunion occurred in two of these patients due to improper reduction at the time of surgery. These fractures were associated with extensive metaphyseal combination.

In the present study, deltoid split approach was used in 84% (21) of patients for open reduction and internal fixation of proximal humeral fracture whereas for other 16% (04) of patient's deltoid-splitting approach was used. The mean duration of surgery were 114 minutes and 112 minutes respectively in the deltoid split group and deltopectoral group; statistically there was no significant difference between the approaches ($p=0.267$). Buecking et al reported an average time taken for surgery in deltopectoral approach was 67 minutes where as in deltoid split approach was 62 minutes and Waliulah et al reported 84 minutes and 72 minutes respectively.^{26,27} Being tertiary health care setup, training is a part of routine curriculum; with this there was higher operating time in this study due to involvement of multiple surgeons.

The size of the plate was determined by the fracture pattern and distal extension of the fracture. In this report, five-holed PHLP was used for 18 (72%) patients, followed by eight-holed PHLP for 05 (20%) cases; three holed PHLP and ten-holed proximal humerus locking plates (PHLPs) were used for 1 (4%) patients each, respectively.

In our study, average Constant-Murley score observed at the end of six months follow-up was 70. In the literature, there was difference in the reported average Constant-Murley scores <70 was reported.^{28,29} The variations in reported Constant-Murley score among different studies attribute to a multitude of reasons like the average age of patients, various follow-up periods and as most of the

studies are Western studies with the difference in physical characteristics of patients with individual race.

The Constant-Murley score for individual parameter at the end of 6 months follow-up showed 12.7 pain score, 16.3 activities of daily living score, 31.1 the range of motion and 9.5 strength score. Lacobellis et al reported 10.3 strength score.²⁹ The differences in physical built of the European and Indian population, and gender variation and follow up period is also very long in their study (21 months) compared are the reasons for difference in the strength score.

When functional outcome was assessed, one patient (4%) in this study had excellent constant score (86–100), 11 (44%) patients each had good constant score (71–85), moderate (56–70) scores respectively and 2 (8%) had poor constant-score (0-55). These results are consistent with Vijayvargiya et al, Erasmo et al and Fazal et al reports and gender wise, statistically the difference was not significant in functional outcome at 6 months follow-up.^{21,22,31}

CONCLUSION

The proximal humeral locking plate is an adequate device for the fixation of displaced two-part, three-part and four-part PHF. Patient can regain good shoulder function, resume normal activities much earlier. PHLP is an effective system for stabilizing these fractures. Additional studies with larger cohorts and longer follow-ups are necessary to better define the appropriate indications and expected outcomes of this technology.

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