

Original Research Article

Functional outcome of displaced proximal humerus fractures managed by proximal humerus interlocking system plate

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ABSTRACT

Background: Fractures of the proximal humerus are the second most common upper extremity fracture and the third most common fracture, after hip and distal radial fractures. The fractures can occur at any age, but the incidence rapidly increases with age.

Methods: The study was conducted in patients treated for displaced proximal humerus fracture at Adichunchanagiri Institute Of Medical Sciences, BG Nagar from the month of June 2014 to August 2016. Twenty proximal humerus fracture patients were taken into the study; all were fixed with PHILOS plate. Patients' age ranged from 18 to 75 years with a mean of 42.9.

Results: The sample consisted of twenty patients of proximal humeral fractures. 08 were males and 12 females. The patients' ages ranged from 18-75 years with a mean age of 42.9 years. The causes of fractures were road traffic accident in 13 patients, fall in 06 patients and electric shock in 1 patient. 11 fractures involved the right side and 09 involved the left. Patients were followed up from 03 weeks to 06 months. Functional outcome was rated as per Constant-Murley Shoulder Score, we got excellent results in 04 cases, satisfactory in 10, unsatisfactory in 05 xi and failure in 01 patient. Mean Constant-Murley score of this study at the end of the final follow-up period was 81.6.

Conclusions: The PHILOS plate is a good implant to use for fractures of the proximal humerus. However, proper placement of the plate and fixation are required to produce satisfactory results. We recommend use of this implant in Neer 2-part, 3-part, 4-part fractures with or without dislocation and osteoporotic fractures.

Keywords: Proximal humeral fracture, Osteoporotic fracture, Neer's classification, Open reduction and internal fixation, Deltpectoral approach, Philos, Constant-Murley score

INTRODUCTION

Fractures of the proximal humerus represent approximately 4% of all fractures and 26% of humerus fractures.¹ These are the second most common upper-extremity fracture and the third most common fracture, after hip and distal radial fractures. The fractures can occur at any age, but the incidence rapidly increases with age. The risk factors for proximal humeral fractures are primarily associated with low bone mineral density and an increased risk of falls. The most common mechanism

of injury in proximal humeral fractures in elderly patients is a fall from standing height onto an outstretched upper extremity. In patients aged less than 50 years, the mechanism is often related to high-energy trauma, such as significant falls from height, motor vehicle accidents, or athletic 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.

Treatment of proximal humerus fracture has been the subject of much controversy and confusion. This is because of the complexity of these injuries; fracture displacements are without careful radiographic views and associated soft tissue injuries. Further, there has always been diversity of opinion about the care of shoulder fractures, with frequent controversies and lively debate, further more even good anatomical results achieved at operative repair may lead to poor results unless there is meticulous post-operative rehabilitation, which can be more challenging in shoulder than operative technique.²⁻⁴

Most studies indicate that for the majority of good results of fractures of this region are obtained by conservative methods. Some studies state that operative treatment is better, depending on type of fracture and the quality of the bone. Management of these fractures is associated with some morbidity and undesirable sequelae. They include complication like avascular necrosis, malunion, non-union, infection, neurovascular injury, loss of motion of shoulder from adhesive capsulitis, chronic edema, elbow stiffness and atrophy of the soft tissues of the immobilized limb causing significant disability during healing and afterwards.

Objectives

1. To study the effectiveness of PHILOS in anatomical reduction and stability of fixation of displaced proximal humeral fractures.
2. To analyse the functional outcome of management of displaced proximal humeral fractures by PHILOS by evaluating pain, activities of daily living, range of motion and muscle power.

METHODS

The study is a clinical, prospective and observational study on functional outcome of displaced proximal humerus fractures managed by proximal humerus interlocking system (PHILOS) plate was conducted in the period from June 2014 to August 2016 at Adichunchanagiri Institute of Medical Sciences, B.G. Nagara, Mandya

Inclusion criteria

Inclusion criteria were all skeletally mature patients presenting with displaced proximal humeral fractures according to NEER two, three and four-part fracture, patients with associated dislocation of the shoulder, patients undergoing revision surgery for failure of earlier implants.

Exclusion criteria

Exclusion criteria were patients medically unfit for surgery, patients age less than 18 years, severely

comminuted fracture in elderly, humeral head-splitting fractures.

Procedure

All patients were treated by open reduction and internal fixation using 3.5 mm proximal humerus interlocking system (PHILOS) plate under general anaesthesia. The patient with a proximal humerus fracture is placed in the beach-chair position or supine position. A deltopectoral approach is used. Preserve the cephalic vein and retract it medially with the pectoralis major following coagulation and division of the perforating veins from the deltoid. The fractured fragments are reduced in anatomical position and fixed provisionally with 1.5 – 2 mm Kirschner wires under the guidance of fluoroscopic image intensifier. The plate is positioned proximally at least 8 mm distal to the upper end of the greater tubercle (rotator cuff insertion) centered on the lateral aspect against the greater tubercle, ensuring that a sufficient gap is maintained between the plate and the long biceps tendon (arterial blood supply). With the aid of drill sleeve, under image intensifier, predrilled screw holes through both cortices are made using 2.8 mm drill bit using the drilling gun and 3.5 mm locking screws of appropriate length (measured using depth gauge; deducting 10 mm from the measured reading) are inserted into the proximal section of the plate depending on the fracture patterns. Ideally the plate should be secured with at least 4 or 6 proximal screws or more, particularly if the bone quality is poor. The PHILOS plate is fixed distally through LCP combi-holes using bicortical self-tapping cortical screws or locking screws of appropriate length, as desired, measured using depth gauge. The reduction is confirmed under C-arm. The operative site then is irrigated abundantly using sterile saline, and standard layered closure is performed.

RESULTS

In our series of twenty patients, four were in the age group of less than 18-20 years (20%), four in the age group of 21-40 (20%), nine in the age group of 41-60 (45%), three in the age group of greater than 60 (35%).

In our study eight out of twenty (40%) were males and twelve (60%) were females

In our study most of the patient sustained injury to the right side 11 (55%) and involvement of left side is 9 (45%).

In our study 18 cases (90%) were closed fracture and only two cases (10%) were open fracture.

The common type of fracture observed in our series was two part fracture accounting for eight of twenty patients (40%), along with three-part fracture accounting for eight of twenty patients (40%). Four-part fracture accounted

for two of twenty patients (10%).The fracture dislocation was observed in two patient (10%).



Figure 1: Pre-op x-ray: AP view.



Figure 2: Post-op x-ray: AP view.



Figure 3: Follow-up x-ray: AP view.

The most common mode of injury observed in our series was road traffic accident. It accounted for thirteen of twenty patients (65%). The next common cause was history of fall accounting for six of twenty patients (30%) and one patient had an electric shock (5%).

In our study, twenty patients (100%) were treated by open reduction and internal fixation with 3.5 mm proximal humerus internal locking system (PHILOS) plate.

In our study, six patients were treated within six hours after injury, six patients were treated between twelve to twenty four hours after injury and eight patients were treated more than twenty four hours after injury.

The average time taken for clinical union was 8.2 weeks (6 to 10 weeks) and for radiological union 8.4 weeks (6 to 14 weeks).

Table 1: Distribution of age of patients studied.

Age in years	Number of patients	%
18-20	4	20.0
21-40	4	20.0
41-60	9	45.0
>60	3	15.0
Total	20	100.0

Table 2: Distribution of Gender of patients studied

Gender	Number of patients	%
Male	8	40.0
Female	12	60.0
Total	20	100.0

Table 3: Distribution of Age of the injury of patients studied

Age of the injury	Number of patients	%
<=12 hours	6	30.0
12-24 hours	6	30.0
>24 hours	8	48.0
Total	20	100.0

Table 4: Distribution of Complications of patients studied

Complications	Number of patients(n=20)	%
Nil	14	70.0
Present	6	30.0
Post-op Infection	1	5.0
Stiffness	4	20.0
Implant loosening	1	5.0
Malunion	0	0.0
Non union	0	0.0
osteonecrosis	0	0.0

In our study, Constant and Murley score study was done on patient every 3rd week, 6th week, 12th week and finally at 24th week. Study shows that out of twenty patients, all twenty patients (100%) had Constant and Murley score below 70 at 3rd week, seventeen patients

(85%) had score below 70 and three patients (15%) had score in between 70-79 at 6th week, five patients (25%) were below 70, twelve patients (60%) were in between 70-79 and three patients (15%) were in range 80-89 at 12th week. Final Constant and Murley score at 24th week (6 months) showed one patient (5%) below 70 which went for failure outcome, five patients (25%) were in the range of 70-79 showing unsatisfactory outcome, ten patients (50%) were between 80-89 score showing satisfactory outcome and four patients (20%) had score above 90 showing excellent results.

During the follow up period four patients had post-operative stiffness (20%), one patient had post-operative infection (5%), and one patient had implant loosening (5%). There were no incidences of non-union, malunion & osteonecrosis of the proximal humeral head.

At the end of clinical and radiological union and full functional recovery the results were evaluated by Constant-Murley shoulder score. Of the twenty patients, four patients (20%) had excellent results, ten patients (50%) had satisfactory results, five (25%) had unsatisfactory results and one (5%) was a failure.

The mean, median and standard deviation score observed on the final Constant-Murley score of this study after 6 months follow-up of 20 patients under study was 81.6, 81 and 7.69 respectively.

At the end of full functional recovery all patients assessed by Constant and Murley shoulder score had restriction of abduction, forward flexion and external rotation. The average loss of abduction was 54°, forward flexion 46°, external rotation was 28°, internal rotation 31.5°, extension 7°. The average range of movements observed was abduction 126°, forward flexion 180°, extension 45°, external rotation 32°, internal rotation 58.5°.

DISCUSSION

Proximal humeral fractures account for almost 4 to 5% of all fractures. These fractures have a dual age distribution occurring either in young people following high energy trauma or in those older than 50 years with low velocity injuries like simple fall. Most fractures of proximal humerus occur through osteoporotic bones in older patients due to fall onto an outstretched hand. High energy trauma may result in such fractures at any age. Once the fragments separate, muscle forces contribute to their displacement. The shaft is generally drawn anteriorly and medially by the pectoralis major. Greater tuberosity may be pulled posteriorly by infraspinatus. The subscapularis tend to retract medially.⁵

Earlier these fractures were considered simple and were managed by plaster cast technique, slings and slabs. There are many factors which determine the type of management and in turn influence the outcome. They include number of fractured fragments, displacement of

tuberosities, presence of posteromedial spike in the articular fragment, degree of osteoporosis and comminution. Increased number of fragments and dislocation of the articular fragment lead to high incidence of avascular necrosis (AVN) of head of humerus. The presence of posteromedial spike in the articular fragment reduces the chance of avascular necrosis (AVN). Degree of osteoporosis and the extent of soft tissue injury will decide the implant to be used.

Of these the proximal humeral internal locking system (PHILOS) plate is anatomically shaped to accommodate the junction of the humeral head and the shaft. In the area of the humeral head, in addition to the holes for the locking head screws, the plate has small holes in order to fix the rotator cuff with sutures or cerclage wires. The plate sits firmly on the bone due to the converging/diverging screw orientation in the area of the humeral head and the locked screw anchorage.

The PHILOS plate acts as an external fixator, placed internally. The function of screws in the plate is more like that of external fixator pins. The basic advantage of the PHILOS plate is its angular stability. In locking plates the screws are locked to the plate, thus forming a fixed-angle construct. In the conventional plate there is friction caused by compression between the bone and the plate, but in contrast in locking plate, compression between bone and plate is avoided, thereby biological integrity of periosteum is maintained.

Mode of injury

The mode of injury commonly observed in this series was road traffic accidents accounting for 13 (65%), 6 (30%) patients had a history of fall and 1 (5%) had a history of electric shock. Thus showing high velocity injury as the main mechanism. These observations were found to be consistent with the studies in literature^{6,3}, which revealed 19 (45%) road traffic accidents, 20 (50%) history of fall and 01 (5%) history of assault out of the forty cases studied. In another study 12 (75%) had road traffic accident and 04 (25%) had history of fall in a series of 16 cases studied. Comparing this study with the published series, it is found that the emergence of high velocity injury due to Road traffic accidents has changed the complete outlook towards the management of these fractures; this is because of the younger age group involved and early return to pre-injury status is the order of the day.

Type of fracture

The study of type of fracture in this series revealed 08 (40%) were 2 part fractures, 8 (40%) were 3 part fractures and 2 (10%) were a 4 part fracture and 2 (10%) were fracture with dislocation. Neer⁴ study shows, 31 (26.5%) were 2 part fractures, 43 (36.8%) were 3 part fractures and 43 (36.8%) were 4 part fractures. In study done by Dolfi Herscovici, 20 (50%) were 2 part fractures, 16

(40%) were 3 part fractures and 4 (10%) were 4 part fractures indicating that the incidence of type fracture is nearly consistent with the studies in literature.⁶

In two part surgical neck fractures, the head was in the neutral position as both the tuberosities were attached to it, and the shaft was pulled medially due to the pull of the pectoralis major. Traction, with flexion and some adduction was required to reduce the fracture. In the case where reduction was not possible, there was found to be soft tissue interposition which was blocking reduction, on open reduction. Displaced three part fractures were difficult to reduce and still more difficult to hold reduced (unstable fracture), probably because if the greater tuberosity was attached to the head, it was pulled into external rotation with the humeral articular surface facing forward. If lesser tuberosity was attached to it, the articular surface was facing posteriorly. The shaft was pulled medially by the pectoralis major and the long head of biceps was caught between the fracture fragment and prevented reduction. Moreover, since the fracture usually occurred in osteoporotic bone, vigorous manipulation and repeated attempts at reduction could cause further comminution at the fracture site. The similar finding has been found in literature published by various authors. In this study the results were similar, which is consistent with the opinion of other authors in earlier studies.

Approach

The approach meticulously followed in this study series of 20 patients is deltopectoral approach. The same approach has been used in other studies. Deltopectoral approach provides easy access to all the fracture fragments and reduction is done under direct vision.

Hospital stay

The duration of hospital stay seen in a study done by Beucking et al was 10 days for 60 patients in whom deltoid-splitting approach was used, and also 10 days for the rest 60 patients in whom deltopectoral approach was used.⁷ Comparing with this study, the present study of 20 patients were all discharged on 10th postoperative day except for 1 patient who had postoperative superficial infection, following which culture and sensitivity was done and as per the reports, culture-specific IV antibiotics was continued until infection subsided and suture removal was delayed till 17th postoperative day and was discharged. The present study results are comparable to the other study.

Rate of union

In the present study series of 20 patients with proximal humerus fracture, all the fractures (Neer 2-part surgical neck, 3-part, 4-part fractures and fracturedislocation) united by 6 – 14 weeks; average time of radiological union was 8.4 weeks. In one case, where cancellous bone grafting was done. The patient had undergone massage

on the injured shoulder following trauma. Initially closed reduction and K-wire fixation was done. There was gap at the fracture site. The patient was again posted for open reduction and internal fixation using PHILOS plate with cancellous bone grafting. Fracture united radiologically after 14 weeks. The rate of union in the present study is comparable to other standard study series.⁸

Complications

In this series 04 patients (20%) had shoulder stiffness, 01 (5%) had postoperative infection and 01 (5%) went for implant loosening. Compared to other series, we had stiffness in 20% of the patients; most of these patients were elderly who were unwilling to comply with shoulder rehabilitation programme. 5% of our patients had post-operative infection, one of them had superficial infection which responded to systemic antibiotics and infection subsided. In one patient, there was implant loosening, probably due to inadequate fixation and osteoporosis. In patients complicated with stiffness, phase wise physiotherapy was started after clinical union was confirmed. They ended up with satisfactory results. The complications in other series like study done by Neer, 3 had post-operative infection, 4 had malunion, 7 had non-union and 08 had avascular necrosis of the humeral head.^{4,5} In another series of 15 patients 2 had implant loosening and 2 had avascular necrosis of the humeral head.⁶ Out of 20 case series of proximal humeral fractures, this study had 08 two part, 08 three part, 2 four part fractures and 2 fracture dislocation, out of which 18 had closed fractures and 2 had open fractures. 8 patients were males and 12 patients were females. The median age was 45 years ranging from 18-75 years, 13 of the fractures were caused by road traffic accidents, 6 were due to fall and 1 was due to electric shock. 11 patients were with fracture on the right side and 9 on the left side.

Mean constant-murley shoulder score

The mean Constant-Murley shoulder score of this study at the end of the final follow-up period of 6 months is comparable with the mean Constant-Murley score of other standard studies done on the functional outcome of PHILOS plating for proximal humerus fractures.⁹

CONCLUSION

Present study used the plate through open reduction technique (deltopectoral approach). The soft tissue damage is considerably less, since periosteal stripping and soft tissue exposure can be kept to a minimum. Use of locking compression plate through less invasive stabilization system and minimally invasive percutaneous plate osteosyntheses would probably further decrease the amount of soft tissue trauma. Post-operative shoulder stiffness was seen in 20% cases. This maybe in accordance to the fact that early shoulder mobilization was delayed due to noncompliant nature of the elderly patients and failure to adhere to the postoperative

shoulder physiotherapy protocol. Lack of facilities in the rural areas added to the limitation of movements. There was minimal difference in individual fracture type healing and shoulder range of movements.

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Ethical approval: The study was approved by the institutional ethics committee

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