

Original Article Orthopaedics

EVALUATION OF FUNCTIONAL OUTCOME FOLLOWING PHILOS PLATE FIXATION IN PROXIMAL HUMERAL FRACTURES: A PROSPECTIVE STUDY OF 30 CASES

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Article submitted on: 13 April 2016

Article Accepted on: 16 April 2016

Abstract:

Introduction: Proximal humeral fractures account for approximately 5% of all fractures & 45% of all humeral fractures. Proximal humeral fractures requiring surgical stabilization remain a therapeutic challenge particularly in elderly patients with unstable fracture types and diminished bone quality. Techniques for the fixation of two, three, and four part proximal humerus fractures have rapidly shifted towards the use of locking plates. The aim of the present study was to evaluate functional outcome and complication rates after open reduction and internal fixation of displaced proximal humerus fractures by Proximal humerus interlocking osteosynthesis plate.

Material & Methods: The PHILOS plate was used for internal fixation of displaced proximal humeral fractures in 30 patients (24 males, 6 females; mean age 49.8 years). According to the Neer's classification, 17, 9, and 4 patients had displaced 2-, 3-, or 4-part fractures, respectively. All patients received a similar physiotherapy program following internal fixation with the Proximal humerus locking plate. The patients were assessed clinically and radiographically after a mean follow-up of 7 months. Functional outcome were assessed using the Constant & Murley scoring system. Complications during the follow-up period were recorded.

Results: At the end of the followup period, the mean Constant-Murley score was 77.03. The results were excellent in 7 patients (23%), good in

14 patients (47%), moderate in 7 patients (23%), and poor in 2 patients (7%). Eleven complications (36.66%) were seen during the follow-up period. Complications included varus malunion in three patients (10%), avascular necrosis of the humeral head in two patients (6.7%), joint stiffness in two patients (6.7%), screw perforation in two patients (6.7%), subacromial impingement in one patient (3.3%) and infection in one patient (3.3%). Subacromial impingement was mainly caused by the superior plate position.

Conclusion: Fixation of proximal humerus fractures with proximal humerus locking plates is associated with satisfactory functional outcomes in 2-part and 3-part fracture. Advanced surgical skills and surgeons experience are considered to be more critical for successful operative treatment. Our results demonstrate that the PHILOS plate provides satisfactory fracture stabilization in the treatment of proximal humeral fractures of elderly patients.

Key Words: Proximal humerus fracture; PHILOS; Constant & Murley score.

Introduction

Proximal humeral fractures are now recognized as an increasingly common fracture, accounting for 4%- 5% of all fractures and 26% of all humeral fractures.¹ As the life expectancy is increasing, incidence of these fractures is on rise as a consequence of osteoporosis. Some epidemiological studies show that in people more than 60 years of age, fracture of proximal humerus is more frequent than fracture around hip joint.² In elderly patients with poor bone stock, these fractures usually result from low velocity indirect trauma while in younger age group the mechanism is that of high velocity trauma like road traffic accidents.³ Management of these fractures has been controversial. Different surgical methods for reduction and fixation either by closed, minimally invasive or open technique have been used. Bone sutures, circlage wires, smooth and threaded pins, tension band wiring, T plates, angular blade plates, interlocking nails, proximal humeral locking plates (PHLP), proximal humeral interlocking osteosynthesis (PHILOS) plate are the different modalities of fixation of proximal humeral fractures. Each modality of fixation has its own merits and demerits. Complications are associated with each modality but are least with locking plates. Locking plates (PHLP & PHILOS) designed to match proximal humeral anatomy, act as a rigid fixed angle construct for stable fixation of proximal humeral fractures to allow early rehabilitation without risk of screw loosening and failure as seen with conventional plates.⁴ Both PHLP and PHILOS work on same basic principle with difference in number of holes for screw placement.⁵ This study was planned to evaluate the

outcome of proximal humerus fractures managed with PHILOS plate.

Materials & Methods

This was a prospective study conducted in our institute in which 30 consecutive patients with displaced proximal humerus fracture as per Neer's criteria (i.e. angulation of the articular surface of $>45^\circ$ or displacement of >1 cm between the major fracture segments) were treated with the proximal humerus interlocking osteosynthesis plate (PHILOS) from September 2013 to October 2015. All displaced proximal humerus fractures in Adult patients above (>18 years), close or Gustilo grade I and II open fractures were included in the study. Patients with type III open fractures, non-displaced proximal humerus fractures, pathological fractures, associated injuries of ipsilateral upper extremity, fractures with dislocation and fracture more than three week old were excluded.

All routine investigations and preoperative X-rays were done. Classifications of fracture were done using Neer's classification system.⁶ After pre-anaesthetic work up all patients were treated with proximal humerus interlocking osteosynthesis plating through standard delto-pectoral approach.

Surgical technique

Surgery was performed in supine position on a radiolucent table using the universal deltopectoral approach. The cephalic vein was retracted laterally. The greater and lesser tuberosity fragments were tagged with non-absorbable sutures. The tuberosity fragments were reduced to the lateral cortex of the shaft. Reduction of the tuberosities may indirectly reduce the head fragment; alternatively, to restore

the medial calcar of the proximal humerus, an elevator was inserted to disimpact the head fragment. The fracture fragments were reduced and provisionally fixed into position using Kirschner wires. On the anteroposterior view, the plate was ideally placed 8-10 mm distal to the superior tip of the greater tuberosity; from the lateral view, the plate was centred against the lateral aspect of the greater tuberosity. An adequate gap was left between the plate and the biceps tendon to prevent disruption of the anterior humeral circumflex artery or entrapment of the tendon. After achieving the appropriate fracture reduction and plate position, the locking screws were inserted into the humeral head. At least three distal shaft screws were inserted. A final fluoroscopic image was taken to ensure adequate reduction and proper medial support. The wound was closed in layers and suction drain was inserted.

Postoperatively the patients were given shoulder immobilizer. Suture removal was done at two weeks. Active assisted and passive exercises were used during the first two weeks, and 3 weeks later active motion was started. At the 8th postoperative week, daily activities were allowed. The average follow-up period was 7 months (range, 3-18 months). Patients were followed up at 2 weeks at first postoperatively then at 4 weeks, 6 weeks, 8 weeks, & 3 months then every month till maximum possible time. At every follow up, patients were assessed clinically for shoulder stability and range of motion and radiographically checked for the progress of fracture healing. The complications were also documented. Evaluations of results were done on basis of scoring system given by Constant and Murley.⁷ The scoring system comprises four parts:

pain, activities of daily living, range of movement and strength.

The subjective Variables [Maximum Score - 35]

- Pain – maximum score 15
- Limitation of Activities of daily living (sleep, work, recreation / sport). No limitations gets maximum score, 20

The objective Variables [Maximum Score - 65]

- Range of motion – Maximum score 40
- Strength – Maximum Score 25

Total Constant & Murley Score is calculated by adding the scores from subjective and objective variables. Maximum possible total score is 100.

Results

In our study, age of patients varies from 18 to 70 years with mean age of 49.48 years. 16 patients (53%) belong to age group more than 50 years suggesting a strong relation of proximal humerus with age related osteoporosis. Majority of patients sustained injury due to domestic fall (77%) followed by road traffic accident (20%) and other causes (3%). Males were more commonly affected and male to female ratio was 4:1. Seventeen cases involved the right side. 17 patients (57%) had 2-part fractures, 9 patients (30%) had 3-part fractures and 4 patients (13%) had 4-part fractures according to Neer's classification.

Function

All patients were assessed for functional outcome by Constant and Murley scoring system.

Table 2 and table 3 shows Constant scores of the patients at the final follow up visit according to fracture types

and age respectively. The functional outcome was found to be excellent in 7 patients (23%), good in 14 patients (47%), moderate in 7 patient (23%), and poor in 2 patients (7%). The mean Constant score achieved was 77.03

(range, 53-91). We found that patients with Neer's type II fractures had the highest Constant scores while patients with Type IV had the lowest Constant scores. Patients from younger age group showed better response (Table

Table 1:

Functional Outcome according To Constant And Murley Scoring System

Interpretation Of Constant And Murley Scoring System	Number of cases	Percentage of total cases
Excellent (86-100)	7	23%
Good (71-85)	14	47%
Moderate (56-70)	7	23%
Poor (<55)	2	7%

Table 2:

Average Constant Score According To Fracture Type

Fracture type	No of patients	Avg. constant score
Two part	17	77.52
Three part	09	70.7
Four part	04	65.5

Table 3:

Average Constant Score According To Age Group

Age group	No of patients	Avg. constant score
18-30	04	88.5
31-40	05	86.4
41-50	05	79.8
51-60	10	70.5
61-70	06	65.8

Complications

Various complications seen in our study have been shown in table 4. In this study, eleven complications (36.66%) were seen during the follow-up period.

Table 4:
Complications

Complications	No. of Patients	Percentage
Joint stiffness	2	6.7
Primary and secondary screw perforations	2	6.7%
Sub acromial impingement	1	3.3%
Avascular necrosis of humeral head	2	6.7%
Infection	1	3.3%
varus Malunion	3	10%

Figure - 2:
Neer's three part fracture. (A)
Pre-operative AP & LAT (B) Post-
operative. (C) Final follow-up
radiograph.



Clinical Photographs

External rotation Internal rotation



Abduction Forward flexion



showed a higher incidence of proximal humerus fracture in males compared to females. High ratio can be explained by a more involvement of males in day to day activities as compared to female.

In accordance with the majority of studies in western literature that consider low energy falls as a more common cause for proximal humerus fractures, our study had 77% patients with history of fall. Low energy trauma can cause significant injury in elderly patient with osteoporotic bones.

There are different surgical options for the fixation of proximal humeral fractures. Fixation of proximal humeral fractures with plates and screws has been associated with complications such as pullout of screws in osteoporotic bone, subacromial impingement and avascular necrosis of the humeral head. Kristiansen and Christensen⁹ had reported a high incidence of fixation failure following use of T-buttress plates in fixation of proximal humeral fractures.

More recently newer implants such as the Polaris nail and the PHILOS plate have been used for fixation of proximal humeral fractures. In our study we used PHILOS plate in the management of displaced proximal humeral fractures. The PHILOS plate combines the principles of fixation with a conventional plate with those

of locking screws. The benefits of this implant are that it gives enhanced purchase in osteopenic bone, there is no loss of reduction or varus/valgus angulations, the locking screws into the plate provide angular and axial stability of the construct and it is a low-profile plate. We have been able to produce the early results with regard to functional outcome following use of locking plates (PHILOS). Plate can also be used with minimally invasive technique. It permits indirect fracture reduction thus lowering the possibility of Avascular necrosis and by reducing the need of immobilization time helps diminishing the possibility of frozen shoulder.

We achieved a mean Constant Murley score of 76.3. Various studies had reported varying results. Thyagarajan et al.¹⁰ in their study on 30 patients showed an overall average Constant score of 57.5. Kettler *et al.*¹¹ reported a Constant-Murley score between 52 to 72 points after ORIF with the PHILOS plate. Hente *et al.*¹² reached a mean Constant-Murley score of 55 points in these specific fracture types, which was lower than for fractures without dislocation. The Constant-Murley score of different studies are difficult to compare. However, the systematic review by Thanasis et al.¹³ reported an overall Constant score of 74.3

Discussion

Proximal humerus fractures are more common in older age group⁸ because cancellous bone of the humeral neck gets weakened by senility. In our study 53% patients were from 51 to 70 years age group. Numerous age related studies points towards this and our study is consistent with this.

As with earlier studies, our study

Study	Mean Constant & Murley score
P. Moonot et al.(2007) ¹⁴	66.5
Kiliç B et al.(2008) ¹⁵	75.5
Flexi Brunner et al. (2009) ¹⁶	72
D. Lewis et al.(2009) ¹⁷	73.4
Björkenheim et al. (2004) ¹⁸	72
Koukakis et al.(2006) ¹⁹	76
Our Study	76.3

Most of other studies had reported good functional outcomes and recommended the use of locking plates for proximal humerus fractures especially in elderly patients with poor bone quality. This leads us to believe that application of locking plate technology for proximal humerus fractures has a steep learning curve and appropriate surgical technique is very important for achieve good functional outcome.

In our study, the mean Constant score for 4-part fractures was 65.5 which was inferior as compared to 2-part and 3-part fractures (81.8 & 70.7 respectively). Our result was comparable to the one prospective study conducted by Aggarwal et al.²⁰ in which the mean Constant score for 4-part fractures was significantly inferior to other types. These results are expected as these fractures are more complex and open reduction and internal fixation is tougher.

We found difference in outcome between patients of age group less than or more than 50 years of age. Patients less than 50 years of age group showed better response. Similar findings had been reported by Aggarwal et al.²⁰ who found the Constant scores to be higher in younger patients as compared to older patients. Rizwan Shahid et al. (2008)²¹ concluded that PHILOS plate were equally good in all the patients but the functional outcome was better in younger patients.

Post operatively, various complications were observed. A varus malunion was observed in 3 patients (10%) and was found to be the commonest complication in our study. Varus malunion was found in five out of 47 patients in one study.²⁰ We did not observe any valgus malunion in our study. We thus found that a varus malalignment was causing loss of

fixation with poor outcome and must be avoided intra-operatively at any cost. In our study we attempted to achieve correct anatomic reduction of the fragments but still had a high percentage of patients with this complication.

Within our patient population, screw perforation occurred in 2 patients (6.7%). Yang et al.²² found an overall complication rate of 35.9 with a screw cut-out rate of 7.6%. Helwig et al.²³ reported screw penetration of the humeral head in 11 of 87 patients (12.6%) & Thanasis et al.¹³ showed a screw cut-out rate of 11.6% in their review of 791 patients. These previous studies agree that screw perforation of fixed-angle implants has replaced the complications of secondary displacement and implant loosening as the main implant related complication of non-fixed-angle implants.

The locking mechanism was found to give inadequate evaluation of the bone quality and screw fixation. We always checked the correct proximal position of every single screw separately by rotating the arm using an image intensifier. We preferred to put a smaller sized screw whenever the length measured fell between two screw sizes in our patients, the screw size was measured with the help of depth gauge under image intensifier.

Postoperatively, impingement was observed in 1 patient (3.3%). This patient with impingement had severe limitation of overhead abduction initially associated with pain in his operated shoulder. The systematic review of twelve studies by Thanasis et al.¹³ reported an impingement rate of 5.5%. In our study we placed the plate in such a way that, proximal most part of the plate was in line with the tip of the greater tuberosity. Plate was

fix with k-wires through the proximal most hole and check under C-arm throughout the arc of abduction.

Avascular necrosis (AVN) is one of the most dramatic complications requiring re-operation. 2 patients (6.7%) in our study were reported to have developed osteonecrosis of the humeral head and poor results. One patient was of three part fractures and one patient was of four part fractures. As per the published literature, the chances of AVN of the humeral head are directly proportional to the severity of the injury. The risk of osteonecrosis increases if the anterolateral branch of the anterior humeral circumflex artery is damaged. Utmost care should be taken while exposing the biceps tendon in the bicipital groove.

Deep wound infection was seen in 1 patient (3.3%). the infection had settled after formal debridement and specific antibiotics. However superficial wound infection, not requiring a formal debridement, was seen in 1 of our patients. The patient with superficial infection was treated with oral antibiotics & dressing. In our study, we did not encounter any implant breakage consistent with systematic review who reported this complication to be rare with an incidence of 0.7%¹³ We achieved good fracture fixation with no implant failures even in the osteopenic bones.

Conclusion

PHILOS plate provides good fracture stability and allows early mobilization of the shoulder without compromising fracture union. Complications may be related to inappropriate surgical technique or fracture geometry. Adequate surgical skills and surgeons experiences with the surgical technique are necessary to achieve correct implant fixation

and avoid these intraoperative errors. An adequate surgical technique will minimize complications and an aggressive rehabilitation regime will ensure the best possible result. We would recommend the use of the PHILOS plate as a surgical option in the management of displaced proximal humeral fracture

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