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Study on functional outcome of proximal humerus internal locking osteosynthesis system plating for displaced proximal humerus fractures: A prospective and retrospective study

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Abstract

Background: Management of proximal humerus fractures still remains controversial. The goal of proximal humerus fracture fixation is to achieve stable anatomical reduction and to allow early mobilization. There are many methods of fixation of proximal humerus fractures. This study focuses on functional outcome of proximal humeral fractures fixed with Proximal Humeral Internal Locking Osteosynthesis System (PHILOS) plating.

Methods: Fifty-five patients who underwent surgery with PHILOS plate for displaced proximal humerus fractures were analysed. The classification method used was Neer's classification. All patients had a radiographic and clinical follow-up performed at one, three and six weeks, one and six months and at one and two years. The clinical outcomes were measured with the use of the Constant-Murley system.

Results: Out of 55 patients, 10 patients (18%) had excellent functional outcome, 34 patients (62%) had good outcome, 8 patients (15%) had moderate outcome and 3 patients (5%) had poor outcome according to Constant-Murley scoring system. Complications were noted in 10 of 55 patients. The mean Constant-Murley score was 75.27 ± 10.56 . The mean time to bone union was about 12 weeks in 90% of patients. Ten patients developed complications (18.18%) which included 1 avascular necrosis (1.82%), 3 impingements (5.45%), 2 implant failures (3.64%), 2 nonunions (3.64%) and 2 stiffness (3.64%). The mean Constant Murley score for Neer's two-part fracture was 84.83 ± 8.77 , for three part it was 79.91 ± 6.24 and for four part fracture the score was 68.52 ± 10.27 . Mean Constant Murley for patients aged < 60 years was 80.73 ± 7.15 and the score for more than 60 years age was 68.72 ± 10.35 . The correlation between mean Constant Murley score and Neer's 2, 3 and 4 part fractures ($p < 0.001$) and age ($p < 0.0001$) was found to be considered statistically significant.

Conclusion: Proximal humeral locking plate is a good method of osteosynthesis for complex proximal humerus fractures allowing early mobilization, good functional outcome. The PHILOS plate is an ideal construct and a stable implant to use for fractures of the proximal humerus in Neer's 2-part, 3-part, and 4-part and osteoporotic fractures. Proper surgical technique and skills can be incorporated to avoid the complications.

Keywords: philos plating, constant murley scoring system, functional outcome and neer's classification

Introduction

In 1970, Neer's classification expanded on the four-part concept and included anatomic, biomechanical, and treatment principles, providing clinicians with a useful framework to diagnose and treat patients with these fractures [1].

Proximal humerus fractures are a common injury accounting for approximately 5 % of all fractures. It accounts for up to 45% of all humeral fractures. They represent no more than 3% of all upper extremity fractures [2]. Their overall incidence has been reported to be 73 cases per 100,000 individuals per year [3]. Within the last three decades, the age-adjusted incidence of proximal humeral fractures increased by 15% per year. Increased incidence of proximal humeral fractures is associated with more complications [4]. They occur with increasing frequency in elderly patients with a majority occurring in patients over 60; there is a 3:1 female-to-male preponderance in this age group [5].

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About 80% fractures are minimally displaced and are effectively treated symptomatically with immobilization followed by early motion [6]. These fractures challenge the treating orthopaedician because of its osteoporotic quality in the elderly people and the deforming forces of the muscles attached. Different techniques have been described for fixation of comminuted and displaced proximal humeral fractures, including sutures, cerclage wires, K-wires, screws and plates, intramedullary devices and shoulder arthroplasty [7, 8, 9]. Several complications have been reported, such as cut-out or back-out of the screws and plates, non-union, avascular necrosis, nail migration, rotator cuff impairment and impingement syndrome [10].

The Proximal Humerus Internal Locking System (PHILOS) plate has been introduced to reduce these complications especially in older osteoporotic individual. Even minimally displaced fracture can be treated with PHILOS plate to early mobilise the fracture thereby to avoid shoulder stiffness. Highly comminuted 3 & 4-part fractures can be reconstructed with rotator cuff sutural ties with plate and thereby enhance the functional outcome.

Our study enlightens the functional outcome of management of the fracture of humerus involving the proximal part, with PHILOS plate using Constant–Murley Scoring system and the complications encountered with PHILOS plating.

Methodology

This was a Retrospective and Prospective study conducted at Manipal hospital, Bangalore on skeletally mature patients above 20 years of age, who presented with acute (<3 weeks) displaced proximal humerus fractures (Neer's two, three and four part fracture) and underwent Proximal Humeral Interlocking Plating System (PHILOS) procedure during the

period 1st August 2016 to 30th May 2018. Patients with pathologic fractures, open fractures, associated head injury, ipsilateral associated fracture of clavicle and scapula, Polytrauma, severely comminuted fractures not satisfying Neer's criteria, associated pre injury shoulder pathology, neurovascular injury were excluded.

The sample size for the present study, based on formula $n = \frac{4pxq}{d^2}$ with precision (d) of 15%, prevalence of good outcome 77.27% (p) and calculated sample size (n) is 53. However the scope for extension of sample size is kept open.

Sample size estimation:

$$n = \frac{4pxq}{d^2}$$

n = sample size

p= prevalence of good outcome

$$q = 1-p$$

d = precision

X-rays of the shoulder in AP and CT scan of the involved shoulder with 2D and 3D reconstruction images were obtained. The functional outcome was assessed using Constant Murley scoring system.

Post-operative radiological outcome was evaluated by taking serial X rays at follow up at 1,3 and 6 weeks, 6, 9 and 12 months respectively and documenting on quality of reduction, fracture alignment, restoration of articular congruity, fracture union, PHILOS plate deviation, screw penetration, screw backout, implant loosening and failure. Functional outcomes for pain, range of motion and muscle power, and function are assessed using the Constant and Murley scoring system. Patients were followed up at every visit to detect complications like infection, avascular necrosis, subacromial impingement, shoulder stiffness, implant failure, malunion and nonunion.



Fig 1: Pre-operative and post-operative X-rays

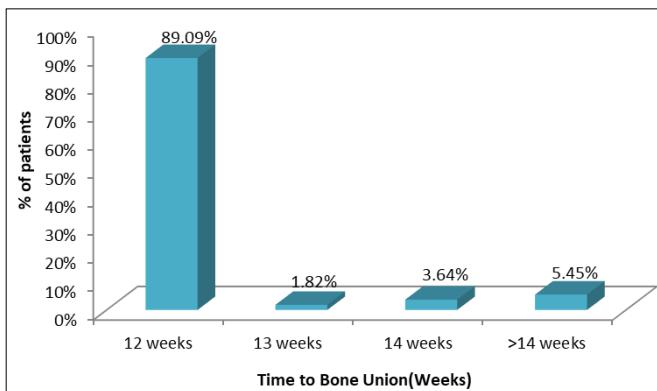
Results

Statistical analysis was done by using descriptive and inferential statistics using chi square test and software used in the analysis were SPSS 22.0 version and Graph Pad Prism 6.0 version and $p<0.05$ is considered as level of significance.

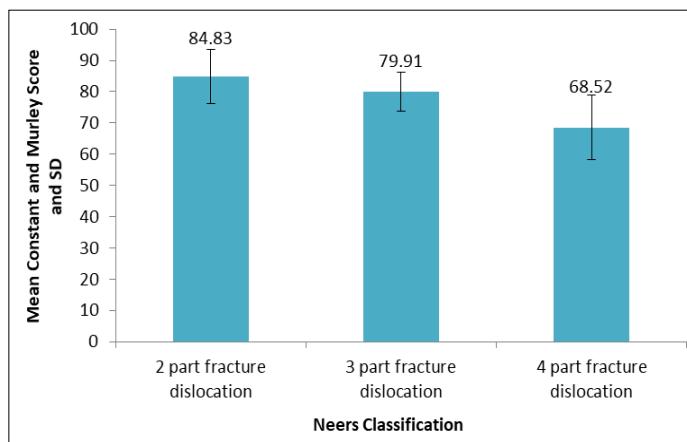
In this study of 55 patients, 40 patients were males (72.73%) and 15 patients (27.27%) were females, out of which, 9 patients (16.36%) were in the age group of 21-30 years, 9 patients (16.36%) were in the age group of 31-40 years, 8 patients (14.55%) were in the age group of 41-50 years, 7 patients (12.73%) were in the age group of 51-60 years, 25 patients (45.45%) were above 61 years of age. The mean age group in years was 53.10 ± 19.28 . The mean age group for males was 48.72 ± 19.07 years and the mean age group for females was 64.80 ± 14.82 . Six patients (10.9%) had two-part Neer's fracture, 24 patients (43.60%) had Neer's three part

fracture and 25 patients (45.50%) had four part Neer's fracture. The average operating time was 59.12 ± 14.05 mins and the mean duration of the hospital stay was 5.09 ± 1.86 days (range 3-11 days).

In 49 patients (89.09%), the time of fracture union was about 12 weeks and in 1 patient the fracture united at 13 weeks (1.82%), the fracture united at about 14 weeks in 2 patients (3.64%). In 3 patients (5.45%) it took more than 14 weeks for fracture union. Mean fracture union time was 12.45 ± 1.57 weeks. Nonunion was observed in 2 patients and avascular necrosis in one patient. Ten patients (18.2%) had excellent functional outcome, 33 patients (60%) had good functional outcome, 9 patients had moderate outcome (16.3%) and 3 patients (5.50%) had poor functional outcome. The mean CM score was 75.27 ± 10.26 .

**Graph 1:** Time to bone union (weeks)

One patient (1.82%) had avascular necrosis, 3 patients (5.45%) had subacromial impingement, 2 patients (3.64%) had non-union, 2 patients (3.64%) had implant failure and 2 patients (3.64%) had shoulder stiffness. No complications

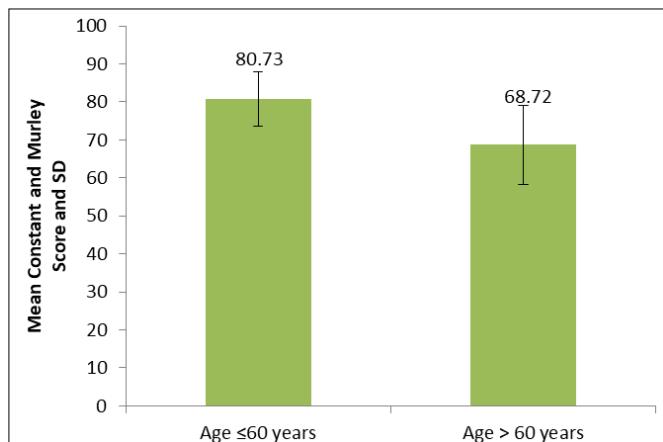


were seen in 45 patients (81.82%). Ten patients (18.18%) had excellent outcome, 33 patients (60%) had good outcome, 9 patients (16.36%) had moderate outcome and 3 patients (5.45%) had poor outcome.

Table 1: Mean constant and Murley Score

Constant and Murley Score	No of patients	Percentage (%)
Poor(<55)	3	5.5
Moderate(56-70)	9	16.4
Good(71-85)	33	60.0
Excellent(86-100)	10	18.2
Total	55	100
Mean ± SD	75.27 ± 10.56(49-94)	

In our study, the mean CM score for Neer's two-part fracture is $84.83 \pm 8.77\%$, for three-part fracture is $79.91 \pm 6.21\%$ and for four-part fracture is 68.52 ± 10.56 . In our study, the Mean CM score for patients aged ≤ 60 years was 80.73 ± 7.15 and for patients aged > 60 years was 68.72 ± 10.35 .

**Graph 2:** (A) Mean CM score for Neer's classification and (B) for age ≤ 60 yrs and > 60 yrs

Discussion

Operative treatment of comminuted and displaced proximal humeral fractures, especially in osteoporotic bone, has been a complex and challenging problem. Different techniques have been described for fixation of comminuted and displaced proximal humeral fractures. Functional outcome not only depends on the quality of bone stock, but also on the stability provided by the implant. In an internal locking system like the PHILOS plate, all forces are transmitted from the bone via the locking head screws to the blade, and vice versa. Hence, the principle of fixed angle plates enables a gain in torsional stiffness and stability and may therefore promote a superior outcome. We could achieve a mean Constant Murley score of 75.27 ± 10.56 in our study. Various studies had reported varying results. David Thyagarajan *et al.* [11] in their study on 30 patients showed an overall average Constant score of 57.5. The mean age in their series was 58 years (range 19-92 years) and fractures were Neer's 2-part, 3-part, and 4-part fractures. Their results show that good fracture stability was achieved, and the functional outcome was very good in younger patients and it declined with increasing age which is similar to the results obtained in our study. In our study the outcome is low in patients aged > 60 years compared to < 60 years.

In a study by Jan Magnus Bjorkenheim [12], they retrospectively reviewed the complications and functional outcome after a minimum follow-up of 1 year in 72 patients treated with this method. Two fractures failed to unite, and 3 patients developed an avascular necrosis of the humeral head.

In addition, 2 implant failures were observed due to a technical error. 4 of the patients had an excellent functional outcome, 32 patients had a good score, 31 patients had moderate score, and 5 patients had a poor outcome according to the Constant Score. The total complication rate was 9.7%. In our study, the complication rate was 18.18% and the mean CS score was better in patients aged < 60 years which was 80.73 ± 7.15 which was better compared to 68.72 ± 10.35 in patients > 60 years. So, outcome in our study was good to excellent in < 60 years and moderate to good in < 60 years whereas the rate of complications is high when 2 implant failures were noted which is like the above study.

In our study, the functional outcome was excellent in 7 out of 10 (70%) patients in age group 21-30 years which is similar to the results obtained by Rizwan Shahid *et al.* [13] who found in their study that the results of PHILOS plating were equally good in all patients but functional outcome was better in younger age group and in males compared to females. These results were comparable to our study. The mean time to bony union was about 8 weeks in 40 out of 41 patients (97.5%), whereas in this study was approximately about 12 weeks 49 out of 55 patients (89.09%) which is comparatively lower with the above study.

In our study, Constant score was poor in three patients and these patients age was more than 65 years. We found difference in outcome between patients of age group less than or more than 60 years of age. Significant difference has been noted Similar findings have been reported by Aggarwal *et al.*

[¹⁴] who found the Constant scores to be higher in younger patients as compared to older patients (>65). In our study mean constant score was 68.72 in age >60 years and 75.27 in age <60 years of age.

The mean Constant score in our study was 75.27 ± 10.56 , which was better than study by Geiger *et al.* [¹⁵], in which Constant-Murley score was 57.9 ± 21 . In the study by Geiger, the results were excellent or good in 16 patients (57.1%), moderate in one patient (3.6%), and poor in 11 patients (39.3%). Eleven complications (39.3%) were seen during the follow-up period. Complications included avascular necrosis of the humeral head in two patients (7.2%), subacromial impingement in six patients (21.4%), loosening of a locking head screw in one patient (3.6%), and transiently decreased radial nerve sensation in two patients (7.2%). The results are better in our study and outcome is better with lesser complications. We had 10 complications out of 55 (18.18%) which included one avascular necrosis in one patient as seen in the above study.

Avascular necrosis (AVN) is one of the most dramatic complications requiring re-operation. One of our patients reported AVN of head till 2 years of follow up. As per the published literature, the chances of AVN of the shoulder 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. In a study by Geiger *et al.* [¹⁵] avascular necrosis was seen in 2 (7.14%) out of 28 patients and in our study avascular necrosis was seen in 1 (1.82%) patient out of 55. In our study the patient did not undergo re-surgery.

There were a few limitations of our study such as, bone mineral density was not considered in the preoperative investigation as the fractures are more common in elderly age group in female population (>60 years), which would affect the functional outcome in the study and bone healing. A large sample size would be required to extrapolate the results onto the general population.

Conclusion

PHILOS plating appears to be good mode of fixation for displaced proximal humeral fractures which allows for early mobility and enhanced functional outcome. The PHILOS plate is an ideal construct and a stable implant to use for fractures of the proximal humerus in Neer's 2-part, 3-part, and 4-part and osteoporotic fractures. It provides good range of movements in elderly patients with osteoporotic fractures which cannot be managed by conservative methods.

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