

A STUDY ON PROXIMAL HUMERAL FRACTURES STABILISED WITH PHILOS PLATEPraveen Sivakumar K¹, Syam Sunder B², Manikumar C. J³¹Assistant Professor, Department of Orthopaedics, Rangaraya Medical College, Kakinada.²Associate Professor, Department of Orthopaedics, A.C. Subba Reddy Government Medical College, Nellore, Andhra Pradesh.³Assistant Professor, Department of Orthopaedics, Rangaraya Medical College, Kakinada.**ABSTRACT****BACKGROUND**

Techniques for treating complex proximal humeral fractures vary and include fixations using tension bands, percutaneous pins, bone suture, T-plates, intramedullary nails, double tubular plates, hemiarthroplasty, plant tan humerus fixator plates, Polaris nails and blade plates. Complications of these techniques include cutout or back out of the screws and plates, avascular necrosis, nonunion, malunion, nail migration, rotator cuff impairment and impingement syndromes. Insufficient anchorage from conventional implants may lead to early loosening and failure, especially in osteoporotic bones. In general, nonoperative treatment of displaced three and four-part fractures of the proximal humerus leads to poor outcome due to intraarticular nature of injury and inherent instability of the fragments. Comminuted fractures of the proximal humerus are at risk of fixation failure, screw loosening and fracture displacement. Open reduction and internal fixation with conventional plate and screws has been associated with unacceptably high incidence of screw pull out. PHILOS (the proximal humeral internal locking system) plate is an internal fixation system that enables angled stabilisation with multiple interlocking screws for fractures of the proximal humerus.

MATERIALS AND METHODS

30 patients with proximal humerus fractures who were admitted in the Department of Orthopaedics, Government General Hospital, Kakinada, during the period November 2014 - November 2016 were taken up for study according to inclusion criteria. All patients were treated with PHILOS plate. These proximal humerus fractures were classified according to Neer's classification. Patients were followed up at 6 weeks, 12 weeks and 6 months' interval. Functional outcomes for pain, range of motion and muscle power and function were assessed using the Constant-Murley scoring system. Collected data analysed with independent t-test and ANNOVA test.

RESULTS

The outcome of the study was 1 case (3.33%) had excellent result, 12 cases (40%) had good results, 12 cases (40%) had moderate results and 5 cases (16.66%) had poor results. Collected data analysed with independent t-test and ANNOVA test. In our study, T-test value was 8.529. Probability (P value) was <0.001, which was significant.

CONCLUSION

The results demonstrate both potential benefits and problems of using the PHILOS plate. We obtained good functional results and bone healing in a vast majority of our patients. There was no statistical difference in the functional outcome between the fracture types at a minimum of 18 months postoperatively. However, we caution all surgeons on the high potential for complications and hence the chances reoperation with its use.

KEYWORDS

Shoulder Fractures C26.404.625, Internal Fixators E07.695.370, Rehabilitation E02.760.169.063.500.

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BACKGROUND

This study was a descriptive, prospective clinical study in which functional outcome of proximal humerus fractures treated surgically with PHILOS plate was assessed. PHILOS

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is an angular stable implant for fixation of complex proximal humeral fractures.^{1,2,3} Precontoured locking plates work on the principle of angular stability, less disruption of vascularity and less chances of plate failure.⁴ Improved fixation by locking plates was attributed to the angular stability of the screws locking in the plate and their three-dimensional distribution in the humeral head. But, their use for the treatment of proximal humerus fractures demands an accurate surgical technique, long learning curve to avoid plate impingement and screw perforation of the articular surface.^{3,4,5} Like with all locking plates, fracture reduction must be achieved prior to plate application, which can be challenging.

AIM AND OBJECTIVES

1. The goal of the study is to assess the efficacy and functional outcome of PHILOS plate in proximal humerus fractures.
2. To evaluate the incidence of complications that may occur with locking plate in proximal humerus fractures.
3. To achieve early mobilisation of shoulder joint to achieve normal function.

MATERIALS AND METHODS

The study was a descriptive and prospective study done at Government General Hospital, Kakinada, involving 30 adult patients aged >18 yrs. with proximal humerus fractures admitted in the Department of Orthopaedics from November 2014 to November 2016. In this study period, 30 cases of fractures of proximal humerus treated surgically by open reduction and internal fixation with PHILOS plate were evaluated. At the arrival of the patient with these fractures, patients were resuscitated depending on their general condition. Fracture was stabilised using U-slab or arm sling pouch. A thorough preoperative assessment of the patients was done, which included the following; general condition of the patient, clinical and radiological assessment of the fracture, type and size of fragments. Routine blood examination for haemoglobin %, total and differential leucocyte count, ESR, blood grouping and echocardiography as and when needed. X-ray of proximal humerus with shoulder joint- AP view, axillary view, lateral view, chest PA view were taken in all patients. CT scan shoulder joint was performed optionally in three cases of grossly comminuted fractures (Neer's four part fractures). All the patients were shifted toward after primary resuscitation. Analgesics and antibiotics were given as needed. Patients were evaluated for associated medical problems and associated injuries and were evaluated and treated simultaneously. All patients were operated on an elective basis. All patients received a dose of 1 g ceftriaxone + sulbactam intravenously preoperatively an hour before surgery.

Anaesthesia

General anaesthesia with or without supraclavicular block was used in all patients.

Surgical Approach and Technique

The operation was done in supine position with small sand bag under shoulder under general anaesthesia. Through deltopectoral approach, the fracture was exposed and reduced with minimal soft tissue dissection. 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 external rotation and flexion of the arm. Reduction was checked under image intensifier. The tendons of the rotator cuff (subscapularis, supraspinatus, infraspinatus) were secured with additional

tension band sutures through the small holes in the plate. Calcar screws were used in all varus displaced fractures, especially if there is medial comminution. Their purchase in the inferomedial humeral head added mechanical stability. Range of motion of shoulder was checked on the table for impingement. Wound was closed under negative suction, which was removed after 48 hours. Suture removal done after 10-12 days. Postoperatively, opioids were administered for analgesia along with antibiotic regimen intravenously for 48 hrs. The suction drain was removed after 24-48 hours. Dressing was changed on second postop day. The patient was usually discharged on the 4th or 5th postop day with oral medication. Patients were followed up after 14 days for suture removal. At 6 weeks, 12 weeks and at 6 months' intervals, all patients were followed for clinical and radiological evaluation.

Rehabilitation

Physiotherapy was initiated in phases-

1. Early rehabilitation- Surgery to 2 weeks.
 - a. Passive accessory movements to the shoulder.
 - b. Active elbow, wrist and finger movements.
 - c. Gravity-assisted pendulum exercises.
2. Intermediate rehabilitation- 2-8 weeks' postop.
 - a. Supervised passive shoulder exercises in supine.
 - b. Functional exercises without causing pain exacerbation.
 - c. Increase passive physiologic movements to full range.
3. Late rehabilitation- 8 weeks or more.
 - a. Active exercise against gravity.
 - b. Isometric strengthening of rotator cuff muscles.
 - c. Encourage functional exercise without sling.

Patients were followed up at 6 weeks, 12 weeks and at 6 months interval for functional assessment, clinical and radiological evaluation. The data collected was subjected to statistical analysis by the biostatistician of our institution.

Statistical Analysis- Functional outcomes for pain, range of motion and muscle power and function are assessed using the Constant-Murley scoring system.

Constant-Murley Scoring System

This scoring system consists of four variables that are used to assess the function of the shoulder. The right and left shoulders were assessed separately. The subjective variables were pain and ADL (sleep, work, recreation/sport), which give a total of 35 points. The objective variables were range of motion and strength, which give a total of 65 points.

Subjective

Pain 15 points, ADL (sleep, work, recreation/sport each unhampered task 5 points) 20 points.

Objective

Range of motion 40 points, strength 25 points.

The higher the score, the higher is the quality of function (minimum 0, maximum 100).

Pain scoring consists of no pain, 15 points; mild, 10 points; moderate, 5 points; severe, 0 points.

Scoring for abduction consists of 151-180, degrees 10 points; 121-150 degrees, 8 points; 91-120 degrees, 6 points; 61-90 degrees, 4 points; 31-60 degrees, 2 points; 0-30 degrees, 0 points.

Scoring for External Rotation (Hand is Not Allowed to Touch the Head)

Scored as full elevation over top of the head (ER5), 10 points; hand on top of head with elbow back (ER4), 8 points; hand behind head with elbow back (ER2), 4 points; hand behind head with elbow forward (ER1), 2 points; not reaching the head (ER0), 0 points.

Scoring for Internal Rotation

Scored as end of thumb to T7 (interscapular region) (IR5), 10 points; end of thumb to T12 (IR4), 8 points; end of thumb to L3 (waist) (IR3), 6 points; end of thumb to lumbosacral junction (IR2), 4 points; end of thumb to buttock (IR1), 2 points; end of thumb to lateral thigh (IR0), 0 points.

Strength- Measured at 90° lateral abduction 1 point per 0.5 kg, maximum 25 points.

Interpreting Constant-Murley Scoring System

Excellent- Score between 86 and 100; Good- Score between 71 and 85; Moderate- Score between 56 and 70; Poor- Score less than 55.

Inclusion Criteria

1. Proximal humerus fractures Neer’s 2 part, 3 part and 4 part.
2. Adults aged >18 yrs. of either sex were included.
3. Patients fit for surgery.

Exclusion Criteria

1. Patients who were <18 yrs. old.
2. Open fractures.
3. Patients medically unfit for surgery.
4. Pathological fractures.
5. Associated humeral shaft fracture.

RESULTS

In our study, maximum age was 74 years and minimum was 24 years with an average age of 46.66 years. 18 male and 12 female patients were studied in our series. In our study, left side was more involved than right in a ratio of 3:2. The mode of injury in our study was trivial fall accounting for 16 cases followed by road traffic accident in 14 cases. The type of fracture according to Neer’s classification showed 43% two-part fractures, 47% three-part fractures and 10% four-part fractures. Eight out of thirty cases developed complications. Out of 8 cases with complications, 5 had stiffness, 1 had superficial wound infection and 2 had avascular necrosis of humeral head. The complications occurred in the present study were also compared with multiple studies (Table 1). Constant-Murley score includes 4 components, i.e. pain, activities of daily living, range of motion and strength. In the current study, 60% of patients experienced no pain, 23% reported mild pain and 17% complained moderate pain. There were no patients with severe pain. Maximum ADL score noted in this study was 16 and minimum was 10 and the average was 13 (Table 2). Majority of the patients (60%) achieved a flexion range of 120-140 degrees. Average flexion was 129.33 degrees (Graph 1). 50% patients gained an abduction range of 100-117.33 degrees with an average abduction of 116.33 degrees (Graph 2). 46.67% patients had an external rotation score of 6. Average external rotation score was 5.96 (Graph 3). 40% patients had an internal rotation score of 4. Average internal rotation score was 4.86 (Graph 4). 26.67% patients gained strength score of range 17 to 19. Average strength score was 16.2 (Graph 5). According to Constant-Murley score, the total minimum score of the present study was 35 and maximum was 89 with an average score of 66.46 (Table 3). The outcome of the study was 1 case (3.33%) had excellent result, 12 cases (40%) had good results, 12 cases (40%) had moderate results and 5 cases (16.66%) had poor results. Collected data was analysed with independent t-test and ANNOVA test. In our study, t-test value was 8.529. Probability (P value) was <0.001, which was significant. The final result were compared with multiple studies (Table 4).

Author	Ramchander Siwach et al	Felix Brunner et al	Sameer Agarwal et al ²	Our Study
Number of cases	25	157	56	30
Infection %	-	1.26	3.5	3.33
Nonunion %	8	2.53	-	
Avascular necrosis %	-	8.22	-	6.66
Impingement %	8	2.53	1.8	
Stiffness %	-	2.53	-	16.7
Screw penetration %	-	13.9	1.8	
Implant loosening%	4	3.16	3.5	

Table 1. Comparison of Complications in Other Study Groups with Our Study

Subjective Score	Excellent and Good	Moderate and Poor	Mean Value
Pain score	13.21	8.75	10.83
ADL score	13.85	12	12.86

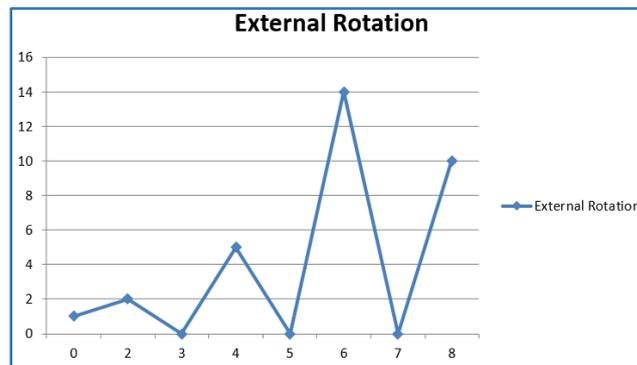
Table 2. Mean Subjective Score

Objective Score	Excellent and Good	Moderate and Poor	Mean Value
Flexion	144	144	128
Abduction	134	101	116
External rotation	7.42	5.25	6.26
Internal rotation	6.28	3.62	4.86
Strength	19	14	16
Constant-Murley score	77.69	57.88	66.46

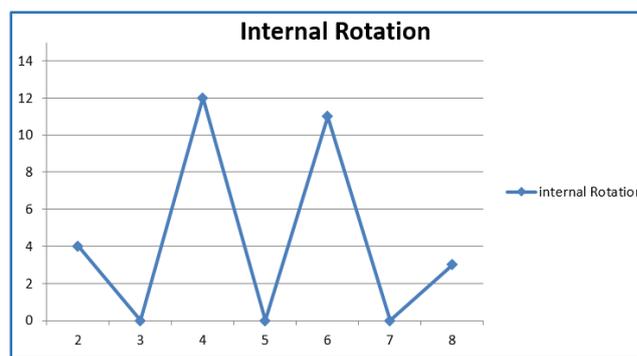
Table 3. Mean Objective Score

Result	Excellent and Good	Moderate	Poor	Mean Constant Score
AA Martiz et al	82%	14%	2%	80
Sameer Agarwal et al	55.5%	34%	10.5%	72.1
Geiger EV, et al	57.1%	3.6%	39.3%	57.9
C Kumar et al	65.8%	19.5%	14.7%	71.7
V Bansal et al	60%	16%	24%	57.4
Our Study 2014-15	43.33%	40%	16.66%	66.46

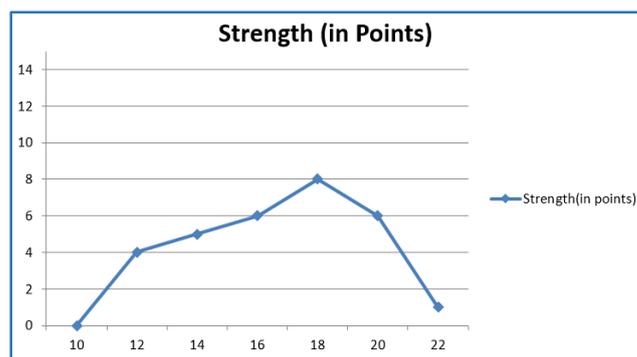
Table 4. Comparison of Final Results



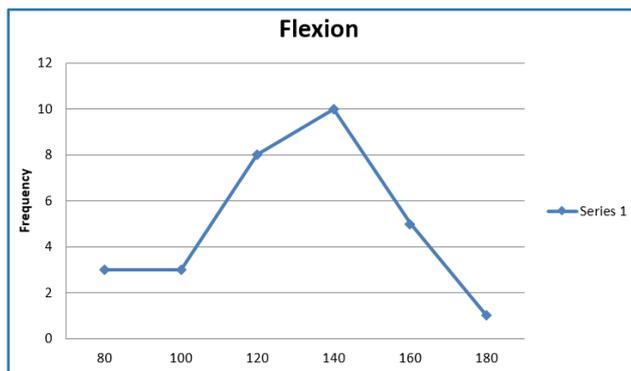
Graph 3. External Rotation (ER)



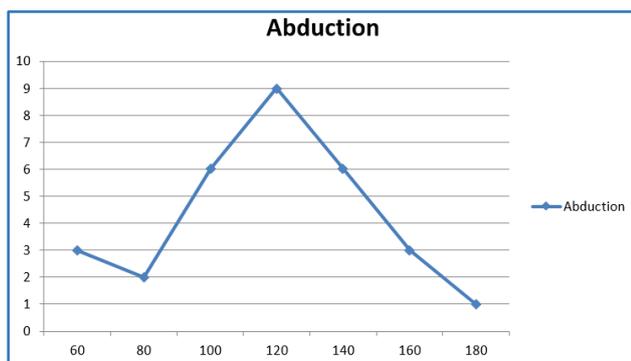
Graph 4. Internal Rotation (IR)



Graph 5. Strength



Graph 1. Range of Flexion



Graph 2. Range of Abduction

DISCUSSION

Defining correct treatment guidelines through analysis of current treatment options is becoming increasingly important as the prevalence of osteoporotic fractures of the proximal humerus are expected to rise in the next three decades and the functional outcome achieved after treatment may determine a patient’s level of independence.⁶ The PHILOS plate was designed to improve screw fixation and minimise soft tissue dissection. It attempts to achieve these aims through a combination of multidirectional locking screws for the head, precontoured plate and locking screws in the shaft. The clinical results to date have been mixed.^{7,8,9} This study evaluated the clinical and radiological results of the PHILOS plate used in 30 patients over a two-year period in a university-based Level 1 trauma center. In our study, 74% (n=30) of the patients

had excellent to good outcome. The overall mean constant score was 77.6%. The functional outcome was better in the 2 or 3 fragment fracture group than in patients with four-part fractures in our series. In our study, the comparison of subcomponents of constant score shows a significant difference between four-part fracture and other two fracture types. Locking anatomical plate fixation offers many advantages compared to non-locking plates.^{10,11} Care must be taken to preserve the soft tissue attachment during open reduction and internal fixation since damage to soft tissues may decrease the vascularity of fracture fragments.^{1,6,7,8,9,10,11,12} In our study, we used the standard deltopectoral approach in all the patients. It is important to place the plate according to anatomy of proximal humerus, determination of screw length with fluoroscopy, insertion of screws to the head in adequate number and position and providing medial cortical continuity prevention of varus¹³ and also to fix tubercle fragments by passing sutures through the plate and rotator cuff bone junction.^{8,14} Egol et al observed only one case of acute infection in their series of 51 patients who mainly had three- and four-part fractures.¹⁵ Gardner et al reported superficial wound dehiscence in one patient and Moonot et al reported one superficial infection that healed with oral antibiotic treatment.^{9,14} Low incidence of infection in our study was attributed to meticulous surgical techniques and the special attention paid to soft tissue preservation. Humeral head screw penetration (0-23%) was noted in various studies.^{16,17,18,19} In our study, there is not even a single such case as we have used intraoperative fluoroscopic monitoring of the drill bit while drilling and also monitored the screw position in two views to avoid articular penetration. In the past, incidences of AVN have been reported in a wide range 4%-75% of cases.^{1,9,15,20,21,22} In our study, we had two cases of humeral head AVN. However, followup was short term. More cases of AVN could potentially arise with longer observation. Hertel and his colleagues evaluated risk factors for humeral head, avascular necrosis following intracapsular proximal humerus fracture. They noted that most important predictor was the length of the dorsomedial metaphyseal extension (<8 mm), the integrity of the medial hinge (defined by greater than 2-mm shaft displacement in any direction) and fracture with an anatomic neck component (types 2, 9, 10, 11 and 12 in their binary description system). When three of these criteria were present, the positive predictive value for ischaemia was 97%. Varus malunion is one of the potential complications following fixation of proximal humeral fractures. It is defined as a head shaft angle of less than 120 degrees. Moonot et al reported the incidence of malunion in three- and four-part proximal humeral fractures.¹⁴ Bjorkenheim et al reported 26.3% of the fractures having two, three and four-part united in slightly varus position after open reduction and internal fixation with locking plate.

Limitations of Our Study

Analysing long-term results not feasible because of limited study period. Because of small sample, size we were not able to comment on few complications and results.

CONCLUSION

Precontoured PHILOS plates work on the principle of angular stability, less disruption of vascularity (more biological) of humeral head, but their use for the treatment of proximal humeral fractures demands an accurate surgical technique with long-learning curve to avoid plate impingement and screw perforation of the articular surface. Also, like with all locking plates, fracture reduction must be achieved prior to plate application, which can be challenging, more so when one is trying to do by minimally-invasive surgical technique or by indirect reduction manoeuvres for fracture reduction. The results demonstrate both potential benefits and problems of using the PHILOS plate. We obtained good functional results and bone healing in a vast majority of our patients. There was no statistical difference in the functional outcome between the fracture types at a minimum of 18 months, postoperatively. However, we caution all surgeons on the high potential for complications and hence the chances reoperation with its use.

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