Management and Outcome Analysis of Proximal Humerus Fractures by PHILOS - A Prospective Study

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ABSTRACT

BACKGROUND

Proximal humerus fractures are one of the commonest fractures of upper limb encountered by trauma surgeons. Their varied geometry and associated comorbidities make them difficult to treat. PHILOS plate has revolutionized management of these fractures. Careful application and adhering to principles can give magical results in these fractures. We wanted to evaluate functional outcomes of proximal humerus fractures using PHILOS Plate.

METHODS

This study was done from July 2018 to January 2020 in a tertiary care trauma center. 58 proximal humerus fractures were operated. The results were evaluated using Constant Murley Score and Visual Analogue Scale.

RESULTS

Majority of patients had an excellent or good outcome on Constant Murley Score. The Visual Analogue Scores were better for two-part and three-part fractures than the four-part fractures for first 18 months after which they were somewhat similar. We also encountered complications in six patients.

CONCLUSIONS

PHILOS can be considered as an excellent modality for managing proximal humerus fractures.

KEY WORDS

Neer Classification, Proximal Humerus Fractures, PHILOS Plate, Proximal Humerus Interlocking Osteosynthesis System, PHILOS

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BACKGROUND

Proximal humerus fracture is considered as one of the common fractures in everyday clinical life. Five percent of all extremity fractures are represented by proximal humerus fractures. Most of these fractures occur as a result of osteoporosis in elderly population whereas younger people are likely to have fracture secondary to high energy trauma. Proximal humerus fractures are often nondisplaced or minimally displaced fractures with two parts, which can be managed conservatively. Displaced fractures with two or more fragments require surgical intervention for good functional results.[1]

Due to increased frequency of road traffic accidents, the proximal humerus fractures are on the rise and also the fracture pattern is becoming more complex. Various muscles are attached to the proximal humerus. There is a limited space available for fixing the implant at the proximal end of humerus in cases of its fracture. This has made the management of proximal humeral fractures mysterious. The treatment comparatively is more challenging for articular fractures. Neer's system of classification comprises of two, three and four-part fractures and those with humeral head dislocations. Conservative management might be allied with complications such as Mal-union, Non-union, avascular necrosis (AVN) resulting in painful dysfunction.

There are various factors that are taken into consideration in treatment of this complicated fracture which includes quality of the bone, degree of comminution and fracture pattern. The other factors which affect the treatment are patient factors such as age, lifestyle and level of activity. Minimum shoulder pain with maximal shoulder range of motion should be the paramount objective.

Surgical interventions include closed reduction and percutaneous pinning (CRPP). It also involves trans-osseous suture fixation, Open Reduction Internal Fixation (ORIF) with either conventional or Proximal Humerus Interlocking Osteosynthesis System (PHILOS) or hemiarthroplasty. Fracture assessment should be done on individual basis. Thirteen to sixteen percent of proximal humerus fractures involve three part and four-part fractures. Treatment of these type of fractures is open reduction and internal fixation as recommended by Neer.[1]

Recent advances in the field of biomechanics and pathophysiology have changed the architecture and mechanics of newer forms of osteosynthesis. The advent of PHILOS has occurred recently. It gives assuring outcome for displaced osteoporotic proximal humerus fractures.[2]

The PHILOS gives an advantage mechanically in improving the stability of the fracture owing to the stable angle construct. It means that the bone to plate interface generates a single beam construct. This implies that there shall be no drive between individual parts following in an increased resistance to pull-out. On the other hand, there shall be a point of contact of the cortical bone that is recreated mechanically. This occurs as a result of locking the screw to the plate when it is deficient. This might be beneficial in poor-quality cancellous bone.[2]

PHILOS has overcome some downsides of conventional plating techniques. Howsoever complications have been testified which include screw-back out, AVN of the head of humerus, impingement due to plate, humeral head collapse, implant failure and infection. Previously it was a thought that blood supply to the head of humerus, the arcuate artery, gets disengaged and thus causes avascular necrosis. But it has been found that a medial metaphyseal extension of the humeral head fragment is adequate to maintain the blood supply.[3]

Good clinical outcomes have been achieved by the PHILOS as they stabilize the proximal humeral fractures with steady fixation in osteoporotic bone and assisted aged patients in early functional exercises which resulted in early recovery.

METHODS

This study was conducted at department of Orthopaedics of tertiary care teaching hospital from July 2018 to January 2020 with 58 patients. Patients were taken for study after obtaining their consent and ethical clearance was obtained from institutional ethical committee. The statistical analysis of data was performed using the computer program, Statistical Package for Social Sciences (SPSS for Windows, version 20.0. Chicago, SPSS Inc.) and Microsoft Excel 2010. The Inclusion Criteria were - Two-part, Three-part, Four-part fracture of the proximal humerus and Adults (>18 years). The exclusion criteria were - Children and adolescent patients, Isolated proximal 1/3rd humerus shaft fractures, Patients medically unfit for surgery, Acute infections, pathological fractures and open fractures.

The Demographic data constituting factors like age, gender and profession of the patient. Mechanism of injury, severity of the injury, classification of the type of fractures by Neer's classification, associated injuries, primary management and time interval between trauma and surgery were recorded (Table 1). Routine preoperative investigations were sent and patients were taken up for surgery as soon as deemed fit. The patients were operated under brachial block or general anaesthesia. Surgical approach was chosen based on fracture pattern and either deltopectoral or deltoid splitting approach was used. The patient was operated in either beach chair or supine position.

Surgical events and surgical difficulties faced, post-surgery local or systemic complications, time needed for fracture union and time taken to return to pre-fracture activity were documented (Table 2). The fracture fragments are reduced and provisionally fixed with Kirschner wires. Heavy sutures (Ethibond No. 2) are placed at the lesser and greater tuberosity. The sutures placed at the lesser tuberosity are pulled laterally to correct the retroversion of humeral head, whereas the sutures placed at the greater tuberosity are pulled in a downward direction to correct any varus deformity.[4] The reduction is confirmed under image intensification. The PHILOS Plate is positioned so as least 5-

8 mm gap is there from the upper end of the greater tuberosity and is 2 mm posterior to the bicipital groove. It was ensured that there was a sufficient gap between the plate and the long head of the biceps tendon. When the fracture reduction and probable screw positioning is deemed adequate, the plate was fixed definitively using angular stable screws in the humeral head, calcar and other screws. The ends of Ethibond were passed through suture holes in the PHILOS plate and were tied with each other. A final check to verify correct screw placement was performed under continuous fluoroscopy.

All the surgical procedures were performed by the same orthopaedic team. Antibiotic prophylaxis with intravenous Cefuroxime, preoperatively and post operatively for 48 hours was given which was later changed to oral for next five days. The patients received a daily dosage of oral Rivaroxaban during the stay. Standard rehabilitation protocols were followed and patients were discharged on fourth post-operative day. Arm slings are given for the first 6 weeks combined with limited mobilization as follows; a) after 2 weeks, pendulum exercises and active range of motion are started, subsequently after another 2 weeks active external rotation is encouraged and initiated under the guidance of a Physiotherapist.

Early passive assisted exercises help to avoid adhesion formation. No limitation of exercises during the pain-free ROM was necessary. Shoulder strengthening and resistance exercises were initiated only after bony consolidation was established on plain roentgenograms.

Antero-Posterior, Axillary and Scapular Y view roentgenograms were taken immediately post-surgery. Regular follow up radiographs were taken six and twelve weeks postoperatively, afterwards again at six and twelve months subsequent the date of surgery.

RESULTS

A total of 58 patients were operated in this study and all were present for follow up throughout the study. They were followed up till there were signs of union on radiographs or for at least a period of one year.

The results were assessed with Constant Murley Score[5] at six months post-surgery and Visual Analogue Scale at six weekly intervals and are tabulated in Table 3 and 4.8 patients, 13.8% of the total study population had hypertension while 6 patients, 10.3% had diabetes mellitus and 4 patients, 6.9% had both hypertension and diabetes mellitus.

The mean Constant score for two-part fractures was 88.1, for Three-part 82.5, for Four-part 72.7. The patients with two-part and three-part fractures had a significantly better VAS than patients with four-part fractures till 18 months of surgery. After 18 months the VAS was somewhat similar for all three groups.

We found that a total of six patients (10.3%) developed complications. 4 patients (6.9%) developed shoulder stiffness out of which two each had glenohumeral joint arthritis and sub acromial impingement. Two patients from four-part fracture group developed Varus angulation which did not proceed and united in same manner. Out of these two patients one patient also developed screw pull-out. The complications are tabulated in Table 5.

	3 Part	4 Part
Number of patients (M:F)	35 (22:13)	23 (15:8)
History of a) RTA	14	17
b) Fall	17	6
c) Shoulder dislocation	4	0
Comorbidities	2	6
Time (Trauma to Surgery) a) 0 to 2 days	29	8
b)2 to 5 days	8	6
c)>5 days	1	6

Table 1. Basic Demography and Patient Information

	3 Part	4 Part
Blood Loss (Mean)	173 ml	220 ml
Duration of Surgery (Mean)	82 min	108 min
Approach- a) Deltopectoral	19	11
b) Triceps splitting	10	7
Reduction difficulties	3	4

Table 2. Intraoperative Data

	3 Part	4 Part
Excellent (86-100)	8	2
Good (71-85)	22	12
Fair (56-70)	5	7
Poor (0-55)	0	2
Mean	81.5	72.2
S.D.	8.84	10.50

Table 3. Constant Murley Score at 6 Months Post-Surgery

	3 Part	4 Part
6 weeks	3.9	5.7
12 weeks	3.5	5.1
18 weeks	2.8	4.4
24 weeks	2.6	2.9
52 weeks	1.4	2.8

Table 4. Visual Analogue Scale (Mean) for Pain during Active Shoulder Movements

	3 Part	4 Part
Infection	0	0
Shoulder Stiffness	1	3
a) Glenohumeral Arthritis	0	2
b) Sub-acromial impingement	1	1
Varus Deformity	0	2
Screw Pullout	0	1

Table 5. Complications

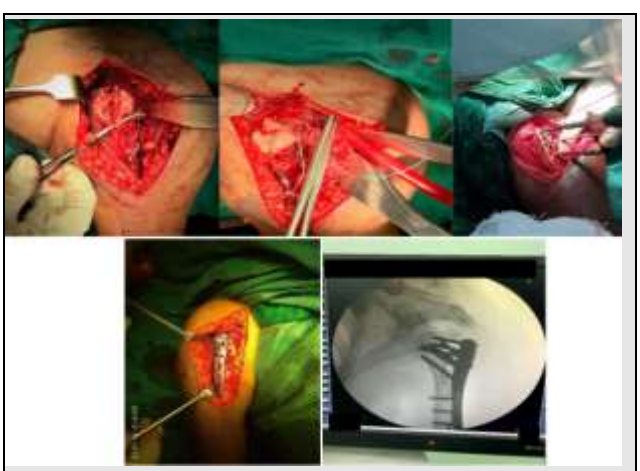

Figure 1. Intraoperative Images Showing PHILOS Plate Placement Using Ethibond to Secure the Comminuted Fragments and Final Fluoroscopic Image

Figure 2. Pre-Operative and 12-Month Post-Operative Anteroposterior Radiographs of a Proximal Humerus Fracture and Clinical Photos Showing Movements 12 Months Post Operatively

Figure 3. A Patient with Sub Acromial Impingement and Limited Range of Motion of the Shoulder Joint

Figure 4. An Anteroposterior Radiograph Showing Varus Deformity

DISCUSSION

Operative management of the comminuted and displaced proximal humerus fractures especially in the osteoporotic bones has remained a complex and thought-provoking problem. There have been different established techniques that stood described for the fixation of these complex fractures. The established techniques have been associated with complications such as screw back out, non-union of fractures, avascular necrosis of the head of humerus, post-operative shoulder stiffness, and shoulder impingement. Thus, the functional outcome not only hangs on the quality of bone stock but also the stability offered by the implant used.

Non-operative methods of treatment for proximal humerus is done only in undisplaced two-part fracture of humerus. Bigorre N et al[6] has observed displaced two-part fractures and comminuted three- or four-part fracture requires a surgical management to rectify the position of the fracture.

Gerber C et al[7] and Misra A et al[8] had observed that the treatment with PHILOS has tremendous potential of success. In the younger age group this technique of treatment is successful because of the good bone quality nonetheless in the elderly group of patients due to osteoporosis unsatisfactory results can be obtained.

In our study there was a male preponderance of 37 patients to the female 21 patients. Male to female ratio 1.76:1. This could be explained by the higher engagement of male patients in day-to-day pursuits than the female patients. This gender linked issue found in the present study was similar to the study of Kumar GN et al[9] in which male to female ratio was 2.19:1.

Kulkarni S et al[10] in a prospective study has described high energy trauma, road traffic accidents in 38 cases 63.33% to be the most common mode of injury followed by low energy trauma, that was fall, in 22 cases 36.67%. The mechanism of injury in our study was road traffic accident in 31 patients (53.4%), fall on outstretched hand in 23 patients, 39.6% and shoulder dislocation in 4 patients (6.9%). P-value is 0.5 so it is not statistically significant. In his study of 60 patients has reported 6.67% (4) patients were 2-part fractures, 73.33% (44) of his patients has suffered a 3-part fractures, 20% (12) had 4-part fractures. In the present study we found 19% patients had 2-part fractures, 50% had 3-part fractures and 31% had 4-part fractures. It was observed in this study that majority of the patients were encountered with 3-part fractures of the proximal humerus that tallies with the study of Kulkarni S et al.[9]

In the present study, the time interval between the trauma to surgery was <2 days in 14 patients, 2-5 days interval was seen in 37 patients and >5 days interval in 7 patients. Mostly it was noted that the trauma to surgery interval was between 2-5 days which is ideal for favourable outcomes.

Kulkarni S et al[10] in a prospective study found that out of 56 patients that were available for follow-up: 24 patients, according to the Constant Murley Score, have Excellent results in which 4 patients are Two part, 20 patients are Three-part fractures. 32 patients having Good results in which 22 are Three part, 10 are Four-part fractures. None of the patients had fair or poor results. Kulkarni S et al[10] found mean Constant Murley Score was 91 for Two-part fractures, 84.5 for Three-part fractures, 76 for Four-part fractures.

In the present study it was found that 15 patients had excellent results, 4 patients of two part, 9 patients of three-part and 2 patients of four-part fracture. Good results were seen in 29 patients, 5 patients with two part, 16 patients with three part and 8 patients with four-part fractures. 12 patients had fair results, 2 patients with two-part, 4 patients with three-part and 6 patients with four-part fractures. Poor result was seen in 2 cases of four-part fracture.

The mean Constant score for two-part fractures was 88.1, for Three-part 82.5, for Four-part 72.7. P-value <0.05

for all types. This gives an inference that the outcome after management by PHILOS is correspondingly good in all type of fractures.

CONCLUSIONS

Fixation of proximal humerus fractures with PHILOS is associated with satisfactory functional outcomes. Based on our observations, improper positioning of the PHILOS lead to reduced functional outcome. Henceforth, to improve the functional results, we consider the plate positioning to be of paramount importance. As the complex four-part fracture dislocations are difficult to achieve anatomical reduction, thorough knowledge of the surgical anatomy of proximal humerus is required and might require CT scan for better visualization of the complex fracture pattern preoperatively. Routine habit of tying the fracture fragments with Ethibond or Vicryl and later passing through the PHILOS holes, dedicated for such manoeuvre makes the comminuted fractures easier to reduce. Post-operative rehabilitation and encouragement for physical therapy also plays role in better functional outcomes.

From the present study, we can conclude that the PHILOS is safe, effective, dependable and delivers stable fixation for the treatment of the proximal humerus fractures generally, and also in patients with indigent bone quality. Number of fractures didn't affect the outcome.

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