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To assess the functional outcome of 3-Part and 4-Part proximal humerus fracture treated by philos

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Abstract
Background: Majority of the fractures of proximal humerus are relatively common injuries in adults and are low-energy osteoporotic fractures. In the current study proximal humerus fracture 3 and 4 part were treated by PHILOS fixation technique depending on the fracture pattern and assessment of the functional outcome was done so as to provide some inference regarding the functional outcome and patient selection.
Material and methods: We received 183 patients with proximal humerus fracture in our institute from December 2019 to December 2020, out of which 23 were 3- part and 13 were 4-part, with predominance to elderly and female. Out of 36 total patients 32 (20 3-part and 12 4-part) were operated by PHILOS.
Results: In 3-part fracture CMS and ASES score at 6 month follow up were 78.5 and 77 respectively and in 4 part fracture functional score at 6 month follow-up CMS-62 and ASES 64.2.
Conclusion: Patient with 3-part fracture showed good recovery and good functional recovery, but guarded by the age and other patient related factor. In 4-part fracture the functional recovery and union are fracture dependent as the patient did not complain of pain and stiffness, but in a demanding patient ROM and joint ability is compromised. This limitation of the management choice in these fracture are highly directed by the status and requirement of patient, it showed good result in 3-part fracture but 4 – part fracture results were not satisfactory.

Keywords: Fracture, proximal humerus, PHILOS, CMS, ASES

Introduction
The proximal humerus consists of the head, anatomical neck and the greater and lesser tuberosities. The intertubercular or bicipital groove is located between the greater and lesser tuberosities along the anterior surface of the humerus [1]. Fractures of the proximal humerus are relatively common injuries in adults, representing 4%-5% of all fractures presenting to the accident emergency department and approximately 5% of fractures of the appendicular skeleton. The vast majority are low-energy osteoporotic fractures with a 2-3 to 1 female to male preponderance [2].
In younger patients, proximal humeral fractures are usually caused by high-energy trauma, such as traffic accidents, sporting accidents, direct assault etc. In elderly patients, the most common cause is a fall onto the outstretched arm from a standing position, which is a type of low-energy trauma [3]. Fracture is mostly isolated in elderly, but may be associated with glenohumeral dislocation, clavicle fracture, shaft humerus fracture, in young patients high energy trauma is more common are associated with multiple fracture, head injury and the associated injury affects the rehabilitation.
Two classification systems are most commonly used. Neer's classification system is based on six groups and four main fracture segments (parts) comprising the head, greater tuberosity, lesser tuberosity and shaft [4]. Displacement is defined as more than 1cm of translation or 45 degrees of angulation of the respective fracture part. The AO/OTA classification employs a combination of letters and numbers to describe different levels and patterns of proximal humerus fractures [5]. Broad range of techniques for management according to various fracture pattern include Conservative, trans-osseous suture fixation, Closed reduction percutaneous fixation, Open reduction and internal fixation with conventional and locked-plate fixation, and Hemiarthoplasty. The goals of operative fixation are to restore the anatomy of the proximal humerus to allow for successful union and maximize function.

The articular surface's relationship to the shaft must be restored to maximize range of motion as well as stability [6].
The main challenge in the operative treatment of displaced and unstable proximal humerus fractures is to achieve effective stabilization of an adequately reduced fracture to maximize the functional patient outcome. Especially in osteoporotic bone and comminuted fractures operative stabilization is challenging and the management of displaced and unstable fractures remains controversial.
In the current study proximal humerus fracture 3 and 4 part were treated by PHILOS fixation technique depending on the fracture pattern and assessment of the functional outcome was done so as to provide some inference regarding the functional outcome, and patient selection.

Material and methods: In this comparative prospective study, we received 183 patient with proximal humerus fracture in our institute from December 2019 to December 2020, out of which 23 were 3- part and 13 were 4-part, with predominance to elderly and female. Out of 36 total patients 32 (20 3-part and 12 4-part) were operated by PHILOS. All skeletally mature patients (16yr above) and closed fractures or grade 1 compound/open fractures (Gustilo-Anderson Classification) were included in the study. Patients with pathological fracture, fracture in children<16 yrs, old fractures associated with AVN, fracture with nerve injury and fracture with associated injuries like (fracture of clavicle and scapula, dislocation of shoulder joint and acromio-clavicular joint etc), rotator cuff injuries were excluded from the study.
Anteroposterior and axillary radiographs were done, fracture classified according to NEER & AO classification, All proximal humerus fractures were admitted and were immobilized in splint/U slab/shoulder immobilizer or arm sling/pouch. The functional assessment was done of patient at 3 month and 6 month follow-up by CMS (constant murley score) and ASES (american shoulder and elbow surgeon score). Appropriate investigations were done. Results were noted and compiled accordingly.

Open reduction and internal fixation: After the pre-operative preparation, placed the C-arm on the opposite side of the table from the surgeon. Deltopectoral approach was taken. Released the anterior portion of the deltoid to expose the fracture site. If necessary, used a threaded pin as a joystick in the posterior humeral head to derotate the head into a reduced position. Sutures placed through the rotator cuff tendon (supraspinatus) to get help for mobilization. For three-part or four-part fractures, placed sutures into the rotator cuff tendons attached to the displaced tuberosity to aid in reduction. Placed the plate onto the greater tuberosity, posterior to the biceps tendon, and provisionally fixed it in place with Kirschner wires; confirmed correct plate position with fluoroscopy. A plate were placed considering, too far proximal placement may cause impingement, and a plate placed too close to the biceps tendon may damage the anterior humeral circumflex artery. Placed two locking screws through the plate holes into the humeral head segment and one or two screws into the shaft. Confirmed subchondral placement of the proximal screws and the quality of the reduction with fluoroscopy. When accurate reduction was confirmed, remaining screws under direct fluoroscopic guidance were placed. For fractures with medial comminution, fixed the plate to the proximal segment with screws and reduce the shaft segment to the plate. This helped avoiding varus malposition which is associated with higher failure rates. Screw fixation into the inferomedial humeral head also adds stability for fractures with medial comminution. In three-part or four-part fractures, sutures inserted into the supraspinatus and subscapularis tendons aided in controlling the fracture fragments. Reduced the tuberosities to the articular surface and to each other with pins or sutures or both. Observation or palpation through the rotator interval aided in reduction of the lesser tuberosity to the humeral head. Fixed the plate in the same manner as for a two-part fracture. Rotator cuff sutures can be incorporated into the plate for added stability. Confirm reduction and screw placement on Anteroposterior and lateral fluoroscopy images. The wound was closed in layers ans sterile dressing was done

Fig 1: Pre-op X-Ray

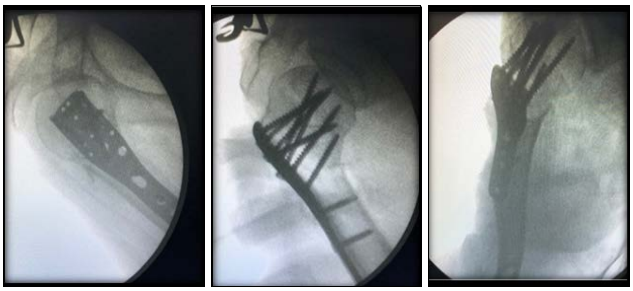


Fig 2: Intra-operative xray

Fig 3: Immediate post-operative x-ray

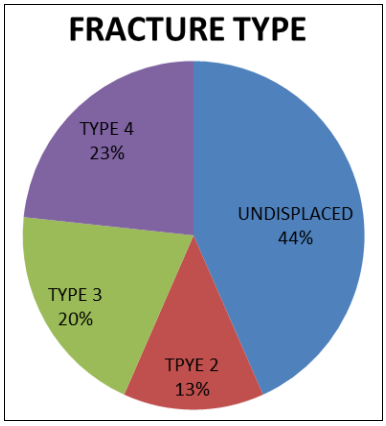
Rehabilitation in cases of OR & IF with 3-part/ 4-part fractures was done in three defined phases and patients were followed up after two weeks, six weeks, three month and 6 months. On each subsequent visit, clinical and radiological examination was done. Functional outcome was assessed at the 3rd month and final follow up 6th month on the basis of Constant –Murley Score and American Shoulder and Elbow Surgeon Score.

Statistical analysis

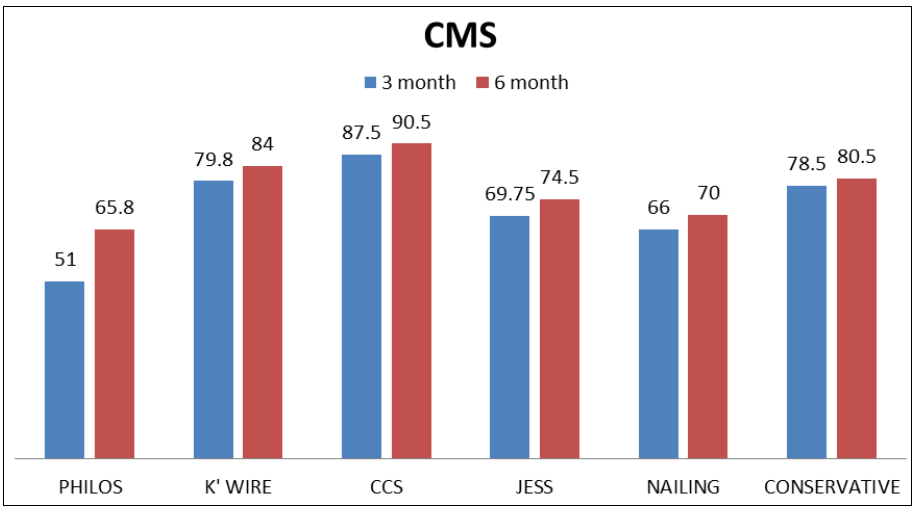
Data entry was made in MS Office Excel software in codes and analysis was done by SPSS software® version 18.0. Descriptive statistical analysis, which included frequency, percentages, mean and standard deviation was used to characterize the data. Student's unpaired t-test, Mann Whitney U test and chi square test was applied to check association and differences.

Results

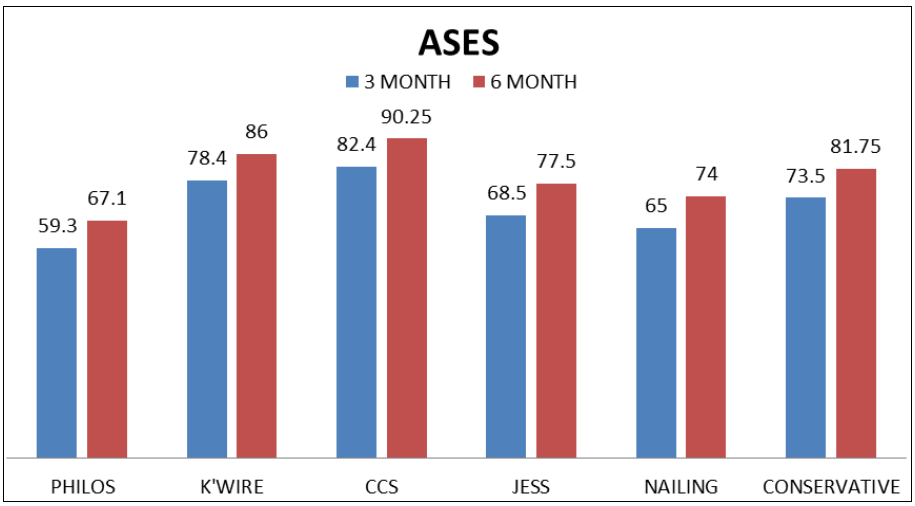
It was found that the males (56.7%) are more prone to suffer from the proximal humerus fracture as compared to the female (43.3%), suggesting their work environment and activites makes them more likely of getting it. 10%, 20%, 23.33%, 26.67% and 20% of the subjects were having age of <30, 30-39, 40-49, 50-59 and >60 years respectively. "K" wire fixation done in 26.7% patients (16.65% female and 9.9% male), nailing done in 3.3% patient (male), PHILOS in 30% patients (13.32% female and 16.65% male), jess in 13.3% patients (3.32% female and 9.96% male), conservative in 13.3% (6.65% female and 6.65% male), Cannulated cancellous screw in 13.4% (3.35% female and 10.05% male). Most common type of fracture is undisplaced type fracture (43.33%) followed by type 4 (23.34%) and 3 (20%) respectively in the study (graph 1).



Graph 1: Fracture type



Graph 2: Constant Murley Score (CMS) with all type of fracture treated follow-up



Graph 3: American Shoulder and Elbow Score (ASES) with all type of fracture treated follow-up

At 6 month follow-up stiffness was seen in 7 patients in which 3 were from PHILOS group, 2 each from JESS and K wire fixation. Post-op infection was seen in one patient of PHILOS on the 2nd day, malunion was present in 1 patient of JESS group (table 1).

Table 1: Complications among the study subjects according to technique

Technique	Stiffness	Postop-Infection	Malunion	Implant failure
PHILOS	3	1	-	1
JESS	2	-	1	-
K Wire Fixation	2	-	-	-
Conservative	-	-	-	-
Nailing	-	-	-	-
Cannulated Cancellous Screw	-	-	-	-

Discussion

Proximal humerus fracture accounts for 5-6 % of the total fracture reported in the casualty department and due to increase in the risk factors in the era the percentage is towards the increasing trend, thus the proper management of the same is necessary to enable the patient with the best functional capacity possible. The study was conducted to find the suitable technique for the management of the proximal humerus fracture with respect to various factors, which will enable to give the appropriate approach.

The mean age in the study was 46.6 yr which is in the adult group which is comparable to various studies. Vijayvargiya *et al*. [7] conducted a study from 2011-2013 in which mean age of the patients were 46yr, Zhu *et al*. 2011 [8] found mean age for 50.5 yrs in 51 patients with the follow up of 3 yrs. The increasing trend in age of the patients with proximal humerus fracture as the most common age group seen was 50-59 yrs with 8 pt followed by 7 pt in 60 yrs and 6 pt in 40-49 yrs age, which indicates the higher incidence of the fracture in the older age groups.

There were 17 males and 13 females in the study ratio (1.3:1 M:F), there were similar findings in the other studies, Vijayvargiya *et al*. [7] conducted a study from 2011-2013 in which M:F was 1.36:1. Though most of the studies showed higher incidence in the females, as the data size is small the study the result varies.

In the present study the undisplaced fracture pattern was the most common type 43.3%, followed by type 4 (23.3%), type 3(20%) and type 2 (13.4%) respectively. which is comparable to study published by Adam Shumaier (2018) [9] which states that 50% to 65% of all proximal humerus fractures are minimally displaced fractures of the greater, tuberosity and/or surgical neck, Approximately 20% to 30% of proximal humerus fractures are 2-part surgical neck fractures, Three- and four-part fractures account for 21% to 23% of proximal humerus fractures. A. Roux *et al*. (2012) [10] evaluated 368 fracture in the emergency department for a period of 1 yr and published that Forty-two percent of the fractures were NEER type 1; these are considered to be slightly or not displaced. Fifty-nine percent of the fractures were displaced (type 2, 3, 4).

In the present study the different fracture management techniques are evaluated according to their union time “K” wire fixation is done in 8 patients (5 undisplaced, 1 type 2 and 2 type 3) it has a mean l union of 7.5 wk. Barkat *et al*. [11] conducted a study on 18 patients with followup of 14 m concluded that The average time of healing was seven weeks, Nishikant Kumar *et al*. (2013) [12] conducted a prospective study for 3 yr and concluded that the average time of healing was 7 weeks in fracture fixed by percutaneous pins. Satish *et al*. [13] published a study in 2016 evaluating 25 patients for followup of 6 m Mean duration for union was 6.5 (±1.18) weeks.

JESS is used in 4 patients 3 in type 3 and 1 in type2 fracture in the present study it shows mean union time at 9 wk (6 week in 2-part and 10 week in 3 part), which is comparable to findings of Nikose *et al*. (2016) [14] published astudy after 14 mnth of follow-up that the time to radiological union took almost 12 (range 9-14) weeks. Om P Gupta *et al*. (2016) [15] conducted a study of 18 patients for 18 month follow-up concluded that. All fractures united in mean duration of 9.33 weeks.

PHILOS (plate fixation) was done in 9 patient 7 of type 4 fracture and 2 of type 2 fracture, the mean union time is 12.66 wk which is comparable to findings of Parmaksizoğlu *et al*. (2010) [16] conducted a study on 32 patient with follow-up 12-36 m stated that All fractures united in a mean of 12 wk (range 8 to 20 wk).

Cannulated cancellous screw percutaneous fixation was done in 4 patient all undisplaced types Having a mean union of 9wk, which is comparable to Chen *et al*. 1998 [17] conducted a study on 19 patients undergone percutaneous ccs fixation in proximal humerus fracture, for afollow-up of 21 months mean concluded observed radiographic union at 8 to 12 weeks postoperatively.

In the present study Nailing was done in 1 case and the mean union time is 12 wk, the study have comparable findings to study by Hao *et al*. (2017) [18] conducted a study on 22 patients of proximal humerus fracture with nailing and follow-up for 12 months concluded that Radiographic fracture union was achieved at a mean of 12 wk post-op.

In the present study 2-part fracture (4 cases) were treated by PHILOS, “K” wire fixation and JESS and the mean radiological union time was found to be PHILOS- 6 week, ‘K’ wire- 6 week, JESS-6 week, all the union times were similar. 3-part fracture (6 caes) were treated by JESS, “K” wire and conservative and the mean radiological union time was found to be ‘K’ wire- 9 week, JESS -10 week conservative-12 week. 4-part fracture (9 cases) were treated by PHILOS and “K” wire and the mean radiological union time was found to be PHILOS- 14.56, “K” wire- 6 week.

Mean CMS at 6 month of present study in all fracture types treated by the PHILOS was 65.8 which was comparable to study published by Solberg *et al*. in 2009 [19] who found it to be 63 and study published by Schleiman B *et al*. [20] in 2015 who found it to be 71.3 Mean ASES score at 6 month in PHILOS was found to be 67.1 in the present study which was comparable to study published by Hardeman *et al*. [21] who published a study in 2011 found it to be 75.3. Mean ASES score at 6 month in “K” wire was found to be 86 in the present study which was comparable to study published by Jiang CY *et al*. [22] in 2004 who found it to be 91.4.

Mean CMS score at 6 month of present study in all fracture types treated by the percutaneous fixation by Cannulated Cancellous Screw (CCS) was 90.5. Mean ASES score at 6 month in CCS was found to be 90.25 in the present study which was comparable to study published by Leslie Fink Barnes *et al*. [23] in 2015 who found it to be 82.

Mean CMS at 6 month of present study in all fracture types treated by the Joshi External Stabilizing System (JESS) was 74.5 which was comparable to study published by Om P Gupta *et al*. [15] in (2016) who found it to be 72. Mean ASES score at 6 month in JESS was found to be 77.5 in the present

study. Mean CMS at 6 month of present study in all fracture types treated by the Proximal Humeral Nail (PHN) was 70 which was comparable to study published by Hao *et al.* [18] in 2017 who found it to be 75.1 and study published by Jason Wong *et al.* [24] in 2016 who found it to be 72.8

Mean ASES score at 6 month in PHN was found to be 74 in the present study which was comparable to study published by Hao *et al.* [18] in 2017 who found it to be 81.7 and Jason Wong *et al.* [24] who published a study in 2011 found it to be 84.3.

Mean CMS at 6 month of present study in all fracture types treated by the Conservative technique was 80.5 which was comparable to study published by R Nanda *et al.* [25] in 2018 who found it to be 74.2 and study published by Clement *et al.* [26] in 2015 who found it to be 68.8. Mean ASES score at 6 month in Conservative was found to be 81.75 in the present study.

Of all the 30 cases there has been, 1(3.3%) case of implant failure in the plate fixation (PHILOS) with account to the plate fixation its 1/9 (11.1%) cases of PHILOS. The incidence of implant related complications are associated with the increase in fracture complexity, poor bone quality and improper fixation. Similar failure rates have been found in different studies Roderer *et al.* [1] (2011) found that implant-related complications occurred in 9 of 54 patients (17 %) with unstable proximal humeral fractures using the locking plate. Hardeman *et al.* [21] (2012) reported an average failure rate of 15.3% evaluated from 368 cases from the mean interval of 4.3 yr.

The only limitation in the present study was the small sample size. Thus larger randomized controlled trials should be carried out in the future to overcome this limitation.

Conclusion

In our study of 30 patient majority were elderly of more than 40 yrs and males were more commonly affected. Undisplaced type fracture were most common followed by 4-part and 2-part least. 2- part fracture having the similar union time with all technique used but the best functional outcome was seen with “K” wire fixation. 3-part fracture “K” wire fixation gave the earliest union time with best functional outcome. 4-part fracture were only treated by PHILOS and the radiological union and functional outcome is satisfactory in low functional age group and good in young. Stiffness was the most common complication seen. PHILOS is more prone for the fracture complication as implant failure and post-operative infection. Malunion was reported in JESS. Rehabilitation is essential for the good functional results

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