



COMPARATIVE EVALUATION OF FUNCTIONAL OUTCOME OF OPEN REDUCTION AND INTERNAL FIXATION WITH PHILOS AND CLOSED REDUCTION AND PERCUTANEOUS FIXATION WITH K-WIRES IN PROXIMAL HUMERAL FRACTURES

Orthopaedics

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ABSTRACT

Background: Fracture of the proximal humerus represents the second most common (29.1%) fracture type in the upper extremity after Colle's fracture (37.2%) of the wrist. Significant controversy continues regarding the best modality for treating displaced proximal humerus fractures. The objective of our study is to comparatively evaluate the functional outcome of ORIF with Proximal Humerus Internal Locking System (PHILOS) and Close Reduction and Percutaneous Fixation with K-wires in proximal humerus fractures.

Method: A prospective study was conducted after getting ethical approval at N.S.C.B. Medical College & Hospital, Jabalpur, (M.P.) upon 50 cases admitted with proximal humerus fractures as per inclusion criteria. 25 cases were treated with PHILOS plate in group A and 25 patients were treated with Closed Reduction and Percutaneous Fixation with K-wires in group B. Post op follow up was done at 6 weeks and 12 weeks and functional outcome evaluated by Neer's scoring criteria.

Results: Out of 50 cases, excellent scores was obtained in 22 (88%) cases treated with PHILOS in group A, and 18 (72%) cases treated with k-wire fixation in group B, satisfactory score was obtained in 3 (12%) in Group A and 6 (24%) in Group B.

Conclusion: We obtained excellent results in both groups with each procedure having its own advantage and disadvantages. We found that PHILOS provides secure fixation with better functional outcome in terms of range of motion. Fixation with Percutaneous K-wires is also efficient treatment option with intraoperative advantage in terms of invasiveness, blood loss and time taken for surgery with least tissue dissection than PHILOS plating.

KEYWORDS

proximal humerus fracture, Neer's score, PHILOS plate and K wires.

INTRODUCTION

Fracture of the proximal humerus represents the second most common (29.1%) fracture type in the upper extremity, after Colles' fracture (37.2%) of the wrist¹. It constitutes 4-5% of all fractures in the whole body. The incidence of proximal humerus fracture in the older population is related to osteoporosis following low energy injury with the incidence of three times more often in women than in men². A younger patient typically presents with proximal humerus fracture following high energy trauma such as a motor vehicle accident. The choice of treatment depends on the pattern of the fracture, the quality of the bone encountered, the patient's requirement, and the surgeon's familiarity with the procedures. The age of the patient, physical activity, and medical fitness also largely influence the treatment options.

Significant controversy continues regarding the best methods of treating displaced proximal humerus fractures. Over the last 3 decades, various modalities of fixations have evolved for the proximal humerus fractures (trans-osseous suturing, percutaneous pinning, tension band wiring, plating, rush nailing, arthroplasty). Among various treatment options available, one is closed reduction and percutaneous K-wire fixation³ and advantage of this technique is its minimal invasivity, less blood loss, less exposure, and soft tissue stripping and usefulness in older patients^{4,5}. Early immobilization had a significant detrimental effect on the mechanical properties of the native tendon. However, four weeks of immobilization led to a significant loss of strength of the bone-tendon complex in the native tendon^{6,7}. Open reduction and internal fixation (ORIF) with plating is another method to achieve anatomical, stable, and secure reduction with immediate mobilization. The proximal humerus interlocking system (PHILOS) is anatomically contoured and the threaded screw heads are locked into the threaded plate holes to prevent screw toggle, slide, and pull out, and give angular stability. These plates have a low profile and hence the danger of postoperative soft tissue impingement syndrome is very less.

The purpose of our study is to analyse the functional outcome between Open Reduction and Internal Fixation with PHILOS and Closed

Reduction and Percutaneous Fixation with K-wires for closed fracture Proximal Humerus fracture.

MATERIALS AND METHODS

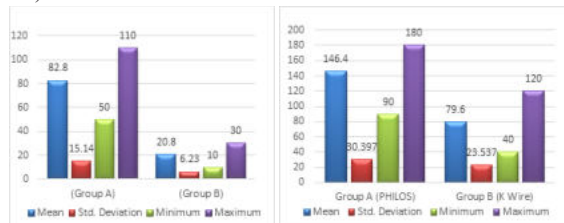
In our prospective study, 50 patients of age more than 18 years with displaced Proximal Humerus fracture (2, 3 & 4 part fractures with displacement of 1 cm or 45-degree angulation) who were admitted in the Department of Orthopaedics, from 1st January 2019 to 31st August 2020 were included. Patients with fracture extending to shaft of Humerus, undisplaced fractures, fractures involving the articular surface, pathological fractures, associated nerve injury and fracture dislocation were excluded. Informed consent and ethical committee clearance was obtained before starting the study. Since it was a time-bound study, total 50 patients were operated for fracture of the proximal humerus. Consecutive Randomized sampling was adopted for dividing patients into two groups. The first patient is selected for group A (ODD), operated on with PHILOS and the second patient for Group B (EVEN), operated by K-wire fixation. We analyse our results using Neer's scoring system and followed up the patients at 6 and 12 weeks.

RESULTS

25 patients were operated for PHILOS & K-wire fixation each. The mean age in our study was 43 years, with the youngest patient of 19 years and the oldest of 67 years. The mean age was 42.68 years in Group A and 43.16 in Group B. Out of 50 patients, 35 (70%) were males and 15 (30%) were females. Significant male preponderance was observed, accounting to 72 % in Group A with M:F ratio 2.5:1, and 68 % in Group B with M:F ratio 2.1:1. This may be due to more exposure of male patient to road traffic accident. Road traffic accident was the most common mode of injury with 32 patients (64%) followed by fall on the ground 16 patients (32%), 2 patients (4%) were slipped in the bathroom.

Out of 50 patients, 4 patients with Neer's 2-part fractures were treated with PHILOS and 8 with K-wire, 16 patients each with 3-part fractures were treated with PHILOS and K-wire, 5 with 4-part were treated with

PHILOS and one with K-wire. The average blood loss was 82.8 ml in Group A and 20.8 ml in Group B (Graph no.1). The mean operative time was 146.4 minutes in Group A and 79.6 min in Group B (Graph no.2).



Graph no.1 Blood loss

Graph no.2 Duration of surgery

The mean Neer's Score^{8,9} for pain was 34.80 in group A compared to 33.80 in group B, which was statistically significant. The mean Neer's Score function in group A was 26.8 compared to 25.44 in group B. The mean Neer's Score anatomy in group A was 9.76 compared to 9.28 in group B. Anatomy of head and their relationship with shaft of humerus and glenoid is better results in PHILOS plating compared to K-wire group which is statistically significant. The mean Neer's score radiological union in group A was 12.44 compared to 12.84 in group B, which is statistically insignificant (Table No.1).

Table No.1 Neer's Score and their component

Neer's Score		No	Minimum	Maximum	Mean ± SD	P-value	Significance
Pain	Group A (PHILOS)	25	30	35	34.80±1.00	0.001	HS
	Group B (K Wire)	25	25	35	33.80±2.61		

Table No. 2 Mean Neer's Score

Age Distribution	Total	Group A (PHILOS)				Group B (K-Wire)			
		2-part	3-part	4-part	Mean Neer's Score	2-part	3-part	4-part	Mean Neer's Score
18-30 yrs	9	0	4 (90.7)	0	4 (90.7)	3 (92.3)	2 (89)	0	5 (90.6)
31-45 yrs	20	2 (93)	6 (91)	3 (90.3)	11 (91.1)	4 (92)	5 (89.2)	0	9 (90.8)
46-60 yrs	15	2 (87)	5 (90.8)	1 (90)	8 (89.7)	1 (90)	6 (88)	0	7 (88.5)
61-75 yrs	6	0	1 (88)	1 (89)	2 (88.5)	0	3 (87.3)	1 (79)	4 (83.1)

Functional outcome in terms of range of movement (in all planes) was better and statistically significant in patient treated with PHILOS as compared to K-wire at 6 weeks. Also early mobilization was found to be more feasible with PHILOS plating. At 12 weeks functional outcome in terms of range of movement was better and statistically significant in patient treated with PHILOS as compared to K-wire. (Figure No. 1 & 2)



Figure No.1 Pre-op and Post-op X-ray of 35 yr old male operated with PHILOS plate for Neer's 3-part fracture of Proximal Humerus and their Follow-up at 6 and 12 weeks.



Function	Group A (PHILOS)	25	22	30	26.08±1.47	0.079	NS
	Group B (K Wire)	25	18	30	25.44±2.48		
Anatomy	Group A (PHILOS)	25	08	10	9.76±.663	0.001	HS
	Group B (K Wire)	25	06	10	9.28±1.137		
Radio-Union	Group A (PHILOS)	25	12	16	12.44±.1.22	0.106	NS
	Group B (K Wire)	25	12	18	12.84±1.15		

Out of the 50 patients, excellent scores achieved in 22 (88%) in group A, and 18 (72%) patients in group B. 3 (12%) had satisfactory score in Group A and 6 (24%) in Group B. One patient had unsatisfactory score in Group B. Both the procedure gave equivocal results at 12 weeks follow-up, with statistically insignificant difference (p value=0.137). The mean Neer's score for the younger age group (18-30) was 90.7 in Group A compared to 90.6 in Group B, for the middle age group (31-45) was 91.1 in group A compared to 90.8 in group B, for the old age group (46-60) was 89.7 in group A compared to 88.5 in Group B and for older age group (>60) was 88.5 in group A compared to 83.1 in group B. PHILOS plating was found to be more effective and statistically significant as compared to K-wire in older age group (> 46 yrs). The mean Neer's score for Neer's 2-part fracture was 91.25 in Group A in comparison to 91.12 in Group B, for Neer's 3-parts fracture was 89.62 in Group A compared to 86.37 in Group B, and for Neer's 4-parts fracture was 90.00 compared to 61 in Group B. PHILOS plating was found to be more effective with advancement of fracture comminution (Table No. 2).

Figure No.2 Pre-op and Post-op X-ray of 28 yr old male operated with Percutaneous K-wire fixation for Neer's 2-part Proximal Humerus Fracture and their follow up at 6 and 12 weeks.

Complication

In our study, 6 complications were seen in group A (PHILOS), two patients had subacromial impingement, which caused restricted range of movement despite of all phases of physiotherapy. Screw backout, screw perforation, delayed union, and secondary varus displacement was encountered in one patient each. 10 complications were seen in group B (K-wire), 3 patients had shoulder stiffness followed by 2 patients each of delayed union and secondary varus displacement and one patient each of avascular necrosis and superficial infection.

Most of the complications that we came across in our study were related to the technique. The precise surgical technique, stable fracture fixation, and restoration of the correct neck-shaft angle are necessary for improved outcomes. Meticulous preoperative surgical planning is a must. Minimal dissection, proper placement of plate, judicious use of aiming block with K-wire sleeves to judge the correct placement and order of locking and non-locking screws under image intensifier play especially important role. Incorporation of sutures through the rotator cuff into the plate is a critical step and should not be skipped, because it allows the deforming forces of the rotator cuff to be counterbalanced and neutralized.

DISCUSSION

Displaced proximal humerus fracture continues to be a challenge to the Orthopaedic surgeon. These fractures have been treated with wide range of options, like Conservative, Percutaneous screw and/ or K-wire fixation, external fixation, and internal fixation with wide range of available implants. Each modality of treatment has its own advantages and disadvantages. Choice of treatment depends on many factors including age, functional demand of the patient, associated comorbidities, and surgical expertise. However, in the present scenario, in order to return back to activities of daily living as soon as

possible and to avoid stiffness and other complication related to conservative management, internal fixation is accepted as the standard modality of treatment.

Among various fixation techniques, percutaneous fixation has its own limitations in the form of poor reduction of fracture fragments, pin tract infection, long period of recovery, and cosmetic issues. However, it has some advantages in terms of less soft tissue stripping, less exposure, less blood loss, and minimal invasiveness, especially in elderly population. Open reduction internal fixation with PHILOS has the advantage of anatomical reduction, stable internal fixation, early mobilization, and better fixation in osteoporotic bones, although it requires surgical expertise, meticulous dissection and comes with disadvantages of subacromial impingement.

In our study, the mean age was 42.68 years in Group A (PHILOS) and 43.16 in Group B (K-wire). The maximum number of patients was observed in the 4th decade. It is important to mention that middle age group is more likely to be exposed to road traffic accidents as compared to the older age group. Hence, as expected the road traffic accidents is likely to occur in middle age group as reflected in our present study. Also, the mean age-group of our study is comparable with similar study by Wijgman, Roolker et al¹⁰ who carried out a study on fifty-two patient where mean age of patient was 48 years. In 2007, Moonot P, Ashwood N et al¹¹ studied 32 patients where mean age is 59.9 years. In 2017, Nitin Sharma, Mohit Dhingra, Deepak Sharma et al¹² had mean age of 43.64 years in 25 patients.

There was a significant male preponderance in our study, accounting for 70% of the patients. This can be due to exposure of significant number of male patients to road traffic accidents as compared to female patients, on account of the fact that males are more likely to go out for earning their livelihood. Similar study by Nitin Sharma, Mohit Dhingra, Deepak Sharma et al¹² carried out study on 25 patients with proximal humerus fracture showed significant male preponderance accounting to 76%.

Road traffic accident was the most common mode of injury in our study accounting to 64% of the cases, especially in younger and middle age group. Old age patients suffered this fracture due to trivial trauma like slip in the bathroom. Study performed by Kumar et al¹³ had maximum number of patients due to road traffic accident. On the contrary, MA Fazal et al¹⁴ in his study on 27 patients encountered majority from fall on ground followed by road traffic accident. In our study, 54% patients had a fracture on the right side, which is like the findings of Jan Magnus Bjorkenheim et al¹⁵.

The average interval between fracture and operative intervention is 5.4 days in Group A and 4.84 days in Group B. This delay of 4 to 5 days can be accounted to the delayed reporting of patient after trauma and time taken for obtaining fitness for surgery. Similar study by Nitin Sharma, Mohit Dhingra, Deepak Sharma et al¹² showed average delay of 3.28 days between fracture and operative intervention. The average blood loss was 82.8 ml in Group A and 20.8 ml in Group B. Blood loss was significantly less in the K-wire technique as it was percutaneous procedure, and PHILOS being an open procedure with significant soft tissue dissection, had a comparative more blood loss. Study by Kumar et al¹³ had mean blood loss in the PHILOS group of 710±105.56 ml and in K-wire group was 127±18.23 ml which is statistically significant. Chandra Mohan Singh et al¹⁶ had similar study where they found mean blood loss was 600 ml in group A and 100 ml in group B.

In our present study, the mean operative time was 146.4 minutes in Group A and 79.6 min in Group B. There is significant difference in time of surgery which shows group B is better in terms of time taken for surgery. This can be attributed to the technique of close reduction and percutaneous fixation. Study by Kumar et al¹³ had mean time of surgery as 102±9.22 min in the PHILOS group compared to 60.67±23.06 min in K-wire fixation group. Chandra Mohan Singh et al¹⁶ had similar study where they found mean operative time was 100 min in group A and 50 min in group B.

In our study, functional outcome at 12 weeks revealed excellent scores in 22 (88%) patients in group A (PHILOS), and 18 (72%) patients in group B (K-wire). 3 (12%) had satisfactory score in Group A and 6 (24%) in Group B. One patient had unsatisfactory/failure score in Group B. Both the procedure gave equivocal results at 12 weeks follow-up, with statistically insignificant difference (p value-0.137).

Study by Akshat Vijay et al¹⁷ found seven patient scored excellent results in group A (treated with PHILOS plate) and 5 have excellent in group B (treated with K-wire fixation), and 13 were satisfactory in group A and 7 in group B. Similar study by Chander Mohan Singh et al¹⁶ showed 7 patients (28%) in group 1 (treated with K-wire fixation)) had excellent results, 12 patients (48%) had satisfactory results, 2 patients (8%) had unsatisfactory results while 4 patients (16%) had poor outcome. For Group 2 (treated with PHILOS plate), as per Neer's scoring system, 12 patients (48%) had excellent results, 9 patients (36%) had satisfactory results, 2 patients (8%) had unsatisfactory results while 2 patients (8%) had a poor outcome. Study by Addanki Vijayanand et al¹⁸ on 30 cases showed 23 cases to have excellent results, 4 cases satisfactory, 2 cases unsatisfactory, and one case had a failure. Study by Pappu Marandi et al¹⁹ comprised of 5 (26%) excellent, 6 (31.6%) satisfactory, 3 (15.8%) unsatisfactory and 5 (26.3%) failure cases in total 19 patients treated with PHILOS.

The mean Neer's score for the younger age group (18-30) was 90.7 in Group A compared to 90.6 in Group B, for the middle age group (31-45) was 91.1 in group A compared to 90.8 in group B, for the old age group (46-60) was 89.7 in group A compared to 88.5 in Group B and for older age group (>60) was 88.5 in group A compared to 83.1 in group B. PHILOS plating was found to be more effective and statistically significant as compared to K-wire in older age group (> 46 yrs). Study by Shiva et al²⁰ observed that the functional outcome of patient who underwent K-wire fixation below the age of 60 years was 81.6 and more than 60 years old of age was 66.8 and similarly, functional outcome of plating below 60 years of age was 85.3 and after 60 years 72.

The mean Neer's Score for Neer's 2-part fracture was 91.25 in Group A in comparison to 91.12 in Group B, for Neer's 3-part fracture was 89.62 in Group A compared to 86.37 in Group B, and for Neer's 4-part fracture was 90 compared to 61 in Group B. PHILOS plating was found to be more effective as compared to K-wire with advancement of fracture comminution.

The mean Neer's Score for Pain was 34.80 in Group A compared to 33.80 in Group B, which was statistically significant. The mean Neer's Score Function in Group A was 26.8 compared to 25.44 in Group B. The mean Neer's Score Anatomy in Group A was 9.76 compared to 9.28 in Group B. Anatomy of head and their relationship with shaft of humerus and glenoid is better results in PHILOS plating compared to K-wire group which is statistically significant. Similar study by Addanki et al¹⁸ performed their study on 30 cases, they observed Neer's score for pain (33.5 units), Function (23.5 units), range of motion (16.55 units), and anatomy (6.9 units).

In our study, 6 complications were seen in group A (PHILOS), two patients had subacromial impingement. Screw backout, screw perforation, delayed union, and secondary varus displacement was encountered in one patient each. 10 complications were seen in group B (K-wire), 3 patients had shoulder stiffness, 2 patients each of delayed union and secondary varus displacement and one patient each of avascular necrosis and superficial infection. Similar study by Sameer Aggarwal et al²¹ found complication like screw perforation of head, AVN, subacromial impingement, loss of fixation in patients treated with locking compression plate. A varus malalignment is strong predictor of loss of fixation. Akshat Vijay et al¹⁷ carried out a study on 48 cases and found ten complications (subacromial impingement-1, screw perforation-1, infection-1, malunion-2, stiff shoulder-3, and pain in shoulder-2) were seen in six patients (25%) treated with PHILOS and 17 complications (K-wire migration-2, infection-2, malunion-4, stiff shoulder-6, and pain in shoulder-3) were seen in 10 patients (41.1%) fixed with K-wire. Study in 2011 by Georg Osterhoff et al²² found humeral head necrosis occurred in 6 patients in (c+, 15.4%) and 3 in (c-, 14.3%). Cut out of the proximal screw were observed in 3(c+, 7.7%) and 1 (c-, 4.8%) cases. In each group, 1 patient showed a delayed union. Study by Adithya C Pawaskar et al²³ found mean loss in neck-shaft angle in the first 3 months was 3.8° as compared to 1.3° in the p period between 3 months and final follow up.

Functional outcome in terms of range of movement (in all planes) was better and statistically significant in patient treated with PHILOS as compared to K-wire. Also, early mobilization was found to be more feasible with PHILOS plating. Similar study conducted upon 20 patients with PHILOS plating by Younes Akel et al²⁴ showed stable fixation, enabled an early range of motion exercise to achieve

acceptable functional result. Study conducted by Chander Mohan Singh et al¹⁶ found that PHILOS plate provide stable fixation even in Comminuted multi-fragmented osteoporotic proximal humerus fracture with advantage of anatomical reduction and early rehabilitation.

CONCLUSION

In our present study, we concluded that PHILOS plate provide better functional outcome as compared to K-wire fixation in old age group owing to excellent stable construct in osteoporotic fracture. Functional outcome was equivocal in both the treatment modality in younger and middle age group, if less comminution is associated. Patients treated with PHILOS plating showed significant recovery of range of motion as compared to K-wire fixation at 6- and 12-weeks follow-up. Better functional outcome with PHILOS group is attributable to stable fixation & early mobilization, although K-wire fixation is definitely having the less blood loss & less invasiveness.

LIMITATION

Our study represents the short-term follow-up of 12 weeks, which is the limitation of our study. A longer follow-up with a greater number of cases is recommended to evaluate the long-term functional outcome of the cases.

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