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Original Research Article

A prospective study on functional and radiological outcome of PHILOS plating for the management of proximal humerus fracture

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ABSTRACT

Background: Proximal humerus fracture is a common injury near the shoulder joint that poses a significant challenge in management due to its rising incidence and impact on functional recovery. Therefore, the purpose of this study was to evaluate the functional and radiological outcomes of PHILOS plating in the surgical management of proximal humerus fractures.
Methods: This prospective observational study at the Department of Orthopaedic Surgery, BMU, Shahbag, Dhaka and New Life Hospital Limited, Green Road, Dhaka (March 2021–September 2023) included 30 patients with proximal humerus fractures who underwent PHILOS plating. Functional (VAS, Constant Murley Score) and radiological outcomes were assessed at 1, 3, 6 and 12 months. Data were analyzed using SPSS v26 ($p<0.05$).
Results: In 30 patients treated with PHILOS plating, mean age was 49.1±9.7 years, 53.3% were male and 56.7% had 3-part fractures. Mean union time was 9.57±1.89 weeks. At 6 months, mean flexion was 152.1°±16.7, abduction 156.2°±18.8, internal rotation 67.1°±7.7 and external rotation 73.3°±7.8. VAS improved from 8.33±0.80 to 1.10±0.63 ($p<0.001$). Mean Constant Murley Score was 84.8±7.0 (excellent 43.3%, good 53.3%, moderate 3.3%). Complications occurred in 13.3% and 86.7% reported satisfactory outcomes.
Conclusions: PHILOS plating provides effective functional recovery, satisfactory pain relief and low complication rates in the management of proximal humerus fractures.

Keywords: Functional outcomes, Proximal humerus, PHILOS plating, Radiological outcomes

INTRODUCTION

Proximal humerus fracture (PHF) is a frequently encountered injury near the shoulder joint and remains a major challenge in orthopedic practice. It constitutes about 4–10% of all fractures and is considered the third most common fracture among the elderly, following hip and distal radius fractures.[1,2] The incidence of PHF, estimated at 90–105 cases per 100,000 people per year, is rising, largely due to the aging population and increasing prevalence of osteoporosis, with annual rates increasing by nearly 13.7%.[3,4] In older adults, these fractures commonly occur after low-energy falls on an outstretched hand, whereas in younger individuals, high-energy trauma such as road traffic accidents and sports injuries is more typical.[5] The management of PHF is complex and often

debated, with non-operative treatment generally reserved for stable, minimally displaced fractures, while surgical intervention is preferred for displaced, unstable fractures or fracture dislocations, particularly those resulting from high-energy trauma.[6,7] Proximal humerus fractures involve the area at or around the surgical neck of the humerus. Neer's classification is widely used to categorize these fractures, based on fragment angulation exceeding 45° and/or displacement greater than 10 mm. This classification has important implications for treatment decisions and expected outcomes.[8] About 80% of proximal humerus fractures are non-displaced and are typically managed conservatively with a plaster of Paris or a cuff-and-collar sling. However, managing displaced fractures continues to be challenging for orthopedic surgeons, with no universal consensus on the optimal approach.[9]

Various surgical options for proximal humerus fractures include K-wires, screws, buttress plates, conventional plates, locking plates and prosthetic replacements, each with distinct advantages and limitations. Angular stable plates have been developed to maintain anatomic alignment while providing secure fixation, particularly in osteoporotic bone. The 3-dimensional PHILOS plate, with its multidirectional locking mechanism in the humeral head, is capable of withstanding physiological forces even in compromised bone, supporting functional recovery.[10] Clinical evidence indicates that PHILOS plating leads to favorable outcomes, with the majority of patients attaining satisfactory to excellent functional recovery, although a small number may encounter complications. Additionally, studies indicate that the majority of patients treated with PHILOS achieve excellent or satisfactory results according to Neer's criteria.[6,11]

Despite growing evidence supporting PHILOS plating, variations in functional and radiological outcomes persist across different patient populations, fracture patterns and follow-up durations. Limited prospective data are available in the local context, particularly regarding standardized assessment of both functional recovery and radiographic union after PHILOS plating. Therefore, the purpose of this study was to evaluate the functional and radiological outcomes of PHILOS plating in the surgical management of proximal humerus fractures.

Objective

To evaluate the functional and radiological outcomes of PHILOS plating in the surgical management of proximal humerus fractures.

METHODS

This prospective, observational study was conducted at the Department of Orthopaedic Surgery, Bangladesh Medical University (BMU), Shahbag, Dhaka and New Life Hospital Limited, Green Road, Dhaka, Bangladesh, between March 2021 and September 2023. A total of 30 patients were included, selected based on specific inclusion and exclusion criteria to evaluate the functional and radiological outcomes following PHILOS plating.

Inclusion criteria

Age 18 to 60 years**,** both genders**, *p***atients with two-, three- or four-part proximal humerus fractures**,** displacement ≥1 cm and angulation >45°, Injury duration ≤3 weeks

Exclusion criteria

Undisplaced fractures, open fractures, other fractures in the same limb, pathological fractures, shaft humerus fractures with proximal extension, local soft tissue infection, neuromuscular disorders, neurovascular injury of the same limb, severe or uncontrolled comorbid conditions.

After obtaining written informed consent, a detailed history and physical examination were performed. Imaging included plain radiographs of the proximal humerus with the shoulder joint and CT scans with 3D reconstruction were obtained when necessary. Preoperative investigations ensured surgical fitness. All patients underwent PHILOS plating, with operative duration, perioperative blood loss and any complications recorded. Postoperatively, patients were followed at 1, 3, 6 and 12 months. Functional outcomes were assessed using the Visual Analogue Scale (VAS) for pain and the Constant Murley Shoulder Score, while radiological union was evaluated by X-ray for bridging callus and clinical pain-free function. Delayed union, nonunion and malunion were defined according to standard criteria. Qualitative variables were expressed as frequency and percentage and analyzed using the chi-square test, while quantitative variables were expressed as mean±SD and analyzed using Student's t-test or Mann–Whitney U test. Statistical analyses were performed using SPSS version 26 (IBM®, Armonk, USA), with significance set at $p<0.05$.

RESULTS

Table 1 shows the baseline distribution of patients according to age, sex, occupation, dominance, side of involvement, mechanism of injury and Neer's classification. The majority of patients were aged between 51–60 years (46.7%), with a mean age of 49.1±9.7 years. Male were slightly more common (53.3%) than female (46.7%). Homemakers (33.3%) and service holders (30.0%) were the predominant occupational groups. Most patients had right-hand dominance (86.7%) and involvement of the right side (63.3%). Falls on the ground were the most frequent mechanism of injury (63.3%), followed by road traffic accidents (33.3%). According to Neer's classification, 3-part fractures were the most common (56.7%), followed by 2 part (30.0%) and 4 part fractures (13.3%).

The mean union duration in patients treated with PHILOS plating was 9.57±1.89 weeks, ranging from 6 to 14 weeks.

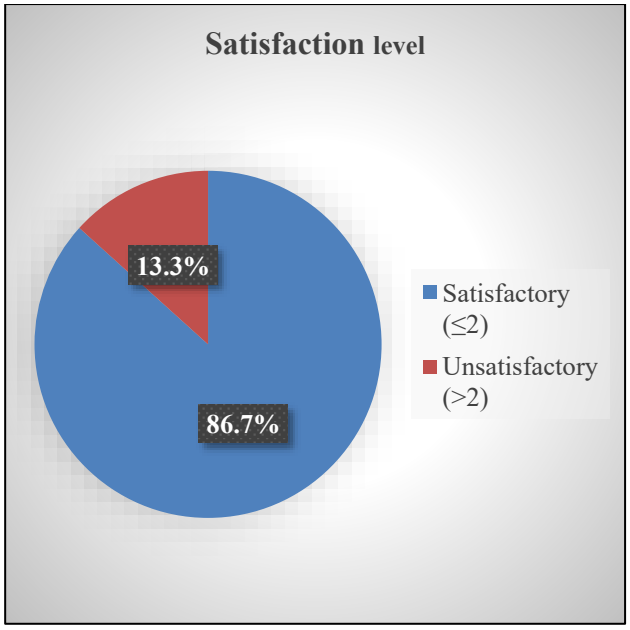

Figure 1: Distribution of patients according to satisfaction level (n=30).

Patients demonstrated favorable functional outcomes after PHILOS plating. The mean shoulder range of motion was 152.14°±16.70 for flexion, 156.19°±18.77 for abduction, 67.14°±7.68 for internal rotation and 73.33°±7.80 for external rotation. The mean VAS pain score significantly improved from 8.33±0.80 preoperatively to 2.48±0.81 at 3 months and 1.10±0.63 at 6 months ($p<0.001$). The mean Constant Murley Score was 84.76±7.04, with 43.3% achieving excellent outcomes, 53.3% good and 3.3% moderate. Functional outcomes varied with Neer's classification, with 2-part fractures showing the highest mean scores (88.33±1.51), followed by 3 part (84.50±7.83) and 4-part fractures (78.67±7.57).

The majority of patients (86.7%) experienced no postoperative complications. Surgical site infection occurred in 3 patients (10.0%) and avascular necrosis (AVN) of the humeral head was observed in 1 patient (3.3%). Most patients (86.7%) reported satisfactory outcomes (score≤2) following PHILOS plating, while 4 patients (13.3%) reported unsatisfactory outcomes (score>2), indicating a high overall patient satisfaction rate with this treatment.

Table 1: Baseline characteristics of the study population (n=30).

Variable		Frequency (N)	(%)
Age (in years)	18–30	0	0.0
	31–40	6	20.0
	41–50	10	33.3
	51–60	14	46.7
	Mean±SD	49.1±9.7	
Gender	Male	16	53.3
	Female	14	46.7
Occupation	Student	1	3.3
	Homemaker	10	33.3
	Business	6	20.0
	Service Holder	9	30.0
	Unemployed	4	13.3
Dominant hand	Right	26	86.7
	Left	4	13.3
Side involved	Right	19	63.3
	Left	11	36.7
Mechanism of injury	Road Traffic Accident	10	33.3
	Fall on ground	19	63.3
	Sports	1	3.3
Neer's classification	2 Part	9	30.0
	3 Part	17	56.7
	4 Part	4	13.3

Table 2: Radiological union.

Parameter	Mean±SD (range)
Union duration (in weeks)	9.57±1.89
Mean±SD (Min-Max)	(6–14)

Table 3: Functional outcomes following PHILOS plating.

Parameter		Mean±SD (range) / frequency (N)	%
Range of motion (°)	Flexion	152.14±16.70 (110–165)	
	Abduction	156.19±18.77 (100–170)	
	Internal rotation in abduction	67.14±7.68 (45–80)	
	External rotation in abduction	73.33±7.80 (55–85)	
Vas pain score	Pre-operative	8.33±0.80 (7–10)	
	3-month post-operative	2.48±0.81 (1–4)	
	6-month post-operative	1.10±0.63 (0–2)	
	P value	<0.001	
Constant Murley score	84.76±7.04 (70–100)		
	Excellent (86–100)	13	43.3
	Good (71–85)	16	53.3
	Moderate (56–70)	1	3.3
	Poor (0–55)	0	0.0
Neer type	2 Part	9	88.33±1.51 (86–90)
	3 Part	16	84.50±7.83 (82–100)
	4 Part	5	78.67±7.57 (70–84)

Table 4: Distribution of patients according to postoperative complications (n=30).

Complication	Frequency (N)	%
Surgical site infection	3	10.0
Pin tract infection	0	0.0
Pin loosening	0	0.0
AVN of head of humerus	1	3.3
Malunion	0	0.0
None	26	86.7

DISCUSSION

This study evaluated the profile of patients, fracture characteristics and postoperative outcomes following PHILOS plating for proximal humerus fractures in a tertiary care setting in Bangladesh. Proximal humerus fractures, particularly displaced or unstable patterns, pose significant challenges to orthopedic management due to their impact on shoulder function and potential for complications. The findings highlight the influence of factors such as age, mechanism of injury and Neer's fracture classification on both radiological union and functional recovery. High rates of satisfactory functional outcomes, timely fracture union and overall patient satisfaction emphasize the effectiveness of PHILOS plating in achieving optimal surgical results while minimizing complications.

In this study, the majority of patients with proximal humerus fractures were aged between 51–60 years, with a mean age of 49.1±9.7 years, which is consistent with previous reports indicating that the incidence of proximal humerus fractures increases with age (Orthobullets).[12] Male slightly outnumbered female in this cohort (53.3% vs. 46.7%), though other studies, such as Rodríguez et al have shown a higher prevalence among older female, likely due to osteoporosis-related fragility fractures.[13] Fall on the ground was the most frequent mechanism of injury (63.3%), supporting the observation that low-energy trauma is common in older patients, whereas younger individuals more often sustain fractures due to high-energy events like road traffic accidents, which accounted for 33.3% in this study (Orthobullets).[12] Regarding fracture patterns, 3 part fractures were the most prevalent (56.7%), followed by 2 part (30.0%) and 4 part fractures (13.3%), which closely parallels the distribution reported by Iglesias-Rodríguez et al, where 32.3% were two-part, 30.9% three-part and 6.9% four-part fractures according to Neer's classification.[13] Overall, these findings align with existing literature, highlighting the predominance of middle-aged to older adults, low-energy mechanisms and a higher occurrence of multi-part proximal humerus fractures.

In the present study, the mean radiological union time following PHILOS plating was 9.57±1.89 weeks (range 6–14), which demonstrates relatively early fracture healing. Similar studies have also reported satisfactory union times, though slightly longer than ours. Ethiraj et al, observed a mean union time of 13.75 weeks in 40 patients, while Doshi et al reported an average of 12 weeks and Kumar et al, documented a mean of 14.5 weeks in their series of 34 patients.[14-16] These findings indicate that our results are comparable to published data but suggest a tendency

toward faster union, highlighting the effectiveness of PHILOS plating in promoting stable fixation and favorable healing outcomes in proximal humerus fractures.

In our study, patients treated with PHILOS plating demonstrated favorable functional outcomes, with a mean Constant Murley score of 84.76±7.04 and 96.6% achieving good to excellent results, along with significant improvements in pain and range of motion over follow-up. These findings are comparable to those reported by Jaura et al who observed a mean Constant score of 84.6 (range: 61–100) in elderly patients at long-term follow-up, closely aligning with our results.[17] Similarly, Kushwaha et al reported that 73.2% of their cohort achieved good to excellent outcomes after PHILOS plating, which, while slightly lower than our study, supports the effectiveness of this fixation method in restoring shoulder function.[18] Together, these findings reinforce that PHILOS plating provides reliable functional recovery among patient groups.

In our study, the overall complication rate was relatively low, with surgical site infection observed in 10% of patients and avascular necrosis (AVN) in 3.3%, while the majority (86.7%) experienced no complications. These findings are consistent with the meta-analysis by Oldrini et al who reported a 23.8% overall complication rate among 4,200 patients treated with PHILOS plating, with an AVN rate of 3.1%, closely paralleling our result.[19] This similarity underscores that despite some variability in infection rates, the incidence of AVN in our cohort aligns well with larger published data, suggesting that PHILOS plating offers favorable safety outcomes when applied in appropriate clinical settings.

In this study, the majority of patients reported satisfactory outcomes following PHILOS plating, with 86.7% expressing high levels of satisfaction and only 13.3% reporting unsatisfactory results. This high satisfaction rate reflects the favorable functional recovery, pain relief and overall clinical outcomes achieved with PHILOS fixation in proximal humerus fractures. The small proportion of unsatisfied patients may be attributed to individual variations in fracture complexity, postoperative complications or slower functional recovery. Overall, the findings indicate that PHILOS plating is a reliable method associated with excellent patient satisfaction.

Despite careful attention, certain limitations remained as the study was conducted in tertiary-level hospitals, the findings may not fully represent the overall population of the country. The use of purposive sampling introduced the possibility of selection bias. The short follow-up duration limited the assessment of long-term outcomes.

CONCLUSION

Surgical management of proximal humerus fractures with PHILOS plating resulted in favorable functional and radiological outcomes. Patients achieved good shoulder mobility, significant pain reduction and better functional recovery. Postoperative complications were minimal and the majority of patients reported satisfactory recovery outcomes, indicating that PHILOS plating is an effective and reliable treatment for proximal humerus fractures.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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