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Original Research Article

Comparative analysis of proximal humerus internal locking system plating and external fixation in proximal humerus fracture management: a prospective study on functional outcomes

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ABSTRACT

Background: The management of proximal humerus fractures presents challenges due to their intricate anatomy and varied fracture patterns in NEER'S type 3,4. This prospective study aimed to compare functional outcomes between proximal humerus internal locking system (PHILOS) plating and external fixation ((UMEX).
Methods: Fifteen patients in each group, classified as NEER type 3 and 4 fractures were included. Patient demographics showed no significant age or gender differences between the groups. Patients' selection was randomized.
Results: Functional assessment using disabilities of the arm, shoulder, and hand (DASH) scores revealed superior outcomes in the external fixator group at 6 weeks (55.54±6.50 vs. 50.50±6.10), 3 months (66.91±5.34 vs. 61.67±7.08), and 6 months (77.83±2.79 vs. 65.29±5.15), with significant differences observed (p=6 weeks: 0.0370, 3 months: 0.0299, 6 months: <0.0001). Similarly, visual analogue score (VAS) scores demonstrated lower postoperative pain levels in the external fixator group at 6 weeks (2.85±1.21 vs. 4.14±1.10) and 6 months (0.33±0.52 vs. 1.00±0.58), with significant differences noted (p=0.0049 and p=0.0024). Furthermore, regarding range of motion, the external fixator group consistently outperformed the PHILOS group across all measured shoulder movements at 3 and 6 months, showing significant differences (abduction: p=0.0127, extension: p<0.0001, external rotation: p=0.0004, internal rotation: p=0.0002, flexion: p<0.0001).
Conclusions: These findings underscore the potential superiority of external fixation in achieving better clinical outcomes, lower pain levels, and improved range of motion compared to PHILOS plating in proximal humerus fracture management.

Keywords: Proximal humerus fractures, PHILOS plating, External fixation, DASH score, VAS

INTRODUCTION

Proximal humerus fractures represent a significant orthopedic challenge due to their high prevalence and potential for functional impairment. These fractures account for approximately 5 to 6% of all fractures and are particularly common among the elderly population.[1,2] The incidence of proximal humerus fractures varies globally, with higher rates reported in developed countries, such as the United States and Europe.[3,4] In India, while specific data on the incidence of proximal humerus fractures may be limited, the aging population and increasing incidence of osteoporosis suggest a rising trend in fracture cases.[5] The management of proximal humerus fractures often requires surgical intervention, especially in cases of displaced or unstable fractures. Various surgical techniques are employed to stabilize these fractures and facilitate proper healing. Two commonly utilized methods are PHILOS plating and external fixation (UMEX).[6]

PHILOS plating is a widely accepted surgical technique that involves the internal fixation of fractures using a locking plate system. This method aims to provide stable fixation and facilitate early mobilization, thus improving

functional outcomes.[7] On the other hand, external fixation involves the application of an external frame or fixator device to stabilize the fracture externally. This technique offers the advantage of minimal soft tissue dissection and preservation of blood supply to the fracture site. However, it may be associated with certain limitations such as pin tract infections and decreased patient comfort.[8]

While both PHILOS plating and external fixation are commonly used in the management of proximal humerus fractures, there is a lack of consensus regarding the optimal treatment approach. Studies comparing the outcomes of these techniques have yielded conflicting results, with some suggesting superiority of one method over the other.[10,11]

A comparative analysis of PHILOS plating and external fixation is essential to evaluate their respective efficacy and determine the most appropriate treatment approach for proximal humerus fractures. This prospective study aimed to assess functional outcomes and pain relief associated with PHILOS plating and external fixation in the management of proximal humerus fractures. By comparing the outcomes of these two surgical techniques, we seek to identify any differences in terms of functional recovery, pain relief, and complication rates. Additionally, we aimed to address existing gaps in the literature regarding the comparative effectiveness of PHILOS plating and external fixation in proximal humerus fracture management.

The primary purpose of this study is to provide valuable insights into the selection of optimal treatment modalities for proximal humerus fractures, thereby improving patient outcomes and enhancing clinical decision-making in orthopedic practice. Through comprehensive evaluation and analysis, we endeavor to contribute to the advancement of evidence-based practices in fracture management.

METHODS

This prospective study was conducted at Bharati Vidyapeeth (DTU) medical college and hospital, Pune, following ethical approval from the institutional ethics committee. The study included 30 participants with proximal humerus fractures, divided into two groups: the PHILOS plating group and the external fixation group (UMEX), with 15 participants in each group. All participants provided informed consent prior to enrollment in the study.

Patients eligible for inclusion were those diagnosed with displaced or unstable proximal humerus fractures requiring surgical intervention. Exclusion criteria included open fractures, pathological fractures, previous shoulder surgery, and severe medical comorbidities that could affect surgical outcomes. Participants in the PHILOS plating group underwent internal fixation using the PHILOS locking plate system, while those in the external fixation group received external fixation using an appropriate fixator device. Surgical procedures were performed by experienced orthopedic surgeons following standard techniques.

Outcome measures included functional outcomes assessed using validated scoring systems such as the DASH score and pain relief evaluated using a VAS. Follow-up assessments were conducted at 6 weeks, 3 months, and 6 months postoperatively to evaluate functional recovery and pain relief. Any complications encountered were also recorded.

Data analysis was performed using appropriate statistical methods to compare the outcomes between the two groups. Descriptive statistics were used to summarize demographic and clinical characteristics, while inferential statistics such as t-tests and chi-square tests were employed to analyze differences in functional outcomes and pain relief between the PHILOS plating and external fixation groups.

RESULTS

The present comparative study was conducted to study the functional outcomes of PHILOS plating versus external fixators for proximal humerus fractures at various follow ups. In the "external fixator" group, the average age was 58.13 years, and in the "PHILOS" group, it was 50.40 years, with no significant difference (p=0.1397). The gender distribution was also similar, with the external fixator group having 47% female and 53% male, and the PHILOS group having 40% female and 60% male, showing no significant difference (p=0.9999).

Patient outcomes were measured using the DASH score. In the external fixator group, mean DASH scores were 55.54 at 6 weeks, 66.91 at 3 months, and 77.83 at 6 months. In the PHILOS group, mean DASH scores were 50.50 at 6 weeks, 61.67 at 3 months, and 65.29 at 6 months.

The differences were statistically significant at 6 weeks (p=0.0370), 3 months (p=0.0299), and 6 months (p<0.0001), with higher scores in the external fixator group.

Table 2 present a comparative analysis of VAS between the external fixator and PHILOS groups at various post-operative time points. Pre-operatively, both groups had similar VAS scores (external fixator: 6.60, PHILOS: 6.67, p=0.8523). At 6 weeks post-surgery, the external fixator group had a significantly lower VAS score (2.85) compared to the PHILOS group (4.14, p=0.0049).

At 6 months, the external fixator group's VAS score remained lower (0.33) than the PHILOS group's (1.00, p=0.0024). There was no significant difference in VAS scores at 3 months (p=0.1795).

The comparison of range of motion between the external fixator and PHILOS groups at 6 weeks, 3 months, and 6 months revealed significant differences across all shoulder joint movements. At 6 weeks, the external fixator group showed significantly better results in abduction (p=0.0032), extension (p<0.0001), external rotation (p=0.0002), internal rotation (p=0.0065), and flexion (p<0.0001).

At 3 months, the external fixator group maintained significantly better outcomes in abduction (p=0.0127), extension (p<0.0001), external rotation (p=0.0004), internal rotation (p=0.0002), and flexion (p<0.0001).

By 6 months, external fixator group sustained superior performance in abduction (p=0.0092), extension (p=0.0001), external rotation (p=0.0038), internal rotation (p<0.0001), and flexion (p=0.0001).

Overall, external fixator group consistently demonstrated better range of motion in all measured shoulder movements at each time point, with all differences being statistically significant.

Table 4 presents complications associated with external fixator and PHILOS procedures. External fixator complications included accidental device removal and pin tract infections (1 each patient).

PHILOS complications comprised surgical site infections and stiffness (1 each patient), suggesting potential mobility or flexibility reduction.

Table 1: Comparison of DASH score between the groups at 6 weeks, 3 months and 6 months.

DASH score	External fixator		PHILOS		P value
	Mean	SD	Mean	SD	
At 6 weeks	55.54	6.50	50.50	6.10	0.0370
At 3 months	66.91	5.34	61.67	7.08	0.0299
At 6 months	77.83	2.79	65.29	5.15	<0.0001

Table 2: Comparison of VAS score between the groups at pre-operatively, at 6 weeks, 3 months and 6 months.

VAS score	External fixator		PHILOS		P value
	Mean	SD	Mean	SD	
Preoperatively	6.60	0.99	6.67	1.05	0.8523
At 6 weeks	2.85	1.21	4.14	1.10	0.0049
At 3 months	1.46	0.93	1.92	0.90	0.1795
At 6 months	0.33	0.52	1.00	0.58	0.0024

Table 3: Comparison of range of motion between the groups at different follow ups.

Range of motion		External fixator		PHILOS		P value
		Mean	SD	Mean	SD	
6 weeks	Abduction (70-160)	93.67	16.53	74.00	16.82	0.0032
	Extension (30-55)	41.67	4.88	29.00	3.38	<0.0001
	External rotation (35-60)	46.00	6.87	34.00	8.49	0.0002
	Internal rotation (40-60)	43.33	4.08	37.67	6.23	0.0065
	Flexion (80-120)	92.00	4.55	76.33	6.11	<0.0001
3 months	Abduction (70-160)	105.00	20.09	83.67	23.64	0.0127
	Extension (30-55)	42.67	4.95	32.67	5.30	<0.0001
	External rotation (35-60)	48.00	5.28	38.00	8.19	0.0004
	Internal rotation (40-60)	47.67	5.63	38.33	6.46	0.0002
	Flexion (80-120)	96.67	7.48	82.00	9.22	<0.0001
6 months	Abduction (70-160)	115.67	16.24	97.67	18.89	0.0092
	Extension (30-55)	48.33	4.08	39.67	5.81	0.0001
	External rotation (35-60)	48.00	6.21	39.67	8.12	0.0038
	Internal rotation (40-60)	52.33	5.30	41.33	5.81	<0.0001
	Flexion (80-120)	101.00	7.84	86.33	8.96	0.0001

Table 4: Complications between the groups.

External fixator	PHILOS
Accidental removal of ex fix (3)	Surgical site infection (1)
Pin tract infection (1)	Stiffness (2)

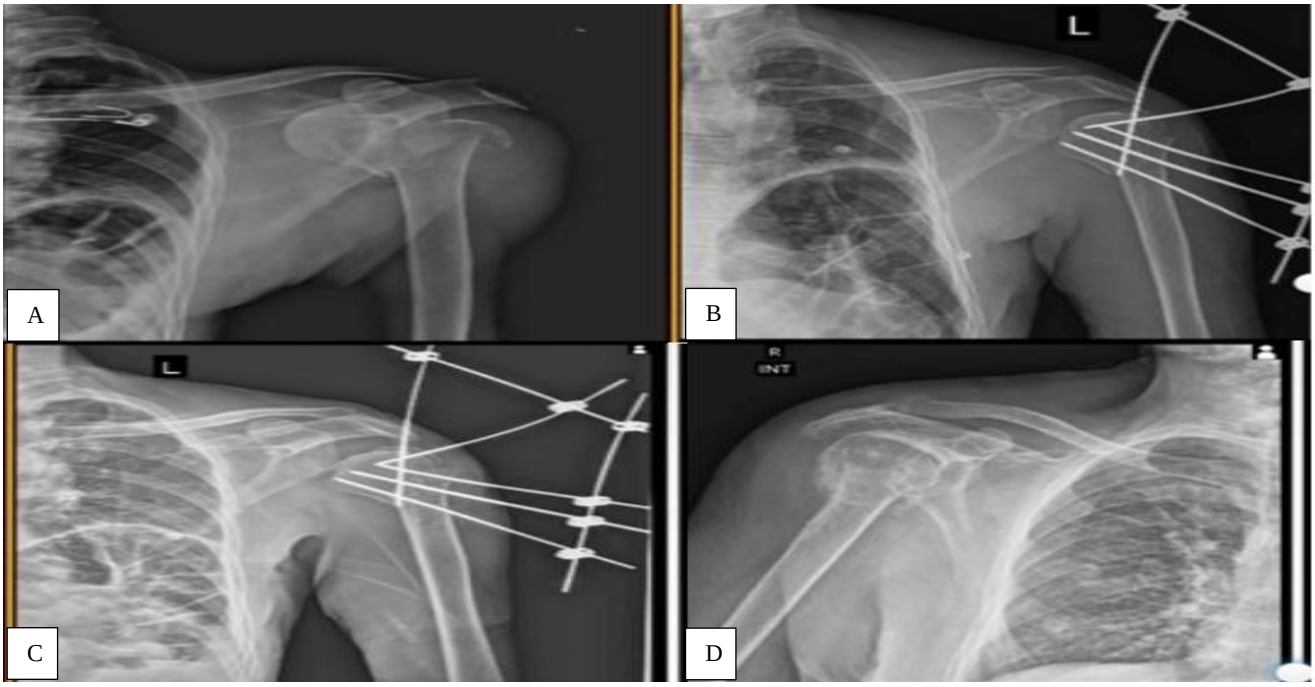

Figure 1 (A-D): X-ray clinical images of external fixator-pre operated X-ray, immediate post operative x-ray, 6 week post operative and 3 months post operative x-ray image.

Figure 2 (A-E): Clinical images of range of motion of external fixator (External rotation, internal rotation, flexion, extension, abduction).

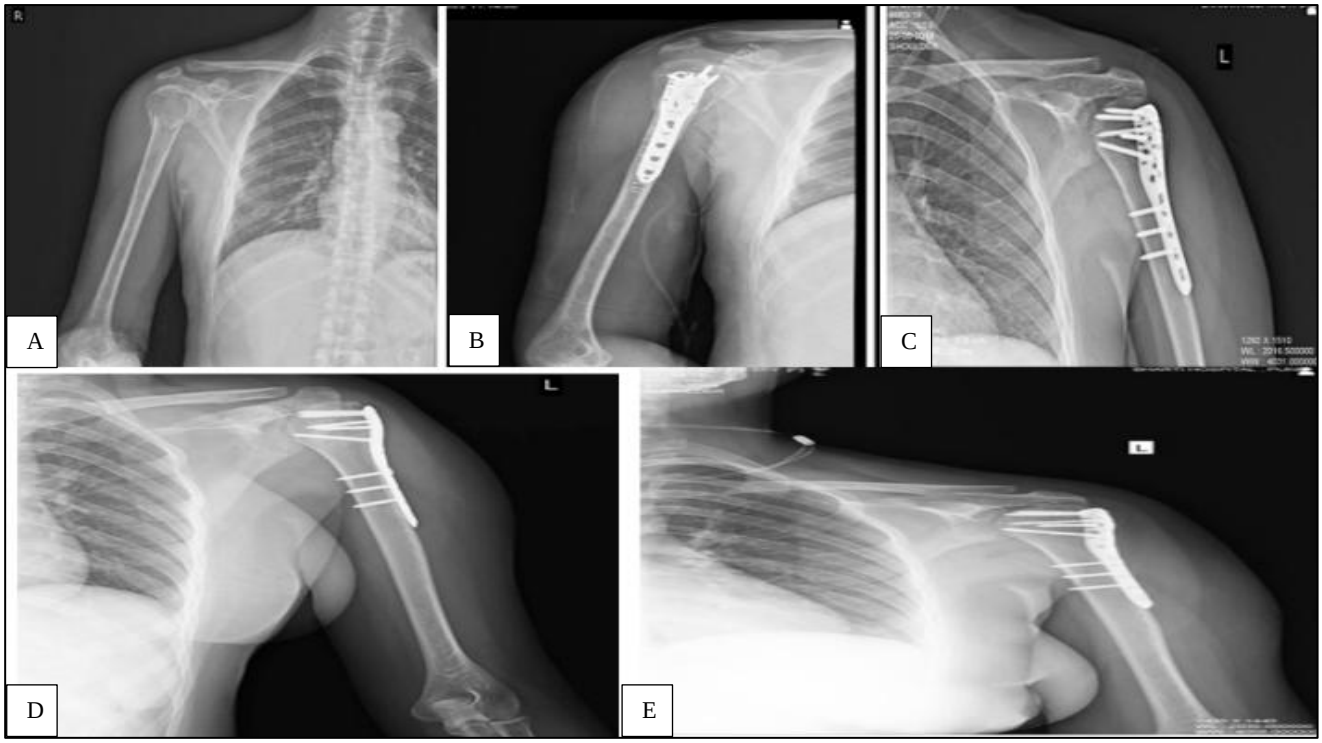

Figure 3 (A-E): X-rays images of PHILOS plating. (Pre-operated, immediate post-operation, 6 week post operation, 3 months post operation and 6 months post-operation).

Figure 4 (A-E): Clinical images of PHILOS plating (Flexion, extension, internal rotation, external rotation and abduction).

DISCUSSION

Proximal humerus fractures pose significant challenges in orthopedic management, often necessitating surgical intervention for optimal outcomes. Various surgical techniques have been developed to address these fractures, each with their advantages and limitations.[4,12] Two commonly used methods include PHILOS plating and external fixation each offering distinct approaches to fracture stabilization.[13,14] While several studies have investigated the outcomes of these techniques individually, there remains a lack of consensus regarding their comparative effectiveness.

Therefore, this study aimed to conduct a comparative analysis of PHILOS plating and external fixation in the management of proximal humerus fractures, focusing on functional outcomes and pain relief. By comparing the results of the current study with previous research findings, we seek to elucidate the relative merits of each technique and identify any gaps in the existing literature. In present study, demographic analysis revealed comparable age distributions between the external fixation and PHILOS plating groups, with no statistically significant difference observed. Gender distribution also showed no significant distinction between the two treatment cohorts, reflecting balanced representation across both male and female participants.

In present study comparing PHILOS plating and external fixation for proximal humerus fracture management, we found that participants treated with external fixation exhibited significantly better functional outcomes and lower pain levels compared to those treated with PHILOS plating, as indicated by DASH scores and VAS scores. This trend was observed consistently across all assessed time points, including 6 weeks, 3 months, and 6 months post-surgery. These results suggest that external fixation may offer early and sustained advantages in terms of functional recovery and pain relief in the immediate and long-term postoperative periods.

Our findings align with those of Thyagarajan et al, Patel et al and Hirschmann et al which demonstrated favorable functional outcomes and pain relief following PHILOS plating.[15-17] However, our study suggests that external fixation may yield superior results in terms of both DASH scores and VAS scores compared to PHILOS plating, contrasting with the findings of Chen et al, Doshi et al and Geiger et al.[11,18,19] Notably, Chen et al reported significantly better outcomes in the PHILOS group at 30 days post-surgery, while Doshiet al and Geiger et al highlighted promising functional outcomes but noted complications associated with PHILOS plating.[11,18,19]

Thyagarajan et al reported a median ASES score of 66.5 and a median constant score of 57.5 among patients treated with PHILOS plating.[15] Similarly, our study observed favorable functional outcomes in both the PHILOS plating and external fixation groups, as evidenced by validated scoring systems such as the DASH score and VAS for pain assessment. The results of Patel et al also align with our findings, demonstrating the efficacy of PHILOS plating in achieving satisfactory to excellent outcomes, particularly in osteoporotic bone.[16] Our study's divergence from these findings underscores the importance of considering various factors, including patient demographics, fracture severity, and surgical expertise, in determining the most appropriate treatment approach.

In present study comparing PHILOS plating and external fixation for proximal humerus fracture management, at 6 weeks post-surgery, participants in the external fixation group exhibited significantly better outcomes in all measured shoulder movements compared to the PHILOS plating group. This included abduction, extension, external rotation, internal rotation, and flexion, with p values indicating statistical significance. These findings suggest that external fixation may offer early advantages in terms of range of motion and functional recovery compared to PHILOS plating in the immediate postoperative period.

Similarly, at 3 months post-surgery, participants in the external fixation group continued to demonstrate significant superior outcomes compared to the PHILOS plating group across all measured shoulder movements, highlighting the continued advantage of external fixation in promoting functional recovery and range of motion. Similar findings were noted after 6 months of surgery.

Hirschmann et al reported long-term improvements in shoulder range of motion among patients treated with PHILOS plating, which is consistent with the functional outcomes observed in our study at 6 months postoperatively.[17] Regarding external fixation, our study corroborates the findings of Chen et al who reported favorable outcomes with the use of a custom neutral-position shoulder and elbow sling in conjunction with external fixation for proximal humerus fractures.[11] Similarly, Geiger et al observed good anatomical alignment and functional outcomes among patients treated with external fixation, albeit with a higher complication rate compared to internal fixation methods.[19]

In our present study, we observed relatively low rates of complications associated with both external fixation and PHILOS plating for proximal humerus fractures. However, comparing our findings with previous studies reveals varying rates and types of complications across different treatment modalities. Our study aligns with the findings of Zhang et al and Ricardo et al which reported minimal complications associated with closed reduction and external fixation using a mini-external fixator.[20,21] Similarly, Thyagarajan et al, Patel et al and Hirschmann et al noted minimal complications with PHILOS plating, emphasizing its efficacy and safety in fracture management.[15-17] Conversely, studies by Geiger et al and Aggarwal et al reported higher rates of complications, including humeral head avascular necrosis, screw loosening, and subacromial impingement, associated with

PHILOS plating.[19,22] These discrepancies highlight the importance of careful patient selection, surgical technique, and postoperative management in minimizing complications and optimizing outcomes in proximal humerus fracture treatment.

Overall, our study findings indicate that external fixation may offer advantages over PHILOS plating in terms of functional outcomes and pain relief in the management of proximal humerus fractures. These results contribute to the existing body of literature on fracture management techniques and provide valuable insights for clinicians in selecting optimal treatment approaches for their patients. However, further research with larger sample sizes and longer follow-up periods is warranted to confirm and expand upon these findings, ultimately improving patient outcomes and informing clinical practice.

CONCLUSION

In this study we found that the functional outcome of external fixator was superior when compared to PHILOS plating. This can be attributed to minimal soft tissue dissection and early mobilization which can be done in fracture fixed with external fixator. External fixator is superior in terms, cost effectiveness, less chance of SSI and patients with multiple co-morbidities.

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REFERENCES

1. Relvas Silva M, Linhares D, Leite MJ, Nunes B, Torres J, Neves N et al. Proximal humerus fractures: epidemiology and trends in surgical management of hospital-admitted patients in Portugal. JSES Int. 2022;6(3):380-4.
2. Pencle F, Varacallo M. Proximal Humerus Fracture. In: StatPearls. Treasure Island (FL): StatPearls Publishing. 2024.
3. Razaeian S, Wiese B, Zhang D, Harb A, Krettek C, Hawi N. Nonsensus in the treatment of proximal humerus fractures: uncontrolled, blinded, comparative behavioural analysis between Homo chirurgicus accidentus and Macaca sylvanus. BMJ. 2020;371:m4429.
4. Baker HP, Gutbrod J, Strelzow JA, Maassen NH, Shi L. Management of Proximal Humerus Fractures in Adults-A Scoping Review. J Clin Med. 2022;11(20):6140.
5. Taskesen A, Göçer A, Uzel K, Yaradılmış YU. Effect of Osteoporosis on Proximal Humerus Fractures. Geriatr Orthop Surg Rehabil. 2020;11:2151459320985399.
6. Handoll HH, Elliott J, Thillemann TM, Aluko P, Brorson S. Interventions for treating proximal humeral fractures in adults. Cochrane Database Syst Rev. 2022;6(6):CD000434.
7. Kumar GN, Sharma G, Sharma V, Jain V, Farooque K, Morey V. Surgical treatment of proximal humerus fractures using PHILOS plate. Chin J Traumatol. 2014;17(5):279-84.
8. Hadeed A, Werntz RL, Varacallo M. External Fixation Principles and Overview. In: StatPearls. Treasure Island (FL): StatPearls Publishing. 2024.
9. Gupta AK, Gupta M, Sengar G, Nath R. Functional outcome of closed fractures of proximal humerus managed by Joshi's external stabilizing system. Indian J Orthop. 2012;46(2):216-20.
10. Brunner A, Thormann S, Babst R. Minimally invasive percutaneous plating of proximal humeral shaft fractures with the Proximal Humerus Internal Locking System (PHILOS). J Shoulder Elbow Surg. 2012;21(8):1056-63.
11. Chen X, Yu ZX, Wang HY, Shen F, Lin GB, Wang S, et al. Proximal humeral internal locking plate combined with a custom neutral-position shoulder and elbow sling for proximal humerus fractures: A randomized study. Medicine (Baltimore). 2019;98(17):e15271.
12. Jordan RW, Modi CS. A review of management options for proximal humeral fractures. Open Orthop J. 2014;8:148-56.
13. Spross C, Platz A, Rufibach K, Lattmann T, Forberger J, Dietrich M. The PHILOS plate for proximal humeral fractures--risk factors for complications at one year. J Trauma Acute Care Surg. 2012;72(3):783-92.
14. Marsh JL, Mahoney CR, Steinbronn D. External fixation of open humerus fractures. Iowa Orthop J. 1999;19:35-42.
15. Thyagarajan DS, Haridas SJ, Jones D, Dent C, Evans R, Williams R. Functional outcome following proximal humeral interlocking system plating for displaced proximal humeral fractures. Int J Shoulder Surg. 2009;3(3):57-62.
16. Patel YC, Majumdar S, Shah S, Lathiya H, Bhadani A. Study of outcome of proximal humerus fracture treated with proximal humerus internal locking system (Philos) plating. Int J Orthop Sci. 2023;9(2):117-26.
17. Hirschmann MT, Fallegger B, Amsler F, Regazzoni P, Gross T. Clinical longer-term results after internal fixation of proximal humerus fractures with a locking compression plate (PHILOS). J Orthop Trauma. 2011;25(5):286-93.
18. Doshi C, Sharma GM, Naik LG, Badgire KS, Qureshi F. Treatment of Proximal Humerus Fractures using PHILOS Plate. J Clin Diagn Res. 2017;11(7):RC10-3.
19. Geiger EV, Maier M, Kelm A, Wutzler S, Seebach C, Marzi I. Functional outcome and complications following PHILOS plate fixation in proximal humeral fractures. Acta Orthop Traumatol Turc. 2010;44(1):1-6.
20. Zhang J, Ebraheim N, Lause GE. Surgical treatment of proximal humeral fracture with external fixator. J

Shoulder Elbow Surg. 2012;21(7):882-6.
21. Ricardo M. External fixation for proximal humerus fractures in elderly patients. Ortho Rheum Open Access J. 2021;18(5):555996.
22. Aggarwal S, Bali K, Dhillon MS, Kumar V, Mootha AK. Displaced proximal humeral fractures: an Indian experience with locking plates. J Orthop Surg Res. 2010;5:60.

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