Evaluation of Surgical Treatment by PHILOS Plate versus Conservative Treatment for Displaced Proximal Humeral Fractures in Elderly patients

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Abstract

Background: Proximal humeral fractures account for 5:6% of all adult fractures; according to Neer classification displaced fracture could be two-, three-, and four-part fractures of the proximal humerus.

Objectives*:* This study aims to evaluate surgical treatment outcomes by PHILOS plate versus conservative treatment for displaced humeral fractures in elderly patients.

Patients and methods: This was a prospective randomized comparative study that was conducted on a total of 40 patients that fulfilled inclusion criteria presented with displaced proximal humeral fracture randomly selected from those seeking the medical care of the Orthopedic Surgery Department of our institute between 2022 and 2023, managed either by conservative management or by PHILOS plate.

Results: Forty patients presented with proximal humerus fracture, twenty in the Conservative treatment group and twenty in the PHILOS group. The PHILOS Plate group showed a highly significant increase in extension over the three visits (p-value < 0.0001*). There was an increase in internal rotation for both the Conservative Treatment group (p-value < 0.0001*) and the PHILOS Plate group (p-value = 0.031*).

Conclusion: The conservative treatment group and the PHILOS plate group experienced significant improvements in flexion and internal rotation, with the PHILOS plate group displaying a substantial enhancement in extension and external rotation. The conservative group showed a higher Constant score.

Keywords: Proximal humerus fracture; PHILOS; Conservative; Elderly patients.

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Introduction

Proximal humeral fractures account for 5:6% of all adult fractures **(Brown and Caesar, 2006).** A fall from standing height is the most common trauma mechanism 89% of cases **(Launonen et al., 2015**). The mechanism of trauma is related to age: low-energy trauma in elderly patients is observed. Neer defined a classification system for proximal humeral fractures, he described two-, three-, and four-part fractures of the proximal humerus **(Neer, 1970).**

According to Neer classification, 3-part and 4-part proximal humeral fractures are comminuted displaced fractures which represent 13% to 16% of all proximal humeral fractures **(Horak and Nilsson, 1975)**. A main controversy pertains to elderly patients with varying degrees of osteoporosis and displaced proximal humeral fractures after low- energy trauma. A wide range of treatment options for proximal humeral fractures is available. Soft tissue protection and fracture stabilization are important factors for union **(Bell et al., 2011)**. Non- operative management of proximal humerus fractures with a period of immobilization and progressive physiotherapy is a simple, noninvasive, and readily available treatment option, however it may result in non-union or malunion and give rise to poor functional results **(Polinder, 2013)**.

Open reduction internal fixation with Proximal Humerus Interlocking System (PHILOS) plate **(Yang et al., 2011)** is a good method for fine reduction, but extensive soft tissue exposure impairs the vasculature and doubles the risk of humeral head avascular necrosis **(Crenshaw and Perez, 2007**).

The work aimed to evaluate surgical treatment outcomes by PHILOS plate versus conservative treatment for displaced humeral fractures in elderly patients.

Patients and methods

This was a prospective randomized comparative study that was conducted on a total of 40 patients that fulfilled inclusion criteria presented with displaced proximal humeral fracture randomly selected from those seeking the medical care of the Orthopedic Surgery Department of our institute between 2022 and 2023, managed either by conservative management or by PHILOS plate.

This work was approved by the Research Ethics Committee of our institution, informed and written consent was obtained from all participants.

Ethical approval code: SVU-MED-ORT017-1-22-10-475.

Patient Selection

Inclusion criteria:

- Age > 50 years
- Displaced closed proximal humeral fractures.
- Low-energy trauma.

Exclusion criteria:

- Pathological fractures.
- Associated shoulder dislocation.
- Ipsilateral upper extremity injuries.
- Coexisting neurological or muscular diseases affecting the function of the injured shoulder.

Pre-operative assessment: All of the patients were subjected to the following:

Initial management and resuscitation: trauma survey and resuscitation measures to stabilize general condition.

Detailed History taking including: Age, sex, address, phone number, hand dominance, job, pre-fracture working ability and skills, medical co-morbidities and mechanism of injury, duration from injury till operation are recorded preoperatively.

Clinical Examination: Attention should be given to neurovascular status and any skin or soft tissue compromise.

Investigations: Routine Laboratory work up and preoperative fitness. Plain X-ray: Plain radiographs including a preliminary Anteroposterior (AP) and lateral radiograph of the affected side will be performed for diagnosis.

Patient Randomization: Patients were randomized to either Group A (Conservative management) or Group B (PHILOS).

Group A*:* closed reduction was performed, and the shoulder was immobilized in an arm sling for 3 weeks with passive ROM exercises starting after 2 weeks including pendulum exercises, followed by progressive exercises against resistance. Active Range of Motion (ROM) exercises were administered at the fourth week. After that to physical therapy and rehabilitation is started. Follow up was performed at the outpatient clinic at the 1st, 3rd, and 6th months of surgery **(Budharaju et al., 2023).**

Group B:

Surgical Technique:

Under general anesthesia, the patient is positioned in beach chair position (**Fig.1**).

Approach: Delto-pectoral approach or Deltoid split approach (transdeltoid lateral approach)

1- **Deltopectoral Approach (Sirisreetreerux et al., 2021):** Incision: a straight 10:15 cm incision is made following the line of the deltopectoral groove.

Internervous Plane: It is between the deltoid muscle supplied by axillary nerve and pectoralis major muscle supplied by lateral and medial pectoral nerves.

Fig.1. Intra-operative Beach-chair position

Superficial Dissection: the deltopectoral groove is identified, within it lies the cephalic vein surrounded by some fatty tissue so it may be difficult to visualize (Try to preserve the cephalic vein in order to reduce postoperative upper limb edema).

Deep Dissection: the short head of the biceps and coracobrachialis arise from the coracoid process (the conjoint tendon) and are retracted medially. The fascia on the lateral side of the conjoint tendon (clavipectoral fascia) is incised to reveal the subscapularis. The insertion of pectoralis major can be released partially at its superior edge as traverses the wound it can be released partially at its superior edge. The insertion of deltoid can be elevated to expose the lateral aspect of the humerus for plate positioning.

2- **Deltoid split approach (Robinson and Murray, 2011):** Deltoid splitting approach is done. Starting from the acromial tip, a 5cm longitudinal incision is made down the lateral aspect of the arm. Deltoid splitting is in line with its fibers so that there is no true internervous plane in lateral Approach. Subacromial bursa is deep to deltoid muscle and could be excised. Deltoid splitting is not more than 5cm to avoid axillary nerve injury, so another incision is done distal to the area crossed by axillary nerve or extended deltoid splitting approach is used which is distal longitudinal extension of the previous approach. A great caution must be taken on deltoid splitting to identify and trace the axillary nerve by inserting an index finger and directing it distally and laterally and the nerve is protected by a rubber sling (**Fig.2**).

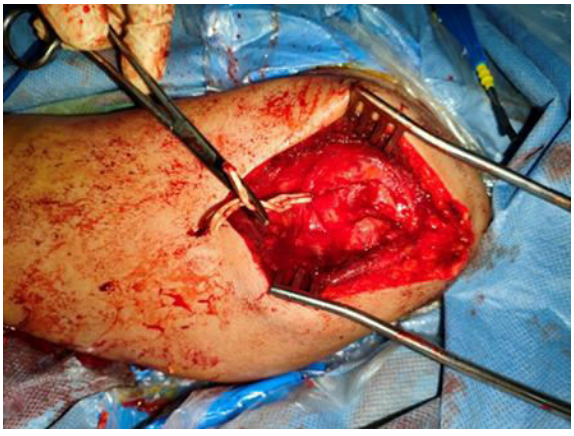

Fig.2. Intraoperative image of the axillary nerve protected by a rubber string

Deltoid splitting is avoided in the area crossed by the nerve and splitting is continued below this area.

Reduction: distal traction with increased angulation could be helpful for disimpact the fracture. Joy-stick technique may be used for reduction by inserting a k-wire into proximal fragment and gentle manipulation. To expose the humeral head, we use a blunt curved huhmann. Temporary fixation with 2-3 wires is done after reduction.

Fixation: by image intensification we make sure that we have a good correct reduction in 2 planes. Then positioned by sliding it down the lateral aspect of the humerus under the axillary nerve and should be 8mm distal to top of greater tuberosity.

The plate is fixed to the bone by 2 wires proximally (each has a specific hole) and 2 wires distally then reconfirm the reduction and plate position by c-arm images.

Drill sleeves are better to be used for proximal screws to avoid drilling the subchondral bone and the shoulder joint so that we drill the near cortex only, the screw length should be shorter than the measured length then inserted through the sleeve into the humeral head.

Distal screws (2:3) should be away from the axillary nerve may be through another incision distal to it.

Finally, we check the correct reduction and length of screws using C-arm.

Post-operative care:

A) Medications prescribed: Pain control using analgesics postoperatively is important to ensure early mobilization. Postoperative antibiotics are used for 2 weeks.

B) Immediate Postoperative Plain radiograph: AP and lateral radiographs were obtained in the first postoperative day.

C) ROM exercise should be started as early as possible

Outcome assessment

Follow up appointments are scheduled at 1 month, 3 months, 6 months, (**Fig.3 &4**).

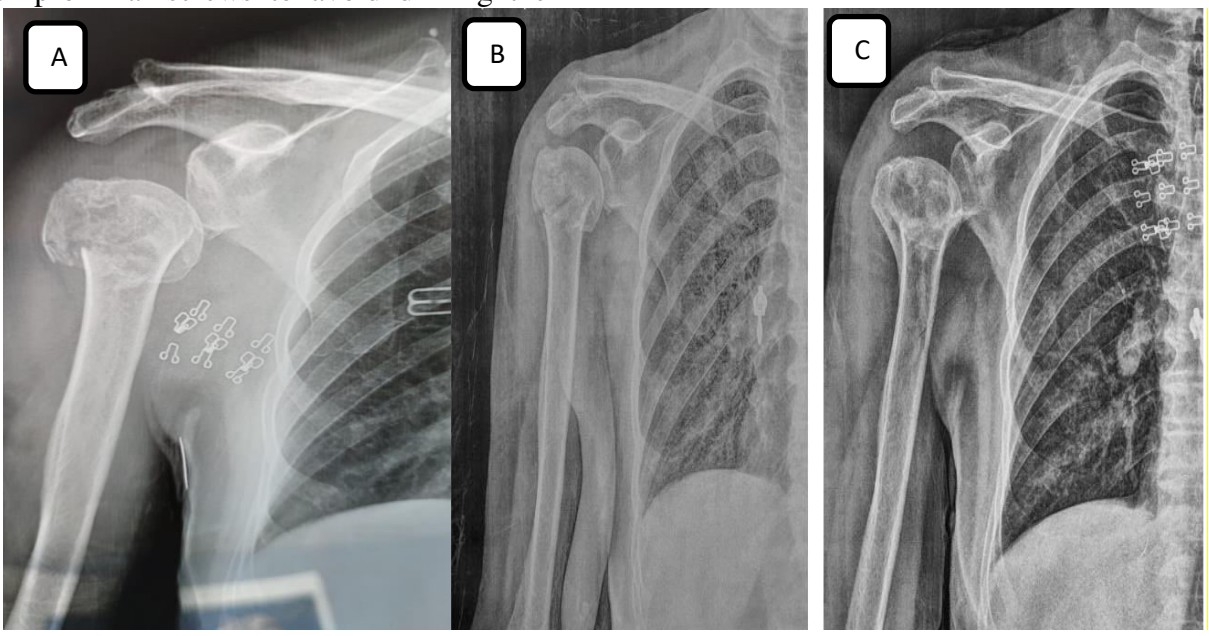

Fig.3. A: plain x-ray at time of trauma, B: follow up 1 month, C: follow up 6 months for a case treated by the conservative approach with closed reduction.

Functional evaluation consists of ROM, Constant shoulder Score at 6 months postoperatively and American Shoulder and Elbow Surgeon's Score (ASES). The Constant-Murley score (CMS) is a 100-points scale composed of a number of individual parameters. These parameters define the level of pain and the ability to

carry out the normal daily activities of the patient.

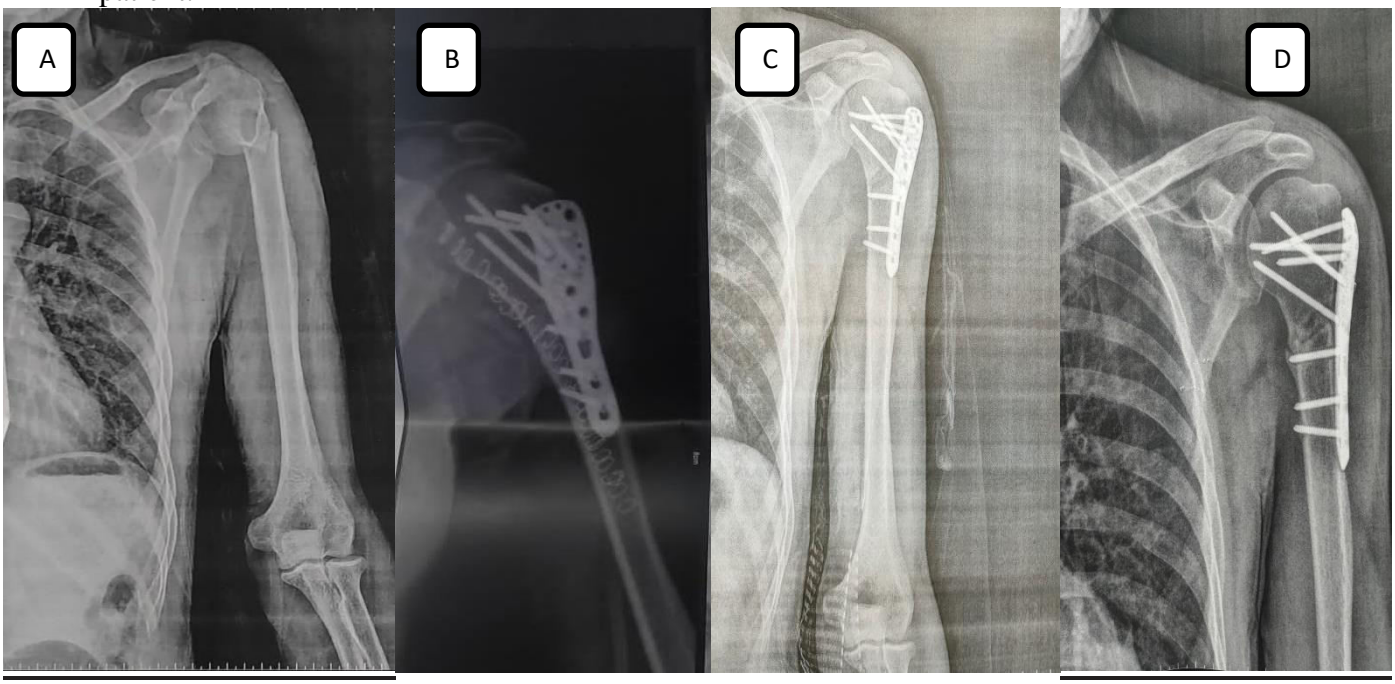

Fig.4.A: plain x-ray at time of trauma, B: immediate postoperative x-ray, C: follow up 1 months, D: follow up 6 months for a case treated under general anathesia open reduction and internal fixation by PHILOS were done.

The ASES is a 100-point scale that consists of two sections: pain (7 items) and activities of daily living (10 items). Scores range from 0 to 100 with a score of 0 indicating a worse shoulder condition and 100 indicating a better shoulder condition.

Statistical analysis

All data were collected, tabulated and statistically analysed using SPSS 26.0 for windows (SPSS Inc., Chicago, IL, USA). Qualitative data were described using number and percent. Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. All statistical comparisons were two tailed with significance Level of P-value < 0.05 indicates significant while, P> 0.05 indicates non-significant difference.

Chi-square (X2) test of significance was used to compare proportions between qualitative parameters. Fisher Exact test was used to compare proportions between qualitative parameters if one parameter represented 0 or 100% of the group. independent T-test was used to compare between two independent groups with parametric quantitative data. Mann-Whitney U test: This test was used to compare between two independent groups with non-parametric quantitative data.

Results

Forty patients presented with proximal humerus fracture above 50yrs old, twenty in the Conservative treatment group and twenty in the PHILOS group. The average age for Conservative Treatment Group - 57.1 years, while PHILOS Plate Group - 57.5 years, Gender distribution varies slightly but is not statistically significant in Conservative Treatment group 80% female, PHILOS Plate group average: 60% female.

Flexion: At the 1st month, the average flexion was 127.3 degrees for the Conservative Treatment group and 129.5 degrees for the PHILOS Plate group (p-value = 0.66044), indicating no significant difference between the groups. However, at the 6th month a significant difference in flexion was found between the groups: The average flexion for the Conservative Treatment group was 165.5 degrees, while

for the PHILOS Plate group, it was 150.3 degrees (p-value = 0.00612). (**Table.1**).

Table 1. Flexion analysis in both study groups through study

Variables		**Conservative Treatment Group (N = 20)**	**PHILOS Plate Group (N = 20)**	**P. Value**
1 month (1st visit)	**Mean ± SD**	127.3 ± 12.45	129.5 ± 18.41	0.66044
	Median (Range)	128.5 (108-142)	129 (108-155)	
3 months (2nd visit)	**Mean ± SD**	145.7 ± 4.92	137.6 ± 21.53	0.10925
	Median (Range)	147 (138-152)	131.5 (115-166)	
6 months (3rd visit)	**Mean ± SD**	165.5 ± 10.58	150.3 ± 20.89	0.00612*
	Median (Range)	163 (150-183)	158.5 (125-173)	
P. Value for 3 visits		<0.0001*	<0.0001*	

SD: Standard Deviation

Extension: At the 1st month, there was no significant difference. The Conservative Treatment group had an average extension of 34.2 degrees, while in PHILOS Plate group was 28.2 degrees (p-value = 0.08091). Furthermore, at the 6th month, no significant difference. The Conservative Treatment group had an average extension of 49.9 degrees, and in the PHILOS Plate group was 49.6 degrees (p-value = 0.92181). Overall, the comparison reveals a non-significant difference in extension for the Conservative Treatment group (p-value = 0.92181), while the PHILOS Plate group showed a highly significant increase in extension over the three visits (p-value < 0.0001*), (**Table.2**).

Table 2. Extension analysis in both study groups through study

Variables		**Conservative Treatment Group (N = 20)**	**PHILOS Plate Group (N = 20)**	**P. Value**
1 month (1st visit)	**Mean ± SD**	34.2 ± 12.72	28.2 ± 7.88	0.08091
	Median (Range)	31 (15-51)	30 (20-41)	
3 months (2nd visit)	**Mean ± SD**	39.6 ± 12.45	36.7 ± 10.24	0.42608
	Median (Range)	39.5 (25-60)	39.5 (26-60)	
6 months (3rd visit)	**Mean ± SD**	49.9 ± 9.43	49.6 ± 9.77	0.92181
	Median (Range)	50.5 (39-61)	49.5 (38-61)	
P. Value for 3 visits		0.0213*	<0.0001*	

SD: Standard Deviation

Adduction: At the 1st month, there was no significant difference in adduction between the two study groups. The Conservative Treatment group had an average adduction of 70 degrees, while the PHILOS Plate group had 64.8 degrees (p-value = 0.69416). At the 6th month, no significant difference in average adduction was found between the groups. The Conservative Treatment group had an average adduction of 94 degrees, and the PHILOS Plate group had 94.4 degrees (p-value = 0.97981). Overall, no significant difference in adduction for both groups (Conservative Treatment group p-value = 0.5956, PHILOS Plate group p-value = 0.2736), (**Fig.5**).

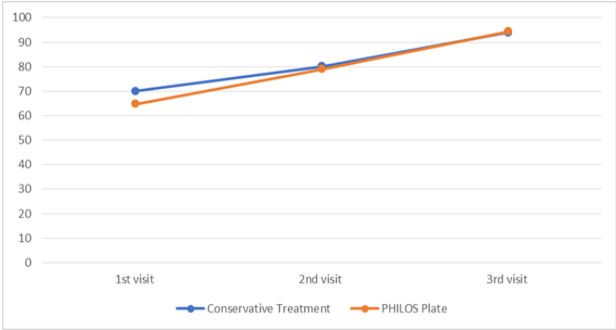

Fig.5. Adduction analysis in both study groups through study

Abduction: At the 1st month, there was no significant difference in abduction between the two study groups. The Conservative Treatment group had an average abduction of 85.7 degrees, while the PHILOS Plate group had 96 degrees (p-value = 0.57315). At the 6th month, no significant difference was found: The Conservative Treatment group had an average abduction of 111.5 degrees, and the PHILOS Plate group had 109 degrees (p-value = 0.90472). Overall, the comparison shows no significant difference in abduction for both groups (Conservative Treatment group p-value = 0.5998, PHILOS Plate group p-value = 0.9199), (**Fig.6).**

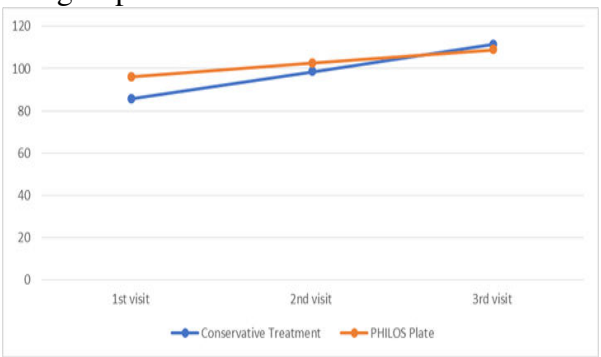

Fig.6. Abduction analysis in both study groups through study

Internal rotation: At the 1st month, there was no significant difference. The Conservative Treatment group had an average internal rotation of 56.3 degrees, while the PHILOS Plate group had an average internal rotation of 56.8 degrees (p-value = 0.83109). However, at the 6th month, a significant difference was found between the groups. The Conservative Treatment group had an average internal rotation of 77.1 degrees, while the PHILOS Plate group had an average internal rotation of 68.5 degrees (p-value = 0.00102*). The overall comparison shows a highly significant increase in internal rotation for both the Conservative Treatment group (p-

value < 0.0001*) and the PHILOS Plate group (p-value = 0.031*), (**Fig.7**).

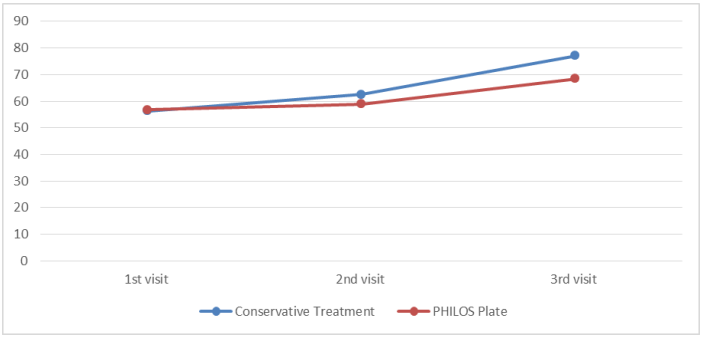

Fig.7. Internal rotation analysis in both study groups through study

External rotation: At the 1st month, there was no significant between the two study groups. The Conservative Treatment group had an average external rotation of 52.1 degrees, while the PHILOS Plate group had an average external rotation of 58.6 degrees (p-value = 0.12586). Likewise, at the 6th month, no significant difference was found between the groups. The Conservative Treatment group had an average external rotation of 69.1 degrees, and the PHILOS Plate group had an average external rotation of 67.5 degrees (p-value = 0.66979).). However, when considering the data from all three visits combined, a significant increase in external rotation was observed for the Conservative Treatment group (p-value = 0.0018*). In contrast, the PHILOS Plate group showed no significant change in external rotation over the three visits (p-value = 0.4167), (**Fig.7).**

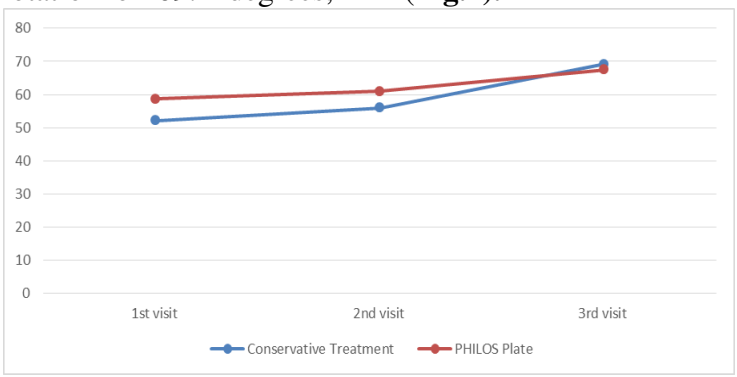

Fig.8. External rotation analysis in both study groups through study

Constant score and ASES: The Constant score show significant difference between groups (Conservative group average: 14.8, PHILOS Plate group average: 11.5, p-value = 0.01859*). Similarly, the ASES score shows no significant difference between groups (Conservative group average: 75.5, PHILOS Plate group average: 79.9, p-value = 0.23251), (**Table.3**).

Table 3. Constant score and ASES in both study groups

Variables		Conservative Treatment Group (N = 20)	PHILOS Plate Group (N = 20)	P. Value
Constant	**Mean ± SD**	14.8 ± 4.02	11.5 ± 4.45	0.01859*

score	**Median (Range)**	15 (9-21)	9 (9-20)	
ASES	**Mean ± SD**	75.5 ± 8.2	79.9 ± 7.72	0.23251
	Median (Range)	79 (60-82)	79 (70-94)	

SD: Standard Deviation; ASES: American Shoulder and Elbow Surgeon's Score

Discussion

In our study, both groups demonstrated considerable engagement with physiotherapy and comparable average session counts. Examining joint motion, we observed that in terms of flexion, there were no noteworthy disparities between the Conservative Treatment and PHILOS Plate groups during the first ($p = 0.66044$) and second ($p = 0.10925$) visits. Notably, a remarkable improvement emerged during the third visit ($p < 0.0001$*), revealing average flexion values of 165.5 degrees for Conservative Treatment and 150.3 degrees for PHILOS Plate. Additionally, our study found consistent extension values between the two groups across all visits, resulting in statistically nonsignificant comparisons ($p = 0.92181$). Likewise, for adduction, abduction, internal rotation, and external rotation, no significant differences were observed between the Conservative Treatment and PHILOS Plate groups at any visit, underscoring the stability and consistency of motion outcomes.

In contrast, **Çaliskan et al. (2019)** aimed to compare the functional outcomes of non-operative management and open reduction internal fixation using the proximal humerus internal locking system for 2-, 3-, and 4-part proximal humerus fractures. Their investigation encompassed a total of 92 proximal humerus fractures, comprising a nonoperative group (n = 47) and an operative group (n = 45), in addition to a healthy control group (n = 45). The study's findings revealed that the operative group exhibited reduced shoulder range of motion (ROM) compared to the nonoperative group, with a statistically significant difference observed only in abduction. Additionally, in terms of muscle strength, the operative group demonstrated significantly greater power in both arm flexor and forearm extensor muscles. While operative treatment led to improved muscle strength in certain muscle groups, it was associated with a reduction in shoulder ROM, particularly in abduction.

Similarly, **Olerud et al. (2011)** conducted a study comparing locking plate surgery to non-operative treatment for three-part fractures. The surgery group achieved flexion ranges of 120° and abduction of 114°, while the non-operative group had respective values of 111° and 106°. However, these differences were not statistically significant and had no clinical relevance.

In our study, we noted a significant disparity in the Constant score, with Conservative Treatment yielding a higher average (14.8 vs. 11.5) compared to PHILOS Plate ($p = 0.01859$*), while no significant difference was observed in ASES score ($p = 0.23251$).

The difference in the Constant score between the Conservative Treatment and PHILOS Plate groups, along with the absence of a significant difference in the ASES score, can be comprehended by considering the specific aspects these scoring systems evaluate and how different treatment methods may impact these aspects. The Constant score is a comprehensive tool that assesses various dimensions of shoulder function, including pain, range of motion, strength, and daily activities. The higher Constant score observed in the Conservative Treatment group could be attributed to several factors associated with this treatment approach.

Conservative treatment generally involves interventions that are less invasive, potentially leading to fewer post-operative complications and less discomfort. This could contribute to lower pain levels, which would be reflected in a better score in the pain component of the Constant score. Furthermore, if the conservative treatment approach resulted in maintained or improved range of motion and strength, it would positively influence the respective components of the score. Cumulatively, these factors might explain the higher Constant score seen in the Conservative Treatment group **(Vrotsou et al., 2018; Zielger et al., 2019)**.

In contrast, the American Shoulder and Elbow Surgeons (ASES) score predominantly focuses on evaluating pain and function. The lack of a significant difference in ASES scores between the two treatment groups may indicate that both the Conservative Treatment and PHILOS Plate groups achieved similar outcomes in terms of pain reduction and functional improvement. This suggests that while the Constant score takes into account a broader range of parameters, the ASES score, emphasizing pain and function, likely yielded more comparable results between the groups **(Tashjian et al., 2017).**

Olerud et al. (2011) reported that the surgery group achieved a Constant score of 61, while the non-operative group had respective values of 58.4. However, these differences were found to lack both statistical significance and clinical relevance.

Likewise, **Tamimi et al. (2015)** examined the medium-term functional outcomes of four common proximal humeral fracture treatments (conservative, PHN, PKW, LP) in patients over 65 years of age. They discovered no significant distinctions in Constant and DASH scores between conservative and locking plate treatments, with p-values of 0.39 and 0.80, respectively. This suggests a similarity in shoulder function and arm use within this age group. In relation to our findings, we identified a higher Constant score with Conservative Treatment underscores the distinct outcomes associated with different treatments for proximal humeral fractures.

The absence of complications in both groups such as non-union, infection, osteopenia, nerve injury, revision, or intraarticular screw penetration speaks to the success of the treatment approaches utilized in maintaining bone stability and minimizing adverse events. This underscores the importance of appropriate patient selection, careful surgical technique, and vigilant post-operative management in reducing the risk of complications.

These results contrast with the study conducted by **Okike et al. (2015**), which reported a 40% malunion rate following surgical treatment for proximal humeral fractures (PHFs), underscoring the diverse outcomes associated with various treatment approaches.

Furthermore, the study by **Rangan et al. (2015)** emphasized a relatively higher risk of complications (28.8%) associated with surgical treatment compared to conservative treatment (18.4%), underscoring the need to balance efficacy and complication rates when determining the appropriate treatment strategy.

One notable complication of conservative treatment for PHFs is the potential loss of mobility. However, studies like the one by **Olerud et al. (2011)** have compared surgical and non-operative approaches and found relatively comparable ranges of motion and functional scores between the two groups. The differences observed were not statistically significant or clinically relevant. This suggests that while mobility might be a concern, it might not be a decisive factor when choosing between surgical and non-operative treatments for three-part fractures.

Moreover, our study's findings point to a higher malunion rate in the Conservative Treatment Group, diverging from **Soler-Peiro et al. (2020)** research that favored conservative treatment for three-part and four-part PHFs. Soler-Peiro et al.'s

study suggested successful fracture healing and good functional outcomes with conservative treatment, while our findings highlighted differences in malunion rates. The collective evidence, including our study, underscores the complexity of treatment decision-making for proximal humeral fractures, necessitating a comprehensive assessment of radiological outcomes, complication rates, and functional considerations.

Also, **Fjalestad et al. (2012)** studied displaced three and four-part fractures in patients over 60 years of age. They found no evidence that surgical treatment with an angle-stable device provided better results than conservative treatment.

Our results were in disagreement with **Lange et al. (2016)** who reported that the nonoperative group encountered fewer complications, highlighting the safety advantages of nonoperative treatment. The complication rate of 37% was higher in the surgery group with a reoperation rate of 32%.

In contrast, research by **Tamimi et al. (2015)** showed positive radiological outcomes in operative groups and fewer complications in nonoperative groups. These differing perspectives underscore the complex considerations surrounding treatment decisions for proximal humeral fractures, where factors such as healing time, complication rates, and radiological outcomes play crucial roles.

Limitations: The relatively small sample size of forty patients, with twenty in each group, might limit the generalizability of our findings to a broader population. The short duration of follow-up could potentially overlook longer-term complications or outcomes. The lack of blinding and potential biases associated with the subjective nature of certain assessments, such as range of motion measurements, could influence the interpretation of our results.

Conclusion

The conservative treatment group improved flexion and internal rotation, whereas the PHILOS plate group improved extension and exterior rotation. Conservatives scored better on Constant. Functional results may benefit from the Conservative Treatment Group's higher Constant score. Conversely, the PHILOS Plate Group had a reduced fracture union time, suggesting bone healing benefits.

Abbreviations: ASES: American Shoulder and Elbow Surgeon's Score, AP: Anteroposterior, CMS: Constant-Murley Score, CT: Computed Tomography, PHILOS: Proximal Humerus Interlocking System, ROM: Range of Motion, SPSS: Statistical Package for Social Sciences.

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