

## Evaluation of Proximal Humerus Internal Locking System in Management of Proximal Humeral Fractures

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### ABSTRACT

**Background:** Because they provide tight anatomical fixation and better angular stability, the proximal humerus PHILOS plate is now the implant of choice for treating displaced proximal humerus fractures.

**Objective:** This study aimed to improve radiological & clinical outcome of proximal humeral fractures using PHILOS Plate.

**Patients and Methods:** A prospective study involving 30 cases of proximal humeral fractures was done from January to December 2021. All patients were operated at Zagazig University Hospitals. All patients were treated surgically, with open reduction of the fractures and internal fixation with proximal humeral locking plates. The cases were followed for 6 months to a year.

**Results:** All fractures healed satisfactorily, except in five patients. In two patients, there was stiffness, one with avascular necrosis (type 4 Neer classification) scheduled for plate removal and hemiarthroplasty and one with infection, which subsided after treatment. Fracture healing happened with varus displacement in one patient, and the patient was pleased with the outcome.

**Conclusion:** Locking plates offer more advantages than conventional plates specially when dealing with osteoporotic bone. It is recommended to use locking plate whenever an elderly patient is indicated for internal fixation.

**Keywords:** Proximal humeral fractures, Internal locking system.

### INTRODUCTION

Approximately 5% of all adult fractures result in dislocation of the proximal humerus. Low-energy trauma is the most common cause of injury in elderly osteoporotic patients. Even in cases of minor displacement, sling therapy and functional rehabilitation under medical supervision are effective. Displaced proximal humerus fractures with significant displacement or comminution require surgical treatment in 15% to 20% of cases <sup>(1,2)</sup>.

The number of fracture sections and the displacement are the two key components of the Neer classification, which is one of the classifications for proximal humerus fractures <sup>(3)</sup>.

The best treatment options for displaced proximal humerus fractures are still up for dispute. For proximal humerus fractures, various fixation techniques have evolved, including plating, arthroplasty, transosseous suturing, tension band wiring nailing percutaneous, and pinning. Nonunion, malunion, and osteonecrosis are major postoperative risks with any humeral-head-preserving procedure. Humerus proximal PHILOS plates are the preferred implant for treating displaced proximal humerus fractures because they provide tight anatomical fixation and increased angular stability, allowing for early mobilization and a satisfactory functional outcome <sup>(4, 5, and 6)</sup>.

It was the goal of this work to improve radiological & clinical outcome of proximal humeral fractures using PHILOS Plate.

### PATIENTS AND METHODS

This study was conducted in the period from January 2021 to December 2021 in the Orthopedic Surgery Department, Zagazig University Hospitals. We retrieved 30 cases with proximal humeral fractures where open fracture reduction and internal fixation with proximal humeral locking plates were used in all of the cases.

#### Ethical consent:

**Zagazig University's Research Ethics Council approved the study as long as all participants signed informed consent forms and submitted them to ZU-IRB#6095.**

**We adhered to the Helsinki Declaration, which is the ethical norm for human testing established by the World Medical Association.**

#### Inclusion criteria:

Patients with a displaced proximal humeral fracture as defined by the Neer classification system, skeletally mature patients aged above 18 years, fracture dislocation proximal humerus, floating shoulder, and elderly porotic patients.

#### Exclusion criteria:

Infection, skeletally immature patients, and undisplaced proximal humeral fractures.

**All patients were subjected to the following:**

**Full history:**

Name, age, sex, residence, medical history of chronic and metabolic diseases, date of examination and/or admission, contact information and other habits of medical interest.

**Clinical examination:** General examination, local examination and neurovascular examination were done.

**Laboratory investigations:** Random blood sugar, complete blood picture, and renal function tests

**Radiological investigations:**

**Plain radiography:** Axillary, Antero-posterior (AP), as well as lateral scapular (Y view) radiographs during a shoulder trauma series, were obtained for each patient.

**Value of CT:** It was utilized for assessment of fracture displacement, articular involvement as well as glenoid rim fractures.

**Operative technique:**

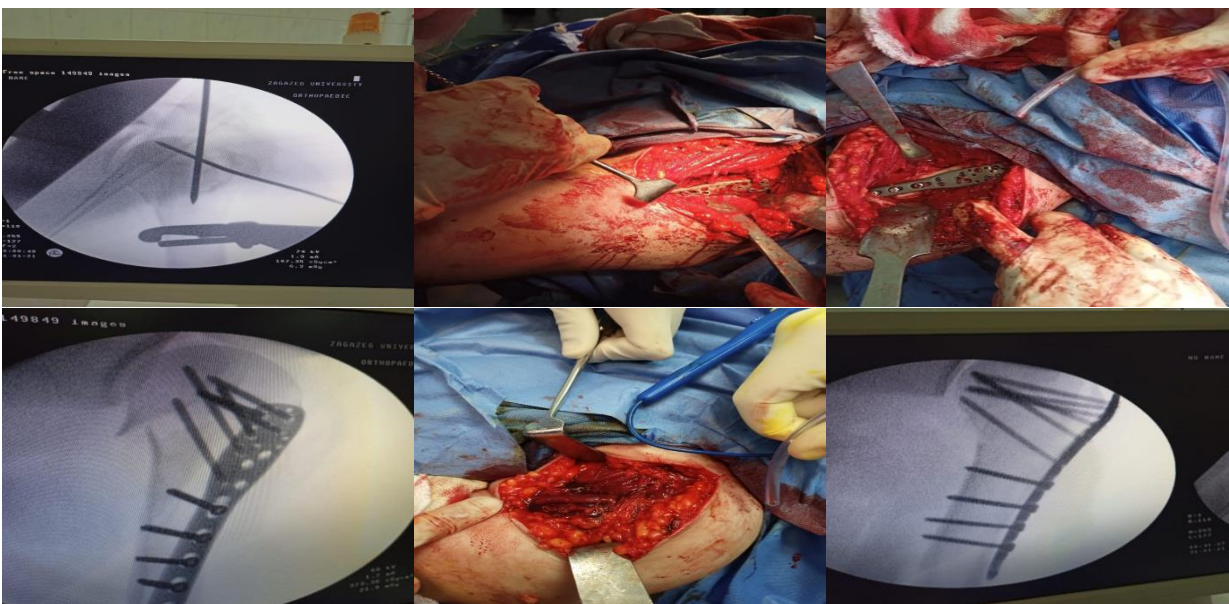
An arm board supported one patient's dangling arm while he was being operated on from the table's

edge in an elevated position. Using this method, the fracture might be decreased anatomically because the arm could move freely. A deltopectoral approach was employed to get access to the proximal humerus and the acromion's tip was palpated and used as a landmark. The route of muscle fibers, the cephalic vein itself, and the adipose tissue surrounding the vein all point to the cephalic vein being exposed and then retracted medially or laterally.

To avoid surgical limb oedema, do a blunt dissection between the deltoid and pectoralis muscles to reveal the clavipectoral fascia. Following this procedure, the clavipectoral fascia fracture fragments were cut. An image intensifier directed K-wires to hold the reduced fracture pieces in place.

The slotted gliding hole on plates should be drilled first in the center to allow for modest plate height variations. Long head of biceps tendon saved during definitive fixation by locked plate lateral to bicipital groove.

The larger tubercle's apex was at least a centimeter away from the plate. There was a table set up to measure the shoulder's range of motion and whether or not it was impinged.



**Figure (1):** Proximal humerus fracture with steps of reduced fracture fragment with k-wire and placement (Philos) plate.

**Follow up:** Following surgery, all patients were examined clinically (at 2 weeks, 6 weeks, 3 months, and 6 months postoperatively) and radiologically (at 6 weeks, 3 months, 6 months postoperatively, and 1 year postoperatively).

**Clinical evaluation:** Patients were rated using the Constant score (CS), a 100-point rating system created by Constant and Murley at the end of their follow-up period (7).

**Radiological evaluation:** In AP and lateral shoulder radiographs, fracture healing and reduction maintenance were assessed. Fracture healing was defined as the emergence of callus on radiographs and/or the elimination of fracture lines.

**Statistical analysis**

The collected data were coded, processed and analyzed using SPSS (Statistical Package for Social Sciences) version 22 for Windows® (IBM SPSS Inc., Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as frequencies and relative percentages. Chi square test ( $\chi^2$ ) was used to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean  $\pm$  SD (Standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value < 0.05 was considered significant.

**RESULTS**

This study included 30 patients, female represented 33.3% of them with age ranged from 30 to 75 years and a mean age of 53.97 years (Table 1).

Concerning Neer classification, six patients (20%) had class 2, 50% had class 3 and 30% had Neer class 4. Right side lesion represented 60% of patients. Fifteen patients (50%) had fracture caused by fall on outstretched hand and 33.3% had road traffic accidents (Table 2).

On studying postoperative complications, one had avascular necrosis of head, one had infection, one had malunion and two patients had stiffness. Twenty-five patients passed uncomplicated (Table 3).

**Forward flexion** ranged from 70° to 180° with a mean of 138.87°. **Abduction** ranged from 80 ° to 180 ° with a mean of 138.4 °.

**Regarding external rotation**, 13.3% of patients can get hand behind neck and elbow back, 16.7% of patients can get hand behind neck and elbow forward, 36.7% of patients can get hand above neck and elbow back and 33.3% of patients have full elevation of arm.

**Regarding internal rotation of dorsum of hand**, 13.3% of patients can get it to lumbosacral junction, 13.3% of patients can get it to waist, 36.7% of patients can get it to 12<sup>th</sup> dorsal vertebrae and 36.7% of patients can get it to interscapular region.

**Mild pain** occurred in 23.3% of patients. One patient (3.3%) had moderate limitation of daily activities, seven patients (23.3%) had mild limitation while remaining twenty-two patients had no limitation with a score ranged from 7 to 20 and a mean of 16.07 (Table 4).

**Constant score (Table 5):** Constant score ranged from 40 to 99 with a mean of 76.43. Based on this, a score of 90 to 100 points was seen as excellent. A score of 80 to 89 points was considered satisfactory. 70 to 79 scores were deemed acceptable, while less than 70 points were deemed poor. Two patients (6.7%) had poor outcome, three patients (10%) had fair outcome, ten patients (33.3%) had good outcome while remaining fifteen patients (50%) had excellent outcome.

**Table (1):** Distribution of the studied patients according to demographic data

	N=30	%
<b>Age (year):</b>		
Mean $\pm$ SD	53.97 $\pm$ 13.57	
Range	30 – 75	
<b>Gender:</b>		
Female	10	33.3%
Male	20	66.7%

**Table (2):** Distribution of the studied patients according to fracture-related data

	N=30	%
<b>Neer class:</b>		
Two	6	20%
Three	15	50%
Four	9	30%
<b>Side:</b>		
Left	12	40%
Right	18	60%
<b>Mechanism:</b>		
Fall from height	5	16.7%
Fall on outstretched hand	15	50%
Road traffic accident	10	33.3%

**Table (3):** Distribution of the studied patients according to complications

	N=30	%
<b>Complications:</b>		
No	25	83.3%
Avascular necrosis	1	3.3%
Infection	1	3.3%
Malunion	1	3.3%
Stiffness	2	6.7%

**Table (4):** Distribution of the studied patients according to components of constant score

	Mean ± SD	Range
<b>Range of forward flexion (°):</b>	138.87 ± 28.25	70 – 180
<b>Abduction (°):</b>	138.4 ± 28.25	80 – 180
	N=30	%
<b>External rotation:</b>		
Hand behind neck and elbow back	4	13.3%
Hand above neck and elbow forward	5	16.7%
Hand above neck and elbow back	11	36.7%
Full elevation of arm	10	33.3%
<b>Internal rotation:</b>		
Dorsum hand to lumbosacral junction	4	13.3%
Dorsum hand to waist (third lumbar)	4	13.3%
Dorsum of hand to 12 <sup>th</sup> dorsal vertebrae	11	36.7%
Dorsum of hand to interscapular region	11	36.7%
<b>Pain:</b>		
No	23	76.7%
Mild	7	23.3%
<b>Daily living activity:</b>		
No limitation	22	73.3%
Mild limitation	7	23.3%
Moderate limitation	1	3.3%
<b>Mean ± SD</b>	16.07 ± 3.04	
<b>Range</b>	7 – 20	

**Table (5):** Distribution of the studied patients according to components of constant score

	N=30	%
<b>Outcome:</b>		
Poor	2	6.7%
Fair	3	10%
Good	10	33.3%
Excellent	15	50%
<b>Mean ± SD</b>	76.43 ± 12.99	
<b>Range</b>	40 – 99	



**Figure (2):** A 55-years-old female patient with no significant past medical history had a left two -parts proximal humeral fracture after falling on her shoulder. There was no neurovascular injury or associated fractures. The fracture was fixed by a long four-hole. Radiological evaluation of Case (1), (a) Left two parts proximal humeral fracture, (b) 24 weeks post-operatively.

**DISCUSSION**

An adult's proximal humerus fracture is common, making up about five percent of all fractures in adults. The majority of injuries in elderly osteoporotic adults are stable and caused by low-energy trauma. Slightly displaced fractures can be successfully treated with conservative sling therapy and functional rehabilitation under medical supervision. Surgical therapy is preferred in 15% to 20% of displaced proximal humerus fractures with considerable displacement or comminution (7).

The goal of this study was to improve the radiological and clinical outcomes of proximal humeral fractures using the PHILOS plate by evaluating the radiological outcome of PHILOS plate fixation in proximal humeral fracture management, as well as the clinical outcome of PHILOS plate fixation in proximal humeral fracture management. In addition, the radiological and functional outcomes of PHILOS plate fixation in the treatment of proximal humeral fractures were compared.

The current study included 30 patients, males represented 66.7% of the cases, while females represented 33.3% of them. The age ranged from 30 to 75 years with a mean age of 53.97 years. Charalambous *et al.* (8) reported that during their study period for proximal humeral fractures, 25 PHILOS fixations were performed in 23 patients. The mean age was 63 years ranging between 30 and 83 years?

Regarding gender, 12 cases were males, and 11 cases were females. Erasmo *et al.* (9) reported that in 82 cases, the patients in the study were 42 girls and 39 males, with a mean age of 56 years (range 20–86 years). One patient had a vascular injury to the axillary artery, which was corrected with an autograft venous transplantation, while another had partial brachial plexus neuropraxia at the time of admission (9).

Concerning Neer class for fracture classification, six patients (20%) had class 2, 50% had class 3 and 30% had class 4. Right side lesion represented 60% of patients. Regarding the injury mechanism, fifteen patients (50%) had fracture caused by fall on outstretched hand and 33.3% had road traffic accidents. Thyagarajan *et al.* (10) reported that the average age of the 30 patients was 58 years old, according to the study (range, 19-92 years). Only 5 of the patients were under the age of 35, 8 were between the ages of 36 and 55, 9 were between the ages of 56 and 75 and 8 were between the ages of 76 and 95. The most common cause of injury was a simple fall, although other reasons included car accidents, skiing, and a ladder fall. Erasmo *et al.* (9) reported that there were seven two-part fractures, 40 three-part fractures, and 35 four-part fractures, according to Neer classification. Twelve of the patients also suffered proximal humerus fractures and dislocations.

The current study showed that on studying postoperative complications, one had avascular

necrosis of hip, one had infection, one had mal-union and two patients had stiffness. Twenty-five patients passed uncomplicated. **Jose et al.** <sup>(11)</sup> reported that two patients developed a profound infection by the second month of follow-up, necessitating IV antibiotics and the removal of the implant. One patient suffered a brachial plexus damage after surgery. In the third month, one of the patients developed shoulder joint subluxation. Avascular necrosis of the humeral head was discovered in one patient after six months of follow-up. There were no other implant-related problems save for one patient who had subacromial impingement due to a cranially inserted Locking plate. No patients experienced an undetected primary screw perforation of the humeral head during surgery. In total, three patients (10%) underwent a second unscheduled surgery less than six months following the first. Patients who did not have any issues had a statistically significant higher Constant score than those who had any of the difficulties <sup>(11)</sup>. **Tang et al.** <sup>(12)</sup> reported that infection and liquefaction occurred in two cases, both of which were treated following treatment and the other 29 cases had primary wound healing. Shoulder pain affected five people.

In our study, the range of forward flexion ranged from 70° to 180° with a mean of 138.87°. Abduction ranged from 80° to 180° with a mean of 138.4°. **Safwat et al.** <sup>(13)</sup> reported that the range of forward flexion ranged from 90° to 170° with a mean degree of 139.67±28.44, while the range of abduction ranged from 70° to 160° with a mean degree of 122.07±30.12. There was significant decrease relation between forward flexion and pain score (P=0.001)

The current study showed that regarding external rotation, 13.3% of patients can get hand behind neck and elbow back, 16.7% of patients can get hand behind neck and elbow forward, 36.7% of patients can get hand above neck and elbow back and 33.3% of patients had full elevation of arm. **Charalambous et al.** <sup>(8)</sup> reported that three of the fractures that did union were mal-united, two of these fractures were not successfully reduced, with neck-shaft angles of 119° and 108° in the immediate post-operative period, respectively, and 113° and 103° at final follow-up. The third patient's immediate post-operative neck-shaft angle was 127°, and the final was 118°, indicating that malunion was caused by post-operative fracture collapse.

Regarding internal rotation of dorsum of hand, 13.3% of patients can get it to lumbosacral junction, 13.3% of patients can get it to waist, 36.7% of patients can get it to 12<sup>th</sup> dorsal vertebrae and 36.7% of patients can get it to interscapular region. **Safwat et al.** <sup>(13)</sup> reported that the shoulder was supported in a right-angled sling for 10 days. Passive mobilization was initiated in the immediate post-operative phase, depending on the degree of system stability and the grade of osteoporosis in elderly patients and passive mobilization was delayed for two weeks. Single pendulum exercises with passive mobilisation up to 30° were allowed in the first two weeks, with a range

increased to 90° in the third week. At that time, active-assisted shoulder workouts began and continued for up to 6 weeks. After 4 weeks, passive movements should be introduced, followed by active movements after 6 weeks. Elbow, wrist, and hand exercises were also prescribed. In the fourth week, active mobilization without weight was allowed, and in the sixth week, complete active mobilization was allowed <sup>(13)</sup>.

Mild pain occurred in 23.3% of patients. One patient (3.3%) had moderate limitation of daily activities, seven patients (23.3%) had mild limitation, while remaining twenty-two patients had no limitation with a score ranged from 7 to 20 with a mean of 16.07. **Safwat et al.** <sup>(13)</sup> reported that regarding pain classification, six patient did not suffer from any pain, also, six cases suffered from mild pain, while three cases suffered from moderate pain <sup>(13)</sup>.

Our results showed that Constant score ranged from 40 to 99 with a mean of 76.43. Based on this, a score of 90 to 100 points was regarded excellent. A score of 80 to 89 points was considered good. A decent score was 70 to 79 points, while a score of less than 70 points was considered poor. Two patients (6.7%) had poor outcome, three patients (10%) had fair outcome, ten patients (33.3%) had good outcome while remaining fifteen patients (50%) had excellent outcome. **Tang et al.** <sup>(12)</sup> reported that according to UCLA score, the patients had achieved significantly better outcomes in function, active forward flexion, strength of forward flexion, and subjective satisfaction in simultaneous operation group than in delayed operation group at 3, 6, and 12 months after operation (P<0.05). However, there was no significant difference in pain between the two groups (P>0.05). **Safwat et al.** <sup>(13)</sup> reported that reduction and osteosynthesis have numerous advantages over prosthetic replacement. The procedure is less intrusive, there are less postoperative problems, and recovery is easier and faster. Furthermore, the prosthetic implant's lifespan is limited, and shoulder prosthesis revision might be a demanding surgery. **Hirschmann et al.** <sup>(14)</sup> showed in a clinical evaluation of 57 patients treated with the Philos1 plate, 75% of patients had good-to-excellent results. They noted that the majority of problems and the need for reoperation occurred during the first 12 months after surgery.

## CONCLUSION

Locking plates offer more advantages than conventional plates specially when dealing with osteoporotic bone. It is recommended to use locking plate whenever an elderly patient is indicated for internal fixation. The reduction accomplished using Philos plates is preserved, and a favorable functional outcome can be envisaged. However, due to primary and secondary screw perforations into the glenohumeral joint, the frequency of complications is considerable.

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