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# PHILOS Plate Fixation for Displaced Two part to Four Part Fractures: A Prospective Study

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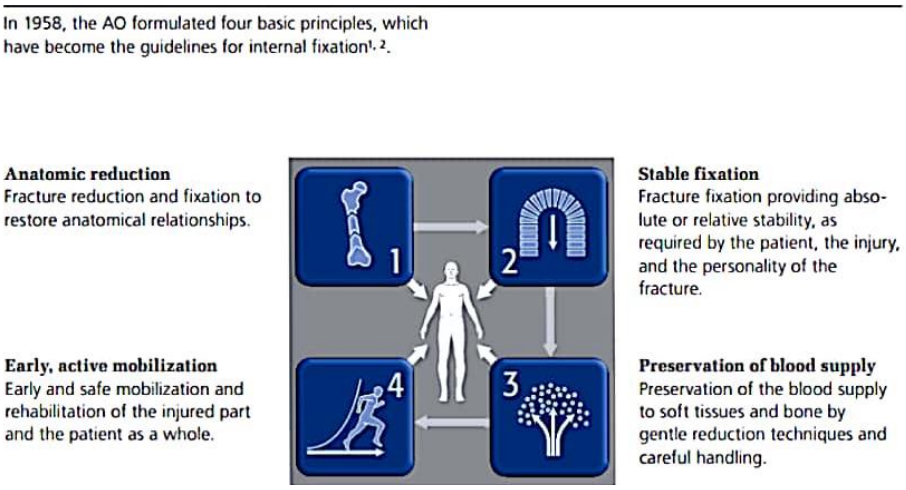
**Abstract:** Proximal humeral fractures constitute about 5 percent of all upper extremity fractures. It is the 3rd most common fracture in patients over the age of 65 years. Thus 65 percent of these fractures occur in patient above the age of 60 years. The female: male ratio is 3:1 and the incidence of this fracture increases with age. In the older patients, the mechanism of injury is low energy trauma. Hence therapists usually categorize these fractures under FOOSH injuries. Since majority of those sustaining these types of fractures have osteoporotic bone, operative treatment with locking compression plate has become the gold standard. The aim of this study is to analyse prospectively 30 cases of proximal humeral peri-articular fractures occurring in the osteoporotic bone of the elderly in the age group of 60 to 79 years trelated surgically with PHILOS plating. It is to study their radiological and functional outcome score and clinical outcomes and then to compare it with published literature. Also comparison shall be made as to the time elapsed from injury to surgery, surgery duration, loss of blood during surgery, post-op complications and time required for radiological bony union. In our series, the clinical outcome assessed as per Constant Shoulder Score achieved 40% fair, 40% good and 16.67% excellent results. We had 3.3% of poor outcomes. Our study concludes that LCP should be considered as a gold standard in treating displaced peri-articular proximal humeral fractures in the elderly with osteoporotic bone.
**Keywords:** Fragility fractures, proximal humerus fractures, PHILOS plating, locking compression plate.

## INTRODUCTION

Proximal humeral periarticular fractures in the elderly osteoporotic bone are categorized as fragility fractures. A fragility fracture indirectly implies the diagnosis of osteoporosis [1]. These fractures occurs in bone with reduced bone quantity and mineral density [2] and are extremely prevalent in the elderly and more so in the women. Fragility fractures are mostly low energy fractures that occur from fall from standing height or less [3]. The most common locations are vertebrae, hip, wrist and the proximal humerus [4]. The management of these types of fragility fractures have undergone a paradigm shift over the past 10 years [5]. Minimally invasive approaches combined with biologically friendly internal fixation have become accepted methods of treatment of these complex fractures [6]. The biomechanical properties of locking plates have distinguished and defined their clinical efficacy compared to conventional plates [7]. Locking plates function as 'internal fixators' with multiple anchor points [8]. The indications for use of locking plates have been evolving. The literature demonstrates low rates of non-union and overall less complication rates with locking compression plates in difficult meta-diaphyseal fragility peri-articular fractures [9]. Poor bone quality encountered in older adults, increases the technical difficulty and complications of operative treatment of fragility fractures. The goal of these surgeries is to optimize bone and/or joint alignment, preserve blood supply to aid healing and provide stability to allow early mobilization [10]. With locking plates screws become "one" with the plate reducing the possibility of hardware failure. Stability and "pullout" strength are determined by the sum of all locked screws, instead of a single screw. When screws are locked into fixed angles, the broken bones stay closer together on both ends of the fracture, increasing the likelihood of proper healing.

The plate-screw in a LCP assembly distributes uniformly the stresses along the entire length of the plate, making locking plates better suited for osteoporotic bone and multi-segment fractures. The use of the PHILOS plate via anterolateral deltoid splitting

approach has in the literature shown good outcomes and the same technique has been followed in our operative series also. While using this approach have several advantages, including minimal soft tissue disruption, preservation of natural biology and minimal blood loss, there has been an increased risk for axillary nerve damage. In our series, we have demonstrated that with strict adherence to the proximal humeral surface anatomy, the theoretical risk of damage to the axillary nerve can be avoided. In our series of PHILOS plate fixation of proximal humerus, we have adhered strictly to the principles of biological fixations as pioneered by AO group.




## MATERIALS AND METHODS

This prospective study was done at Sree Balaji Medical College and Hospital, Chromepet, Chennai from September 2015 to December 2017. In this 28 months of study duration, the recruitment of fresh case was stopped in April 2017, so that there would be a minimum follow up period of 8 months.

### Inclusion criteria

- Both male and female patients in the age group 60-79 years were included in the study.
- NEER fracture Type two part to four parts were included in the study.

### Exclusion criteria

- Type one part fractures were excluded from the study.
- Severely comminuted with head split fracture four parts were excluded from the study as they qualified for arthroplasty.
- Polytrauma patients were excluded from the study.
- Fractures older than 3 weeks from the time of injury were excluded from the study.

### NEER Classification [11]

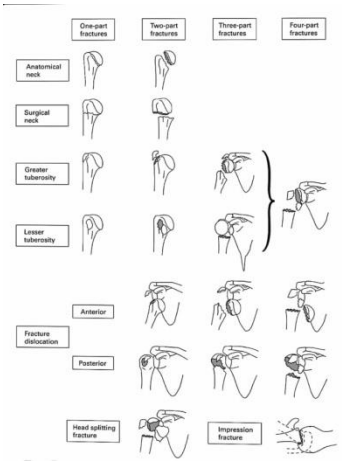
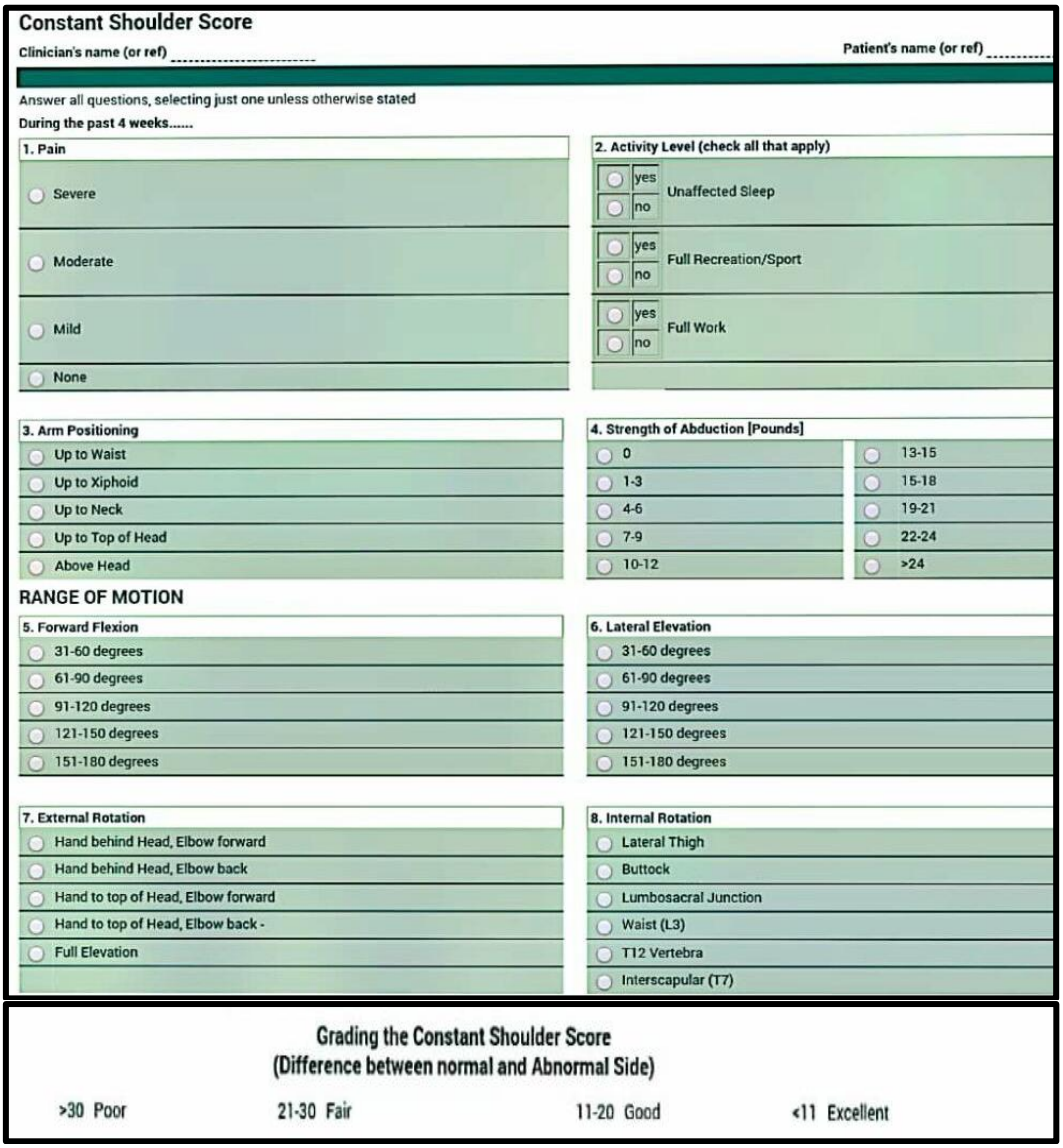



**Fig-1: NEER proximal humerus fracture classification.**

### Constant shoulder scoring [12] system adopted in our study



**Constant Shoulder Score**

Clinician's name (or ref) _____ Patient's name (or ref) _____

Answer all questions, selecting just one unless otherwise stated

During the past 4 weeks.....

**1. Pain**

- Severe
- Moderate
- Mild
- None

**2. Activity Level (check all that apply)**

- Unaffected Sleep — yes / no
- Full Recreation/Sport — yes / no
- Full Work — yes / no

**3. Arm Positioning**

- Up to Waist
- Up to Xiphoid
- Up to Neck
- Up to Top of Head
- Above Head

**4. Strength of Abduction [Pounds]**

- 0
- 1-3
- 4-6
- 7-9
- 10-12
- 13-15
- 15-18
- 19-21
- 22-24
- >24

**RANGE OF MOTION**

**5. Forward Flexion**

- 31-60 degrees
- 61-90 degrees
- 91-120 degrees
- 121-150 degrees
- 151-180 degrees

**6. Lateral Elevation**

- 31-60 degrees
- 61-90 degrees
- 91-120 degrees
- 121-150 degrees
- 151-180 degrees

**7. External Rotation**

- Hand behind Head, Elbow forward
- Hand behind Head, Elbow back
- Hand to top of Head, Elbow forward
- Hand to top of Head, Elbow back -
- Full Elevation

**8. Internal Rotation**

- Lateral Thigh
- Buttock
- Lumbosacral Junction
- Waist (L3)
- T12 Vertebra
- Interscapular (T7)

**Grading the Constant Shoulder Score**
**(Difference between normal and Abnormal Side)**

>30 Poor | 21-30 Fair | 11-20 Good | <11 Excellent

**Fig-2: Constant Shoulder scoring System.**

All cases were worked up for anaethestic fitness and taken up for surgery. All patients were operated upon by the same surgical team and through a deltoid splitting approach, locking compression plate (PHILOS – Proximal Humeral Interlocking Osteosysnthesis) was done, with or without autologous bone grafting from ipsilateral iliac crest. Prophylactic and post-operative IV antibiotics (ceftriaxone with sulbactum) were given for a period of 48 hours. Post – operatively patients were given an arm sling and for relief of pain, paracetamol infusion was given. Pendular exercises were done by the bedside by POD 5. DT removal was done on POD 2. Suture or staple removal was done on POD 12.

Active shoulder mobilization exercises were initiated from the 3rd week onwards or as tolerated by the patients. Fracture union was assessed clnically and radiologically at the end of 6 weeks, 12 weeks and 16 weeks or till radiological consolidation. Constant shoulder score was assessed at the end of 4, 6 and 8 months and the results were tabulated.

## OPERATIVE HARDWARE

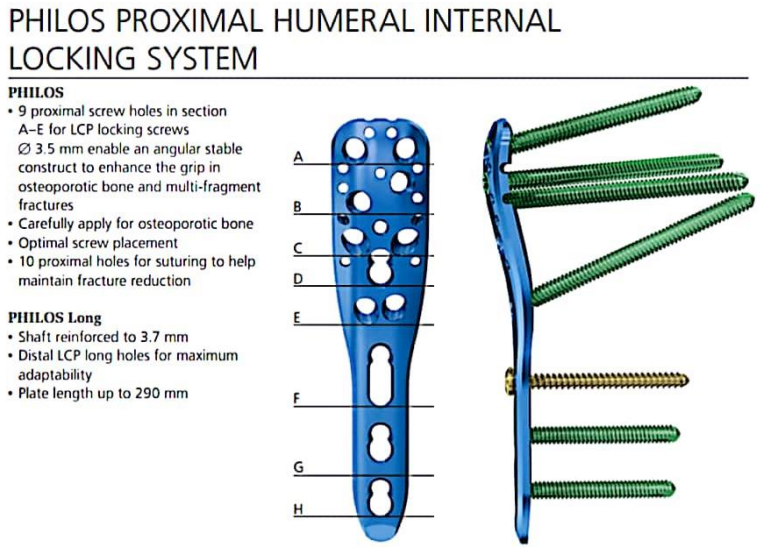



**Fig-3: PHILOS plate construct**

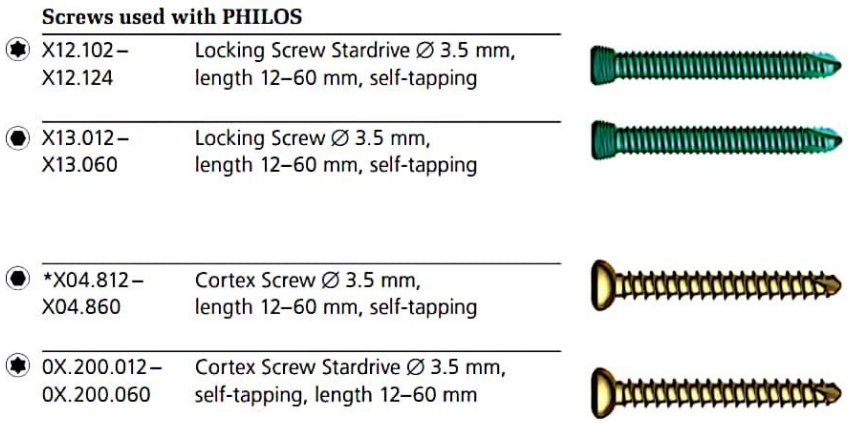



**Fig-4: Screw types used in PHILOS plate**

**Operative procedure for proximal humeral fracture**

Previous studies have shown that the traditional delto-pectoral approach to the proximal humerus provides limited access to the postero-lateral aspect, of the shoulder and that visualisation and reduction of a large retracted greater tuberosity poses a difficulty. Further the delto-pectoral approach requires extensive soft tissue dissection and muscle retraction to gain adequate exposure to the lateral aspect of the humerus. This can cause further devascularisation during dissection and plating leading to disruption of critical blood supplies to the humeral head and other fracture fragments.

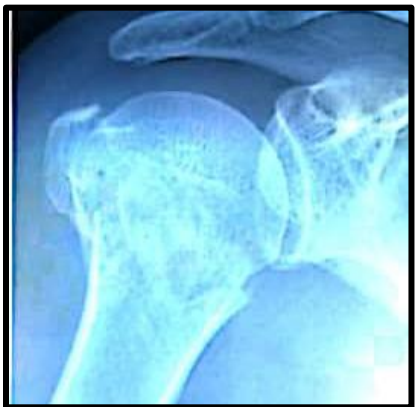


**Fig-5: X-ray Image taken intra-op.**


**Fig-6(a): Pre-operative skin marking to avoid injury to axillary nerve. The area in between the dotted lines is the danger zone. The axillary nerve lies at a distance between 5 to 7cm from the tip of the acromion**

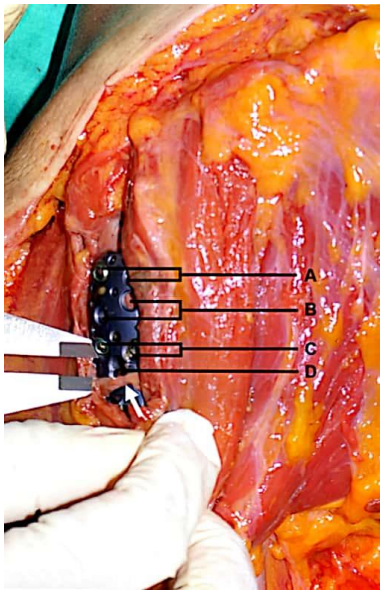



**Fig-6(b): The proximal holes of the PHILOS plate are marked as (A-D), while the white arrow indicates the axillary nerve which just passes across the plate below hole (D). This was considered to be the "safe zone" for screwing above the (D) hole**

**Fig-6(c): Intraoperative picture showing the axillary nerve and the plate bring slid under it**

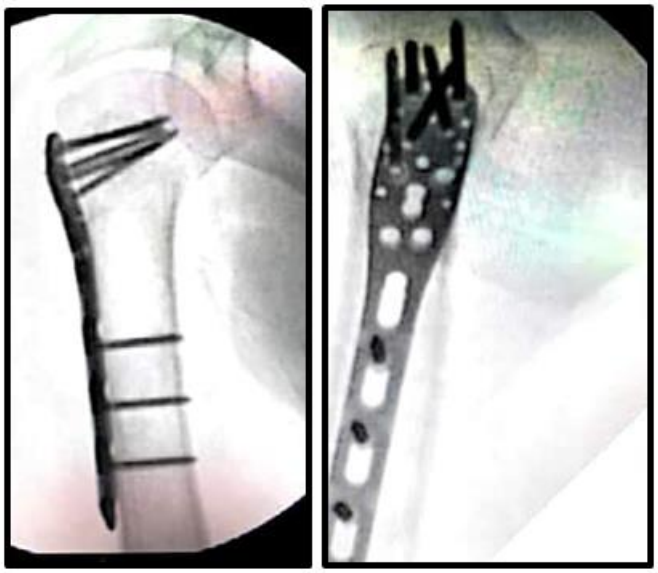


**Fig-7: Immediate post-op X-ray C arm image AP and Lateral views**

**Fig-8: Note the minimal surgical incision length**

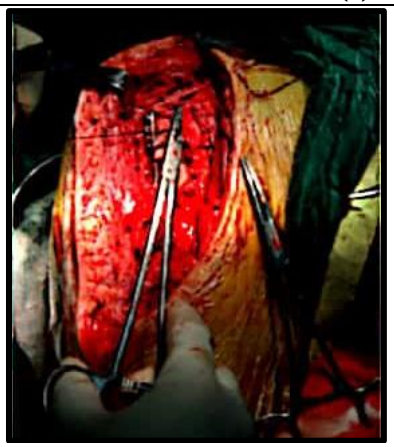


**Fig-9: Shown for comparison the extensive incision about 14 cm, needed if routine delto-pectoral approach is used**

The deltoid splitting approach which is an alternative method provides for good visualization of the postero-lateral aspect of the shoulder without excessive soft tissue dissection or forcible retraction, however there is an increased risk of injuring the axillary nerve. We adopted MIPPO technique via the antero-lateral deltoid splitting combined with mini skin incisions for our series of proximal humeral fractures. This approach has been advocated by many in the recent studies [13-16]. This technique leads to less soft tissue injury, decreased postoperative pain and improved functional outcomes. MIPPO allows for the visualization of axillary nerve and the plate can safely to slid under it (Fig-6c).

## RESULTS

**Table-1: Age and Sex Distribution of proximal humeral fractures**

| Age in Years | 60-64 | 65-69 | 70-74 | 75-79 | Total |
|---|---|---|---|---|---|
| no. of patients | 4 | 6 | 11 | 9 | 30 |
| M- Male<br>F- Female | M- 1<br>F- 3 | M- 1<br>F- 5 | M- 3<br>F- 8 | M- 2<br>F- 7 | M- 7<br>F- 23 |
| % age | 13.33% | 20% | 36.67% | 30% | 100% |

**Table-2: Mechanism of injury in proximal humeral fractures**

| Mechanism of Injury | N (no. of Patients) | % age | Total |
|---|---|---|---|
| Slip and Fall | 24 | 80% | 100% |
| RTA | 6 | 20% | |

**Table-3: Fracture type distribution (as per NEER classification)**

| NEER fracture type | n (% age) |
|---|---|
| Two part | 10 (M- 4, F- 6) 33.33% |
| Three part | 14 (M- 2, F- 12) 46.67% |
| Four part | 6 (M- 1, F- 5) 20.00% |
| Total | 30 (M- 7, F- 23) 100% |

**Table-4: Time elapsed between Injury and Surgical Intervention**

| Time period elapsed(in days) | Male n (% age) | Female n (% age) | Total n (% age) |
|---|---|---|---|
| 0-2 | 1 (3.33%) | 4 (13.34%) | 5 (16.67%) |
| 3-5 | 3 (10%) | 13(43.33%) | 16(53.33%) |
| 6-8 | 2 (6.67%) | 3 (10%) | 5 (16.67%) |
| 9-11 | 1 (3.33%) | 3 (10%) | 4 (13.33%) |
| Total | 7 (23.33%) | 23(76.67%) | 30 (100%) |

**Table-5: Cases for which autologous bone grafting was done**

| Male n (% age) | Female n (% age) | Total n (% age) |
|---|---|---|
| 1 (3.33%) | 4 (13.33%) | 5 (16.66%) |

**Table-6: Time taken for radiological evidence of bone consolidation**

| Time in weeks | Male n (% age) | Female n (% age) | Total n (% age) |
|---|---|---|---|
| 10-12 | 2 (6.67%) | 2 (6.67%) | 4 (13.34%) |
| 12-14 | 4 (13.32%) | 18 (60%) | 22 (73.32%) |
| 14-16 | 1 (3.34%) | 3 (10%) | 4 (13.34%) |
| Total | 7 (23.33%) | 23 (76.67%) | 30 (100%) |

**Table-7: constant shoulder score**

| Sex | Score more than 30 POOR | Score 21-30 FAIR | Score 11-20 GOOD | Score less than 11 EXCELLENT | Total n (% age) |
|---|---|---|---|---|---|
| **Male** | 0 | 3 | 3 | 1 | 7 (23.33) |
| **Female** | 1 | 9 | 9 | 4 | 23 (76.67) |
| **Total** | 1 (3.33%) | 12 (40%) | 12(40%) | 5 (16.67%) | 30 (100%) |

**Table-8: Complications in proximal humerus fractures:**

| Complication | n (% age) |
|---|---|
| Humeral head collapse | 0 (0%) |
| Hardware penetration | 0 (0%) |
| Impingement | 4 (13.33%) |
| Varus collapse | 1 (3.33%) |
| AVN | 0 (0%) |
| Total | 5 (16.66%) |

A total of 30 patients qualified for the study in adherence to our inclusion criteria. According to the age and sex distribution, in our series 36.67% (n=11) of patients were in the age group 70-75 and this was followed by 30% (n=9) in the age group 75-79. 76.67% (n=23) of patients in our series were female and remaing 23.23% (n=7) of the patients were male.

With regard to the mechanism of injury 80% (n=24) of patients were injured by simple slip and fall from standing height and 20% (n=6) were injured by RTA. 46.67% (n=14) of fractures were of NEER type three part followed by 33.33% (n=10) which were of NEER type two part. The average time elapsed between injury and surgery was 4.2 days (range: 0-11 days).

16.66% (n=5) of patients required autologous grafting from ipsilateral iliac crest. All of these cases were of type NEER four part. The average duration of surgery was 78.4 minutes (range: 70-100 minutes) and the average blood loss was 83ml (range: 68-96ml). The average period for radiological bone healing was 12.8 weeks (range: 10-16 weeks). As per the Constant Murley Shoulder Score, 16.67% (n=5) had excellent, 40% (n=12) had good and 40% (n=12) had fair outcomes. There was 3.33% (n=1) poor outcome in our series. We had 16.66% (n=5) of complication of which 13.33% (n=4) were probably avoidable iatrogenic because of proximal implant fixation, causing impingment and 3.33% (n=1) case had varus collapse. It is this patient with varus collapse, who had a poor outcome in the Shoulder Score. We had no instances of humeral head collapse, hardware penetration or AVN as a complication. The average follow-up period was 14.6 months (range: 8 to 27 months).

## DISCUSSION

Fixation with routine compression plates has its limitations. One of the methods adopted to overcome to problem to achieve fracture stability was dual plating. To achieve fracture stability, the axial, tortional and three point bending forces have to be neutralized. The ability of the conventional plates to achieve stability is limited by the screw torque. Osteoporosis, cancellous bone, comminution and/ or pathological bone can prevent adequate thread purchase to allow for achieving adequate torque (1.5N) in order to achieve stability. This is exactly the case with the fragility fractures of the proximal humerus. Further with conventional plates, the excessive soft-tissue stripping which is required to improve the friction coefficient between the bone and plate, severly compromises on the vascular supply to the osseous fragment and the soft tissue. Locked plates have become an attractive alternative to conventional plates as they act as ‘bridge plates’ and preserve fragmentary blood supply.

Percutaneous fracture fixation is based on three basic principles namely percutaneous reduction, extra-periosteal plate placement and bridging fixation.

In our series of 30 cases, 76.67% of patients were females and 23.33% were males. In other series, sex distribution was as follows:

**Table-9: sex distribution**

| | **Study** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Sex** | **Geiger *et al.*, [17]** | **Parmak sizoglu *et al.*, [18]** | **Kumar GN *et al.*, [19]** | **Korkmaz *et al.*, [20]** | **Kilic *et al.*, [21]** | **Chowdary *et al.*, [22]** | **Aksu *et al.*, [23]** |
| **Male** | 8 | 10 | 35 | 16 | 13 | 54 | 33 |
| **Female** | 20 | 22 | 16 | 25 | 9 | 16 | 70 |

Thus in our study more than two thirds of the patients were females, which exceeds the ratio of 2:1 which was reported by Parmaksizoglu *et al.*, and Aksu *et al.*

In the age distribution factor, since our inclusion criteria allowed us only to include patients in the age range 60-79 years, we had a preponderance of patients in the age group of 70-74 years (36.67%) followed by the age group 75-79 years (30%). This compares well with study of Geiger *et al.*, [17] whose age mean was 60.7+/- 12.9 years and the study by Konard *et al.*, [26] 62.9 +/- 15.7 years. The study by Aksu *et al.*, [23] also had a mean age of 62 years. This establishes the fact that proximal humeral fractures are common in the age above 60 years and more so in females.

The most common mode of injury was fall from standing height (80%) followed by RTA (20%). This compares well with the study of Geiger *et al.*, [17] who reported similar mechanism in 75% of the cases in his series. In our series three part fractures dominated at 46.67% (n=14) of cases.

Our study compares well with the study done by Geiger *et al.*, [17] and Kumar *et al.*, [19].

**Table-10: The NEER fracture type distribution in other studies**

| **Study** | **Study** | **Study** | **Study** |
|---|---|---|---|
| Our study | 10 | 14 | 6 |
| Geiger *et al.*, [17] | 8 | 12 | 4 |
| Erasmo *et al.*, [24] | 7 | 40 | 35 |
| Parmaksizoglu *et al.*, [18] | - | 12 | 20 |
| Kumar *et al.*, [19] | 8 | 15 | 23 |
| Chowdary *et al.*, [22] | 22 | 38 | 10 |

Our average time lag between injury and surgery was 4.2 days (range: 0-11 days). The average duration of surgery was 78.4 minutes (range: 70-100 minutes) and the average blood loss was 83 ml (range: 68-96ml). 16.66% (n=5) patients in our series, all having four part fracture, required autologous iliac crest bone grafting. This again highlights the fact that, when biological fixation with locking compression plate is opted for, the need for bone grafting decreases.

Thus our duration of radiological healing was in tandem with other studies. Our outcome closely matches the findings of Chowdary *et al.*, [22].

**Table-11: The time duration for radiological evidence of bony union in other studies**

| Study | Average duration in weeks | Range in weeks |
|---|---|---|
| Our study | 12.8 weeks | 10-16 |
| Kilic *et al.*, [21] | 13.6 weeks | 10-20 |
| Kumar *et al.*, [19] | 12 weeks | 8-20 |
| Chowdary *et al.*, [22] | 11.4 weeks | 6-12 |

**Table-12: The constant Murley score as reflected in various studies**

| Study | **Constant score outcomes** | | | |
|---|---|---|---|---|
| | Poor | Fair | Good | Excellent |
| Our study | 3.33% | 40% | 40% | 16.67% |
| Kumar *et al.*, [19] | 9.80% | 11.76% | 25.49% | 49.02% |
| Chowdary *et al.*, [22] | 8.57% | 31.42% | 40% | 20% |
| Geiger *et al.*, [17] | 39.3% | 3.6% | 37.1% | 20% |
| Erasmo *et al.*, [24] | 6.10% | 20.73% | 63.41% | 9.7% |
| Parmaksizoglu *et al.*, [18] | 6.3% | 25% | 28.1% | 40.6% |

**Table-13: Complications as encountered in various studies**

| Complication | Our study | Geiger *et al.*, [17] | Erasmo *et al.*, [24] | Parmak Sizoglu *et al.*, [18] | Kumar *et al.*, [19] | Korkmaz *et al.*, [20] | Kilic *et al.*, [21] | Chowdary *et al.*, [22] | Aksu *et al.*, [23] |
|---|---|---|---|---|---|---|---|---|---|
| Humeral Head collapse | - | - | - | - | - | - | - | - | - |
| Hardware Penetration | - | - | - | - | 1.96 | 2.4 | - | 8.57 | - |
| Subacromial Impigment | 13.33% | 21.4% | 3.6 | - | 1.96 | - | 4.54 | 8.57 | 4.85 |
| Varus Collapse | 3.33% | - | 4.8 | - | 7.84 | 7.3 | 9.09 | - | 8.73 |
| AVN | - | 7.2 | 12% | 6.2% | - | - | 9.09 | - | - |
| Adhesive capsulitis | - | - | - | - | - | - | 9.09 | 1.42 | - |
| Superficial infection | - | - | 1.2 | - | - | - | - | 2.86 | - |
| Deep infection | - | - | - | - | 1.96 | - | - | - | 0.97 |
| Haematoma | - | - | - | - | - | - | - | 2.86 | - |
| Decreased radial Nerve sensation | - | 7.2 | - | - | - | - | - | - | - |
| Reoperation | - | 28.57 | - | - | - | - | - | - | - |
| Loosening of locking head screw | - | 3.6 | - | - | - | - | - | - | - |
| Non union | - | - | 2.4 | - | - | - | - | - | - |
| Displacement of greater tuberosity | - | - | - | - | - | 2.4 | - | - | - |
| Reflex symp dystrophic | - | - | - | - | - | - | 9.09 | - | - |
| Implant fracture | - | - | - | - | - | - | - | - | 0.97 |
| Total | 16.66% | 67.97% | 24% | 6.2% | 13.72% | 12.1% | 40.9% | 24.28% | 15.52% |

Due to strict adherence to AO principles and methodological surgical approach, we have been able to keep our complication rates relatively low. Our complication rates were comparable to the study by Kumar et al., [19], Korkmaz et al., [20] and that of Aksu et al., [23].

## CONCLUSION

Proximal humeral fracture is by far the commonest fracture of the shoulder. It is the second most common site of fracture in the upper limb after distal radius in the elderly. In the aged group osteoporosis complicates the fracture pattern. ORIF with PHILOS plate for proximal humerus fragility fractures in the aged has the advantages of accurate reduction, early mobilization and better fixation. It also helps reconstruct the comminuted irreducible fracture fragment. It is imperitive to mention here that the deltoid splitting approach if done with adequate safety precaution, give good access to the proximal posterior fragment, minimizes blood loss and gives impressive cosmetic scar healing. The present study concludes that the PHILOS plate provides for an excellent stable construct even in two to four part fractures. We concur with Fazal et al., [25], whose study conclusively proved the efficacy of PHILOS plating for proximal humerus fragility fractures.

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