

## Original Research Article

# Evaluation of results of three and four-part fracture dislocations of proximal humerus in young adults using philos (proximal humerus internal locking system)

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### ABSTRACT

**Background:** The fractures of proximal humerus constitute about 5% of fractures in adults third in number to fracture colles and hip usually in elderly patients due to a low energy trauma. In young patients the fractures are mostly due to high energy trauma and as such are associate with other soft tissue injuries. A sub group of young patients have a three or four fracture dislocation of shoulder joint. The aim of this study was to find the results of fixation by PHILOS in these young patients.

**Methods:** This study was done in a tertiary referral centre over a period of about 1 year. All patients were operated within three weeks. Open fractures, patients with age more than 50 years were excluded from the study. All patients underwent open reduction and fixation using commercially available PHILOS. A minimum of 6 months follow up was essential for inclusion into the study. Final functional results were evaluated by Constant Murley scoring.

**Results:** 14 patients were included in the study. The average age of patients was 38.42years. All fractures united. We had 71.4% excellent or good results. The complications noted were shoulder stiffness in 3, inadequate post op reduction, rotator cuff insufficiency, head necrosis, secondary osteo arthritis 1 each.

**Conclusions:** Despite the relatively high rate of complications encountered in the management of these complicated high-energy fractures, the PHILOS plating system could be considered an adequate management of these patients.

**Keywords:** Fracture dislocation shoulder, PHILOS plate, Proximal humerus fractures

### INTRODUCTION

The incidence of proximal fractures of the humerus is about 5% of all fractures.<sup>1</sup> Fractures and fracture dislocations of the proximal humerus constitute a spectrum of injuries ranging from non-displaced fractures to severe four parts displaced, anatomic neck, head-splitting, and head-impaction injuries.<sup>2</sup> In people aged over 65years, fracture of the proximal humerus is the third most common fracture, after Colles fracture and hip fracture usually as a result of low energy trauma.<sup>3</sup> In

younger more active patients main cause is high-energy trauma, and displacement is often more severe.

The Neer classification is the most widely used systems to evaluate and determine treatment of proximal humeral fractures.<sup>1,3,4</sup> Classification is based on the four-part anatomy of the proximal humerus: the humeral head, the lesser and the greater tuberosities and the proximal humeral shaft. The criteria for displacement is greater than 1cm of separation or angulation of 45 degrees or more. Displaced three parts and four part fractures markedly alter the articular congruity of the

glenohumeral joint and have the highest likelihood of disruption of blood supply to proximal humerus and osteonecrosis.<sup>5</sup>

In very high-energy fractures the problem is even more pronounced. This might be due to severe soft-tissue injury, associated fractures, comminuted fracture patterns, and dislocation of the joint in severe cases. Secure fixation of high-energy fractures of the proximal humerus remains a problem. Various methods of fixation for such complex fracture patterns have been described, including Kirschner (K)-wires, external fixation, tension band fixation, intramedullary nails and plating.<sup>3</sup> The proximal humeral internal locking system (PHILOS) plate has been described to improve screw fixation in osteoporotic bone and to minimize soft-tissue dissection.<sup>6</sup>

In fracture dislocations of the proximal humerus, the PHILOS plate would be of special value because the plate is pre-shaped and contoured for the proximal humerus and no compression of the plate is required, which reduces the risk of loss of reduction and preserves the blood supply of the bone. Locking the screws into the plate ensures axial as well as angular stability and reduces the risk of loss of reduction. The locked interface also provides fixed stability.<sup>7</sup>

This study was designed to evaluate the early clinical and radiological results of management of high-energy fractures dislocations of the proximal humerus in a relatively young and more active population of patients with the use of the commercially available PHILOS plates.

## METHODS

This study was done at tertiary care referral centre of north India between September 2015 and December 2016. All patients who were admitted with the diagnosis of three or four-part fracture dislocation of proximal humeri were enrolled for the study. Exclusion criteria were open fractures, fracture more than 3 weeks old, patients age more than 50 years of age. Patients older than 50 years having such injuries were considered for replacement surgery. All patients were investigated for routine pre-anesthetic checkup. Beside an AP and lateral view of shoulder joint was taken. In all cases a CT scan with 3D reconstruction was taken before surgery to evaluate fracture geometry and to plan reduction maneuvers. All patients underwent open reduction and fixation using commercially available PHILOS. A minimum of 6 months follow up was essential for inclusion into the study.

### *Surgical technique*

Patient positioning was crucial for good intra-operative fluoroscopy. A regular surgical table with a radiolucent footplate was used. The table was rotated 180° so that the patient's head was at the foot of the bed, and the shoulder

rested on the radiolucent footplate. General anesthesia was given for all the patients, and the head of the patient was then elevated about 30° (modified beach-chair position). The large C-arm was positioned parallel to the patient at the head of the bed, thereby avoiding interference with the anesthesiologist who stood perpendicular to the table with the anesthesia apparatus.

An anterior deltopectoral approach was routinely used for all the patients. The cephalic vein was retracted laterally to prevent inadvertent injury during retractor placement. The subdeltoid space was then developed. After release of the subdeltoid space, a retractor was carefully placed under the muscle to facilitate exposure. The arm was then abducted to minimize the deltoid tension. The anterior one-third of the deltoid was dissected (if needed) off its insertion into the deltoid tubercle in cases with diaphyseal extension of the fracture.

The subcoracoid space was then developed and the axillary nerve was identified by gentle palpation at the inferior margin of the sub-scapularis muscle. The lateral conjoined tendon was released off the lateral tip of the coracoid to facilitate exposure in some cases. The biceps tendon was then palpated deep to the pectoralis major muscle. Using the biceps tendon was useful as a landmark, because usually there was a fracture hematoma obscuring the normal anatomy. The biceps tendon was found interposed between the fracture fragments in 6 of the 14 cases (42.8%) and was freed. The rotator interval was opened by following the course of the biceps tendon to its attachment at the superior margin of the glenoid. Initial attempts were made to preserve the tendon for use as a landmark for correct plate placement. In fracture-dislocation cases, and in split head fractures, the head or a head segment was located anterior and medial to the glenoid along the glenoid neck. In these cases, the release of the pectoralis major tendon and the lateral conjoined tendon, as well as the subcoracoid and subdeltoid spaces were often released before any attempts at fracture reduction in order to preserve the blood supply for the head fragments and to avoid forcible reduction. A Cobb elevator or shanz pins were used for relocating the head fragment back into the joint. The greater and lesser tuberosity fragments were tagged with non-absorbable sutures. The tuberosity fragments were reduced to the lateral cortex of the shaft. Reduction of the tuberosities may indirectly reduce the head fragment; alternatively, to restore the medial calcar of the proximal humerus, an elevator was inserted to disimpact the head fragment. The fracture was reduced and provisionally fixed into position using Kirschner wires.

Krackow sutures were passed through the rotator cuff and attached to the plate through the suture eyelets before permanent fixation with the contoured proximal humerus locking plate was performed. The sutures were passed through the proximal humerus plate, and the plate was positioned directly on the middle of the lateral cortex. These sutures could be passed into the suture eyelets even

after plate positioning and fixation in the plate design used in this study. Once the plate was positioned an adequate gap was left between the plate and the biceps

tendon to prevent disruption of the anterior humeral circumflex artery or entrapment of the tendon.

**Table 1: Master chart.**

Age	Sex	Injury	Days at surgery	Duration of hospital stay	Associated injury	Constant score			Result	Complications
						N	I	D		
33	M	Dislocation	3	5		91	83	8	Excellent	
42	M	Dislocation	5	9	Blunt trauma chest	87	62	25	Fair	Shoulder stiffness
36	M	Dislocation	2	5		92	83	9	Excellent	
47	F	Dislocation	3	6	Shaft femur fracture	88	73	15	Good	
29	M	Split head	4	6		92	78	14	Good	
31	M	Dislocation	14	19	Splenic trauma, head injury	92	65	27	Fair	Inadequate reduction
39	M	Dislocation	3	5		94	81	13	Good	
33	M	Dislocation	3	5		90	82	8	Excellent	
43	M	Dislocation	4	6		94	78	16	Good	
45	M	Dislocation	7	11	Head injury	90	64	26	Fair	Shoulder stiffness
38	F	Split head	3	6		94	80	14	Good	Sudeks osteodystrophy
36	M	Dislocation	3	5		92	83	9	Excellent	
36	F	Dislocation	5	11	Blunt trauma chest	96	79	17	Good	
50	M	Split head	6	9		83	48	35	Poor	Rotator cuff insufficiency, head necrosis, secondary OA

The initial screw was then placed in the elongated hole in the humeral shaft, so that the height of the plate could be adjusted. In cases of proximal humerus fractures with diaphyseal extension, inter-fragmentary screws were sometimes needed to stabilize these long complex fractures, before plate fixation. Once appropriate fracture reduction and plate position had been achieved, the locked screws were inserted into the humeral head using the insertion guide and sleeve assembly. At least three distal shaft screws were inserted. A final fluoroscopic image was taken to ensure adequate reduction and proper medial support. No bone grafting was performed in this study. The wound was closed in layers and a suction drain was inserted and left for about 24 to 36hours, then removed.

#### **Post-operative management**

The patient was placed in a shoulder immobilizer post-operatively, with elbow and wrist range of motion allowed. After drain removal, gentle pendulum and active assisted forward elevation with the contralateral

extremity was permitted. Passive and active-assisted range of motion activities were initiated afterwards once patient was comfortable and relatively pain free. Unassisted active motion was allowed at eight weeks post-operatively or when callus formation was first noted radiographically. Muscle strengthening was instituted in the last phase of therapy, usually beginning at 10week.

The radiographic assessment was done at immediate post op, 6weeks, 12weeks and 6months. Functional outcome was assessed by constant score comparing with the opposite healthy shoulder. Statistical analysis was performed for all the gathered data and were analyzed and compared to other similar studies.

#### **RESULTS**

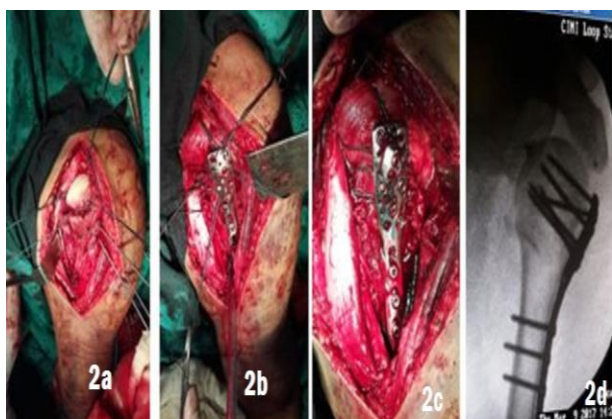
14 patients were included in the study with age from 29-50years, average age was 38.42years. Out of 14 patients 11 were male and 3 female patients. The average delay in surgery was 4.64days (range 2-14days) and average days hospitalization was 7.71days (range 5-19days). We had 3 (21.4%) split fracture head of humerus with dislocation

while 11 (78.6%) were fracture dislocations without any split in humeral head.



**Figure 1: a) x ray showing 3-part fracture dislocation. b, c) CT cuts of the same fracture. d) immediate post op x ray showing a valgus reduction. e, f) x rays at union.**

The associated injuries noted were blunt trauma chest in 2 (14.3%), head injury in 2 (14.3%), splenic trauma in 1 (7.1%) and fracture shaft of femur in 1 (7.1%) patient. The complications noted were shoulder stiffness in 3 (21.4%), inadequate post op reduction in 1 (7.1%), rotator cuff insufficiency in 1 (7.1%), head necrosis in 1 (7.1%), secondary osteo arthritis in 1 (7.1%). We also had one patient who developed sudeks osteodystrophy.



**Figure 2: a) ethibond sutures passed into the rotator cuff muscles around the fracture to aid in reduction. b) sutures passed into the PHILOS. c) sutures tied over the plate to keep reduction maintained and for better function of rotator cuff muscles. d) intra op fluoroscopy image to see reduction and stability of construct.**

Based on Constant and Murley score and comparing it with opposite side of the patient, we had 10 (71.4%) excellent and good results, 3 (21.4%) fair and 1 (7.1%) poor result.<sup>8,9</sup>



**Figure 3: a, b, c) Final shoulder function of the same patient. Patient had a good functional outcome.**

## DISCUSSION

Three and four-part proximal humerus fractures are difficult injuries to evaluate and treat. Internal fixation of such fractures with fixed-angled locked plating still warrants caution because of the lack of comparable data with other treatment methods.

Many recent articles were found in the literature reporting the early and middle term results of management of proximal humerus fractures using different PHILOS plating systems. Although the results were encouraging, it was found that most of the studies included only fragility fractures in older age groups. Studies describing the use of the PHILOS plates for the early management of high-energy proximal humerus fracture dislocation in active young age groups were not found. These types of fractures are not due to bone weakness but due to the higher magnitude of trauma and are usually comminuted and associated with dislocation.

Weinstein et al found that the locking plate provided better torsional fatigue resistance and stiffness than a blade plate.<sup>10</sup> Edwards et al noted that a locking plate was far superior to a proximal humerus nail in regard to both varus bending and torsional stability. Given that most proximal humerus fractures fail because of rotational and bending moments, such added stability could potentially prevent many of the failures noted with other implant types.<sup>11</sup>

Precise surgical technique is critical for a good result, as reported failures were due to impingement that resulted from proximal positioning of the plate.<sup>12</sup> Kettler et al reported on 225 fractures treated with the PHILOS plate. One hundred and seventy-six patients were



available for review. Complications resulting from technical error included 24 screw perforations (11%), 8 implant dislocations (4.5%), and 25 cases (14%) of initial malreduction of the head and tuberosities. Björkenheim et al reported their early clinical experience of 72 patients treated with the PHILOS proximal humerus locking plate. At one-year follow-up, 2 non-unions were noted, and 3 patients developed osteonecrosis. Forty-eight patients had anatomic fracture healing. Nineteen fractures were noted to have mild post-operative settling; these subsequently healed in mild varus positioning. Traction sutures were used to aid in the initial reduction.<sup>13</sup> Fankhauser et al reviewed their experience of 28 patients with 29 proximal humerus fractures treated with the locking proximal humerus plate. Twenty-four of these fractures were AO classification type B or type C. All fractures healed. Five complications were noted, with one broken plate and 4 instances of loss of reduction (one related to a deep infection). Two patients developed partial osteonecrosis, one after deep infection. In this series, traction sutures were incorporated into the plate, but active motion was initiated as early as two weeks.<sup>14</sup>

Given these reports, it was noted that the variation in the final end-results between different reports could be due to the following main points:

- Different types of fractures were included in different studies and not all the studies focused on the 3 and 4 complex fracture patterns. Moreover, fracture-dislocations, and split head fractures were excluded from some studies, while others included open and closed fracture patterns;
- The approach used, and surgical experience and preference vary between different centers and the level of the trauma center at which the patients were treated influenced the final outcome;
- Different types of commercially available designs were used. It is of value here to mention that the plates which enable the surgeon to attach the rotator sutures to the suture eyelets, after provisional fixation of the plate, provided more proper plate positioning and were easily applied;
- Bone grafting was obligatory in some series while others did not use any grafting, including the current study;
- The variation in the follow-up period was of great importance as some late complications were recorded in some middle-term studies, specially osteoarthritis and avascular necrosis of the humeral head;
- Lack of long-term comparative studies with other treatment modalities for such complicated fracture patterns, in particular the joint replacement option in older age groups;
- Finally, this study was introduced to test the efficiency of the PHILOS plate in fixation of complex 3 and 4-part fractures, split head fractures with fracture dislocations in a younger active age population submitted to high-energy trauma.<sup>14-18</sup>

Other studies tend to reflect an older population than in this study, which predominantly seems to be due to the incidence of high-energy injuries in younger people rather than osteoporotic fragility fractures in older age groups. It is thought that the better Constant and Murley score recorded in this study are due to the better bone stock found in younger active patients. This might also be the reason why no bone grafting was needed. It is suggested that the hardware complications were dramatically reduced in this study due to the better bone quality of the studied young patients.

Finally, although this is a study with relatively small number of patients included, and based on the results recorded, it is suggested that fixation of 3 and 4 part high-energy fractures with fracture dislocation using the PHILOS plating system is an adequate method of treatment, and when well performed is expected to give relatively favorable results. Also, because of the relatively young age of the patients and high manual demands, arthroplasty was not an option. It is mandatory to stress on the meticulous soft-tissue dissection and fracture reduction, especially with good medial support, in such complex fracture patterns. Every single fracture should be thoroughly investigated, screened and studied before surgery. Treatment modality should be tailored to the fracture pattern and one should always remember that it is not only a bone problem but sometimes a massive soft-tissue injury as well. Other fixation options should always be prepared in the operating room to be used if needed. Other studies are needed to compare different types of fixations of such complex patterns of injury, as well as long-term studies to evaluate the adequacy of different fixation modalities.

## CONCLUSION

The use of the PHILOS plating system for reduction of 3 and 4-part, split head with fracture dislocation pattern due to high-energy trauma in a relatively younger more active age population proved to be an adequate alternative. This might be attributed to the better bone quality and better vascularity in this age group.

The technique is technically demanding and is expected to be associated with a high complication rate. Meticulous soft tissue dissection is obligatory with special attention to the rotator cuff tears. Different plating systems are available commercially, and correct plate selection and pre-operative evaluation is mandatory for each case. The final clinical and radiographic outcomes of treatment of such complex high-energy fractures are promising but long-term studies are needed, as well as comparative studies with other forms of management.

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