PHILOS plate fixation in proximal humeral fractures: functional outcomes

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ABSTRACT: Objectives: The purpose of this study was to evaluate functional outcomes of proximal humerus fractures treated with the PHILOS plate. **Methods:** Proximal humerus fractures of 24 patients (13males, 11 females; mean age 55 years; range 28 to 83 years) were treated with the PHILOS plate and followed up over a median period of 17 months (range 6 to 36 months) by clinically and radiographically. According to the Neer Classification, 9, 8, and 7 patients had displaced 2-, 3-, or 4-part fractures, respectively. The final follow-up included anteroposterior and lateral x-rays, the Constant Score and the American Shoulder and Elbow Surgeons (ASES) score. **Results:** At the final follow-up, union was observed in 23 patients (95.8%), 20 fractures (83.3%) healed in good anatomical position by radiographically. However, one patient had hardware failure. There was no evidence of screw penetrated into the joint primarily or secondarily and no evidence of avascular necrosis (AVN) as well as screw cutout at most recent follow-up. Clinical visits and review of medical records showed two patient suffered painful and frozen shoulder. The mean ASES score was 77.8 (range 40 to 95), and the mean Constant Score was 70.8 (range 32.5 to 92). The results were good in 14patients (58.3%), moderate in 8 patient (33.3%), and poor in 2 patients (8.4%).Three complications (12.5%) were seen during the follow-up period. Reoperation was required in 8 patients (33.3%). **Conclusion:** Our results demonstrate that fixation with the PHILOS plate is a excellent technique with a high union rate and satisfaction rate in the treatment of proximal humeral fractures.
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Key words: philos plate; proximal humeral fractures; internal fixation; functional outcomes; ASES

1. Introduction

The proximal humeral fractures account for 5% of all fractures approximately, and more than 70% of patients are over the age of 60 years, and rank third in fragility fractures, after the hip and distal radius [1,2,3]. Approximately 80% of these fractures are nondisplaced or minimally displaced that can be treated nonoperatively, the functional outcomes were satisfactory [4]. However, we treat displaced or unstable proximal humeral fractures operatively in clinic, including sutures, cerclage wires, K-wires, screws and plates, intramedullary devices, and shoulder arthroplasty [5,6,7,8].

Locking plates have been introduced in proximal humeral fracture fixation for decades. These new implants provide greater angular stability, better screw anchorage in osteoporotic bone and function as a locked internal fixator [9,10,11]. The PHILOS plate as the new generation of locked plates can be applied with a minimal invasive method, and it provides more stability and has less complications than traditional plates [12].

The purpose of this retrospective study was to report the clinical outcome and analyze our experience from the use of Philos plate for the treatment of proximal humeral fractures.

2. Patients and methods

Between 2008 and 2011, a series of 24 patients (13 male and 11 female; mean age 55 years; range 28 to 83 years) with displaced proximal humeral fractures were treated in our department by open reduction and internal fixation with PHILOS plate. The fractures were classified according to the Neer classification as displaced 2-, 3-, or 4-part fractures based on radiographs and, when available, computed tomography [13]. Nine patients had the 2-part fracture, eight patients had the 3-part fracture, and seven patients had the 4-part fracture.

Inclusion criteria were as follows: *(i)* age older than 18 years and *(ii)* closed proximal humeral fracture (two-, three-, or four-part according to the Neer classification system) [13].

Preoperative evaluation included plain anteroposterior and lateral x-rays and, when available, computed tomography.

Surgery was performed in beach chair position [14], under general anaesthesia and under C-arm control. A standard deltopectoral approach was used [14], the cephalic vein was routinely retracted medially and the subdeltoid space was developed. The fracture was exposed and fragments mobilized without excessive periosteal stripping to preserve soft tissues and blood supply. Care was taken to avoid damage of the axillary nerve and the ascending branch of the anterior circumflex artery. There are different reduction

techniques for different fracture patterns. The fracture patterns were reduced and, when available, provisionally stabilised with Kirschner wire with confirmation by C-arm in both anteroposterior and lateral planes. Then an anatomically precontoured PHILOS plate was placed 5 to 10 mm distal to the tip of the greater tuberosity and temporarily fixed with a stabilizing wire, plate placement and reduction was confirmed by C-arm in both anteroposterior and lateral planes. Placing the first screw in the gliding hole located in the distal part of the plate, facilitating accurate plate placement by allowing for minor adjustments. Placing the first screw into the head, the desired depth was into subchondral bone of the central, posterior, and inferior regions of the humeral head between 5 and 10 mm from the articular margin with confirmation by C-arm in both anteroposterior and lateral planes. Similar steps were used for the placement of the remaining screws in the head and the shaft, each depth and direction of drilling and screw placement being confirmed by C-arm in both anteroposterior and lateral planes. Total 5-7 screws were placed in the humeral head. As for displaced or unstable tubercle fragments, we use one or two screws to fix.

Fluoroscopic evaluation was done again to reconfirm reduction and screw placement (Fig 1). Meanwhile, the shoulder was put through a full range of motion to determine the security of fixation and that there was no obstruction to motion. Finally, the wound was closed in layers over a drain.

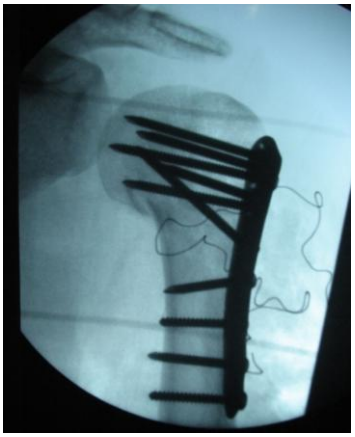

Figure 1. Intraoperative fluoroscopy shows screws placement in the head and the shaft. The desired depth was into subchondral bone of the central, posterior, and inferior regions of the humeral head between 5 and 10 mm from the articular margin.

Postoperatively, the arm was placed in a shoulder sling, intravenous treatment to prevent infection was administered for 24 h, and the drain was placed for 24-48 h. Passive motion and pendulum exercises were initiated on the third postoperative day, active exercises were initiated about 4-6 weeks postoperatively and active -resistance exercises were initiated after fracture healing.

The final follow-up included anteroposterior and lateral x-rays, the range of shoulder motion(flexion, abduction ,internal rotation and external rotation), the Constant Score [15] (0-55 points: poor, 56-70 points: mean, 71-85 points: good and 86-100 points: very good), and the American Shoulder and Elbow Surgeons (ASES) score [16].

3. Results

The average duration of hospitalisation was 21.7 days, ranging from 7 to 110 days. All cases were available for an average follow-up of 17 months (range, 6-36 months). In the early postoperative period no superficial or deep wound infections, nerve or vascular injuries were observed.

Upon viewing all radiographs, 23 fractures were united with no change or loss of reduction (Fig 2a, b, c); however, one patient had hardware failure (Fig 3a, b, c). There was no evidence of screw penetrated into the joint primarily or secondarily and no evidence of avascular necrosis (AVN) as well as screw cutout at most recent follow-up. Clinical visits and review of medical records showed two patients suffered painful and frozen shoulder (Fig 4a-h). They presented with a Constant–Murley score of 32.5 points and 40 points at the latest follow-up. One required removal of hardware in the first postoperative year. They were treated with nonsteroidal antiinflammatory drugs and physical therapy. In addition, no signs of impingement were appeared due to the position of the plate. Seven patients required removal of hardware.

The mean ASES score was 77.8 (range 40 to 95), and the mean Constant Score was 70.8 (range 32.5 to 92). The results were good in 14patients (58.3%), moderate in 8 patients (33.3%), and poor in 2 patients (8.4%) on final review.

Figure 2. (a) Preoperative X-ray of a three-part proximal humeral fracture. (b) One month postoperative X-ray shows satisfactory fracture reduction and rebuilding of callus. (c) Six months postoperatively X-ray shows fracture healing without fragment displacement.

Figure 3. (a) Preoperative X-ray shows comminuted and displaced proximal humeral fracture. (b) and (c) Postoperative X-ray show fixation failure in both anteroposterior and lateral position.

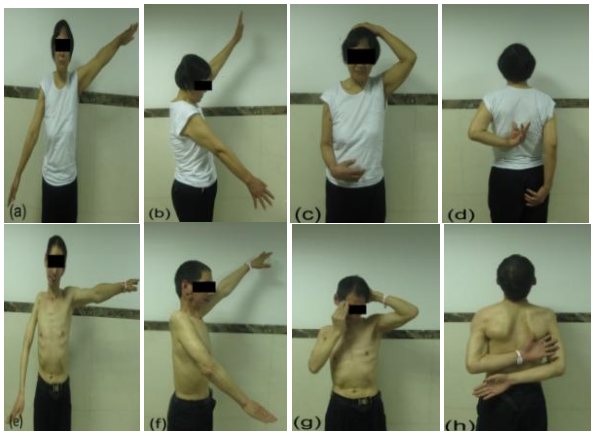

Figure 4. (a)- (d) A female patient has limited function including abduction, elevation, external rotation and internal rotation due to frozen shoulder. (e)- (h) A male patient has limited function including abduction, elevation, external rotation and internal rotation due to frozen shoulder.

4. Discussion

Operative treatment of comminuted and displaced proximal humeral fractures, especially in osteoporotic bone, has been a complex and challenging problem. The traditional surgical treatment for proximal humeral fractures exist many disadvantages, sucs as extensive soft tissue dissection and disruption of the periosteal blood supply, large and stiff implant, high incidence of complications**,** resulting in unsatisfactory outcome [17,18].

The PHILOS plate as the new generation of locked plate is provided with a series of advantages, for instance internal locking system, design of anatomical configuration, being used with a minimally invasive technique. Recent studies [12,19-22] have reported clinical outcome following PHILOS plate fixation of proximal humeral fractures. In a retrospective study , Konrad G et al[12], reviewed 318 patients treated with the PHILOS plate and locking proximal humerus plate (LPHP) , which showed a significantly shorter surgical time, less pain at the fracture site, and better functional outcome was achieved by PHILOS-treated patients with 2-part fractures throughout the one-year follow-up and with 3-part fractures at three months ($p < 0.05$). Schulte et al [23] evaluated 44 proximal humeral fractures in 43 patients treated with the Locking Proximal Humerus Plate. They observed no evidence of screw cutout, varus collapse, or avascular necrosis. The mean disabilities of the arm, shoulder and hand score was 11. The average American Shoulder and Elbow Surgeons score was 85. The average visual analog pain score was 0.8. The average range of motion was as follows: elevation, 140°; external rotation at side, 49°; external rotation in abduction, 77°; and internal rotation, T11.

Our study evaluates the early clinical and radiologic outcome and demonstrates the clinical results of osteosynthesis in proximal humeral fractures using the PHILOS plate. Union was observed in 23 patients, 20 fractures (83.3%) healed in good anatomical position by radiographically. There was no evidence of screw penetrated into the joint primarily or secondarily and no evidence of avascular necrosis (AVN) as well as screw cutout at most recent follow-up. Clinical visits and review of medical records showed two patients suffered painful and frozen shoulder.

The mean ASES score was 77.8 (range 40 to 95), and the mean Constant Score was 70.8 (range 32.5 to 92). The results were good in 14patients (58.3%), moderate in 8 patients (33.3%), and poor in 2 patients (8.4%). Three complications (12.5%) were seen during the follow-up period.

The main complication was frozen shoulder associated with insufficient exercise postoperatively, suggesting that it be important to start both the passive and active exercises as soon as possible after surgery. Despite some inhomogeneity, our results are comparable with those reported for the PHILOS plate.

Despite the reported good functional results with the PHILOS plate, fixation of proximal humeral fractures with PHILOS plates and screws has been associated with complications such as avascular necrosis(AVN), frozen shoulder, subacromial impingement, screw cutout, implant failure, malunion. Recent studies [24-30] have reported complication rates between 8.9% and 70.3%. Among them , the most frequently occurring complications are screw cutout and subacromial impingement [24,30], compared with frozen shoulder in our study.

Two patients had limited function due to frozen shoulder in our study which is comparable with previous report [24,30]. This may be attributed to insufficient exercise postoperatively. One patient still had limited function after the implant removed. Therefore, we emphasize the important role of passive

and active motion as soon as pain had subsided. In addition, conservative treatment can be applied as an aid in improving shoulder function in patients with frozen shoulder. Yilmazlar et al[31] reported interscalene brachial plexus block and subsequent rehabilitation under catheter analgesia provided sufficient analgesia and contributed to the recovery of shoulder function, with no side effects or complications. In a retrospective study, Tashjian[32] showed shoulder functions with frozen shoulder were most effectively improved by steroid injections, laser therapy, some mobilization techniques, arthrographic distension, and suprascapular nerve block.

Based on our observation, inferomedial support affects the results of the PHILOS plate for the treatment of the proximal humeral fractures.

Adequate support in the inferomedial region of the proximal humerus resulted in good functional outcome. Therefor, to improve functional results and reduce the incidence of fixation failure, we consider adequate inferomedial support to be of utmost importance when using PHILOS plate fixation.

A recent systematic literature showed that postoperative loss of fixation and screw cut-out are the most frequent complications and most common reasons for revision surgery after fixation of proximal humerus fractures[24]. Recent studies show high failure rates after fixation of proximal humerus fractures with a range from 2.7% to22%[24,30,33]. Unfortunately, failure after surgical fixation occurred in one patient, lack of inferomedial cortical support of the proximal humerus was found to be a significant predictor for failure in our study. Gardner et al[34] reported that mechanical support in the inferomedial region of the proximal humerus is critical in maintaining fracture reduction and that inadequate medial support may increase the complication rate. Dietmar Krappinger et al[35] demonstrated that preoperative assessment of the local BMD and the patients' biological age as well as intraoperative anatomic reduction and restoration of the medial cortical support are the essentials for successful surgical fixation of proximal humerus fractures. In addition, Egol et al[36] reported that early complications were related to restoration of the medial buttress in proximal humerus fractures treated with locked plates.

Besides, several risk factors for failure have been described. Agudelo et al[37] find that there was a statistically significant association between varus reduction (<120 degrees) and loss of fixation (30.4% when the head-shaft angle was <120 degrees, versus 11% when the head-shaft angle was ≥120 degrees; P = 0.02). Micic reported possible risk factors for failure including malreduction, loss of medial support, and negligence of tension band sutures on the tuberosities.

This study has several limitations. Firstly, this study lack of a control group, but a great many studies had made comparison between PHILOS plate and traditional plates. Secondly, the small sample size reduces statistical power. Thirdly, short follow-up does not allow for an analysis of the long-term effect of PHILOS plate in proximal humerus fractures.

In conclusion, our results demonstrate that fixation with the PHILOS plate is an excellent technique with a high union rate and satisfaction rate in the treatment of proximal humeral fractures.

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References

[1] Aguedelo J, SchurmannM, Stahel P,etc. Analysis of efficacy and failure in proximal humerus fractures treated with locking plates. J Orthop Trauma 2007;21:676-681.
[2] Sudkamp N, Bayer J, Hepp P,etc. Open reduction and internal fixation of proximal humerus fractures with use of the locking proximal humerus plate: results of a prospective, multicenter,observational study. J Bone Joint Surg Am 2009;91:1320-1328.
[3] Lanting B, MacDermid J, Drosdowech D, Faber KJ. Proximal humerus fractures: a systematic review of treatment modalities. J Shoulder Elbow Surg2008;17:42-52.
[4] Zyto K, Ahrengart L, Sperber A, etc. Treatment of displaced proximal humeral fractures in elderly patients. J Bone Joint Surg [Br] 1997;79:412-417.
[5] Eid A, Osman M, Fekry HE. Percutaneous fixation with Schanz screws for displaced two- and three- part fractures of the proximal humerus in patients above fifty years of age. Int J Shoulder Surg. 2011 Apr;5(2):38-43.
[6] Lungershausen W, Bach O, Lorenz CO. Locking plate osteosynthesis for fractures of the proximal humerus. Zentralbl Chir. 2003 Jan;128(1):28-33.
[7] Bernd Fuchtmeier, Stefan Breckner, Reiner Hente, etc. The treatment of dislocated humeral head fractures with a new proximal intramedullary nail system. Int Orthop. 2008 December; 32(6): 759–765.
[8] Matthew P. Noyes, Benjamin Kleinhenz, Ronald J. Markert,etc. Functional and radiographic long-term outcomes of hemiarthroplasty for proximal humeral fractures.J Shoulder Elbow Surg (2011) 20, 372-377.
[9] Lungershausen W, Bach O, Lorenz CO. Locking plate osteosynthesis for fractures of the proximal humerus. Zentralbl Chir. 2003 Jan;128(1):28-33.
[10] Lill H, Hepp P, Rose T, etc. The angle stable locking-proximal-humerus-plate (LPHP) for proximal humeral fractures using a small anterior- lateral- deltoid-splitting-approach-technique and first results. Zentralbl Chir. 2004 Jan; 129(1): 43-48.
[11] Bigorre N, Talha A, Cronier P, etc. A prospective study of a new locking plate for proximal humeral fracture. Injury. 2009 Feb;40(2):192-196.

[12] Konrad G, Hirschmüller A, Audige L, etc. Comparison of two different locking plates for two-, three- and four-part proximal humeral fractures-results of an international multicentre study. Int Orthop. 2012 May;36(5):1051-1058.
[13] Neer CS 2nd. Displaced proximal humeral fractures. I. Classification and evaluation. J Bone Joint Surg [Am] 1970;52:1077-1089.
[14] Hoppenfeld S, deBoer P. Surgical exposures in orthopaedics: the anatomic approach. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2003.
[15] Constant CR, Murley AH. A clinical method of functiona assessment of the shoulder. Clin Orthop Relat res,1987(214):160-164
[16] Richards RR, Kai-Nan AN, Bilgian LU, etc. A standardized method for the assessment of shoulder function. J Shoulder Elbow Surg,1994,3:347-352
[17] Kristiansen B, Christensen SW. Plate fixation of proximal humeral fractures. Acta Orthop Scand. 1986 Aug;57(4):320-323.
[18] Paavolainen P, Bjerkenheim JM, Sletis P, etc. Operative treatment of severe proximal humeral fractures. Acta Orthop Scand. 1983 Jun; 54(3): 374-379.
[19] Bulent, Mustafa, Bekir Murat, etc. Early results of treatment of proximal humerus fractures with the PHILOS locking plate. Acta Orthop Traumatol Turc 2008;42(3):149-153.
[20] Periklis Papadopoulos, Dimitrios Karataglis, etc. Mid-term results of internal fixation of proximal humeral fractures with the Philos plate. Injury, Int. J. Care Injured 40 (2009):1292–1296.
[21] Emanuel V. GEIGER, Marcus MAIER, etc. Functional outcome and complications following PHILOS plate fixation in proximal humeral fractures. Acta Orthop Traumatol Turc 2010; 44(1):1-6.
[22] Alexander Brunner, Sebastian Thormann, Reto Babst. Minimally invasive percutaneous plating of proximalhumeral shaft fractures with the Proximal Humerus Internal Locking System (PHILOS). J Shoulder Elbow Surg (2011), 1-8.
[23] Schulte LM, Matteini LE, Neviaser RJ. Proximal periarticular locking plates in proximal humeral fractures:functional outcomes. J Shoulder Elbow Surg. 2011 Dec; 20(8):1234-1240.
[24] Spross C, Platz A, Rufibach K, etc. The PHILOS plate for proximal humeral fractures--risk factors for complications at one year. J Trauma Acute Care Surg. 2012 Mar; 72(3):783-792.
[25] Gaheer RS, Hawkins A. Fixation of 3- and 4-part proximal humerus fractures using the PHILOS plate: mid-term results. Orthopedics. 2010 Sep 7; 33(9):671.
[26] Parmaksizoglu AS, Ozkaya U, Kabukcuoglu Y, etc. Locking plate fixation of three- and four-part proximal humeral fractures. Acta Orthop Traumatol Turc. 2010;44(2):97-104.
[27] Aksu N, Kara AN, Isiklar ZU, etal. Complications encountered in proximal humerus fractures treated with locking plate fixation. Acta Orthop Traumatol Turc. 2010;44(2):89-96.
[28] David S. Thyagarajan, Samarth J, etc. Functional outcome following proximal humeral interlocking system plating for displaced proximal humeral fractures. Int J Shoulder Surg. 2009 Jul-Sep; 3(3): 57–62.
[29] Geiger EV, Maier M, Kelm A, etc. Functional outcome and complications following PHILOS plate fixation in proximal humeral fractures. Acta Orthop Traumatol Turc. 2010;44(1):1-6.
[30] Faraj D, Kooistra BW, Vd Stappen WA, etc. Results of 131 consecutive operated patients with a displaced proximal humerus fracture: an analysis with more than two years follow-up. Eur J Orthop Surg Traumatol. 2011 Jan;21(1):7-12.
[31] Yilmazlar A, Türker G, Atici T, etc. Functional results of conservative therapy accompanied by interscalane brachial plexus block and patient-controlled analgesia in cases with frozen shoulder. Acta Orthop Traumatol Turc. 2010; 44(2):105-110.
[32] Tashjian RZ. The effectiveness of nonoperative treatment for frozen shoulder: a systematic review. Clin J Sport Med. 2012 Mar; 22(2):168-169.
[33] Meier RA, Messmer P, Regazzoni P, etc. Unexpected high complication rate following internal fixation of unstable proximal humerus fractures with an angled blade plate. J Orthop Trauma. 2006 Apr; 20(4):253-260.
[34] Gardner MJ, Weil Y, Barker JU, etc. The importance of medial support in locked plating of proximal humerus fractures. J Orthop Trauma 2007; 21:185-191.
[35] Dietmar Krappinger, Nicola Bizzotto, Stephan Riedmann, etc. Predicting failure after surgical fixation of proximal humerus fractures. Injury. 2011 Nov; 42(11):1283-1288.
[36] Egol KA, Ong CC, Walsh M, etc. Early complications in proximal humerus fractures (OTA types 11) treated with locked plates. J Orthop Trauma 2008; 22: 159-164.
[37] Agudelo J, Schürmann M, Stahel P,etc. Analysis of efficacy and failure in proximal humerus fractures treated with locking plates. J Orthop Trauma. 2007 Nov-Dec; 21(10):676-681.'

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