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Internal Fixation of Displaced Proximal Humerus Fractures Using PHILOS: A Prospective Study

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Abstract: ***Background: Proximal humeral fractures requiring surgical stabilization remain a therapeutic challenge particularly in elderly patients with unstable fracture types and diminished bone quality. Achieving stable fixation has been a challenge in proximal humerus fractures, especially with poor bone stock. PHILOS plate is the recent generation of angular stable implant, that reduces the risk of secondary dislocation of screws or fracture segments when the bone of the humeral head is osteoporotic and also preserves the biological integrity of the humeral head. Objective: The aim of the present study was to evaluate functional outcome and complication rate after open reduction and internal fixation of displaced proximal humerus fractures by PHILOS plate. Methods: This is a prospective study in which 33 patients with displaced proximal humerus fractures, who provided written informed consent to participate in the study were treated with PHILOS plate between October 2011 and November 2014. Fractures were classified according to Neer's classification. Patients were followed up for 18 to 24 (mean, 20) months. Radiographic results were assessed by a three-view trauma series (anteroposterior, lateral and axillary view). Functional evaluation was measured according to the Constant-Murley scoring system and DASH score. Results: The mean age of the 21 female and 12 men was 62 years (27-79 years). According to the Neer's classification 9 patients had two parts fracture, 13 patients had three parts fracture and 11 patients had four parts fracture. Mean Constant Score of 78 points and a DASH Score of 15 points were obtained. Complications observed were one partial humeral head necroses after a head-splitting fracture, superficial infection in two cases, secondary screw perforation in two cases, secondary loss of reduction in three patients with a four part fracture without medial buttress and one patient developed frozen shoulder after the surgery. Conclusion: The PHILOS method appears to be safe and can be recommended for the treatment of proximal humeral fractures in patients with poor bone quality with few manageable complications.***

Keywords: Osteoporotic fractures, Proximal humerus fractures, PHILOS, Stable fixation, Early rehabilitation.

1. Introduction

Proximal humeral fractures are one of the most common osteoporotic fractures, accounts for 5% of all injuries to the appendicular skeleton[1,2]. The prevalence of these fractures is increasing in the elderly[3,4]. Fractures of the proximal humerus follow a unimodal elderly distribution curve with a low incidence under the age of 40 years and an exponential increase thereafter[1]. There are marked gender differences, with approximately 70% of fractures occurring in women.[1,5,6]. Fractures in adolescents and younger adults are usually produced by high-energy injuries, mainly from road traffic accidents, sports injuries, falls from height or gunshot wounds. However, these are much less common than fractures in the elderly, which are usually low-energy osteoporotic injuries[5,6,7,8]. More than three quarters follow low-energy domestic falls[2,5,6,9] and the risk of fracture is increased in sedentary individuals with low bone mineral density, a family history of osteoporotic fracture, frequent falls, and evidence of impaired balance[10]. During impact on the shoulder, the head of the humerus is thought to fracture on the hard-packed bone of the glenoid, which acts as an anvil[11]. Elderly patients, with advanced osteoporosis or with medical co-morbidities, are more likely to have displaced fractures[12]. A proximal humeral fracture may occur from direct impact to the shoulder or indirectly by transmission of forces from a fall onto the outstretched arm. There is universal agreement that most stable fractures, which often occur in frail, elderly patients, are best treated non-operatively. The major controversy surrounds the minority of more complex, displaced and multipart fractures. There is a wide range of treatment options for these injuries, each with its advantages and disadvantages. Operative stabilization of fractures of the humeral head is still a surgical challenge and remains the subject of many clinical and experimental investigations. A wide variety of treatment modalities have been used in the past which include transosseous suture fixation, tension band wiring, standard plate and screw fixation, hemireplacement arthroplasty, percutaneous wire and screw fixation[13-15]. But consensus is available on the ideal treatment modality especially of 3-part and 4-part fractures[16-18]. Precontoured locking plates work on the principle of angular stability, less disruption of vascularity and less chances of plate failure[19]. Improved fixation by locking plates is attributed to the angular stability of the screws locking in the plate and their three dimensional distribution in the humeral head. But their use for the treatment of proximal humerus fractures demands an accurate surgical technique, long learning curve to avoid plate impingement and screw perforation of the articular surface[20-21]. Also, like with all locking plates, fracture reduction must be achieved prior to plate application which can be challenging.

2. Materials & Methods

This was a prospective study conducted in our institute in which 33 consecutive patients with displaced proximal humerus fracture as per Neer's criteria[22] (i.e. angulation of the articular surface of >45degrees or displacement of >1 cm between the major fracture segments) were treated with the locking plate (PHILOS) from October 2011 to November

2014 over a period of 36 months, after obtaining institutional ethical committee clearance and who provided written informed consent prior to enrolment. Open fractures, isolated tuberosity fractures, bilateral fractures, fractures with ipsilateral significant injuries which could prevent early rehabilitation, fracture dislocations, and fractures occurring in children less than 18 years old were excluded from the study. Stable fractures and fractures with minimal displacement and adequate stability were excluded. There were no axillary nerve injury or tendon injuries recorded in our series of 33 patients. Anteroposterior and axillary views of shoulder were obtained in all patients and fracture fragments were analyzed and involvement of the head of the humerus, greater and lesser tuberosities and their displacements and angulations with the shaft of the humerus and each others were assessed & the fractures were classified according to Neers's classification, 9 patients had two parts fracture, 13 patients had three parts fracture and 11 patients had four parts fracture.

3. Operative Procedure:

Patient was placed supine on the operating table under general anaesthesia. After the assessment of shoulder images revealed by fluoroscopy the operative field was draped and prepared in sterile manner. The deltopectoral approach was used; the cephalic vein was identified and retracted laterally. Minimal invasive meticulous soft tissue dissection was performed until the fracture site was visualized. The humeral head was reduced carefully, temporary fixation was performed by two or three K-wires. Then, the plate was positioned lateral to the intertubercular sulcus. The plate was then fixed with angle stable screws on the humeral head and shaft. Position of plate and screws were checked by fluoroscopy to see the length of the screws. The tendons of the rotator cuff and the tuberosity were fixed to the plate with purse string sutures. In some cases we stabilized the greater tuberosity with a single screw. At the end of surgical procedure sterile dressings were applied. No cast or splint was applied but the limb was placed in elevation in arm pouch. Immediate postoperative check x-rays were taken in both anteroposterior & lateral views.

4. Post-Operative Rehabilitation

Elbow and shoulder exercises were encouraged from the next day of operation to promote circulation, avoid edema and stiff shoulder. For first 6 weeks passive assisted stretching done, followed by 4-6 weeks of active range of motion exercises with terminal stretching exercises until maximum active range was achieved. At 10 weeks resisted strengthening exercises were given. Second check x-ray was taken on follow up at 6th week, the fracture union was assessed clinically by absence of tenderness and radiolographically by bridging callus formation. Patients were followed up at 6 weeks, 3 months, 6 months, 1 year, 1.5 years, and 2 years. At each visit, functional evaluation was done according to Constant‑Murley scoring system and DASH score.

5. Results

33 consecutive patients with displaced proximal humerus fractures were treated with the locking compression plate (PHILOS). The mean age of patients was 67 years (range 27-79 years). There were 21 females and 12 males. There was no axillary nerve injury or tendon injuries recorded in our series of 33 patients. The mean time from injury to operation was 3 days (range 1-7 days). According to the Neer's classification fractures were classified as two part (n=9), three part (n=13) and four part (n=11). Patients were followed up for 18 to 24 (mean, 20) months. The average union time was 14 weeks (range 9‑22 weeks) (Figure 1). Clinical evaluation was done using the Constant score (Table-1). According to the Constant score, score was graded as poor (0–55 points), moderate (56–70 points), good (71–85 points) or excellent (86–100 points). Functional outcomes were excellent in 15(45.45%) patients, good in 11(33.33%), moderate in 3(9.09%), and poor in 4(12.12%). The mean Constant score was 78 (range, 40–100). Excellent to good result were seen in 78% of all patients and DASH Score of 15.0 points was obtained at final follow-up. In our study 27% of the patients developed complications (Table-2). Complications observed were one partial humeral head necroses after who was having head-splitting fracture, superficial infection in two cases, secondary loss of reduction was seen in three patients with a four part fracture without medial buttress; the fracture healed after a short period of immobilization. Secondary screw perforations were seen in two cases, one patient developed frozen shoulder after the surgery, improved by conservative treatment and physiotherapy.

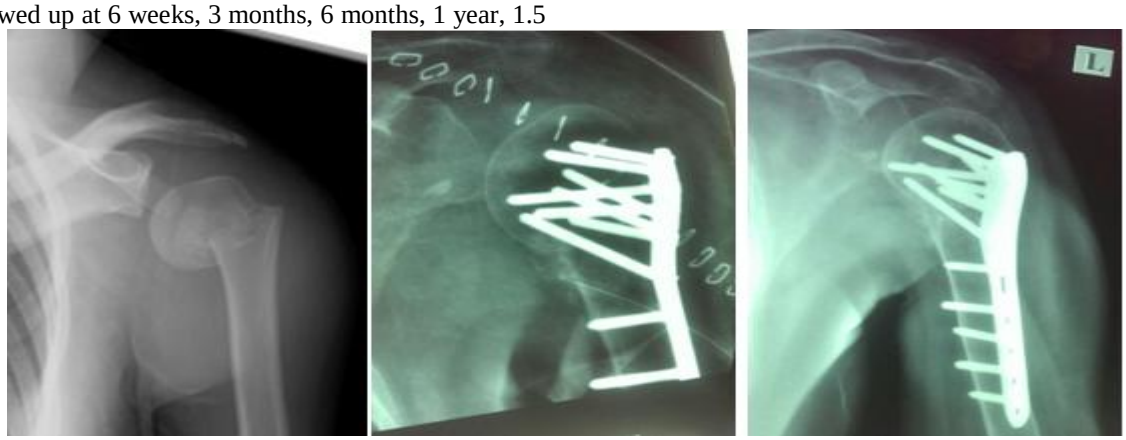

Figure 1: A two part fracture treated with a PHILOS plate, showing multiple-angle screw fixation and solid bony union in an anatomical position at 15 weeks.

Table 1: Functional outcome in the different fracture types, presented as mean and range of the Constant score at 3, 6 and 12-month follow-up.

3 months	60 (34–84)	77 (68–84)	59 (40–72)	44 (34–55)
6 months	74 (36–93)	86 (76–93)	78(54–84)	58 (36–63)
12 month	78 (37–96)	90 (79–92)	84 (71–89)	60 (36–74)

Table 2: Complications associated with management of proximal humerus fractures with proximal humerus locking plate.

Complications	No. of cases	%
Partial humeral head necrosis	1	3
Secondary loss of reduction	3	9
Secondary screw perforation	2	6
Frozen shoulder	1	3
Superficial infection	2	6

6. Discussion

In general, non-operative treatment of displaced three and four-part fractures of the proximal humerus leads to poor outcome due to intra-articular nature of injury and inherent instability of the fragments[23,24]. Comminuted fractures of the proximal humerus are at risk of fixation failure, screw loosening and fracture displacement[25]. Open reduction and internal fixation with conventional plate and screws has been associated with a high rate of complications, namely avascular necrosis, subacromial impingement or screw loosening in osteoporotic bone[26-29]. The technique requires extensive soft tissue stripping, compromising the vascular supply to the humeral head. Minimally invasive methods of plate osteosynthesis may increase the risk of neurovascular structural damage[30,31]. Percutaneous pinning requires advanced skills, good bone quality, minimal fracture comminution and a cooperative patient[32-35]. A careful assessment of the patient in terms of age, activity level, bone quality, fracture pattern, degree of comminution and vascular status of the fracture fragments is required before committing to the type of treatment to be used in a particular patient[27,28]. Operative treatment is challenging in terms of fixation and stability of construct in comminuted fractures and osteoporotic bone[23,27]. This is a fairly common scenario in elderly patients, in whom osteoporosis leads to comminuted fractures of the neck and head of humerus. Conventional plating in such fractures leads to unacceptably high incidence of screw pullout [24]. In order to obtain better and reproducible results, the AO/ASIF has developed a special locking compression plate (PHILOS) for fractures of the proximal humerus (Frigg 2003, Ring and Jupiter 2003). Biomechanical evaluation shows that pull out strength of locked head screws is better than conventional screws due to the axial and angular-stability of screws. PHILOS provides better angular stability, works as a low profile internal fixator and provides good stability even in osteoporotic bones. Advantages of PHILOS in proximal humerus fractures include a high resistance to back out even in patients with poor bone stock because of the combination of fixed angle screw plate locking and three dimensional placement of screws in the humeral head and possibility of early exercise and short period of immobilization because of the high initial stability achieved[36,37]. The combination of locking head screws with three dimensional positioning of the screws within the humeral head leads to improved stability. In our study, 78% (n = 26) of the patients had excellent to good outcome. The overall mean Constant score was 78. The functional outcome was better in the 2 or 3 fragment fracture group than in patients with 4-part fractures in our series. In our study, the comparison of subcomponents of Constant score shows a significant difference between 4-part fracture and other two fracture types. Similar findings were reported by Aggarwal *et al*[38]. Parmaksizoğlu *et al* in their study showed 68.7% excellent to good results, in their study mean age was 63 years (range 29-82 years) and fractures were Neers' 3-part and 4-part 31.8% (n=10). Patients have not achieved optimal results[39]. Solberg*et al*. in their retrospective study of Neers' 3 and 4-part fractures showed mean Constant score of 64.7 in 4-part fracture[40]. The limitation of this study is lack of a control group. We conclude that PHILOS fixation for 2-part and 3-part fractures has good functional outcome but its use in 4-part fractures is associated with high complication rate. The insertion of this new device is technically demanding; in particular the insertion of the proximal screws entails the risk of perforation of the sub-chondral bone by the screw tip. This is because of the sphericity of the humeral head and misleading assessment of the length of screw under fluoroscopy[41,42]. Reconstruction of the medial buttress in the metaphyseal area of humerus is a key point in fixation of proximal humerus with proximal humerus interlocking system[43]. Use of this implant needs technical expertise and most of the complications occur because of intra-operative technical errors. Precise knowledge of and experience with the surgical technique is required to maximize clinical outcomes, including appropriate preoperative and postoperative management.

7. Conclusion

The PHILOS plate is effective in maintaining fracture reduction in proximal humerus fractures. Due to stable fixation it allows the patient to regain better shoulder function and early return to work. Loss of reduction was rarely seen compared with other implants. Complication increased in older patients due to higher rates of secondary impaction, screw perforations and humeral head necrosis. The use of PHILOS in the treatment of displaced proximal humerus fractures is becoming more prevalent. The primary goal of surgery should be to create a construct stable enough to allow early ROM of the shoulder. Precise knowledge of and experience with the surgical technique is required to maximize clinical outcomes, including appropriate preoperative and postoperative management. Our early results on the use of this plate are encouraging and it appears that use of PHILOS in three and four part humerus fractures, particularly in osteopenic bone, provides good results.

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