The Proximal Humerus Locking Plate As A Fixation Modality In Proximal Humeral Fractures: Preliminary Results

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Abstract

Introduction

Proximal humeral fractures are the third most common fractures after hip and distal radius in elderly population. The majority of proximal humeral fractures are minimally displaced and can be successfully treated non-operatively with early rehabilitation.[1,2] Early studies reported less satisfactory results for 3- and 4-part fractures treated by closed reduction, with only 10% of patients achieving satisfactory function.[3,4] Closed reductions of comminuted fractures are difficult to maintain. Three- and 4-part fractures in healthy, active patients are typically treated with surgery to optimize shoulder function.[3,5]

Despite general agreement that complex fractures should be treated operatively, no consensus exists on the type of surgical technique. Closed reduction and percutaneous pinning,[6] tension band wiring,[7] intramedullary nailing,[8] plate fixation,[9] and hemiarthroplasty[10] have demonstrated mixed results.

Defining appropriate treatment protocols is complicated by poor reproducibility and reliability of the commonly used classification system devised by Neer.[11-13] The AO/Association for the Study of Internal Fixation (AO/ASIF) classification system also has been shown to be insufficiently reproducible.[14]

Several new locked plate devices have been developed because research suggests plates with attached (locked) screws may provide improved fracture stability and healing.[15] Locking the screw to the plate mechanically recreates a point of cortical bone contact,[16] which may be useful in the poor cancellous bone of the proximal humerus. Locking plates also have a preconfigured shape and screw direction, which may reduce hardware complications. Early clinical results using the locking proximal humerus plates have been promising.[17,18]

This retrospective review examines all proximal humeral fractures consecutively treated using the Proximal Humerus locking Plate (PHLP) at our institution during the first 12 months of its use.

MATERIAL AND METHODS

The Retrospective Study was performed from Jan 2008 to 2009 at the orthopaedics Department. P.D.U. Hospital ,Rajkot .Gujrat ,India.There were 10 women and 15 men with a mean age of 61.6 years (19 to 86). Ten of the patients sustained their injury following a fall, 14 from a road traffic accident and 1 from direct assault.

All patients evaluated Anteroposterior (AP) and axillary plain radiographs of the shoulder obtained at the time of injury, postfixation, and at most recent follow-up to classify the fracture and measure the fracture displacement and head–neck angle. Computed tomography (CT) scans were used in few complex fractures.

The proximal humerus fracture was classified by the AO/Orthopaedic Trauma Association system.[22] There were 5 type IIA (2-part), 10 type IIB fractures (3-part), and 10 type IIC fractures (4-part). The 7 patients with fracture dislocations were distributed among the treatment groups. All fractures met the indications for operative treatment outlined by Neer et al[7], i.e. an angulation of the articular surface of more than 45 degrees' or displacement between the major fracture fragments of more than 1cm. It is protocol maintain to treat some fracture-dislocations (particularly in the physiologically elderly), head-splitting fractures, and

impression fractures that involve over 40% of the articular surface with a hemiarthroplasty.

The intraoperative variables studied from OT Records like, operative time, estimated blood loss, No. of units of blood transfused and other complications related to implants. Anesthesia was decided by consultant anesthetist.

O perative Technique:
All cases were performed by a senior orthopaedic surgeon. Patients received prophylactic intravenous antibiotics. Most of patients were placed in the supine position and the C-arm was positioned parallel to the patient at the head of the bed. Satisfactory imaging was ensured before prepping the patient. A delto-pectoral approach was used with minimal soft tissue dissection. The biceps tendon was identified and retracted, and the fracture exposed. On occasion the biceps tendon was found to be interposed in the fracture fragments requiring mobilisation. Traction sutures were then placed around the tendon-bone interfaces of the rotator cuff and tuberosity fragments. The head fragment, when involved, was then reduced from its typical varus position through manipulation and flexing of the arm. Once in position the traction sutures were used to bring the fragments beneath the head to buttress the articular fragment. The facture was then held temporarily with K wires and the reduction checked fluoroscopically. The traction sutures were then passed through the proximal eyelets on the plate without any tension. The PHLP was then applied lateral to the bicipital groove, 1-2cm distal to the upper end of the greater tuberosity. A conventional non-locking screw was then inserted into the slotted gliding hole on the plate this both brings the plate to the bone and allows for minor adjustments in plate height and position when checked on fluoroscopy. The polyaxial locking screws were inserted into the head, and locking screws were also inserted into the shaft.

The arm was placed in a sling after wound closure. Using the immediate anteroposterior post-operative radiograph the humeral neck-shaft angle was determined. The anatomic neck-shaft angle of the humerus varies from 130 to 140 degrees. All patients were given prophylactic antibiotics and postoperative antibiotics (Third generation cephalosporin), for 72 hours as per the OT and Department Protocol. The incidence of any postoperative complications and hospital stay were recorded. First dressing and removal of negative suction was done after 72 hrs post op. 2 nd dressing was done at day 5 and patient discharged from the hospital if there is no evidence of infection. Stitch removal was done on 14 th day at Hospital and reassessed for infection. Outpatient follow up was carried out at 1 month, 3 month, 6month and year.

Pendular exercises only were permitted for the first 4 weeks post-operatively, with elbow and wrist range of motion also encouraged. Passive progressing to active range of motion was then commenced under the guidance of a physiotherapist at 4-6 weeks post-op. Resistive strengthening was begun when fracture union was ensured.

All patients had a 12-month minimum clinical follow-up, with average of 15 months. At the most recent follow-up, shoulder range of motion (ROM) was evaluated by the neutral person and recorded. Postoperative outcome was measured with the Quick Disabilities of the Arm, Shoulder, and Hand Outcome Measure (QuickDASH) at a minimum of 12 months postoperatively. The QuickDASH is an eleven-item questionnaire that has been validated for either proximal or distal disorders of the upper limb[20,21].The total score ranges from 0 to 100 points, with 100 indicating the most disability. Functional outcome using DASH has been rated as excellent (<20 points), good (20-39 points), fair (40-60 points) or poor > 60 points.

RESULTS

The mean operative time was 81 minutes (range, 60-123) and the mean blood loss was 222 millilitres (range, 150-600). One patient developed superficial wound infections, and responded to intravenous antibiotics. Other patient had deep infection requires implant removal. No neurovascular injuries occurred.

The fracture displacement between the inferior edge of the head fragment and the adjacent medial edge of the shaft fragment was measured on the initial anteroposterior shoulder radiograph. The initial head–shaft fracture displacement was 26 mm on average (range, 5-76 mm).

Data for forward flexion, abduction, and external rotation were available for 18 of 25 the patients (78%). Internal rotation was reported too infrequently for meaningful analysis. At recent follow up, Mean forward flexion was 123, mean abduction was 110, and mean external rotation. Abduction and external rotation not significantly improved as it may be due to extensive surgical dissection.

Twenty one patients (87%) responded to the DASH questionnaire. Posoperative Quick DASH scores ranged

from 0 to 93.2 (mean = 22.7). The 4 patients who did not respond had undergone an uneventful recovery, had united their fractures radiologically and had been discharged from the clinic.Average DASH scores per AO/ASIF fracture type were 25.3 for type A, 21.4 for type B and 22.7 for type C. There was no statistically significant difference between these groups.

The mean DASH score for patients under 65 years of age (n=10) was 21.5, and 27.5 for patients over 65 years of age (n=10). The difference was statistically significant (p=0.03).

There was a trend towards "better fracture alignment" with intra-operative restoration of the humeral head-neck angle to greater than 90 degrees (n=15) to have better outcome (mean DASH score = 20.4) than those who were fixed with an angle of under 90 degrees (n=10, mean DASH score 24.3). However this was not statistically significant. (The final anteroposterior shoulder radiograph was used to measure the final displacement of the inferior edge of the humeral head from the medial humeral shaft and the head–neck angle as described by Keene.[22])

Complications occurred in 7 of 25 patients (24%). Complete humeral head osteonecrosis developed in 2 patient. One of these 2 patients was treated with revision to hemiarthroplasty. The other patient requested nonoperative symptomatic treatment. One patient reported "impingement symptoms" and stiffness related to prominent hardware that required removal. One patient had a deep infection that required implant removal, debridement, prolonged intravenous antibiotics, and revision internal fixation. One had superficial infection responded to antibiotics. One patient developed post-traumatic arthrosis.

DISCUSSION

The literature describes many options for treatment of displaced proximal humeral fractures.[3-10] Treatment focuses on the displaced fracture fragments, since these may have limited vascularity and may benefit from reduction and fixation. Using the Neer's classification, >85% of all proximal humerus fractures are 1-part fractures that should heal successfully after a brief period of sling immobilization followed by early physical therapy within 14 days of injury.[1,2] In our retrospective study, we focused on displaced or high-energy 2-, 3-, and 4-part fractures.

If we overview the results of other technique,Neer[2] originally Stableforth[4] followed by Flatow et al[7] experienced up to 90% satisfactory results with a suture tension band technique in three part fractures and up to 100% 2 part fractures. Although this has worked effectively in older patients, it may be less reliable in younger patients with complex high-energy fractures or multiple extremity injuries. Jaberg et al[6] reported 95% fracture union with closed reduction and percutaneous pinning, but noted 4 cases (7%) of pin tract infection. Neurovascular complications, articular penetration, and pin migration have also been noted.[23]

Kristiansen and Christensen[24] reported only 45% satisfactory results according to Neer criteria using an AO T plate for 3-part fractures. Paavolainen et al[25] obtained 63% satisfactory results using the same technique by positioning the T plate more inferiorly on the greater tuberosity to avoid "impingement" on the acromion; however, they still encountered intra-articular screw placement. In a group of younger patients (20 to 40 years), Moda et al[26] obtained 83% satisfactory results with meticulous placement of a T plate and screws but noted poor results in patients with severe rotator cuff damage. In an attempt to avoid hardware-related complications of the T plate, Esser[9] used a cloverleaf plate and was able to obtain 92% satisfactory results with a contoured cloverleaf plate. Semitubular plates fashioned into a blade plate for improved fixation have also demonstrated good results with few hardware complications.[19,27]

Early clinical results using the Proximal Humerus locking Plate have been promising, though not without complications.[28-30] Björkenheim et al[18] reported the results of 72 elderly patients (mean age, 67 years) with isolated proximal humerus fractures treated with the Locking Compression Plate. Thirty-six patients (50%) achieved a good or excellent Constant score at 1-year follow-up, with reduced scores in elderly patients and those with type C fractures. There were 3 cases of osteonecrosis and 2 nonunions, but 19 fractures (26%) developed varus malalignment. Initial varus malreduction has been noted to increase the risk of fracture fixation failure.[28,31] Fankhauser et al[17] noted loss of proximal screw fixation and varus malalignment in 10% of cases. They recommended augmenting the proximal fixation with sutures placed through the rotator cuff and attached to the Locking Compression Plate.

Trends were noted toward improved fracture reduction (mean displacement, 2.5 mm) and valgus head–neck alignment (mean, 142.1°) in the proximal humerus locking

plate, which could be advantageous for fracture healing.[28,29] A larger study may demonstrate improved alignment with the proximal humerus locking Plate, especially compared to blade plates or other fixation techniques, since the postoperative displacement and head–neck angle mean differences were minor between these groups. The ROM of all patients (mean forward flexion, 123°; mean abduction, 110°; mean external rotation, 45°).However, our data did not establish a relationship between better fracture alignment and ROM or functional outcome. Complete surgical exposure for the this technique involves extensive dissection of the deltoid. Fortunately, in all patients mean range of shoulder motion was functional, as defined by Matsen et al's criteria.[32]

One notable finding of this review was that nearly all patients had worse functional outcome scores. But, the postoperative ROM was statistically associated with an improved outcome score, which reflects the fact that improved DASH and quick DASH scores require functional shoulder ROM. Although successful postoperative reduction and head–neck angle restoration were not associated with improved outcome scores, 80% of patients had surgical reductions within 1 cm and a head–neck angle >100°. This reduction functionally converts the fracture to a Neer 1-part fracture that can be treated with rehabilitation.

Successful operative treatment may depend on the same variable that leads to successful nonoperative treatment of simple 1- and 2-part fractures: early physical therapy. Perhaps the best indication for surgical treatment is to maintain an adequate stable fracture reduction to proceed with early ROM.

One limitation of the study is the size of the study. The cohorts were too small to achieve statistical differences in the fracture reduction, ROM, and outcomes. Since the majority of proximal humeral fractures are treated nonoperatively, it is difficult to collect a large group of surgically treated patients. A multicenter trial may be required to collect enough patients requiring surgical treatment.

We couldn't compare the results of LCP with the other treatment options, which remain the second limitation of our study. As in spite of batter fracture alignment, rigid fixation and early rehabilitation of the patients, final functional score remained worse, which we need to compare.

These preliminary results suggest that the Locking Compression Plate Proximal Humerus Plate is a favorable treatment option for displaced, comminuted proximal humeral fractures sustained by both low- and high-energy mechanisms and that it compares favorably to other established techniques. Several patients treated by this method required revision to hemiarthroplasty after developing fracture malalignment or complete humeral head osteonecrosis. Hemiarthroplasty remains a viable option for older patients with osteonecrosis and head splitting fractures.

CONCLUSION

Treatment of displaced proximal humeral fractures using the Locking Compression Plate Proximal Humerus Plate (PHLP) offers several theoretical advantages over other treatment modalities. We retrospectively reviewed the results and outcomes after treatment with the Locking Compression Plate.

This review of the early experience with the proximal humeral Locking Plate (PHLP) shows a significant rate of complication (7/25 cases) and functional ROM results similar to other previously described techniques. Fixation with a Locking Compression Plate (PHLP) provides "Better fracture alignment" with high degree of stability to preserve achieved reduction, and which benefits the good functional outcome. However surgical technique related complication risks are high, particularly due to fixation failure and screw perforations into the joint. But problems related to "impingement" in older implants can be clearly decreased with PHLP. Augmented awareness and improvement of surgical technique should reduce other complications. Complex fracture types and higher age increases the risk to sustain complications, where as only severity of fractures impairs the functional outcome.

This plate provides an alternative method of fixation for fractures of the proximal humerus. It provides a stable fixation in young patients with good quality bone sufficient to permit early mobilization. Failure of the screw s to maintain fixation in the elderly remains a problem. A randomized control trial comparing it to classical techniques would seem appropriate.

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