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Three Part Proximal Humerus Fracture Fixation with K-wires Vs Minimally Invasive Locking Plate

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Abstract: ***Background: Treatment of proximal humerus fractures is controversial and various operative modalities have been tried. The aim of the present study was to evaluate functional outcome after open reduction and internal fixation of three part proximal humerus fractures by proximal humerus locking plate compared with k wire fixation. Methods: Fractures were classified according to Neer's classification. We reviewed a total of 40 patients with proximal humerus 3 part fractures in 20 patients (Group 1), who were treated with minimally invasive deltoid splitting Proximal Humeral Locking plate and 20 patients (Group 2) who were treated with percutaneous K-wire fixation. Functional outcome was assessed using Constant-Murley Score. Results: The average follow up period was around 24 months. Mean Constant-Murley score was 88.4points (range: 61- 100) in Group 1 and - 72.4 points (range:56-100) in Group 2 at final follow up. Complications included screw perforation of head, non union, mal union, loss of fixation, and infection. Conclusion: Proximal humerus locking plate gives stable fixation with minimal implant problems and enabled early range-of motion exercises to achieve acceptable functional results for 3-part fractures compared with K-wire fixation.***

Keywords: K- wire fixation, proximal humerus locking plate, 3 part proximal humerus fracture

1. Introduction

Proximal humerus fractures are relatively common, accounting for 4% - 5% of all fractures. These fractures can pose a challenge for the treating orthopaedician because of the generally osteoporotic nature of bone in the elderly and the relative deforming forces of the surrounding muscles. Fractures are classified according to the Neer criteria, and treatment is often guided by the relative displacement of the anatomic fragments. Nondisplaced fractures have historically been treated conservatively, with generally good outcomes. Displaced fractures with angulation of the articular surface >45° and displacement of the major segments >1 cm have been treated surgically, as have fractures with substantial valgus impaction, all with mixed results. Surgical techniques have included percutaneous fixation, standard plate-and-screw fixation, intramedullary fixation with rods or pins, the use of tension bands with and without plates or rods, standard plate modification into blade plate constructs, and hemiarthroplasty. Many of these alternative open techniques were developed because of the high failure rates noted initially with standard plating. The inherent difficulties with internal fixation have led several authors to recommend hemiarthroplasty for the treatment of four-part humerus fractures. However, locked plates allow for more secure fixation in compromised bone, thereby possibly leading to reduced incidence of failure of internal fixation. Newer plates also incorporate suture eyelets that further enhance the fixation construct and resist deforming muscular forces. Additional investigation is necessary, but early results with locked plate fixation for the treatment of proximal humerus fractures have been encouraging. It is anticipated that this technique will provide another potentially viable alternative to prosthetic replacement for the treatment of these difficult injuries. There may be special technical requirements for the success of such a plate which need to be defined. Thus the objective of our study was to determine the efficacy of proximal humerus locking plate.

2. Materials and Methods

A prospective study was conducted in our institution over three years of a total of 40 patients with proximal humerus 3 part fractures. Group 1 included 20 patients who were treated with ORIF with PHILOS plate . Group 2 included 20 patients who were treated with closed reduction and percutaneous K-wire fixation

Inclusion criteria:
1) Displaced 3 part fractures
2) Both males and females between age 20 to 80 years.
3) Patients operated within 10 days of injury.
4) Patients with a minimum follow up period of 2 year.

Exclusion criteria:
1) Skeletally immature patients
2) Patients with open fractures and fractures in the same limb.
3) Pathological fractures.
4) Patients with distal neurovascular deficit.
5) Patients with nonunions, malunions or delay in surgery(>10 days)

Three part proximal humerus fracture fixation with K-wire vs minimally invasive locking plate. All proximal humeral fractures met the indications for the operative treatment as outlined by Neer, i.e., an angulation of articular surface of more than 45 degrees, a displacement between the major fracture fragments more than 1 cm or a fracture with valgus impaction.

Preoperative true AP, lateral and axillary X rays along with CT scans of the area were reviewed by two of the specialist orthopedic surgeons to define fracture type and outline the plan of surgery. Fracture patterns were classified according AO/OTA system and the Neer`s classification.

Operative technique for each group was as follows:

Group 1 (Proximal humerus locking plate): Surgery was performed in supine position on a radiolucent table using the minimally invasive deltoid splitting approach. After the usual preparation and draping, a longitudinal surgical incision was created slightly distal to the lateral edge of the acromion and extended distally 5 cm In the sagittal plane, this incision was positioned in the center of the humeral head. More deeply, the deltoid musculature was split parallel to its fibers to expose the underlying sub deltoid bursa and the proximal edge of the greater tuberosity .The fracture was reduced by several methods. Often, manual manipulation of the fragments followed by axial compression of the fracture was sufficient for adequate reduction. Once the head–shaft segment had been reduced, the greater tuberosity fragment, if present, could be manually reduced. The displaced piece was palpated posterosuperior to the humeral head because of the external rotation and abduction afforded by supraspinatus, infraspinatus, and teres minor. The tuberosity was held into its reduced position by the plate or by a provisional Kirschner wire (K-wire) The K-wire should be directed away from future plate placement. In another reduction technique, K-wires were placed into the articular segment and used as joysticks to restore the neck–shaft angle. After confirmation with fluoroscopy, the reduction was stabilized with K-wires into the glenoid. When the fracture reduction could not be maintained because of inadequate assistance or fracture instability, K-wires were inserted anteriorly from the shaft into the head to temporarily stabilize the fracture.

After adequate reduction was obtained, the plate was inserted safely between the bursa and the greater tuberosity before the plate was advanced distally on the humerus. The axillary nerve was identified easily by inserting an index finger into the wound and curling it distally; the nerve, which runs transversely 5 cm distal to the lateral edge of the acromion, was readily palpable on the undersurface of the deltoid. The axillary nerve was protected manually as the deltoid was elevated and the plate slid distally beyond the fracture site. If any soft-tissue resistance was appreciated before the distal tip of the plate reached the deltoid insertion, the plate was removed and reinserted. Standardized orthogonal fluoroscopic images, including true anteroposterior and trans-scapular lateral views of the shoulder, confirmed correct plate position.. This plate was provisionally secured using either 2 K-wires or 2 drill bits Each screw was prepared using standard AO technique and fluoroscopic guidance. An incision of 1.5 cm was made centrally over the distal 2 screw holes to facilitate screw preparation and placement. We attempted to fill the majority of locking screw holes into the humeral head proximally and place at least 3 bicortical screws into the distal fragment. We avoided placing screws within the vicinity of the axillary nerve, as this area usually correlates with the flare of the plate.A combination of locked and unlocked screws was used for each construct, depending on bone quality and screw position. Plate position and screw size were reassessed fluoroscopically and readjusted as necessary. Before wound closure, the axillary nerve was palpated to ensure that the nerve was not ensnared by a screw or trapped beneath the plate. The deltoid fascia and subcutaneous tissues were repaired with a nonabsorbable suture, and the skin edges were reapproximated with non absorbable suture. A sterile dressing was applied with the extremity placed into a sling.

The post operative rehabilitation protocol included immediate passive and active assisted range of motion exercises up to 60 degrees of abduction and elevation with no forced external rotation for 6 weeks. Full ROM with active exercises was started at 6 weeks.

Group 2 (K-wire fixation): Surgery was performed under general anaesthesia with the patient in beach chair position. Near anatomical reduction was achieved by manual traction and arm mobilization. Three to four threaded 2.5 mm K-wires under image intensifier were inserted depending on the number of fracture fragments. In the case of difficult reduction one K-wire of 3.5 mm k wire was used as a joystick. Care was taken on the orientation and pin placement to avoid injury to the axillary nerve, the radial nerve and the anterior circumflex humeral vessels lying medially. K-wires were left out of skin and bent at the extremity to control migration. Patients were encouraged to start active mobilisation of wrist and elbow on the second postoperative day. Dressing of the pin tracts were done on alternate days.

Passive ROM exercises were initiated on the second postoperative day. Active shoulder mobilization exercises were started at 4 to 6 weeks postoperatively depending on patient's co-operation.

Mean operation time was 100 minutes (range 80-120 minutes) in Group 1 and 50 minutes (range 35-70 minutes) in Group 2. In Group 1 the average blood loss during surgery was300 ml (range 200-400) whereas in Group 2 it was 60 ml (range40-80ml). Both groups received broad spectrum antibiotics postoperatively. There were no major complications intraoperatively in both the groups.

Patients were followed up on OPD basis at two weeks postoperatively, then monthly for 6 months, 3 monthly till the end of 1st year and yearly thereafter. At every follow up visit standard AP and axillary radiographs were obtained and thorough clinical assessment done. Anticipated postoperative complications included loss of reduction, fragment displacement, major varus or valgus deformation, head necrosis or implant-related problems (screw perforation, screw loosening or backing out, plate pullout, or breakage), and surgical and other general complications such as wound infection or soft-tissue problems (rotator cuff lesions, adhesions, frozen shoulders, impingement, and nerve lesions).

3. Results

All fractures united with an average union time of 20 (16-25) weeks. Post operatively complications were noted in 3 patients in Group 1 and in 8 patients in Group 2.

In Group 1, one patient had infection, one patient had loss of fixation and non-union , one patient had screw perforation of humeral head . Patients with infection were treated with

intravenous antibiotics after obtaining the culture sensitivity reports.

In Group 2, four patients had pin tract infection and pin loosening, two patients had non-union, two patients had malunion. Patients with pin tract infection were treated with daily dressings and antibiotics, those with non-union were treated with ORIF and bone grafting. Patients in whom the fracture had malunited did not require any treatment, as the range of movements was acceptable.

Mean Constant- Murley score was 88.4 points (range: 61-100) in Group 1 and 72.4 points(range:56-100) in Group 2 at final follow up.

4. Discussion

Treatment of proximal humerus fractures has been revolutionized by locked plating. Previous instrumented fixation methods, including rods, nails, pins, and plates and screws, were often limited by inadequate purchase into the humeral head. Locked plating provides more rigid fixation into the metaphyseal bone and consequently allows for earlier mobilization, which theoretically decreases postoperative stiffness. Before the advent of locked plating, minimally invasive techniques were limited to extra-articular diaphyseal or metaphyseal fractures or nondisplaced articular fractures amenable to isolated screw or pin fixation.Locked plating not only has afforded more effective stabilization of fractures with poor cortical bone, such as metaphyseal fractures or osteoporotic fragility fractures, but has allowed plating of these fractures through smaller incisions. Locked plating has prompted a growing trend toward obtaining stable fracture fixation through minimally invasive techniques. As the axillary nerve is consistently 5 cm to 7 cm distal to the lateral edge of the acromion, percutaneous plate fixation is ideally suited to fractures involving the proximal humerus. Through the proposed incision, the axillary nerve can be palpated easily and protected. With these precautions, MIPO may be safer than other techniques, such as percutaneous pinning, in which screws or pins may be blindly inserted adjacent to the axillary nerve.

Evidence suggests that minimally invasive techniques also pose less risk to the vascular supply of the humeral Head. In a cadaveric study of MIPO, Gardner and colleagues demonstrated preservation of the humeral head arterial supply, which included the ascending branch of the anterior humeral circumflex vessel and an unnamed posterior branch, when the plate was placed in the “bare spot” on the proximal lateral region of the humerus.

Esser reported excellent results in 22 out of his 26 patients of three part and four part fractures of proximal humerus treated with a modified clover leaf plate. Wijgman et al et al reported good to excellent results in 87% of their 60 patients with three or four part proximal humeral fractures operated with a T-buttress plate and cerclage wires. Paavolainen et al reported satisfactory results in 74.2% of their 41 patients with severe proximal humerus fractures treated with plate and screw devices. However all these authors found poor results in 4 part fractures and recommended a prosthetic replacement in such patients. Several clinical studies have corroborated the benefits of minimally invasive vs standard K-wire techniques in limiting facture reduction and maintain the contour of humeral head. Another advantage of this technique is the ability to obtain a “good” reduction of the greater tuberosity.

Several authors have indicated that attaining anatomical reduction of the greater tuberosity is important to the ultimate outcome after proximal humeral fractures.

Our clinical success with the 2-incision technique prompted our performing MIPO through a lateral incision. We feel that this technique, which provides ample exposure to the greater tuberosity, allows for reduction of all fracture fragments.

Figure 1: 3 part proximal humerus fracture

Figure 2: Postoperative film with good reduction of greater tuberosity and valgus reduction

Figure 3: 3 part fracture

Figure 4: Fluoroscopic image with K-wire fixation

Table 1: Postoperative complications in Group 1 and Group 2

	Infection	Non union	Malunion	Others	Average Constant Murley Score
Group 1 (plating)	1, treated with culture and sensitivity antibiotics	1, with loss of fixation, treated with bone grafting	Nil	1, screw perforating humeral head, treated by removal of screw	88.4
Group 2 (K-wire)	4, pin tract infection, treated with dressing and antibiotics	2, treated with bone grafting	2, patients had good range of motion	4, pin loosening and backout, treated by repeating K-wiring	72.4

5. Conclusion

Proximal humerus locking plate gives stable fixation with minimal implant problems and enabled early range-of motion exercises to achieve acceptable functional results for 3-part fractures compared with K-wire fixation.

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