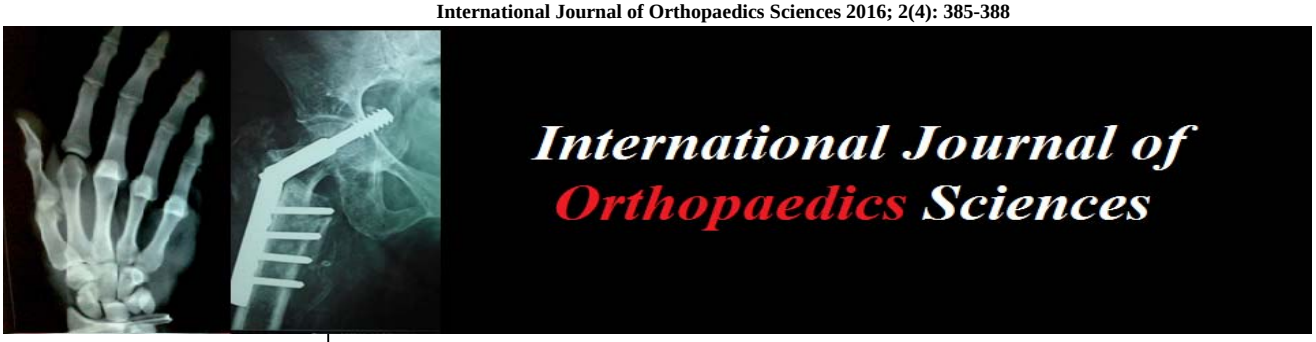

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Clinical study of the management of proximal humeral fractures with the use of the locking compression plate

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Abstract
Introduction: Most of proximal humerus fractures, in younger patients as well as well as in the elderly, are stable and minimally displaced and can be treated conservatively. Nondisplaced fractures with minimal displacement and adequate stability usually are successfully treated non-operatively
Methodology: The present study is a prospective clinical study of the management of the proximal humerus fractures with the use of the locking compression plate. The study was done in the department of Orthopaedics and during the study 17 patients with displaced proximal humerus fractures were treated with open reduction and internal fixation with locking compression plate
Results: At the end of clinical and radiological union and full functional recovery, the results were evaluated by Constant Score. Mean scores observed on Constant Score for its different parametres were pain 14.11, activities of daily living 18.82, range of motion 23. 76, power 22.05. The mean Constant score was 78.76.
Conclusion: The plate allows for gentle fracture reduction, with use of indirect reduction maneuvers and consequent limited soft tissue dissection. The plate does not need to be configured to the bone surface and the angular screw fixation ensures a fixed-angle stabilization.

Keywords: Management, Proximal Humeral Fractures, Locking Compression Plate

Introduction
Fractures of the proximal humerus are relatively common and comprise about 4-5% of all fractures in most studies [1]. Proximal humeral fracture is the second most common fracture of the upper extremity, following distal forearm fracture[4]. More than 70% of patients with these fractures are older than sixty years of age, and 75% of them are women [5]. These fractures have a dual age distribution occurring either in young people following high energy trauma or in those older than 50 years with low velocity injuries like simple fall [6]. In the elderly population, most of these fractures are related to osteoporosis [2].
Most of proximal humerus fractures, in younger patients as well as well as in the elderly, are stable and minimally displaced and can be treated conservatively [3]. Nondisplaced fractures with minimal displacement and adequate stability usually are successfully treated nonoperatively. In contrast, the treatment of displaced and unstable fractures of the proximal humerus remains controversial. Internal fixation has led to unpredictable results, especially in patients with osteopenic bone and those with comminuted fractures [4]. Closed reduction methods, particularly with comminuted, unstable fracture patterns, have led to poor clinical results because of the inability to gain and maintain a satisfactory reduction. Non operative treatment of complex (i.e., three-part and four part) fractures often results in malunion and stiffness of the shoulder [5]. A variety of treatment techniques have been proposed, including open reduction and internal fixation with proximal humeral plates, hemiarthroplasty, and percutaneous or minimally invasive techniques such as pinning, screw osteosynthesis, and the use of intramedullary nails [6]. However several complications have been described in association with these techniques, including implant failure, loss of reduction, nonunion or malunion of the fracture, impingement syndrome and osteonecrosis of the humeral head. In patients with osteoporotic bone and/or comminuted fractures, operative stabilization is challenging [7]. Although these fractures can be treated adequately by surgery, their complex pattern, displacement and comminution make their secure anatomical fixation difficult. In contrast to locking plates, non-locking plates which rely for stability of their osteosynthesis on

friction between the plate and bone, their effectiveness decreases with bone quality which may lead to screw loosening and high failure rates in osteoporotic bone. In order to minimize these complications, the locking compression plate (the Locking Proximal Humerus Plate, LPHP) was developed by the AO Foundation. This device is precontoured to the anatomy of the lateral aspect of the proximal humeral metaphysis and functions to assist internal fixation by securing an anatomical reduction with angular stability [8].

Open reduction and internal fixation (ORIF) of proximal humerus fractures with plate and screws has been associated with complications such as screw loosening from insufficient holding power of screws in osteoporotic bone, subacromial impingement, and avascular necrosis from excessive periosteal and soft tissue stripping.

Theoretical advantage of implants with angular stability (locking plates) is better anchorage of screws in osteoporotic bone as well as their function of a locked internal fixator. Because of the good fixation there is a potential of enhanced stability that could allow early mobilization, improving range of motion. Additionally they can be inserted using a minimally invasive technique without additional trauma to the soft tissues [1].

Methodology

The present study is a prospective clinical study of the management of the proximal humerus fractures with the use of the locking compression plate. The study was done in the department of Orthopaedics. During the study 17 patients with displaced proximal humerus fractures were treated with open reduction and internal fixation with locking compression plate. After ethical committee clearance, and after taking informed consent, patients with proximal humerus fractures were included under the study after they have met the inclusion criteria.

Inclusion criteria

Patients with proximal humeral fractures, who

i) are skeletally mature and age more than 18 years ii) satisfy Neer's criteria for operative treatment i.e. displacement of >1cm between the major fracture fragments or angulation of the articular surface of >45 degrees

Exclusion criteria

1. Undisplaced stable fractures
2. Open fractures
3. Pathological fracture or Refracture

Most of the patients were brought to the casualty or emergency department or admitted though outpatient basis. All patients were initially evaluated in the outpatient department or casualty according to their presentation and later detailed evaluation was done in wards after admission. History was taken through verbal communication with the patient or their attendants to note particularly the mode of injury, and associated injuries. Then assessment of the patient's general condition was carried out and clinical examination both local and systemic was done with careful local examination of the skeletal system, soft tissue injuries, neurovascular examination and other associated injuries was done. Pain was relieved by analgesics, and then patient's injured arm was initially placed in a sling. Immediately after basic investigations, radiological examination was done with true AP view and scapular lateral views of the involved shoulder and axillary view when needed was done to analyze the fracture anatomy, classify and plan the mode of treatment. Later the involved arm was immobilized in an arm sling or collar n cuff or shoulder immobilizer or U-slab.

The common symptoms were pain, swelling and inability to move the involved shoulder. Clinical findings usually noted were tenderness about the shoulders especially in the area of greater tuberosity, crepitus, and painful restriction of motion of the involved shoulder. Ecchymosis became visible about 24-48 hours after the injury over the involved shoulders and in some cases it spread across the chest or down to the elbow. A detailed neurovascular examination was conducted of the involved limb as brachial plexus and its braches (particularly axillary nerve), or axillary artery medial to the coracoids process might have been injured. The axillary nerve was tested by sensations over the deltoid region.

Results

The age of these patients ranged from 23 to 78 years with mean age of 48.3 years.

In our series of 17 patients five patients were in the age group of 21 - 30 years(29.4%), one patient in the age group of 31 – 40 years(5.8%), one patient in the age group of 41 – 50 years(5.8%), 7 patients were in the age group of 51 – 60 years(41.2%), one patient in the age group of 61 – 70 years (5.8%) and two were in the age group of71 – 80 years(11.7%)

Table 1: Showing age incidence

Age group(years)	Number of patients
11 to 20	00
21 to 30	05
31 to 40	01
41 to 50	01
51 to 60	07
61 to 70	01
71 to 80	02

The most common type of fracture observed in our series was two part fractures accounting for 13 patients(76%), 4 patients had three part fracture, two patients had 4 part fracture, and one patient had 3 part fracture dislocation with head splitting fracture.

Table 2: Showing type of fracture

Two part fractures	10
Three part fractures	04
Four part fractures	02
Fracture dislocations or head splitting fractures	01

Six patients had associated injuries, and in most of the patients with these injuries, the mode of injury was a road traffic accident.

Table 3: Showing associated injuries

Associated injuries	No. of patients
Head injury	01
Ipsilateral femur fracture	01
Contralateral humerus shaft fracture	01
Ipsilateral both bones forearm fracture	01
Ipsilateral clavicle fracture and metacarpal fractures	01
Ipsilateral tibia fracture	01

Average blood loss: average blood loss was between 200 to 350 ml.

Follow up and clinical evaluation

The average follow up duration was 14 months (range 08 – 23months). The average time taken for clinical union was (range 11 – 16 weeks) and radiological union (12 – 22 weeks). Intraoperatively no complications were noted. During the follow up period, two patients had superficial infection which healed eventually, one patient had deep infection following muscle necrosis, one patient had impingement and restricted abduction due to high placement of plate, one patient had screw backout or implant loosening.

Secondary to these complications, late complications seen were stiffness in one patient to a marked degree because of deep infection and muscle necrosis and moderate stiffness in two patients secondary to impingement in one patient and superficial infection in other patient. There were no incidences of nonunion, malunion or osteonecrosis of the humeral head.

Table 4: Postoperative complications

Superficial infection	02
Deep infection	01
Shoulder impingement	01
Screw backout or implant loosening	01
malunion	00
nonunion	00
osteonecrosis	00

Evaluation of results by Constant Score

At the end of clinical and radiological union and full functional recovery, the results were evaluated by Constant Score. Mean scores observed on Constant Score for its different parametres were pain 14.11, activities of daily living 18.82, range of motion 23. 76, power 22.05. The mean Constant score was 78.76.

Table 5: Showing different parametres of Constant score

Modality	Maximum score	Mean observerd score
pain	15	14.11
Activities of daily living	20	18.82
Range of motion	40	23.76
power	25	22.05
Total score	100	78.76

Results by Constant score

According to the Constant score, of the 17 patients, two patients had excellent results, 11 patients had good outcomes, three patients had moderate outcome and one patient had a poor outcome.

Table 6: Showing results by Constant score

Outcome	No. of patients
Excellent (score >86)	02
Satisfactory (71 to 86)	11
Moderate outcome (56 – 70)	03
Poor outcome(0 – 55)	01

Discussion

The treatment of the displaced proximal humerus fractures is complex and their appropriate management is still controversial[9]. Proximal huemrus fractures represent an increasing challenge for the health care system because of the increasing proportion of elderly individuals in the populataion[10]. Stable reduction is essential for healing of these fractures and for achieving early functional recovery if the shoulder. In patients with osteoporosis and/or comminuted fractures, operative stabilization is challenging. Various techniques have been used to stabilize fractures of the proximal part of the humerus, including intramedullary nails, plate and screw osteosynthesis, tension band wiring, hemiarthroplasty, and minimally invasive techniques such as percutaneous pinning, screw osteosynthesis, etc., However various complications have been described with these techniques including implant failure, loss of reduction, stiffness, non-union or malunion of the fracture, impingement syndrome and osteonecrosis of the humeral head. Non - locking plates which rely for stability of their osteosynthesis on friction between the plate and the bone, their effectiveness decreases with bone quality which may lead to screw loosening and high failure rates in metaphyseal fractures, comminuted fractures and in osteoporotic bone [11, 12].

New techniques with the use of plates and screws with angular stability have been introduced in order to avoid these complications. The locking compression plates (locking proximal humerus plate or PHILOS plate) have been introduced in order to avoid these complications. These plates were designed to maintain a stable fracture reduction even in osteoporotic bone, comminuted fractures and periarticular metaphyseal fractures [12].

Advantages of these plates include gentle fracture reduction with the use of indirect maneuvers, a high resistance to avulsion 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 the possibility of early exercise and a short period of immobilization because of the high initial stability achieved [12].

There have been only a limited number of clinical studies investigating the results after open reduction and internal fixation of proximal huemrus with locking compression plates and most of these studies included only a small number of patients [12]. In those studies, the average Constant score at the time of latest follow-up ranged from 72 to 76 points. Complications included osteonecrosis, loss of reduction, plate breakage, and non-union of the fracture [12]. Most authors have concluded that the locking compression plate design provides stable fixation with a good clinical outcome and have recommended the use of locking plates for the treatment of proximal humerus fractures with poor bone quality [12].

In our institution we studied the management of the proximal humerus fractures treated with the locking compression plate in seventeen patients. The age group of the patients ranged between 23 to 78 years (with mean age of 48.3 years). Of the 17 patients, 13 were males and 4 were females with male to female ratio of 3.25: 1. Road traffic accidents were the main mode of injury accounting for 9 cases (53%), followed by falls (06 cases-35%) and assaults (2 cases-12%). In our study, right side was affected in 12 cases (70.5%) and left side was affected in 5 cases (29.5%). There were 10 patients with two-part fractures, 5 patients with three-part fractures (4 pure three-part fractures and one three-part fracture dislocation) and 2 patients with four-part fractures.

Conclusion

1. Provides stable fixation even in osteoporotic bone, comminuted fractures and metaphyseal fractures which allows for early rehabilitation.
2. Moreover, complications associated with the plate were few, and the functional outcome was comparable with earlier studies.
3. Many of the common complications of the conventional

plating such as loss of reduction, implant loosening, screw back out, and excessive soft tissue dissection can possibly be avoided

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