

## LOCKING COMPRESSION PLATE FOR PROXIMAL HUMERUS FRACTURES. - A PROSPECTIVE STUDY.

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**ABSTRACT:** Proximal humerus fractures encompass a broad spectrum of injuries. They are often the result of a fall in an osteoporotic patient, but also occur in high-energy trauma. These account for 4 -5 % of all fractures and incidence increase rapidly with age and occurs twice as often in women as in men. Functional results associated with non-operative treatment of displaced fracture of proximal humerus are poor. Over the last decades, several techniques have been applied for treatment of proximal humerus fractures. Widely accepted is the initiation of a conservative treatment regimen for undisplaced fractures, however, the ideal treatment of displaced fractures, especially 3 and 4 part fractures is still the center of scientific debate . In our hospital 36 patients with 36 proximal humerus fractures were treated with locking compression plate from December 2010 to December 2012. Among these 21 patients were male & 15 patients were female. Youngest patient was 29 years & oldest was 76 years. Fractures were classified according to Neer's classification & type 2, 3, & 4 were included in the study. Post operatively rehabilitation started depending upon stability of fixation & tolerability of patient. According to Neer's scoring system approximately 60% of patients had satisfactory to excellent results, 30% had fair results and 10% had unsatisfactory to poor results.

**KEYWORDS:** Proximal humerus fractures, locking compression plate, Neer's classification and osteoporotic fractures.

**INTRODUCTION:** Proximal humerus fractures are estimated to account for 4 to 5% of all upper extremity fractures<sup>1, 2</sup>. Incidence rapidly increases with the age, older individuals are more likely to sustain these injuries: 71% of proximal humeral fractures occur in patients over the age of sixty years<sup>3, 4</sup>.

It occurs twice as common in females than in males. In the elderly population, most of these fractures are related to osteoporosis<sup>5</sup>. Most common mode of injury was fall from a standing height where as in younger patients it was high impact trauma. Non- displaced fractures and fractures with minimal displacement and adequate stability usually are successfully treated nonoperatively<sup>6-8</sup>. Unless contraindicated, the recommended general strategy for the management of displaced proximal humeral fractures is operative, with use of some forms of internal fixation.

A variety of treatment techniques has 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<sup>9-17</sup>. The basic principle in many of these methods is to provide stability to fracture, which prevents loss of reduction; however there are several complications that have been reported in association with

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these techniques, including implant failure, nonunion or malunion of the fracture, impingement syndrome, and osteonecrosis of the humeral head<sup>10, 18-20</sup>.

Recent advances in fracture fixation technology have shown developing interest in treating these fractures using Locking compression plates and screws as they provide angular stability and its low profile implant with better purchase in especially osteoporotic fractures. Though there are few complications related to this technique but most of them can be prevented at the time of surgery such as humeral head perforation, mechanical impingement, and loss of fixation.

**MATERIALS & METHODS:** This prospective observational case series was conducted at S.S.I.M.S & R.C Hospital, Davangere between Dec 2010 and Dec 2012 under Dept of Orthopaedics. There were 36 patients with proximal humerus fracture who were treated with clover leaf LCP. There are various locking compression plate designs available for fixation of the proximal humerus fracture, most commonly used is PHILOS plate. In our study we have used AO Clover leaf LCP because of cost constrains and it also provides angular fixation, it's a low profile internal fixator, excellent in osteoporotic bone and suits better to the proximal humerus anatomy.

Our aim was to achieve union, normal to near normal functional outcome with no or minimal complications.

After thorough pre operative evaluation, patients with proximal humeral fractures were included if they were skeletally mature, who met the indications for operative treatment as per Neer's criteria<sup>21</sup> (i.e., angulation of the articular surface of >45degrees or displacement of >1 cm between the major fracture segments) and who provided written informed consent prior to enrollment.

Undisplaced stable fractures and fractures with minimal displacement and adequate stability as well as fractures involving only the greater or lesser tuberosities were not considered for treatment with the Locking Compression Plate<sup>22</sup>.

There were 21 males & 15 females between age group of 29-76 yr. mean age group 52yr.

Commonest mode of injury was fall from a standing height in elderly and high velocity injury in young patients.

All fractures were classified using Neer's classification. 15 patients had two parts fracture, 12 patients had three parts fracture and 9 patients had four parts fracture.

Pre-op evaluation consisted of careful inspection of the shoulder. Tenderness was elicited over the shoulder and the movements of the shoulder were painful & restricted.

There was no axillary nerve injury or tendon injuries recorded in our series of 36 patients.

Routine X Rays of anterior posterior and axillary lateral views of the shoulder were taken 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.

In all elderly patients 2D Echo, routine blood & urine investigations were done.

All patients were immobilized in arm pouch until the time of surgery.

All 36 cases were done under general anaesthesia and fixed with clover leaf LCP.

## **SURGICAL TECHNIQUE:**

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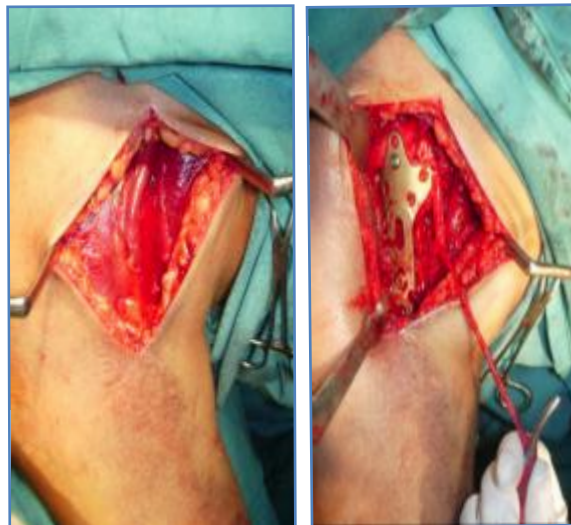
Patient was placed supine on the operating table under general anaesthesia. The entire upper limb including shoulder up to the neck was scrubbed with savlon, and beta scrub and was painted with betadine and spirit & draped.

Under strict aseptic precautions, with standard deltopectoral approach incision was made, deltoid was retracted fracture fragments exposed and identified and reduced, if required temporarily fixed with K wires, reduction checked by image intensifier both in AP and lateral views. Once acceptable reduction achieved it was stabilized with clover leaf LCP and locking screws and once again the fracture reduction and fixation was confirmed by image intensifier. It was made sure the LCP was placed distal to greater tuberosity and lateral to the bicipital groove and biceps tendon was protected completely.

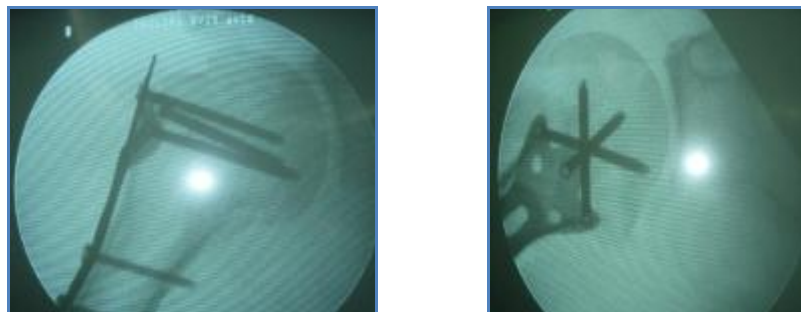
At the end of surgical procedure sterile dressings were applied. No cast or splint was applied but the limb was placed in elevation in arm pouch.

Antibiotics (Injection Ceftriaxone 1gm IV BID for 3 days, then orally Cefixime 200mg BD for 5 days) were given along with analgesics.

Average duration from the date of injury to the date of surgery was 1-3 days.



Intra-operative fluoroscopy



POST OPERATIVE CARE AND REHABILITATION

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Immediate postoperative check X-rays were taken in both anterior posterior & lateral views.

- Phase 1 - Passive assisted stretching for 6 weeks.
- Phase 2 - Active ROM with terminal stretch until full active range for 4-6 weeks.
- Phase 3 - At 10 weeks resisted strengthening with maximum recovery by 1 year.
- Patients followed up at 2 weeks, 6 weeks, 3 months, 6 months & 1 year.

Neer's shoulder scoring system to document functional outcome

Elbow and shoulder exercises are encouraged post-operatively immediately from the day of operation to promote circulation, avoid edema and stiff shoulder.

Dressings were removed on 3rd postoperative day patient was discharged.

Second check X-ray was taken on follow up at 6<sup>th</sup> week, the fracture union was assessed clinically by absence of tenderness and radiologically the bridging callus formation.

All cases were followed at an interval of 6 weeks, 3 months, 6 months and 12 months.

## RESULTS:

The follow-up ranged from 3 months to 12 months with an average follow-up of 7.5 months.

- There were no cases of infection as long as they were followed till the 12 months. In our study greatest limitation was abduction in few patients.
- 3 patients (2 type IV & 1 type III) had partial necrosis of head with minimal functional limitation.
- 2 patients (type IV) had collapse at fracture site with secondary penetration of screw into the joint & chondrolysis.
- 1 patient had myositis ossificans.
- 2 patients had implant back out but the patients were protected till the fracture united.

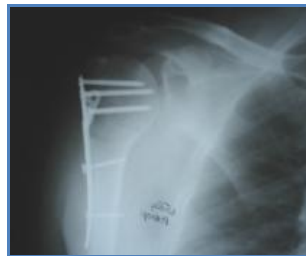
Criteria for results at 6 months include deformity, subjective evaluation, range of movements; complication according to Neer's scoring system.



Three part fracture



immediate post  
operative X ray



Follow up 6 weeks



6 months

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Four Part fracture



Immediate follow up



6 weeks follow up

Around 23 patients had good radiological fixation and union & good range of motion, minimal or no pain and at the end of 12 months. Hence the result was rated as good.

10 patients had pain, limitation of motion and restricted activities around the shoulder. The range of motion of the shoulder had limitation to less than 50% to that of normal. 2 patients in this group had loosening of implants due to back out and hence the fracture was protected in the arm pouch with restricted mobility. At the end of the fracture union there was limitation of the abduction and the result was rated as fair.

- 2 patients (type IV) had collapse at fracture site with secondary penetration of screw into the joint & chondrolysis. This led to pain and limitation of motion of more than 50% and weakness and restricted activities around the shoulder. There was associated slight crepitation in the shoulder joint. 1 patient developed Myositis ossificans around the deltoid and there was gross restriction of all movements around the shoulder. Hence the result was rated as poor.

Radiographs demonstrated maintenance of neck shaft angle, reduction within 1mm of original reduction in all patients except in one who had implant back out with shortening.

The overall result according to the rating system based on Neer's shoulder scoring system was:

- 60% excellent results.
- 30% fair results.
- 10% poor results.
- Average Neer score,

|          |    |
|----------|----|
| Type 2 # | 80 |
| Type 3 # | 70 |
| Type 4 # | 50 |

**DISCUSSION:** The management of displaced fractures of proximal humerus are highly challenging and requires careful assessment of patient factors such as age and activity level, and fracture related factors like fracture type, pattern, degree of comminution and bone quality. Since majority of this fractures are seen in elderly patients more than sixty years old and most of the proximal humeral fractures in this population are related to osteoporosis<sup>5</sup>. Stable reduction is essential for healing of the fracture and for achieving early functional recovery of the shoulder. In patients with osteoporotic bone and/or comminuted fractures, operative stabilization is challenging and the treatment of displaced & unstable fractures remains controversial<sup>22</sup>.

A large variety of methods are available and have been used to stabilize fractures including buttress plates, intramedullary nails, tension band wiring technique, percutaneous K wires fixation, and hemiarthroplasty<sup>11,13-15,18</sup>. Successful outcomes after plate osteosynthesis of proximal humeral fractures have been reported<sup>10, 15, and 22</sup>. Open reduction and internal fixation of proximal humeral fractures with non locking plates and screws has been shown to provide the strongest fixation in non-osteoporotic bone<sup>15</sup>. As the age advances and the bones become osteoporotic, there are high chances of screw loosening due to insufficient purchase of screws resulting in high failure rate especially in three or four part fracture<sup>22</sup>.

Kristiansen and Christensen<sup>18</sup> reported satisfactory or excellent results in only nine of twenty patients who had fixation of proximal humeral fracture with a T- buttress plate, and there was a high fixation failure rate<sup>22</sup>.

Fenichel et al<sup>24</sup>, in their retrospective review study of fifty patients who had unstable two or three part fractures treated with percutaneous pin fixation with use of threaded pins reported that seven patients had severe loss of reduction and three patients requiring revision surgery. They have not included four part fractures in their study and good results obtained in only surgical and anatomical neck fractures only.

Wanner et al<sup>10</sup>, used double plate technique fixation using conventional one third tubular plate. They treated sixty shoulder fractures ( proximal humerus) with one third tubular plates fixed orthogonally on the anterior and lateral cortices, of which sixty three percent had good and excellent results and twelve percent had complications such as fracture displacement, osteonecrosis, adhesive capsulitis, subacromial impingement and hardware loosening. Though this study reported good results this procedure is technically more demanding and doubtful in providing stability in elderly and osteoporotic bone.

Robinson et al<sup>25</sup> retrospectively reviewed the results of shoulder hemiarthroplasty for the proximal humerus fractures at a single centre and found consistent improvement in the constant score from six weeks to six months post operatively but little change thereafter. At one year patients reported reasonable pain relief but poorer scores for function, range of motion and for strength. Routinely hemiarthroplasty is indicated in head splitting fractures, fractures with vascular compromise of the fragments, certain fracture dislocations and impression fractures with >40% articular involvement. Though in these fractures hemiarthroplasty can provide good pain relief but functional improvement is limited especially in active and younger patients.<sup>26</sup>



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Locking compression plates and screws provides angular stability, works as a low profile, internal fixator, and provides good stability even in osteoporotic bones. Advantages of LCP in proximal humerus fractures include gentle fracture reduction with use of indirect reduction, 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 <sup>22, 28</sup>. There have been only few clinical studies including small number of patients who have reported their results after open reduction and internal fixation of proximal humerus fractures with LCP. Most authors have concluded that plate design provides stable fixation with good clinical outcome and have recommended the use of LCP for the treatment of proximal humerus fractures especially with patients with poor bone quality. <sup>11, 22,29,30,31</sup>.

In our series we have treated 36 patients with clover leaf LCP and screws and achieved 90% excellent to fair results and 10 % poor results. We observed those three patients who resulted in poor functional outcome where of type IV fractures, two of them had secondary screw penetration in to the humeral head and one had myositis ossificans.

In conclusion, open reduction and internal fixation of the type 2, 3 and 4 fractures of proximal humerus with LCP and screws having good functional results depends on the fracture type and personality, meticulous surgical technique and early rehabilitation programme. In our study with clover leaf LCP we had satisfactory results particularly in osteoporotic proximal humerus fractures. However there is scope to improve results in the type four fractures. The key to success for good functional results in the proximal humerus fractures using LCP and screws is to achieve good anatomical reduction, adequate screw purchase into the humeral head, minimizing intraoperative errors and early mobilization and rehabilitation.

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### Neer's score for proximal humerus fractures.

|                       |  |    |
|-----------------------|--|----|
| Pain                  | None / Ignores                                       | 35 |
|                       | Slight, occasional, no compromise in activity        | 30 |
|                       | Mild, no effect on ordinary activity                 | 25 |
|                       | Moderate, tolerable, makes concessions, uses aspirin | 15 |
|                       | Marked, serious limitations                          | 5  |
|                       | Totally disabled                                     | 0  |
| Function (30 points)  |  |    |
| Strength              | Normal   | 10 |
|                       | Good   | 8  |
|                       | Fair   | 6  |
|                       | Poor   | 4  |
|                       | Trace  | 2  |
|                       | Zero   | 0  |
| Reaching              | Top of head  | 2  |
|                       | Mouth  | 2  |
|                       | Belt buckle  | 2  |
|                       | Opposite axilla                                      | 2  |
|                       | Brassiere hook                                       | 2  |
| Stability             | Lifting  |    |
|                       | Throwing   |    |
|                       | Pounding   |    |
|                       | Pushing  |    |
|                       | Hold overhead  |    |
| Range of motion       |  |    |
| Flexion<br>(sagittal) | 180 °  | 6  |

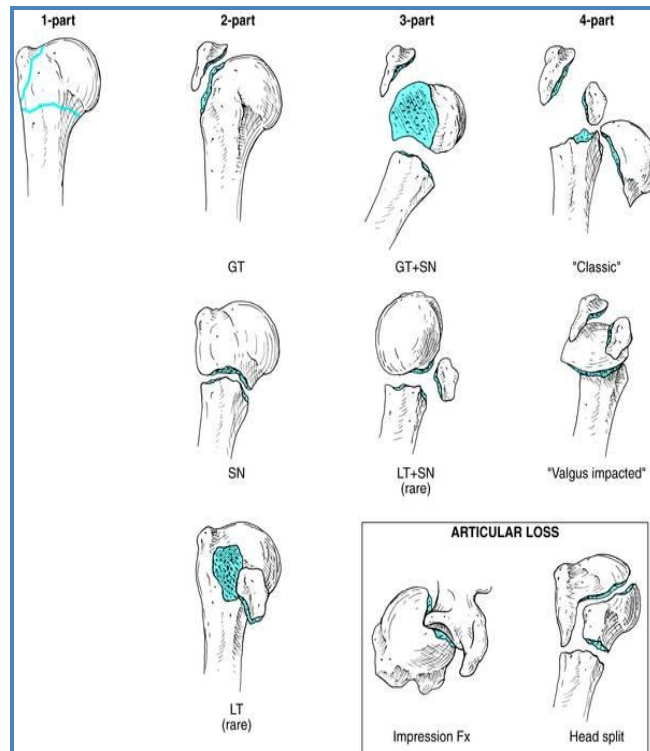
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|                           |                |                |
|---------------------------|----------------|----------------|
| plane)                    |                |                |
|                           | 170 °          | 5              |
|                           | 130 °          | 4              |
|                           | 100 °          | 3              |
|                           | 80 °           | 2              |
|                           | <80 °          | 1              |
| Abduction (coronal plane) | 180 °          | 6              |
|                           | 170 °          | 5              |
|                           | 140 °          | 4              |
|                           | 100 °          | 3              |
|                           | 80 °           | 2              |
|                           | <80 °          | 1              |
| Extension                 | 45 °           | 3              |
|                           | 30 °           | 2              |
|                           | 15 °           | 1              |
|                           | <15 °          | 0              |
| External rotation [1]     | 60 °           | 5              |
|                           | 30 °           | 3              |
|                           | 10 °           | 1              |
|                           | <10 °          | 0              |
| Internal rotation [1]     | 90 ° (T-6)     | 5              |
|                           | 70 ° (T-12)    | 4              |
|                           | 50 ° (L-5)     | 3              |
|                           | 30 ° (gluteal) | 2              |
|                           | <30 °          | 0              |
| Anatomy [2]               | None           | 10             |
|                           | Mild           | 8              |
|                           | Moderate       | 4              |
|                           | Marked         | 0-2            |
| Results                   | 90 -100 points | excellent      |
|                           | 80-89 points   | satisfactory   |
|                           | 70-79 points   | unsatisfactory |
|                           | <70 points     | failure        |

[1] From anatomical position with elbow bent

[2] Rotation, angulation, joint incongruity, retracted tuberosities, metal failure, myositis, non-union, avascular necrosis

## Neer's Classification



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