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## Study of use of Uni-condylar locking plate in extraarticular distal humeral shaft fractures in adults

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### Abstract

**Objective:** The purpose of this study was to evaluate the clinical and functional outcome of Uni-condylar Locking Compression Plating for Extra-articular Distal Humeral Shaft Fractures in adults and comparison with other techniques for management of extra-articular distal humerus fractures.

**Methods:** This Prospective Study was carried out in the Department of Orthopaedics in Shadan Institute of Medical Sciences, Teaching Hospital and Research Centre, Hyderabad, Telangana during July 2018 to January 2021. Patient selection was based on Inclusion and Exclusion criteria. 20 patients with extra-articular distal humeral shaft fractures were treated with Uni-condylar Locking Compression Plating. The patient was placed, either in the lateral decubitus position with shoulder at 90 degrees of abduction and flexion and the elbow at 90 degrees of flexion, or fully prone position over bolsters. Through triceps sparing posterolateral approach, Unicondylar Locking Compression Plating was done. Assisted exercises and physiotherapy were started as early as possible. The functional outcome was evaluated using The Rating System of Cassebaum, for time taken for fracture union, complications and compared with other techniques of fixation.

**Results:** All fractures in this study healed well within a period of 22 to 24 weeks with a mean average of 16.1 weeks without any implant related complications. Only 1 patient showed delayed fracture union at 32 weeks and 1 patient developed superficial wound infection which resolved subsequently with use of antibiotics. The overall outcome of this study ranged between Fair and Excellent.

**Conclusion:** This study has yielded excellent results and it shows that Uni-condylar Locking Compression Plating (LCP) is an excellent technique for internal fixation of extra-articular distal humeral shaft fractures, as it promotes high rate of early fracture union without any implant related and other complications.

**Keywords:** Uni-condylar locking plate, extra-articular fractures, distal humeral shaft fractures, single column plating, locking compression plating

### Introduction

Distal Humeral Shaft Fractures represent one of the most complicated and challenging fractures in the upper extremity. The results of managing these fractures non-operatively are limited by failure to get anatomical reduction and early mobilization, which often results in painful stiff elbow and/or pseudo-arthritis. Hence an operative management with anatomical reduction of the fragments becomes the treatment of choice for these fractures<sup>[1]</sup>.

The distal humeral shaft fractures are rare fractures constituting 2%<sup>[2, 3]</sup> of all body fractures. Watson and Jones<sup>[4]</sup> wrote "few fractures are more difficult to treat" while describing them, thus describing their complexity. The forearm musculature originating on the condyles tends to produce rotational re displacement even when closed reduction is achieved<sup>[5]</sup>. The only reliable method for restoring the normal alignment and contour of the distal humerus is operative exposure and direct manipulation of fracture fragments<sup>[7]</sup>. However, fixation of fracture fragments must be stable enough to allow motion while ensuring union. In most cases open reduction with stable rigid internal fixation is required to fulfill the above goal.

The Recommendations for treatment have ranged widely from essentially no treatment to operative reduction and extensive internal fixation. Those who have recommended operative treatment differ widely in their opinions with regard to extent, approach, type of internal fixation to be used and when to start the post-operative mobilization.

The recent trend has been immediate open reduction, stable and rigid internal fixation and early post-operative mobilization [10, 12]. The anatomic complexity of distal humerus makes surgical reconstruction difficult. The fabrication of newer implants however, has increased the reliability of the operative stabilization, while placing additional demands on the surgeon expertise.

Injuries of the elbow lead to chronic pain and permanent restriction of motion, limiting the use of hand in most activities. Basic daily activities from eating to personal hygiene require a wide range of positions and movements at the elbow in flexion, extension and forearm rotation [16].

An attempt has been made in this study to evaluate the role of open reduction and internal fixation in the treatment of distal humeral shaft fractures. Patients selected for this operation were of different ages and genders, admitted and treated in Shadan Institute of Medical Sciences, Teaching Hospital and Research Centre, Hyderabad, during July 2018 to January 2021. The classification criteria used was AO classification [20]. Most of them were AO type 12.C and a few were AO type 12.B. and AO type 12.A.

## Materials and Methods

### Study Population

This is a prospective study, which was carried out in the Department of Orthopaedics in Shadan Institute of Medical Sciences, Teaching Hospital and Research Centre, Hyderabad, Telangana, India during July 2018 to January 2021.

### Inclusion Criteria

1. Those patients who are above the age of 20 years and managed surgically were included in the study
2. Patients presenting with isolated distal humerus fractures with or without osteoporotic changes were included in the study.
3. Both closed and open distal humerus (Grade I & II) fractures were included in the study.

### Exclusion Criteria

1. Children with distal humerus fractures in whom, growth plate is still open.
2. Patients lost in follow up.
3. Patients managed conservatively for other medical reasons.
4. Patients medically not fit for surgery
5. Pathological fractures.
6. Incomplete and undisplaced fractures in adults
7. Grade III compound fractures

The present study is a prospective study of 20 cases of extra-articular distal humerus fractures (AO Type 12.A, 12.B and 12.C) [21], 13 male and 7 females age ranging from 20 to 70) treated by open reduction and internal fixation, which was conducted over a period of two and a half years, from July 2018 to January 2021. Case wise detailed study was done in all cases by noting the age, sex, social status, nature of trauma, duration of the injury and information regarding medical problems and any local problems in relation to bone and joints.

On admission, emergency care was given, with special attention to A (air way), B (breathing), C (circulation). A thorough systematic examination is done to rule out other injuries. They were examined for signs of fractures, deformity and any compromise of distal neurovascular status.

A thorough general examination and local examination was performed. Radiological examination of the part and routine investigations were carried out. Patients were taken up for surgery as early as possible in all the cases. Old people with medical problems after thorough work up were taken up for surgery, once the patient is fit for surgery. Pre operatively all patients were immobilized in above elbow plaster of paris slab with elevation of limb. Associated injuries were dealt simultaneously or at a later date depending upon convenience. Every effort was made to operate as early as possible and mobilized as early as possible.

Criteria taken are history, clinical and radiological. All people between 20 - 70 years who had AO type 12.A, 12.B and 12.C fractures are taken up surgery [20]. Patients with external wounds and associated injuries waited till the conditions permit for surgery

1. Four cases were associated with other injuries such as colles fracture and lower third ulna fracture, head injury, chest injury. No vascular injuries were noted in this series.
2. The average time between admission and operation was 4.7 days. In patients with severe blood loss and in hypovolemic shock, it was corrected with intravenous fluids and blood.
3. In case of compound fractures (of the 20 patients taken up for study 9 were having open fractures) wound was debrided thoroughly and wash was given with normal saline, hydrogen peroxide, betadine and if wound was smaller, primary closure was done. All the cases were initially treated with above elbow Plaster of Paris slab, all compound wounds healed well without causing infection. All compound fractures were covered with Injection Tetanus Toxoid and combination of antibiotics consisting of cephalosporins, aminoglycosides and metronidazole and this regimen effectively prevented infection. For simple fractures antibiotic regimen was started 12 hours before surgery parenterally and continued till third postoperative day, from then till 10<sup>th</sup> post-operative day oral preparation was given.
4. Other fractures and injuries were attended depending upon the priority order and were treated on standard principles and guidelines. All patients were taken up for surgery when general condition was stable under general anaesthesia or brachial block. The implant used was anatomically pre-contoured 4.5 mm extra-articular distal humerus Locking Compression Plate [22].
5. Patients were kept in postoperative ward for first 48 hours and then shifted to respective general ward. On 2<sup>nd</sup> post-operative day drain was removed and antiseptic dressing was done. Post-operative check X-ray was taken.
6. Bed side exercises (active assisted and gravity assisted exercises) were started as early as possible depending on the condition of patient and stability of fracture fixation. Suture removal was done on 10<sup>th</sup> post-operative day and patient was discharged with advice of active assisted exercises and physiotherapy. Follow up was 3 weekly until time of radiological union and monthly till the end of follow up.
7. During the follow up patients were received in outpatient department once in every 3 weeks and fracture union was assessed clinically and radiologically.
8. The follow up period ranges between 20 weeks to 40 weeks with average of 7 months and patients were

assessed for functional capacity and radiological fracture healing capacity periodically every 4 – 6 weeks.

- For functional evaluation of the results, Cassebaum's scale<sup>[11]</sup> has been chosen.

### The Rating System of Cassebaum<sup>[11]</sup>

Excellent: Extension deficit of 15 degrees or less and flexion to 130 degree or more

Good: Extension deficit of 15 to 30 degrees and flexion of 120-130 degrees

Fair: Extension deficit of 30- 40 degrees and flexion to 90-120 degrees

Poor: Extension deficit of 40 degrees or more and flexion to less than 90 degrees

The data on elbow motion was combined with the patient's subjective symptoms to provide an overall functional rating. An excellent rating was given for a symptom free elbow with a normal or nearly normal range of motion, a good overall rating for good or excellent elbow motion with some subjective symptoms; a fair rating for a fair range of motion of the elbow with or without symptoms; and a poor rating for both limited mobility and limited function.

### Management and Surgical Technique

We have employed open reduction and internal fixation with single posterior plating by triceps sparing Campbell's posterolateral approach<sup>[8, 13]</sup> as the method of treatment of extra-articular distal humerus fractures in our study.



**Fig 1:** The method of treatment of extra-articular distal humerus fractures in our study

### Indications for Surgery

The indications for operative anatomic reduction and stable rigid internal fixation are:

- Intra articular displacement greater than 2 mm.
- Marked supracondylar comminution and displacement.
- Open Fractures.
- Neurovascular injury / Compartment syndrome.
- Floating elbow.
- Young and active patients (relative indication).

### Contraindications

Old age per se is not a contraindication, but may be associated with many medical problems that increase the risk.

Each and every patient should be explained of the consequences and results of the fractures and should take a valid consent, before any operative internal fixation is undertaken.

### Pre-Operative Planning

It is must in every case, high quality anteroposterior and lateral roentgenograms are required. Correct evaluation of the

radiographs and computed tomography, analysis of the biomechanics and the displacements of fracture, determine the surgical steps and choosing the correct implants. The exact nature of the fracture must be understood before surgical intervention is attempted.

Roentgenograms of the opposite, normal, distal humerus also must be obtained ideally, to use as templates for preoperative planning, using tracing paper. The various fracture fragments are drawn and superimposed on the normal bony template. Using the appropriate implant transparencies, the fixation can be planned and added to the drawing. The fracture now can be studied, detailed operative technique planned, and the appropriate implants made available for surgery.

### Anaesthesia

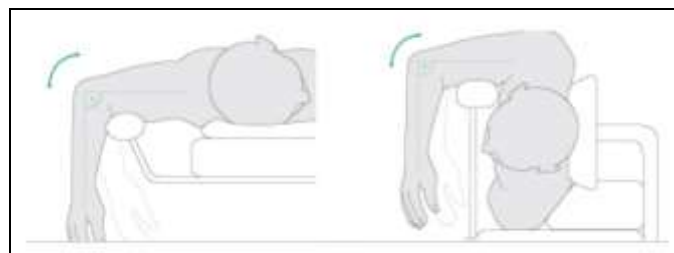
Usually general anaesthesia is preferred. Brachial block, regional anaesthesia can also be used.

### Tourniquet

Pneumatic tourniquet can be applied but should be as proximal on the arm as possible.

### Position

The patient can be placed either in the lateral decubitus position with shoulder at 90 degrees of abduction and flexion and the elbow at 90 degrees of flexion or fully prone position over bolsters. Both of them provide excellent access to posterior aspect of elbow.



**Fig 2:** Position of patient for open reduction of distal humerus fractures

### Surgical Implant

Distal Humerus Locking Compression Plate is a specially designed 4.5 mm narrow fixed angle locking plate having elongated combiholes in proximal part that accepts 3.5 mm screws and distal part is tapered with an angular offset to rest on the posterior aspect of lateral column with increased hole density to accommodate five 3.5 mm locking screws. The plate is available in six lengths with 4 (122 mm) to 14 (302 mm) combiholes with different plates for right and left side.<sup>[22]</sup>

### Plate Positioning

Position the plate on the posterior aspect of the humerus. Adjust the distal end of the plate to the lateral column of the distal humerus. Take care that the plate does not cause an impingement with the olecranon. Check the correct plate position proximally in line with the humerus.

### Placement Under Radial Nerve

Frequently the posterior plate is longer than expected and requires a proximal placement under the radial nerve which must be identified and mobilized. In these cases, proper documentation of the relation between the radial nerve and the plate should be recorded in the operation note.

**Insert First Distal Screw**

Fix the plate to the distal humeral segment by using a bicortical cortical screw. Check the fracture reduction and plate position again.

**Insert First Proximal Screw**

Fix the plate to the humerus proximal to the fracture by using a second bicortical cortical screw. Check the fracture reduction and plate position again.

**final screw insertion**

Insert the remaining locking screws through the plate distal and proximal to the fracture. Typically, one should look for 6 cortical holds each proximal and distal to the fracture.

**Closure**

The tourniquet is deflated and homeostasis is obtained. A suction drain is placed and meticulous wound closure is completed.

The patient is placed into a bulky cotton padding and plaster of paris splint, and is elevated for 24-48 hours. After 48 hours suction drain is removed and dressing changed. Depending on fracture stability active and active assisted range of motion is started, as tolerated by the patient.

**Results and Discussion****Table 1:** Distribution of patients based on Age

Age distribution	No. of patients	Percentage
21-30 yrs.	7	35
31-40 yrs.	8	40
41-50 yrs.	5	25
Total	20	100

In the present study distal humerus fractures were common in 3<sup>rd</sup> to 4<sup>th</sup> decade, with 35% in 3<sup>rd</sup>decade, 40% in 4<sup>th</sup> decade and 25% in 5<sup>th</sup> decade. Average age in the present study is 34.5 years.

**Table 2:** Distribution of patients based on Sex

Sex	No of Patients	Percentage
Male	13	65
Female	7	35
Total	20	100

In the present study fractures were more common in males with 65% of cases

**Table 3:** Distribution based on AO classification

Muller AO Classification	No. of patients	Percentage
AO 12. A2	3	15
AO 12. A3	4	20
AO 12.B1	5	25
AO 12. B3	3	15
AO 12. C1	5	25
Total	20	100

In the present study A type simple fractures are seen in 35% cases, B wedge fractures in 40% cases and C complex fractures in 25% cases.

**Table 4:** Mechanism of Injury

Mechanism of injury	No. of patients	Percentage
Road traffic accident	15	75
Accidental Fall	5	25
Total	20	100

Common mechanism of injury in this study was RTA 75%.Direct fall over elbow constituted 25% cases.

**Table 5:** Side Affected

Side affected	No of Patients	%
Left	12	60
Right	8	40
Total	20	100

In the present study, right side involved in 40% of cases and left side involved in 60% of cases.

**Table 6:** Time to Radiological Union

Radiological union	No. of patients	Percent
< 14 weeks	2	10
14-16 weeks	12	60
17 – 19 weeks	3	15
. 20 – 22 weeks	2	10
Delayed union	1	5
Non-union	0	0
Total	20	100

In the present study, 60% cases (12) showed radiological union between 14-16 weeks; rest healed in maximum of 22 weeks; except one which took 32 weeks.

**Table 7:** Outcome

Outcome	No. of patients	Percent
Excellent	10	50
Good	8	40
Fair	2	10
Poor	0	0
<b>Total</b>	<b>20</b>	<b>100</b>

Outcome of management of distal humerus fractures in adults was evaluated using Cassebaum scale<sup>[11]</sup> it was observed that 50 % cases presented with excellent outcome, 40 % cases presented with good outcome, 10 % cases presented with fair outcome.

**Table 8:** Complications Observed

Complications	No. of patients	Percentage
None	18	90
Delayed union	1	5
superficial wound infection	1	5
Total	20	100

In the present study 5% patients had superficial wound infections and 5% patients had delayed union. Rest 90% fractures healed without any complications.

**Discussion**

Fractures of the distal humerus in adults are difficult fractures to treat because of their rarity and associated significant comminution. The results of managing these fractures non-operatively are limited by failure to get anatomical reduction and early mobilization, which often results in painful stiff



elbow and/or pseudo-arthritis. Hence an operative management with anatomical reduction of the fragments becomes the treatment of choice for these fractures.

While there have been numerous studies regarding the management of this uncommon fracture, the overall number of the reported cases has been small, the fracture has been classified by varying criteria, and the results have been judged by wide range of methods of functional evaluation. Diversity has been found even with individual series, as different treatment recommendations were proposed for selected types of fracture patterns.

A number of classification systems have been proposed for various patterns found in fractures of the distal end of the humerus [20, 21]. The classification system of Muller's *et al* (AO) is used in this study because it is well suited for operative conditions [20].

In our study we have operated twenty patients with extra-articular distal humerus fractures using anatomically pre-contoured 4.5 mm extra-articular distal humerus LCP. The results obtained in our study were favourable.

AO12. A2, A3, B1, B3, C1 [20] all fractures healed well within period of 22 to 24 weeks with mean of 16.1 weeks which is closer to other studies.

Tarkin *et al*, however, has shown that the triceps sparing approaches positively affects the extensor lag as opposed to

triceps splitting approach.

The critical factors for successful outcome remain those advocated earlier by Cassebaum [11]. These include meticulous surgical technique, stable internal skeletal fixation, and early controlled post-operative mobilization.

With early mobilization of elbow within 10 days postoperatively the problem of extensor lag can be addressed.

No case reported the complication of hardware failure, loss of reduction, infection or ulnar neuritis.

In our study the management of extra-articular distal third humerus fracture with anatomically pre-contoured 4.5 mm Extra-articular distal humerus Locking Compression Plating [22], along with early mobilisation, results in predictably good union rates and excellent results in terms of patient outcome. The stability of locking construct by providing extra purchase due to shape of plate as well as minimal periosteal compromise, provides high union rates.

The advantage of this plate is that its distal contour reduces the incidence of complication of olecranon fossa impingement, it has low profile to minimize soft tissue irritation and it has high density of distal locking screws to maximize the fixation. Its shape makes it useful in long oblique fractures with proximal extension allowing central placement of plate on the humeral shaft. These features make it an ideal implant for such fractures.



**Fig 3:** Case 1



Fig 4: Case 2



Fig 5: Case 3

### Conclusion

Our study has yielded excellent results without any implant related complications in internal fixation of extra-articular distal third humerus fractures with single posterolateral locking compression plate. We recommend using this 4.5 mm extra-articular distal humerus Locking Compression Plating for these humerus fractures, because of its consistent results with respect to fracture union, stability across the fracture site and early mobilization for better functional results. The provision of greater screw hole density of the plate distally and using 3.5-mm screws instead of 4.5 mm allows adequate number of screws to be placed in the distal fragment.

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