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Study Of Surgical Fixation Of Extra-Articular Distal Humerus Fractures Using Extra-Articular Distal Humerus Locking Plate

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Abstract

Background

The aim of this study was to evaluate the mechanical properties of distal humerus fracture fixation using extra-articular distal humerus locking plate osteosynthesis. There are numerous types of plates used in this region and one among them is the extra articular distal humerus locking plate. This anatomically precontoured plate is specifically designed for fixation of extra articular distal humerus fractures. Usually distal humeral extra-articular fractures are often associated with complications. This study reports satisfactory outcome with the usage of extra-articular plate osteosynthesis for extra-articular humerus fracture management. It has now become a choice of management in our centre for management of extra articular distal humerus fractures because of its advantages. We evaluated the clinical and functional outcomes of treating these fractures.

Materials and Methods:

We studied 20 patients who underwent fixation over two years. Mayo Elbow performance score was used to analyse functional outcome. The time for union, range of motion at shoulder and elbow and secondary procedures were recorded in follow up. shoulder and elbow fuction was assessed using the Mayo Elbo Performance Score (MEPS).

Results:

During the study of 20 cases of distal humerus fractures treated by extra articular distal humerus locking plate. Majority (40%) of the study participants were in the age group of 18-30 years. Mean age group is 39.8 years. Among 20 patients thirteen were males and seven were female patients showing a male preponderance. About 14 and 6 patients with the right and left sides involved respectively. 85 % of the fractures united within 16 weeks whereas for 3 patients (15%) fracture united at 18 weeks. Mean average time to union is 15.2 weeks. Eighteen (90%) patients had excellent elbow movement. Two (10%) patients had elbow stiffness. This reduced at 32 weeks. All the patients were mobilized in day two after surgery.
Eighteen patients (90%) had excellent results. Fair results were observed in two patients.

Keywords: DCP - Dynamic Compression Plate, LCP - Locking Compression Plate, EADHLP - Extra Articular Distal Humerus Locking Plate, CRIF - Closed Reduction Internal Fixation. MEPS - Mayo Elbo Performance Score

Introduction

Distal humerus fractures remain some of the most challenging injuries in management. They have complex anatomy with limited options for internal fixation. Injuries to this region require a systematic approach in managing the soft tissues, achieving anatomic reduction and a stable construct.

With a recent trend to high velocity injuries, treatment of distal humerus fractures have become difficult. Fracture pattern, soft tissue injury and bone quality critically influence the fixation technique. Operative management include plate osteosynthesis, screw fixation, K-wire fixation, external fixators, intramedullary nailing and total elbow arthroplasty are the various options available. Among these intramedullary nailing is not feasible in this region due to the distal nature of the injury because of which the distal screws cannot be placed and to the possibility of rotational malalignment during the course of fracture healing. External fixators can lead to inaccurate reduction, malunion, non-union and pin tract infection.[1] Primary elbow arthroplasty has evolved to become a viable treatment option for elderly patients with articular fragmentation, comminution, and osteopenia.[2]

Open reduction and internal fixation of extra-articular distal third humerus fractures provides skeletal stability, allows for early rehabilitation, and decreases soft tissue complications.[3] Fixation of the distal humerus fractures can be problematic due to its unique architecture. The anatomically pre-contoured 3.5 mm LCP Extra-Articular Distal Humerus Plate was specifically designed for fixation of extra-articular distal humerus fractures. The plate is contoured to fit the anatomy of the posterolateral distal humerus and provides an increased number of distal fixations. The purpose of this study was to evaluate the functional outcome of the 3.5 mm LCP Extra-Articular Distal Humerus Plate in the fixation of distal extraarticular distal humerus diaphyseal fractures.

Locking plates are plates in which the screw heads are threaded and, when tightened lock into the threads in the plate. A fixed angle construct is thus created. Such constructs are much less prone to loosening or toggling than traditional non-locking plates.[4] The precise anatomic shape of the 3.5 mm LCP Extra-Articular Distal Humerus locking plate prevents primary fracture fixation failure due to inexact contouring of other plates.

Screw locking minimises the compressive forces exerted by the plate on the bone, and thus avoids disturbance to the bone blood supply. The LCP provides greater bending stiffness, torsional stiffness, and less chances of failure. In an improved plate design, the self-compression and the locking mechanisms have been combined to impart dual ability to compress and lock. A plate with integrated hole offers fixation with conventional bone screws, fixation with threaded head screws and fixation with conventional and threaded head screws.[5]

Proximally, the plate uses elongated 3.5 mm combination hole system with locking and nonlocking screw options in the humeral shaft. Distally, it curves along the lateral supracondylar ridge thus avoiding the olecranon fossa and has five screw holes angled medially for achieving a strong purchase in the trochlea and capitellum. The plate head is tapered to minimize soft tissue irritation.[6] As the plates are anatomically contoured, there are different plates for the right and left sides and it is available from 4 hole (122 mm) to 14 (302 mm) hole length.

MATERIAL & METHODS :

It is a hospital based prospective study to access the clinical and radiological functional outcome of distal humerus diaphyseal fractures which is managed surgically with extra articular distal humerus locking plate. The radiological and clinical outcome will be accessed in the outpatient department of Orthopaedics, at Sri Manakula Vinayagar Medical College and Hospital, Pondicherry, India. Universal sampling technique will be adopted in this study. All the patients fulfilling the inclusion criteria during the above mentioned study period will be included. Patient is placed in the lateral position under general anaesthesia, with the arm hanging by the side. A triceps-reflecting posterolateral approach of Gerwin *et al* [7] is utilized to expose the fracture site. After performing a midline skin incision on the posterior aspect of arm, full thickness flaps are developed on the lateral side.

On the lateral side, using blunt dissection, the lower lateral cutaneous nerve of the arm is identified and its origin traced to the radial nerve. The triceps is elevated from the lateral inter-muscular septum and the lateral supracondylar ridge, and the radial nerve is then carefully dissected. After adequate fracture visualization, reduction clamps are used to reduce the fracture fragments. Provisional fixation is achieved with K wires, and lag screws are used wherever possible to increase the strength of the construct and achieve adequate compression in spiral fractures.

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Finally, extra-articular distal humerus plate is applied over the posterior surface of humeral shaft and fixed with locking screws distally and a combination of cortical and locking screws proximally. The plate is positioned so that its shaft portion is located centrally on the posterior aspect of the humerus, while the distal end curved along the posterior aspect of the lateral column. Plate bending is required in some cases for better seating of the plate to the bone surface. Post-operatively, the patient is placed in a soft dressing and arm pouch sling and early range of motion of the elbow, wrist and shoulder is started.

All patients were resuscitated as per the Advanced Trauma and Life Support protocol. During the resuscitation phase, all injuries were identified and adequately imaged. Primary screening roentgenograms including chest, pelvis, cervical spine and involved long bones were taken. Long bone fractures were identified and splinted. The routine trauma protocol were followed and with continuous assessments by the neurosurgeon, general surgeon, thoracic surgeon, orthopaedic surgeon and the intensive care physician.

After acute resuscitation, all patients were evaluated with anteroposterior and lateral roentgenograms of humerus with elbow joint. In case of intra articular fractures, CT scan was performed. All fractures were as per AO classification.

After obtaining anaesthetic fitness, fracture fixation using extra articular distal humerus locking plate performed by two senior surgeons after reserving adequate blood depending on individual requirements. Prophylactic intravenous antibiotics were administered just before induction of anaesthesia.

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Patients were followed up for a minimum period of 10 weeks. Patients were assessed once in 3 weeks both clinically and radiologically. Radiologically, sign of callus formation was noted and clinically, the improvement in the range of motion and the reduction in pain were noted. All patients were assessed according to Mayo elbow performance index. In patients who requested for the implant to be removed, it was done after consolidation of the callus was noted in the radiographs, usually not before 18 months from surgery.

RESULTS

The following observations were made from the data collected during the study of 20 cases of distal humerus fractures treated by extra articular distal humerus locking plate. The age of patients in the study ranged from 20 to 70 years, majority (40%) of the study participants were in the age group of 18-30 years. Mean age group is 39.8 years. Among 20 patients thirteen were males and seven were female patients showing a male preponderance. About 14 and 6 patients with the right and left sides involved respectively. Incidence of injury was more in indirect injury than direct trauma. All patients were operated

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early and surgery was delayed for those with co-morbidities.

The duration of fracture union found to be 75 % union rate within 16 weeks its highly significant compare to 25% within 24 weeks shown in Table 1.Mean average time to union is 15.2 weeks.

Seventeen (85%) patients had excellent elbow movement (Arc >100 degrees) Three (15%) patients had elbow stiffness. This reduced at 32 weeks. Two (10%) patients had plate prominence but it did not affect their functional ability shown in Table 2. We did not have any wound infection or skin breakdown in our study. We had two cases with implant prominence with no disturbance in function.

Overall outcome in our study showed highly significant of seventeen patients (85%) had excellent results and Good results were observed in three patients (15%) who were above 40 years age group shown in Table 3.

DISCUSSION

Management of extra articular distal humerus fractures are demanding and difficult because of its periarticular location, comminution and a little distal fragment available. However, the goal of any fixation in these fractutres are stable fixation and early mobilisation of the elbow joint. So, surgical management is preferred over conservative management.

Scolaro et al[8] found in their study that single posterolateral column fixation of extra-articular humerus fractures is appropriate for more proximal fractures but that dual plate fixation is superior for more distal fractures.

Kharbanda et al[9] on their study with 20 patients suggested that 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.

Fawi et al[10] conducted a study on 23 patients and found the advantage of this plate is that the distal contour obviates the risk of olecranon impingement in treatment of distal one third humerus fractures.

Kumar et al[11]showed the advantage of EADHP is that its distal contour removes the risk of olecranon fossa impingement, it has low profile to minimise soft tissue irritation and it has high density of distal locking screws to maximize the fixation. It also useful in long oblique fractures with proximal extension allowing central placement of plate on the humeral shaft. They have also have suggested that more aggressive rehabilitation with elbow mobilisation during first week should further improve the range of motion and overcome the problem of extensor lag.

Anand et al[12] proved that use of single extra articular plating is more advantageous than bipillar plating having benefits like less soft tissue damage, low cost, less mean surgical timing and less chances of infection.

Gupta et al[13] emphasized on the low rate of implant failure indicates that the technique is promising.

Chawda et al[14] advocated that use of interfragmentary screw gives superiorty to construct and also stated that optimal stabilization of distal humerus with locking precontoured plate helps early mobilization and prevent stiffness at elbow.

In our study we evaluated the functional outcome after ORIF of extra articular distal humerus using extra articular distal humerus locking plate. All 20 patients showed radiographic healing with maintained reductions, with anatomic alignment and with adequate callus. 17 patients had a elbow arc of motion of more than 100 degrees and 3 patients had a arc of motion of less than 100 degrees because of inadequate mobilization after discharge of which 1 patient improved with physiotherapy and elbow ROM. Early elbow range of movement was initiated in all our cases to avoid stiffness of the elbow joint. Mayo elbow scoring index showed excellent results in 17 cases, good results in 3 cases. No case in our study had fair or poor results.

In respect to neurovascular injuries, there was no case with preoperative or postoperative radial nerve palsy. Plate prominence was evident in two thin built individuals which did not have impact on the outcome as there was no pain or restriction of movement. In Radiological findings, union was evident in all the cases at the end of the followup, with maintenance of the metaphyseal-diaphyseal angle, humeral-ulnar angle, shaft-condylar angle. These are some of the benefits attained in extra articular distal humerus locking plate.

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The extra articular distal humerus locking plate works as a single coloumn plating. There are distal locking screws adequately which increases the stability of the locking construct. The posterior surface of lateral coloumn is non articular which gives the advantage of placement of plate without risk of injury to cartilage and also avoids impingement with flexion and extension.

In this study we used the triceps splitting approach, extending 8cms below the anconeus and the olecranon fossa according to the site of fracture.[15] The exposure can be extended proximally and distally; proximal exposure upto the spiral groove is effective and distally to access the joint olecranon osteotomy if needed. This approach has a relatively reduced blood shed plane,tourniquet was not used in any of our study. Radial nerve was exposed only if need and was not exposed routinely, so we did not encounter any nerve injury in our study.

Mayo elbow Performance score was used to assess the functional outcome. The questionnaire involves patient's symptoms, ability to perform activities, range of motion and also the stability of elbow joint is taken into account.

There were limitations to this study, relatively small sample size and lack of comparison with other methods of management.

Extra articular distal humerus diaphyseal fractures are challenging as it requires sufficient hold and stable fixation distally, which areencountered and found to do well with EADHP. These plate osteosynthesis have a benefit of distal curve contouring the lateral condylar ridge posteriorly with angled locking screws distally to maximize stability and fixation with reducing failure chances.

Conclusion:

EADHP has been shown to successfully treat distal third diaphyseal humerus diaphyseal fractures. The advantage of this plate is that the distal locking system reduces the risk of olecranon impingement during flexion or extension, also offers good functional outcome to these patients in our study group. This system can be considered as treatment of choice for these type of fractures particularly.

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Figures

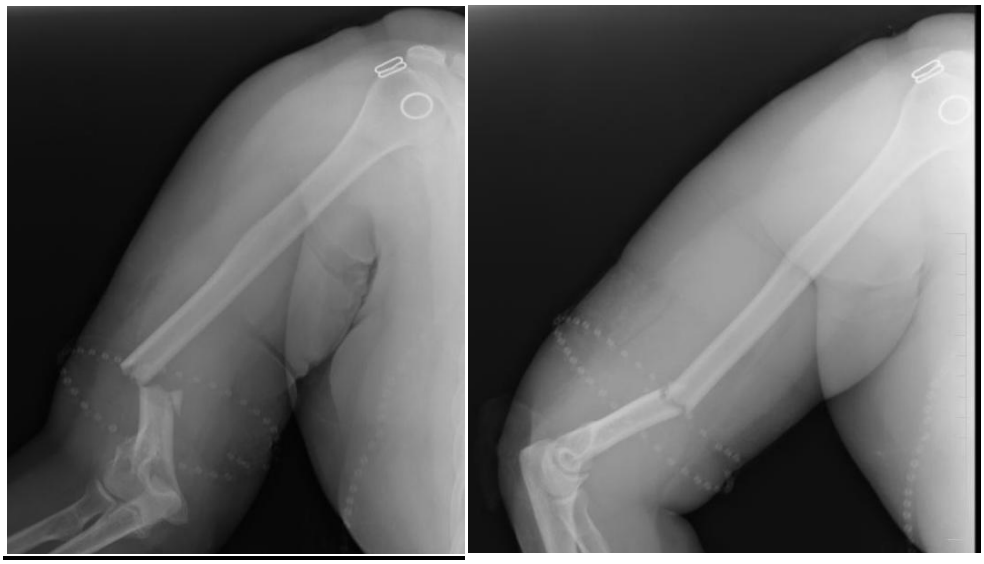

Fig 1: Pre-operative X-ray

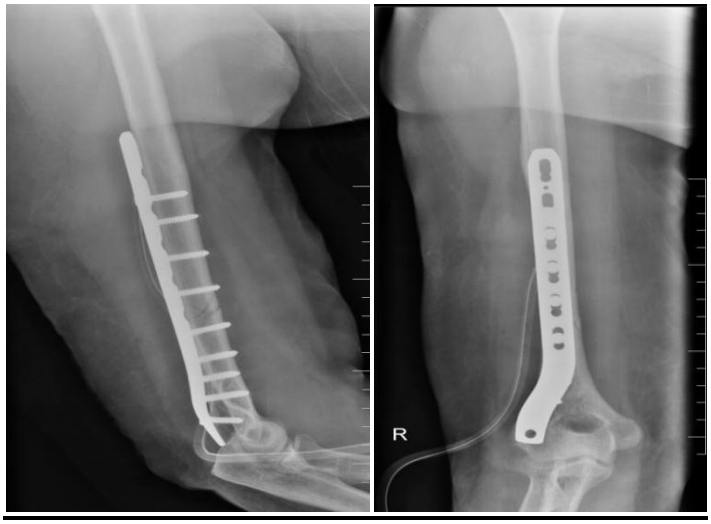

Fig 2: Immediate Post-operative X-ray

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Fig 3: 6 months followup

Fig 4: Post Operative Patient on flexion of Elbow at 12 weeks

Fig 5: Post Operative Patient on Extension of Elbow at 12 weeks.

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Table 3: Association between age and final outcome (n=20)

Age (in years)	Excellent n (%)	Good n (%)	Fair n (%)	Poor n (%)	Total n (%)	p value
18 - 30	8	0	0	0	40	
31 - 40	2	0	0	0	10	
41 -50	2	1	0	0	15	<0.05
51 - 60	5	1	0	0	30	
61 - 70	0	1	0	0	5	
Total	17	3	0	0	100	

Table 2: Distribution of study participants based on complications (n=20)

Complications	**No. of patients**	**%**
None	15	75
Non union	0	0
Delayed union	0	0
Infection	0	0
Plate prominence	2	10
Implant failure	0	0
Neurovascular complications	0	0
Elbow Stiffness	3	15

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Table 1: Distribution of study participants based on duration of fracture union (n=20)

Weeks	No. of patients	Percentage (%)
12	8	40
14	1	5
16	6	30
20	2	10
24	3	15
Total	20	100

Legends

Table 1: Distribution of study participants based on duration of fracture union(n=20)

Table 2: Distribution of study participants based on complications (n=20)

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Fig 1: Pre-operative X-ray

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Fig 4: Post Operative Patient on flexion of Elbow at 12 weeks

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