ORIGINAL ARTICLE

FUNCTIONAL OUTCOME OF EXTRA-ARTICULAR DISTAL HUMERUS FRACTURE FIXATION USING A LATERAL COLUMN LOCKING COMPRESSION PLATE

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Background: A host of different methodologies have been implemented in the management of distal humerus fractures, including conservative measures and surgical fixation with a variety of plates. This study was conducted to evaluate the functional outcome of open reduction and internal fixation of extra articular distal humerus fractures with distal humerus locking compression plate. **Methods:** This is a retrospective cohort study of patients with close extra articular distal humerus fractures who underwent open reduction and internal fixation with a distal humerus locking compression plate at Ghurki Trust Teaching Hospital from July 2017 to December 2019. Various demographic indicators were used for data analysis and radiological union was assessed in serial follow-ups. Functional outcome was evaluated using the Mayo Performance Elbow Score at the final follow-up. **Results:** Thirty-one patients presented with extra-articular fracture of humerus (N=31) with average age 33.5±9.90 years. The average follow-up period was 13.8 months. Radiological union was achieved in 14.8 weeks (range 12–20 weeks). Out of 31 patients, 28 had excellent results with mean Mayo Elbow Performance Score of 94.8. Two patients (6.5%) had radial nerve palsy post-operatively. **Conclusion:** This study shows that open reduction and internal fixation of extra-articular distal humerus fractures with distal humerus locking compression plates allows for stable fixation, good functional outcome, and low complication rates.

Keywords: Humeral fractures; Orthopedic fixation devices; Internal fixators; Radial neuropathy

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INTRODUCTION

Distal humerus fractures sparing the elbow consist of 3% of all fractures in adults.[1] In the distal humerus a two-column structure supports the articular segment with 60% of load on the lateral column and the medial column bearing 40% of the stress.[2] Keeping in mind the location of the fracture near the elbow joint, the associated comminution generally present in these fractures, and the relatively smaller size of the distal fragment, management of these fractures can prove to be difficult.[1] The chances of radial nerve injury are also increased due to its course near the distal and lateral aspect of the humerus.[2, 3]

The primary aim of treatment of humeral fractures is to perform stable fixation with correct alignment to allow for mobilization of elbow and shoulder joints as early as possible.[4] Largely, humeral shaft fractures have been managed successfully through both surgical methods such as plate fixation or with an intramedullary nail as well as more conservative methods such as bracing or the use of a hanging cast. Available data suggests that non-surgical methods aren't always viable because of the smaller size of the distal fragment and its inclination to go into adduction. [5] Surgical management has shown to have more predictable alignment and avoids the skin problems and angular deformity associated with bracing.[6] Prolonged bracing can also result in a delayed return to work and normal function, which is especially significant to younger patients, along with stiffness of the elbow joint.[7] Overall, despite certain considerations, operative treatment has proven to the preferred option when handling distal humeral fractures, particularly in lieu of it's more immediate curative effect.[7]

Operative management of distal humerus fractures through plating employs the use of 4.5mm screws in a low-contoured dynamic compression plate (DCP) as the favored approach for most with the plate holding eight cortices total in proximal and distal fragments. However, in repair of extra-articular distal humerus fractures, a low-contoured 4.5mm screw DCP has not been shown to yield good results as it doesn't provide an adequate area to hold a sufficient number of cortices given the small size of the distal fragment.[8] A 4.5mm screw DCP also risks impingement of structures in the olecranon fossa.[8] Double-plating with two 3.5 mm screw plates can

deal with this problem but has its own pitfalls such as requiring extensive soft tissue dissection leading to prolonged surgery time.[6,8] That being the case, double-plating has still shown to provide more satisfactory control of angulation and optimal stability while allowing for early range of motion.[1]

An extra-articular distal humeral locking compression plate (EADHLCP) has been designed to circumvent shortcomings seen with double plating.[5,9] An EADHLCP has the advantage of allowing for plate placement in the center of the humerus extending proximally and distally with the use of a pre-contoured "J" shaped plate. The oblique design prevents impingement on the olecranon fossa.[8] In this study, we have reviewed outcomes of the use of EADHLCP in extra-articular distal humerus fractures.

MATERIAL AND METHODS

A retrospective cohort design was chosen for this study in which outcomes of patients who underwent open reduction and internal fixation with distal humeral locking compression plate for extra-articular distal humerus fracture were followed and analyzed. Patient data collected from Ghurki Trust Teaching Hospital, Lahore including patients who presented from January 2017 to December 2019. As patient data was collected retrospectively and did not affect patient management, the need for ethical approval was waived by the institutional ethical review committee. Patients with intra-articular distal humerus fractures, open injuries, pathological fractures, polytrauma, fractures associated with neurovascular injuries and pediatric cases were excluded from the study.

A total of 31 patients were included in the study, all of whom underwent fixation with an extra-articular distal humeral locking compression plate (EADHLCP) through the triceps-sparing posterolateral approach. Radiological union was accessed on follow-up. The functional outcome was evaluated using the Mayo Elbow Performance Score (MEPS) at the final follow-up where pain, motion, joint stability, and effect on daily function were assessed. A score >90 was denoted as 'excellent', 75–89 as 'good', 60–74 as 'fair', and below 60 as 'poor'. The study recorded various patient details including age, gender, mode of injury, laterality of limb affected, pre-operative radial nerve status, comorbidity, development of complications, and lag screw and functional outcome. All data was entered and analyzed using SPSS version 22. For categorical variables, frequencies and percentages were used, whereas continuous variables were represented and analyzed in terms of mean and standard deviation. A post-stratification chi-square test of independence was applied to determine whether various predictors (demographic, diagnostic history, complication, functional outcome) have a significant association. A *p*-value <0.05 was considered statistically significant.

RESULTS

A total of 31 patients, 23 (74.2%) were male, and 8(25.8%) were female. The average age of patients was 33.5±9.90 and ranged from 17–54 years. More than half the cases were affected by the right side than the left side (18:13). Road traffic accidents (RTAs) were the most common mode of injury (64.6%) followed by traumatic falls (19.4%). At the time of the presentation, three patients had associated radial nerve palsy while one patient had hardware-related complications. The average Mayo Elbow Performance Score (MEPS) was 94.8±6.20, ranging from 68–100. Functional outcome was found to be 'excellent' in 24 cases, 'good' in 4 cases, 'fair' in 2 and 'poor' in 1 case (Figure-1). Lag screws were used for fixation in 27 patients. No significant association was found between functional and different demographic characteristics of the patients (Table-1). Radiological union was achieved in a mean time of 14.8 weeks, ranging from 12–20 weeks. Implant-related complications and infections were not observed (Figure-2).

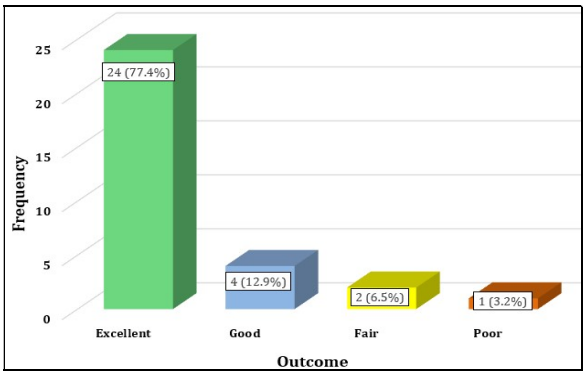

Figure-1: Distribution of functional outcome using the Mayo Elbow Performance Score (MEPS)

Figure-2: Pre- and post-operative radiology of a patient who underwent lateral column locking compression plate with gross appearance during postoperative elbow flexion and extension

Table-1: Comparison of functional outcome of distal humerus fracture patients who underwent extra-articular distal humerus locking plate according to demographic characteristics, diagnostic history, and complications (n=31*)*

Characteristics	Categories	Excellent	Good	Fair	Poor	*p*-value
Gender	Male	20 (82.6)	2 (8.6)	1 (4.3)		0.444
	Female	6 (75)	-	1 (12.5)	-	
Side	Left	10 (76.9)	-	2 (15.4)	1 (7.7)	0.066
	Right	15 (83.3)	3 (16.7)	-	-	
Mode of Injury	RTA	15 (75)	2 (10)	2 (10)	1 (5)	0.845
	Fall	5 (83.3)	1 (16.7)	-	-	
	Others	4 (83.3)	1 (16.7)	-	-	
Comorbidity	Hypertension	2 (66.7)	1 (33.3)	-	-	0.069
	Diabetes Mellitus	3 (50)	-	2 (33.3)	1 (16.7)	
	Nil	19 (86.4)	3 (13.4)	-	-	
Complications	Radial Nerve	1 (50)	1 (50)	-	-	0.127
	Nil	26 (89.7)	3 (10.3)	-	-	
Lag Screw		24 (88.9)	2 (7.4)	1 (3.7)	-	0.745

DISCUSSION

Among the numerous different bones in the human body that are at risk of injury, extra-articular distal humerus fractures have proven to be a challenging conundrum on their own, particularly in lieu of the many ways they can be managed. In a discussion conducted and published by Dr. David Ring, a variety of treatment options were discussed with the experts delineating the pros and cons of the different methods. Non-operative methodologies were stated as having a rather adequate functional outcome whilst avoiding the hurdle of having patients undergo invasive procedures, despite techniques such as bracing having their own impediments. Having said that, the time taken to return to normal functional status is drastically reduced with surgical intervention which is particularly important for younger patients and gives it a clear advantage over conservative measures.[10]

When evaluating surgical methods, open reduction and internal fixation with plate osteosynthesis is usually the mainstay. M. C. Zimmerman *et al*. compared results of four different approaches to surgical intervention including varieties of nailing techniques and plate osteosynthesis with an AO compression plate, each implementation possessing different biomechanical properties. Fixation with the AO compression plate showed superior bending ability and was also comparatively easier to perform than intramedullary nailing as the distal fragment of the humerus is small and the medullary canal is narrow, making it harder to connect to an intramedullary device.[11]

As mentioned earlier, conventional 4.5 mm plates are widely used but aren't considered ideal as they do not allow for stable fixation given the relatively smaller size of the distal fragment.[9] Different plate models and designs have been tested in an attempt to overcome this problem and yield more favorable results such as Moran's use of an oblique posterior plate[12] or Levy's use of a modified plate with a 22^{o} angular offset, the latter reporting practicable results[9]. The use of hybrid metaphyseal locking compression plates consisting of 4.5 mm locking holes proximally and 3.5mm locking holes distally was also studied by Spitzer *et al*. with "advantageous" results.[13] Lambda® plates were introduced by Saragaglia *et al*. which have an inverted Y-shaped plate that can be contoured distally and uses oval holes instead of locking screws.[14] A popular alternative mentioned earlier is the employment of dual-plating which showed promising results but comes with its own set of downsides. In a study performed by Nehad El Mahboub and Waleed

Arafat, thirty patients with extra-articular distal humerus fractures (EADHFs) were operated on with dual plating techniques. While a substantial percentage of patients had a successful and uneventful post-operative course, two patients showed delayed union following fixation and one patient developed postoperative radial nerve palsy.[15]

A study conducted by Gösling T. *et al*. compared the use of a unilateral locked screw plate with double plating in complex tibial fractures and showed "no statistically significant difference between the two methods of fixation".[16] Another variation on plate fixation was with oblique metaphyseal locking compression plates (MLCPs) which, due to the oblique arrangement allowed for more stable fixation and can possibly decrease the risk of non-union. This was attempted by Yang et al. in series of nineteen patients in which 52.6% of the patients had an excellent Mayo Elbow Performance Score (MEPS), though there was still one case of iatrogenic radial nerve palsy reported.[17]

In an attempt overcome some of the risks and difficulties of the dual plating system and some of the other variations, anatomically pre-contoured locking plates have been utilized and tested, including in this study. The extra-articular distal humerus locking compression plate (EADHLCP) is a single column plating system which allows for a larger number of screws to be placed in the distal segment to enhance overall screw hole density and subsequent stability. The extent of soft tissue dissection, and consequently operating time, are reduced as only the lateral column is exposed. The posterior part of the secondary column is non-articular which allows for a more posterior placement of the implant without damaging the cartilage.[3]

Our study reviewed the implementation of EADHLCPs in treating extra-articular distal humerus fractures with promising results. Our study established a mean MEPS of 94.8% compared to a mean MEPS of 79.7% seen with the use of double plating. The use of EADHLCPs also showed no reported cases of non-union and demonstrated a higher proportion of patients with a motion arc at the elbow greater than 100 degrees (94% as compared to 46.7% in a series of double plating).[15] Some other studies showed a high mean MEPS similar to our study such as 90.8%, 94.7%, and 96.15% conducted by Trikha V *et al*[1], Ali N *et al*[5,] and Jain *et al*.[18] respectively. The use of EADHLCPs has also shown to result in significantly greater bending stiffness and torsional stiffness compared to other implants, as shown in the experimental biomechanical model by Scolaro JA *et al*.[19] Fawi *et al*. studied the use of EADHLCPs and have since made it the surgical treatment of choice in their center due to its more-than-satisfactory results.[20] Similarly, Capo JT *et al*. retrospectively studied twenty-one patients treated with EADHLCP for distal humerus fractures and demonstrated good results in terms of radiological union and clinical outcome.[21]

In this study, the lateral column was exposed using the paratricepetal approach, minimizing the soft tissue dissection. The triceps-splitting or the lateral paratricepetal approach does not affect the motion arc and allows for more elaborate radial nerve exploration and for the extender mechanism to be maintained.[1,18,20] No case of non-union was reported in our study compared to incidences up to 7.7% in other series.[1,3,18–21] In our study, pre-operative radial nerve palsy was present in 6.45% of patients compared to different studies reporting incidences ranging from 4.3–23.3%. Post-operative radial nerve neuropraxia ranged from 0–8.3% in various studies compared to 4.2% of cases in our study.[15,18] This study was limited by its relatively small sample size, the restriction of the population to cases in one hospital and the retrospective nature of the data collected.

CONCLUSION

Implementation extra-articular distal humerus locking compression plates (EADHLCPs) have shown to yield promising results in the often-challenging management of extra-articular distal humerus fractures (EADHFs). Our study shows favorable outcomes with the use of an EADHLCP for such fractures as their use allows for stable fixation, requires minimal soft tissue dissection and surgery time, and results in early range of motion while minimizing complications such as radial nerve palsy.

AUTHORS' CONTRIBUTION

AG: Literature search, conceptualization of study design. FE: Write-up, data analysis, proof reading, literature search. HRA: Literature search, data collection, data interpretation. MTA: Data collection, data analysis. SJ, AA: Review and editing.

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