

Original Research Article

An alternative osteosynthesis technique: single column anatomical plate fixation for distal humerus diaphyseal fractures

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ABSTRACT

Background: The treatment of distal humerus diaphyseal fractures presents significant challenges for orthopedic surgeons. The goal of this study is to evaluate the effectiveness and outcomes of a single column anatomical plate as an alternative method of osteosynthesis for fixing distal humerus diaphyseal fractures.

Methods: A Prospective analysis of patients who underwent surgery for distal humerus diaphyseal fractures at a tertiary care medical center was conducted. Patients who received treatment using a single column anatomical plate were included in the study. Preoperative, intraoperative, and postoperative data, including fracture type, surgical approach, complications, range of motion, and radiographic outcomes, were collected and analyzed.

Results: Type B2 fractures were more common in our study i.e., 80%. The maximum incidence was between 18 to 59 years i.e., 21 cases (77%). Average radiological union was seen at 15 weeks. This study shows Excellent outcome in 67% and Good in 30% of patients. Average post-operative ROM at 1 year was mean flexion 120°(SD 7), mean extension of 6 degrees (SD 4.7), mean pronation 81.25°(SD 2.5) and mean supination 82.5°(2.8). Average MEPS score was 95.5 at 1 year. The mean metaphyseal-diaphyseal angle was 85°, the mean humeral-ulnar angle was 14°, which was within the normal limits.

Conclusion: The use of a single column anatomical plate for fixing distal humerus diaphyseal fractures appears to be a promising alternative method of osteosynthesis. However, further prospective studies with larger sample sizes and longer follow-up periods are warranted to validate the efficacy and safety of this technique.

Keywords: Humerus, Diaphyseal fractures, MEPS score, Anatomical locking compression plate, Gustilo Anderson classification

INTRODUCTION

Treatment for distal humerus fractures is complicated and challenging. Adults experience 10% of distal humerus fractures and 16% of humeral shaft fractures, which include extra-articular supracondylar humerus fractures.¹ The majority of these are either diaphyseal fractures or some present with intra-articular extension, making it difficult to treat. In order to allow for early elbow range of motion (ROM), which is essential for a positive functional

outcome, alignment must be restored and secure fixation must be achieved during extra-articular distal humerus fracture treatment.^{2,3} Treatment techniques for treating distal humerus fractures include conservative, intra-medullary nailing, plate osteosynthesis, and functional bracing.⁴⁻⁶ Numerous authors have recommended using open reduction and internal fixation (ORIF) with immediate elbow motion to treat these fractures.⁷ In case of ORIF with PO, a large-fragment plate with a thickness of more than 3.5 mm and a minimum of four screw holes

in both the proximal and distal fragments are recommended. However, distal humeral shaft fractures, particularly those in the metaphyseal transition zone between the shaft and the supracondylar ridges, make it challenging to follow these guidelines. Longer plates have a tendency to press on the olecranon fossa, making it challenging to fixate the distal piece with three or four screws.⁷ Double columnar plating using two 3.5-mm plates in an orthogonal (90-90 degree) pattern or parallel (180°) patterns are commonly advised. Common single-plating methods frequently fall short of achieving sufficient stability.³⁻⁵ Although double-plating procedures produce good functional results, non-unions and infections are nevertheless common.^{5,6} For treatment of non-communited extra-articular distal humerus fractures, authors have used a single posterolateral compression plate to reduce substantial soft tissue and periosteal stripping and surgical time.^{2,5,7} Reduced surgical exposure, shorter operation times, and perhaps quicker rehabilitation due to less iatrogenic soft tissue injury are all benefits of using a single plate.

Objectives

The objective of this study is to evaluate the effectiveness and outcomes of a single column anatomical plate as an alternative method of osteosynthesis for fixing distal humerus diaphyseal fractures.

METHODS

Prospective research from January 2021 to January 2023 is being conducted in Department of Orthopaedics, Saveetha Medical College and Hospital, Chennai. Single Column Anatomical Plates were used to treat 27 adult patients with Distal Humerus Diaphyseal Fractures who were admitted to the orthopaedic surgery department and who met the inclusion criteria. Statistical analysis was done with IBM SPSS software version 28.

Inclusion criteria

Patients willing to undergo procedure with explained consent, Communited and non-communited fractures diaphyseal fractures, any neurological deficit - wrist drop or sensory alteration due to radial nerve involvement, Patients above 18 years of age and other associated fractures in the ipsilateral upper limb were included

Exclusion criteria

Patients with intra articular involvement/extension, pathological fractures and poly trauma patients with expected delay in primary and immediate fixation and patients who are unfit for surgery and not willing for regular follow-up were excluded.

All the patients were evaluated radiographically and clinically. Antero-posterior (AP) and lateral views of the whole shaft humerus were taken. Clinically wrist drop or

sensory loss was evaluated. AO classification was used to classify fractures. All the patients were operated on elective basis after proper pre- anaesthetic check-up.

Preoperative evaluation

Each patient was encouraged and given information regarding their aesthetic concerns and post-operative safety precautions. Written authorization that was legitimate and in order was received. Following a routine checkup and a judgement that the patient was surgically fit, they were sent for surgery. ECG, chest X-ray, HBsAg, HIV, serum creatinine, blood urea, fasting blood sugar, and haemoglobin percentage were among the studies that were carried out. Prior to the day of surgery, parts were prepared. The Instruments and Plates had undergone inspection and sterilisation. Preoperatively, tetanus toxoid and an antibiotic test dose were given.

Surgical procedure

Patient in lateral position with injured side up, under aseptic precaution, regional anaesthesia/ general anaesthesia given, parts painted and draped. Through posterior approach, intermuscular plane created between lateral and long head of triceps, radial nerve visualised. Medial head visualised and retracted. Fracture reduced and fixed with distal humerus anatomical plate over the lateral side of the posterior humeral aspect and plate fixed using 3.5 mm cortical and cancellous screws, fracture site reduction checked using image intensifier, wound closed in layers. Sterile dressing applied. Post operatively patient was started on active or assisted shoulder and elbow ROM exercises on POD 1. Wound dressing was done in POD 2 and POD 5. Suture removal done on POD 12. Patient followed up on 6 weeks, 3 months, 6 months and 1 year. MEPS score done on follow-up.

RESULTS

The age group ranged between 18-73 years, with a standard deviation of 25 (Table 1). Type B2 fractures were more common in our study i.e., 63%. The maximum incidence was between 18 to 59 years i.e., 21 cases (77%). Road traffic accident (RTA) was major cause of trauma 22 cases (81%), fall while working at house at work place was seen in 19% cases (Table 2).

Majority of subjects were males 19 (70%) (Table 3) with left side was involved in majority of cases i.e., 17 cases (62%) (Table 4). Closed injuries were present in 19 cases (70%) and grade 1 Gustilo Anderson classification open injury were present in 3 cases (37.5%) (Table 5). Average radiological union was seen at 15 weeks. Average post-operative ROM at 1 year was mean flexion 120° (SD 7), mean extension of 6 degrees (SD 4.7), mean pronation 81.25° (SD 2.5) and mean supination 82.5° (SD 2.8) (Table 6). Clinical and Radiological evaluation was done at each follow up and functional outcomes were evaluated using Mayo Elbow Performance score (MEPS) which

includes Pain intensity, Motion, stability and function. We had an Excellent outcome in 67% and Good in 30% of our patients.

Table 1: Age group.

Age (years)	N
18-59	21
≥60	6

Table 2: Mode of injury.

Mode of injury	N
RTA	22
Slip and fall	5

Table 3: Sex distribution.

Sex	N
Male	19
Female	8

Table 4: Side involved.

Side	N
Right	10
Left	17

Table 5: Nature of injury.

Nature of injury	N
Open	8
Closed	19

Table 6: Mean range of movements.

Range of movements	Mean/SD
Elbow flexion	120 degrees/7
Elbow extension	6 degrees/4.7
Supination	82.5 degrees/2.8
Pronation	81.25 degrees/2.5

Table 7: Outcome evaluation using MEPS score.

MEPS Score	%
Excellent	66.6
Good	29.6
Fair	-
Poor	3.7

Average MEPS score was 95.5 at 1 year. The mean metaphyseal-diaphyseal angle was 85°, the mean humeral-ulnar angle was 14°, which was within the normal limits (Table 7). The anterior humeral line passed through 100 % of the capitellar width, which is considered normal. There were no patients with secondary loss of reduction at the fracture site, non-union, ulnar nerve problems, superficial or deep infection.

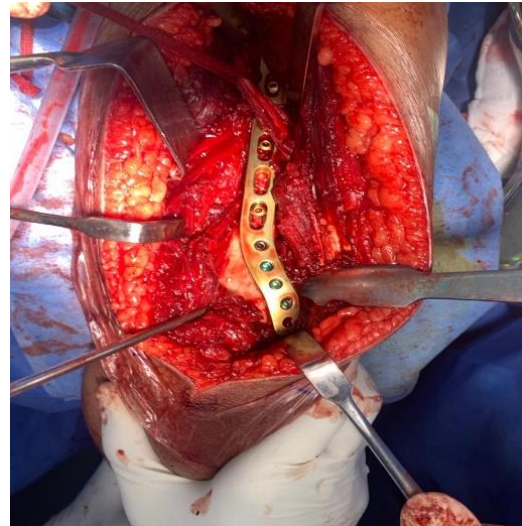


Figure 1: Intra-op image of plate placement.



Figure 2: (Case 1) Pre op X-ray of left distal 1/3rd humerus fracture AP and lateral views.



Figure 3: Immediate Post-op X-ray of AP and lateral views showing distal humerus single column locking compression plate.

DISCUSSION

One of the hardest fractures to treat is distal humerus fractures. Frequently, they are multi-fragmented and have a complicated morphology and are seen in osteopenic bone. Even With anatomical and stable fixation of fractures, the outcome are frequently linked to pain, numbness, and stiffness in the elbow and neurological injuries.

The ideal elbow joint is one that is pain-free, stable, and mobile. enables the hand to carry out regular chores. Sarmiento et al suggestion of functional bracing is an efficient modality for treating these fractures, although this technique is technically challenging, and there are several complications such as skin issues, restriction of movement at the shoulder joint and proper alignment of the fracture was not achieved.⁵ When using functional bracing, the frequency of non-union has been estimated to range between 5% and 24%.



Figure 4: Six month follow up X-ray of AP and lateral views of left humerus showing fracture union.

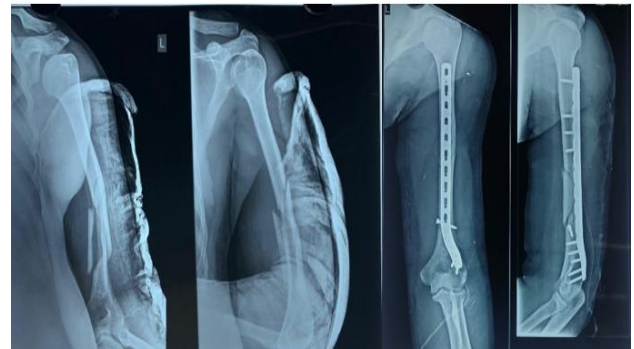


Figure 7: (Case 2) Pre-op and post-op radiographs.



Figure 5: 1 year follow up X-ray of AP and lateral views of left humerus showing fracture united.



Figure 8: (Case 3) Pre-op and post-op radiographs.



Figure 6: Clinical image of the patient performing elbow flexion and elbow extension at 1 year post-op.

Pehlivan et al showed 100% union rates in management of isolated humeral diaphyseal fractures with a custom-made functional brace.⁸ Our study deals with lower diaphyseal fractures of the humerus treated using a 3.5-mm LCP posterior triceps-splitting approach. Levy et al modified the Synthes Lateral Tibial Head Buttress Plate for use at the distal humerus.⁹ An ipsilateral lateral tibial head buttress plate was modified by removing the posterior hole of the proximal expanded section of the plate with the help of a high-speed rotary diamond-cutting tool. The sharp edges were made blunt with a diamond-cutting wheel. The plate was then bent so that the bend in the proximal section of the plate was reversed. This resulted in a 4.5-mm limited contact dynamic compression plate (LC-DCP) with a distal angular offset of approximately 22 degrees that allowed the modified plate to be placed on the lateral column of the distal humerus. The authors reported good results in their series. The problem with this approach is the necessity for elaborate modification of an existing

design or the necessity for bulk production of such a modified design. Spitzer et al used a custom-made 'hybrid' locking plate for difficult fractures of the meta-diaphyseal humeral shaft.¹⁰ This was a special plate prepared for use by the author with 4.5 mm locking holes at one end and a cluster of 3.5 mm locking holes at the other end (distal). The outcome was excellent in their series. Malhar et al conclude that the use of one or two lag screws in addition with a single posteriorly placed 4.5 mm contoured locking compression plate having at least two locking screws in the distal fragment provides sufficient rigid fixation in distal metaphyseal fractures of the humerus.¹⁰

In our study we used only single plate which provided sufficient rigid fixation. In our study, 5 (18.5%) patients had co-morbidities and 5 patients has associated injuries, of which all were managed conservatively, which did not affect the functional outcome. Table 1 shows predominant age group involved in our study ranged from 18-59 years. The (Table 4) shows side of fracture involved, in our study predominantly left side is involved. The (Table 2) shows mode of injury, in our study road traffic accidents is the commonly seen. Similarly in study conducted by Butala et al road traffic accident (RTA) was major cause of trauma-12 cases (55%), followed by fall was seen in 45% cases.¹² Majority of subjects were males 13 (65%) and right side was involved in majority of cases (Table 3). Average MEPS score in there study was 95.5. Similarly in our study average MEPS score was 95. The (Table 5) shows nature of injury, where 8 patients had grade 1 gustilo anderson classification open and 19 patients had closed injury, which did not show difference in the functional outcome. Malhar et al conducted a study in which the mean duration of surgery was 110±15.3 min (90-150 min).¹¹ Average blood loss was 155±25.5 ml (130-240 ml). Radiological union was evident by an average of 13.5±1.46 weeks (10-17 weeks).

In our study the mean surgery duration was 100 mins, average blood loss was 150 ml, radiological union was achieved by an average of 15 weeks. Our radiography findings showed that the mean humeral-ulnar angle 14 degrees and the mean metaphyseal-diaphyseal angle 85 degrees, were all within the normal range. Furthermore, the anterior humeral line was also within the usual range. These radiography results show that the elbow joint alignment and bone reduction are successfully maintained by the single column fixation throughout time. Single-column fixation is said to take less time than both-column fixation in either orthogonal or parallel mode, Less bleeding, minimal surgical dissection and less soft tissue manipulation. The post-operative rehabilitation course is also improved by avoiding an olecranon osteotomy hence helps in early mobilisation. The study's limited patient volume, brief follow-up period, and lack of a control group to compare the findings are its main limitations. In order to compare overall complication rates and assess the functional outcomes of fixing the distal humerus fractures, long-term trials and larger sample size studies are necessary.

CONCLUSION

In comparison to traditional compression plating or posterior plating, the single column anatomical locking compression plate, or Extra Articular Distal Humeral Plate, provides us excellent benefits, because they need less soft tissue exploration, are rigid in construction, have anatomically tailored plating, and offer a variety of fixing choices for extra articular distal humeral fractures with excellent radiological and functional results. We did not see any cases of loss of reduction or iatrogenic nerve palsy.

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