

Comparison of Double Anatomical Locking Compression Plate Versus nonlocked Plates in Distal Humerus Fractures

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Research Article

Keywords: anatomical locking compression plates, conventional plates, plating

Posted Date: May 13th, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-1460862/v1>

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Abstract

Background: The current literature contains no guidelines for choosing the method of fixation for fractures of the distal humerus. This study aims to compare the functional and radiological outcomes between anatomical locking compression plates and nonlocked reconstruction plates in fractures of the distal humerus (AO type A 3).

Methods: This was a prospective cohort study that was conducted between 2015 and 2021 on 60 patients with distal humeral fractures (AO type A 3). There were 30 patients (23 males and 7 females) with a mean age of 40 years and two months who were followed up for 62 months in group 1. The patients in group 1 underwent Open reduction and internal fixation with double anatomical LCP. There were 30 patients (21 males and nine females) with a mean age of 41 years and seven months in group 2. The mean follow-up period was 58 months. Fifteen of the patients in group 2 underwent open reduction and internal fixation with nonlocked plates.

Results: There was no significant difference in the degree of extension, flexion, arch of motion, and MEPS between the two groups at the six-month follow-up appointment. There was a highly significant difference between the study groups in the mean union time (3.27 ± 0.46 months vs. 4.27 ± 0.70 months) and time taken to mobilize the elbow joint after surgery (10–14 days [mean 11.33 ± 1.40] vs. 21–30 days [mean 24.87 ± 4.45] days) in groups A and B, respectively.

Conclusions: There was no difference in the functional outcomes of distal humeral fractures (AO type A 3), including range of motion and MEPS, between the precontoured anatomical LCP and 3.5-mm nonlocked reconstruction plates. There was improvement in the union time and short postoperative time of mobilization in group 1.

Background

Fractures of the distal humerus are relatively uncommon and comprise approximately 2% of all fractures. These fractures require complex and accurate management [1–4]. Distal humeral fractures occur in the younger age groups and are secondary to high-energy trauma. Most of these fractures (96%) have a complex pattern that involves the columns and extends to the articular surface.

The risk of functional disability after nonoperative treatment is reportedly high; therefore, operative management is the gold standard for juxta-articular and intra-articular distal humeral fractures [5, 6].

Open reduction and internal fixation (ORIF) has become the treatment of choice as it results in good results. Methods of fixation of distal humeral fractures via internal fixation include double-plate osteosynthesis with 3.5-mm reconstruction plates and anatomical LCP osteosynthesis (which provide better angular stability) [7–9].

The current literature does not contain any guidelines for choosing the type of fixation; so, this study aims to compare the functional and radiological outcomes of anatomical LCP osteosynthesis to those of conventional reconstruction plates in patients with distal humeral fractures (AO type A3).

Methods

We included 60 patients with distal humeral fractures (AO type A 3) who underwent surgery at our hospital in this prospective cohort study conducted between 2015 and 2021.

Our inclusion criteria were as follows:

- Distal humeral fractures (AO type A3)
- Skeletally mature patients
- Closed fractures

Our exclusion criteria were as follows:

- Vascular Injuries
- Pathological fractures
- Previous elbow skeletal injury
- Uncontrolled diabetes mellitus
- Non-united and mal-united fractures
- Rheumatoid patients

The 60 patients that were included in this study, 30 were assigned to group 1. Among these 30, there were 23 males and seven females with a mean age of 40 years and two months (40.20 ± 9.62 , range: 23–48 years). Twenty-six (86.7%) of them were right-handed. The mean follow-up period was 62 months (range: 38–68 months). The patients in group 1 underwent ORIF with double anatomical LCP. There were 30 patients in group 2, 21 males and nine females with a mean age of 41 years and seven months (range: 24–52 years), with 20 (66%) of them being right-handed. The average follow-up period was 58 months (range: 38–68 months; Table 1). Fifteen of the patients in group 2 underwent ORIF with 3.5-mm nonlocked reconstruction plates. Written informed consent was obtained from all the patients, and the study was performed in accordance with the principles of the Declaration of Helsinki.

Co-morbidities such as HTN and smoking were present in five and six patients, respectively, in group 1 and in three and five patients, respectively, in group 2. The mechanism of injury was a road traffic accident in 16 patients, MBA (Motor bicycle accident) in 12 patients and falling on outstretched hands in 2 patients in group 1. In group 2, these were the mechanisms in 20 patients (53.3%), 7 patients, and 3 patients, respectively (Table 1).

The injured limbs were examined both generally and locally. Plain X-rays of the affected elbows and humeri were performed in both lateral and anteroposterior views. CT scans were done in five cases only, to confirm no intra-articular extension. All patients were immobilized in an above elbow slab. Antiedematous measures were taken as the patients were prepared for surgery. Randomization was performed by sequential selection.

Surgical technique

All patients in the study were put under general anesthesia and placed in the lateral decubitus and tourniquets were applied as high on the arm as possible. The posterior approach to the distal humerus was used in all patients. Triceps splitting and the para-tricepial approach were used in all cases [10, 11].

Group 1

All patients underwent ORIF with double anatomical columnar LCP plates. After reducing the fracture, the anatomical posterolateral plate was applied on the posterolateral aspect of the distal humerus with the lateral support extending over the most protruding tip of the lateral epicondyle, then a 2.7-mm locking screw was inserted into one of the threaded holes of the distal part of the plate. The medial plate was positioned on the medial ridge with its distal tip reaching down to the insertion of the medial collateral ligament.

Group 2

Fifteen patients underwent ORIF with nonlocked reconstruction plates. Both medial and lateral 3.5-mm reconstruction plates were slightly under-contoured to provide additional compression at the metaphyseal region when applied. The length of each plate was selected so that at least three screws could be placed at the proximal part of the humeral shaft, after which the medial plate was extended to the articular margin in cases of very distal or comminuted fractures. The lateral plate was applied in a posterior position that did not extend beyond the center of the capitellum distally to avoid injury to the LCL complex. Plates that ended at different levels proximally were always chosen to avoid the creation of stress-risers.

Postoperative management and follow-up

Surgery time, intraoperative blood loss, perioperative blood transfusion, and intraoperative complications were documented in the patients' clinical records.

A complete follow-up was conducted for all patients by the main surgeons who performed postoperative clinical evaluations at the outpatient clinic. Immediate neurovascular status assessments were performed after the patient's regained consciousness and immediate postoperative X-ray were performed at two weeks, with the concomitant removal of stitches. The patients were encouraged to use their hands and elbows at 6 weeks, 12 weeks, and 1 month till complete union. Radiological assessments were done by X-ray and functional assessments were done according to the MEPS.

Statistical analysis

The data were coded and entered into SPSS version 23, which was also used for statistical analysis. Continuous data were presented as mean values and standard deviations while categorical data were presented as frequencies and percentages. The comparison between two groups with quantitative data and parametric distribution was done by using Independent t-test while that for non-parametric data was done by using Mann-Whitney test. The quantitative variables were compared, and P-values of < 0.05 were considered statistically significant.

Results

The mean blood loss in both group 1 and group 2 was (392.67 ± 133.07) ml and (366.67 ± 40.82) ml. The mean surgery time was 125.80 ± 17.98 min and 127.33 ± 10.50 min in group 1 and group 2, respectively, with no significant difference between the two groups (Table 2).

Table (1): Difference between anatomical and conventional groups regarding demographic data.

		Group1	Group 2	P-value	Sig.
		No. = 30	No. = 30		
Sex	Females	7 (33.3%)	9 (40.0%)	0.705	NS
	Males	23(66.7%)	21(60.0%)		
Age (years)	Mean±SD	40.20 ± 9.62	41.7 ± 6.39	0.611	NS
	Range	23 – 548	24 – 52		
Side of dominance	Right hand	26 (86.7%)	20 (66.0%)	0.143	NS
Mode of trauma	FOOSH	2 (6.6%)	3 (10%)	0.290	NS
	MBA	12 (40 %)	7 (23.3%)		
	RTA	16 (53.4%)	20 (66.7%)		

Table.2: Difference between anatomical and conventional groups in operation duration and intraoperative blood loss.

		Group 1	Group 2	Test value	P-value	Sig.
		No. = 15	No. = 15			
Duration of operation (min)	Mean±SD	125.80 ± 17.98	127.33 ± 10.50	-0.285	0.778	NS
	Range	100 – 160	110 – 140			
Blood loss (cc)	Mean±SD	392.67 ± 133.07	366.67 ± 40.82	0.723	0.475	NS
	Range	250 – 630	300 – 450			

The degree of extension 18.33 ± 11.60 in group 1, and 15.33 ± 15.06 in group 2, flexion was 129.33 ± 11.93 in group 1, and 126.00 ± 16.39 in group 2, arch of motion 111.00 ± 18.34 in group 1, and 110.67 ± 27.64 in group 2 and MEPS was 87.67 ± 9.04 in group 1, and 87.00 ± 4.93 in group 2, Respectively. There was no significant difference after six months of follow-up between the two groups (Table 3).

Table.3: Clinical and functional results at 6 months.

At 6 months		Group 1	Group 2	Test value	P-value
		No. = 15	No. = 15		
Extension	Mean±SD	18.33 ± 11.60	15.33 ± 15.06	-0.832 ¹	0.406
	Range	0 – 30	0 – 40		
Flexion	Mean±SD	129.33 ± 11.93	126.00 ± 16.39	-0.384	0.701
	Range	100 – 145	90 – 145		
Arch of motion	Mean±SD	111.00 ± 18.34	110.67 ± 27.64	-0.293	0.770
	Range	70 – 135	70 – 145		
Mayo elbow performance score (MEPS)	Mean±SD	87.67 ± 9.04	87.00 ± 4.93	-0.587	0.557
	Range	70 – 100	80 – 95		

There was a highly significant difference in the mean union time (3.27 ± 0.46 months vs. 4.27 ± 0.70 months in groups A and B, respectively) and time required for mobilization of the elbow joint after surgery (10–14 days [mean 11.33 ± 1.40 days] vs. 21–30 days [mean 24.87 ± 4.45] in groups A and B, respectively) between the two study groups (Table 4).

Table 4: differences between the anatomical and conventional groups as regards union time and mobilization after operation.

		Group 1	Group 2	Test value	P-value	Sig.
		No. = 15	No. = 15			
Union time (month)	Mean ± SD	3.27 ± 0.46	4.27 ± 0.70	4.613*	< 0.001	HS
	Range	3 – 4	3 – 5			
Mobilization after (days)	Mean ± SD	11.33 ± 1.40	24.87 ± 4.45	11.228*	< 0.001	HS
	Range	10–14	21 – 30			

Discussion

Double-plate osteosynthesis is the current gold standard for the treatment of distal humeral fractures; however, plate type and configuration are controversial topics in the literature [11]. The distal humerus can be represented as a triangular structure that consists of three columns, which are the medial, lateral, and transverse intercondylar regions. Its stability depends on the integrity of this triangle [12]. The correct use of the plates in terms of placement, size and number of screws can result in a stable and painless elbow and prevent complications such as stiffness or nonunion.

In this study, there was no significant difference in stiffness between the two configurations. Similar results were reported in biomechanical studies using epoxy composite humeri [13, 14, 1]. In this study, we used a perpendicular configuration to compare the effectiveness of distal humeral locking compression plates to that of nonlocked reconstruction plates in achieving good functional results.

In this study, the average range of motion after six months of follow-up was 111° (range: 70–135) and 110° (range: 70–145) in group 1 and group 2, respectively. The mean arc of flexion was 129° (range: 100–145) and 126° (range: 90–145) in group 1 and group 2, respectively. The mean deficit in extension was 18° (range: 0–30) and 15° (range: 0–40) in group 1 and group 2, respectively. We found no statistically significant difference in the range of motion between both groups. This finding is in line with those of Patel *et al.* in 2017 [15], who conducted a prospective study on 31 patients that underwent ORIF using anatomical plates with a mean elbow flexion of 115.80° (range: 85.0–150.0). The mean deficit in extension was 190° (range: 50–350). Also, in 2010, Shin *et al.* [16] conducted a randomized clinical trial on 35 patients with intra-articular distal humeral fractures (18 were treated using anatomical plates and 17 using conventional plates). They reported that in the anatomical plates group, the arc of flexion averaged 112° (range: 95–135) while in the conventional plates group the arc of flexion averaged 119° (range: 90–135). In 2001, Eralp *et al.* [17] studied 17 patients with intra-articular fractures of the distal humerus. These patients underwent ORIF using two reconstruction plates. The evaluation of the range of movement revealed a mean loss of extension of 20° (5°–39°) and a mean range of flexion of 125° (90°–

145°). Our findings are in line with those of previous studies that reported that the range of motion is not affected by the type of plates used for the fixation of fractures of the distal humerus.

In our study, the mean MEPS score after six months of follow-up was 87.6 points (range: 70–100) and 87 points (range: 80–95) in groups 1 and 2, respectively. We reported no significant difference in the Mayo score between the two study groups, which is in line with the findings of the study by *Shin et al.* in 2010 [16]. They reported that the mean MEPS was 94.3 (range: 70–100) in the anatomical group and 91.5 points (range: 70–100) in the conventional group. Also, in 2017, *Patel et al.* [18] reported that at the final follow-up appointment, the mean MEPS was 87.9 points out of 100 (range: 55–100), and there were 19 patients (61%) with a mean excellent result (90–100) and nine patients (29%) with a mean good result (75–89).

In this study, 11 patients (73.3%) attained complete union after three months while four patients (26.7%) attained complete union after four months in group 1, with a mean union time of 3.27 (range: 3–4) months. In group 2, three patients (20%) attained complete union at three months, six patients (40%) attained complete union at four months, while six other patients (40%) attained complete union at six months, with a mean union time of 4.2 (range: 3–5) months. There was a statistically significant difference in the union rate between the two study groups. We have to consider that our results do not match those of *Patel et al.* [15], who reported in 2017 that complete fracture union was attained in 29 patients (93.5%) at the final follow-up appointment. The mean time required for union was 16 (range: 12–24) weeks. Also, in 2004, *Huang et al.* [19] conducted a retrospective study on 40 patients with fractures of the distal humerus that were fixed using reconstruction plates. They reported that all the fractures united well without any malalignment. The average union time was 11.7 (range: 9–16) weeks.

Conclusion

There was no significant difference in the functional outcomes of distal humeral fractures (AO type A 3), including the range of motion and MEPS, between precontoured anatomical LCP and 3.5-mm nonlocked reconstruction plates. There was also a highly significant difference in the union time and time-lapse between surgery and mobilization between the two groups.

Abbreviations

MEPS

Mayo Elbow Performance score

LCP

Locking compression plate osteosynthesis

Declarations

Declarations: there is no Conflict of interest, the authors have no relevant financial or non-financial interests to disclose.

Ethical approval: Ethical approval was obtained from the IRB of Al-Azhar University (No. 2018122001).

Acknowledgments: None.

Funding: The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Contributions: All the authors made substantial contributions to the conception and design of the study, data collection, data analysis and interpretation, and the write-up of the manuscript.

Consent to participate: Written informed consent was obtained from the parents.

Data availability: All data and materials are available.

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