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Original Article

# Anterolateral vs. Posterolateral Dual Plating for Extra-articular Distal Third Humeral Fractures

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## ABSTRACT

**Objective:** The present study aimed to evaluate and compare the clinical and radiological outcomes of anterolateral or posterolateral dual plating in patients who underwent surgery because of extra-articular fractures of the distal one-third of the humerus.

**Methods:** Patients were followed-up for a minimum of 2 years and were evaluated and compared with each other in terms of union time, surgery duration, intraoperative fluoroscopy shot count, iatrogenic nerve injury, infection, need for revision surgery, and elbow flexion-extension degrees and Disabilities of Arm, Shoulder and Hand (DASH) scores at the last follow-up.

**Results:** Twenty patients (mean age 35.6 ± 5.4 years; range 25-47) who underwent surgery and received anterolateral dual-plate fixation were compared with 19 patients (mean age 34.7 ± 4.8 years; range 23-47) who underwent posterolateral dual-plate fixation between January 2018 and October 2021 ($P > .05$). No significant differences were observed between the 2 groups in terms of sixth month DASH score, union time, elbow flexion, elbow extension, infection, iatrogenic nerve injury, or need for revision surgery ($P > .05$). However, the differences in duration of surgery and number of fluoroscopy shots between the groups were significant ($P < .05$).

**Conclusion:** Because the patient lies in the supine position during anterolateral dual plating, there is a positional advantage over posterolateral dual plating, particularly in polytrauma patients. Anterolateral dual plating is a safer alternative to posterolateral dual plating because of the shorter preoperative preparation and the lower fluoroscopy shot counts.

**Keywords:** Iatrogenic disease, multiple trauma, plate fixation, distal humerus fractures, radial palsy

## INTRODUCTION

Extra-articular distal third humeral fractures pose challenging decision-making situations regarding surgical and conservative treatment options. Patients may experience loss of reduction with conservative treatment, and contractures may develop in the elbow and shoulder due to prolonged immobilization.[1] With surgical treatment, more appropriate alignment is achieved, and earlier rehabilitation is possible, but complications associated with iatrogenic nerve damage, infection, nonunion, implant failure, and anesthesia may also occur.[2]

In humeral fractures, treatment options and surgical difficulties may vary depending on the fracture location and type. Particularly the triangular expansion of the anatomical cylindrical structure of the distal humerus and the concave surface anteriorly and convex surface posteriorly make surgical planning and fixation difficult.[3] There is no gold standard for distal humeral fracture surgery, and the position of the patient during surgery, surgical approach, and type and number of implants used may vary.[4,5]

Posterior approach is generally preferred for treating distal one-third humeral fractures. It is often preferred due to surgeons' familiarity with the approach, ease of plate application, and relative safety concerning vascular and nerve structures. On the other hand, the lateral approach has gained popularity recently and is reported to be safer in terms of nerve damage.[6] Depending on the shape of the fracture, the number of plates to be used and the

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localization of the plate may vary. Studies have been conducted on the surgical approach, plate localization, number of plates (single vs. dual), but there are no studies on the configuration of dual-plate application (anterolateral vs. posterolateral dual plating).

The aim of the present study was to evaluate and compare the outcomes of anterolateral dual plating with posterolateral dual plating following extra-articular distal third humeral fractures, both clinically and radiologically.

The hypothesis of the study is that in patients undergoing anterolateral dual plating, there would be no need for repositioning, thus making surgery more reliable, particularly in polytrauma cases, and resulting in shorter surgical duration.

## MATERIAL AND METHODS

### Patients

Patients who underwent surgery for extra-articular distal third humeral fractures between January 2018 and October 2021 were evaluated, and 39 patients who met the study criteria were included in the study (Figure 1). Patients were divided into 2 groups: patients who underwent surgery with an anterolateral approach in the supine position (group 1) and patients who underwent surgery with a posterior approach in the lateral decubitus position (group 2). Group 1 consisted of 20 patients (15 males and 5 female), while group 2 consisted of 19 patients (13 male and 6 female). Duration of surgery, intraoperative fluoroscopy shot counts, union times, preoperative and postoperative neurologic complications, number of infections, implant-related complications, sixth-month Disabilities of Arm, Shoulder and Hand (DASH) scores, sixth-month range of motion (ROM), and revision surgery requirements were evaluated and compared between the groups.

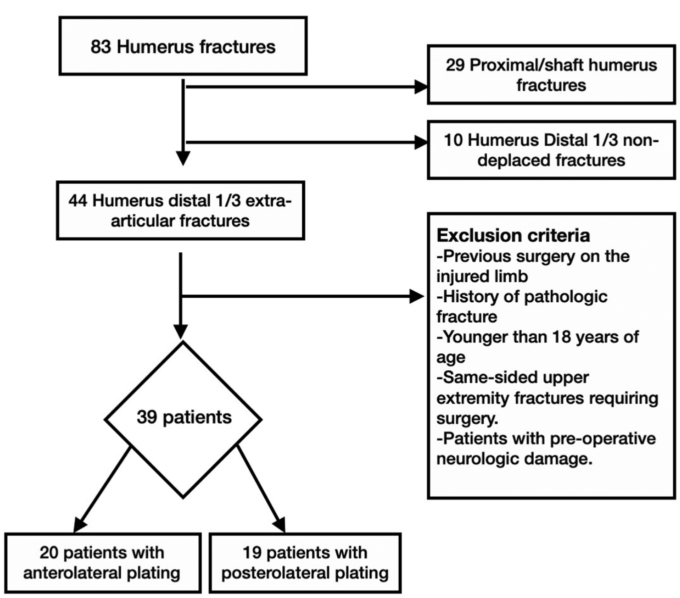


**Figure 1.** Inclusion and exclusion criteria.

The general condition of the patient and the surgeon's preference were influential in performing surgery with anterolateral dual-plate or posterolateral dual-plate configuration.

The study protocol was approved by the University of Health Sciences, Van Training and Research Hospital Ethical Committee (IRB No. 2023/14-01, July 5, 2023), and written informed consent was obtained from all patients. This is a retrospective comparative study.

### Surgical Methods

After the administration of standard surgical prophylaxis (1 g cefazolin sodium), all patients were given general anesthesia.

The patients undergoing surgery via the anterolateral approach were placed in the supine position and adequately draped. An incision was made laterally from the deltoid insertion toward the lateral epicondyle. The posterior skin and subcutaneous tissue were retracted posteriorly, and a deep fascial incision was made from the triceps overlying the lateral intermuscular septum. Subsequently, to access the anterior compartment of the arm, the fascia was lifted anteriorly from the edge of the lateral intermuscular septum. At the mid-distal one-third humerus level, the radial nerve was located at the lateral intermuscular septum. Distally, the radial nerve between the brachialis and brachioradialis in the anterior compartment of the arm was dissected. After achieving appropriate fracture reduction, fixation was performed by applying dual anterolateral humeral plates of varying lengths, depending on the fracture pattern (Figure 2).


**Figure 2.** Preoperative x-ray image of the patient with anterolateral plate.

The patients undergoing surgery with the posterolateral approach were placed in the lateral decubitus position. After adequate draping, an incision was made from the proximal olecranon to the proximal-middle one-third level of the humerus. After opening the fascia from the same line, the lateral and long head of the triceps were exposed. Through blunt dissection on the lateral side, the lateral cutaneous nerve was identified and traced proximally, revealing the radial nerve at the level of the lateral intermuscular septum. The distal part of the triceps muscle was split, allowing access to the posterior aspect of the distal humerus. Subsequently, the triceps muscle was dissected away from the lateral intermuscular septum, reaching the lateral aspect of the humerus. After achieving proper fracture reduction, fixation was accomplished using posterolateral dual plates of varying lengths, according to the fracture pattern, to stabilize the humerus (Figures 3 and 4).

The plates used in all patients were of the same thickness. The plates consisted of a 4.5-mm locking compression plate and one-third tubular 3.5 mm locking compression plates.

### Follow-up and Radiographic Evaluations

After suture removal in the postoperative second week, all patients underwent follow-up and monitoring at 6 weeks, 3 months, 6 months, 1 year, and 2 years. The follow-ups were conducted by the same surgical team, and patients in both groups underwent the same rehabilitation program (passive elbow and shoulder movements for the first 3 weeks, followed by active shoulder and elbow movements between weeks 3 and 6). During the patients' follow-up appointments, anteroposterior and lateral x-rays of the humerus were taken. The union was assessed radiologically by the presence of callus formation or continuity in at least 3 cortices.[7] Patients who did not show significant union until the sixth month were considered to have delayed union, and those who lacked callus formation by the ninth month and experienced clinical pain were considered as nonunion. During follow-ups, patients were evaluated for wound site infections, neurological complications, range of joint motion, and their DASH scores at 6 months.

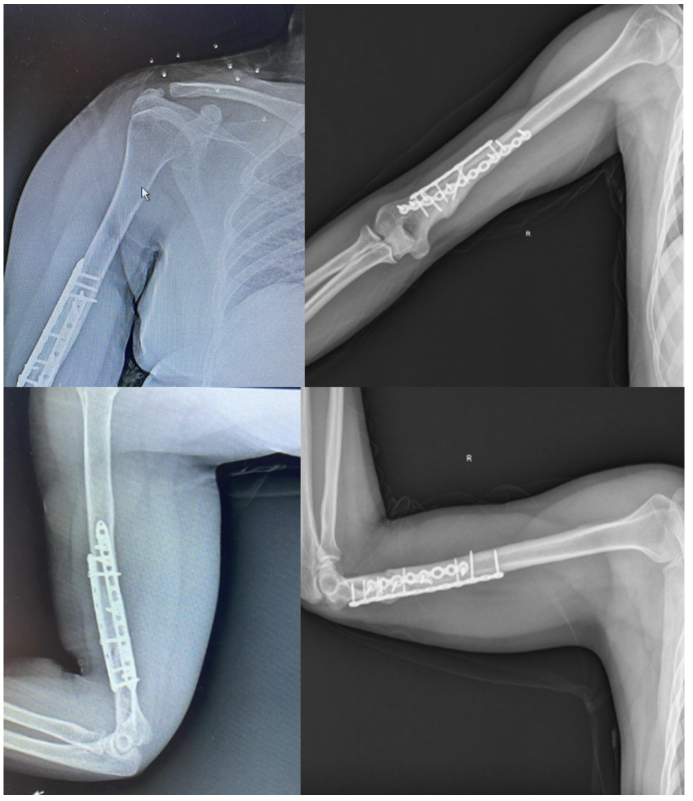

**Figure 4.** Postoperative humerus anterior–posterior x-ray of anterolateral and posterolateral double plating.

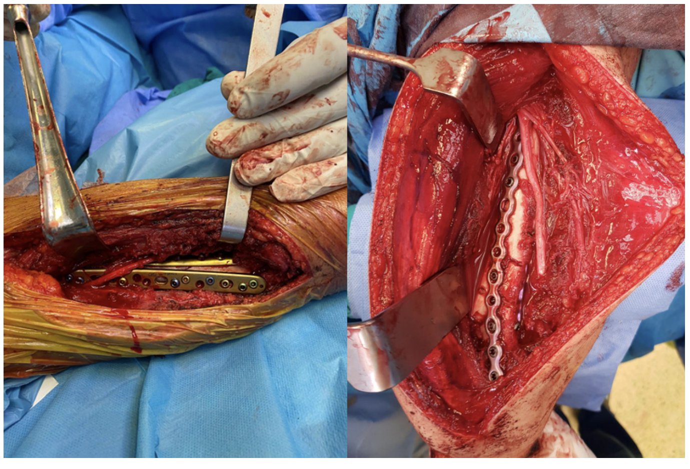

**Figure 3.** Intraoperative view of humerus anterolateral double plating.

### Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences version 21.0 (IBM SPSS Corp.; Armonk, NY, USA). All quantitative variables were assessed using measures of central tendency (mean and median) and dispersion (standard deviation and standard error). The data normality was determined using skewness and the Kolmogorov–Smirnov test. The Student's *t*-test was used to compare normally distributed variables between the groups. All statistical tests were performed as 2-sided analyses with a significance level set at .05.

## RESULTS

Group 1 consisted of 15 male and 5 female patients, whereas group 2 consisted of 13 male and 6 female patients. The mean age of the patients in group 1 was

35.6 ± 5.4 (range: 25-47) years, while the mean age of the patients in group 2 was 34.7 ± 4.8 (range: 23-47) years (*P* > .05). The mean time to surgery was 2.1 ± 1.3 days in group 1 and 2.4 ± 1.5 days in group 2, and there was no significant difference between the 2 groups (*P* > .05). The mean follow-up period of the patients was 29.8 ± 3.4 months. There was no significant difference between the 2 groups in terms of fracture types (*P* > .05).

All fractures were evaluated according to the Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification. Accordingly, 6 cases were A2 (15.3%), 6 cases were A3 (15.3%), 6 cases were B1 (15.3%), 12 cases were B2 (33.3%), and 9 cases were B3 (23%) fractures. There was no significant difference between the 2 groups regarding fracture classification (*P* > .05).

The injury mechanisms for patients in group 1 were as follows: 8 falls (40%), 10 nonvehicular traffic accidents (50%), and 2 direct traumas (10%). The injury mechanisms for patients in group 2 were as follows: 6 falls (31%), 11 nonvehicular traffic accidents (57%), and 3 direct traumas (15%). In group 1, 6 patients had vertebral fractures and 1 patient had a spleen laceration. In group 2, 3 patients had vertebral fractures.

In group 1, the mean surgical duration was 121 ± 11.3 min (range: 113-145 min), while the mean length of hospital stay was 7.2 ± 0.8 days (range: 6-9 days). In group 2, the mean surgical duration was 132.1 ± 11.8 min (range: 108-153 min), while the mean length of hospital stay was 7.08 ± 0.8 days (range: 5-9 days). While there was a significant difference between the groups in terms of surgical duration (*P* < .05), there was no significant difference in terms of the length of hospital stay (*P* > .05). The mean follow-up period was 25.5 ± 2.6 (range: 25-32) months in group 1 and 26.1 ± 2.8 (range: 32-43) months in group 2. There was no significant difference between the groups in terms of follow-up periods (*P* > .05).

The clinical outcomes of patients in both groups were evaluated. In group 1, the mean time to bone union was 12.8 ± 1.8 (range: 10-16) weeks. At 6 months, the mean degree of elbow flexion was 137° ± 4.8° (range: 134°-146°), the mean degree of elbow extension limitation was 2.5° ± 4.2° (range: 0°-88°), and the mean DASH score was 10.3 ± 2.7 (range: 8-17). In group 2, the mean time to bone union was 12.9 ± 2.2 (range: 10-16) weeks. At 6 months, the mean degree of elbow flexion was 135° ± 4.3° (range: 134°-146°), the mean degree of elbow extension limitation was 1.1° ± 2.2° (range: 0°-8°), and the mean DASH score was 9.7 ± 2.3 (range: 8-15). There was no significant difference between the 2 groups in terms of union time, elbow flexion degree, elbow extension degree, and DASH scores (*P* > .05). The number of fluoroscopy shots taken during surgery was 31.2 ± 5.4 in group 1 and 45.4 ± 6.5 in group 2, and there was a significant difference between the groups (*P* < .05) (Table 1).

**Table 1.** Clinical and Radiological Comparison of Anterior–Lateral vs. Posterior–Lateral Dual Plating

| | Plate Configuration | N | Mean | SD | *P* |
|---|---|---|---|---|---|
| Neuropraxia | Anterolateral | 20 | 1.50 | 0.527 | .742 |
| | Posterolateral | 19 | 1.56 | 0.527 | |
| Surgical time (min) | Anterolateral | 20 | 121 | 11.3 | **.017** |
| | Posterolateral | 19 | 132.1 | 11.8 | |
| Fluoroscopy shots number | Anterolateral | 20 | 31.2 | 5.4 | **<.05** |
| | Posterolateral | 19 | 45.4 | 6.5 | |
| Bone union time (weeks) | Anterolateral | 20 | 12.8 | 1.8 | .310 |
| | Posterolateral | 19 | 12.9 | 2.2 | |
| DASH score | Anterolateral | 20 | 10.30 | 2.791 | .732 |
| | Posterolateral | 19 | 9.78 | 2.386 | |
| Elbow flexion (°) | Anterolateral | 20 | 137.00 | 4.830 | .837 |
| | Posterolateral | 19 | 135.00 | 4.330 | |
| Elbow extension limitation (°) | Anterolateral | 20 | 2.50 | 4.249 | .542 |
| | Posterolateral | 19 | 1.11 | 2.205 | |
| Complication | Anterolateral | 20 | 1.60 | 0.516 | .131 |

DASH, Disabilities of Arm, Shoulder and Hand.

While no implant irritation was observed in group 1, 3 patients experienced implant irritation in group 2, and the implants were removed after radiological union was achieved. Superficial skin infection was observed in 2 patients in group 1. The infections were treated with local debridement and antibiotic therapy. Iatrogenic nerve damage (neuropraxia) developed in 4 patients in group 1 and 3 patients in group 2. In all patients, neuropraxia was resolved by the 6-month mark. Evaluation of the complications showed no significant difference between the 2 groups (*P* > .05). In group 1, primary union was achieved in 11 patients, while callus formation was observed in 9 patients. In group 2, primary union was achieved in 14 patients, while callus formation was observed in 5 patients.

## DISCUSSION

The most important findings of the study were that anterolateral plating provides a position advantage in patients with polytrauma and shortens the surgical time. In addition, the number of fluoroscopy shots during surgery was significantly lower than posterolateral dual plating (*P* < .05). We believe that the most significant factors contributing to the reduction in surgical duration include quicker patient positioning and enhanced stability of the patient in the supine position. Similarly, we believe that the reduced number of fluoroscopy shots is due to easier access of the scope to the humerus and a decrease in position-related superimposition.

Distal humeral fractures are considered challenging in terms of treatment management. In addition to the surgical approach to fractures, the type and location of the fixation material to be applied also varies. Distal third fractures of the humerus pose additional challenges due to the anatomical structure of the bone. The aim of the present study was to compare anterolateral and posterolateral dual plating methods in extra-articular distal third humeral fractures.

There are many studies comparing single plating vs. dual plating in extra-articular distal third humeral fractures. Mao et al.[8] compared single plating and dual plating and reported that single plating had similar results in terms of union rate, union time, and elbow ROM compared to dual plating; however, dual plating provided better pain control and functional results at the second week, fourth week, and third month. Tecimel et al.[9] also compared single plating and dual plating and found that the number of plates did not affect the union time and union rate but provided early joint motion. Gupta et al.'s[10] study demonstrated that dual plating with a posterior incision provided rigid and stable fixation, allowing for early mobilization and enabling excellent union in the fracture. Similar studies exist that support the biomechanical advantage of dual plating by providing stronger fixation. Other studies also showed that dual plating shortened the union time and allowed for earlier active movement.[11-13] In the present study, implant failure was not observed in any of the patients who underwent dual plating, and the functional outcomes of the patients were satisfactory (excellent–good–fair).

In addition to the studies evaluating the number of plates to be used in humeral fractures, various studies have been conducted on the configuration of the plates and the type of plates to be used. Although posterior plating is commonly performed, there are also recommendations for anterior and lateral plating.[14] Wei et al.[15] demonstrated that anterior plating was safer and more advantageous than posterior plating in humeral shaft fractures. In Shin et al.'s[14] study, both anterior and posterior plating showed satisfactory clinical and radiological outcomes for extra-articular distal third humeral fractures. Implant-related complaints have been observed at a higher rate in posterior plating, highlighting the importance of consideration when choosing the surgical method for extra-articular distal third humeral fractures.[16] In the present study, implant irritation was observed in 3 patients who underwent dual plating in the posterolateral configuration, while no implant irritation was observed in patients who underwent anterolateral dual plating.

Previous studies comparing dual plating often focus on medial–lateral parallel plating and posterolateral dual plating.[17,18] In the present study, we evaluated the outcomes of anterolateral dual plating, which has not yet been extensively explored, compared with posterolateral dual plating. The results revealed that anterolateral dual plating is as safe as posterolateral dual plating. In the present study, orthogonal plating was performed in an anterolateral configuration, and there were no instances of implant failure throughout the follow-up period. Anterolateral dual plating has a similar complication rate and certain advantages over posterolateral dual plating. The most important advantage of anterolateral dual plating is that it allows the patient to be operated in the supine position. It is evident that the preoperative preparation time is as crucial as the surgical process itself. Prolonged anesthesia, particularly in polytrauma patients, can lead to morbidity and mortality.[19]

The effect of performing nerve exploration following iatrogenic radial nerve injury on the recovery of the radial nerve remains debatable. However, early surgery and follow-up have been shown to have a similar effect on radial nerve healing.[20,21] In the present study, a similar rate of radial nerve injury occurred in both groups, and all the patients we followed showed complete radial nerve recovery by the sixth month. Both surgical methods we performed showed no superiority over each other in terms of iatrogenic radial nerve injury.

Significant limitations of the present study include the relatively small sample size, single-center design, lack of knowledge regarding the biomechanical effectiveness of different configurations of plate application, and a relatively short follow-up period. Future studies focusing on biomechanics involving a larger patient population will shed more light on this topic.

In the present study, patients undergoing anterolateral and posterolateral dual plating showed similar clinical, radiological outcomes and complication rates. We believe that the anterolateral dual plating method for the treatment of extra-articular distal third humeral fractures is reliable, particularly in polytrauma patients, as it does not require additional patient positioning.

**Data Availability Statement:** The data that support the findings of this study are available on request from the corresponding author.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the Ethics Committee of University of Health Sciences, Van Training and Research Hospital, Van, Türkiye (date: July 5, 2023; number: 2023/14-01).

**Informed Consent:** Written informed consent was obtained from all patients who participated in this study.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept – D.A.; Design – D.A., A.A.; Supervision – D.A., A.A., F.A.; Resources – M.C.; Materials – M.C.; Data Collection and/or Processing – D.A.; Analysis and/or Interpretation – A.A.; Literature Search – F.A.; Writing Manuscript – A.A.; Critical Review – D.A.; Other – M.A.

**Declaration of Interests:** The authors have no conflict of interest to declare.

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