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The comparison of single plate and double plate fixation methods for treatment of humeral shaft non-union

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Abstract

Introduction: Humerus shaft fractures may be treated conservatively or surgically. In 2.5% to 13% of cases, non-union is observed, and it leads to severe pain and morbidity. Plate osteosynthesis has become popular in the treatment of non-union of the humeral shaft. In this study, we compared the clinical outcomes of patients with humerus shaft non-union whom we treated with single- or double-plate fixation.

Materials and Methods: Fifty-three patients diagnosed with aseptic humeral shaft non-union and treated with plate fixation were included in the study. Patients were evaluated according to the number of plates (single vs. double plates). The two groups were subjected to statistical evaluation according to their clinical and radiographical results.

Results: The average age of the patients was 53 years (range: 1-86); 28 (52.8%) were female and 25 (47.2%) were male. The union rate was 90.32% for single plate and 90.91% for double plate fixation. There was no statistically significant difference between single and double plates in the clinical and radiographical results (union time, union rate, Q-DASH score) ($p > 0.05$).

Conclusion: There was no statistically significant difference in terms of time to union and union rates between single plate and double plate fixations for surgical treatment of humeral shaft nonunions. However, superior clinical results were obtained in the early recovery phase of shoulder and elbow functions with double plate fixation.

Keywords: Double plate, humerus shaft fracture, nonunion, single plate.

Introduction

There are several conservative and surgical methods in the treatment of humerus shaft fractures. Although it is possible to achieve good results in the majority of fractures with conservative methods, rates of pseudo arthrosis of 8 to 12% in humerus shaft fractures have been reported in the literature, and nonunion rates are higher particularly in patients with proximal shaft fracture and butterfly fragment [2].

Despite all options, the union rate is 82 to 95%. Probable reasons for surgical failure are inadequate fixation, devitalization of bone fragments, infection, osteopenia, and bone defects [5, 6]. In the nonunion of humerus shaft fractures, morbidity is frequently associated with shoulder and elbow joint stiffness, pain, and weakness. For a functional upper extremity, it is important that union within acceptable limits is provided [6].

In this study, we compared demographic data of the patients with humeral shaft nonunion who were treated surgically. We also wanted to evaluate the union rates for humeral shaft nonunion with single or double plates. The aim of this study, was to evaluate the need for an additional plate and advantages or disadvantages of a second plate for humerus shaft nonunions.

Patients and Methods

Patients who did not achieve union within six months with conservative or surgical methods and who were followed for at least one year after surgery were included in the study. Pathological fractures, infected cases of nonunion, type 3b or 3c open fractures, patients whose skeletal maturity was not yet complete, and patients with intraarticular extension fractures were excluded from the study.

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Clinical evaluation of the patients was performed according to the Quick DASH (Disabilities of Arm, Shoulder, and Hand) (Q-DASH) score. Bone union was evaluated radiologically with bone callus formation and bone bridges in at least three cortices and clinically regression of pain in the fracture site.

This examination identified 57 patients who had plate osteosynthesis due to nonunion of humeral shaft fractures. Four patients were excluded from the study because their radiological and clinical records were incomplete. Thus, 53 patients were included in the study. The surgeries were performed with a single plate for 31 patients and with double plates for 22 patients.



Fig 1: A-B): X ray of a 50-year-old female patient with left humerus fracture non-union. C-D): Grafting and fixation with a single plate in treatment of nonunion



Fig 2: A-B) x ray of 45-year-old male patient with right humerus non-union, C) computed tomography of non-union, D-E) Grafting and fixation with a dual plate in treatment of nonunion

The fracture site of the patients was proximal in 9 cases, middle in 30 cases, and the distal shaft in 14 cases. Seven patients had hypertrophic and 46 patients had atrophic nonunion. Nonunion developed in 14 patients after conservative treatment, in 34 patients who had one surgery (plate in 18 cases, intramedullary nailing in 12 cases and external fixator in 4 cases), and in five patients who had multiple surgeries. The average time from the fracture to the last surgery was 19.49 months (range: 6-108).

For single-plate fixation, narrow plates and screws with 4.5 mm diameter were used. Plates were applied through a lateral incision to the anterolateral aspect of the bone. In double-plate fixation, plates of 3.5 mm were applied to the anterolateral and lateral sides with a lateral incision. An iliac crest autograft was applied in both groups. The radial nerve was exposed in all patients and interposed in the soft tissue at the end of the surgery.

Results

The mean age of all patients was 53.09 (Range: 21-86) years, and 52.8% (N=28) of the patients were female while 47.2% (N=25) were male. In 45.3% (N=24) of the patients, nonunion was present in the right humerus and in 54.7% (N=24) nonunion had occurred in the left.

When patients treated with single plates and double plates were compared, there was no statistically significant difference between the mean ages of the two groups according to the Mann-Whitney U test ($P=0.162$, $p>0.05$). There was no significant difference between gender and side distribution between the two groups according to Pearson's chi-square test ($P=0.442$ and $P=0.561$, $p>0.05$).

Discussion

Today, the refreshing of fracture ends, plate fixation, and bone grafting have become gold standards in the treatment of nonunion of the humeral shaft. Fixation with a plate and at least 7 screws with 4.0-4.5 mm diameter is advised, providing both biomechanically stable fixation and good compression. The reason for this is that the most important cause of surgical failure in humeral shaft nonunion is inadequate fixation.

In a biomechanical study, the humerus was fixed in four different ways: 1) a single plate, 2) a single plate and an additional interfragmentary screw, 3) double plates, and 4) double plates and an additional interfragmentary screw. The most stable fixation was found in the 4th group. However, it was observed that there was no stability difference between the 1st and 3rd groups.

Age is also an important factor in long-bone nonunion treatment. The complication rate is expected to be high in these patients due to both bone quality deterioration and concomitant diseases. Therefore, applying two plates may provide better stabilization in cases of nonunion in the elderly or osteoporotic patients. In a biomechanical study, one plate with 8 holes was applied to the lateral aspect of the humerus and one plate with a different number of screws was applied to the anterior one. The authors suggested a combination of 8-4 screws in young patients and 8-8 in elderly osteoporotic patients. In two clinical studies focusing on elderly and osteoporotic humeral shaft nonunion, the union rates of the patients were found to be over 90%. Nonunion treatments were mostly performed with a single plate, but special plates (blade plates, wave plates) and double plates were also applied. In both studies, it was stated that the results were good when more stable fixation was obtained in osteoporotic and elderly patients.

There are also studies suggesting strengthening the bone and increasing stability. Those researchers aimed at increasing the stability of the bone quality by extramedullary or intramedullary strut grafts and were generally successful.

The limitations of our study are its retrospective design and the relatively small number of patients. Prospective randomized studies on the treatment of humeral nonunion should be conducted with higher numbers of patients. On the other hand, at the literature most of the studies on humeral shaft nonunions are case series. In our study two different methods of plate fixation is compared statistically.

Conclusion

Although humerus diphyseal nonunion is still a severe problem, it is possible to obtain good functional results with the application of double plating and single plating in the treatment of humerus shaft fracture nonunion. In our study,

there was no statistically significant difference in terms of time to union and union rates between single plate and double plate fixations for the surgical treatment of humeral shaft nonunions. However, superior clinical results were obtained in the early recovery phase of shoulder and elbow functions with double plate fixation.

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