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COMPARISON OF TWO SURGICAL METHODS FOR THE MANAGEMENT OF MID–DISTAL HUMERUS FRACTURES NOT INVOLVING THE JOINT

(PLATE–SCREW OSTEOSYNTHESIS WITH ELASTIC NAIL-SUPPORTED EXTERNAL FIXATOR APPLICATION)

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Abstract

Aim: The open reduction-plate method is frequently used in the surgical treatment of mid-distal humeral fractures. However, the radial nerve is always a major problem. In our study, we tried to present a surgical procedure that would eliminate this problem. For this reason, patients who were operated on for humeral mid-distal fractures in our hospital were investigated.

Methods: We compared the elastic nail-supported external fixator after closed reduction with plate-screw osteosynthesis after open reduction. Group 1 (16) was divided into elastic nail supported external fixator, Group 2 (39) plate screw osteosynthesis. Groups were analyzed retrospectively.

Results: While there was no delayed union and no neurological complications in group 1, three patients in group 2 had pseudoarthrosis and two patients had iatrogenic radial nerve deficit.

Conclusions: There was no significant difference in union times and complication rates. However, in the method we defined; operative time, length of hospital stay were statistically significantly lower. We have also demonstrated further advantages of the technique we have described. These; protection of fracture hematoma, no incision scar, no plaster fixation, early rehabilitation, ease of removal of implants. Its disadvantage is that the fixator stays on the patient for about three months. We think that the method will become widespread when the advantages and disadvantages of this technique are evaluated by surgeons. A monolateral external fixator supported by an elastic nail can be used safely, successfully, and easily for the treatment of mid–distal humerus fractures that do not involve the joint.

Keywords: *Humerus fracture, osteosynthesis, fixator application, plate-screw, radial nerve*

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Introduction

Mid-distal humerus fractures constitute 1-7% of fractures in the body[1–3]. It is usually treated with plate. In the distal humerus, neurovascular structures are located very close to the bone. Due to this, successful distal humerus fracture operation necessitates extensive surgical experience and meticulous effort[4] .

In the operation, locating and gently retracting the radial nerve is the most critical stage in the exploration before reduction. In addition to the prolonged duration of the surgery, up to 7% of iatrogenic radial nerve injury occurs at this stage[5,6] .

In our clinic, we treat humerus mid–distal fractures with open reduction and plating, but we also treat some eligible patients with elastic nail-supported external fixation after closed reduction. This method has several advantages, including avoiding the drainage of the fracture hematoma, avoiding radial nerve exploration, and reducing the duration of the surgery. The goal of this study was to scan patients with distal humerus fractures that did not involve the joint and compare the results of these two methods.

Materials and Methods

After receiving approval from the ethics committee (Reference No. 1556, Date: September 16, 2021), patients who were admitted to our hospital's emergency department with a diagnosis of humerus fracture and were operated in our clinic between January 1, 2018, and June 1, 2021 were retrospectively screened. The study comprised patients aged 18 to 70 years who presented to the emergency department with fractures of the middle 1/3 of the humerus and the distal end that did not involve the joint and required radial nerve exploration during the surgery. The study excluded those with a follow-up period of fewer than six months, preoperative radial deficits, pathological fractures, and open fractures.

Patient files were retrospectively reviewed. Patients' age, gender, smoking, AO/OTA classification of fractures, preoperative duration, duration of surgery, length of hospital stay, the operational method used, and time to union, need for rehabilitation, preoperative and postoperative elbow AP/lateral X-rays, and Mayo elbow performance scores were documented**.** [7] Missing data was obtained by contacting the patients over the phone.

Patients who underwent osteosynthesis with an elastic nail-supported external fixator after closed reduction were included in group 1. The patients who underwent plate osteosynthesis with open reduction internal fixation and lateral incision were included in group 2. All patients underwent the surgical procedure under general anesthesia in the supine position.

In group 1, the humeral fracture was treated with antegrade technique with two 2mm schanz The reduction was checked with fluoroscopy. Then, a monolateral external fixator was applied using four schanz from proximal and distal. The distal schanz was applied around the fossa olecranon. Therefore, it did not affect the elbow movement. After that, the carbon fixator was fixed by manual compression. Splint fixation was not performed. Active exercises were initiated on the first postoperative day. Depending on the union, the implants were determined to be removed after 3 months. Only the fixator of patients whose elastic nail was not clearly palpable was removed in the outpatient clinic. All implants of patients with prominent elastic nails were removed under anesthesia. Patients with elbow motion restriction at the end of the six-week period were referred for physiotherapy. Postoperative X-rays were evaluated on the 1st day, 3rd week, 6th week, and 3rd and 6th month follow-ups.

In group 2, the surgical site was painted and covered appropriately. The surgery was initiated by entering through an incision lateral to the upper arm fracture line. Palpation was used to locate the radial nerve after the fascia was sharpened and the muscles were separated with blunt dissection. The radial nerve was displaced using a Penrose drain after

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careful exploration. The operation was completed with the plate-screw technique from the fracture lateral. It was followed with splinting for three weeks.
At the end of the third week, elbow exercises were initiated. Patients with elbow motion restriction at the end of the six-week period were referred for physiotherapy.

Statistical analysis

The data was statistically analyzed using the SPSS 23.0 package software. Continuous measurements were summarized as mean, standard deviation, and minimum–maximum, whereas categorical measurements were presented as numbers and percentages. The Shapiro–Wilk test was used to check for normal distribution conformity. The categorical variables were compared using the Chi-square and Fischer tests. In groups with normal distribution, the independent Student's t-test was used, whereas in groups without normal distribution, the Mann–Whitney U test was used. In all the tests, the level of statistical significance was $p<0.05$.

Table 1. AO/OTA fracture classification, gender, age, smoking status, preoperative duration, duration of operation, length of hospital stays, time to union, presence of iatrogenic radial nerve deficit, and Mayo Elbow Performance Scores across both the groups.

		Group 1 (n=18) n(%)	Group 2 (n=39) n(%)	Total (n=55) n(%)	p
Gender [c]	Man	11 (68.8)	28 (71.8)	39 (70.9)	0.532
	Woman	5 (31.2)	11 (28.2)	16 (29.1)	
AO Class [c]	12 A1	-	1 (2.6)	1 (1.8)	0.363
	12 A2	9 (56.3)	19 (48.7)	28 (50.9)	
	12 A3	5 (31.3)	18 (46.2)	23 (41.8)	
	13 A3	2 (12.4)	1 (2.6)	3 (5.5)	
Side [c]	Right	12 (75)	26 (66.7)	38 (69.1)	0.544
	Left	4 (25)	13 (33.3)	17 (30.9)	
Need for rehabilitation [c]	No	8 (50)	13 (33.3)	21 (38.2)	0.248
	Yes	8 (50)	26 (66.7)	34 61.8	
MAYO[c]	Good		5 (12.8)	5 (9.1)	0.133
	Excellent	16 (100)	34 (87.2)	50 (90.9)	
Smoking [c]	No	8 (50)	25 (64.1)	33 (60.0)	0.332
	Yes	8 (50)	14 (35.9)	22 (40.0)	
Radial Deficit [c]	No	16 (100)	37 (94.9)	53 (96.4)	0.356
	Yes		2 (5.1)	2 (3.6)	
Age [a]		44.0±8.7	42.3±13.7	42.8±12.5	0.641
Preoperative duration [b]		6 (4-24)	5 (4-24)	6 (4-24)	0.552
Duration of operation [b]		30 (25-38)	70 (60-90)	65 (25-90)	0.001
Length of hospital stay [b]		1 (1-2)	1 (1-3)	1 (1-3)	0.027
Time to union [b]		95 (90-100)	95 (90-420)	95 (90-420)	0.361

* $p<0.05$, ** $p<0.001$, [a]Independent student t-test (mean, standard deviation), [b]Mann–Whitney U test (med–min–max), [c]Chi-square and Fisher's exact tests

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Results

The study comprised 55 patients who were treated in our clinic between January 2018 and January 2021 for middle and distal 1/3 humerus fractures that did not involve the joint. Osteosynthesis was successful in 39 of the 55 patients (39 males, 16 females) in the study using a plate–screw and in 16 using an elastic nail-supported external fixator. The mean age of the patients was 42.8±12.5 years. (Group 1: 44.0±8.7, group 2: 42.3±13.7)

After being admitted to our hospital, the patients underwent an operation an average of 6 hours (4–24) later (group 1: 6, group 2: 5). In group 1, the operation took 30 minutes (25–38) whereas in group 2, it took 70 minutes (60–90). The patients were discharged in one day. (Group 1: 1 (1–2) group 2: 1 (1–3)). Group 1 began active movements on the first postoperative day, whereas group 2 began elbow movements at the end of the third postoperative week. The patients were followed for a period of six months. The time to union was 95 days in groups 1 as well as 2 (90–100, 90-120, respectively).

Two patients in group 1 developed a pin-site infection, whereas one patient in group 2 had a local wound infection; all three patients were treated with oral antibiotics. While group 1 had no postoperative neurological deficits, group 2 had two patients with postoperative neurological deficits (radial nerve). Although there was no delay in the union in group 1, three patients in group 2 experienced pseudoarthrosis. The fractures of two of the three patients fused following autografting and plating. In the third operation the other patient required osteosynthesis with an acute shortening double plate. The mean flexion values in groups 1 and 2 were as follows when the elbow range of motion was assessed at the final follow-ups: 136° (115–145) in group 1 and 138° (115–145) in group 2. There was no loss of extension in both the groups. The Mayo elbow performance scoring system findings were as follows: excellent results in 16 patients (100%) in group 1, and good results in 5 patients (12.8%) and excellent results in 34 patients (87.2%) in group 2. The mean duration of operation ($p<0.001$) and length of hospital stay ($p=0.027$) of the patients in group 2 were higher than the mean values of the patients in group 1 ($p<0.05$). There was no significant difference between the two groups in other parameters.

The overall comparison is presented in Table 1. Preoperative, postoperative 1. day, 45. day, 3. month and 6. month x-rays are given in figure 1-5.

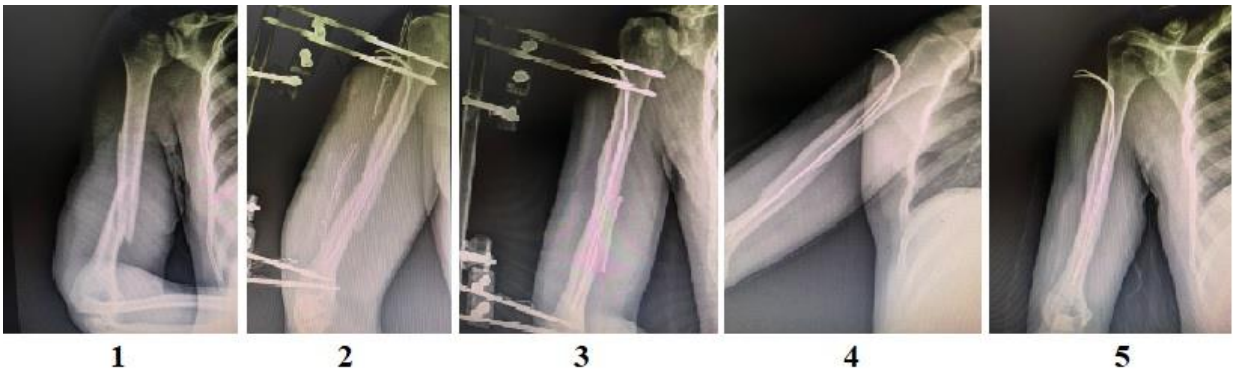

Figure 1-5.
1: preoperative X-ray,
2: postoperative X-ray,
3: postoperative 45. day X-ray,
4: postoperative 3. month X-ray,
5: postoperative 6. month X-ray.

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Discussion

The radial nerve is the most important structure that comes to mind when distal humerus fractures are addressed. The radial nerve is very close to the bone, 8-10 cm proximal to the lateral epicondyle[8]. As a result, radial nerve injury in mid–distal humerus fractures may occur during the accident, reduction, or intraoperative exploration[9].

Conservative treatment and operation are the two approaches for distal humerus fractures that do not involve the joint.

Some authors claim that conservative treatment is as good as surgical treatment in humerus fractures[10-12].

Cebesoy et al[13] evaluated the results of conservative treatment in humeral fractures.

10% radial nerve deficit, 15% patients underwent revision with plate. In terms of not using a cast, a small incision, a short operation time, and no implants at the end of the treatment, we consider our technique to be a useful alternative to conservative treatment.

Implant plate–screw systems, on the other hand, are the most widely followed techniques today. In plate–screw osteosynthesis, open or closed reduction procedures, such as Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO), are used[14,15].

An incision long enough to allow the plate to be placed and gentle radial nerve exploration are necessary in the open reduction internal fixation approach for distal humerus fractures. Radial nerve exploration is a nightmare for surgeons who are just starting out in their careers, as it can be dangerous even when the nerve is retracted.

In 2014, Huri et al[15] reported the results of MIPPO treatment of 14 patients with humerus mid-shaft fractures. They encountered iatrogenic radial nerve palsy in one patient. They indicated that conditions such as poor neurovascular monitoring, prolonged fluoroscopy time, difficulty in maintaining the reduction, and anatomical obstacles encountered during the placement of the plate make this method difficult. Although our technique involves a closed reduction, fluoroscopy is not needed as much as it is in MIPPO. Furthermore, because the internal fixation elastic nail is inserted intramedullary and the external fixator is placed in anatomically safe areas, no neurovascular structures, including the radial nerve, are harmed. The application of the external fixator is made easier by the fact that the reduction is unlikely to slip after being fixed with the elastic nail.

A long arm splint is applied when a distal humeral fracture is treated with a plate-screw system. and the pain produced by the wound delays rehabilitation. Movement-related and functional limitations may emerge as a result of the inability to perform mobilization and essential rehabilitation early[4].When the two groups were compared in terms of rehabilitation need, there was no significant difference observed; however, when the two groups were examined proportionally, group 2 had a higher rate of a need for rehabilitation. We believe that active movement on the first postoperative day decreases the need for physical therapy following our technique.

Postoperative elbow and shoulder movements of the patient are shown in figure 6-8.

In 21 patients with humerus fractures treated with locking nails, McCormack et al16 reported two cases of nonunion. The high rate of nonunion is due to insufficient compression. Compression from weight bearing is the key to intramedullary nailing success in the lower extremity. The fracture line does not receive appropriate postoperative, compression as the upper extremity does not bear weight. The weight of the arm, on the other hand, tends to separate the fracture line. During the locking phase of the fixator, however, we were able to perform significant manual compression in our study. A movable rod can be inserted between the Schanzes if desired, and compression–distraction as in the Ilizarov system can be performed. We believe that the compression–distraction method could be beneficial, particularly in cases of pseudoarthrosis in which plate has been tried multiple times. There have been several studies on the use of the Ilizarov external fixator in humerus open fractures and non-unions [17].

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6 7 8

Figure 6-8.
6: 15th day elbow flexion photo,
7: 15th day elbow extension photo,
8: 15th day shoulder flexion photo.

Moreover, it is obvious that the application of the Ilizarov technique in humerus fractures is much more difficult than the application of monolateral fixation.

We provided stability by applying the Schanzes as far away from the fracture line as possible in this technique. Rehabilitation can begin on the first postoperative day because there is no need for a long arm splint, which is typically used for 20 days postoperatively in the plate–screw system. From the first week, the majority of the patients began to eat with their hands.

The disadvantage of our method is that it requires patients to live with an external fixator for up to three months. However, the significant reduction in surgical time, the fact that the learning curve is not as steep as that with the plate–screw system, the fact that there is no risk of radial nerve injury during the operation and removal of the implants, and the technical ease with which the patient and surgeon can remove the implants make this technique advantageous.

Upadhyay et al[18] found implant-associated impingement in 8% and stiffness in 4% of patients in their study on elastic nail application in humerus diaphysis fractures. There were no problems in terms of fracture union in the patients. The time to union was, however, increased to 32 weeks. Because the elastic nail insertion site was far from the shoulder joint in the technique we described, shoulder complications were not detected. Furthermore, we believe that the prolongation of the time to union is related to the distraction caused by the arm's weight. We did not experience any delays in union because we used an external fixator to achieve compression.

There was no significant difference between the two groups, except for the length of hospital stay and operation time. However, although there was no significant difference, patients with radial deficits increased the mean length of stay, and pseudoarthroses increased the mean time to union. These increases could not be demonstrated statistically because the median value was considered, not the mean, due to the uneven distribution.

Closed surgery reduces the duration of surgery and the amount of blood loss. Therefore,

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it is safer than the plate-screw system in patients with poor general condition.
Our study's limitation is lack of equality in the number and distribution of patients in the two groups. By increasing the sample size and narrowing the age range, this issue can be better elucidated.

Conclusion

A monolateral external fixator supported by an elastic nail can be used safely, successfully, and easily for the treatment of mid–distal humerus fractures that do not involve the joint.

Conflict of interest
The author declare that they have no conflict of interest.

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Author declared no financial support.

Ethical approval
Adana City Training & Research Hospital Ethical Committee approved the research protocol.

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