

Effectiveness and Short Term Functional Results of Surgical Treatment with Locking Plate in Proximal Humerus Fractures

Proksimal Humerus Kırıklarında Kilitli Plak ile Cerrahi Tedavinin Etkinliđi ve Kısa Dönem Fonksiyonel Sonuçları

Özgün Arařtırma
Research Article

Tolgahan Kuru , Onur Yılmaz 

ABSTRACT

Objective: In this study, we aimed to investigate postoperative short term outcomes, union status, early and late complications and the relationship between them in patients treated with plate osteosynthesis due to proximal humerus fractures in our hospital.

Method: A total of 34 patients aged between 18-92 years were included in the study. Patients' demographic data as age, gender, and also fracture pattern, time from hospitalization to the surgery, time from surgery to discharge and comorbidities were recorded and evaluated.

Results: The mean duration of hospitalization was found as 3.4±1.7 days. There was no significant difference between the patients with and without comorbidity in terms of the mean duration of hospitalization. There was no significant difference between the patients with and without complications in terms of the mean time from hospitalization to the surgery. According to Neer classification, postoperative late complications occurred in 40%, 29.4%, and 8.3% of Neer Type 4,3, and 2 fractures, respectively.

Conclusion: Internal fixation with locking plate seems a reliable option in the treatment of proximal humerus fractures, especially in osteoporotic bones and Neer Type 2 fractures.

Keywords: Proximal humerus fracture, displaced fracture, Neer classification system, locking plate fixation

Öz

Amaç: Bu çalışmada, hastanemizde proksimal humerus kırıkları nedeniyle plak osteosentez uygulanan hastalarda postoperatif yakın dönem sonuçları, kaynama durumunu, postoperatif komplikasyonları ve bunlar arasındaki ilişkiyi arařtırmayı amaçladık.

Yöntem: Çalışmaya 18-92 yaş arası 17'si kadın ve 17'si erkek olmak üzere toplam 34 hasta dahil edilmiştir. Hastaların yaş ve cinsiyet gibi demografik verileri, kırık oluşma paterni, hastaneye yatış ile cerrahi arasında geçen süre, cerrahi ile taburculuđa kadar geçen süre, hastanede yatış süresi ve ek hastalıkları kaydedilmiştir.

Bulgular: Hastaların ortalama hastanede yatış süresi 3,4±1,7 gün olarak bulunmuştur. Ortalama hastanede kalış süresi açısından komorbiditesi bulunan ve bulunmayan hastalar arasında anlamlı bir fark bulunmamıştır. Geç komplikasyon görülen hastalar ile komplikasyon görülmeyen hastalar arasında operasyona kadar geçen ortalama süre açısından istatistiksel olarak anlamlı fark saptanmamıştır. Neer Tip 4 kırıkların %40'unda, Neer Tip 3 kırıkların %29,4'ünde ve Neer Tip 2 kırıkların %8,3'ünde postoperatif geç komplikasyon oluştuđu saptanmıştır.

Sonuç: Kilitli plak ile internal fiksasyon, başta osteoporotik kemikler ve Neer Tip 2 kırıklar olmak üzere proksimal humerus kırıklarının cerrahi tedavisinde güvenilir bir seçenek olarak görünmektedir.

Anahtar kelimeler: Proksimal humerus kırığı, deplase kırık, Neer sınıflandırma sistemi, kilitli plak fiksasyonu

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Tolgahan Kuru

Çanakkale Onsekiz Mart
Üniversitesi Tıp Fakültesi,
Ortopedi ve Travmatoloji
Anabilim Dalı,

Çanakkale - Türkiye

✉ mdtolgahankuru@gmail.com

ORCID: 0000-0003-1245-6390

O. Yılmaz 0000-0001-7515-0300

Çanakkale Onsekiz Mart
Üniversitesi Tıp Fakültesi,
Ortopedi ve Travmatoloji
Anabilim Dalı,
Çanakkale, Türkiye

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INTRODUCTION

Proximal humerus fractures account for about 5% of all fractures and are the third most common type of fractures in elderly patients ⁽¹⁾. More than 70% of the patients with these fractures are over 60 years old and 75% of them are women ⁽²⁾. Most of these fractures are associated with osteoporosis in geriatric population. According to the data in the literature, the annual incidence of proximal humerus fractures is 70/100000 in the general population, but this rate raises up to 400/100000 in women aged over 70 years ⁽³⁾. Eighty percent of these fractures are caused by simple falling ⁽⁴⁾. Whereas these types are more commonly associated with high-energy traumas in younger patients. The risk factors of proximal humerus fractures include low bone density, personal history of fracture, low physical activity level, poor vision, insulin-dependent diabetes and alcohol consumption. Possible risk factors that have been suggested in association with falling are the use of drugs for the treatment of epilepsy and similar diseases, depression, the use of hearing aid and left handedness ⁽⁵⁾.

The goal of the treatment of proximal humerus fractures is restoration of a painless shoulder with a satisfying functional result. Non-displaced fractures and those with minimal displacement and sufficient stability are usually successfully treated with non-operative methods ⁽⁶⁾. These non-displaced or minimally displaced fractures account for 80% of proximal humerus fractures. On the other hand, the management of displaced and unstable fractures remains controversial.

There are a wide spectrum of fixation methods used in surgical treatment of proximal humerus fractures. Among these, the most commonly used methods are tension band wiring, modified tension band wiring with Enders nails, closed reduction and percutaneous pinning, and open reduction internal fixation techniques with various plaque-screw constructs.

In plaque method, T plaques, blade plaques and relatively newer locking proximal humerus plaques are used. In the literature, indications and contraindications of all these methods are still controversial ⁽⁷⁾.

The objective of this study was to investigate postoperative short-term outcomes, union status, functional results, early and late postoperative complications and the relationship between these in patients who underwent plaque osteosynthesis due to proximal humerus fractures in our hospital.

MATERIAL and METHOD

Epicrisis reports and X-ray images of patients treated with locking plate method due to proximal humerus fractures in the orthopedics and traumatology clinic of our hospital between January 2016 and December 2018 were retrospectively screened and recorded from the hospital records. Patients aged 18-92 years with displaced 2, 3, and 4-segment fractures who underwent locking plate fixation were included in this study. Non-displaced fractures, open fractures and pathologic fractures were excluded from the study.

After retrospective examination, data of 72 patients were accessed. Twenty-seven patients because of conservative follow-up, nine patients who underwent a different surgical method and two patients with missing data were not included in our study; and finally our study was conducted with evaluation of 34 patients. X-ray images of the patients were examined and classified according to the Neer classification system.

Patients' demographic data such as age and gender, mechanism of fracture, time from hospitalization to surgery, time from surgery to discharge, duration of hospitalization and comorbidities were recorded. In addition, duration of patients' postoperative outpatient clinic follow-up, postoperative 3rd month Constant-Murley shoulder scores, postoperative union status, complications that occurred during

treatment, and postoperative complications were also recorded. In this study, the fractures were divided into groups according to the Neer classification system and evaluated in terms of short-term operation outcomes and complications.

Neer Classification System

In 1970 Charles Neer described a 4-segment classification system⁽⁸⁾. In this classification system a segment is defined as displaced fracture if the fracture is displaced by more than 1 cm or angulation exceeds 45°C. There is no fragment that meets displacement criteria in Neer Type 1. As in our study non-displaced and minimally displaced fractures were excluded, there was not any patient with this type of fracture. In Neer Type 2 fractures, greater tuberosity, lesser tuberosity and articular segment are displaced at the level of anatomic neck or surgical neck. In Neer Type 3 fractures there is a 3-segment fracture. One of the tuberosities and surgical neck fracture are displaced, and the remaining tuberosity is attached and produces a rotational deformity. In Neer Type 4, all four segments (both tuberosities, articular surface and shaft) meet displacement criteria. This is a severe injury and carries a high risk of necrosis^(8,9).

Before the beginning of the study, necessary approval was received from the Clinic Research Ethics Committee of our university (decision date: 06/12/2019 and # 2019-12). The study was conducted in line with the principles of the Declaration of Helsinki.

Surgical Method

The patient was given semi-sitting position and the upper extremity of the fracture side was located, and prepared for the operation. Muscle fascias were opened by subcutaneous passage from anterior through a deltopectoral incision. The cephalic vein was dissected, and all humeral and fracture lines were exposed. Periosteal elevator was inserted between the capsule and subscapular layer, and dissection was achieved. The fracture was reduced with a

reduction clamp, height and position of the proximal humerus locking plate were controlled by scopy, and it was inserted at 2-3 mm posterior to the bicipital groove and 5-10 mm distal to the large tubercle leaving a sufficient distance between the plate and the long head of the biceps. After placement of the plate, 2 Kirschner wires were inserted through the holes in the proximal end of the plate. During insertion of these guide wires care was taken not to exceed the apex of the tuberculum majus and thus, the height of the plate was adjusted to prevent compression. Height and position of the plate were checked by scopy. Then the proximal humerus anatomic plate was fixed with a sufficient number of screws and the guide wires were removed. Following irritation and bleeding control, one hemovac drain was inserted and the layers were closed properly. After dressing, Velveau bandage was applied and the procedure was terminated.

Statistical Analysis:

Data obtained in the study were analyzed using SPSS v.22.0 (IBM Statistical Package for Social Sciences, SPSS INC, Chicago, IL, USA) package software. Normality of the data was tested using Kolmogorov-Smirnov test. Non-parametric tests were used for non-normally distributed variables. Categorical data were compared using chi-square and Fisher exact tests. Non-normally distributed continuous variables were analyzed with Kruskal-Wallis and Mann-Whitney U tests. Descriptive statistics were expressed as mean, standard deviation, interquartile range, minimum and maximum values. $p < 0.05$ values were considered statistically significant.

RESULTS

In this study, a total of 34 patients including 17 male and 17 female (M/F: 1/1) participants who received treatment with locking plate due to proximal humerus fracture in the orthopedics and traumatology clinic of our hospital between January 2016 and December 2018 were evaluated. The mean age of

the patients was 61.5 ± 17.1 (min-max: 18-92) years. The mean duration of hospitalization was found as 3.4 ± 1.7 (min-max: 1-8) days. The mean duration of hospitalization was 3.7 days in patients with comorbidity (-ies) and 2.6 days in the patients without , although the intergroup difference was not statistically significant ($p=0.138$).

The mean time from hospitalization to surgery was found as 2.9 ± 2 days. The mean time to operation was found as 2.6 ± 0.5 days in the patients without late complications and 4 ± 1.5 days in the patients with late complications. No statistically significant difference was found between the patients with and without late complications in terms of the mean time to operation ($p=0.132$).

The mean time from hospitalization to surgery was found as 1.8 ± 0.6 days in patients without comorbidity and 3.3 ± 0.7 days in patients with comorbidity. No statistically significant difference was found between both groups in terms of the mean time to operation ($p=0.126$).

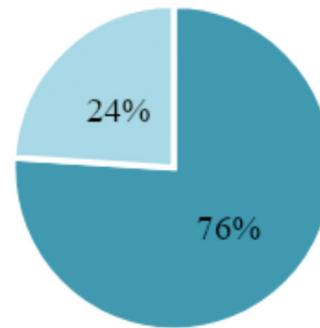
The mean time from surgery to discharge was 1.8 ± 1.2 (min-max: 1-6) days. No statistically significant difference was found between the patients with and without comorbidity in terms of the mean time from surgery to discharge ($p=0.6$).

The patients were in age groups of 20-40 ($n=4$: 11.7%), 41-60 ($n=9$: 26.5%), and >60 years ($n=21$: 61.8%). When the patients were evaluated according to the Neer classification; Neer Type 2 ($n=12$: 5.3%), 3 ($n=17$: 50%), and 4 ($n=5$: 14.7%) fractures were found in respective number of patients. All patients evaluated as having Neer Type 4 fractures were in >60 years age group. There was no correlation between age groups and Neer classes of the patients (Table 1). No statistically significant difference was found between Neer groups in terms of the time to discharge. Distribution of the patients according to the trauma mechanisms is given in Figure 1.

Table 1. Distribution of Neer fracture types according to age groups.

Age group	Neer Type 2	Neer Type 3	Neer Type 4	Total
20-40	3	1	0	4 (11.7%)
41-60	2	7	0	9 (26.5%)
>60	7	9	5	21 (61.8%)
Total	12	17	5	34 (100.0%)

Mechanisms of Trauma



■ Falling ■ Traffic accident

Figure 1. Distribution of the patients according to the mechanisms of trauma.

According to the Constant-Murley scoring of disabilities functional state proximal humerus of the patients were evaluated as very good in 5, good in 14, moderate in 11, and poor in 4 patients. There was a statistically significant difference between Neer types of fractures in terms of Constant-Murley scores ($p=0.026$). Constant-Murley scores were significantly higher in Neer Type 2 fractures (Table 2).

Table 2. Distribution of Constant-Murley scores according to Neer fracture types.

Neer Types	Constant Murley Scores			
	85-100 (Very good)	76-85 (Good)	56-70 (Moderate)	<56 (Poor)
Type 2	3 (8.8%)	8 (23.5%)	1 (2.9%)	0 (0%)
Type 3	2 (5.9%)	6 (17.6%)	7 (20.6%)	2 (5.9%)
Type 4	0 (0%)	0 (0%)	3 (8.8%)	2 (5.9%)
Total	5 (14.7%)	14 (41.2%)	11 (32.4%)	4 (11.8%)

Regarding union status of fractures complete union was found in 26 (76.5%), malunion in 6 (17.6%) and avascular necrosis (AVN) in 2 (5.9%) fractures. When

postoperative late complications were evaluated, 26 patients did not develop late complications, while malunion developed in 2, AVN in 2, arthrosis in 1, distal plate fracture in 1, and varus collapse in 2 patients. When patients who developed complications were examined according to Neer types; postoperative late complications were found in indicated percentages of patients with Neer Type 4 (40%) 3 (29.4%), and 2 (8.3%) fractures. No significant correlation was found between the fracture types and late complications ($p=0.21$) (Table 3).

Table 3. Distribution of postoperative late complications according to Neer fracture types.

Neer Types	Postoperative Late Complications					
	No	Malunion	AVN	Arthrosis	Distal Fracture	Varus Collapse
Type 2	11 (32.4%)	0	0	0	1 (2.9%)	0
Type 3	12 (35.3%)	1 (2.9%)	2 (5.9%)	1 (2.9%)	0	1 (2.9%)
Type 4	3 (8.8%)	1 (2.9%)	0	0	0	1 (2.9%)
Total	26 (76.5%)	2 (5.9%)	2 (5.9%)	1 (2.9%)	1 (2.9%)	2 (5.9%)

DISCUSSION

Although most of proximal humerus fractures can be treated with non-surgical methods, approximately 20% of these fractures are displaced fractures and dislocations and conservative treatment may not be possible for these fractures⁽¹⁰⁾. Unsatisfying results and complications have been reported in the treatment of displaced proximal humerus fractures with plates and screws⁽²⁾. There are clinical studies in the literature reporting good outcomes with locking plate method in proximal humerus fractures⁽¹¹⁻¹³⁾. Fixation of proximal humerus fractures with locking plate offers more advantages compared to many other implants, and it has been shown to be superior to unlocked plates⁽¹⁴⁾. These plates wrap the fracture well, have a low profile, enable insertion of multidirectional screws, and their reliability is higher in osteoporotic bones⁽¹⁵⁾. Locking plate systems have been developed in order to provide a higher resistance to implant failure and to combine rotational and angular stability⁽¹⁶⁾.

In our study, the mean age of the patients was found as 61.5 years. In the literature, studies conducted with the same technique reported the mean age of patients as 45-61 years^(17,18). The mean age of the patients in our study was consistent with those reported in the literature. Various results have been reported for the incidence of proximal humerus fractures in women and men. In a study by Singh et al.⁽¹⁹⁾ reporting the results of the fixation of proximal humerus fractures with locking plate, 60% of the patients were female and 40% were male⁽¹⁹⁾. In our study, this rate was 50% in both sexes. We think that this difference might be resulted from smaller number of patients (15 patients) in the mentioned study. The most common fracture type in our study was found as Type 3. Similar observations were reported by Koukakis et al.⁽¹¹⁾, Rose et al.⁽²⁰⁾, Siwach et al.⁽¹⁵⁾ and Frankhauser et al.⁽¹²⁾. On the other hand, the most common fracture type was reported as Type 2 by Singh et al.⁽¹⁹⁾.

As in other surgeries, locking plate is also associated with various complications. Clavert et al.⁽²¹⁾ reported screw cut, nonunion, malunion, AVN, secondary falls and osteonecrosis, and even dislocation in 3-and 4-segment fractures. However, the development of locking plates is ongoing and recent studies have reported promising results. Edwards et al.⁽²²⁾ reported that locking plate is highly superior over proximal humerus nailing in terms of both varus bending and torsional stability. In a study by Rohra et al.⁽²³⁾ reporting the results of locking plate method for proximal humerus plate, overall complication rate was indicated as 20 percent. In our study also overall complication rate was found as 23.5 percent. In the literature, acute infection has been reported as a complication, especially in patients with Type 3 and 4 fractures⁽¹⁷⁾. In our study, none of our patients developed infection. We think that this was associated with meticulous surgical techniques used in our study, and attention paid to spare soft tissues.

Previous studies have reported the incidence of AVN

between 4% and 75%⁽²⁴⁾. In our study, the incidence of AVN was found as 5.9%. This finding was consistent with the literature.

When the results of treatment in proximal humerus fractures was evaluated according Constant-Murley scores; the results were found as very good or good in 55.9% of the patients. Looking at the literature, very good or good results were obtained in 60% of the patients by Mariados et al.⁽¹³⁾, and in 47% by Moonot et al.⁽²⁵⁾.

In general, surgeons reported the results of locking plates for proximal humerus fractures as limited isolated case reports and in complex patient groups. We think that trauma surgeons who use this method should continue to report their findings in different patient groups. In our study, there was no significant correlation between Neer fracture types and postoperative complications. However, we could not find any study in the literature evaluating results and complications according to the Neer classification. Therefore, this finding of ours could not be compared with the literature.

This study has some limitations. First, our study has a retrospective design and included relatively small number of patients. In addition, no comparison could be performed between locking plate method and other techniques in the treatment of proximal humerus fractures. Furthermore, age range of our patients was wide. We could not compare data between patients aged <60 and ≥ 65 years.

Data on locking plate in proximal humerus fractures are limited in the literature, and the studies in general consist of case reports and case series. Therefore, we believe that our results will provide contribution to the existing results in the literature regarding the treatment of proximal humerus fractures.

In conclusion; indications for the techniques of open reduction internal fixation of proximal humerus have

been expanded with the introduction of locking plate technology. Internal fixation using locking plate seems a reliable option in the treatment of proximal humerus fractures, especially in osteoporotic bones and Neer Type 2 fractures. Postoperative results and complication rates we obtained in this study are satisfying. However, we think that further prospective and comparative studies with longer follow up results should be conducted on this subject.

Ethics Committee Approval: T.C. Çanakkale Onsekiz Mart University Rectorate Clinical Research Ethics Committee approval was obtained (12.06.2019-12).

Conflict of Interest: None.

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Informed Consent: As it was a retrospective study, informed consent was not obtained.

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