



The Role of Wrist Circumference (Regional Obesity Versus Local Swelling) in Conservatively Treated Distal Radius Fractures: A Single Center Experience

Konservatif Olarak Tedavi Edilen Distal Radius Kırıklarında El Bilek Çevresinin Rolü (Bölgesel Obeziteye Karşı Lokal Şişlik): Tek Merkez Deneyimi

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ABSTRACT

Aim: Regional obesity around the wrist due to local excessive fat or local swelling due to edema has not been studied as a risk factor to predict the possibility of reduction loss during conservative treatment of distal radius fractures. We aimed to investigate the impact of wrist circumference on reduction loss risk in conservatively treated distal radius fractures.

Material and Methods: Patients with distal radius fractures who were conservatively in our institution between January 2021 and December 2021 are retrospectively reviewed. Patients' demographics, wrist circumference, radiographic parameters were obtained from hospital registry notes. Wrist circumference was measured with an unstretchable tape positioned on a line passing from lister tubercle of the distal radius and distal ulna. The difference in the wrist circumferences between the injured and uninjured extremities represented local swelling. The association of these factors with reduction loss was evaluated.

Results: A total of 73 consecutive patients (19 male, 54 female) with a mean age of 61.1 ± 12.9 were included. There were 18 reduction losses. There was no association with reduction loss between injured and uninjured wrist circumferences ($p > 0.05$). However, local swelling, initial displacement at dorsal angulation and radial inclination, presence of dorsal comminution, and accompanying ulnar styloid fracture were associated with reduction loss ($p < 0.05$). Local swelling had an odd ratio of 6.661 (1.848 – 24.006, $p = 0.004$).

Conclusion: Excessive local swelling is found to be a risk factor to predict reduction loss in conservative treatment of distal radius fractures while regional obesity is not.

Keywords: Wrist circumference, regional obesity, local fat, distal radius fracture, redisplacement

ÖZ

Amaç: Distal radius kırıklarının konservatif tedavisi sırasında redüksiyon kaybı olasılığını öngörmek için lokal aşırı yağ dokusuna bağlı bölgesel obezite veya ödeme bağlı lokal şişlik araştırılmamıştır. Konservatif olarak tedavi edilen distal radius kırıklarında bilek çevresinin redüksiyon kaybı riski üzerindeki etkisini araştırmayı amaçladık.

Gereç ve Yöntemler: Ocak 2021-Aralık 2021 tarihleri arasında kliniğimizde konservatif olarak izlenen distal radius kırığı olan hastalar retrospektif olarak incelendi. Hastaların demografik bilgileri, bilek çevresi, radyografik parametreleri hastane kayıt notlarından elde edildi. Bilek çevresi, distal radius ve lister tüberkülü ve distal ulnadan geçen bir hat üzerinde konumlandırılan ve gerilemez bir bant ile



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ölçüldü. Kırık ve sağlam ekstremiteler arasındaki el bilek çevrelerindeki fark, lokal şişlik olarak tanımlandı. Bu faktörlerin redüksiyon kaybı ile ilişkisi değerlendirildi.

Bulgular: Yaş ortalaması 61.1 ± 12.9 olan toplam 73 ardışık hasta (19 erkek, 54 kadın) çalışmaya dahil edildi. 18 adet redüksiyon kaybı görüldü. Kırık ve sağlam el bilek çevresi ölçüleri ile redüksiyon kaybı ile ilişki yoktu ($p>0.05$). Ancak lokal şişlik, dorsal açılanma ve radyal eğimdeki ilk yer değiştirme, dorsal parçalanma varlığı ve eşlik eden ulnar stiloit kırığı; redüksiyon kaybı ile ilişkiliydi ($p<0.05$). Lokal şişliğin odd oranı 6,661 idi ($1,848 - 24,006$, $p= 0,004$).

Sonuç: Aşırı lokal şişlik, distal radius kırıklarının konservatif tedavisinde redüksiyon kaybını öngörmek için bir risk faktörü olarak bulunurken, bölgesel obezite bulunmamıştır.

Anahtar Sözcükler: El bilek çapı, Bölgesel obezite, Bölgesel yağlanma, Distal radius kırığı, Redüksiyon kaybı.

INTRODUCTION

Distal radius fractures are one of the most common injuries that occur on the upper extremity worldwide. Distal radius fractures account for around 17% of all adult fractures diagnosed (1). These injuries are reported to affect more than 85.000 individuals per year in the United States. Its incidence is rising in older adulthood due to prolonged life expectancy and accompanying osteoporosis in this elderly population (2).

Several treatment options exist in the treatment of distal radius fractures. Closed reduction and casting is the mainstay of conservative treatment. However, reduction loss in the cast is the major drawback of this treatment modality in addition to slow functional recovery due to prolonged immobilization (3). The incidence of reduction loss was reported up to 64% in the previous literature (4). Open reduction and internal fixation is also well-established treatment for these injuries. Volar plates are the most popular fixation devices in surgical treatment (5). Although good functional outcomes have been reported after both conservative and surgical treatments, the ideal treatment modality is still being debated (6).

Several anthropometric indicators such as wrist circumference, waist circumference, waist to hip ratio, and body mass index (BMI) have been described to determine obesity. Although BMI is the most common method for the determination of obesity, it cannot differentiate body fat distribution (7). In recent studies, wrist circumference has been shown to be a better indicator than BMI in terms of defining the fat distribution (8, 9).

Reduction loss during conservative treatment of distal radius fractures is a frequent issue. Therefore, predictive factors for reduction loss have been extensively studied in the literature (3, 10). Lafontaine et al. described the former criteria for fracture instability including initial dorsal angulation above 20 degrees, dorsal comminution, intraarticular fracture, accompanying ulnar fracture and age over 60. Any fracture posing three or more criteria are considered unstable (11). Several studies confirmed these criteria (12) while some did not (10). In addition to these criteria, obesity is identified as a risk factor as well (13). Although the correla-

tion of wrist circumference with obesity has been described (14), regional obesity around the wrist has not been studied yet as a risk factor for reduction loss. Furthermore, local swelling around the wrist is not an uncommon finding but is not quantified as a risk factor for reduction loss. Following these rationales, we hypothesized that wrist circumference in the contralateral extremity as a regional obesity marker and wrist circumference difference between the injured and contralateral extremity as a local swelling parameter could be a risk factor for reduction loss in the conservative treatment of distal radius fractures. The aim of this study is to investigate the impact of wrist circumference on reduction loss risk in distal radius fractures.

MATERIAL and METHODS

Patients who had distal radius fractures and were conservatively treated with closed reduction and casting in our institution between January 2021 and December 2021 are retrospectively reviewed. The protocol of the study was approved by the local ethics committee (2021/743). A written informed consent was obtained from each patient. The study was conducted in accordance with STROBE guidelines. Patients with neurovascular injury, open fractures, accompanying radius deformity, history of previous ipsilateral radius fractures, lost during follow-up, and aged below 18 were excluded.

Patients' demographics, BMI, and waist circumference was obtained from hospital registry records. Radiographic evaluation of the patients included fracture type according to AO (Arbeitsgemeinschaft für Osteosynthesefragen) classification, dorsal angulation and radial inclination of the fracture prior to closed reduction, presence of dorsal comminution and ulnar styloid fracture, cast index after closed reduction. Patients with excessive local swelling at the initial presentation were placed in a short arm splint to reduce swelling before close reduction and casting. The timing of the closed reduction was determined by the surgeon's preference.

AO classification was used to classify the distal radius fractures. AO classification groups extra-articular fractures as AO 23-A, partial articular fractures as AO 23-B, and complete articular fractures as AO 23-C (15).

Patients' wrist circumference of injured and uninjured extremities was recorded prior to closed reduction. Wrist circumference was measured with an unstretchable tape positioned on a line passing from the lister tubercle of the distal radius and distal ulna in a sitting position (14) (Figure 1). Local swelling was defined as the difference in the wrist circumference between the injured and uninjured extremities. Patients who had unacceptable reduction criteria ($>10^\circ$ dorsal angulation, radial shortening >3 mm, or intra-articular step-off) on weekly obtained radiographs were considered as loss of reduction (Figure 2). Patients' radiographs were obtained at 1st, 2nd, 3rd, and 6th weeks.

Descriptive statistics were expressed as mean and standard deviation (SD) for continuous numerical variables, cat-

egorical variables were expressed as number of patients and percentage. Distribution of variables was measured with the Kolmogorov-Smirnov test. Statistical analysis was performed with t-test to compare mean values. Categorical variables were compared with Pearson Chi-square test. A multiple logistic regression analysis was used to analyze relationship between risk factors and reduction loss. The results were considered statistically significant when the p-value was <0.05 .

RESULTS

A total of 73 consecutive patients (19 male, 54 female) with a mean age of 61.1 ± 12.9 were included in the study. During conservative treatment, 18 patients had reduction loss. Of these 18 reduction losses, 5 occurred in the first week while 13 occurred in the second week.

There was no statistical difference in age and gender, BMI, waist circumference, injured and uninjured wrist circumferences, cast index, or fracture type in patients who had reduction loss and whose reduction were maintained ($p>0.05$). However, local swelling was significantly higher in patients who had loss of reduction (2.1 ± 0.7 cm versus 1.2 ± 0.6 , $p<0.001$). Initial displacement of the fracture including dorsal angulation and radial inclination, presence of dorsal comminution, and ulnar styloid fracture were associated with loss of reduction ($p<0.05$) (Table 1). Logistic regression analysis revealed local swelling had an odd ratio of 6.661 (1.848 – 24.006, $p= 0.004$). (Table 2).

DISCUSSION

Reduction loss after conservative treatment of distal radius fractures is a frequent problem (10). Identification of risk factors for reduction loss helps orthopedic surgeons in managing this injury in a more optimal manner. For that reason, risk factors for loss of reduction after conservative



Figure 1: A) Measurement of wrist circumference on the injured and B) uninjured extremity.



Figure 2: A) Anteroposterior (AP) and B) lateral radiographs of a 61-year-old female patient with AO type 23-A distal radius fracture. After closed reduction, C) AP radiograph showed 20° of radial inclination and D) lateral view showed 8° of volar tilt. At 2nd week follow-up, there was a reduction loss on E) AP and F) lateral views with 14° of radial inclination, 5° of dorsal angulation, and 4 mm of radial shortening.

Table 1: Demographics, wrist circumferences, and radiographic parameters between reduction loss and reduction maintained groups.

	Reduction loss (n=18)	Reduction maintained (n=55)	p
Age (years), mean ± SD	64.8 ± 12.2	59.5 ± 13.2	0.140
Gender (M/F)	3/15	16/39	0.297
BMI (kg/m ²), mean ± SD	29.6 ± 5.8	29.1 ± 5.9	0.729
Waist circumference (cm), mean ± SD	102.5 ± 11.2	102.3 ± 12.6	0.959
Uninjured contralateral wrist circumference (cm), mean±SD	17.6 ± 1.4	17.8 ± 2.2	0.704
Injured wrist circumference (cm), mean ± SD	19.8 ± 1.7	19.0 ± 2.4	0.245
Local swelling (cm), mean ± SD	2.1 ± 0.7	1.2 ± 0.6	<0.001
Cast index, mean ± SD	76.7 ± 10.3%	79.2 ± 5.9%	0.214
Fracture type (AO classification)			0.321
AO 23-A	14	32	
AO 23-B	2	10	
AO 23-C	2	13	
Dorsal angulation, mean ± SD	22.3° ± 7.0°	13.0° ± 13.0°	0.009
Dorsal comminution	11/18	16/55	0.015
Radial inclination, mean ± SD	17.1° ± 4.1°	20.0° ± 3.7°	0.006
Ulnar styloid fracture	14/18	18/55	0.001
Intra-articular fracture	4/18	24/55	0.105

M: Male, **F:** Female, **BMI:** Body mass index

Table 2: Multivariate regression analysis for risk factor of reduction loss.

	Odds ratio (95% confidence interval)	P
Local swelling	6.661 (1.848 – 24.006)	0.004
Ulnar styloid fracture	4.672 (0.984 – 2.222)	0.052
Female gender	2.881 (0.425 – 19.607)	0.278
Dorsal comminution	1.325 (0.253 – 6.939)	0.739
Dorsal angulation	1.003 (0.932 – 1.077)	0.939
Radial inclination	1.113 (0.892 – 1.388)	0.343

treatment of distal radius fractures have been extensively studied in the literature (12, 16). Although reduction loss has multifactorial causes, our study showed local swelling at the fractured wrist compared to the uninjured side significantly increased the reduction loss risk, however, there was no relation between contralateral wrist circumference as a regional obesity marker with reduction loss.

Obesity has also been shown as a risk factor for reduction loss in conservative treatment of distal radius fractures (13). In the previous literature investigating obesity as a risk factor for fracture displacement, it is commonly defined and stratified using BMI values of the patients (17). Furthermore, the association between wrist circumference and

obesity has been documented (14). However, to the best of our knowledge, there is no previous study investigating the wrist circumference as an obesity parameter that could be a risk factor for loss of reduction after conservative treatment of the distal radius fracture. In this study, we have not found an association with contralateral wrist circumference as an obesity parameter with the reduction loss of distal radius fractures. Given the similar cast index values in reduction loss and maintained group, we may argue that proper casting techniques allowed manipulation of subcutaneous fat tissue around the wrist.

Local swelling around distal radius fracture is a common finding. Soft tissue edema after surgery of distal radius fractures is associated with prolonged pain and joint contracture (18). Several methods such as compression therapy (19), and intermittent pneumatic compression devices (20) have been described for the reduction of postoperative local tissue swelling. Although it is a well-known entity, quantitative analysis of local swelling has not been discussed in reduction loss after conservative treatment of distal radius fractures. We have found that local tissue swelling is significantly associated with reduction loss. We believe that manipulation of local swelling is challenging and sometimes impossible with casting techniques. Awareness of local swelling as a risk factor for reduction loss is important in decision making of distal radius fractures and could be considered as a relative surgical indication.

Reduction loss is a multifactorial entity in the conservative treatment of distal radius fractures. Several risk factors were identified which included but were not limited to accompanying ulnar styloid fracture, dorsal comminution, initial displacement, and older age (10). The univariate analysis of this study showed initial displacement, dorsal comminution, and accompanying ulnar styloid fracture are associated with an increased risk of reduction loss. Our findings were in line with the previous literature.

The incidence of reduction loss following conservative treatment of distal radius fractures was reported to be up to 64% (4). In this study, 18 of 73 (24.6%) patients had reduction loss. Of these 18 patients, 13 had reduction loss between the first- and second-week interval. Considering local swelling is the greatest risk factor in our series, we believe that the majority of the local swelling resolves between the first- and second-week interval. Orthopedic surgeons should be aware of this specific interval, especially in patients with excessive initial swelling.

There are several limitations of this study. First, this is a retrospective study. Second, the study was performed in a single institution therefore its results cannot be generalized to entire population. Third, although the method for wrist circumference measurement was clearly described in the literature (14), it has been not validated.

Excessive local swelling is found to be a risk factor to predict loss of reduction in conservative treatment of distal radius fractures while regional obesity is not. Local fatty tissue that increases wrist circumference can be manipulated with proper casting techniques, whereas edema cannot be managed optimally. Patients with excessive swelling may benefit from exchange casting following the resolution of edema.

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Author Contributions

Concept: **Erdi Özdemir, Ozan Altun, Yılmaz Ergişi, Uygur Daşar, Nadir Yalçın**, Design: **Erdi Özdemir, Ozan Altun, Yılmaz Ergişi, Uygur Daşar, Nadir Yalçın**, Data collection and processing: **Erdi Özdemir, Ozan Altun, Yılmaz Ergişi, Uygur Daşar, Nadir Yalçın**, Analysis and interpretation of data: **Erdi Özdemir, Ozan Altun, Yılmaz Ergişi, Uygur Daşar, Nadir Yalçın**, Literature review: **Erdi Özdemir, Ozan Altun, Yılmaz Ergişi, Uygur Daşar, Nadir Yalçın**, Writing of the manuscript: **Erdi Özdemir, Ozan Altun, Yılmaz Ergişi, Uygur Daşar, Nadir Yalçın**.

Conflicts of Interest

All the authors declare no conflict of interest.

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Ethical Approval

This study was approved by the local ethics committee of Karabuk University (no. 2021/743).

Review Process

Extremely peer-reviewed and accepted.

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