

The Effect of Changes in the Radio-Ulnar Angle on Wrist Scores on the Treatment of Intra-Articular Fractures of the Distal Radius with Wrist Fixator

Distal Radius Eklem İçi Kırıklarının El Bilek Fiksatorü ile Tedavisinde Radio-Ulnar Açıldaki Değişikliklerin El Bilek Skorlamasına Etkisi

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ABSTRACT

Aim: This study was aimed to evaluate the effect of radial inclination (RI) angle, assessed with radiological measurement, on the clinical outcomes of intra-articular fractures of the distal radius (IFDR) treated with closed reduction and penning type dynamic wrist fixator.

Material and Methods: A total of 120 patients who underwent closed reduction and dynamic wrist fixation due to IFDR between 2012 and 2020 were retrospectively reviewed. The effects of the changes in RI on clinical outcomes according to Mayo wrist scoring (MWS) criteria were investigated by measuring the RI angles in anteroposterior wrist radiographs of the patients at postoperative 2nd, 6th, and 10th weeks.

Results: According to the AO fracture classification, 77 (64.2%) of the patients had type C1 and 43 (35.8%) of the patients had type C2 fracture. The patients comprised 69 (57.7%) females and 51 (42.3%) males, and the mean age was 50.08±15.36 years. Fixators were removed at six weeks. RI angles measured at post-op week 10 were 20°-30° in 83 (69.1%) patients, 10°-19° in 32 (26.6%) patients, and 0°-9° in 5 (4.3%) patients. According to MWS, 39 (32.5%) patients were evaluated as excellent, 76 (63.3%) patients as good, and 5 (4.2%) patients as moderate. A statistically significant positive correlation was observed between RI values and MWS ($r=0.369$, $p<0.001$).

Conclusion: Dynamic wrist fixation with closed reduction is a simple and minimally invasive method, and provides successful clinical and functional results in the treatment of IFDR. We consider that optimal RI angles are effective in clinical and functional outcomes.

Keywords: Radius; external fixation; intra-articular fractures; orthopedic surgery.

ÖZ

Amaç: Bu çalışmada kapalı redüksiyon ve penning tipi dinamik el bilek fiksatorü ile tedavi edilen radiusun distal intra-artiküler kırıkları (RDIK)'nda radyolojik ölçüm ile değerlendirilen radial inklınasyon (RI) açısının klinik sonuçlara olan etkisinin değerlendirilmesi amaçlandı.

Gereç ve Yöntemler: 2012 ve 2020 yılları arasında RDIK nedeniyle kapalı redüksiyon ve dinamik el bilek fiksatorü uygulanan 120 hastanın dosyaları geriye dönük olarak incelendi. Hastaların post operatif 2., 6. ve 10. haftalarda radyolojik olarak el bileği ön/arka grafilerinden RI açıları ölçülerek, açısal değerlerdeki farklılıkların, Mayo el bilek skorlaması (MEBS) kriterlerine göre klinik sonuçlara olan etkisi araştırıldı.

Bulgular: AO kırık sınıflamasına göre, 77 (%64,2) hastanın tip C1, 43 (%35,8) hastanın ise tip C2 kırığı vardı. Hastaların 69 (%57,7)'u kadın ve 51 (%42,3)'i erkek olup ortalama yaş 50,08±15,36 yıldı. Fiksatorler altıncı haftada çıkarıldı. Post op 10. haftada ölçülen RI açıları, 83 (%69,1) hastada 20°-30°, 32 (%26,6) hastada 10°-19° ve 5 (%4,3) hastada ise 0°-9° idi. MEBS'e göre, 39 (%32,5) hasta mükemmel, 76 (%63,3) hasta iyi ve 5 (%4,2) hasta ise orta olarak değerlendirildi. RI değerleri ile MEBS arasında pozitif yönde istatistiksel olarak anlamlı bir korelasyon gözlemlendi ($r=0,369$; $p<0,001$).

Sonuç: Kapalı redüksiyon ile dinamik bilek fiksator uygulaması basit ve minimal invaziv bir yöntemdir ve IFDR tedavisinde başarılı klinik ve fonksiyonel sonuçlar sağlar. Optimal RI açılarının klinik ve fonksiyonel sonuçlarda etkili olduğunu düşünüyoruz.

Anahtar kelimeler: Radius; eksternal fiksator; eklem içi kırıklar; ortopedik cerrahi.

INTRODUCTION

Intra-articular fractures of the distal radius (IFDR) are commonly encountered traumas in orthopedics. These fractures are caused by low-energy trauma most often attributed to underlying osteoporosis in elderly individuals, and due to high-energy trauma in young and active individuals (1,2). IFDR occurs as a result of falling on the open hand while the elbow is in extension and the wrist is in dorsiflexion (3). Treatment of intra-articular fractures is much more difficult and complex than extra-articular fractures. These types of fractures have a poor prognosis as they are unstable and pave the way for the development of arthrosis and are unstable. The aim of treatment is to achieve painless wrist and hand functions by providing anatomical reduction of the joint surfaces as much as possible (4,5). Many conservative and surgical methods are used in the treatment of IFDR. The main purpose of wrist fixator applications is to bring together fractures fragments and to bring the joint cartilage, palmar inclination, and radial height to an acceptable anatomical level by providing the appropriate tension of structures such as tendons and ligaments around the wrist with the effect of ligamentotaxis (6). Closed repositioning and external fixation applications yield very successful results as adequate cartilage restoration can be achieved with appropriate reduction without opening the fracture line or disturbing the blood supply of the fracture fragments.

The aim of this study was to evaluate the effects of radial inclination values, obtained with 10-week postoperative radiographic measurements, on hand-wrist scores in patients who underwent closed reduction and external fixation for IFDR.

MATERIAL AND METHODS

Patients

A total of 162 patients who applied to our clinic due to IFDR underwent closed reduction followed by dynamic wrist fixator (penning tip) application between March 2012 and April 2020. Non-invasive ethics committee approval was obtained from Sakarya University Faculty of Medicine on 16.04.2021 with document number 257. 42 of the patients who did not regularly attend follow-ups and patients with additional trauma and open fracture lines were excluded from the study. Accordingly, 120 patients were included in this study. All patients were operated on and followed up in the orthopedics and traumatology clinic of Sakarya Yenikent State Hospital by a single orthopedic surgeon.

Surgical Procedure

All patients underwent operations under the axillary block and 1 gr IV cephazolin sodium was administered to the patients before the operation. Tourniquets were not applied. In regards to surgical technique, traction was applied to the fracture site for 3-5 minutes while the patients were lying in the supine position. Then, the fracture was reduced by adapting the dynamic wrist fixator under fluoroscopy with the placement of two Schanz screws in the proximal base of the second metacarpal and two in the radius diaphysis. The wrist fixator system was locked by applying 20 degrees of ulnar deviation and semiflexion to the wrist. The distraction of the wrist fixator was performed to provide the effect of ligamentotaxis. The patients were checked with fluoroscopy and the bases of

screws were applied with dressing and then wrapped with an elastic bandage.

Follow-up

Radial inclination angles were measured from the anteroposterior (AP) wrist radiographs of the patients taken at post-op 2, 6, and 10 weeks. All patients were evaluated with Mayo wrist score (MWS) at post-op week 10. The effects of radial inclination angles on the wrist score were evaluated.

Statistical Analysis

In this study, statistical analyzes were performed with Number Cruncher Statistical System (NCSS) 2007 Statistical Software (Utah, USA) package program. In addition to descriptive statistical methods (mean, standard deviation, frequency, percentage), the distribution of the variables was examined with the Shapiro-Wilk normality test. One-way analysis of variance was used to assess intergroup comparisons of the normally distributed variables and the Tukey multiple comparison test in the subgroup comparisons. The chi-square test in the comparisons of qualitative data, categorical variables were also analyzed with the Fisher-Freemant-Halton test, and the Pearson correlation test was used to determine the relations of variables between each other. The results were evaluated at a significance level of $p < 0.05$.

RESULTS

A total of 120 patients were included in the study and the mean age was 50.08 ± 15.36 years. The patients consisted of 69 (57.7%) females and 51 (42.3%) males. Fracture types were evaluated as C1 in 77 (64.2%) patients and C2 in 43 (35.8) patients according to the Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification. The operation was performed on the left side in 64 (53.3%), and on the right side in 56 (46.7%) patients. The mean time between hospitalization and operation was 16.5 ± 4.2 hours. The mean operating time was 14.0 ± 3.7 minutes. The mean follow-up period was 4.3 ± 2.1 months. Post-op mean hospital stay was 2.7 ± 1.3 days. The fixators were removed at the end of the post-op 6th week at the latest, and passive and then active physical therapy exercises were initiated in patients (Figure 1 and Figure 2). The complete union was observed in all cases included in the study. Delayed union or nonunion was not observed. The mean union time was 6.7 ± 2.4 weeks. Complications of superficial pin tract infection were observed in eight patients, and complications of loosening of Schanz screws were observed in four patients. These complications did not affect stability and improved with appropriate treatments. In total, the mean radial inclination (RI) was 20.32 ± 4.51 and the mean MWS was 91.12 ± 5.20 (Table 1).

Comparison of the MWS in the RI groups for ages of ≤ 50 , > 50 , and all study groups were presented in Table 2.

In the ≤ 50 age group, a statistically significant difference was observed between the mean MWS of the RI 0° - 9° , 10° - 29° , and 20° - 30° groups ($p < 0.001$). The mean MWS of the RI 0° - 9° group was found to be statistically significantly lower than the mean MWS of the RI 10° - 29° and 20° - 30° groups ($p = 0.001$, $p < 0.001$), Mean MWS of RI 10° - 29° group was found to be statistically significantly lower than the mean MWS of the RI 20° - 30° group ($p = 0.018$).

In the >50 age group, a statistically significant difference was observed between the mean MWS of the RI 0°-9°, 10°-29° and 20°-30° groups (p<0.001). The mean MWS of the RI 0°-9° group was significantly lower than the mean MWS of the 10°-29° and 20°-30° groups (p=0.001, p<0.001). No statistically significant difference was observed between the mean MWS of the RI 10°-29° and RI 20°-30° groups (p=0.981).

In all patients, a statistically significant difference was observed between the mean MWS of the RI 0°-9°, 10°-29° and 20°-30° groups (p<0.001). The mean MWS of the RI 0°-9° group was significantly lower than the mean MWS of the 10°-29° and 20°-30° groups (both p<0.001). No statistically significant difference was observed between the mean MWS of the RI 10°-29° and 20°-30° groups (p=0.194, Table 2).

In the study group, there was a statistically significant difference between the MWS distributions of the RI groups (p<0.001). Excellent MWS was not observed in the RI 0°-9° group, while the rate of excellent MWS was high in the RI 20°-30° group (Table 3).

DISCUSSION

Since intra-articular fractures cause degenerative disorders in the joints, they are usually complicated fractures (6,7). Anatomical restoration of the joint is significant in these types of fractures. The aim of IFDR treatment is to achieve a functional hand and wrist after union by providing

anatomical restoration. Many methods, ranging from conservative to surgical, are used in the treatment of these fractures (7,8). The closed reduction and external fixation technique helps in reduction as it stabilizes the carpal ligaments with the effect of ligamentotaxis without opening the fracture line. Although the effect of ligamentotaxis is effective in providing height and inclination, may be insufficient in the anatomical restoration of joint surfaces (9). However, closed wrist fixators minimize the damage of intra-articular fractures by reducing the load on the bones and joints, even if anatomical repositioning cannot be achieved in the joint (9,10). Dynamic

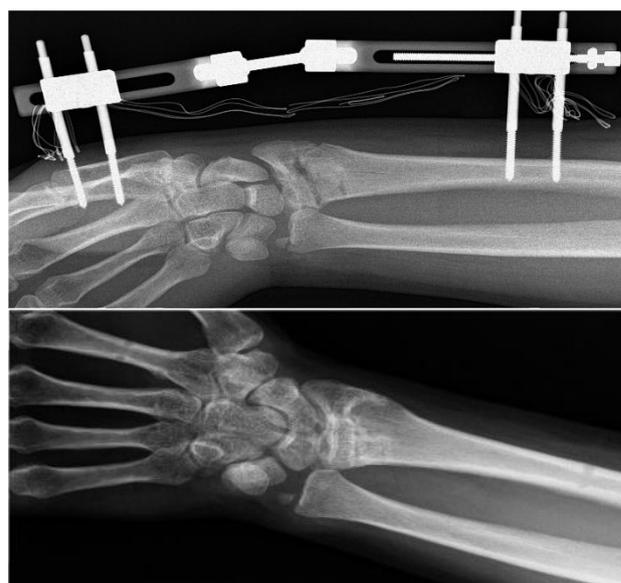


Figure 1. Treatment with fixator application

Table 1. Descriptive characteristics of the patients

Age, n (%)	
≤50 Age	60 (50.00)
>50 Age	60 (50.00)
Gender, n (%)	
Male	51 (42.50)
Female	69 (57.50)
Side, n (%)	
Right	56 (46.67)
Left	64 (53.33)
Radial inclination, n (%)	
0°-9°	5 (4.17)
10°-29°	32 (26.67)
20°-30°	83 (69.17)
Mayo wrist scoring, n (%)	
Medium	5 (4.17)
Good	76 (63.33)
Excellent	39 (32.50)
AO classification, n (%)	
C1	77 (64.17)
C2	43 (35.83)

AO: Arbeitsgemeinschaft für Osteosynthesefragen



Figure 2. Wrist fixator application, pre-op and post-op images

Table 2. Comparison of Mayo wrist score according to the radial inclination in age groups

Age group	0°-9° (n=2)	10°-29° (n=18)	20°-30° (n=40)	p
≤50 years	77.50±3.54 (45.73-109.27)	89.17±4.93 (86.72-91.62)	92.38±3.58 (91.23-93.52)	<0.001
Age group	0°-9° (n=3)	10°-29° (n=14)	20°-30° (n=43)	p
>50 years	80.00±10.00 (55.16-104.84)	92.14±3.78 (89.96-94.33)	91.86±4.88 (90.36-93.36)	0.001
Age group	0°-9° (n=5)	10°-29° (n=32)	20°-30° (n=83)	p
Whole Group	79.00±7.42 (69.79-88.21)	90.47±4.64 (88.80-92.14)	92.11±4.29 (91.17-93.04)	<0.001

descriptive statistics were reported as mean±standard deviation (95% confidence interval)

Table 3. Comparison of the distribution of Mayo wrist score in radial inclination groups

Age group		0°-9° (n=2)	10°-29° (n=18)	20°-30° (n=40)	p
	Mayo wrist score, n (%)				
≤50 years	Medium	2 (100)	1 (5.56)	0 (0.00)	<0.001
	Good	0 (0.00)	15 (83.33)	22 (55.00)	
	Excellent	0 (0.00)	2 (11.11)	18 (45.00)	
Age group		0°-9° (n=3)	10°-29° (n=14)	20°-30° (n=43)	p
	Mayo wrist score, n (%)				
>50 years	Medium	2 (66.67)	0 (0.00)	0 (0.00)	0.001
	Good	1 (33.33)	10 (71.43)	28 (65.12)	
	Excellent	0 (0.00)	4 (28.57)	15 (34.88)	
Age group		0°-9° (n=5)	10°-29° (n=32)	20°-30° (n=83)	p
	Mayo wrist score, n (%)				
Whole Group	Medium	4 (80.00)	1 (3.13)	0 (0.00)	<0.001
	Good	1 (20.00)	25 (78.13)	50 (60.24)	
	Excellent	0 (0.00)	6 (18.75)	33 (39.76)	

wrist fixators are an effective treatment method for rapid healing of the fracture and for the clinical and functional recovery of wrist activity, due to ease of application, shorter operating time, and minimal invasiveness (11). In our study, we observed a correlation between RI angles and clinical and functional results in IFDR treatment; clinical and functional results were inadequate in patients with inclination angles below 10°, and clinical and functional results were adequate or even excellent in cases with RI above 10°.

Güler et al. (12) reported that radiological results and clinical results may not always be consistent in the treatment of IFDR, but the general standpoint is that patients with good radiological findings will achieve good clinical and functional results. Seyfettinoğlu et al. (13) reported that volar plate applications yield successful results in distal radius fractures, but this method may cause some complications and adversely affect the results. Dario et al. (14) conducted a study of 51 patients who were treated with a volar plate and reported that the most important radiographic parameters to be restored were volar tilt and ulnar variance, and that RI angle did not affect the results. Thuysbaert et al. (15) stated that the two most important radiographic parameters in the evaluation of clinical and functional success in IFDR treatment are ulnar variance and RI angles. Ünal et al. (16) reported that volar plate applications yielded satisfactory mid-term results, despite longer operating time and hospital stay compared to external fixation. Özden et al. (17) stated that intra-articular fractures can be evaluated and by arthroscopic methods and corrected. Stirling et al. (18) stated that the RI angle is one of the most important parameters in the evaluation of bone displacement in distal radius fractures. Gereli et al. (19) stated that volar plates are superior to EF in IFDR, but there is no difference in terms of clinical and functional results in the midterm and long term. Sun et al. (20) reported that radial length and RI angle had no effect on correction in 85 patients with IFDR who were treated with EF, while volar tilt was effective in correction, and EF had no chance of treatment success in multi-fragmented fractures. In our study, we achieved the opposite of this result, and we obtained satisfactory results in regard to clinical and functional aspects of the treatment of IFDR. In their study consisting of 46 patients,

Çopuroğlu et al. (21) used external fixators to treat IFDR by providing mild flexion and reduction in ulnar deviation, avoiding excessive distraction; they reported that they achieved complete radiological and clinical union in all patients at the end of postop 7 weeks.

Our study had some limitations. Due to the wide age distribution of the patients, elderly patients with porotic bones and young patients were examined in the same study. In addition, factors affecting the accuracy of the results such as comorbidities, smoking, and additional drug use were not evaluated in the study. The absence of a randomized control group was another limitation of our study.

CONCLUSION

EF application with closed reduction is an effective surgical method in the treatment of IFDR and achieves successful clinical and functional results by providing restoration close to anatomical repositioning on displaced joint surfaces due to the effect of ligamentotaxis. Optimal RI angles in the postoperative period are directly correlated with clinical and functional outcomes. Achieving normal RI angles is critical for clinical and functional success. Considering that this study will shed light on future studies, we believe that more comprehensive studies are needed.

Ethics Committee Approval: The study was approved by the Ethics Committee of Sakarya University Faculty of Medicine (16.04.2021, 257).

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