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Treatment of Unstable Distal Radius Fractures with Non-bridginig External Fixation

Muharrem Kanar[1], Raffi Armagan[1], Yunus Oc[1], Hasan Basri Sezer[1], Osman Tugrul Eren[1]

ABSTRACT:

Treatment of unstable distal radius fractures with non-bridginig external fixation

Objective: In this study, we present functional and radiological results for patients treated for distal radius fractures with a non-bridging external (mini tube) fixator, which allows early movement.

Material and Method: A total of 27 patients (14 female and 13 male) with 29 distal radius fractures were included in the study. The mean age was 56.3 years (range: 23–83 years). According to the AO/ASIF classification, three fractures were of type A, and 26 fractures were of the unstable type C. All the fractures were treated with close reduction and fixed with non-bridging external fixation. The radiological results were evaluated according to Stewart's radiological-anatomical scoring system. The patients' functional levels were evaluated according to the DASH (Disabilities of the Arm, Shoulder and Hand) questionnaire, the MAYO Modified Wrist Score, and Stewart's modification of the Gartland-Werley scoring system. The mean follow-up time was 20.7 months (range: 12–38 months).

Results: According to Stewart's radiological-anatomical scoring system, out of 29 involved extremities in 27 patients, 7 (24.13%) wrists were excellent, 19 (65.51%) were good, and 3 (10.34%) were fair. No patient was graded as bad. According to Stewart's functional scoring system, out of 29 extremities, 6 (20.6%) were excellent, 14 (48.2%) were good, and 7 were (24.1%) fair, but 2 patients (6.8%) were bad.

Conclusion: Non-bridging external fixation is an easy to apply and effective method of treatment for closed reducible distal radius fractures, which allows early motion.

Keywords: Distal radius fracture, early rehabilitation, nonbridging fixator

ÖZET:

İnstabil distal radius kırıklarının el bileğini köprülemeyen eksternal fiksatör ile tedavisi

Amaç: Bu çalışmada instabil radius distal uç kırıklarında el bileğini köprülemeyerek, erken hareket imkanı tanıyan çok amaçlı minitübüler eksternal fiksatör uygulamalarımızın radyolojik ve fonksiyonel sonuçları değerlendirildi.

Gereç ve Yöntem: Çalışmaya 27 hasta (29 el bileği) dahil edildi. Hastaların 14'ü kadın 13'ü erkek; yaş ortalaması 56.3 (23-83 yıl) yıl idi. AO/ASIF sınıflamasına göre 3 olgu A tipi, 26 olgu da C tipi instabil kırık idi. Kırıkların tümü kapalı redükte edildi, el bileğini köprülemeyen eksternal fiksatör perkutan tatbik edildi. Olguların radyolojik değerlendirmeleri Stewart ve arkadaşlarının değerlendirme sistemine göre; fonksiyonel değerlendirmeleri DASH (Disabilities of the Arm, Shoulder and Hand Questionnaire) anketi, Mayo Modifiye El Bilek Skorlaması ve Stewart'ın modifiye ettiği Gartland-Werley skorlama sistemi ile değerlendirildi. Ortalama izlem 20.7 ay (12-38 ay) idi.

Bulgular: Stewart'ın radyolojik-anatomik skorlama sistemine göre, 27 hastanın toplam 29 radius distal uç kırığının 7'sinde (%24.13) mükemmel, 19'inde (%65.51) iyi, 3'ünde (%10.34) orta sonuç elde edildi. Kötü sonuç alınan hasta bulunmamaktaydı. Stewart'ın fonksiyonel skorlamasına göre 29 distal radiusun 6'sında (%20.6) mükemmel sonuç, 14'ünde (%48.2) iyi sonuç ve 7'sinde (%24.1) orta sonuç 2'sinde (%6.8) kötü sonuç elde edildi.

Sonuç: Radius distal uç kırıklarında el bileğini köprülemeyen eksternal fiksatör uygulaması; kolay uygulanabilmesi ve erken harekete izin vermesi nedeniyle normale yakın el bileği hareket açıklığı sağlaması nedeniyle kapalı redüksiyonu sağlanabilen kırıklarda iyi bir tedavi yöntemidir.

Anahtar kelimeler: Radius distal uç kırığı, erken rehabilitasyon, köprülemeyen fiksatör

Ş.E.E.A.H. Tıp Bülteni 2017;51(2):96-101

[1]Sisli Hamidiye Etfal Training and Research Hospital, Department of Orthopaedic and Traumatology, Istanbul - Turkey

Address reprint requests to / Yazışma Adresi:
Muharrem Kanar,
Sisli Hamidiye Etfal Training and Research Hospital, Department of Orthopaedic and Traumatology, Istanbul - Turkey

E-posta / E-mail:
dr.kanar@hotmail.com

Phone / Telefon: +90-212-232-55125

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INTRODUCTION

Distal radius fractures are the most frequent fractures of the human skeleton (1,2), constituting 8-15% of all fractures (3). Increasing motor vehicle use, participation in sports, and longer life expectancy have also increased the incidence of distal radius fractures (4). Although traditionally, conservative treatment is the preferred method, nowadays, surgical intervention is used more and more to increase patients' functional levels (5-7). There is no standard surgical method for the treatment of unstable fractures, although many forms of implants and surgical techniques have been described. Irrespective of the treatment modality, the selected method should provide enough stability to maintain the reduction and allow joint motion to preserve soft tissue function until bony union (8). The other goal of treatment is to restore the radiological measures of the anatomic reduction, such as joint line congruity, radial height, radial inclination, and distal radial palmar tilt.

In this study, we report the clinical results of percutaneous non-bridging external fixation of distal radius fractures. We discuss its complications as well as favorable results in terms of joint mobility.

MATERIAL AND METHODS

We included 27 patients (13 male and 24 female) with 29 unstable distal radius fractures who were admitted to our emergency department between 2010 and 2012 in our study, who had at least 12 months of follow-up. The mean age was 56.3 years (range: 23-83 years). Fifteen (55%) of the fractures were in the dominant extremity. The trauma mechanism was a simple fall in 52% (n=14) of patients, fall from height in 33% (n=9) of patients, and a motor vehicle accident in 15% (n=4) of patients. According to the Gustillo-Andersen (9) classification, three fractures were type 1, and 2 fractures were type 2 open fractures. All patients underwent a systemic evaluation for injury of other systems. All patients were evaluated clinically and radiologically with anteroposterior and lateral wrist x-rays. According to the AO-ASIF fracture classification, 3 fractures were of type A, and 26 fractures were of type C (10). Eight patients had fractures of other regions: two intertrochanteric fractures, one femoral neck fracture, one ipsilateral olecranon fracture, fractures of the contralateral radius shaft and both bones of the cruris in one patient, one 12th thoracic vertebral fracture, one bimalleolar ankle fracture, and multiple fracture dislocations of both feet. Traction x-rays were taken to evaluate the instability of the fractures of the distal radius. Initially unstable fractures and those showing displacement during follow-up were treated operatively. Mean time to operation was 5.37 (range: 1-17) days.

Surgery and Follow-up

Twenty-five patients (92.59%) were operated under general anesthesia, and two patients (7.40%) were operated with regional block. The type of regional block was supraclavicular in one patient and axillary in one patient. In one patient who also had ipsilateral olecranon fracture, tourniquet use was not needed. All of the fractures were treated with closed reduction. The operation time was 59.7 min (range: 30-110 min).

Finger movements were allowed immediately after surgery, and after radiographic control, wrist movements were also encouraged. Patients were encouraged to resume daily activities as tolerated. The mean fixator time was 40 days (range: 33-73 days). The fixators and, if present, supplementary K wires were extracted without anesthesia. The mean follow-up time was 20.74 months (range: 12-38 months).

Statistical analysis of results before the operation and after the fracture union in terms of radial inclination, dorsal angulation, and loss of height were carried out. The measurements were compared with those of the normal side for unilateral fractures and with the normal ranges for bilateral fractures (Table-1).

Patients were evaluated by means of anteroposterior and lateral x-rays at the last follow-up. The radiological criteria of Stewart et al. (11) were used for radiological assessment of fractures.

The joint range of motion was measured with a

Table-1: Operative and healthy side measurements and range of motion

		Operative side		Healthy side	
		Min/Max	**Mean±SD**	**Min/Max**	**Mean±SD**
Radial length		7/18	11.83±2.61	4/18	12.28±3.05
Radial inclination		16/30	20.62±3.19	8/29	21.90±4.68
Dorsal tilt		-8/10	2.76±4.10	-9/11	4.31±4.61
Last follow-up ROM	Volar flexion	45/90	74.48±10.80	70/90	81.28±4.85
	Dorsal flexion	45/85	71.72±11.67	60/90	77.79±6.91
	Radial deviation	10/30	20.34±5.50	15/30	23.14±3.67
	Ulnar deviation	15/35	24.48±6.59	20/40	26.69±5.24
	Pronation	55/90	78.79±8.93	70/90	81.86±5.75
	Supination	50/90	76.21±11.07	60/90	78.31±7.12

goniometer and compared with that of the normal side or the normal range of wrist movements for bilateral fractures. Functional assessment of patients was carried out with the DASH (Disabilities of the Arm, Shoulder, and Hand) questionnaire, the MAYO Modified Wrist Score, and Stewart's modification of the Gartland-Werley scoring system (12).

Surgical Technique

All operations were carried out while the patient was lying in supine position and under fluoroscopic control. All patients received 2 g of cefazolin sodium IV 30 min before surgery. First, the radius was treated with closed reduction, and the reduction was checked fluoroscopically. Every Schanz screw was applied through an incision of less than 1 cm. Soft tissues were protected with blunt dissection to the bone, and a cannula was used to prevent drill or Schanz screw damage. Distal Schanz screws were applied first in two different configurations, which used either two or three Schanz screws according to the type of fracture. In the three Schanz screw configurations, the first Schanz screw was introduced from the styloid process of the radius and directed to the intact cortex of the proximal fragment. This Schanz screw was employed to protect the inclination and radial height. The second Schanz screw was located in the distal fragment between the extensor pollicis longus and extensor digitorum tendons and applied from the dorsal cortex to the volar cortex. The third screw was aimed to support the lunar fragment subchondrally and introduced from the dorsoulnar part of the radius towards the volar cortex. In the two Schanz screw configurations, the distal fragment was supported by two converging screws directed from the dorsal to the volar and from the radial and ulnar to the opposite proximal cortex. Proximal screws were applied at least 8 cm proximal to the fracture line with a 2 cm longitudinal incision. After the protection of the superficial branch of the radial nerve and blunt dissection between the extensor carpi radialis brevis and extensor digitorum muscles, the bone was predrilled with a 2 mm drill and two 4 mm-wide screws were introduced at right angles to the axis of the radius bicortically and without tapping in the dorsal to volar direction by using the drill guide as a centralizer. The screws in the distal fragment were secured with a semicircular titanium half ring. The proximal screws were connected to each other with a longitudinal carbon rod. The two parts of the system were connected after the radial height, inclination, and tilt angles were adjusted to within the desired range. After fluoroscopic control, the system was locked. The incisions were sutured, and the wounds were closed with sterile dressing at the end of the operation.

Aftercare

Immediately after the operation, finger movements were allowed, and after postoperative radiological control, wrist movements were allowed as tolerated. Pin tract care was performed routinely. Rehabilitation and serial radiographies were performed weekly. The fixator was extracted without anesthesia in the outpatient setting (Figure-1).

Figure-1: N E H (R)AO 23C2, Stewart Radiologic Score = good, Stewart Functional Score = excellent, DASH score 11, MAYO wrist score = excellent.

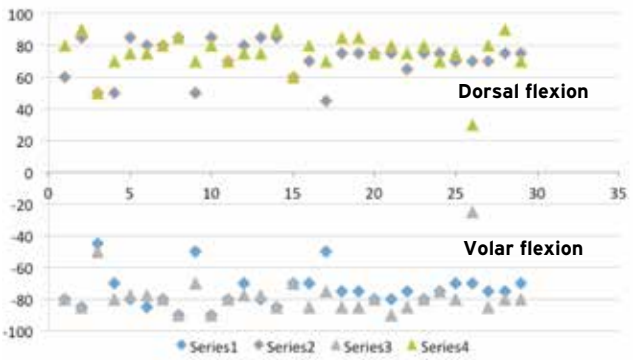

Figure-2: Comparison chart of volar and dorsal flexion values of final follow-ups of patients on both operative and non-operative sides.

RESULTS

At the last follow-up, the mean follow-up time was 20.7 (range: 12-38) months. The functional results were documented by using Stewart's modification of the Gartland-Werley scoring system, the DASH Score, the MAYO Modified Wrist Score, and the visual analog scale (VAS). The radiological outcome was assessed by using the modified radiological criteria of Stewart et al. (12).

According to Stewart's functional (11) scoring system, 6 of 29 distal radius fractures (20.6%) were excellent, 14 (48.2%) were good, and 7 (24.1%) were fair, but for 2 (6.8%), bad results were obtained. The mean DASH-T score was 17.2 (range: 4.2-48.2). According to the Modified MAYO Wrist Score, 11 wrists (37.9%) were excellent, 12 wrists were (41.3%) good, and 5 wrists (17.2%) were fair, but 1 wrist (3.44%) was bad (Figure-2).

VAS scores were 1.14±0.91 ranging between 0 and 4. The patients' mean DASH-T score was 17 (range: 4-48).

Three patients experienced superficial pin tract infection, which resolved with oral antibiotics and wound care. None of these patients required early fixator removal. Four patients (13.79%) displayed signs of reflex sympathetic dystrophy, which resolved with rehabilitation after fixator removal until the last follow-up. One patient (3.44%) had malunion due to excessive osteoporosis, which lead to loss of reduction. The same patient also had delayed union.

DISCUSSION

Coincident with the widespread use of motor vehicles and increasing involvement in sports activities, in addition to the increasing life expectancy, the incidence of distal radius fractures has increased (4). Traditionally, the preferred treatment modality for these fractures was conservative. However, attempts to improve functional results in these patients have resulted in the current increasing

popularity of surgical treatment modalities (5-7).

The selection of a treatment modality depends on fracture type as well as age, social behavior, concomitant health problems, and the physical and mental capacity of the patient (13-15).

The common expectation is good functional results in cases of restoration of neutral height of the radius, obtaining a radial inclination of more than 20°, a dorsal tilt of less than 0-5°, intra-articular displacement less than 2 mm, and restoring intercarpal and distal radioulnar joint stability. The basic extra-articular criteria (radial height, radial inclination, volar tilt) are valuable but not as important as reduction of the intra-articular displacement (15-17).

Margaliot et al. (18) published a meta-analysis comparing external with internal fixation in the treatment of distal radius fractures. Their study included 28 external fixation and 18 internal fixation studies and concluded that there was no statistical difference in terms of wrist range of motion and radiological alignment, neither clinically nor statistically. While patients treated with external fixation were prone to infection, neuritis, and material failure, those treated with internal fixation suffered more frequent tendon complications and obligatory material extraction. As a result, they could not find any proof supporting the superiority of internal fixation over external fixation in the treatment of unstable distal radius fractures (18).

In external fixation treatment for bridging of the wrist, as the reduction is carried out by ligamentotaxis, the magnitude of traction must be appropriate. Excessive traction is proven to negatively affect, even endanger, ligament function by altering carpal kinematics (19,20). Although the effect of ligamentotaxis on non-bridging external fixation is less than on bridging external fixation, attention should be paid to the traction applied distally (21).

Early active motion has an inevitable effect on the healing of bone, cartilage, and surrounding soft tissues and plays a vital role in obtaining good clinical results. Studies demonstrated the positive effect of fixators, which allow early active motion at the wrist joint, on fracture healing and decreasing periarticular osteopenia by increasing the wrist range of motion (21,22). Copuroglu et al. (8) reported reflex sympathetic dystrophy (RSD) in 15 patients out of 46 distal radius fractures (32.6%) treated with a bridging external fixator. McQueen (23) demonstrated significantly less RSD in the wrist joint following distal radius fracture treatment with a non-bridging external fixator in a study comparing bridging and non-bridging external fixators. In our study, we allowed active motion on the day following surgery to optimize joint cartilage and fracture healing. In agreement with the literature, we encountered RSD in 4 (13.79%) patients.

In the literature, non-bridging external fixators can correct the volar tilt of the distal radius directly with Schanz screws applied to the distal fragment, unlike external fixators, which bridge the wrist joint. Krughaug et al. (24) reported a better correction of the volar tilt with a Hoffman type non-bridging external fixator (Dynawrist) than with a bridging external fixator. Mean deviation of the volar tilt of which was 1.55° in our study.

Although there is strong opposition to this point of view, we believe that joint reconstruction and stabilization of the radial height is possible with the use of an external fixator in metaphysodiaphyseal fractures of the distal radius also involving the articular surface (25). We obtained excellent result in a patient with such a fracture. However, there are problems with the supply of suitable fixators.

Active joint movement throughout treatment with non-bridging external fixation affects the functional results positively (26). Only three patients (11%) in our study required assistance with rehabilitation. We evaluated our patients according to Stewart's modification of the Gartland-Werley scoring system and the Modified MAYO Wrist Score and found that 2 and 1 out of 26 patients, respectively, were scored as "bad." The mean DASH score was 17, which was relatively high. Three patients had scores more than 40, of which 2 were unable to cooperate and 1 was suffering from hemiplegia.

Non-bridging external fixators help to reduce and stabilize the distal fragment directly, unlike bridging fixators, which have an indirect effect on the distal fragment. In this way, it is easy to handle the distal fragment and reduce the fracture under fluoroscopic

control (27). Flinkkilä et al. (22) reported that non-bridging fixators were suitable for reduction and fixation of neglected distal radius fractures even 2–3 weeks after the fracture occured. We operated on three patients due to loss of reduction in the second week of fracture and obtained satisfactory reduction by directly handling the distal fragment.

Attention should be paid to infection with non-bridging fixation, because there is a risk of pin tract infection spreading to the joint due to the subchondral placement of the distal screws (22). McQueen et al. (23) reported that the distal metaphysis has a lower tendency to become infected due to its good blood supply. We encountered only three pin tract infections that affected the proximal Schanz screws. We were able to treat these patients, who had infection limited to the soft tissues, with intense wound care and oral antibiotics.

In conclusion, non-bridging external fixation of unstable distal radius fractures is a reasonable method of treatment that is easy to apply, minimally invasive and safe, with the potential to allow early active movement and supply very good anatomical and functional results.

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