RESEARCH ARTICLE

ARAŞTIRMA MAKALESİ

Acta Medica Alanya

2024;8(3): 181-188

DOI: 10.30565/medalanya.1504653

Functional and radiological comparison of volar locking plate and K-wire augmented volar locking plate fixation in intra-articular and comminuted distal radius fractures

Eklem içi ve parçalı distal radius kırıklarında volar kilitli plak ile K-teli destekli volar kilitli plak tespitinin fonksiyonel ve radyolojik karşılaştırması

Cem Yıldırım[1], Mehmet Ekinci[2], Şahan Dağlar[2], Osman Görkem Muratoğlu[3]*, Hüseyin Öztürk[4], Okyar Altaş[1]

1.Basaksehir Cam and Sakura City Hospital, Orthopedic and Traumatology Dept., İstanbul, Türkiye
2.Haseki Training and Research Hospital, Orthopedic and Traumatology Dept., İstanbul, Türkiye
3.Medicana International Istanbul Hospital, Orthopedic and Traumatology Department, Istanbul, Türkiye
4.Öztürk Clinic, İzmir, Türkiye

ABSTRACT

Aim: This study aims to determine whether additional K-wires to volar plating impact the radiologic and functional outcomes of comminuted distal radius fractures (DRFs).
Methods: Forty-two patients treated with either a volar locking plate or a K-wire augmented volar locking plate for intra-articular comminuted distal radius fractures (AO type C) between February 2008 and December 2014 at Haseki Hospital were retrospectively analyzed. Wrist range of motion and hand grip strength were recorded. Patients were evaluated using the Gartland-Werley scale, QuickDASH scale, and Mayo wrist score. Radiological assessments were based on wrist radiographs taken during the last follow-up.
Results: No statistically significant difference was observed between the two groups in terms of the range of motion of the affected wrist joint (all p values >0.05). Similarly, there were no statistically significant differences in the Mayo wrist score, Gartland-Werley score, QuickDASH scale, or Stewart score between the two groups (p=0.17, p=0.36, p=0.38, and p=0.35, respectively). At final follow-ups, radial length loss and radial tilt loss did not significantly differ in either group compared to the healthy side (p=0.98 and p=0.96, respectively).
Conclusion: Given the potential complications associated with bridge external fixators and K-wires in treating comminuted distal radius fractures, volar locking plates can be safely used alone for managing these fractures.

Keywords: Intra-articular distal radius fracture; K-wire augmented locking plate; functional outcomes; wrist injuries

ÖZ

Amaç: Bu çalışmanın amacı, volar plaklamaya eklenen K-tellerinin parçalı distal radius kırıklarının radyolojik ve fonksiyonel sonuçlarını etkileyip etkilemediğini belirlemektir.
Gereç ve Yöntem: Şubat 2008 ile Aralık 2014 tarihleri arasında Haseki Hastanesi'nde eklem içi parçalı distal radius kırıkları (AO tip C) nedeniyle volar kilitli plak veya K-teli destekli volar kilitli plak ile tedavi edilen 42 hasta retrospektif olarak incelenmiştir. Bilek hareket açıklığı ve el kavrama kuvvetleri kaydedilmiştir. Hastalar, Gartland-Werley skalası, QuickDASH ölçeği ve Mayo bilek skoru kullanılarak değerlendirilmiştir. Radyolojik değerlendirmeler, son kontrolde çekilen bilek grafileri ile yapılmıştır.
Bulgular: Etkilenen bilek ekleminin hareket açıklığında iki grup arasında istatistiksel olarak anlamlı bir fark saptanmamıştır (tüm p değerleri >0,05). Aynı şekilde, Mayo bilek skoru, Gartland-Werley skoru, QuickDASH ölçeği ve Stewart skoru açısından da istatistiksel olarak anlamlı bir fark gözlenmemiştir (sırasıyla p=0,17, p=0,36, p=0,38 ve p=0,35). Son kontrollerde radial uzunluk kaybı ve radial tilt kaybı her iki grupta sağlıklı tarafa göre anlamlı farklılık göstermemiştir (sırasıyla p=0,98 ve p=0,96).
Sonuç: Eklem içi parçalı distal radius kırıkları tedavisinde köprü eksternal fiksatörler ve K-tellerinin olası komplikasyonları göz önünde bulundurulduğunda, bu kırıkların tedavisinde volar kilitli plakların tek başına güvenle kullanılabileceği sonucuna varılmıştır.

Anahtar Kelimeler: Eklem içi distal radius kırığı; K-teli destekli kilitli plaklama; fonksiyonel sonuçlar; el bilek yaralanmaları

RECEIVED: 26/06/2024 ACCEPTED: 01/11/2024 PUBLISHED (ONLINE): 30/12/2024

*Corresponding Author: Osman Görkem Muratoğlu, MD, Orthopaedic Surgeon. Medicana International Istanbul Hospital, Orthopedic and Traumatology Department, Istanbul, Türkiye
Phone number: +90 545 456 0900 / mail: gorkemmuratoglu@hotmail.com

ORCID: 0000-0003-0049-7937

To cited: Yıldırım C, Ekinci M, Dağlar Ş, Muratoğlu OG, Öztürk H, Altaş O. Functional and Radiological Comparison of Volar Locking Plate and K-Wire Augmented Volar Locking Plate Fixation in Intra-Articular and Comminuted Distal Radius Fractures. Acta Med. Alanya 2024;8(3): 181-188 doi: 10.30565/medalanya.1504653

Introduction

Distal radius fractures (DRFs) are among the most common fracture types, accounting for 8% to 15% of all fractures [1]. In young patients, intra-articular fractures typically result from high-energy trauma, whereas extra-articular distal radius fractures more commonly arise from low-energy trauma in the osteoporotic geriatric population [2]. The pathophysiology of intra-articular distal radius fractures involves shear forces generated as axial loads transfer from the hand to the radius articular surface. These forces can cause both displaced articular fractures and central impaction [3].

According to the Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification, the “C” subgroup includes comminuted fractures that involve the joint [4]. Distal radius type C fractures are considered unstable. Given the risks of malunion, joint incongruity, and osteoarthritis, unstable DRFs are typically managed surgically rather than conservatively [5]. Various surgical methods have been described for unstable DRFs, including open reduction internal fixation, bridge plating, percutaneous pinning with casting, external fixation, and adjunctive Kirschner (K) wire fixation. However, no consensus exists on an optimal approach [6, 7].

Despite advancements in fixation methods, K-wires remain essential in the treatment of unstable DRFs. In comminuted DRFs managed with open reduction and internal fixation, articular subsidence is common because fracture fragments lack soft tissue attachments and may not be fully supported by peri-articular plates. Additionally, discrepancies between plate design and patient anatomy may result in screw placement below the joint line, limiting direct support for osteochondral fragments. Adding K-wires aims to address these limitations by providing additional stabilization. While a few studies have compared radiologic and functional outcomes of K-wire fixation with internal or external fixation for comminuted DRFs [8, 9], findings suggest no definitive superiority in functional outcomes between methods [8, 9]. However, Micic et al. reported significantly reduced articular step-off when K-wires were added to external fixation [9].

To our knowledge, few studies have examined the role of additional K-wires in volar plating specifically. Thus, our study aims to evaluate whether adding K-wires to volar plating affects the radiologic and functional outcomes of comminuted DRFs. The hypothesis of our study was that fractures fixed with volar plate and fractures fixed with k-wire augmented volar plate would have similar results in terms of joint range of motion, functional scoring, and grip strength, while k-wire augmented volar plating would be superior in terms of radiological evaluations.

Methods

In this retrospective study, we analyzed 42 patients who were treated with either a volar locking plate or a K-wire-augmented volar locking plate for intra-articular, comminuted distal radius fractures (AO type C) between February 2008 and December 2014 at Haseki Training and Research Hospital. The study was approved by the hospital's Institutional Review Board, and informed consent was obtained from all patients. Inclusion criteria were patients aged ≥16 years who had no follow-up loss and responded to the final follow-up call. Patients were excluded if they were aged <16 years, had additional injuries in the same extremity, a history of previous surgery, medical contraindications, open or pathological fractures, bilateral wrist fractures, refused study participation, or presented with AO type A or B fractures. Patients under 16 were excluded to control for the potential impact of bone remodeling on fracture healing. Of the initial 42 patients, six did not meet the inclusion criteria, resulting in a final sample of 36 patients who underwent surgery. (Figure 1.) These patients were classified into two groups based on fixation technique: Group I received volar locking plate fixation (Figures 2a–2d), and Group II received K-wire-augmented volar locking plate fixation (Figures 3a–3d).

Preoperative evaluation of DRFs was conducted using wrist X-rays and computed tomography, and fractures were classified according to the AO classification system [4]. The distribution of fracture types was as follows: Group I - C1 (n=6), C2 (n=9), C3 (n=3); Group II - C1 (n=6), C2 (n=8), C3 (n=4) (Table 1).

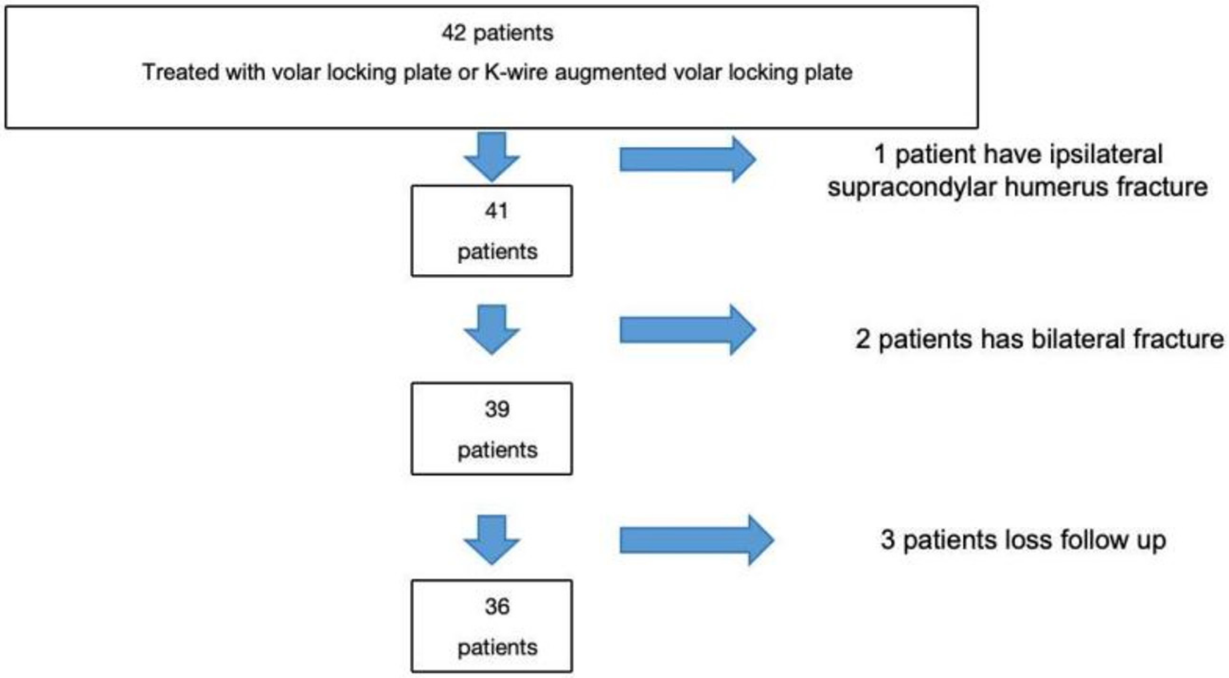

Figure 1. Inclusion and exclusion criterias

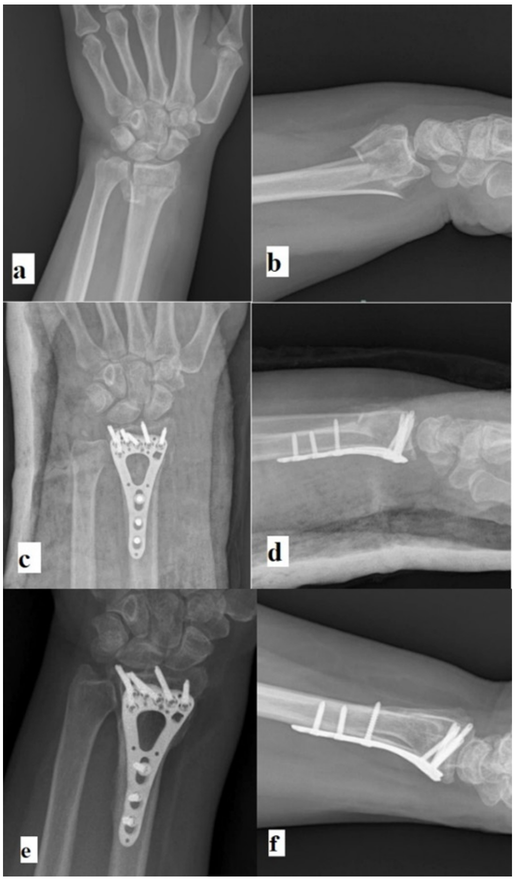

Figure 2. A 45-year-old female patient with an intra-articular fracture of the left radius (AO C2). AP/lateral radiographs in the pre-operative period (a, b). Early radiographs following open reduction with a volar plate (Group I) (c, d). AP/lateral radiographs of the patient at the postoperative 24th month (last follow-up) (e, f).

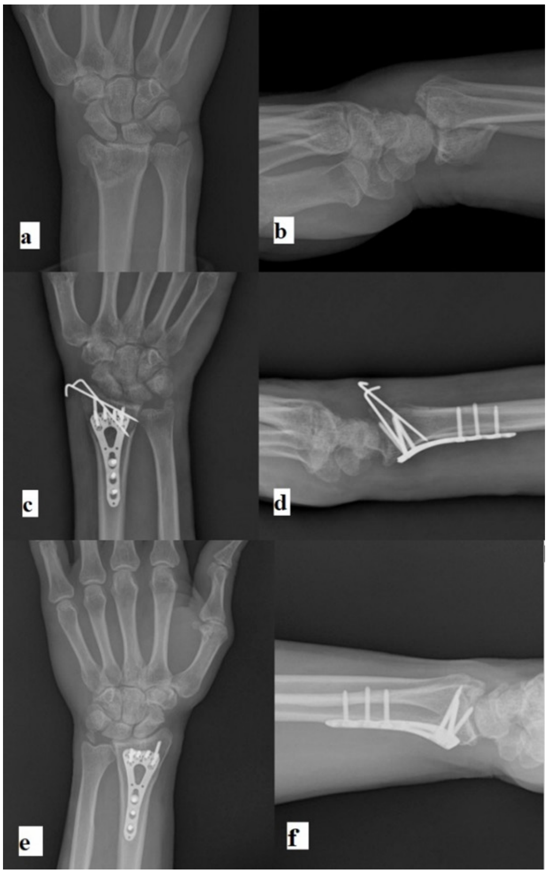

Figure 3. A 54-year-old male patient with an intra-articular fracture of the right radius (AO C2). AP/lateral radiographs in the pre-operative period (a, b). Early radiographs of the patient who underwent K-wire augmented volar locking plate (Group II) (c, d). AP/lateral radiographs of the patient at the postoperative 48th month (last follow-up) (e, f).

Table 1. Patient characteristics of 36 patients treated for type C distal radius fracture in both groups. SD: Standard deviation

Variable	Group I (Volar locking plate) (n=18)	Group II (K-wire augmented volar locking plate) (n=18)	P value
Age (years) (Mean ± SD)	50,05±15,39 (range: 41-87)	53,16±14,19 (range: 41-87)	0.65
Sex			
Female	7	7	1
Male	11	11	
AO type of fracture			
23-C1	6	6	0.9
23-C2	9	8	
23-C3	3	4	
Affected hand (n)			
Right	8	10	0.74
Left	10	8	
Dominant hand (n)			
Right	16	17	0.5
Left	2	1	
Follow-up mean (month)	44,00±22,35 (range: 18-104)	51,44±23,54 (range: 10-100)	0.39
Time interval between trauma and operation (Mean ± SD, range, day)	11,11±5,07 (range: 1-21)	11,66±7,95 (range: 3-30)	0.62
Time of bone healing (Mean ± SD, range, week)	7,27±3,17 (range :4-14)	7,22±2,66 (range: 4-12)	0.91
Complications (n)			
Tenosynovitis	2	2	0.54
Carpal tunnel syndrome (CTS)	1	1	
Pin site infection	0	2	

Surgical Technique

All surgeries were performed by a senior orthopedic surgeon. Patients received a single preoperative dose of 2 g cefazolin administered intravenously, and a proximal tourniquet was applied at 250 mmHg. A skin incision was marked along the volar Henry approach [8]. In Group I, following skin incision, the flexor carpi radialis (FCR) tendon was retracted radially, and the pronator quadratus muscle was detached from its origin and shifted to the ulnar side, exposing the fracture site. After achieving reduction with temporary K-wires under fluoroscopy, a 2.4-mm variable angle, locking compression 2-column distal radius plate (Synthes, Paoli, PA) was secured with locking screws, and K-wires were removed post-fixation. The pronator quadratus muscle was then repaired, the tourniquet was released, hemostasis was achieved, and the skin was closed in layers. In Group II, the same procedure was followed, with the addition of 1.5-mm diameter K-wires to stabilize intra-articular fragments after reduction. An average of two K-wires was used per patient, with the wire ends bent outside the skin.

Postoperative Management

Postoperatively, a soft resting wrist cast was applied to both groups. On the first postoperative day, active and passive exercises for finger and elbow joints were initiated under physiotherapy guidance. The cast was removed after two weeks, following clinical and radiographic evaluation. During follow-ups, patients were encouraged to perform muscle-strengthening and wrist range of motion exercises according to the degree of union. In Group II, wire ends were checked for infection every three days, and the supportive K-wires were removed at six weeks.

Evaluation

Radiographic evaluations were performed using standard posterior-anterior and lateral wrist radiographs during the final postoperative follow-up (Figures 2e, 2f, 3e, and 3f). Comparisons were made between the affected and unaffected sides, measuring radial length, radial inclination, and dorsal angulation for each patient through a calibrated hospital digital imaging system (PACS). Anatomical findings were assessed according to **Stewart's radiological criteria [10].**

Joint range of motion was objectively measured with a standard goniometer at the final follow-up, referencing the healthy side. Grip strength was evaluated using the Jamar Hand Dynamometer (Jamar, Preston, USA), with comparisons made to the unaffected wrist (scored 0 = completely impaired to 100 = normal function). Demographic data, including age, gender, hand dominance, fracture type, and complications, were recorded.

An independent observer conducted a subjective functional evaluation using the Turkish version of the QuickDASH scale [11], visual analog scale (VAS), Gartland-Werley scale [12], and Mayo wrist score at the final follow-up. The mean follow-up duration was 44.00 ± 22.35 months (range: 18–104 months) for the volar locking plate group (Group I) and 51.44 ± 23.54 months (range: 20–100 months) for the K-wire-augmented volar locking plate group (Group II), with no statistically significant difference observed between the groups (Table 1).

Statistical Analysis

The statistical analyses were conducted using SPSS version 22.0 (IBM Corp, 2011, Armonk, New York). Group differences were analyzed using the Mann-Whitney U test, chi-square test, and, when applicable, Student's t-test. A p-value of ≤ 0.05 was considered statistically significant.

Results

All fractures healed without the need for additional intervention. No patients experienced distal radioulnar instability. Group I experienced complications in three patients, with one case of carpal tunnel syndrome (CTS) and two cases of tenosynovitis. In Group II, complications arose in five patients, with carpal tunnel syndrome in one patient, tenosynovitis in two, and superficial pin infection in two (Table 1). Patients with superficial pin infections were treated with oral antibiotics and daily dressing. No deep bone infections were observed at the final follow-up. All cases of tenosynovitis and carpal tunnel syndrome resolved with medical treatment and physical therapy. No patients experienced joint stiffness or reflex sympathetic dystrophy during follow-up.

There were no statistically significant differences in demographic characteristics between groups (p>0.05) (Table 1). The two groups showed similarity in terms of age, gender, fracture type distribution, interval between trauma and surgery, and bone healing time (p=0.65, p=1, p=0.9, p=0.62, and p=0.91, respectively).

The final postoperative mean active range of motion for both groups is displayed in Table 2. Although Group I demonstrated slight superiority in flexion, extension, supination, and pronation, no statistically significant difference was found between groups regarding wrist joint range of motion (all p values >0.05) (Table 2). Grip strength was marginally higher in Group I at the final follow-up but without statistical significance (p=0.38). Group I's mean grip strength was 29.50±8.25 kg (range: 8–42), equating to 80% of the healthy side, while Group II's mean grip strength was 26.88±15.61 kg (range: 4–45), representing 73% of the healthy side (Table 2). The mean VAS score in Group I was 0.77±1.00 (range: 0–0.3) compared to 2.44±2.77 (range: 0–1) in Group II. Although Group I showed an advantage, the difference was not statistically significant (Table 2).

Table 2. Comparison of wrist range of motion and functional assessments of the two treatment groups at final follow-up. SD: Standard deviation. QuickDASH: Quick Disability of the Arm, Shoulder, and Hand

Variable	Group I	Group II	
Range of motion at final follow-up (°)			
Flexion (°) (Mean ± SD)	64,61±24,90 (range: 5-95)	57,83±21,62 (range: 15-90)	0.28
Extension (°) (Mean ± SD)	66,11±21,52 (range: 25-90)	59,16±19,19 (range: 15-90)	0.24
Supination (°) (Mean ± SD)	79,44±12,35 (range: 45-90)	73,61±16,16 (range: 45-90)	0.28
Pronation (°) (Mean ± SD)	80,00±12,60 (range: 45-90)	71,94±8,32 (range: 30-90)	0.15
Radial deviation (°) (Mean ± SD)	16,94±7,88 (range: 5-30)	16,83±9,10 (range: 3-35)	0.91
Ulnar deviation (°) (Mean ± SD)	25,50±10,45 (range: 5-40)	24,16±10,18 (range: 5-50)	0.59
Grip strength (kg)	29,50±8,25 (range: 8-42)	26,88±15,61 (range: 4-45)	0.38
Visual Analogue Scale	0,77±1,00 (range: 0-0.3)	2,44±2,77 (range: 0-1)	0.08
Mayo Wrist Score (Total points)	80,00±16,35 (range: 30-100)	75,00±12,24 (range: 50-90)	0.17
Poor (n)	1	4	0.14
Fair (n)	5	4	
Good (n)	5	8	
Excellent (n)	7	2	
Gartland & Werley Score (Total points)	4,22±4,68 (range: 0-14)	6,44±6,06 (range: 0-22)	0.36
Poor (n)	0	1	0.21
Fair (n)	5	5	
Good (n)	2	6	
Excellent (n)	11	6	
QuickDASH scale	8,96±11,28 (range: 0-40,90)	14,17±16,59 (range: 0-47,72)	0.38

In Group I, the mean Mayo wrist score was 80.00±16.35 (range: 30–100), with results being excellent in seven patients, good in five, fair in five, and poor in one. Group II's mean Mayo wrist score was 75.00±12.24 (range: 50–90), with excellent results in two patients, good in eight, fair in four, and poor in four. No significant difference was observed between groups regarding Mayo wrist score distribution (p=0.14) or means (p=0.17) (Table 2). The mean Gartland-Werley score in Group I was 4.22±4.68 (range: 0–14), yielding excellent results in eleven patients, good in two, and fair in five. In Group II, the mean Gartland-Werley score was 6.44±6.06 (range: 0–22), with excellent results in six patients, good in six, fair in five, and poor in one. No significant difference was noted between groups for Gartland-Werley score distribution (p=0.21) or means (p=0.36) (Table 2). The mean QuickDASH score was 8.96±11.28 (range: 0–40.90) in Group I and 14.17±16.59 (range: 0–47.72) in Group II, with no statistically significant difference (p=0.38) (Table 2).

The final follow-up radiological measurements for both groups are presented in Table 3. Both groups were comparable regarding radial height (p=0.61), radial inclination (p=0.87), and volar tilt (p=0.78). Radial length and tilt losses did not differ significantly from the healthy side in either group (p=0.98 and p=0.96, respectively) (Table 3). In Group I, the mean Stewart score was 1.83±2.70 (range: 0–10), with results classified as excellent in ten patients, good in six, and fair in two. Group II's mean Stewart score was 1.94±1.39 (range: 0–5), with excellent results in five patients, good in twelve, and fair in one. No statistically significant differences were found between groups in terms of Stewart score distribution (p=0.15) or means (p=0.35) (Table 3).

Discussion

This study aimed to evaluate the impact of additional Kirschner wires alongside volar plating on the final follow-up outcomes in terms of range of motion, grip strength, functional scores, and radiological measurements in DRFs with intra-articular collapsed osteochondral fragments. The findings support our initial hypothesis that, although Group I had minor advantages, both techniques would yield comparable outcomes in range of motion, functional scores, and grip strength. However, the lack of significant differences in radiological measurements and scoring between the two techniques does not support our secondary hypothesis.

Table 3. Comparison of radiographic measurements at last follow-up between the two groups. SD: Standard deviation.

Variable	Group I (Volar locking plate) (n=18) (Mean ± SD)	Group II (K-wire augmented volar locking plate) (n=18) (Mean ± SD)	P value
Radial height (mm)	10,61±4,03 (range: 0-15)	10,58±3,64 (range: 4-17)	0,61
Loss of radial length (mm)	3,22±4,26 (range: 0-14)	2,64±2,87 (range: 0-9)	0,98
Radial inclination (°)	18,77±6,59 (range: 2-30)	19,47±4,90 (range: 10-30)	0,87
Loss of radial inclination (°)	3,94±5,12 (range: 0-19)	3,52±4,15 (range: 0-12)	0,96
Volar tilt (°)	7,94±5,41 (range: 0-16)	7,47±3,76 (range: 1-13)	0,78
Stewart score (Total points)	1,83±2,70 (range: 0-10)	1,94±1,39 (range: 0-5)	0,35
Fair (n)	2	1	0.15
Good (n)	6	12	
Excellent (n)	10	5	

Restoring the joint surface and preserving radial height are crucial in the surgical management of comminuted distal radius fractures to protect cartilage and restore normal wrist kinematics [13]. Postoperative joint surface incongruity has been associated with arthritic changes in the wrist [14]. Various approaches to treating comminuted distal radius fractures have been studied extensively [15-17]. Treatment choice is influenced by surgeon preferences, potential complications, and patient factors such as lifestyle, age, comorbidities, mental attitude, and compliance [18,19]. Open reduction and volar plating have become widely accepted approaches for comminuted DRFs, yet these fractures remain challenging for orthopedic surgeons.

Anatomical plates for distal radius fractures generally align well with the average distal radius contour, but variations in patient anatomy and plate design can cause distal screws to be positioned below the joint line, potentially compromising contact with osteochondral fragments [20]. Consequently, osteochondral fragment stability relies on the surrounding bone, which is less rigid and more susceptible to collapse. Our secondary hypothesis—that radiological outcomes might favor the K-wire-augmented volar locking plate group—was based on these anatomical and design limitations. However, our findings showed no significant difference between groups in terms of radial height, radial length loss, radial inclination, radial inclination loss, volar tilt, or Stewart score.

There remains no consensus in the literature on the optimal surgical approach for comminuted distal radius fractures [21,22]. K-wire-augmented external fixation has been reported to yield favorable results, particularly in very distal fractures where screws alone cannot secure osteochondral fragments [8, 17, 23, 24]. Egol et al. found that volar locking plates, as opposed to K-wire-supported external fixation, provided better range of motion and radiological outcomes at three and six months, with better long-term pronation preservation in the volar plating group [17]. Additionally, patients treated with external fixation required twice as much postoperative physiotherapy [17]. Gereli et al. reported improved wrist flexion and supination with volar plate fixation in intra-articular distal radius fractures, with no significant differences in grip strength loss, return-to-work time, Gartland-Werley score, and QuickDASH score between groups [8]. Another study found a significant advantage in wrist pronation and supination in the volar plate group compared to the K-wire-supported external fixation group at early follow-up, with the volar plate group demonstrating better grip strength after one year [24]. Kumbaracı et al. observed no significant difference in grip strength between groups after 12 months, despite the early initiation of wrist ROM exercises in the volar plating group [25]. In our study, no significant difference was found between groups regarding wrist ROM, grip strength, or functional scores (VAS, Mayo Wrist Score, Gartland-Werley Score, QuickDASH) at the final follow-up, aligning with previous literature comparing volar locking plates and K-wire-supported external fixation for intra-articular distal radius fractures.

Minimizing the articular step-off and restoring radial length are key radiological criteria associated with improved postoperative outcomes [26]. Gereli et al. reported that volar plating was superior to K-wire-supported external fixation in preserving ulnar variance and correcting palmar angulation [8]. Similarly, Duramaz et al. demonstrated that all radiological parameters except ulnar variance and palmar tilt favored volar plating over K-wire-supported external fixation [23]. In our study, radiological parameters (radial height, radial length loss, radial inclination, radial inclination loss, volar tilt) were similar between the K-wire-augmented and volar locking plate groups in treating intra-articular distal radius fractures, with no significant difference observed in the Stewart score.

It is essential to consider that excessive distraction and prolonged fixation with K-wire-supported bridge external fixators, commonly used for comminuted distal radius fractures, can lead to complications [27]. Common complications include superficial radial nerve injury, reflex sympathetic dystrophy, grip strength loss, fixation loss, pin tract infections, and joint stiffness [27]. Moreover, loss of palmar angulation may persist long-term, even after fixator removal [27]. Managing these complications is challenging and negatively impacts treatment success. Additionally, studies have shown higher patient satisfaction with volar plating compared to K-wire-supported bridge external fixation for comminuted distal radius fractures [8, 23]. Our study similarly found no significant difference in functional and radiological outcomes when percutaneous pinning was combined with volar plating.

The limitations of this study include its retrospective design, small sample size, lack of randomization, and absence of follow-up data beyond the final assessment. However, the study's strengths include homogeneous demographic data in terms of age, gender, hand dominance, affected hand, time between trauma and surgery, and fracture type. Furthermore, our study provided an average follow-up of at least 44 months for both groups.

Conclusion

In conclusion, our study data did not demonstrate any clinical or radiological superiority of K-wire support when added to volar locking plating in the treatment of comminuted distal radius fractures. In distally located intra-articular distal radius fractures, subchondrally placed distal screws in volar locking plates appear to provide sufficient stability to free osteochondral fragments via a buttress effect. We suggest that the potential impact of K-wire support on radiological outcomes may become evident with a larger sample of AO type C3 distal radius fractures, particularly those involving multiple osteochondral fragments.

Conflict of Interest: The authors declare no conflict of interest related to this article.

Funding sources: The authors declare that this study has received no financial support.

Ethics Committee Approval: Haseki Training and Research Hospital Clinical Research Ethics Committee, 01.03.2023-36-2023

ORCID and Author contribution: **C.Y (0000-0003-4540-1927):** Conceptualization, Writing, Formal Analysis, Supervision. **M.E (0000-0001-5251-8280):** Review, Editing; Formal Analysis, Supervision. **Ş.D. (0000-0002-2477-4321):** Investigation, Review, Editing, **O.G.M. (0000-0003-0049-7937):** Review, Eiting, **H.Ö. (0000-0001-9008-6490):** Investigation, Data collection **O.A. (0000-0002-1262-6073):** Review, Editing.

REFERENCES

1. Shapiro LM, Kamal RN; Management of Distal Radius Fractures Work Group; Nonvoting Clinical Contributor; Nonvoting Oversight Chairs; Staff of the American Academy of Orthopaedic Surgeons and the American Society for Surgery of the Hand. Distal Radius Fracture Clinical Practice Guidelines-Updates and Clinical Implications. J Hand Surg Am. 2021;46(9):807-11. doi: 10.1016/j.jhsa.2021.07.014.
2. Leung F, Tu YK, Chew WY, Chow SP. Comparison of external and percutaneous pin fixation with plate fixation for intra-articular distal radial fractures. A randomized study. J Bone Joint Surg Am. 2008;90(1):16-22. doi: 10.2106/JBJS.F.01581.
3. Trumble TE, Culp RW, Hanel DP, Geissler WB, Berger RA. Intra-articular fractures of the distal aspect of the radius. Instr Course Lect. 1999;48:465-80. PMID: 10098077.
4. Muller ME, Nazarian S, Koch P, Schatzker J. The comprehensive classification of fractures of long bones. Berlin: Springer-Verlag. 1990. p. 100-101.
5. Chhabra AB, Yildirim B. Adult Distal Radius Fracture Management. J Am Acad Orthop Surg. 2021;29(22):e1105-16. doi: 10.5435/JAAOS-D-20-01335.
6. Liporace FA, Adams MR, Capo JT, Koval KJ. Distal radius fractures. J Orthop Trauma. 2009;23(10):739-48. doi: 10.1097/BOT.0b013e3181ba46d3.
7. Lichtman DM, Bindra RR, Boyer MI, Putnam MD, Ring D, Slutsky DJ, et al. Treatment of distal radius fractures. J Am Acad Orthop Surg. 2010;18(3):180-9. doi: 10.5435/00124635-201003000-00007.
8. Gereli A, Nalbantoğlu U, Kocaoğlu B, Türkmen M. Comparison of palmar locking plate and K-wire augmented external fixation for intra-articular and comminuted distal radius fractures. Acta Orthop Traumatol Turc. 2010;44(3):212-9. doi: 10.3944/AOTT.2010.2325.
9. Micic I, Kholinne E, Sun Y, Kwak JM, Jeon IH. The role of additional K-wires in AO type C distal radius fracture treatment with external fixator in young patients. Adv Orthop. 2019;2019:8273018. doi: 10.1155/2019/8273018.
10. Stewart HD, Innes AR, Burke FD. Functional cast bracing for Colles' fractures: a comparison between cast bracing and conventional plaster casts. J Bone Joint Surg Br. 1984;66(5):749-53. doi: 10.1302/0301-620X.66B5.6389558.
11. Öksüz Ç, Düger T. Quick DASH Turkish. Available from: https://dash.iwh.on.ca/sites/dash/public/translations/QuickDASH_Turkish_2012.pdf access date: 24/06/2024
12. Gartland JJ Jr, Werley CW. Evaluation of healed Colles' fractures. J Bone Joint Surg Am. 1951;33-A(4):895-907. PMID: 14880544.
13. Wolfe SW. Patterns and treatment of distal radius fractures. In: Proceedings of the AAOS/ASSH update on the painful and injured wrist. May 29-30, 2009; Rosemont, IL; 2009. p. 66.
14. Trumble TE, Schmitt SR, Vedder NB. Factors affecting functional outcome of displaced intra-articular distal radius fractures. J Hand Surg Am. 1994;19(2):325-40. doi: 10.1016/0363-5023(94)90028-0.
15. Jupiter JB, Marent-Huber M. Operative management of distal radial fractures with 2.4-mm locking plates: a multicenter prospective case series. J Bone Joint Surg Am. 2009;91(1):55-65. doi: 10.2106/JBJS.G.01498.
16. Hull P, Baraza N, Gohil M, Whalley H, Mauffrey C, Brewster M, Costa ML. Volar locking plates versus K-wire fixation of dorsally displaced distal radius fractures: a functional outcome study. J Trauma. 2011;70(6): E125–8. doi: 10.1097/TA.0b013e3181e32714.
17. Egol K, Walsh M, Tejwani N, McLaurin T, Wynn C, Paksima N. Bridging external fixation and supplementary Kirschner-wire fixation versus volar locked plating for unstable distal radius fractures: a randomized, prospective trial. J Bone Joint Surg Br. 2008;90(9):1214–21. doi: 10.1302/0301-620X.90B9.20521.
18. Rundgren J, Bojan A, Mellstrand Navarro C, Enocson A. Epidemiology, classification, treatment, and mortality of distal radius fractures in adults: an observational study of 23,394 fractures from the national Swedish fracture register. BMC Musculoskeletal Disord. 2020; 21(1):88. doi: 10.1186/s12891-020-3097-8.
19. Demirbaş ER, Uğraş AA, Kaya I, Sungur I, Kural C, Cetinus E. Volar plate fixation of distal radius fractures. Ulus Travma Acil Cerrahi Derg. 2012;18(2):162-6. doi: 10.5505/tjtes.2012.64022.
20. Lee J, Lee S, Sim Y, et al. Juxta-articular plate fixation in distal radius intra-articular fractures with accompanying volar free fragments beyond the watershed line. Clin Orthop Surg. 2018;10(2):135-141. doi: 10.4055/cios.2018.10.2.135.
21. Tariq MA, Ali U, Uddin QS, Altaf Z, Mohiuddin A. Comparison between volar locking plate and Kirschner wire fixation for unstable distal radius fracture: a meta-analysis of randomized controlled trials. J Wrist Surg. 2023;13(5):469-80. doi: 10.1055/s-0043-1768235.
22. Paksima N, Panchal A, Posner MA, et al. A meta-analysis of the literature on distal radius fractures: review of 615 articles. Bull Hosp Jt Dis. 2004;62(1):40-46. PMID: 15517856.
23. Duramaz A, Bilgili MG, Karaali E, Bayram B, Ziroğlu N, Kural C. Volar locking plate versus K-wire-supported external fixation in the treatment of AO/ASIF type C distal radius fractures: a comparison of functional and radiological outcomes. Ulus Travma Acil Cerrahi Derg. 2018;24(3):255–62. doi: 10.5505/tjtes.2017.35837.
24. Mishra RK, Sharma BP, Kumar A, Sherawat R. A comparative study of variable angle volar plate and bridging external fixator with K-wire augmentation in comminuted distal radius fractures. Chin J Traumatol. 2021;24(5):301–5. doi: 10.1016/j.cjtee.2021.04.005.
25. Kumbaracı M, Kucuk L, Karapinar L, Kurt C, Coskunol E. Retrospective comparison of external fixation versus volar locking plate in the treatment of unstable intra-articular distal radius fractures. Eur J Orthop Surg Traumatol. 2014;24(2):173-8. doi: 10.1007/s00590-012-1155-0.
26. Trumble TE, Schmitt SR, Vedder NB. Factors affecting functional outcome of displaced intra-articular distal radius fractures. J Hand Surg Am. 1994;19(2):325-40. doi: 10.1016/0363-5023(94)90028-0.
27. Kaempffe FA, Walker KM. External fixation for distal radius fractures: effect of distraction on outcome. Clin Orthop Relat Res. 2000;(380):220–5. doi: 10.1097/00003086-200011000-00030.