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Original Article

Surgical Treatment of Bilateral Distal Radius Fractures: An Analysis of Epidemiological Variables and Outcome Parameters

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ABSTRACT

Objective: Bilateral Distal Radius Fractures (DRFs) are rare injuries with an unknown exact incidence. The existing literature on treatment and outcomes consists of a limited number of case reports and retrospective case series. Our aim was to investigate the epidemiological factors and report the clinical and radiological outcomes of surgically treated bilateral distal radius fractures.

Methods: Patients admitted to two different tertiary trauma centers between 2021 and 2023 with a diagnosis of bilateral DRF treated surgically were examined. Demographic data, fracture types, concomitant fractures and injuries, presence or absence of ulna fracture, and presence of complications were evaluated in all patients. Functional results were evaluated with the Quick Disabilities of the Arm, Shoulder and Hand Questionnaire (QDASH) Scoring System, and radiological results were assessed with radial shortening, radial inclination, and volar tilt parameters.

Results: The most common concomitant fractures were elbow fractures (71.4%), and the most common fractures around the elbow were radial head fractures (42.9%). In the lower extremity, femur fractures were the most common concomitant injuries. The mean QDASH score was 24.1 ± 17.8 (range: 6.8-75) at the last follow-up of the operated patients. In patients with concomitant fractures, the level of comminution of the distal radius fracture was lesser, but the postoperative radial shortness was higher on the dominant side (P = .032 and P = .029, respectively).

Conclusion: Bilateral distal radius fractures are significant injuries that can be effectively treated with volar plate fixation. With volar plating, QDASH scores similar to unilateral DRFs can be achieved in bilateral DRFs. Despite their rarity, it is important to recognize their potential association with the fractures near the elbow.

Keywords: Bilateral distal radius fractures, distal radius fracture, bilaterality, radial shortening, concomitant fractures

INTRODUCTION

Distal radius fractures (DRF), along with hip fractures and proximal humerus fractures, are among the most common fractures seen in emergency departments.[1] DRF have a bimodal distribution pattern and are common among young men after high-energy injuries and postmenopausal women after low-energy injuries.[2] There is no consensus in the literature on the optimal treatment of DRF. Depending on the fracture pattern and patient characteristics, many treatment options are used in clinical practice, ranging from immobilization with a cast to internal fixation with a single or double plate.[2,3] Particularly for intra-articular fractures and in younger patients with active use of the hand, surgery is the most common treatment option. However, several authors stress the importance and efficacy of conservative treatment and report similar outcomes in medium- to long-term follow-up.[4,5]

In contrast to unilateral DRF, bilateral DRF are rare injuries of unknown incidence. Although there is extensive literature on the epidemiology and management of unilateral DRF, the existing literature on treatment and outcomes consists of a limited number of case reports and retrospective case series.[6-13] Several studies in the literature report that surgical treatment is preferred because

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it is a common consequence of high-energy trauma.[11,13] Graham et al. reported the results of Open Reduction and Internal Fixation (ORIF) in 10 patients and observed high complication rates with no significant difference in the range of motion and radiological parameters at postoperative follow-up.[13] A retrospective study of 21 patients with bilateral DRF compared the results of external fixation and ORIF and showed that the fixator could be an important alternative with no significant difference in complication rates.[12]

Our aim in this double-center study was to investigate the epidemiological factors and report the clinical and radiological outcomes of surgically treated bilateral distal radius fractures.

MATERIAL AND METHODS

Study Population and Data Collection

After Ankara Bilkent City Hospital Clinical Research Ethics Committee approval (number: E1-22-2902, date: September 21, 2022) was obtained, patients operated on at two different tertiary trauma centers between 2021 and 2023 with a bilateral distal radius fracture diagnosis were studied. Written informed consent was obtained from the patients who agreed to take part in the study. All patients aged 18 years and older and who underwent surgery with volar plates were included in the study. Patients with pathological fractures, patients who were treated conservatively, patients who did not attend regular postoperative follow-up visits, patients with musculoskeletal diseases (i.e., cerebral palsy) that would interfere with the evaluation, and patients who refused to participate in the study were excluded from the study. According to the inclusion and exclusion criteria, 18 patients were analyzed in the study.

Postoperative Assessment

In addition to demographic data such as age and sex, injury mechanisms, dominant sides, fracture types, concomitant fractures, and injuries, presence or absence of open fracture, presence or absence of ulna fracture, and presence of complications were assessed. In the analysis of concomitant fractures, ulna fractures were considered an independent parameter due to their anatomical proximity to the distal radius and their predisposition to injury with a similar mechanism. The Frykman classification was used to classify the bilateral DRF.[14] Open fractures were classified according to the Gustilo–Anderson classification system.[15]

Functional Evaluation

To evaluate functional outcomes with the Quick Disabilities of the Arm, Shoulder and Hand Questionnaire (QDASH) Scoring System, all patients who completed the minimum follow-up of one year were called for follow-up using the telephone numbers in the system. The Quick DASH Scoring System is an 11-item measurement system that assesses upper extremity symptoms and disability. The first six items measure the difficulty level in performing various physical activities due to hand, arm, and shoulder problems, while the remaining five assess the level of pain and numbness in social and daily activities and sleep quality.[16,17]

Radiological Evaluation

The parameters radial shortness, radial inclination, and volar tilt, commonly used in the literature to analyze DRF, were used to assess radiological findings.[16,18] Radial shortening is measured on an antero-posterior radiograph as the distance between a line drawn perpendicular to the long axis of the radius and tangential to the most distal ulna and a line drawn perpendicular to the long axis of the radius and tangential to the most distal point of the radial styloid. Again on antero-posterior radiograph, the radial inclination is the angle between the line drawn from the end of the radial styloid to the medial corner of the radial articular surface and the line drawn perpendicular to the long axis of the radius. The volar inclination is the angle between the line joining the volar and dorsal end points of the radius on the full lateral radiograph and the line drawn parallel to the long axis of the radius (Figures 1-3).

Statistical Analysis

Statistical analysis was performed using International Business Machiness (IBM®) Statistical Package for the Social Sciences (SPSS®) software v.26.0 (IBM SPSS Corp.; Armonk, NY, USA). The conformity of variables to normal distribution was analyzed by visual (histogram and probability plots) and analytical (Kolmogorov–Smirnov test) methods. As all the variables were skewed distributed, descriptive statistics were expressed as median, interquartile range, and minimum–maximum values. Categorical data were expressed as percentage frequency values. Mann–Whitney *U*-test was used to compare independent binary data groups. The chi-square test was used to compare categorical data, and Fisher's exact test

MAIN POINTS

- Bilateral DRF is usually associated with high-energy injuries, and fractures around the elbow are the most common associated fractures.
- QDASH scores in bilateral DRF treated with the volar plate are similar to the results of unilateral DRF reported in the literature.
- In patients with concomitant fractures, the level of comminution of the bilateral DRF was less, but the postoperative radial shortness was higher at the dominant side.

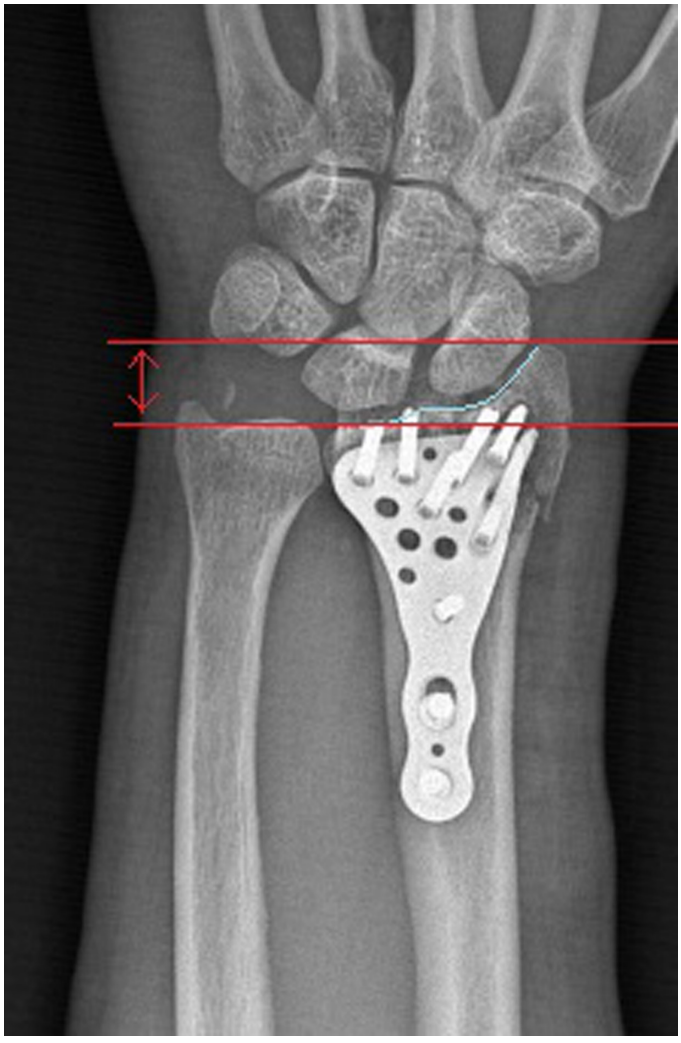

Figure 1. The measurement of radial shortening in a postoperative patient. Radial shortening is measured as the distance between a line drawn perpendicular to the long axis of the radius and tangential to the most distal ulna and a line drawn perpendicular to the long axis of the radius and tangential to the most distal point of the radial styloid.

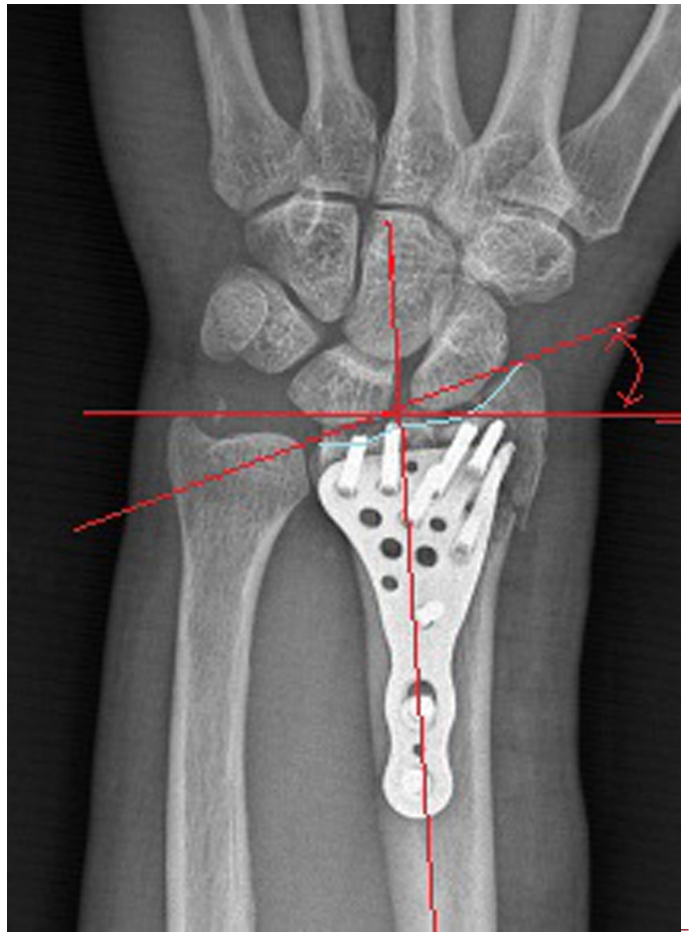

Figure 2. The measurement of radial inclination in a postoperative patient. The radial inclination is the angle between the line drawn from the end of the radial styloid to the medial corner of the radial articular surface and the line drawn perpendicular to the long axis of the radius.

was used when the chi-square assumption was not met. Statistical significance was considered significant when the *P* value was less than .05.

RESULTS

Of the 18 patients included in the study, 66.7% were injured after high-energy trauma. Only four patients (22.2%) had isolated bilateral DRF without concomitant ulna fractures in both wrists. In two patients, unilateral distal ulna fracture was accompanied by bilateral DRF. Seven patients (38.9%) had other concomitant fractures other than ulna fracture. When the concomitant fractures were analyzed, it was seen that the most common injuries were fractures around the elbow (71.4%), and the most common fractures around the elbow were fractures of the radius head (42.9%). In the lower extremity, femur fractures were the most common concomitant injuries. The mean QDASH score was 24.1 ± 17.8 (range: 6.8-75) at the last follow-up of the operated patients. The demographic characteristics of the patients are shown in Table 1, the detailed classification of the fractures in Table 2, the distribution of associated injuries in Table 3, and the postoperative functional and radiological results of the fractures in Table 4.

When patients with and without concomitant fractures were compared, it was found that there was a significant difference in terms of dominant side fracture type and dominant side postoperative radial shortness ($P = .032$ and $P = .029$, respectively). In patients with concomitant fractures, the level of comminution of the distal radius fracture at the dominant side was found to be less severe. Moreover, the postoperative radial shortness was observed to be higher on the dominant side among the surgically treated bilateral DRF patients with concomitant

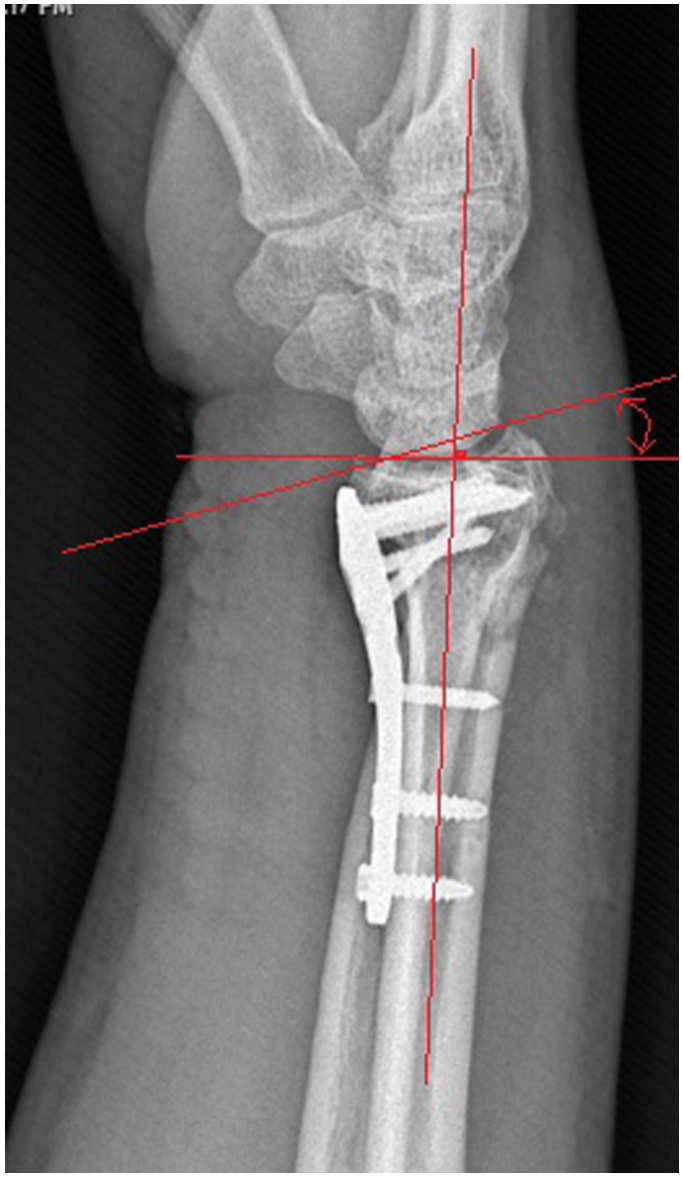

Figure 3. The measurement of volar inclination in a postoperative patient. The volar inclination is the angle between the line joining the volar and dorsal end points of the radius on the full lateral radiograph and the line drawn parallel to the long axis of the radius.

fractures. No additional significance was found in terms of other fracture characteristics and postoperative parameters.

DISCUSSION

Although there is a significant amount of literature on unilateral distal radius fractures, the incidence of bilateral distal radius fractures remains unknown, and there is no consensus on their management due to their rarity. This double-center study aims to investigate the epidemiological factors and report the clinical and radiological outcomes of surgically treated bilateral distal radius fractures. This study's main strength is its contribution to the limited number of case series in the literature.[6-13] Our findings will contribute to the understanding of this rare condition and offer valuable insights for its management.

Table 1. Demographic Profile of the Patients

		Surgically Treated Bilateral DRF (%) (n = 18)
Age*		**45.6 (15.58) (Range: 18-77)**
Gender	Female	4 (22.2%)
	Male	14 (77.8%)
Dominant Side	Right	14 (77.8%)
	Left	4 (22.2%)
Injury Mechanism	Basic Fall	6 (33.3%)
	Fall from Height	9 (50%)
	Vehicle Accident	3 (16.7%)
Concomitant Fractures	None	11 (61.1%)
	Yes	7 (38.9%)

DRF, distal radius fracture; n, number of patients.
*Categorical variables are described as frequency (percentage), whereas "age" is described as median (interquartile range) (minimum–maximum value).

Table 2. Distal Radius Fracture Type and Accompanying Ulna Fractures

			Surgically Treated Bilateral DRF (%) (n = 18)
Bilateral Distal Radius Fracture Frykman Type	Dominant Side	Type 1	1 (5.6%)
		Type 3	1 (5.6%)
		Type 4	2 (11.1%)
		Type 5	1 (5.6%)
		Type 6	1 (5.6%)
		Type 7	4 (22.2%)
		Type 8	8 (44.4%)
	Non-dominant Side	Type 2	1 (5.6%)
		Type 5	2 (11.1%)
		Type 6	1 (5.6%)
		Type 7	3 (16.7%)
		Type 8	11 (61.1%)
Concomitant Ulna Fracture	Dominant Side	None	4 (22.2%)
		Styloid	9 (50%)
		Metaphysis	5 (27.8%)
	Non-Dominant Side	None	6 (33.3%)
		Styloid	11 (61.1%)
		Metaphysis	1 (5.6%)

DRF, distal radius fracture; n, number of patients.

Table 3. Fracture Distribution of Patients with Concomitant Fractures

		Patients with Concomitant Fractures (%) (n = 7)
Elbow Fracture	Radial Head	3 (42.9%)
	Olecranon	1 (14.3%)
	Distal Humerus	1 (14.3%)
	Total	5 (71.4%)
Metacarpal Fractures		1 (14.3%)
Femur Fractures	Proximal	1 (14.3%)
	Diaphyseal	1 (14.3%)
	Distal	1 (14.3%)
	Total	3 (42.9%)
Tibial Plateau Fractures		1 (14.3%)
Patella Fractures		2 (28.6%)
Malleolar Fractures		1 (14.3%)

n, number of patients.

Our most important finding is that fractures around the elbow in the upper extremity and femur fractures in the lower extremity are commonly associated with bilateral DRF. Another important finding of our study was that in bilateral DRFs with concomitant fractures, the amount of fragmentation was lower, but postoperative radial shortening was higher on the dominant side ($P = .032$ and $P = .029$, respectively).

Table 4. Postoperative Functional and Radiological Results of the Surgically Treated Bilateral Distal Radius Fracture Patients

		Surgically Treated Bilateral DRF (%) (n = 18)
Follow-up (months)		10.9 (6.38) (range: 6-30)
QDASH Score		24.1 (17.8) (range: 6.8-75)
Radial shortening	Dominant side	7.6 (3.9) (range: 0-13.4)
	Non-dominant side	6.6 (3.1) (range: 0-13)
Radial inclination	Dominant side	19.6 (7.3) (range: 3.8-30.2)
	Non-dominant side	19.4 (4.6) (range: 12-27)
Volar tilt	Dominant side	8.9 (6) (range: −8-13)
	Non-dominant side	6.6 (5.5) (range: −8.9-12.5)

All variables are described as median (interquartile range) (minimum–maximum value).
fDRF, distal radius fracture; n, number of patients; QDASH, Quick Disabilities of the Arm, Shoulder and Hand Questionnaire Scoring System.

In our study, the majority of the injury mechanisms were high-energy injuries (66.7%). Ehsan et al., in their study of 93 bilateral DRFs, found that bilateral DRF were frequently associated with high-energy injuries, and additional fractures were more prevalent in these patients.[11] de Alencar Neto et al. conducted an epidemiologic study of 13 patients and reported that patients with bilateral DRFs resulting from high-energy injury are more likely to have ulna fractures, open fractures, and concomitant fractures. It is worth noting that the sample size of the study was small.[19] Our findings are consistent with the literature. In our research, the most common additional injuries were found to be around the elbow and femur, which supports the relationship between bilateral DRF and high-energy trauma.

In search for a superior treatment method for bilateral DRF, a study by Dağtaş et al. involving 21 patients compared external fixator and plate fixation. The results showed that the fixator group had less radial shortening, while the plate group had a longer operative time and greater radial shortening radiologically.[12] Graham et al. compared radiologic parameters, wrist range of motion, and upper extremity function in 10 patients with bilateral DRF treated with open reduction and internal fixation to studies on unilateral distal radius fractures and found no significant difference.[13] The mean QDASH score of 24.1 in our study further supports the existing literature on this topic, demonstrating consistency in our findings. Ehsan et al.'s study reported a mean QDASH score of 22.8 for the plate fixation group, while Graham et al.'s study reported a score of 24.8.[11,13]

In our study, patients with bilateral DRF and concomitant fractures exhibit a lower level of comminution but a greater amount of postoperative radial shortening on the dominant side ($P = .032$ and $P = .029$, respectively). When we considered the possible cause of this finding, we hypothesized that on the dominant side, the trauma load is distributed over a wider area due to the more controlled reflexive response during injury. In contrast, on the non-dominant side, due to the more uncontrolled reflexive response, the post-traumatic energy distribution and load are concentrated at a single point and may cause more comminution. The greater radial shortening on the dominant side with lesser comminution can confidently be attributed to the distal screw alignment of the volar plate. In the literature, it is observed that as the screws are placed further from the subchondral area, radial shortening increases during volar plating.[20] On the non-dominant side with more comminution, the screws were intentionally placed closer to the subchondral area to ensure stability, and as a result, the shortening decreased. On the other hand, on the dominant side with lesser

comminution, screws are likely to be placed further away from the subchondral area. This could potentially explain the increased radial shortening observed on the dominant side. Supporting these hypotheses requires animal models and biomechanical studies.

The study had limitations, including a limited number of patients and a retrospective design. However, a double-center study was conducted to increase the number of patients, and more comprehensive data analysis can be performed with multicenter and prospective studies. It is important to note that conservatively followed bilateral DRF was not included in this study. Furthermore, the measurements of functional parameters such as range of motion or muscle strength were not included in the study. Prospectively followed-up multicenter randomized studies, including conservatively treated patients, will objectively reveal the epidemiological characteristics and surgical parameters of bilateral DRF in the future.

In conclusion, bilateral DRF are significant injuries that can be effectively treated with volar plate fixation. With volar plating, QDASH scores similar to unilateral DRFs reported in the literature can be achieved in bilateral DRFs. Despite their rarity, it is essential to recognize their potential association with the fractures near the elbow. Multicenter prospective studies are needed to determine the optimal treatment approach.

Data Availability Statement: The datasets generated during and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

Ethics Committee Approval: Ethical committee approval was received from Ankara Bilkent City Hospital Clinical Research Ethics Committee (Decision number: E1-22-2902, date: September 21, 2022).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

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REFERENCES

1. Çaliskan E, Doğan Ö. PHILOS plate versus nonoperative treatment in 2-, 3-, and 4-part proximal humeral fractures: comparison with healthy control subjects. *J Orthop Surg (Hong Kong)*. 2019;27(3):2309499019875169. [CrossRef]
2. 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 Musculoskelet Disord*. 2020;21(1):88. [CrossRef]
3. Talmaç MA, Görgel MA, Kanar M, Tok O, Özdemir HM. Comparison of three surgical methods in the treatment of intraarticular comminuted distal radius fractures: volar locking plate, non-bridging external fixator, and bridging external fixator. *Eklem Hastalik Cerrahisi*. 2019;30(3):224-232. [CrossRef]
4. Gutiérrez-Espinoza H, Araya-Quintanilla F, Olguín-Huerta C, et al. Effectiveness of surgical versus conservative treatment of distal radius fractures in elderly patients: A systematic review and meta-analysis. *Orthop Traumatol Surg Res*. 2022;108(5):103323. [CrossRef]
5. Sobel AD, Calfee RP. Distal radius fractures in the athlete. *Clin Sports Med*. 2020;39(2):299-311. [CrossRef]
6. Gumbs VL, Segal D, Halligan JB, Lower G. Bilateral distal radius and ulnar fractures in adolescent weight lifters. *Am J Sports Med*. 1982;10(6):375-379. [CrossRef]
7. Ozkan K, Ugutmen E, Unay K, Poyanli O, Guven M, Eren A. Fractures of the bilateral distal radius and scaphoid: a case report. *J Med Case Rep*. 2008;2:93. [CrossRef]
8. Bjørnsen LP. Bilateral combined fractures of the scaphoid and distal radius in a 13-year-old male. *Acta Orthop Belg*. 2008;74(6):856-859.
9. Stone N 3rd, Karamitopoulos M, Edelstein D, Hashem J, Tucci J. Bilateral distal radius fractures in a 12-year-old boy after household electrical shock: case report and literature summary. *Case Rep Med*. 2014;2014:235756. [CrossRef]
10. Tv R, P R, Grover A, Samorekar B. Bilateral distal radius fracture in third trimester of pregnancy with accelerated union: a rare case report. *J Clin Diagn Res*. 2015;9(4):RD01-RD02. [CrossRef]
11. Ehsan A, Stevanovic M. Skeletally mature patients with bilateral distal radius fractures have more associated injuries. *Clin Orthop Relat Res*. 2010;468(1):238-242. [CrossRef]
12. Dağtaş MZ, Ünal ÖK. The external fixation can be a good alternative to plate-screw treatment in the surgical treatment of bilateral distal radius fractures: A retrospective cohort study. *Jt Dis Relat Surg*. 2021;32(2):406-413. [CrossRef]
13. Graham JG, Penna S, Fletcher D, et al. Outcomes of open reduction and internal fixation of bilateral fractures of the distal radius. *J Hand Microsurg*. 2019;11(2):117-120. [CrossRef]
14. Kleinlugtenbelt YV, Groen SR, Ham SJ, et al. Classification systems for distal radius fractures. *Acta Orthop*. 2017;88(6):681-687. [CrossRef]

15. Yim GH, Hardwicke JT. The evolution and interpretation of the Gustilo and Anderson classification. *J Bone Joint Surg Am*. 2018;100(24):e152. [CrossRef]
16. Ingall EM, Bernstein DN, Shoji MM, Merchan N, Harper CM, Rozental TD. Using the QuickDASH to model clinical recovery trajectory after operative management of distal radius fracture. *J Hand Surg Glob Online*. 2020;3(1):1-6. [CrossRef] Erratum in: *J Hand Surg Glob Online*. 2021;3(5):316. (https://doi.org/10.1016/j.jhsg.2021.08.002)
17. Moradi A, Menendez ME, Kachooei AR, Isakov A, Ring D. Update of the quick DASH questionnaire to account for modern technology. *Hand (N Y)*. 2016;11(4):403-409. [CrossRef]
18. Mann FA, Wilson AJ, Gilula LA. Radiographic evaluation of the wrist: what does the hand surgeon want to know? *Radiology*. 1992;184(1):15-24. [CrossRef]
19. de Alencar Neto JB, Jales CDS, Coelho JVV, de Souza CJD, Cavalcante MLC. Epıdemıology, classification, and treatment of bilateral fractures of the distal radius. *Acta Ortop Bras*. 2022;30(3):e245185. [CrossRef]
20. Drobetz H, Black A, Davies J, Buttner P, Heal C. Screw placement is everything: risk factors for loss of reduction with volar locking distal radius plates. *World J Orthop*. 2018;9(10):203-209. [CrossRef]