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ORIGINAL RESEARCH

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Assessing the efficacy of manual reduction and novel traction techniques for distal radius fractures: A randomized controlled trial

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Abstract

Background and Aim: One of the leading reasons that patients, particularly older persons, are brought to the orthopedic emergency room is a fracture at the end of the radius. In this study, a new traction method for distal radius fractures was compared with manual reduction.

Methods: The census method was used in this clinical trial to study 45 patients (46 hands) who were referred to Hamedan Besat Hospital in 2021. Patients were randomly assigned to two groups. The manual reduction (pressure and traction by an assistant and a doctor) method was implemented in Group A, and the new traction procedure (pressure and traction by hardware or a device) was performed in Group B. The radiographic results of reduction in both groups were investigated and compared immediately and in the first and 6 weeks after surgery.

Results: The following results were observed in the new and manual groups in the sixth week after surgery: average volar tilt: 4.19 ± 3.79 and 4.08 ± 3.88 ($p = 0.926$), radial angulation: 2.18 ± 1.27 and 2.21 ± 1.35 ($p = 0.934$), radial shortening: 10.52 ± 0.65 and 10.56 ± 0.68 ($p = 0.828$), radial inclination: 22.52 ± 2.46 and 22.71 ± 2.01 ($p = 0.787$), dorsal angulation: -5.89 ± 0.33 and 5.22 ± -1.91 ($p = 1.00$), ulnar variance: 1.66 ± 0.90 and 1.67 ± 0.81 ($p = 0.958$), and average pain score: 2.40 ± 0.68 and 2.47 ± 0.73 ($p = 0.737$).

Conclusion: The new reduction procedure with hardware in patients with distal radius fractures showed the same effect as the traditional method based on pressure and traction by the assistant and doctor in terms of radiographic changes and pain score of the fracture site.

KEYWORDS

distal radius, fracture, manual, new, reduction

1 | INTRODUCTION

Backward displacement, radial rotation, and radial shortening are commonly associated with a fracture at the distal end of the radius. Smith's fracture is referred to as Colle's fracture on the distal side of the radius without any articular involvement but with anterior rotation. Serious functional defects in the body will occur if both of these injuries are not treated and fuzed in an inappropriate anatomical position.[1,2]

Immobilization of the limb to improve healing and reduce pain is recommended in stable fractures without displacement and intra-articular involvement. Therefore, mobile support devices should be used in these cases.[3] If the pain is tolerated, immobilization should be applied as soon as possible. Closed reduction in the emergency department is recommended for stable extra-articular fractures in which the radiological arrangement is disturbed. Closed reduction is carried out through traction for stable fractures exhibiting posterior displacement.[3] Embedment of external fixators or arthroscopic hybrid methods is another alternative for treating fractures at the end of the radius.[4]

The closed treatment method using the doctor's hand movements is usually used for fractures in the United Kingdom, whereas the traction force is applied in the opposite direction by the assistant to the same site.[5] The problem with this method is that it increases the posterior-radial forces to the end of the radius and the risk of dislocation due to excessive pressure on the wrist during flexion. Furthermore, excessive manipulation could result in the cancellous bone at the end of the radius disintegrating and increasing its instability.[6] In the United States, Colle's fracture is usually treated using a traction device attached to the upper limb and a 4.5–6.8 kg weight known as a finger trap. This method has a lower risk of re-dislocation and is likely to be less complicated. In the recent method, the traction force is applied to the forearm by finger traps that are connected to the radial fingers of the hand, which does not require the presence of an assistant at the doctor's side. By applying force to the back of the hand, the orthopedist can adjust the volar tilt of the front part of the radius.[6,7] Although surgical methods have been largely used to treat Colle's fractures in the last decade, recent studies have not shown any significant difference between the surgical method and closed reduction and the use of splints in terms of the final function of the organ. Even surgery increases the possibility of tendon damage and the need for surgery.[8,9] Although the closed reduction in the fracture of the end of the radius is preferred, the main and optimal solution has not been exactly presented.[10]

This new method is used for closed reduction of anterior or posterior fractures in the distal radius that have not reached the articular plane. This method was developed using several years of clinical experience and other standard methods. The ease of use, rotation, and maneuvers in the anterior, posterior, and lateral planes are advantages of this method over other traction methods. The latter feature allows the doctor to apply several maneuvers under fluoroscopy in different directions on the patient's hand without the presence of an assistant, while the appropriate traction is applied by the device. This device itself will give small doses of radiation to the patient, and finally, if necessary, a pin can be placed in the right place. The device's other advantage is that it can be used on a typical patient's bed without the need for complicated equipment. The device's consistent application of force to the patient's wrist will reduce the likelihood of dislocation and displacement compared with the conventional two-person method. As mentioned earlier, this study aimed to compare the effectiveness of the closed reduction method and the new traction method in patients with a fracture of the end of the radius known as Colle's fracture. The hypothesis of the article was that conventional closed reduction methods for treating Colles' fractures may not demonstrate significant differences when compared with a new traction method.

2 | MATERIALS AND METHODS

2.1 | Participants

In this randomized clinical trial, 45 patients referred to a third-grade specialized university hospital were introduced to an orthopedic resident after a visit by an emergency medicine doctor and if a fracture of the radius bone was diagnosed. Plain anteroposterior and lateral radiographs of the affected limb were obtained from the patients, and if they met the inclusion criteria for the study, they were randomly assigned to two groups after obtaining written and informed consent. Inclusion criteria were diagnosis of a fracture of the distal radius and consent to participate in the study, age over 16 years, no displacement (posterior rotation less than 15° and less than 5 mm of radius shortening in the plain radiographs of the hand) and articular involvement, no soft tissue injury (open fracture) or severe bone injury, and no anterior rotation or any issue that necessitates distinct surgical intervention. Exclusion criteria were a candidate for surgery due to observation of displacement or lack of satisfactory healing progress at the next visit and nonreferral of patients to follow-up on the results of the operation. The traditional manual reduction method was used for one group, whereas a new traction method was used for the second group. This study was approved by the Ethics Committee of Hamedan University of Medical Sciences (ID: IR.UMSHA.REC.1400.311 and the Iranian Registry Code of Clinical Trials: IRCT20151123025202N21).

The sample size of 23 hands was determined based on the findings of Holkenborg et al.[11] and achieved a statistical power of 85% by inputting pertinent information into the G-Power software.

2.2 | Interventions

2.2.1 | Novel method

In this innovative approach, the conventional method of requiring two healthcare professionals to apply traction and induce wrist

FIGURE 1 New traction device.

FIGURE 2 Innovative traction device applied to the hand of a patient with a Colle's fracture.

flexion during distal radius fracture surgeries is replaced with a more efficient and straightforward process. This new technique involves securing the upper limb as a base using a brachial strap and a vertical component placed and closed through the scales of a Chinese finger trap. The vertical part serves as the area where traction is applied, and an achar is used to rotate it, causing the hind to be lifted up and creating traction in the vertical part (Figure 1). This new method offers greater control and accuracy in applying traction because the amount of traction can be fixed and adjusted as needed. In addition, because the entire process is fixed, there is no need for the presence of two auxiliary doctors during the surgery. The surgeon can now perform the surgery alone by correctly positioning the injured part using fluoroscopy and movements in four directions (Figure 2).

2.2.2 | Traditional method

In our traditional method for managing distal radius fractures, we use a technique that involves the use of a stockinet placed under the patient's axilla. This stockinet serves as a traction device that is pulled by one person with two hands to create traction in the upper limb. The purpose of this traction is to help align the fractured bones and reduce swelling in the affected area. Simultaneously, a second person applies manual traction to the hand, creating 15° flexion in the wrist joint. This maneuver helps to further align the bones and position them correctly for pinning by the surgeon. The surgeon then enters the surgical site and pins the fractured bones in place using surgical hardware such as screws and plates. The use of this traditional method has been found to be effective in managing distal radius fractures because it helps to reduce pain, swelling, and inflammation in the affected area. It also allows for better alignment of fractured bones, leading to a faster and more complete healing process. However, it should be noted that this method requires a certain level of skill and expertise from both the surgeon and the assisting personnel, as improper application of traction or manipulation of the bones can lead to further injury or complications.

2.3 | Data collection

Control radiographs were obtained after reduction using both methods. All patients underwent pin embedment through the skin and splinting with a short splint under the elbow, and all patients were given the necessary recommendations. Furthermore, patients were advised to refer to the orthopedic clinic of Besat Hospital at Weeks 1 and 6 after casting. Control radiographs of the affected hand were performed again at each visit. A radiograph of the healthy

hand was also taken during the 6-week visit to compare with the affected hand, and the patients' hand casts were removed if satisfactory improvement criteria were observed during the 6-week visit.

TABLE 1 Basic information of patients with distal radius fracture undergoing manual reduction and new traction method.

Variable	Reduction method		*p* Value
	Traction with a device mean (SD)	Manual reduction mean (SD)	
Gender	Number (%)	Number (%)	
Male	9 (9.42)	12 (0.06)	0.246[a]
Female	12 (1.57)	2 (0.04)	
Total	21 (100)	25 (100)	
Dominant hand			
Right	15 (0.76)	19 (4.71)	0.725[a]
Left	6 (0.24)	6 (6.28)	
Total	21 (100)	25 (100)	
Broken hand			
Right	12 (1.57)	16 (0.64)	0.635[a]
Left	9 (9.42)	9 (0.26)	
Total	21 (100)	25 (100)	
Age	45.47 ± 7.32	48 ± 5.28	0.732[a]
Years	43.19 ± 14.08	47.12 ± 16.31	0.391[b]

Abbreviation: SD, standard deviation.

[a]χ^2 test.

[b]Student's *t* test.

2.4 | Statistical analysis

The normality of the dependent variables was confirmed using the Kolmogorov–Smirnov test. Student's *t* test was employed to compare the average radiographic criteria between the two groups at any time, and repeated-measures analysis of variance (ANOVA) was used over time. All data were analyzed at the 95% confidence level, and the significance level was considered <0.05. Statistical analyses were performed using SPSS 20 (IBM Corp).

3 | RESULTS

As mentioned earlier, this study aimed to compare the manual reduction method with the new traction method for distal radius fractures in patients referred to Besat Hospital in Hamedan. Therefore, 45 patients (46 hands) were examined, and out of 46 cases of distal radius fractures, 21 cases were reduced by the new traction method and 25 cases by the manual method. Table 1 presents basic information about the patients.

No significant difference was observed between the manual reduction method and the new traction method in terms of the average radiographic parameters of volar tilt, radial angulation, radial shortening, radial inclination, dorsal angulation, and ulnar variance before reduction and at the sixth week after reduction (Table 2).

According to the results of repeated-measures ANOVA, all radiographic parameters were significantly improved in both manual and new reduction methods compared with those before reduction, but no significant difference was observed

TABLE 2 Comparison of radiographic findings of patients with distal radius fracture before and after reduction according to reduction method.

Variable	Evaluation time	Reduction method		*p* Value[a] Intergroup comparison at any time
		Traction with a device mean ± SD [confidence interval]	Manual reduction mean ± SD [confidence interval]	
Volar tilt	Before reduction	−30.78 ± 10.51 [−35.275 to −26.285]	−26.44 ± 17.67 [−33.367 to −19.513]	0.238
	Sixth week	4.19 ± 3.79 [2.569–5.811]	4.08 ± 3.88 [2.559–5.601]	0.926
Radial angulation	Before reduction	6.98 ± 3.65 [5.419–8.541]	7.04 ± 3.91 [5.507–8.573]	0.955
	Sixth week	2.18 ± 1.27[1.637–2.723]	2.21 ± 1.35 [1.681–2.739]	0.934
Radial shortening	Before reduction	7.78 ± 1.22 [7.258–8.302]	10.01 ± 1.91 [9.261–10.759]	0.393
	Sixth week	10.52 ± 0.65 [10.242–10.798]	10.56 ± 0.68 [10.293–10.827]	0.828
Radial inclination	Before reduction	17.62 ± 2.33 [16.623–18.617]	17.65 ± 2.77 [16.564–18.736]	0.970
	Sixth week	22.52 ± 2.46 [21.468–23.572]	22.71 ± 2.01 [21.922–23.498]	0.787
Dorsal angulation	Before reduction	29.33 ± 10.39 [24.886–33.774]	20.40 ± 17.96 [13.360–27.440]	0.965
	Sixth week	−0.33 ± 5.89 [−2.849–2.189]	−1.91 ± 5.22 [−3.956–0.136]	1.00
Ulnar variance	Before reduction	2.88 ± 1.01 [2.448–3.312]	2.61 ± 0.96 [2.234–2.986]	0.372
	Sixth week	1.66 ± 0.90 [1.275–2.045]	1.67 ± 0.81 [1.352–1.988]	0.958

Abbreviation: SD, standard deviation.

[a]Student's *t* test.

FIGURE 3 X-ray images taken before and after implementing two different methods. (A) Before and after using traditional traction method. (B) Before and after using novel traction method.

between the two methods at different evaluation times (Figures 3 and 4).

In both manual and new reduction methods, the average pain score of the patients was significantly reduced compared with that before treatment; however, both methods did not significantly differ in terms of the average pain score before reduction, immediately after reduction, and at the first and sixth weeks after reduction. According to the results of repeated-measures ANOVA, no significant difference was observed between the manual and new reduction methods in terms of changes in pain score over time (Table 3).

4 | DISCUSSION

The present study, which was conducted on patients with distal radius fractures, did not show any significant difference between the new reduction method to treat the distal radius fractures and the traditional method (based on pressure and traction by the assistant and the doctor) in terms of changes in the interlinear angle perpendicular to the longitudinal axis and another line between the posterior and anterior edge of the distal radius (volar tilt), the angle of the longitudinal axis of the radius with the articular surface of the end of the radius (radial angulation), the shortening of the length of the

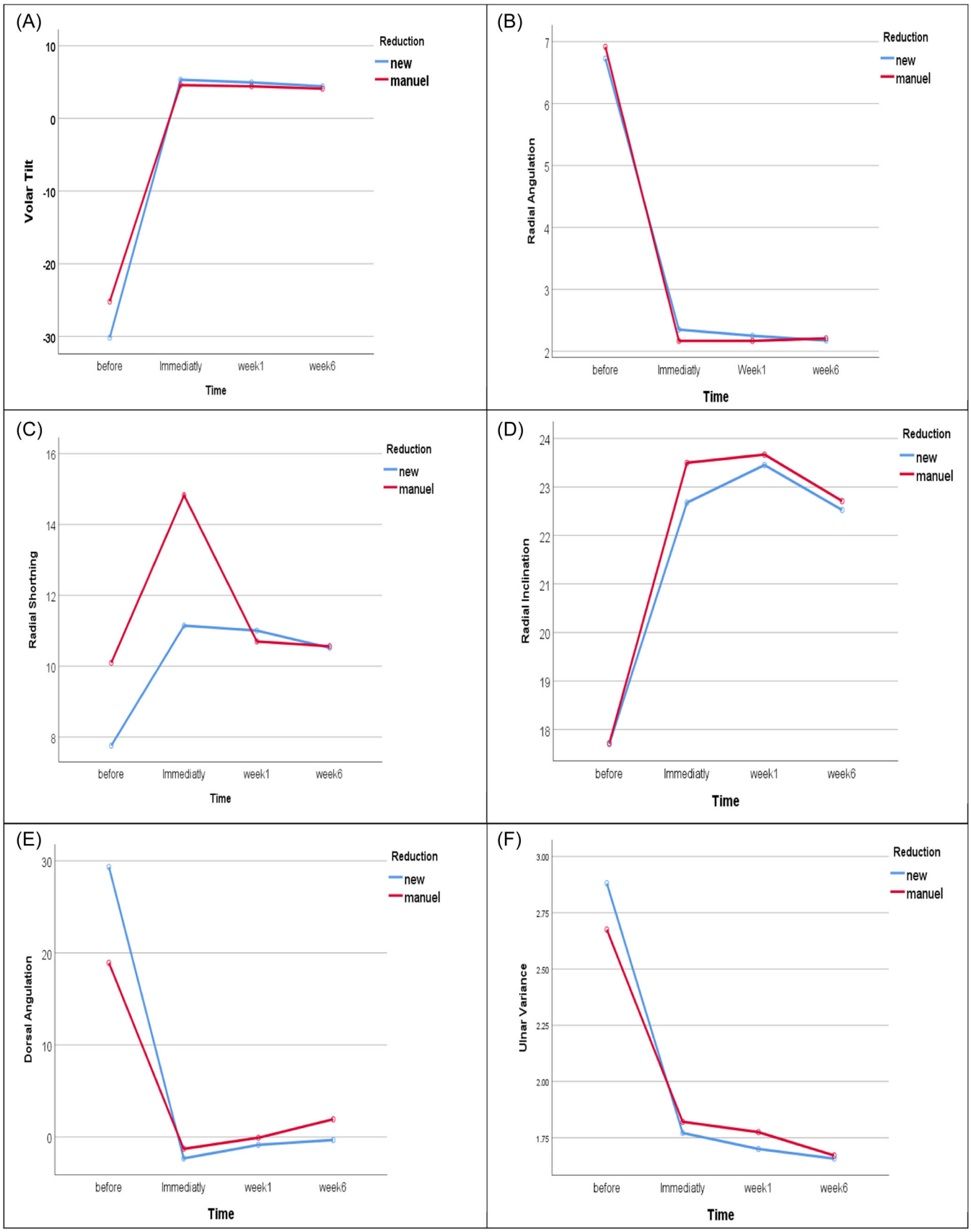

FIGURE 4 (A) Comparison of average volar tilt of patients with distal radius fractures according to the reduction method. (B) Comparison of average radial angulation of patients with distal radius fractures according to the reduction method. (C) Comparison of the average radial shortening of patients with distal radius fractures according to the reduction method. (D) Comparison of the average radial inclination of patients with distal radius fractures according to the reduction method. (E) Comparison of the average dorsal angulation of patients with distal radius fractures according to the reduction method. (F) Comparison of the average ulnar variance of patients with distal radius fractures according to the reduction method.

TABLE 3 Comparison of the average pain score of patients with distal radius fractures according to the reduction method.

Evaluation time	Reduction method		*p* Value[a]
	Traction with a device mean ± SD [confidence interval]	Manual traction mean ± SD [confidence interval]	Intergroup comparison at any time
Before reduction	9.50 ± 0.94 [9.098–9.902]	8.88 ± 2.02 [8.088–9.672]	0.213
Immediately after reduction	7.00 ± 0.79 [6.662–7.338]	6.43 ± 1.77 [5.736–7.124]	0.188
First week	4.74 ± 0.44 [4.552–4.928]	4.35 ± 1.25 [3.860–4.840]	0.180
Sixth week	2.40 ± 0.68 [2.109–2.691]	2.47 ± 0.73 [2.184–2.756]	0.737
Intergroup comparison over time	*p* (group) = 0.239	*p* (time × group) = 0.118	*p* (time) < 0.001

Abbreviation: SD, standard deviation.

[a]Student's *t* test.

radius (radial shortening), the angle between the line perpendicular to the longitudinal axis and the line between the tip styloid and ulnar edge (Radial Inclination), the angle of the longitudinal axis of the radius with the articular surface of the end of the radius (dorsal angulation), and pain in the fracture site (VAS).

Razavipour et al. investigated the relationship between radiographic indices and functional consequences in the fracture of the end of the radius in 64 patients (26 males and 38 females) in the orthopedic department of Sari Hospital. The average age of the patients was 49.66 years,[12] which is similar to the average age of the patients in the present study but less than that reported by Rundgern et al. in Sweden, Hong et al. in China, and Azad et al. in the United States. This difference may be real and is caused by the occurrence of more fractures of the distal radius in middle-aged patients or because some elderly patients with distal radius fractures refer to traditional bone surgeons and do not refer to specialized orthopedic treatment centers.

Moreover, Earnshaw et al. studied 223 patients with Colle's fractures undergoing closed reduction with one of the two traction methods, that is, finger trap or manual procedure, and found that there was no significant difference between them in terms of indices of the radial angle, posterior elevation, and radial shortening, immediately and one and 5 weeks after reduction.[13] The present study investigated and compared the manual traction method with the hardware designed by the researchers for distal radius fracture reduction, but did not observe any significant difference between the manual traction and the new method in terms of radiographic markers immediately and in Weeks 1 and 6 after surgery; a result that is consistent with the findings reported in Earnshaw et al.'s study.

Hong addressed clinical considerations of traction reduction caused by hanging the limb by a pulley and fixing it with a splint to treat distal radius fractures compared with the traditional reduction method on 60 fracture cases in two groups of 30 patients. According to their analysis, radius height, angle of ulnar deviation, and palmar inclination improved significantly in both groups in the eighth week after treatment, and the rate of improvement by using the pulley and fixing it with a splint was significantly higher than that by the traditional reduction method. Finally, the researcher concluded that pulley suspension traction reduction with self-made splint fixation to treat distal radius fractures has more advantages, including stable and reliable traction, good reduction, and better wrist joint function, than conventional manual traction and reduction. Therefore, it can be selected and applied according to the actual condition of the patient.[14] Instead of using a pulley with a splint to fix the bone, the present study used an innovative device for traction and reduction, which exhibited the same effectiveness as the manual traction method and the advantages mentioned in the conclusion section. In their review paper and meta-analysis, Søsborg-Würtz et al. investigated both finger trap and manual traction methods in the closed reduction of distal radius fractures. According to these findings, the finger trap method showed better results regarding the correction of radial shortening, a greater reduction in pain, and fewer side effects.[15] Holkenborg et al. also compared manual and traction methods for the reduction of distal radius fractures in 144 patients over 16 years (66 patients were subjected to the traction method and 78 cases to the manual method). The researchers did not observe any significant difference between the two groups in terms of pain, reduction success rate, side effects, and radiographic changes at different evaluation times.[11] This study studied and compared the short-term consequences of new and manual reduction methods. None of the patients suffered from side effects, and there was no significant difference in the average pain score of the patients before and after fracture reduction. The study on a new reduction method for distal radius fractures has limitations that include a small sample size, the need for comparison with other reduction methods, a focus on short-term outcomes, and the importance of assessing inter-rater and intra-rater reliability in radiographic measurements. To address these limitations, future research should involve a larger multicenter clinical trial, evaluate the new method against other techniques, investigate long-term outcomes such as functional recovery and quality of life, and ensure the reliability of radiographic measurements. Overcoming these limitations can enhance the understanding and application of various reduction methods for distal radius fractures, benefiting both patients and healthcare professionals.

5 | CONCLUSION

This study did not identify any statistically significant variances in outcomes between traditional closed reduction and the new traction methods for treating displaced distal radius fractures in adults. Nonetheless, the new method offers the benefit of requiring less manpower during surgery.

AUTHOR CONTRIBUTIONS

Morteza Majidi: Conceptualization; methodology; project administration. **Erfan Rohani**: Formal analysis; supervision; writing—original draft. **Vahid Chamani**: Data curation; investigation; methodology. **Mehdi Rezaei**: Data curation; investigation. **Mohammad Mohsen Roostayi**: Investigation; supervision. **Alireza Ghaznavi**: Writing—review and editing. **Mobina Khosravi**: Resources; supervision; writing—original draft; writing—review and editing.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

TRANSPARENCY STATEMENT

The lead author Mobina Khosravi affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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