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Effectiveness of manual therapy in patients with distal radius fracture: a systematic review and meta-analysis

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ABSTRACT

Objective: To determine the effectiveness of manual therapy (MT) for functional outcomes in patients with distal radius fracture (DRF).

Methods: An electronic search was performed in the Medline, Central, Embase, PEDro, Lilacs, CINAHL, SPORTDiscus, and Web of Science databases. The eligibility criteria for selecting studies included randomized clinical trials that included MT techniques with or without other therapeutic interventions in functional outcomes, such as wrist or upper limb function, pain, grip strength, and wrist range of motion in patients older than 18 years with DRF.

Results: Eight clinical trials met the eligibility criteria; for the quantitative synthesis, six studies were included. For supervised physiotherapy plus joint mobilization versus home exercise program at 6 weeks follow-up, the mean difference (MD) for wrist flexion was 7.1 degrees ($p = 0.20$), and extension was 11.99 degrees ($p = 0.16$). For exercise program plus mobilization with movement versus exercise program at 12 weeks follow-up, the PRWE was −10.2 points ($p = 0.02$), the DASH was −9.86 points ($p = 0.0001$), and grip strength was 3.9 percent ($p = 0.25$). For conventional treatment plus manual lymph drainage versus conventional treatment, for edema the MD at 3–7 days was −14.58 ml ($p = 0.03$), at 17–21 days −17.96 ml ($p = 0.009$), at 33–42 days −15.34 ml ($p = 0.003$), and at 63–68 days −13.97 ml ($p = 0.002$).

Conclusion: There was very low to high evidence according to the GRADE rating. Adding mobilization with movement and manual lymphatic drainage showed statistically significant differences in wrist, upper limb function, and hand edema in patients with DRF.

KEYWORDS
Distal radius fracture; manual therapy; functional outcomes; randomized controlled trial; meta-analysis

Introduction

Distal radius fractures (DRFs) are the most common type of wrist fractures, with a bimodal distribution, with the first peak incidence in young persons and the second peak in the elderly [1]. Currently, there are multiples treatments, including closed reduction and cast immobilization, closed reduction with percutaneous K-wire fixation, open reduction and internal fixation with volar or dorsal plates, use of an external fixator, or a combination of these techniques [2]. Nevertheless, no consensus has been reached regarding the optimal treatment method [3,4].

After the immobilization period, physical therapy is prescribed to reduce pain, restore range of motion, and improve muscle strength and function [5]. The therapeutic interventions that are used to achieve these aims can be classified as active or passive interventions [6]. Active interventions include advice, a home exercise program, or a program supervised by a physical therapist. Passive interventions refer to techniques where the patient takes a passive role during its application, such as physical agents (i.e. ultrasound, hot pack, and transcutaneous electrical nerve stimulation) or manual therapy (MT) techniques (includes massage, joint mobilization, mobilization with movement, or neural mobilization), which are most commonly used by physical therapists to treat these patients [6,7].

MT is widely used to decrease pain and increase range of motion and wrist function after DRF. However, one systematic review showed insufficient evidence to support the effectiveness of the various interventions used in the rehabilitation of adults with DRF [8]. Another systematic review showed limited evidence for joint mobilizations of the wrist and hand in patients with a wide variety of upper limb pathologies [9]. Nevertheless, no systematic reviews have analyzed the effects of MT in this clinical condition. Therefore, the aim of this systematic review and meta-analysis was to determine the effectiveness of MT for functional outcomes in patients with DRF.

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Methods

Protocol and registration

This systematic review and meta-analysis was performed and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement and followed the recommendations of the Cochrane Collaboration Handbook [10,11]. The registration number in the International Prospective Register of Systematic Reviews (PROSPERO) is CRD42020220531.

Eligibility criteria

Studies on the effectiveness of MT for functional outcomes in patients over 18 years with DRF were considered eligible for inclusion if the following criteria were fulfilled: 1) population: subjects with isolated DRF treated with closed reduction and cast immobilization, closed reduction with percutaneous K-wire fixation, open reduction and internal fixation with volar or dorsal plates (locking or nonlocking), bridge plating, use of an external fixator, or a combination of these techniques; 2) type of intervention: subjects treated with MT techniques that included massage, joint mobilization, mobilization with movement, or neural mobilization with or without other therapeutic interventions; 3) type of comparison: subjects treated with other MT interventions, physical agents (i.e. laser therapy, ultrasound, hot pack), exercise programs, home exercise program, placebo, or sham interventions; 4) types of outcomes: functional outcomes, such as wrist or upper limb function questionnaires, pain, grip strength, and wrist range of motion; and 5) types of studies: randomized clinical trials or controlled clinical trials published in English or Spanish. The exclusion criteria were as follows: 1) studies that included patients with associated fractures (i.e. fractures of the ulnar styloid process, fractures of carpal bones), dislocation of the distal radioulnar joint, or fractures with vascular injury; 2) subjects with previous DRFs on the affected side or pathological fractures; and 3) subjects with immediate complications after DRF, such as acute carpal tunnel syndrome or complex regional pain syndrome.

Electronic search

We systematically searched MEDLINE (via PubMed), the Cochrane Central Register of Controlled Trials (Central), EMBASE, the Physiotherapy Evidence Database (PEDro), the Latin American and the Caribbean Literature in Health Sciences (LILACS), the Cumulative Index to Nursing and Allied Health Literature (CINAHL), SPORTDiscus, and Web of Science databases from inception until June 2021.

The search strategy included a combination of the following medical subject heading (MeSH) terms: 'colles fracture'; 'radius fracture'; 'surgical procedures, operative'; 'fracture fixation'; 'fracture fixation internal'; 'casts surgical'; 'musculoskeletal manipulations'; and 'massage'. These were combined with the following free-text terms: 'distal radius fracture'; 'manual therapy'; 'joint mobilization'; 'mobilization with movement'; and 'neural mobilization'. To identify randomized trials in the Medline, Central, and Embase databases, the highly sensitive Cochrane search strategy was used [10].

Study selection

Two authors (HG-E and CO-H) independently screened the titles and abstracts of references retrieved from the searches. We obtained the full text for references that either author considered to be potentially relevant. We involved a third reviewer (FA-Q) if consensus could not be reached.

Data collection process

Two authors (VM-R and CO-H) independently extracted data on the outcomes of each trial. The following data were extracted from the original reports: i) authors and year of publication, ii) country, iii) sample characteristics (sample size, age, distribution, and sex), iv) characteristics of MT interventions, v) characteristics of other therapeutic interventions, vi) length of follow-up and main outcomes, and vii) main results.

Risk of bias in individual studies

The risk of bias 2 (RoB 2) assessment was performed using the Cochrane RoB tool [12]. This tool evaluates the risk of bias according to the following six domains: bias arising from the randomization process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in measurement of the outcome, bias in selection of the reported result, and overall bias. Each domain could be considered as 'low,' 'some concerns,' or 'high' RoB. Data extraction and quality assessment were independently performed by two reviewers (JV-F and RG-M). We involved a third reviewer (HG-E) if a consensus could not be reached. The agreement rate between the reviewers was calculated using kappa statistics.

Statistical methods

The DerSimonian and Laird random effect or Mantel–Haenszel fixed effect methods were used, depending on the heterogeneity, to compute a pooled estimate of mean difference (MD) and respective 95% confidence intervals (CIs). Pooled MDs were estimated for wrist function, upper limb function, grip strength, wrist range of motion, and edema. The heterogeneity of results across studies was evaluated using the I^2 statistic [13], which considers 0–40% as may not be important, 30–60% as moderate, 50–90% as substantial, and 75–100% as considerable heterogeneity [10]. Also, the corresponding p-values were considered. The meta-analysis was performed with RevMan 5.4. Publication bias was evaluated through visual inspection of funnel plots and using the method proposed by Egger [14].

Rating the quality of evidence

The synthesis and quality of evidence for each outcome were assessed using the Grading of Recommendation, Assessment, Development and Evaluation (GRADE) [15]. The quality of the evidence was classified into four categories: high, moderate, low,

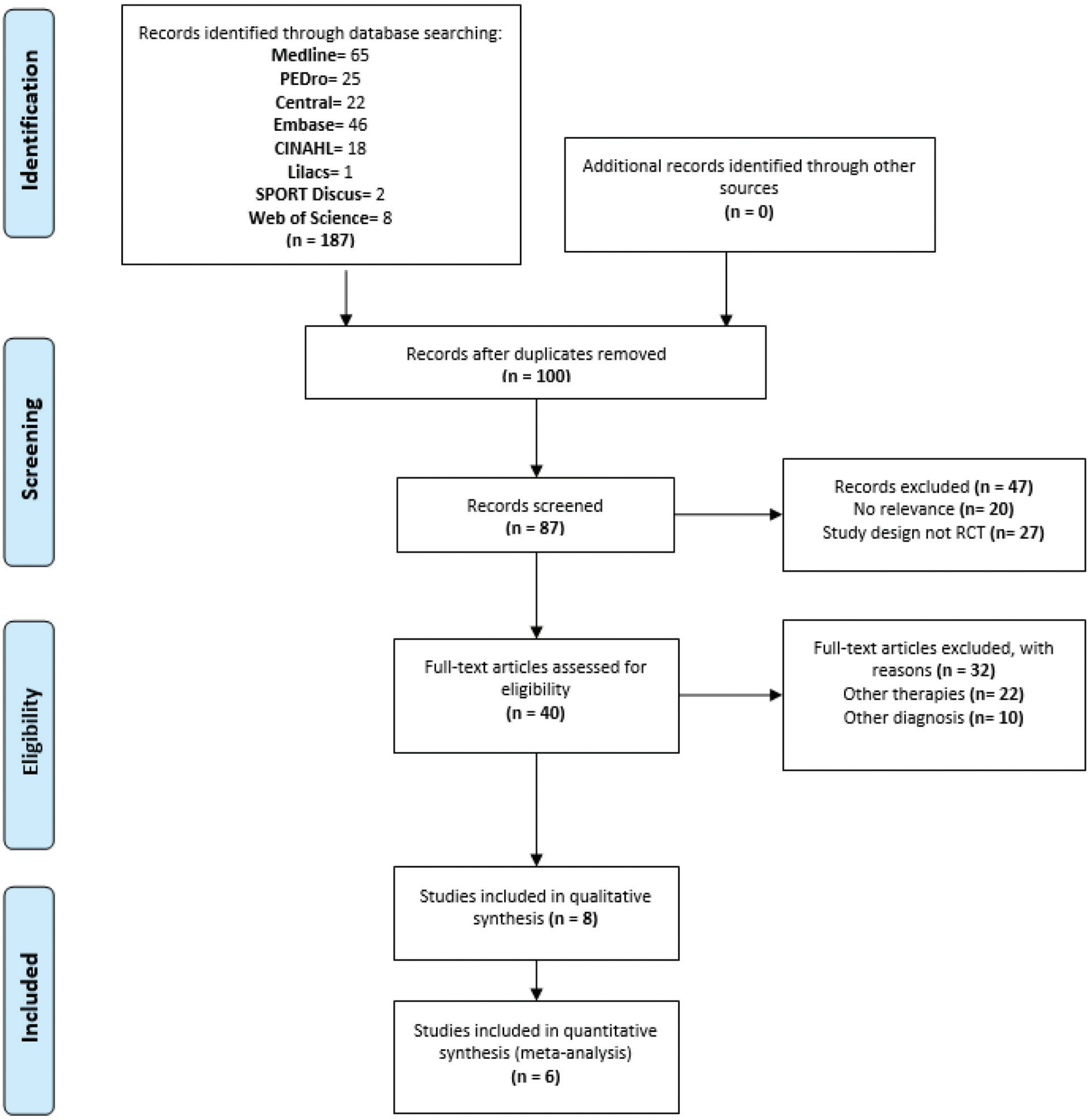

Figure 1. Flow diagram for study selection process.

Figure 2. Risk of bias summary: review authors' judgments about each risk of bias item for each included study.

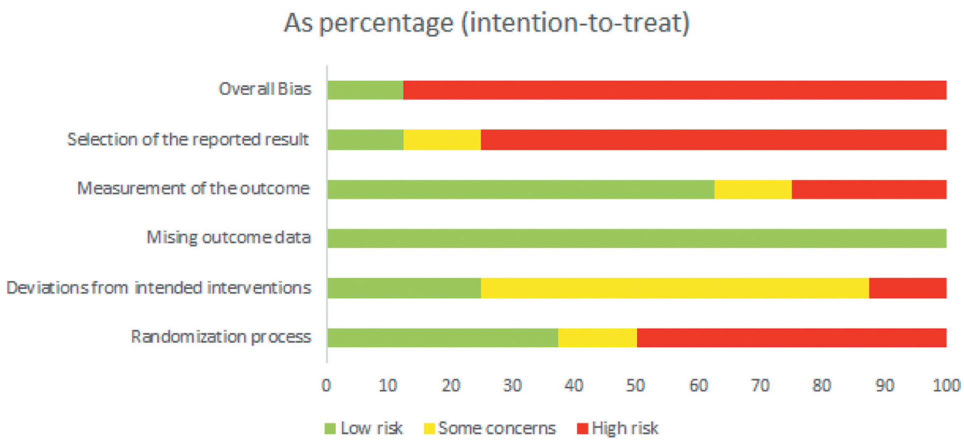

Figure 3. Risk of bias graph: review authors' judgments about each risk of bias item presented as percentages across all included studies.

and very low [16]. We used the GRADE profiler (GRADEpro) to import the data from RevMan 5.4 to create a 'summary of findings' table.

Results

Study selection

A total of 187 studies were found through the electronic searches (Figure 1). Of these, eight studies met the eligibility criteria and were included in the systematic review [7,17–23]. The kappa agreement rate between reviewers was 0.95.

Study characteristics

A summary of the included studies is presented in Table 1. The overall population included 355 patients (174 in the MT group and 181 in the control group). The mean age was 60.4 years (± 7.2), and the mean follow-up was 12 weeks (range 4 to 26).

Risk of bias assessment in the individual studies

The RoB2 assessment is presented in Figures 2 and 3. The Randomization process was rated as high risk 50% [17,18,21,22]. The Deviations from intended interventions

Table 1. Characteristics of the studies included.

		Group Manual therapy		Group Control			Results Between Groups
References	Country	Patient	Intervention	Patient	Intervention	Follow-up Outcomes	
Taylor et al. [17]	Australia	n = 15 Age: 61.9 (9.1)	The group received passive joint mobilization (according to Maitland). In addition to superficial heat, active exercises, and home advice was performed.	n = 15 Age: 63.2 (8.2)	The group received sham mobilization, in addition to superficial heat, active exercises, and home advice was performed.	1 month AROM extension	AROM extension p = 0.586
Kay et al. [18]	Australia	n = 19 Age: 54.7	(13.1)	The	group received passive joint mobilization, which involved accessory mobilizations (Grades 1–2) and was progressed to incorporate end of range physiological movements (Grades 3–4). In addition to advice and exercise program was performed.	n = 20 Age: 51.6 (18.8)	The group received exercise program at home included active exercise, soft tissue stretches, isometric stabilizing exercise and grip strength.
3 and 6 weeks VAS			Function ROM extension, flexion, radial deviation, ulnar deviation, pronation, and supination Grip strength Thumb motion scale	VAS p	= 0.53 Function p = 0.43 ROM extension, radial deviation, ulnar deviation, pronation, and supination. p > 0.05 ROM flexion p = 0.02 Grip strength p = 0.61 Thumb motion scale p = 0.09		
Härén et al. [19]	France	n = 12 Age: 60 (38–78)	The group received conventional treatment that included elevation, active, passive exercises, and compression with elastic bandage. In addition, MLD was performed.	n = 14 Age: 61 (29–85)	The group received conventional treatment that included elevation, active, passive exercises, and compression with elastic bandage.	3, 17, 33 and 68 days Edema	Edema 3 days p = 0.04 17 days p = 0.02 33 days p = 0.1 68 days p = 0.02
Härén et al. [20]	France	n = 25 Age: 62 (50–77)	The group received conventional treatment that included elevation, active and resistive exercises, and compression with elastic bandage. In addition, MLD technique was performed.	n = 26 Age: 63 (51–80)	The group received conventional treatment that included elevation, active and resistive exercises, and compression with elastic bandage.	13 and 58 days Edema	Edema 13 days p = 0.005 58 days p = 0.004
Knygsand-			Roenhoej et al. [21]		Australian	n = 14 Age: 64.4 (9.5)	The group received conventional treatment that included exercises for ROM and strengthening. In addition, modified manual edema mobilization was performed.
n = 15 Age: 62.7 (9.7)	The group		received conventional treatment that included exercises for ROM and strengthening.	1, 3, 6 9 and	26 weeks Edema Pain rest and active. AROM PV AROM CMC ADL	Edema p = 0.13 Pain rest p = 0.42 Pain active p = 0.99 AROM PV p = 0.32 AROM CMC p = 0.81 ADL p = 0.49	
Gutierrez et al. [7]	Chile	n = 37 Age: 72.1	(7.44)	The	group received supervised physiotherapy program that included grade II or III of Maitland techniques and sustained grade I gliding Kaltenborn method was performed in both anteroposterior and posteroanterior directions.	n = 37 Age: 71.62 (7.83)	The group received exercise program at home included passive, active, grip strength exercises and forearm stretching.

(*Continued*)

Table 1. (Continued).

		Group Manual therapy		Group Control			
References	Country	Patient	Intervention	Patient	Intervention	Follow-up Outcomes	Results Between Groups
6 weeks and			6 months PRWE VAS AROM Flexion and extension Grip Strength	PRWE p	< 0.001 VAS $p < 0.001$ AROM Flexion $p < 0.001$ AROM extension $p < 0.001$ Grip Strength $p < 0.001$		
Reid et al. [22]	Australian	n = 33 Age: 56 (16)	The group received upper limb range of motion exercises and advice about swelling control. In addition, received MWM techniques to improve supination and wrist extension.	n = 34 Age: 63 (16)	The group received upper limb range of motion exercises and advice about swelling control.	4 and 12 weeks AROM flexion, extension, supination and pronation. Grip strength. PRWE Quick DASH, SF-8 PCS SF-8 MCS	AROM Flexion Extension Supination $p < 0.05$ AROM Pronation $p > 0.05$ Grip strength $p > 0.05$ PRWE Total $p < 0.05$ Quick DASH $p < 0.05$ SF-8 PCS $p > 0.05$ SF-8 MCS $p > 0.05$
Tomruk et al. [23]	Turkey	n = 19 Age:	45.25 (9.84)	The	group received a standard physiotherapy program consisting of ROM, flexibility, strengthening and home exercises. In addition, MWM techniques for radiocarpal, ulnocarpal, distal radioulnar and proximal radioulnar joints.	n = 20 Age: 57 (15.84)	The group received a standard physiotherapy program consisting of ROM, flexibility, strengthening and home exercises.
3, 6 and			12 weeks PRWE DASH VAS AROM flexion, extension, supination ulnar and radial deviation. Grip strength	PRW p	$= 0.004$ DASH $p = 0.007$ VAS $p = 0.002$ AROM flexion, extension, supination $p < 0.05$ AROM ulnar and radial deviation $P > 0.05$ Grip strength $p = 0.011$		

AROM: Active range of motion; **VAS**: Visual analogue scale; **ROM**: Range of motion; **MLD**: Manual lymph drainage; **PV**: Pulpa vola distance; **CMC**: Thumb carpometacarpal opposition; **ADL**: Activities of daily living; **DASH**: Disabilities of the Arm, Shoulder, and Hand: **PRWE**: Patient-Rated Wrist Evaluation; **MWM**: Mobilization with movement; **SF-8 PCS**: Short-Form 8-item Quality of Life questionnaire physical component summary; **SF-8 MCS**: Short-Form 8-item Quality of Life questionnaire mental component summary.

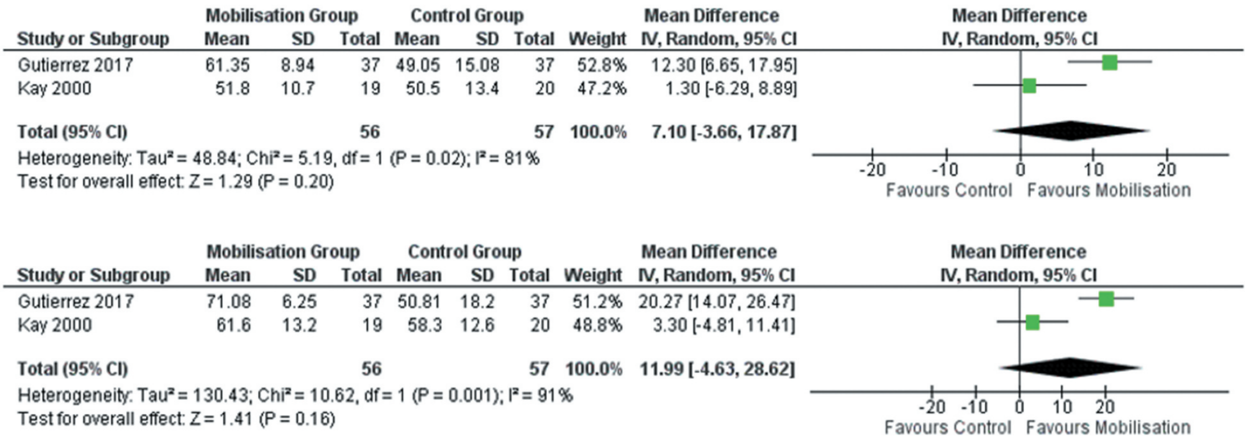

Figure 4. Forest plot summary of supervised physiotherapy plus joint mobilization versus home exercise program in flexion and extension wrist motion at 6 weeks follow-up.

was rated as some concerns 62.5% [7,18–20,22]. The Missing outcome data was rated as low risk 100% [7,17–23]. The Measurement of the outcome was rated as low risk 62.5% [7,20–23]. The Selection of the reported result was rated as high-risk 75% [7,17–21]. Finally, the overall bias was rated as high risk 87.5% [7,17–22].

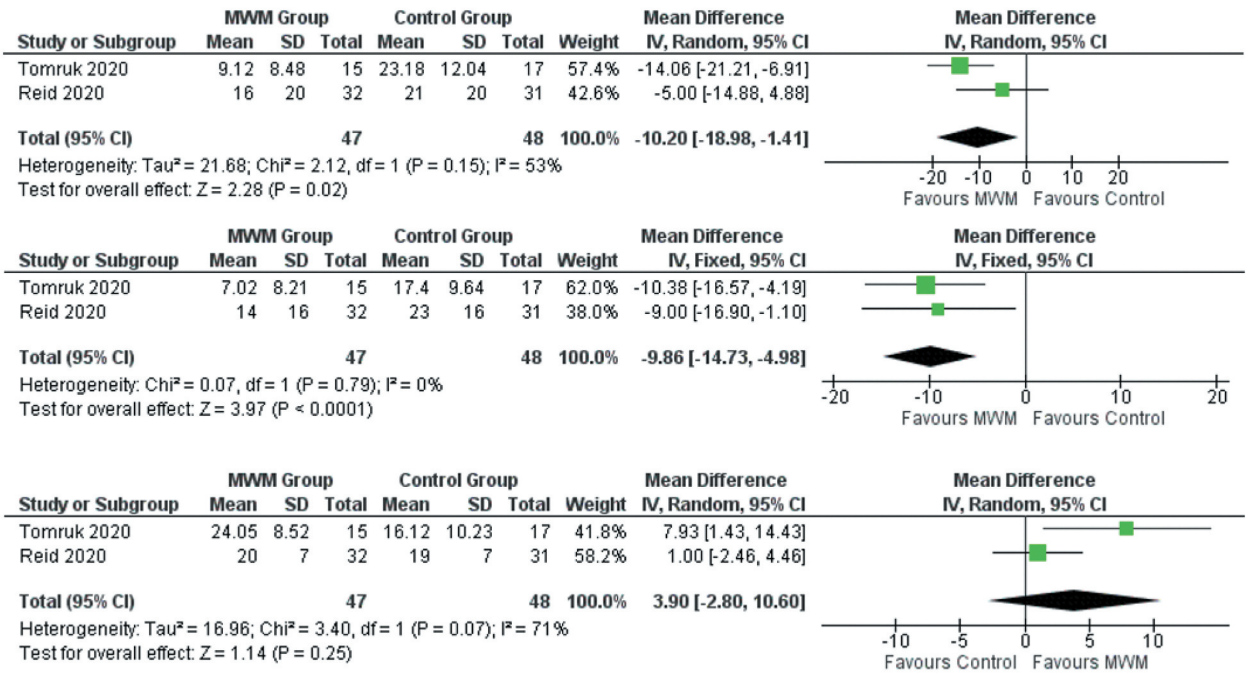

Figure 5. Forest plot summary of exercise program plus mobilization with movement versus exercise program alone in PRWE, DASH and Grip strength at 12 weeks follow-up.

Synthesis of results

Physiotherapy program plus joint mobilization versus an exercise program

Wrist range of motion.

Two studies included data to perform the meta-analysis for flexion wrist motion at 6 weeks, measured with a goniometer [7,18]. The overall pooled MD estimate showed no significant difference for wrist flexion between physiotherapy plus joint mobilization and exercise program at 6 weeks (MD = 7.10 degrees, 95% CI = −3.66 to 17.87, p = 0.20), with substantial heterogeneity ($I^2 = 81\%$, p = 0.02) (Figure 4). There was very low quality of evidence according to the GRADE rating.

Two studies included data to perform the meta-analysis for extension wrist motion at 6 weeks, measured with a goniometer [7,18]. The overall pooled MD estimate showed no significant difference for wrist extension between physiotherapy plus joint

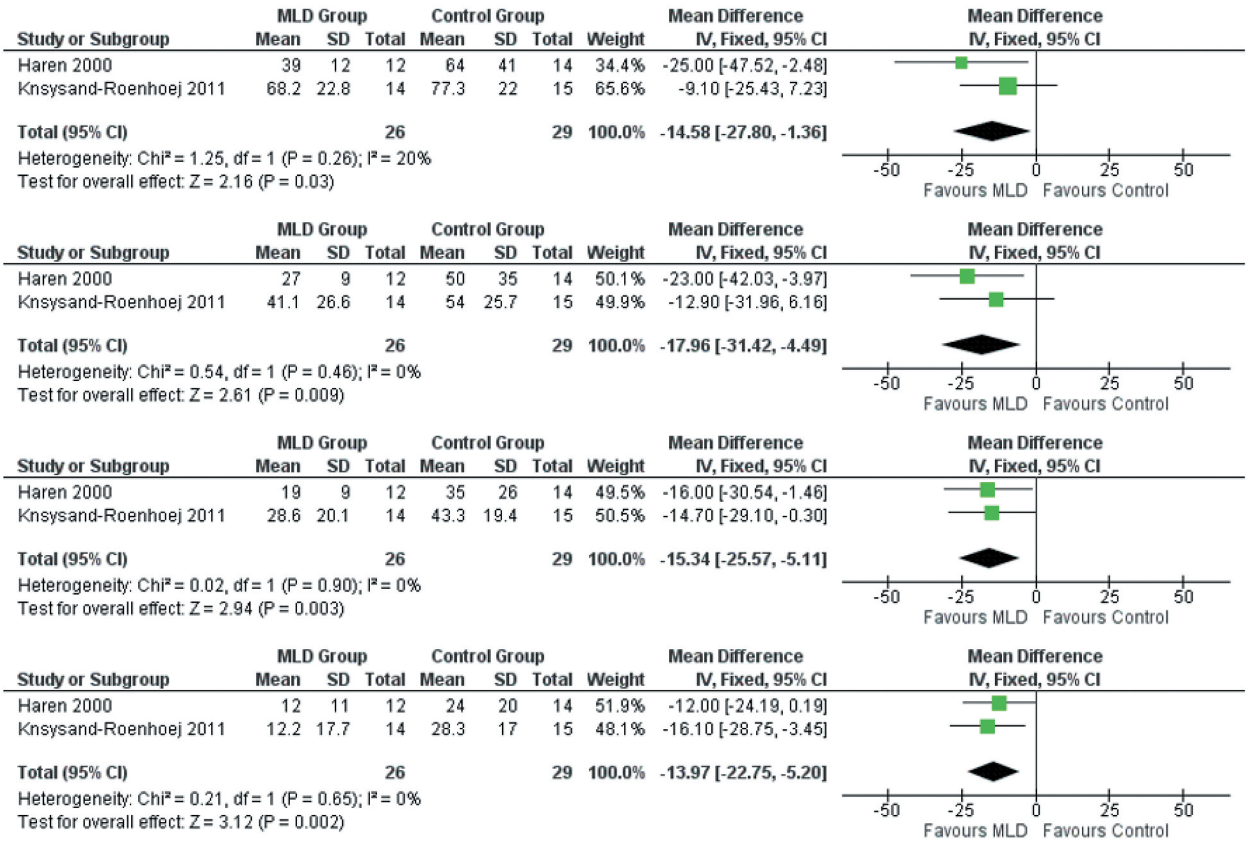

Figure 6. Forest plot summary of conventional treatment plus manual lymph drainage versus conventional treatment alone in edema at 3–7 days, 17–21 days, 33–42 days, and 63–68 days follow-up.

mobilization and exercise program at 6 weeks (MD = 11.99 degrees, 95% CI = −4.63 to 28.62, p = 0.16), with substantial heterogeneity (I^2 = 81%, p = 0.001) (Figure 4). There was very low quality of evidence according to the GRADE rating.

Exercise program plus mobilization with movement versus exercise program alone

Wrist function. Two studies included data to perform the meta-analysis for wrist function at 12 weeks, measured with the Patient-Rated Wrist Evaluation (PRWE) questionnaire [22,23]. The overall pooled MD estimate showed a statistically significant difference for PRWE between exercise plus mobilization with movement and exercise program alone at 12 weeks (MD = −10.2 points, 95% CI = −18.98 to −1.41, p = 0.02), with moderate heterogeneity (I^2 = 53%, p = 0.15) (Figure 5). There was a high quality of evidence according to the GRADE rating.

Upper limb function. Two studies included data to perform the meta-analysis for upper limb function at 12 weeks, measured with the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire [22,23]. The overall pooled MD estimate showed a statistically significant difference for DASH between exercise plus mobilization with movement and exercise program alone at 12 weeks (MD = −9.86 points, 95% CI = −14.73 to −4.98, p < 0.0001), with no important heterogeneity (I^2 = 0%, p = 0.79) (Figure 5). There was low quality of evidence according to the GRADE rating.

Grip strength. Two studies included data to perform the meta-analysis for wrist grip strength at 12 weeks, measured with a Jamar dynamometer [22,23]. The overall pooled MD estimate showed no significant difference for grip strength between exercise plus mobilization with movement and exercise program alone at 12 weeks (MD = 3.9 percent, 95% CI = −2.8 to 10.6, p = 0.25), with substantial heterogeneity (I^2 = 71%, p = 0.07) (Figure 5). There was very low quality of evidence according to the GRADE rating.

Conventional treatment plus manual lymph drainage versus conventional treatment alone

Edema. Two studies included data to perform the meta-analysis for edema at 3–7 days, measuring the difference in volume between the injured and unin-

Table 2. Summary of Findings (SoF) and quality of evidence (GRADE) for manual therapy in patients with DRF.

N° of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Outcome	Number of patients mobilization treatment	Number of patients Control treatment	Effect Absolute (CI 95 %)	Quality of evidence (GRADE)	Importance
2	RCT	Not serious	Very serious	Not serious	Very serious	Wrist flexion at 6 weeks	56	57	MD 7.10 (−3.66 to 17.87)	⊕ Very low	Critical
2	RCT	Not Serious	Very Serious	Not serious	Very serious	Wrist extension at 6 weeks	56	57	MD 11.99 (−4.63 to 28.62)	⊕ Very low	Critical
2	RCT	Not Serious	Not serious	Not serious	Not serious	Wrist function at 12 weeks	47	48	MD 10.20 (−18.98 to −1.41)	⊕ ⊕ ⊕ ⊕ High	Critical
2	RCT	Not serious	Serious	Not serious	Serious	Upper limb function at 12 weeks	47	48	MD 3.90 (−2.80 to 10.60)	⊕ ⊕ Low	Important
2	RCT	Not Serious	Serious	Not serious	Very Serious	Grip strength at 12 weeks	47	48	MD 3.90 (−2.80 to 10.60)	⊕ Very low	Critical
2	RCT	Serious	Not serious	Not serious	Not serious	Edema at 3–7 days	26	29	MD 14.58 (−27.80 to −1.36)	⊕ ⊕ ⊕ ⊕ High	Important
2	RCT	Serious	Not serious	Not serious	Not serious	Edema at 17–21 days	26	29	MD −17.96 (−31.42 to – 4.49)	⊕ ⊕ ⊕ ⊕ High	Important
2	RCT	Serious	Not serious	Not serious	Not serious	Edema at 33–42 days	26	29	MD −15.34 (−25.57 to −5.11)	⊕ ⊕ ⊕ ⊕ High	Important
2	RCT	Serious	Not serious	Not serious	Not serious	Edema at 63–68 days	26	29	MD −13.97 (−22.75 to −5.20)	⊕ ⊕ ⊕ ⊕ High	Important

DRF: Distal radius fracture; **CI**: Confidence Interval; **RCT**: Randomized clinical trial; **MD**: Mean difference

Quality of evidence: High: The research provides a very good indication of the likely effect. The probability that the effect is different is low; **Moderate**: The research provides a good indication of the likely effect. The probability that the effect is substantially different is moderate; **Low**: The research gives some indication of the probable effect. However, the probability that the effect is substantially different is high.**; Very low**: The research does not provide a reliable estimate of the probable effect. The probability that the effect is substantially different is very high.

jured hands (ml) [19,21]. The overall pooled MD estimate showed a statistically significant difference for edema between conventional treatment plus manual lymph drainage and conventional treatment alone at 3–7 days (MD = −14.58 ml, 95% CI = −27.80 to −1.36, p = 0.03), with no important heterogeneity (I^2 = 20%, p = 0.26) (Figure 6). There was a high quality of evidence according to the GRADE rating.

Two studies included data to perform the meta-analysis for edema at 17–21 days, measuring the difference in volume between the injured and uninjured hands (ml) [19,21]. The overall pooled MD estimate showed a statistically significant difference for edema between conventional treatment plus manual lymph drainage and conventional treatment alone at 17–21 days (MD = −17.96 ml, 95% CI = −31.42 to −4.49, p = 0.009), with no important heterogeneity (I^2 = 0%, p = 0.46) (Figure 6). There was a high quality of evidence according to the GRADE rating.

Two studies included data to perform the meta-analysis for edema at 33–42 days, measuring the difference in volume between the injured and uninjured hands (ml) [19,21]. The overall pooled MD estimate showed a statistically significant difference for edema between conventional treatment plus manual lymph drainage and conventional treatment alone at 33–42 days (MD = −15.34 ml, 95% CI = −25.57 to −5.11, p = 0.003), with no important heterogeneity (I^2 = 0%, p = 0.90) (Figure 6). There was a high quality of evidence according to the GRADE rating.

Two studies included data to perform the meta-analysis for edema at 63–68 days, measuring the difference in volume between the injured and uninjured hands (ml) [19,21]. The overall pooled MD estimate showed a statistically significant difference for edema between conventional treatment plus manual lymph drainage and conventional treatment alone at 63–68 days (MD = −13.97 ml, 95% CI = −22.75 to −5.20, p = 0.002), with no important heterogeneity (I^2 = 0%, p = 0.65) (Figure 6). There was a high quality of evidence according to the GRADE rating.

The overall quality and summary of evidence with the GRADE approach are shown in Table 2.

Publication bias

Publication bias was not evaluated, since only eight articles were included in this systematic review and meta-analysis [24].

Discussion

This systematic review and meta-analysis aimed to determine the effectiveness of MT for functional outcomes in patients with DRF. For exercise program plus mobilization with movement versus exercise program, our findings suggest statistically significant differences at 12 weeks in the PRWE and DASH questionnaires. Additionally, for the comparison of conventional treatment plus manual lymph drainage versus conventional treatment alone, in the short term, the edema showed a statistically significant decrease, with all differences in favor of the MT group. Conversely, adding joint mobilization to supervised physiotherapy did not show clinical or statistically significant differences in the wrist range of motion when compared to a home exercise program.

According to our findings, a previous systematic review did not support the added use of joint mobilization after DRF [25]. Additionally, another systematic review showed limited evidence for the joint mobilizations in the treatment of the wrist and hand conditions [9]. Although there are neurophysiological foundations to support joints mobilizations, this does not necessarily translate into improvement of functional results in these patients [9]. Additionally, it is important to consider clinical aspects such as the type of technique and dose used in the studies (oscillatory technique using various frequencies). It is also possible that there may be sub-groups of patients after DRF for whom passive joint mobilization is beneficial; however, no studies have established the characteristics that may help identify them [18]. Possible explanations for our findings are the small number of studies published and the limited methodological quality of randomized clinical trials that have analyzed the effectiveness of joint mobilization techniques in this clinical condition. Even though the number of randomized clinical trials on MT has increased in recent decades, a systematic review showed suboptimal levels in the quality of reporting and high RoB; these findings suggest that the current use of the consolidated standards of reporting trials guidelines and RoB is less than optimal in these studies [26].

In contrast to previous systematic reviews [27–29], this meta-analysis showed that mobilization with movement combined with exercise results in significant differences in wrist and upper limb function in patients with DRF. These MT techniques require a certain direction of application of mobilization forces. In the studies included, the forces were mainly applied in the radiocarpal and ulnocarpal joints with manual glide of the carpal row during active wrist flexion and extension [22,23]. The improvements in motor function are mainly due to the decrease in pain produced by this technique. Although the underlying mechanism of mobilization with movement is still unclear, the traditional explanation provided for the Mulligan concept is biomechanical in nature and based on the existence of bony positional faults and the ability to correct them [30]. Additionally, the sympathetic nervous system excitation during the application of MT techniques, including those of mobilization with movement, produced non-opioid hypoalgesia, and sympathoexcitation is another possible explanation reported by a previous review [27].

According to our findings, a previous systematic review showed moderate evidence that adding manual lymph drainage to conventional treatment produces a significant decrease in edema in patients with DRF [31]. The types of massage for edema reduction analyzed in this review correspond to manual lymphatic drainage [19,20] and manual edema mobilization (which includes exercises in the segment just massaged) [21]. Possible explanations for our findings are that the manual lymph drainage augments lymphatic contractility, increases lymphatic flow through cutaneous lymphatics, and reduces lymphatic fluid, protein molecules, and other large molecules impermeable to the venous system in affected extremities, thus reducing limb swelling [32].

Regarding the effectiveness of MT techniques in musculoskeletal disorders, it is necessary to consider several aspects. The verification of a possible dose–response relationship of applying MT could be relevant, given the wide variation between the application dosage (number of sessions, duration, and weekly frequency) and force applied to the technique. There are several factors that influence the amount of force applied to a patient, including the level of tissue restriction or stiffness at the site of application, the joint being mobilized, and the level of tissue irritability experienced by the patient [33]. According to this, a comprehensive model of mechanisms of MT was proposed. This model suggests that a mechanical force from MT initiates a cascade of neurophysiological responses from the peripheral and central nervous system, which are then responsible for the clinical outcomes [34]. Finally, an understanding of the mechanisms behind MT could assist in the identification of individuals likely to respond to MT and a better understanding of the factors that are determined as predictive [34–36].

To the best of our knowledge, this is the first meta-analysis to analyze the effect of MT techniques on functional outcomes in patients with DRF. Based on the PRISMA guidelines, the recommendations of the Cochrane Collaboration Handbook, the synthesis and quality of evidence assessed with GRADE, and registration of the protocol in PROSPERO, this study used a transparent method for assessing and reporting the evidence.

The limitations of our study are as follows: 1) Although we searched eight databases and included articles in two different languages, we could have missed articles relevant to our search. 2) Methodological limitations, such as the lack of an adequate sample size, unclear concealed allocation, and the lack of blinding of the assessors, could overestimate the effect size of the interventions studied. 3) Due to the limited number of included studies, publication bias could not be assessed. And 4) in the planning stages, we intended to conduct subgroup analyses based on the type of MT technique, age, severity, and type of treatment of DRF. Finally, our results should be interpreted with caution in relation to the methodological limitations and limited number of studies available.

Conclusions

In the short term, there was very low to high evidence according to GRADE rating that adding mobilization with movement and manual lymphatic drainage showed statistically significant differences in wrist, upper limb function, and hand edema. Conversely, adding joint mobilization did not show clinical or statistically significant differences in the wrist range of motion in patients with DRF. There is a need for higher-quality randomized clinical trials investigating the different MT techniques. Future studies should include more patients, have longer follow-up times, and perform subgroup analyses regarding age, severity, and type of treatment of DRF.

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