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Systematic Review

The effectiveness of Mulligan's mobilisation with movement (MWM) on peripheral joints in musculoskeletal (MSK) conditions: A systematic review

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ABSTRACT

Musculoskeletal (MSK) conditions are very common and represent a major concern for the society and global health. The manual therapy technique Mulligan's Mobilisation with Movement (MWM) has shown promising results in treating a variety of MSK conditions. The aim of this review was to systematically review the literature to establish whether MWM treatment is effective for improving pain and function in patients with MSK conditions related to peripheral joints.

Methods: Seven electronic databases (MEDLINE (through Ovid), EMBASE (through ovid), CINAHL (through EBSCO), Cochrane (CENTRAL), Web of Science, SPORTDiscus (through EBSCO) AND PEDro) were searched up to November 2017 for randomized controlled trials (RCTs). The quality of the evidence was rated using the GRADE approach.

Results: Seven published trials were identified in which all trials presented positive clinical outcome in pain and function of MWM. Moderate quality evidence was found for the effectiveness of MWM in pain and function in patients with chronic ankle instability (CAI) and hip osteoarthritis (OA). There was found low quality evidence for shoulder impingement syndrome (SIS) and low and very low quality evidence for lateral epicondylalgia.

Conclusion: Overall MWM interventions applied to peripheral joints seems to be superior to placebo and no intervention controls, but not in comparison with other medical or physiotherapy interventions. There is a need for more high quality trials that investigate the short and long-term effect of a series of MWM interventions.

1. Introduction

Musculoskeletal (MSK) conditions are ubiquitous, representing approximately 20% of the consultations in primary care in the UK (Urwin et al., 1998; Jordan et al., 2010). 33% of the population of the United States was reported to suffer from MSK conditions between 2009 and 2011 (Yelin et al., 2016). The upper and lower limbs are reported to represent 33.2% and 16% respectively of all musculoskeletal consultations (Jordan et al., 2010).

Manual therapy has shown promising clinical effects in managing musculoskeletal conditions (Voogt et al., 2015). Manual therapy consists of several different treatments, including techniques initially advocated by Brian Mulligan (Mulligan, 2010; Wise, 2015). Mulligan described treatment techniques combining passive accessory joint application with repetitive active or passive physiological movements (Mulligan, 2010). These techniques can be applied to the spinal joints (referred to as sustained natural apophyseal glides (SNAGS)) or peripheral joints (Mobilisation with movement (MWM)). This study will focus on the peripheral joints and thereby Mulligan's MWM. This technique was developed by Brian Mulligan in the 1980s and is a common treatment for a variety of joint related and soft tissue conditions of the upper and lower limbs (Hing et al., 2009; Mulligan, 2010). According to Mulligan, the physiological movement should be performed pain-free (Mulligan, 2010) with accessory glides being applied in the direction causing the greatest improvement of the previous painful movement (Mulligan, 2010; Vicenzino et al., 2011).

MWMs have shown promising clinical results such as reduction of pain and improved range of motion (ROM) (Vicenzino et al., 2001, 2006; Hing et al., 2009). Originally, these effects were thought to occur as a result of correction of positional faults in the joint (Mulligan, 2010), however, this has not been supported by research (Vicenzino et al., 2007; Hing et al., 2009). Contemporary understanding suggests underlying neurophysiological mechanisms of MWM (Vicenzino et al., 2001, 2007; Paungmali et al., 2003, 2004). Additionally, mechanisms may include reduction in fear of movement and placebo (Vicenzino et al., 2011).

Two published systematic reviews have investigated the effects of MWM performed to the peripheral joints (Hing et al., 2009; Vicenzino

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et al., 2011). Even though these studies found overall positive clinical effects for MWM, the authors highlighted the need for further studies with improved methodology. Since then a number of additional studies have been conducted thus a current review was deemed appropriate. The aim of this systematic review was to evaluate the effect of MWM performed on peripheral joints in people with MSK conditions to collate evidence of the effectiveness of this treatment technique.

2. Methods

This systematic review is reported following the PRISMA-guidelines (Liberati et al., 2009).

2.1. Search strategy

An electronic search with no date restrictions was performed by one researcher in October 2017 using the following databases: MEDLINE and EMBASE (through ovid), CINAHL (through EBSCO), Cochrane (CENTRAL), Web of Science, SPORTDiscus (through EBSCO) AND PEDro. The search terms were adapted for the particular databases and included "mobili* with movement" OR MWM OR mulligan* OR "mulligan mobili*" OR "man* therapy" AND mobili*. The electronic search was complemented by hand searching the reference lists of relevant articles.

2.2. Study selection

The study selection were undertaken by one reviewer according to the following criteria:

2.2.1. Design

Published, English language randomized control trials (RCTs) were eligible for inclusion. The review was limited to RCTs with parallel group design as this design is the most appropriate for measuring the effectiveness of an intervention (Sibbald and Roland, 1998), and has the highest level of evidence in research (Van Tulder et al., 2003). Other research designs, such as case studies and crossover studies were excluded.

2.2.2. Participants

This review included studies with participants with MSK conditions in the upper or lower limbs independent of age and duration of symptoms. Studies including animals, cadavers, asymptomatic or post-surgical participants were excluded.

2.2.3. Interventions and comparison

Studies including Mulligan's MWM performed on peripheral joints alone or combined with other interventions were included. The MWM intervention had to be compared with a placebo intervention, no treatment control or no manual contact control. Eligible studies could additionally include other comparison interventions, such as physiotherapy or medical interventions.

2.2.4. Outcome measures

This review was not limited to any specific outcome measures for inclusion. All outcome measures of pain, physical measures and function were eligible.

2.3. Data extraction

Key data of each study was extracted in a data extraction form described by Wright et al. (2007). Study characteristics, participant characteristics, interventions, comparison interventions, outcome measures and results were included in the data extraction.

2.4. Risk of bias assessment

The risk of bias of the eligible studies was assessed using the 12 item criteria recommended by the Cochrane Back Review Group. The criteria were scored as "yes (low risk of bias), "no" (high risk of bias) or "unclear". The tool provides a maximum score of 12 points and a study with a score of six or more was defined as a study with a low risk of bias (Furlan et al., 2009). Two researchers assessed the studies independently and disagreement was resolved by consensus. The inter-rater reliability was evaluated by the Cohen's Kappa statistics for overall agreement (www.graphpad.com).

2.5. Data synthesis

Due to heterogeneity of the included studies regarding diagnosis, body region, intervention and outcome measures, a meta-analysis was not possible. Therefore a narrative synthesis using the GRADE approach was used to evaluate the quality of evidence and strength of recommendations (Guyatt et al., 2008). The GRADE approach is divided into four levels of evidence. High: We are very confident that the true effect lies close to that of the estimate of the effect. Moderate: We are moderately confident in the effect estimate. The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. Low: Our confidence of the effect estimate is limited. The true effect may be substantially different from the estimate of the effect. Very low: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect (Balshem et al., 2011).

The quality of evidence was based upon five categories and downgraded by one level for each of the factor that was not encountered: Study limitations (Risk of bias), imprecision, inconsistency of results, indirectness of evidence and reporting bias (Guyatt et al., 2008; Balshem et al., 2011).

3. Results

3.1. Study selection

The electronic search was performed in October 2016 and updated October 2017. The results of the search of the different databases are outlined in Fig. 1. The search of the 7 databases and the secondary searches identified 174 relevant records after removal of duplicates. After a screening of the titles and abstracts, 51 studies were assessed in full-text against the inclusion criteria. Nineteen studies were excluded because of study design, 25 studies were excluded due to lack of control or placebo intervention. At the end of the study selection process, seven studies were included in this systematic review. Fig. 1 show the flow of the search result and study selection.

3.2. Risk of bias and quality of evidence

The risk of bias assessment of all studies in this systematic review is summarised in Table 1. The mean quality score was 9 out of 12. None of the studies demonstrated adequate therapist blinding, and four studies (57%) showed adequate participant blinding. Four studies (57%) demonstrated inadequate concealed allocation. The inter-rater reliability was very good (Kappa = 0.96, SE = 0.029), which is characterised as almost perfect agreement (Cohen, 1960). The only item that the two researchers disagreed was the item of patient blinding.

3.3. Study characteristics

The characteristics of each study are summarised in Table 2. The studies included in total 463 participants with sample sizes ranging from 10 to 190. The included studies investigated the effects of MWM performed on four different peripheral joints; the hip joint (2 studies),

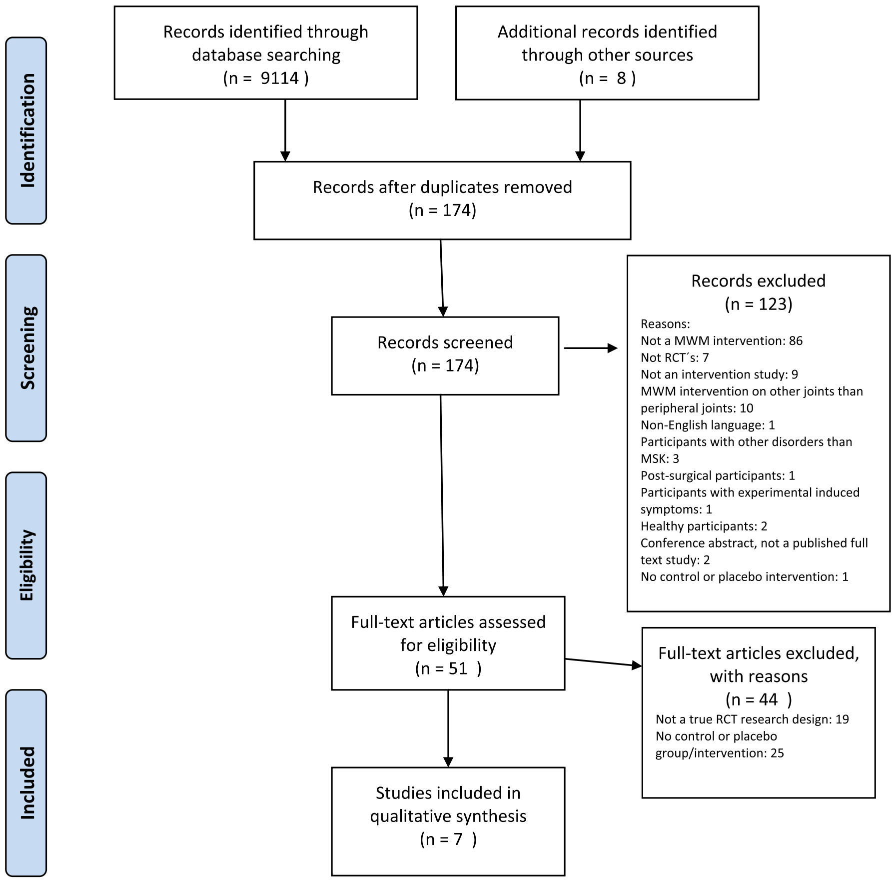

Fig. 1. Flow Diagram.

ankle joint (2 studies), shoulder joint (1 study) and elbow joint (2 studies). The participants were diagnosed with hip osteoarthritis (Beselga et al., 2016; Zemadanis et al., 2017), chronic ankle instability (Cruz-Diaz et al., 2015; Marrón-Gómez et al., 2015), shoulder impingement syndrome (Delgado-Gil et al., 2015), and lateral epicondylalgia (Bisset et al., 2006; Kim et al., 2012).

The studies included compared MWM with several different comparison interventions. Six studies compared two groups in which one group received MWM and the other received a placebo intervention (Cruz-Diaz et al., 2015; Delgado-Gil et al., 2015; Kim et al., 2012; Marrón-Gómez et al., 2015; Beselga et al., 2016; Zemadanis et al., 2017). Two studies compared MWM with no treatment control (wait and see) (Bisset et al., 2006; Cruz-Diaz et al., 2015.) The MWM intervention was also compared with other physiotherapy or medical interventions in some of the studies. One study compared MWM with corticosteroid injections (Bisset et al., 2006), while one study compared MWM with talocrural manipulation (Marrón-Gómez et al., 2015).

All of the included studies had a RCT design (Bisset et al., 2006; Cruz-Diaz et al., 2015; Delgado-Gil et al., 2015; Kim et al., 2012; Marrón-Gómez et al., 2015; Beselga et al., 2016; Zemadanis et al., 2017). Two studies performed only one session of the intervention (Marrón-Gómez et al., 2015; Beselga et al., 2016). In one study the interventions were performed two times a week in a three-week period (Cruz-Diaz et al., 2015), and one study performed four treatments in a two-week timeframe (Delgado-Gil et al., 2015). Another study performed five treatments in ten days (Kim et al., 2012). The participants in one study received 3 treatments per week for 2 weeks (Zemadanis et al., 2017). One study performed 8 sessions of the MWM intervention in a 6-week period (Bisset et al., 2006). MWM was performed as the only intervention in all studies except in two studies in which MWM was combined with exercises (Bisset et al., 2006) and general therapy (Kim et al., 2012).

3.4. Outcome measures

The outcome measures for each of the ten trials are presented in Table 2. Four studies included outcome measures for pain. The pain intensity was measured by the visual analogue scale in two studies (Bisset et al., 2006; Zemadanis et al., 2017) and by the numerical pain rating scale in two studies (Delgado-Gil et al., 2015; Beselga et al., 2016). One study measured the pain-free grip strength with a dynamometer (Bisset et al., 2006). Pain-free range of motion (ROM) was used in one study (Delgado-Gil et al., 2015), while four studies measured maximum ROM (Cruz-Diaz et al., 2015; Delgado-Gil et al., 2015; Marrón-Gómez et al., 2015; Beselga et al., 2016). Physical function was measured by timed up and go, chair stand and 40 meters self paced walk in one study (Beselga et al., 2016). One study assessed the dynamic postural control with the Star excursion balance test (Cruz-Diaz et al., 2015). Functional disability was measured by Cumberland ankle instability tool (Cruz-Diaz et al., 2015), lower extremity function scale (Zemadanis et al., 2017), pain-free function questionnaire (Bisset et al., 2006), global improvement (Bisset et al., 2006) and patient-rated tennis elbow evaluation scale (PRTEE) (Kim et al., 2012). Regarding time of measures, all studies assessed the pre- and post-treatment outcomes, ranged from immediately after the intervention to 6 weeks short-term and three studies included a long-term follow-up at three months (Zemadanis et al., 2017), six months (Cruz-Diaz et al., 2015) and one year (Bisset et al., 2006).

3.5. Effect of the intervention

An overview of the effectiveness of MWM is presented in Table 2

Table 1
Risk of Bias.

Study	Randomization	Concealed allocation	Patient blinding	Care provider blinding	Outcome assessor blinding	Acceptable drop-out rate	Participants analysed in the allocated group	Free of selective outcome reporting	Groups similar at baseline	Co-interventions avoided or similar	Acceptable compliance	Similar timing of outcome assessment	Total (0–12)
Beselga et al. (2016)	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	10
Bisset et al. (2006)	Y	Y	Y	N	Y	Y	Y	Y	Y	N	U	Y	9
Cruz-Diaz et al. (2015)	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	10
Delgado-Gil et al. (2015)	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	11
Kim et al. (2012)	Y	U	N	N	N	N	N	Y	N	Y	Y	Y	5
Marrón-Gómez et al. (2015)	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	9
Zemadanis et al. (2017)	Y	N	Y	N	Y	Y	Y	Y	Y	N	Y	Y	9

and the following paragraphs will summarize the clinical effectiveness of MWM categorised into specific MSK conditions.

3.5.1. MWM for shoulder conditions

One RCT with low risk of bias demonstrated a significant improvement of pain and shoulder ROM compared to a placebo intervention following a two-week period of MWM interventions in patients with shoulder impingement syndrome (SIS) (Delgado-Gil et al., 2015). Since this is only based on one single study, there is low quality evidence (limitation in imprecision) for the effect of MWM for the short-term effect in pain and ROM in patients with SIS.

3.5.2. MWM for lateral epicondylalgia

One RCT with low risk of bias demonstrated short and long term effect on pain, global improvement and disability of MWM and a supervised exercise program compared to wait and see and corticosteroids in patients with lateral epicondylalgia (Bisset et al., 2006). This study included 8 treatments over a 6-week intervention period. The MWM group showed superior outcome compared to wait and see in the first six weeks, but no difference was demonstrated at twelve months (Bisset et al., 2006). The MWM intervention was superior to corticosteroid treatment at 1-year follow-up, but corticosteroids demonstrated significant better improvement at 6 weeks (Bisset et al., 2006). One study with a high risk of bias, which included only ten participants demonstrated superior effect for MWM on pain and functional activities measured with patient-rated tennis elbow evaluation scale (PRTEE) (Kim et al., 2012). There is low quality evidence from one study (limitation in imprecision) for the short- and long term effects of MWM in pain and function in patients with lateral epicondylalgia. There is very low evidence quality evidence from one study (limitation in risk of bias, imprecision and indirectness of evidence) for the short-term effects of MWM on pain and function (PRTEE) in patients with lateral epicondylalgia.

3.5.3. MWM for hip osteoarthritis

Two RCTs with low risk of bias demonstrated clinical effects in pain and function of MWM in patients with hip osteoarthritis (Beselga et al., 2016; Zemadanis et al., 2017). Beselga et al. (2016) revealed an immediate improvement in pain, hip ROM and physical function tests following one single MWM intervention compared to placebo. Zemadanis et al. (2017) demonstrated a significant immediate and long term improvement (3 months) in VAS and lower extremity function scale following six interventions in a two week period in addition to home exercises of MWM compared to placebo. Therefor, there is moderate quality evidence for the effects of MWM in pain and function in patients with hip osteoarthritis.

3.5.4. MWM for chronic ankle instability (CAI)

Two RCTs with low risk of bias demonstrated effect of MWM on ankle range of motion (ROM) in patients with CAI compared to placebo or control (Cruz-Diaz et al., 2015; Marrón-Gómez et al., 2015). Cruz-Diaz et al. (2015) demonstrated a short and long-term effect of a three-week intervention period with weight-bearing MWM for ankle ROM, dynamic postural control and self-reported ankle instability compared to placebo and no treatment control. Marrón-Gómez et al. (2015) showed significant immediate improvement in ROM following a single weight-bearing MWM intervention compared to a placebo intervention, but no significant difference compared to talocrural manipulation. In summary, there is moderate quality evidence (limitation in imprecision) for the effect of MWM in ankle ROM and function in patients with CAI.

Table 2
Study characteristics.

Study	Design	Participants/Inclusion criteria	Intervention	Outcome measures	Results
Delgado-Gil et al. (2015)	RCT	Shoulder impingement syndrome, symptoms < 3 months N = 42 Age = Mean age 55y (SD +-9). Gender: 81% females.	A = MWM. N = 21. PA glide of the humeral head combined with active pain-free shoulder flexion. 3 × 10 repetitions. B = Placebo, n = 21. The same technique but no pressure was applied. 2 sessions per week were performed for 2 weeks.	Pain: NPRS (pain last 24 h, pain during night and pain during shoulder flexion) ROM = Pain-free shoulder flex, ext, ER, IR. Maximum flexion. Follow-up = 24 h, 2 weeks.	The between-group effect sixes showed that MWM had a greater reduction in pain intensity during shoulder flexion (0.9), amount of pain-free shoulder flexion (1,8), maximum ER (0.9) and maximum shoulder flex (1,4) compared to the placebo group.
Bisset et al. (2006)	RCT	Lateral elbow pain/tennis elbow < 6 weeks. Mean duration of symptoms: 22 weeks. N = 198, Age = Mean 47.6 years (SD: 7.8). Gender = 70 females, 128 males.	A = Physiotherapy. MWM + a supervised exercise program, n = 66: Lateral glides combined with active movements. Isometric, concentric and eccentric exercises and taping. Home exercise program with strength and MWM exercises. 8 sessions in 6 weeks. B = Corticosteroid injection to painful elbow points, n = 65. C = Wait and see, n = 67. No manual treatment.	Pain = PFGS, Assessor severity rating. Global improvement, 6 point likert-type scale VAS the last week, Pain free function questionnaire. Follow-up = 3, 6, 12, 26 and 52 weeks.	Injection was superior to wait and see in all outcome measures at 6 weeks and to physiotherapy at 6 weeks except global improvement. At one year follow up the physiotherapy group was superior to the injection group in all outcome measures. The physiotherapy group showed better improvement than wait and see for all outcome measures after 6 weeks, but no difference at 52 weeks.
Kim et al. (2012)	RCT	Lateral epicondylitis within the last 3 months. N = 10 Age MWM group = 49.40y (+-2.88) Age placebo group = 49.20 (+-5.89).	A = MWM. 2 sets of 10 repetitions B = Placebo. Passive elbow flexion for 2 sets of 10 repetitions. Both groups received hot pack for 10 minutes, electrotherapy for 10 minutes and deep friction massage for 10 minutes to all regions of pain. The treatments were performed every other day in 10 days.	Pain and Function = PRTEE. Measured prior to and after five interventions.	Significant change in patient-rated pain (p = 0.02), special activities (p = 0.03) and usual activities (p = 0.002) in the MWM group compared to the placebo group.
Beselga et al. (2016)	RCT	Hip OA. N = 40 Age = Mean 78y (SD + -6y) Gender: 54% females	A = MWM, n = 20. Lateral glides combined with passive flexion and IR. 3 × 10 repetitions for each movement direction. B = Placebo, n = 20. Flexion and IR was maintained for 3 sets of 10 s with no force through the belt. One treatment in one session for each group.	Pain = Pain intensity (NPRS) ROM = Hip flexion, IR. Physical performance: TUG, CS, SPW Assessed immediately after the interventions.	Significant reduction of pain intensity for the MWM group compared with the placebo group (Effect size = 1.9). The MWM group showed a significant increase of hip flexion (effect size 3) and IR (1.4). Significant improvement of TUG,SC,SPW for MWM. An effect size between 1 and 1.7 was demonstrated for the functional tests.
Zemadanis et al. (2017)	RCT	Hip OA N = 40 Age = 68y (SD +- 7,1) Gender: 70% females	A = MWM, n = 20. Passive accessory glides were performed to femur with a seatbelt combined with active hip movement in the most affected direction of hip joint motion (IR, hip ext or hip abd.). 3 × 10 repetitions. Additionally similar MWM exercises were given as home exercises performed 3 × 10 twice daily. B = Placebo, n = 20. The same active movements were performed, but the therapist had only light contact on the patient's hip without mobilisation force. Six treatments in 2 weeks.	Pain = VAS Function = LEFS. Assessed immediately after the intervention and at three months follow- up.	The MWM group demonstrated significant improvement in VAS and LEFS scores immediately after intervention and at 3 months follow up compared to baseline scores (p < 0.001), while there was not shown any significant difference for the placebo group. There was shown a significant difference between the two groups in post-treatment and follow-up scores (p < 0.001).
Cruz-Diaz et al. (2015)	RCT	Chronic ankle instability (CAI) N = 81 Age = mean 27.7y (SD +-6.8y). Gender = 47 males, 34 females.	A = MWM W-B, n = 30. PA glides of tibia with a non-elastic belt, combined with active DF in standing. B = Placebo, n = 31. In supine, a semi-rigid orthesis limited ankle DF and the knee was moved passively in flexion and extension. 2 x 10 repetitions for both interventions. C = Control, n = 29. No-treatment control 2 sessions per week for 3 weeks.	ROM = W-B DFROM. Stability = CAIT, SEBT. Measured immediately after treatment, 3 weeks, 6 months.	The MWM group showed significant better improvement in ROM and SEBT after the first session, at 3 weeks and at 6 months (p < 0.001) compared to placebo and control. Significant increase in CAIT scores at 3 weeks and at 6 months follow- up for the MWM intervention compared to placebo and control (p < 0.001). The effect size of the group-by-time interaction was 0.753 for CAIT, 0.954 for ROM and 0.821 for SEBT Ant.
Marron-Gomez et al. (2015)	RCT	Chronic ankle instability (CAI) N = 52 Age = Mean 20.7y (+-3,4y) Gender = 31 males, 21 females	A = MWM, n = 18. PA glides of tibia combined with active DF in standing.10 repetitions. B = HVLA, n = 19. 3 distraction thrusts of the talocrural joint. C = Placebo, n = 15. Similar to the MWM intervention, but tension through calcaneus and not tibia. One single treatment.	ROM = W-B DFROM. Measured immediately after, 10min, 24 h, 48 h post-intervention	The between group effect size was large for the MWM group (1.31) and HVLA (1.46) compared to placebo 48 h postintervention, but no differences between MWM and HVLA.

MWM = Mobilisation with movement, RCT = Randomized control trial, PA = Posterioanterior, ROM = Range of motion, Flex = flexion, ext = extension, abd = abduction, IR = Internal rotation, ER = External rotation, PFGS = Pain-free grip strength, TUG = Time up and go, STS = Sit to stand, CS = Chair stand, SPW = 40 m self paced walk, DF = Dorsiflexion, W-B = Weight-bearing, DFROM = Dorsiflexion range of motion, CAIT = Cumberland Ankle instability tool, SEBT = The star excursion balance test, HVLA = High-velocity low amplitude, W-B DFROM = Weight-bearing dorsiflexion range of motion, OA = Osteoarthritis, VAS = Visual analogue scale, NPRS = Numeric pain rating scale, LEFS = Lower extremity functional scale. PRTEE = Patient-rated tennis elbow evaluation scale.

4. Discussion

4.1. Summary of evidence

This systematic review summarises the clinical effects of MWM performed to peripheral joints, and demonstrates that MWM is an effective intervention for managing patients with hip osteoarthritis (OA), chronic ankle instability (CAI), shoulder impingement syndrome (SIS) and lateral epicondylalgia. There was moderate quality evidence for the effects of MWM for chronic ankle instability (Cruz-Diaz et al., 2015; Marrón-Gómez et al., 2015) and hip osteoarthritis (Beselga et al., 2016; Zemadanis et al., 2017), while there was found low quality evidence for shoulder impingement syndrome (SIS) (Delgado-Gil et al., 2015). Low and very low quality evidence was found for the effects of MWM for lateral epicondylalgia (Bisset et al., 2006: Kim et al., 2012). All of the seven studies reported superior effects of MWM performed on the hip, shoulder, ankle and elbow joint compared to placebo or no treatment control. Conversely, MWM was not superior to other physiotherapy or medical interventions, such as HVLA manipulation or corticosteroids (Bisset et al., 2006; Marrón-Gómez et al., 2015). MWM demonstrated immediate and short-term effect in all of the patient groups, but only three studies investigated the long-term effects of the treatment. MWM was not superior to wait and see in a one-year follow-up in patients with lateral epicondylalgia (Bisset et al., 2006). In contrast, Cruz-Diaz et al. (2015) demonstrated a superior effect of MWM at six months follow-up in patients with CAI and MWM was found superior to placebo at three months in patients with hip osteoarthritis (Zemadanis et al., 2017).

The results in this review are consistent with the previous systematic reviews reporting positive clinical effects of MWM (Hing et al., 2009; Vicenzino et al., 2011). This present review presents further evidence for the clinical effectiveness of MWM on specific diagnosis of the upper and lower limbs. This review presents evidence of the effectiveness of MWM in patients suffering from hip OA and increased evidence for the effectiveness of MWM in patients with shoulder and ankle joint pain. Regarding the evidence for MWM in patients with lateral epicondylalgia, there was no additional evidence from the previous systematic reviews (Hing et al., 2009; Vicenzino et al., 2011). These two studies included trials with a various design and quality, while this present review has included only RCTs. Systematic reviews that includes high quality RCTs are associated with higher validity (Wright et al., 2007; Higgins and Green, 2011). The finding of hypoalgesic effect following MWM treatment was similar to the results of a systematic review investigating the analgesic effect of manual therapy in patients with MSK pain (Voogt et al., 2015). However, Voogt et al. (2015) was limited to the analgesic effect of manual therapy and included all sorts of manual therapy interventions, including MWM (Voogt et al., 2015).

4.2. Clinical implications

This review provides evidence that MWM is an effective intervention for managing several conditions of the upper and lower limb. However, a majority of the studies reported only the initial effects of one or a few interventions, which could reduce the implication to clinical practice since clinical treatment is often associated with a series of interventions. However it could be argued that the initial hypoalgesic effect following one single intervention may enable greater pain free movement and thus may reduce fear of movement (Rabey et al., 2017). This may lead to longer lasting clinical effects particularly if equivalent home exercises are prescribed. Clinically it is important to determine the long-term clinical effects of MWM treatment, but this review reveals a lack of such trials in the literature. Nevertheless, two of three long-term effect trials revealed positive outcomes for MWM compared to a control intervention (Cruz-Diaz et al., 2015; Zemadanis et al., 2017). This review has revealed the need for future trials investigating the long-term effects of a series of MWM interventions.

4.3. Limitations of the included studies

All of the studies reported positive findings of one or more MWM interventions compared to a placebo intervention (Kim et al., 2012; Cruz-Diaz et al., 2015; Delgado-Gil et al., 2015; Marrón-Gómez et al., 2015; Beselga et al., 2016; Zemadanis et al., 2017). The placebo effect is described as effects caused by other conditions than the actual treatment (Vase et al., 2002), and is important to rule out to determine the effect of an intervention (Lin et al., 2012; Sibbald and Roland, 1998). It is difficult to create a placebo intervention that is similar to the experimental intervention without any component parts of the intervention. Research has shown that trials that compared an intervention with placebo control showed significant greater likelihood for positive outcomes than trials that compared an intervention with other forms of therapy (Colditz et al., 1989). One study compared MWM with no treatment control and reported findings in favour of the MWM intervention (Bisset et al., 2006). A possible limitation of no treatment control is that it limits the relation between the therapist and participant (Degnan et al., 2016). Six of seven included studies had a low risk of bias, which is associated with higher validity of systematic reviews (Wright et al., 2007). However, one study was found to have a high risk of bias (Kim et al., 2012). This study was a pilot study and included only ten participants. Pilot studies with small sample size are associated with insufficient statistical power and are not designed for evaluating the effectiveness of interventions (Leon et al., 2011). Therefor are the results from this study of little value when evaluating the effects of MWM.

4.4. Strength and limitations of this review

A possible strength of this systematic review is that two individual researchers performed the risk of bias assessment and the inter-reliability was strong, which is shown to increase the validity of a systematic review (Wright et al., 2007). This review has also some limitations. Firstly, only one researcher performed the search, study selection and data extraction, which increases the chance of selection bias (Wright et al., 2007; Higgins and Green, 2011). Secondly, the review included English-language studies only, and this provide a risk for language bias (Wright et al., 2007; Higgins and Green, 2011). A meta-analysis was not conducted, due to the heterogeneous nature of the studies, and this could have been valuable for determining the effectiveness of MWM.

5. Conclusion

This systematic review reveals moderate quality evidence for the effects of MWM in improving ROM and function in subjects with chronic ankle instability. Moderate quality evidence was also found for the effectiveness of MWM in pain and function in patients with hip osteoarthritis. Low quality evidence was found for the effect of MWM in pain and function in patients with shoulder impingement syndrome and there was low and very low quality evidence for lateral epicondylalgia. MWM are superior to placebo and no intervention control, but not compared to corticosteroids and other physiotherapy interventions. The majority of the studies investigated the immediate and short-term effects of one or a few interventions and future research should investigate the long-term effect of MWM interventions performed for a longer period of time for better implications for clinical practice. There is also a need for more RCTs with parallel group design to provide strong conclusion about the clinical effects of MWM.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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