Efficacy of Mobilization with Movement for Patients with Limited Dorsiflexion after Ankle Sprain: A Crossover Trial

Andrea Reid, Trevor B. Birmingham, and Greg Alcock

ABSTRACT

Purpose: Although a primary goal of many manual therapy techniques is to improve joint range of motion (ROM), efficacy studies evaluating the effect of treatment on ROM are limited. The purpose of this study was to evaluate the effect of a talocrural joint mobilization-with-movement (MWM) technique on dorsiflexion ROM in participants demonstrating decreased range following lateral ankle sprain.

Method: Twenty-three participants who had sustained unilateral ankle sprains within the past two years and exhibited a restriction in weight-bearing dorsiflexion participated in the study. We used a crossover design with random assignment to either a sham mobilization or an MWM technique. One week later, participants returned and received the alternate technique. Dorsiflexion was assessed using a weight-bearing lunge test.

Results: The change in dorsiflexion following the MWM technique (0.63 $\pm$ 0.89 cm) was significantly greater ($p = 0.02$) than the change following the sham technique (0.18 $\pm$ 0.35 cm).

Conclusions: These findings suggest that a talocurual MWM improves ankle dorsiflexion immediately following treatment. Future research evaluating the effectiveness of multiple treatments on functional outcomes is warranted.

Key words: ankle, physical therapy techniques, randomized controlled trial, range of motion (articular)

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RÉSUMÉ

Objectif: Bien que l'un des objectifs importants de nombreuses techniques de thérapie manuelle soit d'améliorer l'amplitude du mouvement articulaire, les études d'efficacité évaluant l'effet du traitement sur l'amplitude du mouvement sont limitées. L'objectif de cette étude fut d'évaluer l'effet d'une technique de mobilisation avec le mouvement de l'articulation talo-crurale sur l'amplitude articulaire de flexion dorsale du pied chez des participants démontrant une amplitude réduite à la suite d'une entorse latérale de la cheville.

Méthodologie: Vingt-trois participants qui présentaient une foulure unilatérale de la cheville qui s'était prolongée au cours des deux dernières années et une restriction de la flexion dorsale du pied pendant la mise en charge du membre ont participé à l'étude. Nous avons utilisé une méthodologie de permutation des groupes avec assignation au hasard à une mobilisation simulée ou à une technique de mobilisation avec le mouvement. Une semaine plus tard, les participants sont retournés à la clinique et ont reçu l'autre traitement. La flexion dorsale du pied a été évaluée au moyen d'un test d'exécution d'une fente pendant la mise en charge du membre.

Résultats: L'amplitude de la flexion dorsale du pied était significativement plus élevée avec la technique de mobilisation avec le mouvement (0,63 $\pm$ 0,89 cm) ($p = 0{,}02$) qu'avec la technique de simulation (0,18 $\pm$ 0,35 cm).

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Conclusions: Ces observations indiquent qu'une mobilisation de l'articulation talo-crurale avec le mouvement améliore la flexion dorsale du pied immédiatement après le traitement. Il est recommandé d'effectuer d'autres recherches évaluant l'efficacité des nombreux traitements sur les résultats fonctionnels.

Mots clés: amplitude du mouvement (articulaire), cheville, étude contrôlée et randomisée, techniques de thérapie physique

Limited dorsiflexion range of motion (ROM) is common after lateral ankle sprain and should be addressed during rehabilitation.[1-4] Inadequate rehabilitation of dorsiflexion ROM is proposed to lead to long-term pain and ankle instability.[3,4] Although manual therapy techniques are suggested for rehabilitation after ankle sprain, studies evaluating the effect of specific techniques on dorsiflexion ROM, particularly randomized trials, are limited.[5-8]

Manual therapy theory suggests that full physiological ROM cannot occur when limitations in accessory joint motions exist.[9-11] For example, the full posterior sagittal rotation of the talus necessary for dorsiflexion ROM may not be possible when there is a limitation to posterior glide of the talus with respect to the ankle mortise. Treatments aimed at improving posterior gliding of the talus are therefore thought to help restore dorsiflexion range in the presence of restriction.

Techniques known as Mulligan's mobilizations-with-movement (MWM) have been proposed as novel manual therapy techniques to improve joint ROM by combining physiological and accessory joint movements.[12] Although MWM techniques are a relatively new treatment approach, their use in rehabilitation of patients after lateral ankle sprain is becoming increasingly common.

The purpose of this study was to evaluate the effect of a talocrural joint MWM technique on dorsiflexion ROM in participants demonstrating decreased range following lateral ankle sprain. We hypothesized that improvement in weight-bearing dorsiflexion ROM would be significantly greater following MWM than following a sham mobilization.

METHODS

Participants

We used purposive sampling to recruit participants who had sustained a lateral ankle sprain within the past two years. Potential participants were identified from the Fowler Kennedy Sport Medicine Clinic patient database and The University of Western Ontario's (UWO) varsity athletic teams and were contacted by telephone to determine if they would be willing to participate. To be included in the study, participants had to have a minimum of 2.0 cm less weight-bearing dorsiflexion in their affected ankle compared with their unaffected ankle. The a priori decision to recruit participants with a 2 cm difference between limbs that remained after completion of rehabilitation was made in an attempt to obtain a sample with a clearly demonstrable limitation that was unlikely to change simply due to the passage of time. Exclusion criteria included a history of bilateral ankle injury, injury in the past eight weeks and associated bony injuries (e.g., avulsion fracture, osteochondral lesion).

The planned sample size was 31 participants based on a paired analysis of mean change scores following true and sham mobilizations, the ability to detect a difference between change scores equal to 0.5 cm, an estimated standard deviation in change scores of 1 cm, two-sided alpha set at 0.05 and power set at 80%.[13] Ethics approval was obtained from the UWO Ontario Review Board for Health Sciences Research Involving Human Subjects, and written informed consent was provided by all participants prior to screening for inclusion.

Procedures

Participants were barefoot and performed a 'warm-up' consisting of five minutes of upright stationary cycling at a self-determined 'moderate' level of perceived exertion. The seat height was adjusted such that the participant's heel was on the pedal at the bottom of the cycle and the leg was fully extended.

Baseline data were recorded using a weight-bearing lunge measure of dorsiflexion (Figure 1), in accordance with the procedure outlined by Bennell and colleagues.[14] Although the lunge provides a measure of a combination movement, rather than specifically talocrural movement, the technique is suggested to be functional and simple to apply clinically.[14] Based on repeated measurements on 13 healthy volunteers, Bennell and colleagues reported excellent intrarater reliability (intraclass correlation [ICC] = 0.97-0.98; standard error of measurement [SEM] = 0.5-0.6 cm) and interrater reliability (ICC = 0.99; SEM = 0.4 cm).[14]

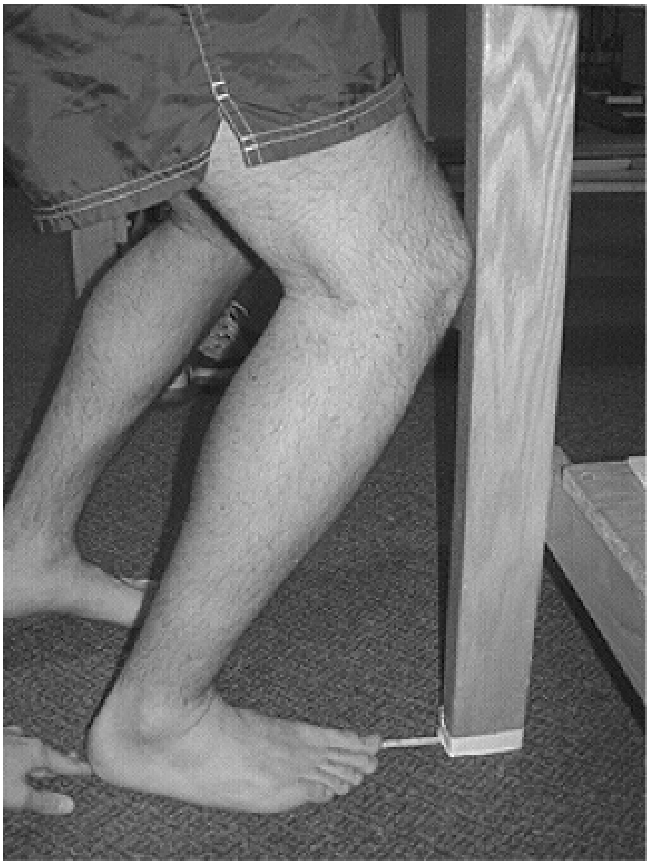

Figure 1. Measurement of weight-bearing dorsiflexion via the weight-bearing lunge test described by Bennell and colleagues.[14] The method was explained as follows: "Place your great toe in line with your heel and on top of the white tape. Keeping your heel firmly on the ground, bend your supporting knee to touch the wall. We are measuring the maximum distance you can place your foot away from the wall while keeping both the heel flat on the floor and your knee touching the wall in front." Written instructions and a diagram were placed at eye level at the measurement station. The examiner ensured that the foot was adequately aligned with the line of the first metatarsal and the midline of the calcaneus running along the line of the measuring tape while palpating the heel to ensure that it did not rise.

Two examiners assessed dorsiflexion, and the same examiner measured each participant at each visit. A measure of distance of the great toe to the wall was made to the nearest 0.1 cm. The procedure was then repeated for the other ankle. This procedure was repeated three times for each ankle. Immediately following the initial assessment, participants with less than a 2.0 cm difference between ankles were excluded from further participation.

Participants were randomized to two groups, using simple randomization from a random numbers table.[15] Group 1 received 'sham mobilization' at session 1 and 'true mobilization' at session 2 (sequence 1), and group 2 received the opposite treatment order (sequence 2). The treatment or sham procedure was administered in a closed room by the primary investigator (PI). Following treatment, participants were remeasured for the post-intervention amount of weight-bearing dorsiflexion using the same measure described. Only the PI had knowledge of treatment group assignment, with dorsiflexion examiners blinded to group assignment. Sessions 1 and 2 were separated by a washout period of seven days to minimize any potential carry-over effects of treatment. Participants were not instructed to work on dorsiflexion exercises but were told to go about their usual activities.

Treatments

The PI performed the true and sham treatments in a room separated from the measurement area. A certified Mulligan instructor had instructed the PI in the MWM technique. For the true mobilization, the participant was positioned in high kneeling with the affected ankle in a weight-bearing neutral position (Figure 2). The participant was offered upper extremity support as required. A padded belt, including a pressure biofeedback unit, was placed such that the bottom of the belt was level with the inferior margin of the medial malleolus. The same pad and belt were used for all participants. The position of the mobilization belt allowed the examiner to fix the talus and calcaneus with her hands and draw the tibia forward on the talus, thereby creating a relative posterior talar glide. The 'glide' was taken to the point where a pressure biofeedback unit read 200 ± 20 mm Hg, and this amount of force was sustained throughout the technique. Two sets of 10 repetitions, separated by a two-minute rest, were performed as described by Mulligan.[12]

The sham mobilization was performed with participants prone-lying on a plinth with a small pillow under the hips. Participants were instructed that the treatment was a passive technique during which they must remain relaxed. To maintain a neutral position, a dorsal splint was placed over the foot and leg and held by the therapist (Figure 3). The therapist firmly grasped the splint, foot and subtalar joint and passively flexed and extended the participant's knee while ensuring that the talocrural joint remained stationary. Two sets of 10 repetitions were performed with a two-minute rest between each set.

Data Analysis

ROM measurements of weight-bearing dorsiflexion were taken before and after each treatment. The change in dorsiflexion was calculated by subtracting the mean of three pre-treatment values from the mean of three post-

Figure 2. Talocrural mobilization with movement technique. The examiner exerts an anterior force to the tibia via the mobilization belt and the participant actively dorsiflexes in a pain-free and weight-bearing manner. The participant was instructed as follows: "At no time should the technique be painful or distressing. If at any time you would like to stop, we may. I will exert the mobilization force, at which time I will ask, 'No pain?' to which you will reply either 'pain' or 'no pain' according to what you feel. After the force is exerted you will start to bend forward at the ankle as far as possible while we continue to confirm that the technique is pain-free. You will continue to bend forward until you reach a position of maximum dorsiflexion. You will then return to the starting position. We will repeat the maneuver 10 times, have a short rest and repeat."

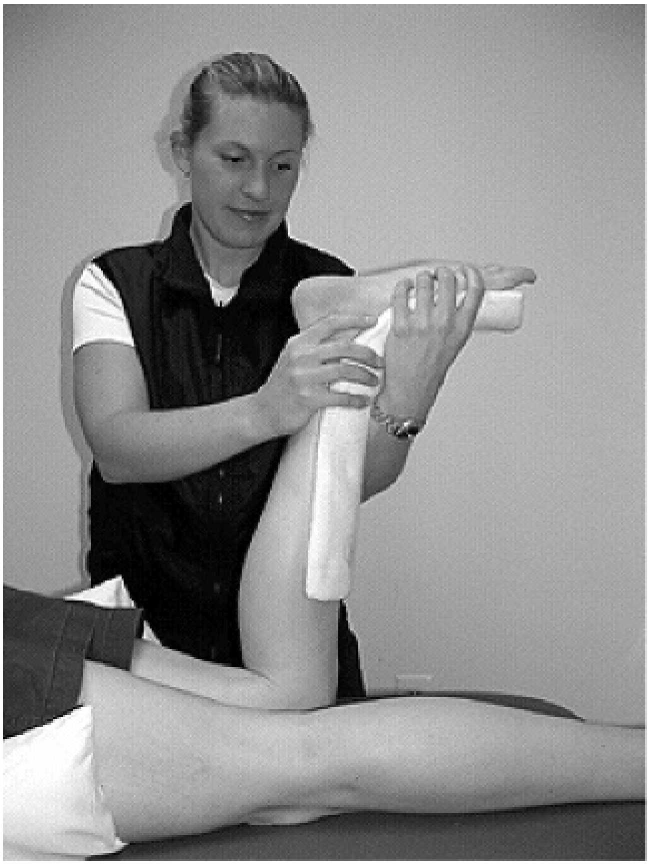

Figure 3. Sham mobilization technique. The examiner passively flexes and extends the participant's knee in prone while ensuring no talocrural movement through the use of a dorsal resting splint.

treatment values for each participant. Change scores for the true and sham treatments were then compared using a paired *t*-test. The 0.05 level was used to denote statistical significance. The Statistical Package for the Social Sciences (version 13; SPSS Inc., Chicago, Ill.) was used for all analyses.

RESULTS

We were able to recruit only 25 participants meeting the eligibility criteria. Two participants did not return for the second treatment and test session (one participant re-sprained the ankle during the washout period and the other moved and could not be contacted), leaving 23 participants retained for analysis (Table 1). Descriptive statistics for pre-treatment, post-treatment and change in weight-bearing dorsiflexion for both treatment sequence groups are reported in Table 2. These same measures are reported for the combined sample in Table 3. Quartiles for the sham mobilization change scores were −0.1 cm, 0.2 cm and 0.4 cm. The Shapiro-Wilk test suggested that these scores were normally distributed ($p = 0.12$). Quartiles for the true mobilization change scores were 0.0 cm, 0.6 cm and 1.2 cm. The Shapiro-Wilk test suggested that these scores were also normally distributed ($p = 0.66$).

Significantly greater change in weight-bearing dorsiflexion was observed following the true mobilization ($t_{(22)} = 2.523$, $p = 0.019$). The mean difference between the true and sham treatment change scores was equal to 0.45 cm (95% confidence interval [CI] = 0.08-0.82 cm), meaning that, on average, the true mobilization resulted in a 0.45 cm greater improvement in weight-bearing dorsiflexion than the sham mobilization.

Table 1. Participant Characteristics: Mean ± Standard Deviation (Minimum-Maximum)

Characteristic	*Group* (N = *23*)	*Sequence 1: Sham then Mobilization* (n = *11*)	*Sequence 2: Mobilization then Sham* (n = *12*)
Age (yr)	25 ± 9 (13-47)	24 ± 8 (16-42)	26 ± 10 (13-47)
Height (cm)	170 ± 9 (158-193)	171 ± 9 (163- 193)	169 ± 8 (158-185)
Weight (kg)	69 ± 11 (54-95)	69 ± 13 (54-95)	68 ± 10 (55-84)
Gender (M:F)	8:15	3:8	5:7
Weight-bearing dorsiflexion in unaffected ankle (cm)	13.3 ± 3.5 (4.6-18.9)	13.3 ± 3.4 (7.6-17.2)	13.2 ± 3.7 (4.6-18.9)
Difference in weight-bearing dorsiflexion between affected and unaffected ankles (cm)*	3.4 ± 1.2 (2.0-6.1)	3.3 ± 1.2 (2.1-6.1)	3.5 ± 1.2 (2.0-5.8)
Time since injury (mo)			
0-3	2	1	1
3-6	9	4	5
6-9	1	1	0
9-12	1	0	1
> 12	10	5	5

*Unaffected dorsiflexion minus affected dorsiflexion.

Table 2. Pre-treatment, Post-treatment and Change in Weight-Bearing Dorsiflexion Measurements (cm) for Sham and True Mobilizations on the Affected Ankle for Both Treatment Sequences (Mean ± Standard Deviation)

	First Session			*Second Session*		
	Pre-treatment	*Post-treatment*	*Change**	*Pre-treatment*	*Post-treatment*	*Change**
Sequence 1: sham then mobilization (*n* = 11)	10.0 ± 3.7	10.1 ± 3.6	0.1 ± 0.2	10.1 ± 3.5	10.6 ± 3.7	0.5 ± 1.0
Sequence 2: mobilization then sham (*n* = 12)	9.8 ± 4.3	10.5 ± 4.0	0.8 ± 0.7	10.3 ± 4.2	10.6 ± 4.3	0.3 ± 0.4

Data from the true mobilization are shaded.
*Post-treatment dorsiflexion minus pre-treatment dorsiflexion.

Table 3. Pre-treatment, Post-treatment and Change in Weight-Bearing Dorsiflexion Measurements (cm) for Sham and True Mobilizations on the Affected Ankle (Mean ± Standard Deviation)

(N = *23*)	*Pre-treatment*	*Post-treatment*	*Change** *(95% Confidence Interval)*
Sham mobilization	10.14 ± 3.87	10.32 ± 3.89	0.18 ± 0.35 (0.03-0.33)
True mobilization	9.92 ± 3.85	10.55 ± 3.79	0.63 ± 0.89 (0.25-1.01)

*Change refers to the improvement in weight-bearing dorsiflexion after treatment, calculated as post-treatment dorsiflexion minus pre-treatment dorsiflexion.

DISCUSSION

The results of this efficacy study suggest that talocrural MWM significantly increases weight-bearing dorsiflexion in patients with limited ROM. This finding will be discussed in relation to our study design. A crossover design was used to permit a within-participants analysis (i.e., paired *t*-test) with increased statistical power for the relatively small sample size.[15,16] A potential limitation of the design is the possibility of systematic change occurring over time—a very real possibility in physical therapy practice that may explain why crossover designs are seldom used. For example, it is possible that the treatment given on the first session has a carry-over effect into the treatment given on the second session. This possibility should be considered by comparing the results within each treatment when it is given first and second (i.e., mobilization: 0.8 cm versus 0.5 cm and sham: 0.1 cm versus 0.3 cm; see Table 2).[16] Another example is a temporal (calendar) effect in which the patient's condition changes with the passage of time. This should be considered by comparing the differences between the true and sham treatments within the separate test sessions (i.e., 0.8 cm − 0.1 cm = 0.7 cm for the first session versus 0.5 cm − 0.3 cm = 0.2 cm for the second session; see Table 2).[16]

Because the participants in the present study were several months beyond their initial injury and had completed rehabilitative interventions, we felt that a period of one week between mobilizations would be sufficient to wash out any carry-over effects of the one-time treatment, and temporal effects would be minimal. If either a carry-over or temporal effect appears to be substantial, however, then an appropriate approach would be to exclude the data from the second test session and do a between-groups analysis (i.e., independent *t*-test) using data from the first test session only.[16] In the present study, although the 95% CI is slightly larger for the between-groups analysis using data from the first test session only (i.e., $n = 11$ versus $n = 12$) than the within-participants analysis combining data from both test sessions (i.e., $N = 23$ and $N = 23$), the estimates of the mean differences between the effects of the true and sham mobilizations are similar (0.65 cm [95% CI = 0.15-1.2 cm] versus 0.45 cm [95% CI = 0.08-0.82 cm] for the between-groups and within-participants analyses, respectively).

Dorsiflexion measures for the uninjured ankle were consistent with those reported by Bennell and colleagues.[14] Stefanyshyn and Engsberg reported the ROM of contralateral ankles to be equal in an uninjured population,[17] the basis on which we used the difference between the affected and unaffected ankles as the primary criterion for inclusion into this study. Our sample lacked an average of 26% of weight-bearing dorsiflexion in their affected ankle (compared with their unaffected side). Patients with this magnitude of limitation in ROM are commonly observed in the clinical setting and mobilized using manual therapy techniques.

We noted that the sham mobilization technique also resulted in a small but true improvement in dorsiflexion ROM (95% CI did not include zero). This change might be attributed to the measurement technique for dorsiflexion. As the participants attained their maximum range of dorsiflexion, they likely experienced a combination of soft-tissue stretching and 'self-mobilization,' resulting in a significant change.

Although our results indicated that a true change in the amount of dorsiflexion occurred with a MWM, the change detected was small (about 0.5 cm or 2°) and of questionable clinical relevance. When viewed as a comparison with the mean amount of restriction, one could reason that the mobilization improved dorsiflexion by 19% (i.e., the sample had approximately one-fifth more dorsiflexion following two sets of 10 mobilizations). Whether this is clinically significant is debatable and requires additional research. Similarly, individual treatment techniques are rarely used in isolation during clinical practice. Mobilization is often paired with stretching and exercise and used over multiple treatments. Future studies should evaluate the effect of these combined treatments on improving ROM.

This study does, however, provide evidence for the efficacy of this technique, in isolation, for improving dorsiflexion ROM. There might be a greater treatment effect in a sample with greater initial restriction, for example, following a period of immobilization. Similarly, participants in this study were invited from a pool of patients known to have received a comprehensive rehabilitation program. The program may or may not have included accessory mobilization of the talocrural joint. Successful initial treatment may have limited the functional deficits observed on baseline measurement and therefore limited the amount of observed improvement. Our findings are consistent with those of previous studies evaluating the effects of ankle joint mobilization techniques. In a case study, O'Brien and Vicenzino used a fibular mobilization technique following acute lateral ankle sprain (< 72 hours).[6] The intervention included a sustained posterior glide to the distal fibula while the patient actively inverted the ankle. The suggested benefits of treatment included reduced pain and increased ROM. Green and colleagues used a parallel-design randomized controlled trial to compare the effect of talocrural joint mobilization in addition to rest, ice, compression and elevation (RICE) with RICE alone in 41 patients less than 72 hours after lateral ankle sprain.[7] The intervention was described as passive joint mobilization using a gentle oscillatory technique to mobilize the talus in an anteroposterior direction. Outcome measures included dorsiflexion ROM, walking gait (stride speed, step length and single support time) and number of treatments required to achieve full dorsiflexion. Green and colleagues concluded that the addition of a talocrural mobilization resulted in fewer physiotherapy sessions to achieve full pain-free dorsiflexion and improved stride speed.[7]

Our findings are also consistent with those from a recent study by Collins and colleagues, who used a crossover design to compare MWM, a sham treatment and no treatment in 14 patients who were an average of 40 days after later ankle sprain.[8] Each participant received all three treatment conditions within one week. Similar to our study, the intervention was a belted posteroanterior tibial glide (relative posterior talar glide) in a weight-bearing position. Outcome measures included weight-bearing dorsiflexion ROM, thermal pain threshold and pressure pain threshold. The difference in the change between the true and sham treatments was 0.98 cm. Change in weight-bearing dorsiflexion was 1.17 cm after the MWM technique and 0.19 after the sham treatment. There were no significant changes in other outcomes.

Longer-duration studies designed to assess cumulative effects by including multiple mobilization sessions on subsequent days are warranted. Rather than being limited to evaluating change in ROM, an impairment-level outcome focusing on body function and structure, future studies should also evaluate the effect of including MWM techniques on measures of activities. Future investigations might incorporate a series of mobilization treatments with assessment of additional outcomes, such as self-reported and performance-based measures of functional activities (i.e., walking, running, hopping, etc.), time and number of treatment sessions required to return to pre-injury activity level and cost of treatment.

CONCLUSIONS

MWM improves range immediately following treatment in patients with decreased dorsiflexion following lateral ankle sprain. Although statistically significant, the amount of movement gained was relatively small. Future research evaluating the effectiveness of multiple treatments on functional outcomes is warranted.

KEY MESSAGES

What Is Already Known on This Subject

- Manual therapy techniques are used clinically to improve joint ROM.
- Studies evaluating the effects of specific manual therapy techniques are limited, especially for peripheral joints.
- MWM, a technique combining passive accessory motion with active physiological motion, has been purported to increase joint ROM.

What This Study Adds

- This study suggests that MWM increases ankle dorsiflexion ROM.

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