The Effect of Mobilization With Movement and Passive Stretching on Hip Range of Motion: A Randomized Controlled Trial

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ABSTRACT

Background and Purpose: A decrease in hip range of motion (ROM) is a risk factor for multiple orthopedic conditions; however, little evidence exists to determine the most effective treatment. The purpose of this study was to determine if hip mobilization with movement (MWM) is superior to passive stretching for increasing hip ROM. **Methods:** Fifty-eight participants with impaired hip ROM were randomized to a control group or received a single bout of either a hip MWM or hip passive stretch (HPS). Measurements for hip ROM were taken immediately before and after the intervention. **Findings:** No significant differences were noted between groups at baseline ($p > 0.05$). Group-by-time analysis revealed a significant difference between the control and treatment groups; however, no significant difference was noted between the hip MWM and hip stretch groups ($p < 0.01$). **Conclusion:** Improvements in ROM were achieved in both stretching and MWM groups indicating comparable efficacy. **Clinical Relevance:** Hip MWM and stretching have comparable treatment effects on ROM. Clinicians may consider patient comfort when choosing the most appropriate approach to treating limitations in hip ROM.

Key Words: flexibility, groin injury, internal rotation, femoral-acetabular joint

INTRODUCTION

The hip joint is characterized by inherent boney stability and serves an important role in linking the trunk and lower limbs. As such, range of motion (ROM) impairments of the hip may impact an individual's ability to perform functional activities and have direct implications on athletic activities. Furthermore, ROM impairments may impact the biomechanical properties of the hip and predispose the hip and neighboring joints to injury. Authors suggest associations between hip ROM deficits and pathology including chronic low back pain,[1-5] hip osteoarthritis (OA),[6,7] athletic chronic groin injury,[8] and sports hernia.[9] More specifically, a Clinical Practice Guideline for hip OA suggests that limited hip flexion and internal rotation (IR) are part of the criteria that may be used to identify patients with hip OA.[7] Groin pain is a concern for many athletes, especially those in rugby, football, soccer, ice hockey, or other sport requiring vigorous repetitive adductor use.[9-11] Authors suggest that groin pain and the overarching sports hernia have multiple etiologies, but significant increased risk factors include participation in higher level of sport, low-training levels compared to sport demand, previous groin injury, reduced hip IR ROM of the symptomatic hip by 3.7° compared to same-sport athletes without groin pain, and decreased hip adductor strength.[10,11]

These deficits in ROM may be related to various physiological factors, including restriction in soft-tissue extensibility, an inability of musculotendinous units to expand to a lengthened position, an arthrokinematic block through bony prominences, or inflammation related swelling of the joint or joint capsule.[12-14] In clinical outpatient settings, stretching and mobilization with movement (MWM) are two frequently used techniques to improve an individual's available ROM. The same two are also the most studied techniques to improve hip ROM.[7,15-20] Passive static stretching is theorized to provide improved flexibility to a muscle through lessened excitability of the muscle spindle, and increased inhibition via autogenic biochemical changes as opposed to mechanical lengthening or increased extensibility of the muscle fiber.[21,22] However, MWM has been studied sparingly in the area of the hip, but its mechanism of action to improve ROM while reducing painful movement includes theories such as stretch of the joint capsule with subsequent improvement in neuromuscular control, and central mechanisms decreasing nociceptive stimuli and fear avoidance to engage in further ROM.[23-25] Stretching and MWM techniques have demonstrated effectiveness[15,16] within the literature. However, it is not clear if one is superior to the other for immediate improvement in hip ROM within the same study population.

To our knowledge, there are only 2 studies that evaluated hip MWM to elucidate effects on hip pain, ROM, and physical performance.[15,16] Neither study included a comparison of stretching and MWM. Therefore, the purpose of this study was to determine the pre- and post-intervention differences in hip ROM when an IR MWM or IR passive stretch (IRPS) was applied to an asymptomatic population with limited hip IR.

METHODS

Study Design

A single-blinded randomized controlled trial was used to compare 2 different techniques used in clinical practice to improve hip ROM--passive hip stretching and hip MWM. A control group was also included that required participants to sit on a table for 5 minutes with no treatment. Pretest measurements for all hip passive ROM motions including flexion, IR, external rotation (ER), and extension were performed on qualifying subjects. Following measurements, groups were determined via randomization, and interventions were subsequently performed based on group allocation. Posttest measurements of hip passive ROM immediately followed the intervention to acutely determine changes in hip ROM.

Subjects

A convenience sample of individuals from the University of Central Florida (UCF) and the surrounding central Florida area was recruited for this investigation. The inclusion criteria consisted of individuals between the ages of 18 and 65 years old with hip passive IR of 25° or less on at least one side. Exclusion criteria consisted of individuals that had undergone surgery on their hip within the last 12 months, and the participant's report of hip pain within the last 12 months. All participants that met the inclusion criteria and agreed to participate in the study were provided with and gave informed consent.

The protocol for this study was approved by the Institutional Review Board at UCF.

Procedure

The study was a single-blinded randomized controlled trial. Investigator 1 provided a brief description of the study, explained the study protocol, and obtained informed consent. Investigator 2 performed the screening and measurements, while Investigator 3 performed the interventions. Investigators 1 and 3 were blinded to the participant group assignment. After the screening was completed, Investigator 2 left the room while Investigator 1 and 3 entered the room. Investigator 3 performed the intervention, while Investigator 1 monitored time and provided supervision to ensure that treatment fidelity was maintained.

Hip Range of Motion

After screening to rule out participants with exclusion criteria and providing consent to participate, participants subsequently received pretest measurements of hip IR, ER, flexion, and extension. The participant's hip IR passive ROM was measured bilaterally in sitting. Sitting hip IR was preferred over prone measurement due to evidence suggesting that despite pelvic stabilization, hip IR in prone leads to increased IR values when compared to the same leg measured in sitting.[13,26,27] Measurements of ER were performed in sitting while flexion was performed in supine. Lastly, extension was performed in prone. All passive ROM were assessed with the measurement technique detailed by Norkin and White.[13] Measurements of hip IR using a goniometer have demonstrated good to excellent reliability, with intraclass correlation coefficient (ICC) values reported as 0.75 to 0.91[28] and 0.80.[29] Aalto et al[30] reported ICC values between 0.813 and 0.982 for hip flexion, and between 0.918 and 0.961 for hip extension.[31]

Randomization

After pretest measurements, participants were randomized into an intervention group by selecting between opaque cards. Each card represented a single intervention assigned to the number on the underside of the card. The number assignment did not change for the entirety of the study, and the number was not shared with the participants to protect the randomization process. Investigator 3 was the only investigator not blind to which number corresponded to which treatment as they were the investigator performing the intervention. Finally, all participants were instructed to not disclose or discuss their intervention with another investigator or potential participant.

Intervention

The technique for the MWM was chosen based on literature from Mulligan and Beselga et al.[15,23] This technique required the participant to be supine, with investigator 3 on the side of the leg to be mobilized. The participant's hip was flexed to 90°, and a mobilization belt was placed around the proximal femur, with the padded portion of the mobilization belt as close to the hip joint as comfortably possible. Once the belt was placed, the participant was allowed to adjust the belt as needed to ensure comfort. The rest of the belt was placed around the hips of investigator and served to create an inferolateral distraction force at the participant's hip that demonstrated the ROM deficit. Additionally, the femur was adducted slightly across the body once the hip was in 90° of flexion. The participant's knee was allowed to stay fully flexed during the MWM to better control the passive IR moment provided by the investigator. Once the distraction force was applied at the hip, the investigator took the participant's hip into full IR while maintaining the distraction (**Figure 1**). This technique was adapted and slightly altered from that described by Beselga et al[15] due to the difference in sample size and lack of pathology or symptoms in all included participants.[23] While maintaining the distraction force, the investigator mobilized the participant's hip into end range IR with overpressure for 10 repetitions, then allowed for 30 seconds of rest. This was repeated for 3 sets, for 30 total repetitions. The participant was instructed to relax their leg and allow for the investigator to move the leg without resistance during the MWM.

The internal rotation passive stretch intervention was provided in the same position described for the MWM but without the use of a mobilization belt or distraction force. The hip was flexed to 90°, the knee was allowed to flex passively to reduce pressure across the knee joint, and the investigator used the same hand placements to apply and sustain a hip IR stretch for 30 seconds (**Figure 2**). The participant rested for 10 seconds after each 30-second period. Three repetitions were completed for a total of 90 seconds of stretch time.[32]

Figure 1. Internal Rotation Mobilization with Movement Used in the Study (N=58)

Figure 2. Internal Rotation Passive Stretch Used in the Study (N=58)

Statistical Analysis

All data were analyzed using SPSS (IBM version 25; Armonk, NY). Baseline statistical differences between-groups were analyzed with an independent t-test. Within-group differences of pre- and posttest measurements were assessed with a dependent t-test. Lastly, group-by-time interactions were evaluated with a repeated measure analysis of variance (ANOVA). All analyses were completed with a 95% confidence interval and a p-value of < 0.05 considered statistically significant.

RESULTS

Demographics of included participants are described in **Table 1**. The sample

Table 1. Baseline Characteristics of Study Participants (N=58)

	Overall (N=58)	MWM group (n=19)	Stretch Group (n=17)	Control Group (n=22)	p-value
Gender, % female	19%	26.3%	17.6	13.6	0.58
Age in years, mean ± SD	25.4 (6.2)	24.1 (5.1)	25.7 (6.1)	26.4 (7.2)	0.49
Height, (cm) mean ± SD	175.7 (10.3	173.1 (11.9)	177.1 (10.6)	176.8 (8.4)	0.43
Body mass (kg), mean ± SD	80.0 (16.4)	79.4 (17.8)	79.7 (18.3)	80.8 (14.4)	0.96
BMI	25.8 (4.1)	26.3 (4.6)	25.3 (4.9)	25.7 (2.9)	0.75

Abbreviations: BMI, body mass index; cm, centimeters; kg, kilograms; MWM, mobilization with movement; SD, standard deviation

included 58 individuals randomized into either MWM (n=19), IRPS (n=17), or control (n=22). **Figure 3** provides a flow diagram of the process to compile our randomized participants for final analysis. At baseline, independent *t* – tests suggest no significant differences between groups for any pre-intervention ROM measurement (**Table 1**). Group-by-time interactions were determined with repeated-measures ANOVA that revealed a significant relationship (p = 0.001) for immediate ROM changes in the hip treatment groups (MWM and IRPS) for IR, ER, flexion, and extension compared to the control group. However, no significant differences were noted between the treatment groups (MWM vs IRPS). Within-group changes assessed with a dependent sample *t* – test revealed significant changes in both MWM and IRPS groups in IR ($p < 0.001$) (**Table 2**).

DISCUSSION

This is the first randomized controlled trial to use a 3-armed, single-blinded design to assess for immediate change in passive hip ROM between IR stretching and MWM. The purpose of this study was to evaluate differences in hip ROM when an IR MWM or IR passive stretch was applied to a population with restricted hip ROM. Our results suggest both interventions are more effective than no treatment; however, there was not a significant difference between the MWM and stretch groups. Prior research on MWM suggests that there is validity in applying an MWM over a sham IR MWM[15] or caudal MWM to improve hip IR.[16] Beselga et al[15] reported a significant change from baseline to end of treatment of 25.1 ± 7.2° to 29.4 ± 7.4° IR, respectively, with a 95% confidence interval (5.8, 2.9) for within-group changes. Hip IR minimum detectable changes have been reported from various sources with goniometery.[15,27] Walsh et al[18] suggested no significant differences in hip ROM with self-performed hip flexion MWM, but clinician-applied caudal hip flexion MWM appeared to increase immediately available standing, functional IR ($p = 0.01$). Differentiating the current study from the past two studies is the increased mean age of participants with the MWM group at 78.3 ± 6.1 and the sham group at 77.5 ± 6.9, each in years.[17] Secondly, the participants in the study by Beselga et al[15] had a clinical diagnosis of OA and chronic hip pain which differs greatly from our criteria that eliminated participants that had hip pain within the past 12 months. Other limitations of comparing the Beselga et al[15] and Walsh et al[16] studies to this investigation include the lack of information of measurement position[15] and use of a bubble inclinometer for IR measurement.[18] As discussed earlier, the position chosen to measure IR will significantly affect the reading favoring larger readings in prone due to the increased compensatory movement of the pelvis and lumbar spine.[26,31,32]

The theories explaining MWM's effectiveness is still debated in the literature. The positional fault theory originally proposed by the pioneer of the MWM, Brian Mulligan,[23] is an unlikely consideration to explain changes in hip ROM due to the congruency of the femoral head in the acetabulum and lack of substantive evidence recording changes in bone position before and after MWM intervention.[15,23,25,33] Other theories have suggested central nervous system processing changes to include hypoalgesia and indirect endogenous pain inhibition may also provide painful joints additional stimulus to

Figure 3. Consort Diagram of Participants Throughout the Study

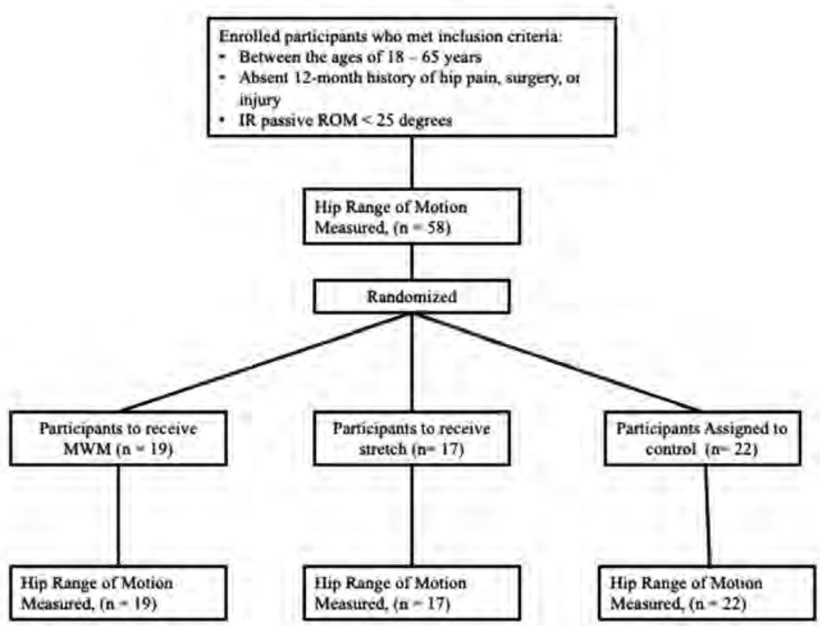

Table 2. Group Comparison Before and After Intervention

	Hip Stretch (n=17)				Hip MWM (n=19)				Control (n=22)				Between Groups at Baseline	Time by Group Interaction
	Pre mean (SD)	Post mean (SD)	p-value	Mean diff (95% CI)	Pre mean (SD)	Post mean (SD)	p-value	Mean diff (95% CI)	Pre mean (SD)	Post mean (SD)	p-value	Mean diff (95% CI)	p-value	p-value
Hip IR	22.4 (±2.1)	25.4 (±3.5)	*p*<0.01	-3.0 (-4.3 to -1.7)	22.8 (±1.9)	26.5 (±3.9)	*p*<0.01	-3.7 (-5.2 to -2.1)	22.2 (±1.8)	22.5 (±2.9)	*p*<0.44	-0.3 (-0.9 to 0.5)	*p*=0.65	p=0.01
Hip ER	30.6 (±1.6)	34.7 (±4.1)	*p*<0.01	5.4 (3.2 to 7.6)	30.3 (±1.7)	37.2 (±6.4)	*p*<0.11	1.9 (-0.4 to 4.2)	31.2 (±1.1)	32.4 (±2.6)	*p*<0.92	-0.1 (-0.9 to 0.8)	*p*=0.12	p=0.01
Hip Flexion	122.2 (±2.1)	131.4 (±2.1)	*p*<0.90	-0.2 (-3.1 to 2.7)	122.1 (±2.8)	131.4 (±2.6)	*p*<0.01	2.8 (1.4 to 4.1)	120.6 (±3.1)	122.3 (±2.1)	*p*<0.34	0.3 (-0.4 to 1.0)	*p*=0.79	p=0.01
Hip Extension	7.6 (±1.1)	14.9 (±2.5)	*p*<0.01	-6.9 (-10.8 to -3.0)	8.1 (±1.1)	19.5 (±4.7)	*p*<0.01	-7.2 (-8.6 to -5.7)	7.5 (±1.2)	7.4 (±1.2)	*p*<0.45	0.1 (-0.2 to 0.5)	*p*=2.34	p=0.01

Abbreviations: CI, confidence intervals; ER, external rotation; diff, difference; IR, internal rotation; MWM, mobilization with movement; SD standard deviation

assist in gating pain to reduce painful end feels, reduce fear avoidance, and allow for increased ROM.[24,25,33-35] However, because this research was performed on individuals who were not experiencing pain, the authors acknowledge these pain inhibiting mechanisms are unlikely to explain the significant changes in hip ROM observed. Authors have suggested neurophysiological changes to decrease contractility of antagonist muscle groups in asymptomatic shoulders and therefore may be a component of interest in this study population.[25,36] However, further research needs to be performed before conclusions should be drawn regarding the neurophysiologic or biomechanical mechanism of MWM.

The implications to improve global ROM and prevent injury or risk for chronic pain are evident. Research from Birrel et al[6] comparing hip IR measurements of individuals with varying degrees of hip OA found severe radiographic OA to be associated with IR of less than 28°. In young rugby athletes, decreased ER and IR range of hip motion was predictive of the development of chronic groin injury over the course of a season of play.[8] Interestingly, all the athletes demonstrated a significant lack in IR in both dominant and non-dominant lower extremities, but only the combination of decreased IR and ER proved to precede groin injury.[8] Furthermore, there are immediate improvements in ROM and reduced pain evident in athletes after receiving hip mobilization interventions.[37,38] Mau and Baker[39] reported a case study of a female collegiate basketball player with an acute lateral ankle sprain who received MWM after 10 days of minimal results from conventional strengthening, balance, and mobility exercises. After the MWM and taping were included in the care plan, they reported their patient no longer experienced pain as reported at baseline. This study evaluates a sample population that may benefit from this technique (ie, individuals with limited ROM).

CONCLUSION

Deficits in hip ROM can lead to difficulties with functional mobility, ambulation, and performing activities of daily living. Hip IR MWM and a passive IR stretch demonstrates the ability to significantly improve available hip ROM. These two interventions may be useful in clinical practice as well as prior to athletic performance to immediately improve hip ROM. Further areas of study surrounding this topic should include testing long-term effects, serial interventions, and the influence of MWM versus stretching of athletes in and out of competition season.

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