ORIGINAL ARTICLE

IJPHY

THE SHORT AND LONG-TERM EFFECT OF WEIGHT-BEARING MOBILIZATION-WITH-MOVEMENT (MWM) AND AUTOMOBILIZATION-MWM TECHNIQUES ON PAIN AND FUNCTIONAL STATUS IN PATIENTS WITH HIP OSTEOARTHRITIS

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ABSTRACT

Background: There is limited evidence to support the therapeutic effect of Manual Therapy on Hip Osteoarthritis (HOA) patients. The purpose of this study was to investigate whether implementation of weight-bearing mobilization-with-movement (MWM) and auto-mobilization had a significant improvement in pain and functionality after a series of sessions.

Methods: Forty patients 50-80 years of age, with HOA, were randomly assigned into two groups. Patients in the treatment group received MWM in standing position and auto-MWM for two weeks, while control patients received a Sham form of MWM. Pain and functionality were measured at baseline, post-treatment and three months' follow-up, using the Visual Analogue Scale (VAS) and the Lower Extremity Functional Scale (LEFS). Mixed ANOVA was used to examine possible differences between treatment phases and between groups, but also interactions among Group and Time factors.

Result: The present findings revealed a significant interaction between factors and significant main effects of each Time and Group factors on pain and functionality. The treatment group showed improved post-MWM VAS and LEFS scores compared to baseline scores ($p<.001$), and improved follow-up MWM and LEFS scores compared to post-MWM scores ($p<0.001$). In control group, no significant differences were found on either of the post or follow up VAS and LEFS scores compared to baseline scores ($p>.001$). Differences between groups were significant in post-treatment and follow-up scores ($p<.001$).

Conclusion: Our findings suggest that weight bearing-MWM and auto-MWM are a significant treatment approach, improving pain and functionality in hip osteoarthritis patients.

Keyword: Mobilization with movement, Hip, Osteoarthritis, Auto mobilization, Manual Therapy.

Received 14th February 2017, revised 24th April 2017, accepted 24th May 2017

www.ijphy.org

10.15621/ijphy/2017/v4i3/149068

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INTRODUCTION

Hip Osteoarthritis (HOA), is a mild inflammatory chronic degenerative osteoarthropathy, affecting11% of the population at the ages of 50-80 years [1]. In the elderly, is the most important factor of disability [2] and in combination with increasing age, the incidence of hip OA increases. Associated symptoms are pain, especially in the morning, limitation of functionality, reduced range of motion (ROM), joint space narrowing as well as sub chondral cysts and osteophytes [3, 4, 5, 6]. Pathophysiology includes the entire capsule, affecting hip periarticular muscles, especially abductors [7]. Definitive diagnosis requires radiographic and physical examination [5, 8].

Conservative treatment is the first line treatment for HOA [9]. Up until now, Manual Therapy (MT) is associated with level B research evidence as an individual intervention and is conditionally recommended as part of a multimodal program in conjunction with therapeutic exercise [9, 10, 11, 12]. Abbott [13], found that MT as a single intervention, had short and long-term improvement in HOA and knee osteoarthritis (KOA) patients, while Hoeksma [14], showed that the MT outweighs exercise as a therapeutic approach in short-term improvements in pain, functionality, and range of motion ROM. French [15], did not find any additional benefit, when MT added in the exercise program, while Bennell [16], found no clinical improvement after an integrated physical therapy program implementation compared with control group. Studies showed reduced MT impact when combined with exercise, probably because of possible negative interaction among simultaneously clinical approaches 13,15, 17].

MT is implemented as manipulation or passive joint mobilization [18]. Moreover, Mobilization with Movement (MWM), as part of Mulligan concept, is a relatively new approach in manual therapy field, introducing active patient movement simultaneously with passive therapist joint mobilization [19]. MWM is easy to apply by the therapist, as well as from patients in the form of auto-mobilizations, without any contraindications. A special feature of those techniques is the immediate symptom improvement after only one session. Up until now, only one study [20] examine the effect of short-term MWM in HOA patients as a single intervention in one session, via control group research design, concluded in significantly improved pain, ROM and functionality. So as the next step to this, there is a need to determine the long-term effect of MWM in HOA, under a series of sessions of single MWM.

The aim of the study was to examine the short and long-term effects of a series of MWM and auto-MWM sessions in HOA patient's pain and functionality.

MATERIALS AND METHODS

Study design

All patients participating in the study suffered from primary OA of the hip according to the clinical criteria of the American College of Rheumatology (ACR) and were referred by orthopedic surgeons. The sample size was 40 patients, aged 50-80 year, divided randomly into two groups (study/ control) each of 20 participants. A double-blind, randomized placebo-controlled trial was conducted on consecutive sampling from December 2015 to August 2016, with a random patient's allocation on computer based Program-Research Randomizer (Version 4.0). Inclusion criteria were: 50-80 years of age, hip pain, hip internal rotation <15°, pain on hip internal rotation[21]. Exclusion criteria were inflammatory arthritis, previous surgery, osteoporotic bone lesions, inability to perform weight bearing hip and knee movements, bilateral osteoarthritis. Treatment decision was taken by physical examination and not on radiological findings [5, 12]. Each patient covered admission criteria and with a referral for physiotherapy, signed the consent form to participate in the study, and the additional questionnaire included demographics, symptoms, possible previous therapy, medication, other potential therapeutic exercise interventions or MT.

Before baseline measurement, all patients completed a questionnaire regarding demographic characteristics information, following a complete physical examination by a physical therapist.

Intervention

Pre-selected MWM techniques were applied on the affected hip in standing position, by a qualified physiotherapist with eight years of clinical experience in Mulligan mobilizations. Over the course of two weeks' time and in the frequency of three visits per week, three techniques were selected from standing positions, aiming to improve the hip internal rotation, extension, and abduction (Figure 1-6). The patient was asked to execute the pain-free active movement, simultaneously with right-angle therapist's seatbelt mobilization of internal rotation, extension, and abduction. Each of MWM performed in three sets of ten repetitions with a one-minute break between sets [19]. The program lasted two weeks with a frequency of three sessions per week and theone-daybreak between sessions.

Figure 1: MWM-hip internal rotation (start)

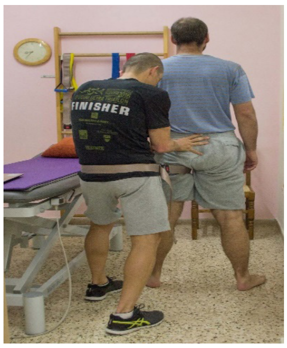


Figure 2: MWM-hip internal rotation (end)

Figure 3: MWM-hip extension (start)

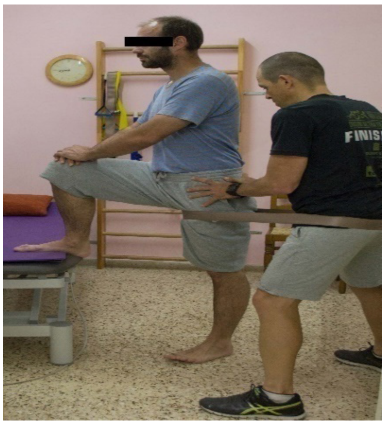


Figure 4: MWM-hip extension (end)

Figure 5: MWM-hip abduction (start)

Figure 6: MWM-hip abduction (end)

Patients were taught to perform auto-MWM techniques in the same standing position with a belt, twice daily at home, in a dose of 3x10 from the first day of the program until the end of the two weeks' period. It was recommended to avoid mobilization in the case of pain or signs of inflammation. Also, they reinforced to continue this home-based auto-mobilization application, after the two weeks' period, as long as they had positive feedback on symptoms elimination and function improvement. At the time of application, patients were instructed to discontinue medication as well as any other form of treatment. Control group virtual applications (Sham) techniques, where applied by the same therapist without mobilization force, but with light contact on patient's hip joint during the execution of the abovementioned movements by the patients.

Outcome measures

Measurements included levels of pain and functionality, through questionnaires translated into the Greek language, at three-time phases: before the intervention (baseline), after the intervention (post-treatment) and three months' follow-up. The Pain was evaluated with Visual Analogue Scale (VAS), [22], which is a single item scale, widely used due to its simplicity and adaptability to a broad range of populations and settings [23]. The scale is a reliable ($r=0.94$, $p<0.001$) and valid tool for HOA patient's assessment with an intra-class coefficient value of 0.95 [24]. Functional status was measured with Lower Extremity Function Scale (LEFS), representing a research tool known for its reliability and validity in HOA patients. Intra-class correlation coefficients (ICCs) value found to be .092, with a minimal detectable change score of 9.9 points. Also discriminate and convergent validity were evident for the LEFS of people with HOA [5, 25]. A blinded examiner, with experience in HOA clinical measurements, carried out all measurements, while participants of both groups were blinded to their intervention.

Statistical Analysis

Data analysis was performed with SPSS (Statistical Package for Social Science) version 24.0. A mixed ANOVA test was performed to detect for interaction between independent variables and also main effects on dependent variables. The dependent variables were LEFS score and VAS score (continues variables). The independent variables were GROUP with two levels (MWM/SHAM) as the between-subjects factor and TIME with three levels (Pro-intervention/ Post Intervention/ Follow-up) as the within-subjects factor. Mixed ANOVA assumptions were tested with Shapiro-Wilk test of normality, Levene test of homogeneity of variances, Box M test of covariances, Mauchly's test of sphericity. The main effect of time was tested whether there were significant changes over time averaged across both groups. The main effect of group was tested whether on average, one group scored higher on the dependent variables than the other group, as well as the interaction between TIME and GROUP. In the case of significant interaction, a pair wise comparison test would be performed to detect significant differences between levels of time measurements. Adjustment for multiple comparisons was made with Bonferroni corrections. Statistical level of significance was set at $a=.05$ and confidence interval at 95%.

RESULTS

Both groups were equal by demographic characteristics (Table 1.) as well as on baseline function and pain scores (Table 2., 3.). Also, there were no drop outs or any adverse effects of the intervention among participants. No patient needed non-steroids anti-inflammatory drugs (NSAIDs) prescription, and no one performed Total Hip Arthroplasty (THA), during the study.

Table 1: Demographic characteristics of participants in value of Mean, ± SD and percentage (%)

Group	MWM	SHAM
Sample size, n	n=20	n=20
Sex, n(female %)	14 (70)	13(65)
Age (years, SD)	68 ±7.1	71 ±9.9
Other forms of therapy, n (%)	5 (25)	8 (40)
Weight (kg, SD)	74 ±9.5	75.3 ±10.3
Height (cm, SD)	163±7.5	164 ± 8.3
Drugs (%)	15 (75)	13 (65)

Table 2: VAS Descriptive Statistics, (mean/ SD) for the two groups

VAS	Group	Mean	SD	N
Pre-treatment	MWM	5,1500	1,08942	20
	SHAM	5,5000	,94591	20
Post-treatment	MWM	1,9500	,68633	20
	SHAM	3,9500	,82558	20
Follow-up	MWM	1,4500	,51042	20
	SHAM	3,8500	,87509	20

Table 3: LEFS Descriptive Statistics, (mean/ SD) for the two groups

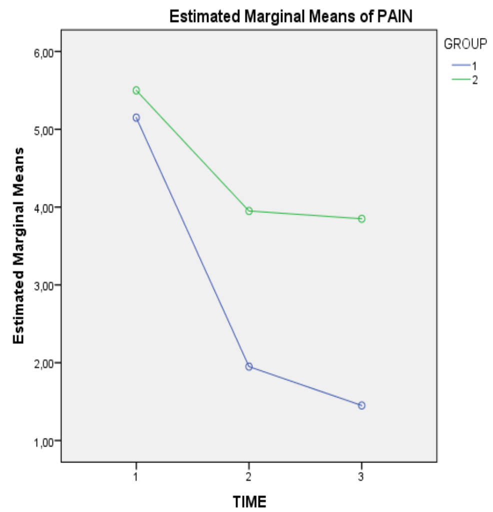
LEFS	GROUP	Mean	SD	N
Pre-treatment	MWM	37,4500	6,74712	20
	SHAM	38,4500	7,51472	20
Post-treatment	MWM	56,1500	6,84624	20
	SHAM	42,9000	7,38348	20
Follow-up	MWM	62,8000	6,90233	20
	SHAM	48,8500	6,41770	20

Shapiro–Wilk test determined the normality of data distribution (p=0.117 for MWM group and p=0.28 for SHAM group as for VAS), (p=0.827 for MWM and p=0.582 for SHAM group as for LEFS). Levine's test of equality of variances for VAS (p=0.645) and LEFS (p=0.745) was found to be non-significant (p>0.05). So there was homogeneity of variances among MWM and SHAM groups, according to dependent variables of VAS and LEFS. Box's M test found to be non-significant (p=0.963), so there was an equality of covariance matrices on the dependent variables. As for within subject's factor of TIME and according to Mauchly's test, the assumption of sphericity had been violated on the dependent variable of PAIN (p< .001), therefore degrees of freedom correction was made using Greenhouse -Geisser estimates of sphericity (ε= 0.95). The test was non-significant, and sphericity was assumed as for within subjects-factor of TIME on the dependent variable of functionality (p=0.441).

Interactions

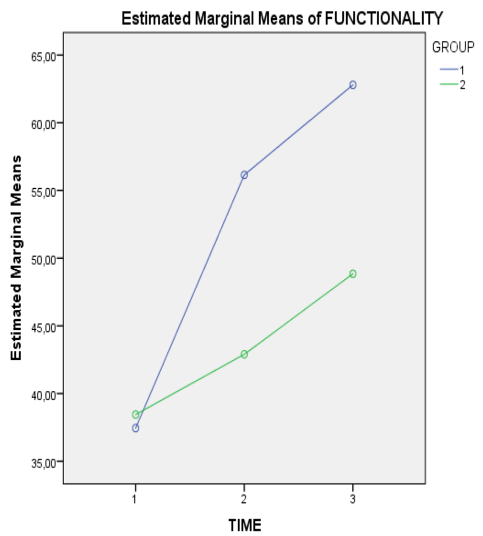
Mixed ANOVA revealed a significant interaction (Figure 7.) between the independent variables of TIME and GROUP, according to Pain, F (2, 37) =17.21, (p<.001).

Figure 7: TIME-GROUP interaction on Pain



Also, there was a significant interaction (Figure 8.) among the independent variables GROUP and TIME, according to functionality, F (2, 37) =21.6. (p<.001).

Figure 8: TIME-GROUP interaction on Functionality



Main Effects

Mixed ANOVA revealed a significant main effect of Group on dependent variables of Pain (VAS score), F (1, 38) = 108.23, (p<.001) and Functionality (LEFS score), F (1, 38) = 28.558 (p<.001). There was a significant main effect of TIME across the two groups for the dependent variables of Pain (VAS score), F (2, 37) = 69.8, p <.001, and Functionality (LEFS score), F (2, 37) = 80.95, p < .001. Table 4 and 5, depict pair wise comparisons with a Bonferroni correction, mean differences among the three levels of a within-subject factor of TIME on pain and functionality at the significance level of .05.

Table 4: Pair wise comparisons of TIME on Pain score

Measure: **PAIN**						
(I) TIME	(J) TIME	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	2,375*	,209	,000	1,853	2,897
	3	2,675*	,228	,000	2,105	3,245
2	1	-2,375*	,209	,000	-2,897	-1,853
	3	,300*	,111	,031	,021	,579
3	1	-2,675*	,228	,000	-3,245	-2,105
	2	-,300*	,111	,031	-,579	-,021

**. Mean scores significantly differ at the, 05 level.*
b. Bonferroni correction.

Table 5: Pairwise comparisons of TIME on Functionality score

Measure: **FUNCTIONALITY**						
(I) TIME	(J) TIME	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-11,575*	1,292	,000	-14,811	-8,339
	3	-17,875*	1,392	,000	-21,360	-14,390
2	1	11,575*	1,292	,000	8,339	14,811
	3	-6,300*	1,159	,000	-9,203	-3,397
3	1	17,875*	1,392	,000	14,390	21,360
	2	6,300*	1,159	,000	3,397	9,203

**. Mean scores significantly differ at the, 05 level.*
b. Bonferroni correction.

DISCUSSION

This study was the first to examine clinical effects of MWM on a sample of hip osteoarthritis patients. Pain and functionality score differences between baseline and post-treatment measures, as well as post-treatment and follow-up measures (3 months), were significant (p<.001) for MWM group, in contrast to SHAM group (p>.001). Differences between groups were also significant (p<.001), regarding VAS and LEFS scores, in post-treatment and follow-up measurements.

We chose to implement MWM in the most affected directions of hip joint motion, like internal rotation, extension, and abduction. According to Kaltenborn and Evjenth, 2014 [18] there is a capsular pattern that reflects limitations of capsular ligaments in hip joint musculoskeletal disorders. In agreement to this, our physical examination found primary limitations on those directions above.

HOA pathophysiology is multidimensional and not just a sum of clinical symptoms such as pain, muscle weakness, reduced ROM and radiographic lesions [26]. MWM on weight-bearing positions is a functional form of manual mobilization, distinguished from usual passive joint mobilization. In this study, functional status of HOA patients improved significantly in both post-treatment and follow-up measurements, pointing out the functional value of MWM.

Hand, 2012 have favored the additive positive effect of MT and exercise [11] or negative effect of this combination, probably due to an interaction that reinforces or reduce clinical outcome [15, 16], or even the absence of any interaction [13]. In a systematic review Sampath, 2015 [17] found low-quality evidence of beneficial short and long-term effect of MT on HOA patients in pain and functionality. We chose to investigate MWM as a single therapeutic program with a control group and not as a combined form of exercise or other intervention, in order to determine a more precise outcome. Our MWM techniques were standardized and not personalized, so that can be incorporated into a therapeutic protocol and be reproducible [27].

Beselga, 2016 [20] found improvements in pain, ROM and functionality in HOA patients after a single MWM application at non-weight bearing position (supine). In addition to this, our study consisted a series of MWM-auto MWM sessions on a weight-bearing standing position, where compressive forces are the primary cause of symptoms [28]. Immediate improvements in post-MWM pain and function measurements are consistent with previous studies, implementing MWM in osteoarthritis of hip and knee [12, 20, 29]. Follow-up measurements also revealed significant improvements, highlighting the value of auto-MWM long-term effects in HOA patient's treatment. Studies have shown that ROM valuation has reduced diagnostic validity. Therefore we did not include any ROM measurement as a dependent research variable [30]. In a recent systematic review Wang, 2015 points out the limited research data about MT effect in HOA [31]. Variability in forms of MT techniques is in agreement with the absence of specific indications, criteria, dosage (force, amplitude, rate, repetition, duration), patient subgroups, prognostic factors and long-term effects [14, 32, 33, 34].

Free pain movement is a fundamental element in Mulligan concept which eliminates the possibility of implementation complications [12, 19]. Simultaneous movement by the patient, in addition to therapist mobilization, reinforce control of motion. The patient receives a positive feedback of normal movement and also a better outcome of exercise that usually follows in rehabilitation program [35]. Probably, MWM mechanical effect is determined by the stimulus of hip joint mechanoreceptors, resulting in stiff muscle relaxation like adductors and reinforcement of inhibiting muscles like abductors [36].

Given the fact that there is limited evidence on MWM underlying mechanism of action and interpretation of clinical effectiveness in musculoskeletal disorders, current literature should focus on biological parameters [37]. Previous theories (Vicenzino, 2007) of positional fault need to be revised [38]. Moreover, MWM on weight-bearing standing position patients is associated with a painless hip-joint movements feedback, reducing the fear of movement [39]. It has been hypothesized that manual therapy act mechanistically to disrupt the pain-spasm-pain cycle [40]. Also, knowing that many biological blood and synovial fluid parameters as biomarkers are embedded in osteoarthritis pathophysiology, there are possible cellular and sub-cellular pathways of manual therapy effect [41, 42, 43]. MT and MWM are incorporated in the field of mechanotherapy and mechanobiology, where interaction among cell membrane mechanical forces (compression, shearing) and intracellular chemical agents, via ion channels, is a very prompted area of research [44]. Degenhardt,2007 [45] found changes in several circulatory pain biomarkers concentrations, after MT application in subjects with chronic with low back pain. Vigotsky, 2015 [46] investigated the descending modulation and neurotransmitters, including serotonin, vasopressin, oxytocin, adenosine, endocannabinoids, and endogenous opioids in conjunction with MT implementation. McPartland [47], proposed that MT effect is associated with changes in the endocannabinoid system.

Limitations of the study were convenience sampling and a relatively small sample size that would allow an extensive statistical analysis. Furthermore, due to the implementation of MWM without any other intervention, as part of the multifactorial program, generalizability is reduced.

CONCLUSION

The application of a therapeutic program consisted of MWM and auto-MWM on weight bearing position, significantly improved short and long term pain and functionality in hip osteoarthritis patients. There is a need for further study on therapeutic hip manual therapy interventions, in a larger sample of patients, determining the appropriate parameters of implementation, patient subgroups, and prognostic application parameters. Research challenges arising, concerning the MWM effect mechanisms at a cellular level.

Financial support: No financial support.

Acknowledgments: We are grateful to the staff at the outpatient clinic for their valuable assistance.

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Citation

Zemadanis, K., Betsos, T., & Mandalidis, D. (2017). THE SHORT AND LONG-TERM EFFECT OF WEIGHT-BEARING MOBILIZATION-WITH-MOVEMENT (MWM) AND AUTOMOBILIZATION-MWM TECHNIQUES ON PAIN AND FUNCTIONAL STATUS IN PATIENTS WITH HIP OSTEOARTHRITIS. *International Journal of Physiotherapy,* 4(3), 160-167.