Research Article

Comparison of Effects of Mulligan Techniques and Muscle Energy Technique on Pain and Function in Knee Osteoarthritis

Abbas Fadhil Taher, Hossein Bagheri*, Zinat Ashnagar, Shohreh Jalaei

Department of Physiotherapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran.

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ABSTRACT

Introduction: Osteoarthritis (OA) is a chronic degenerative disabling worldwide disorder in which the knee osteoarthritis range of motion (ROM) is particularly reduced. Mobilization with Movement (MWM) has shown rapid improvements in pain and functions. The muscle energy technique (MET) is claimed to be effective in muscle lengthening, strengthening, and increasing joint ROM.

Materials and Methods: A clinical trial was conducted to compare knee Mulligan (lateral, medial, and rotational glides) techniques (n=15), and post-isometric relaxation muscle energy techniques (quadriceps, hamstring, and tensor fascia latae) (n=15) on pain and function in OA.

Results: Twenty-two subjects (73.3%) were grade-II of knee OA and 8 subjects (26.7%) with grade III. The visual analogue scale (VAS) showed significant changes in the reduction of pain. In the VAS, the main effect of time of treatment shows that the mean value of the VAS score was statistically significant between at least two assessment stages (before the first session, after the third session, and after a month) (P<0.001) in each group. In knee osteoarthritis outcome score (KOOS), the main effect of time of treatment shows that the mean value of KOOS score is statistically significant in increasing KOOS between at least two assessment stages (before the first session, after the third session, and after a month) (P<0.001) in each group. KOOS showed significant changes for increasing function. Timed up and go (TUG) score showed decremental significant changes in time. In the TUG score, the main effect of time of the treatment shows that the mean value of the TUG score was statistically significant between at least two assessment stages (before the first session, after the third session, and after a month) (P<0.008). In ROM score, the main effect of time of the treatment shows that the mean value of ROM score was statistically significant in increasing ROM between at least two assessment stages (before the first session, after the third session, and after a month) (P<0.002, observed power= 0.927).

Keywords:

Osteoarthritis; Knee; Muscle energy; Mobilization with movement

*** Corresponding Author:**
Hossein Bagheri, Professor, PhD.
Address: *Department of Physiotherapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran.*
Tel: *+98 (21) 77528469*
E-mail: *hbagheri@tums.ac.ir*

Conclusion: Applying MWM is more functionally effective than applying the post-isometric relaxation muscle energy technique, both interventions increase functional performance in the short term in patients with chronic knee osteoarthritis, but they are not functionally effective from a single session. Applying both techniques has effects on reducing pain immediately and in the short term.

1. Introduction

Osteoarthritis (OA) is a chronic degenerative disorder of multi causes characterized by a range of cartilage, bone, synovial membrane, joint capsules, and biochemical and morphological changes [1]. Reported by World Health Organization (WHO) as a major public health problem, OA causes functional impairment and reduces the quality of life worldwide [2]. People over 55 years show radiographic and or clinical evidence of OA. Activity-worsened and rest-reduced knee pain is the leading symptom [3]. The prevalence of OA increases with age, 13.9 % in over 25 years old and 33.6 % in over 65 years old people [4]. Advanced OA is common with persistent aches or night pain. Diagnosis is done by physical and radiological findings, and special functional tests when needed [5]. Knee OA mainly affects the medial joint compartment [6]. Torque production by hip abductors in the stance limb is decreased causing a pelvic drop in the contralateral swing limb [7]. In knee OA, the Range of Motion (ROM) is particularly reduced. Due to damaged articular cartilage, pain, loss of joint capsule, and muscles extensibility in OA knee hamstrings have a major role in developing atherogenic changes which leads to the development of contracture and gradually falls into the loss of hamstring flexibility [8]. Tightness of the hamstring muscles, if not corrected, is likely to develop flexion contracture of the knee in later disease stages [9]. Previous studies reported an increase in hamstring activation with knee OA while performing ADLs. Normalizing the hamstring over activation would be as important as strengthening the quadriceps in preventing the disease progression [10].

Despite the benefits of exercise and various modalities [11], manual therapy also has been reported as useful when used in conjunction with joint mobility and strengthening exercises [12]. Deyle et al. (2005) found greater development in functional status and symptoms with passive physiological and accessory movements in knee OA than with using home exercises only [13]. Van Den Dolder and Roberts (2006) concluded that medial gliding mobilization with movement (MWM) and Cyrix improved function and ROM in anterior knee ache patients. Apart from these two studies, there is very little evidence of the effectiveness of Mulligan's MWM techniques in patients with knee OA [14].

Manual therapy refers to methods used by physiotherapists, osteopaths, and special-training chiropractors [15] to improve ROM and function and decrease pain in the knee [14]. It includes different techniques and previous researchers aimed to assess the efficacy of some of these various therapies [16].

MWM was advocated by Brian Mulligan for treating joint pain, stiffness, and dysfunctions [17]. Mulligan's concept of mobilization with movement is a contemporary form of joint mobilization [18] consisting of a therapist-applied pain-free accessory gliding force combined with active movement [19]. It is hypothesized that MWM may minimize the positional faults at joints that occur following a joint injury [20]. MWM treatments have shown rapid improvements in pain and functions in several studies and trials, but the effect of MWM on knee OA has not been evaluated thoroughly in these studies [21]. There are reports of immediate pain relief and improved function in response to these techniques in several musculoskeletal disorders [22].

MET is a non-invasive, safe, and inexpensive treatment. This technique is considered a moderate and active manual therapy to correct limited joint movements [23] and it is effective for a variety of purposes including lengthening a shortened or contracted muscle, strengthening muscles, and increasing the ROM of a restricted joint [24]. Muscle energy technique (MET) may increase muscle length by a combination of connective tissue creep and plastic changes, flexibility increase after the MET is due to biomechanical or neurophysiological changes, or stretching tolerance increase [25].

There are few studies about the comparison of MET and Mulligan MWM techniques [26-28].

The purpose of this study is to compare the immediate (after the first session) and short-term (after three sessions) effects of tibiofemoral gliding Mulligan MWM techniques, and hamstring, quadriceps, and tensor fascia latae post-isometric MET on pain and functional activities in patients with knee OA.

2. Materials and Methods

Thirty chronic knee OA participants, referred from the orthopedic clinic to the Physiotherapy Department, Baquba Teaching Hospital, Diyala Governorate, Iraq, from November 2020 to February 2021 participated in this study.

The inclusion criteria were as follows

Age between 35–60 years, both genders.

Chronic OA (OA duration of more than one year)

Unilateral or bilateral knee osteoarthritis (grade II or grade III of Kellegren and Lawrence classification).

Body mass index (BMI) ≤30. Patients are independently mobile.

Visual analogue scale (VAS) ≥4.

Knee extension lack ≥20 degrees.

Willingness to participate and follow the treatment schedule.

The exclusion criteria were as follows

Patients had no concomitant disease affecting the knee such as rheumatoid arthritis, recent injury, any surgery to the knee, and intra-articular corticosteroid injection during the last 6 months.

Having no ligament pathology or injury.

Being absent for two or more continuous sessions.

Patients who had pathological fractures, revision surgeries, associated ipsilateral injuries, and neurovascular disorders.

Patients who were not satisfied to continue the treatment (due to personal, economic, and social considerations).

Subjects were divided randomly by using a simple allocation technique to group A (Mulligan MWM technique [n=15]), with a Mean±SD age of 51.13±8.895 years, and group B (post-isometric muscle energy technique [n=15]), with the Mean±SD age of 51.07±9.051 years.

This study has been approved by the ethics committee of the Tehran University of Medical Sciences (IR.TUMS.FNM.REC.1399.179) and registered in the Iranian Registry of Clinical Trials (IRCT) (reference number: IRCT20210121050099N1).

Procedure

The informed written consent of subjects was obtained. Participants were assessed to obtain baseline demographic information (age, sex, osteoarthritis grade, and body mass index) and clinical parameter VAS, KOOS Arabic version, TUG, and active knee extension ROM, outcome assessment after the first and the third session, except for KOOS after the third session and a month later. Patients had three sessions in a week. Both groups were asked to do home routine exercises (quad setting exercise and straight leg rising) [29].

Mobilization With Movement

Subjects suffering knee pain or more pain laterally received lateral glide mobilization using a belt in the prone position (Figure 1), external rotation glide in the standing position with weight bearing, and active knee extension and flexion (Figure 2). Subjects suffering knee pain or more pain medially received medial and internal rotational glides instead (Figure 3). The intervention continued with three sets of the MWM, of 6 repetitions in flexion and extension in each set. The clinician communicated with the patient regarding any discomfort that may occur and the subject takes 30 seconds of rest between sets or whenever feels tired [30].

Muscle energy technique

This technique includes quadriceps, tensor fascia latae, and hamstring post-isometric MET. Quadriceps post-isometric relaxation (PIR) MET.

The therapist stretches the muscle for 30 seconds for patients in the prone position, holding isometric contraction with 20% of maximum voluntary strength against the therapist's resistance for 7-10 seconds followed by the patient's exhalation, (Figure 4). A new end position is found by repeating the technique 3-4 times.

Tensor fascia latae post-isometric relaxation muscle energy technique (PIR-MET)

In the supine position, the patient is treated at the barrier of resistance using light to moderate degrees of effort involving isometric contraction of 5 to 7 seconds (Figure 5).

Figure 1. Mobilization with movement (Knee Lateral Glide)

Figure 2. Mobilization with movement (Knee Medial Glide)

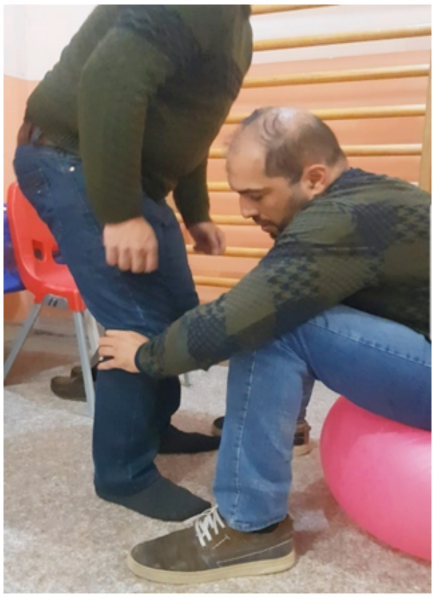

Figure 3. Mobilization with movement (External and Internal Rotation)

Figure 4. Muscle energy technique of quadriceps muscles

Figure 5. MET of tensor fascia latae

Hamstring PIR-MET: The patient's knee and hip are flexed. The instruction might be something like trying to gently bend the knee against the therapist's resistance, starting slowly and using only a quarter of strength. Asking patients to breathe and hold the hamstring isometric for 7-10 seconds followed by exhalation, the therapist stretches the muscle for 30 seconds to straighten the knee towards the new barrier (Figure 6). This technique is repeated until no further gain is possible 3-4 times (usually one or two repetitions achieve the maximum degree of lengthening available at any one session) [28].

Statistical analysis

Data for continuous variables are described with a mean (standard deviation). In the analytical statistics section, we

Figure 6. MET of hamstring muscles

checked the normality of outcome measures distributions by the Kolmogorov- Smirnov test. Muchly test was used for equality of variances. For comparisons within and between group effects and to investigate the interactions, we used a two-way repeated measure analysis of variance (ANOVA) (3×2) with the Bonferroni post hoc test.

3. Results

Demographic characteristics (age, gender, BMI, and OA severity) reported in Table 1 showed an equal male-to-female distribution with 22 subjects (73.3%) of patients with grade-II, and 8 patients (26.7%) with grade III. The results of Kellgren and Lawrence's grade scale in both groups had random distribution and female patients showed more BMI scores than male ones. The values of BMI in both groups had random distribution.

The participants' clinical details of outcome measures (KOOS, VAS, TUG, and ROM) are reported in Table 2.

Table 2 shows analytical statistics of every outcome measure; KOOS, VAS, TUG, and ROM of active knee extension to find changes before and after receiving interven-

Table 1. Descriptive statistics of baseline subjects' details (n=15)

Variables		Mean±SD/ No.	
		MWM	MET
Demographic parameters			
Age (y)		51.13±8.895	51.07±9.051
Gender	Male	8	7
	Female	7	8
Osteoarthritis grade	2	10	12
	3	5	3
BMI kg/m^2		28.1±2.2	27.6±2.7

MWM: Mobilization with movement; MET: Muscle energy technique; BMI: Body mass index.

Table 2. Mean±SD KOOS, VAS, TUG, and ROM Before and After Treatment

Outcome Measures	Mean±SD							P
			MET (n=15)					
	Before Treatment	After Treatment	1 Month Later	P	Before Treatment	After Treatment	1 Month Later	
KOOS (score)	54.93±18.18	65.20±13.95	59.80±16.62	<0.001	50.07±14.74	60.53±16.33	53.07±13.21	<0.001
VAS (cm)	5.27±1.58	4.13±1.99	3.47±2.61	<0.001	6.47±1.64	3.47±2.58	3.47±2.20	<0.001
TUG (second)	18.60±6.62	17.20±6.78	16.47±6.95	<0.008	17.87±6.14	17.20±5.71	15.93±6	<0.008
ROM (degree)	157.80±6.83	159.13±5.59	162.73±5.61	<0.002	152±5.6	155.33±5.98	156.53±8.34	<0.002

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Abbreviations: MET, muscle energy technique; KOOS, knee injury and osteoarthritis outcome score; VAS, visual analogue scale; TUG, Timed up and go test; ROM, range of motion.

tion between both groups. A repeated measure two-way ANOVA was used to detect any significant differences to evaluate the effectiveness of applying the intervention.

In the KOOS score, the main effect of time of treatment shows that the mean value of the KOOS score is statistically significant between at least two assessment stages (before the first session, after the third session, and after a month) (P<0.001, power=0.975) (Figure 7). Bonferroni Post hoc test revealed a significant increase in the value of KOOS score before the first session and after the third session assessment stages (P=0.001), and after the third and after a month (P=0.003).

The main effect of the type of treatment shows there is no significant difference between the two types of treatment (P=0.29, observed power=0.179). There is no interaction effect between time and type of treatments (P=0.86, observed power=0.071).

In the VAS score, the main effect of time of treatment shows that the mean value of the VAS score was statistically significant between at least two assessment stages (before the first session, after the third session, and after a month) (P<0.001, observed power=1) (Figure 8). The post hoc test using the Bonferroni correction revealed a significant decrease in the value of the VAS score only before and after the first session assessment stage (P<0.0001) and before the first and after the third session (P<0.0001). It can be concluded that this treatment decreased the VAS score in the first and the third session compared to the baseline. The main effect

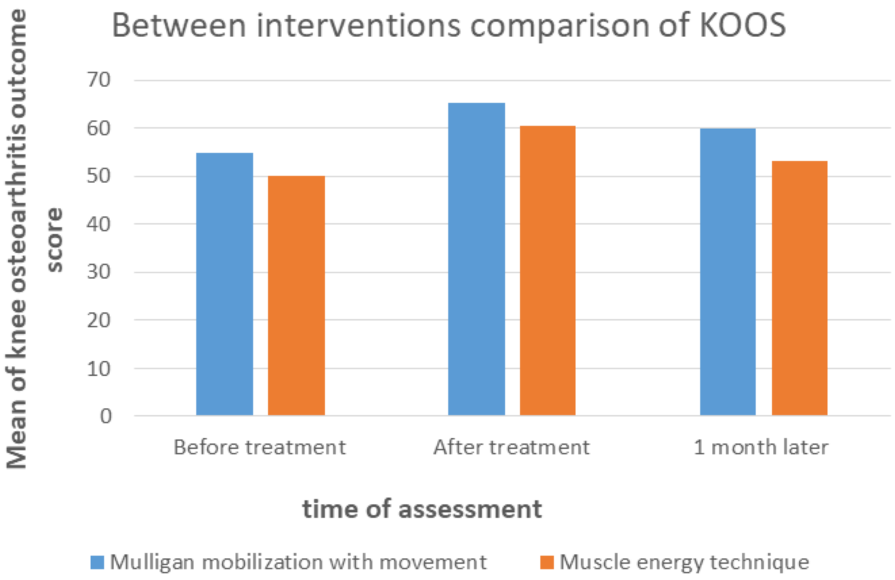

Figure 7. Comparison of KOOS outcome measure at three different times

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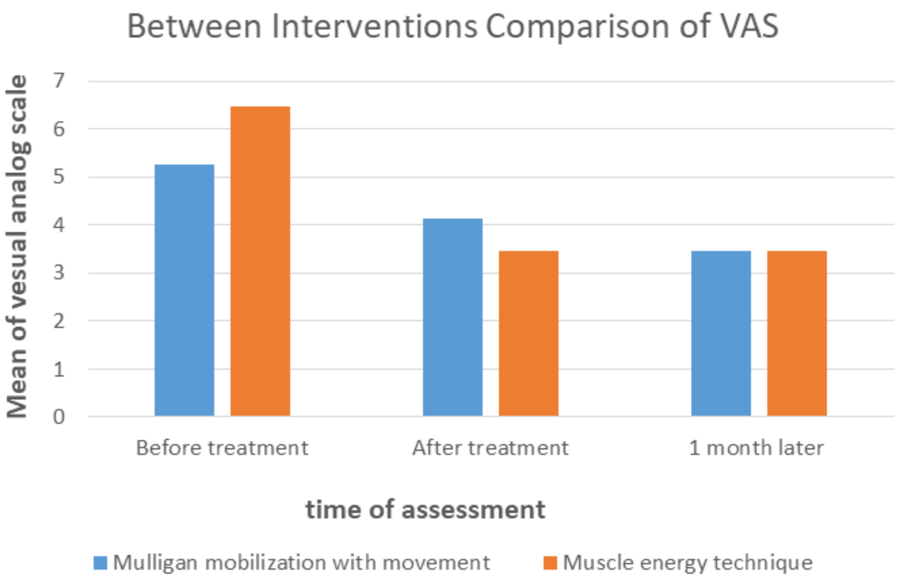

Figure 8. Comparison of VAS outcome measure at three different times

of the type of treatment shows no significant difference between the two types of treatment (P=0.789, observed power=0.058). There is no interaction effect between the time and type of treatments (P=0.39).

In the TUG score, the main effect of time of treatment shows that the mean value of the TUG score was statistically significant between at least two assessment stages (before the first session, after the third session, and after a month) (P<0.008, observed power=0.827) (Figure 9). The post hoc test using the Bonferroni correction revealed a significant decrease in the value of the TUG score only before the first and after the third session (P<0.005). The main effect of the type of treatment shows no significant difference between the two types of treatment (P=0.853, observed power=0.054). There is no interaction effect between time and type of treatments (P=0.647, observed power=0.115).

In ROM score, the main effect of time of treatment shows that the mean value of ROM score was statistically significant between at least two assessment stages (before the first session, after the third session, and after a month) (P<0.002, observed power=0.927) (Figure 10).

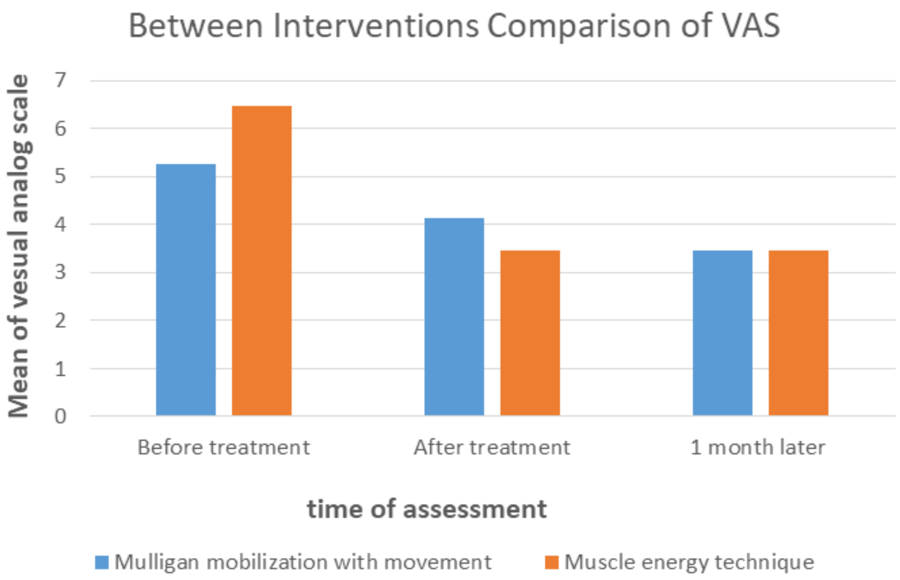

Figure 9. Comparison of TUG outcome measure at three different times

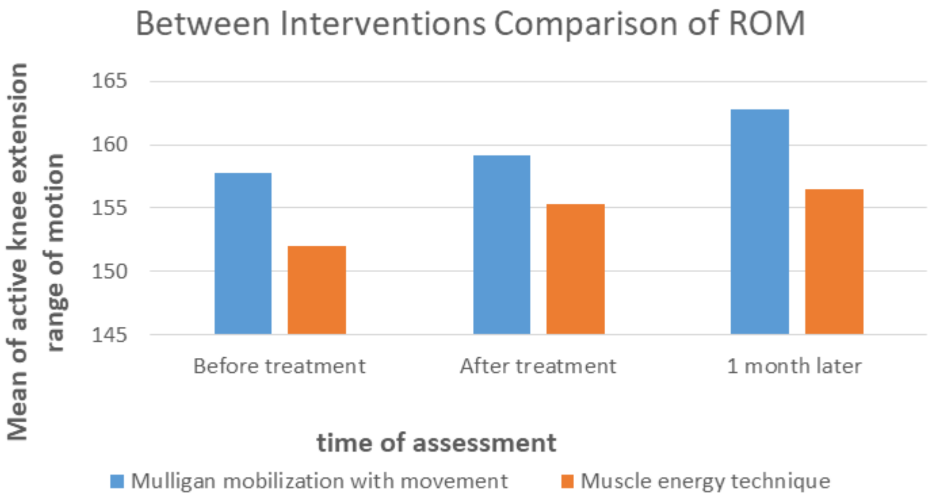

Figure 10. Comparison of ROM outcome measure at three different times

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The post hoc test using the Bonferroni correction revealed a significant increase in the value of ROM score before the first and after the third session (P<0.001). The main effect of the type of treatment shows there is a significant difference between the two types of treatment (P=0.012, observed power=0.734). There is no interaction effect between time and the type of treatment (P=0.464, observed power=0.170).

4. Discussion

The findings of the present study revealed that applying MWM as well as MET techniques can reduce the mean values of the VAS scores in patients with knee OA. Despite the significant changes in pain intensity in both groups, the findings of this study demonstrated that the VAS score was not significantly different between both MET and MWM groups (P=0.789).

The results of this study are partly similar to the results of a study by Khuman et al. [31] who examined the immediate effects of a single session of post-isometric relaxation MET (PIR-MET) and Mulligan's Bent Leg Raise (BLR) technique on pain intensity of the patients with knee OA (n=30 in each group). The VAS score was decreased after applying a single session of techniques in both PIR-MET and Mulligan's BLR groups compared to baseline values (P<0.05).

Besides, Tariq et al. [26] investigating the effectiveness of 12 sessions of MWM BLR and MET techniques on pain intensity of 114 patients with knee OA demonstrated that the pain intensity was decreased more while using Mulligans BLR compare to the MET techniques in patients with knee OA.

On the contrary, in the current study, the mean changes in pain score were not significantly different between both (MET and MWM) groups (P=0.789).

These discrepancies may be due to the sample size of each study. As in the present study, the results of power analysis for group differences were too low (power=0.058). It seems that the results may be affected by the small sample size of the study and results may be different with increasing the sample size.

Furthermore, despite some similarities, the methods of applying the MWM and MET techniques are somehow different among the studies. In the present study, we have used the MET technique for the hamstring, quadriceps, and tensor fascia latae, while in Tariq et al study, they used it only for hamstring PIR-MET.

In addition, applying different gliding during MWM techniques is another source of discrepancies. In the present study, we have used medial, lateral, and internal and external rotation glides MWM techniques, while in the previous two studies, they used only the BLR MWM technique.

In addition, the findings of the present study revealed that applying MET (P=0.008, power=0.828) as well as MWM techniques (P=0.012, power=0.012) can increase the mean values of the KOOS scores in patients with knee OA. The results indicated that the KOOS score was significantly increased by applying one session of MWM (P=0.009) and MET (P=0.052) techniques in knee OA patients compared to the baseline values.

It should be considered that while the results of two-way ANOVA showed significant changes in the values of the KOOS score in the MET group, the Bonferroni post hoc test revealed that the changes in the score were somehow in borderline (P=0.052). Considering the power of the test (P=0.786), it seems that using a larger sample size may result in more significant changes.

The results of this study are in line with the findings of Khan and Rizvi who found that the overall impact of MET on the KOOS scale was higher compared with the stretching group (MET Post: 0.60±0.09; Stretching Post: 0.58±0.16) with both statistically and clinically significant results (P<0.05) [31].

The findings of the present study revealed that applying the MET technique can reduce the mean values of the TUG scores in patients with knee OA (P=0.02, power=0.723).

The results of this study showed that the TUG score was significantly decreased by applying three sessions of MET (P=0.037) compared to baseline values in knee OA patients.

The results of the present study showed that while the mean values of the TUG decreased after applying three sessions of the MWM technique, the changes were not statistically significant (P=0.133). However, considering the low power (P=0.688) of the ANOVA analysis test, it seems that increasing the number of the sample size may change the results.

In addition, Vrushali and Deepak applied MWM along with conventional physiotherapy in patients with knee osteoarthritis for 4 weeks and showed a significant improvement (25.08%) in the KOOS index [32].

The results of this study are in line with Vrushali et al. who assessed the effectiveness of MWM with conventional physiotherapy in knee osteoarthritis and showed a 10.89% improvement in timed up and go test compared to baseline values [27].

The pain-relieving manual therapy mechanisms are biomechanical, neurophysiological, and non-specific mechanisms [33]. Regarding MWM, the biomechanics mechanisms could be the correction of positional faults by glides used in the intervention group of the present study.

Passive Mulligan's techniques could have restored normal kinematics of osteoarthritic knees producing immediate pain relief. The immediate effects after intervention might also be attributed to the pain gate neurophysiological mechanism [34].

The reason Mulligan gave to confirm the hypothesis is that MWM is nearly always at right angles to the plane of movement and it will work in only one direction. When correct MWM is repeated several times, the joint memory to stay on track seems to return.

The mechanism (s) of MWM effects remains somewhat of an enigma. It has been proposed that the MWM treatment technique produces its effects by correcting positional faults of joints which explains the hypothetical mechanism for the first successful Mulligan MWM. Positional fault theory (Mulligan, 1995) says that joint alignment alteration occurs due to injury or chronic/poor arthrokinematics which causes inconsistent bony congruencies that occur after strain or injury [35].

It seems that applying glides in different directions with movement help to restore normal arthrokinematics of the knee joint. It seems that while knee osteoarthritis patients suffer from disorders in the movement of articular surfaces, applying MWM can lead to better articular surface congruent alignment and more flexible dynamics of the knee.

MET reduction in pain intensity is attributed to the hypoalgesia effects explained by the inhibitory Golgi tendon reflex, activated during the isometric contraction that in turn leads to the reflex relaxation of the muscles [36].

It is suggested that the studied post-isometric MET can be effective in the correction of gait mechanisms. As mentioned previously, torque production by hip abductors in the stance limb is decreased which causes a pelvic drop in the contralateral swing limb [7]. Tensor fascia latae is a hip abductor attached to the knee, and applying MET to it might work to eliminate muscle shortness. Additionally, quadriceps MET could increase muscle power and facilitate fulfilling conventional knee osteoarthritis exercises.

Study limitations

Several limitations must be considered in this study. Some of the patients withdrew from participating in the study because of the far distance between their houses and the hospital and also some patients neglected the time of sessions and did not continue the treatment sessions. In addition, based on the observed low power for group differences, it seems that the results may be affected by the small sample size of this study.

5. Conclusion

While applying Mulligan (lateral, medial, and rotational glide), MWM is more functionally effective than applying post-isometric (quadriceps, hamstring, and tensor fascia latae) muscle energy exercises. Both interventions increase functional performance in the short term in patients with chronic knee osteoarthritis, but they are not functionally effective in a single session. The outcome of this study demonstrates that the application of both Mulligan MWM and PIR-MET techniques has effects on reducing pain immediately and in the short term. No side effects were observed in this trial and the results of this study suggest that these methods of treatment, in addition to knee osteoarthritis conventional exercises, are necessary for conservative interventions in the field of rehabilitation of knee osteoarthritis. This intervention may be particularly crucial for patients who do not get improvement from medical therapy or other physical modalities that are contraindicated for them, those who suffer from side effects of drugs, or those who are not candidates for joint replacement specifically elderly patients.

Recommendations

It is recommended that further studies are needed with a larger sample size as well as more sessions of treatment to investigate whether the effects of MET and MWM could be permanent or not and to investigate long-term effects.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of the Tehran University of Medical Sciences (TUMS) (Code: IR.TUMS.FNM.REC.1399.179) and registered in the Iranian Registry of Clinical Trials (IRCT) (Ref. No.: IRCT20210121050099N1).

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declare no conflict of interest.

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