Research Paper: The Pilot Study of the Immediate Effect of Muscle Energy Technique on Flexibility and Stiffness in Healthy Young Females

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ABSTRACT

Introduction: Flexibility is considered as one of the most significant components of rehabilitation protocols including two definitions: static flexibility measured by the Range of Motion, and dynamic flexibility measured by stiffness. Generally, a normal flexibility is necessary for an appropriate posture and flawless activity in daily life. With regard to various methods that contribute to increasing flexibility of hamstring muscles, the current study aimed at investigating immediate effects of Muscle Energy Technique (MET) on hamstring flexibility and stiffness in healthy young females

Materials and Methods: Ten healthy young females with the mean age of 22.5±2.67 years old participated in the study. Flexibility was measured via active knee extension and modified sit-and-reach test, and stiffness was measured based on the ratio of torque to angular changes via Biodex System 3 before and after MET interventions by post-isometric relaxation method.

Results: The amounts of active knee extension and modified sit-and-reach tests significantly increased after MET intervention; the amounts of active knee extension and modified sit-and-reach increased significantly ($P<0.001$). Moreover, the estimated hamstring stiffness decreased significantly in comparison with its values before treatment ($P<0.001$)

Conclusion: The results of this study indicated that MET may improve hamstring flexibility as well as its stiffness.

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1. Introduction

Flexibility refers to elongation ability of skeletal muscle and tendons [1]. From the view point of therapists, flexibility is one of the most significant components of rehabilitation protocols [2]. It is specifically necessary in two-joint muscles for normal posture and flawless ADL [3]. According to Gleim, two definitions can be considered for flexibility [1]: Static flexibility measured via the Range of Motion (ROM), which is equal to tolerance threshold toward stretches, and dynamic flexibility that is the necessary resistance toward stretch and is measured via stiffness. Muscle stiffness refers to the ratio of torque changes to muscle length changes or angular position measured during active or passive motion; therefore, it is better to be calculated alongside muscle flexibility tests [4].

One of the most important two-joint muscles of the body, prone to tightness, is hamstring muscle [5]. Incomplete knee extension followed by pain and discomfort behind the knee, when hip joint is in 90 degrees flexion position, is attributed to hamstring tightness [3, 6]. It is also a risk factor for hamstring strain [2, 7]. Moreover, reduced hamstring flexibility may cause secondary orthopedic problems [8] such as palatopharyngeal pain syndrome, inflammation of plantar fasciitis, disorder of lumbricales rhythm, lumbar pains, etc. [6, 9, 10].

One of the efficient treatments to increase hamstring flexibility is Muscle Energy Technique (MET), which is followed by controlled isometric contraction in the targeted muscle [11, 12]. The results of studies indicated that MET was effective to improve flexibility as well as reduction of pain and discomfort [13-18] and caused more immediate and long term changes [14, 16].

However, there was a gap in the effects of MET on biomechanical properties, such as stiffness. Therefore, the current study aimed at analyzing immediate effects of MET on hamstring flexibility and stiffness in healthy young females.

2. Materials and Methods

Ten young females with 20 degrees (or more) extension lack in popliteal angle, diagnosed by the active knee extension test, voluntarily participated in the current pre-test post-test study.

Inclusion criteria

Inclusion criteria: Age 18-30 years; Body mass index 18.5-29.5 kg/m^2; Extension lack 20 degrees or more; Exclusion criteria: Participation in sport activities three days or more in a week; Severe deformities of back, hip, and knee; Lower extremity prosthesis or surgery; Chronic musculoskeletal disorders; Disclaimer from participation in the study.

Procedures

Hamstring flexibility was measured by two tests: Active Knee Extension Test (AKET) and Modified Sit-and-Reach Test (Mod S & R).

Active Knee Extension Test (AKET)

The subject was placed in supine position and hip joint was fixed at 90 degrees of flexion by sling. Next, the subject extended her knee actively and her popliteal angle was measured by goniometer (Lafayette instrument model, USA) (Figure 1).

Modified Sit-and-Reach test (Mod S & R)

The subject sat on the floor, while her back and head were against the wall and placed her bare feet against the Flex tester box. First, the subject was asked to stretch her arms toward and fingertip was considered as zero. Second, the subject flexed her back with extended knee as far as possible and her fingertips distance to zero point was considered as the test result (Figure 2).

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Figure 1. Measurement of popliteal angle by active knee extension test

Figure 2. Modified Sit-and-Reach Test

To estimate hamstring stiffness, the subject sat on the chair of Biodex System 3 (Biodex medical system, USA), and hip and trunk were fixed with strap. Device setting included: passive mode, angular velocity of 5°/second, and ROM from flexion to the end of the active knee extension. To start the test, the device passively moved the knee to the end range of extension. Since maximum stiffness was estimated at the end of the muscle length, the 30-degree terminal extension was considered as angular position. According to the stiffness definition, torque was calculated at 30 degrees of the terminal range of passive knee extension (Figure 3).

$$Stiffness=\frac{\Delta Torque}{\Delta angular\ position}$$

Muscle Energy Technique (MET)

Post isometric relaxation (the Lewit method) was used to increase the hamstring flexibility. The subject was placed in supine position and hips were placed at 90 degrees of flexion, and then the knee joint was extended passively until restrictive barrier. The subject performed isometric contraction with 75% of Maximum Voluntary Contraction (MVC) [13] against the therapist force in direction of knee flexion and held this position for 7-10 seconds. After this time, she relaxed the muscle and then, knee joint was extended by the therapist to a greater Range of Motion for 10 seconds. This technique was performed three times in one session. Assessments were repeated again after intervention (Figure 4).

Statistical analysis

Ten young females were included in the study according to the inclusion criteria. Their mean age was 22.5±2.67 years (ranging 19 to 26), their mean weight was 63.8±10.88 kg (ranging 42 to 79), and their mean height was 166.3±4.92 cm (ranging 158 to 174), shown in Table 1. The data were analyzed with SPSS version 22. The Kolmogorov-Smironov test demonstrated normal distribution of data; therefore, to analyze the data, the paired samples t-test was applied (P<0.05).

Figure 3. Stiffness measurement by biodex system 3

3. Results

Table 2 presents the measurements of AKE, Mod S & R and Stiffness. AKE increased 20.18% (changed from 59.2±8.49 to 71.15±8.68), and Mod S & R increased 15.73% (changed from 19.7±6.98 to 22.8±7.28), showing a significant difference between the results of before and after treatment (P<0.001). Stiffness decreased 20.2% (changed from 12.87±3.13 to 10.27±3.02), showing a significant improvement in the test results (P<0.001).

4. Discussion

In the current study, immediate effects of MET on hamstring flexibility and stiffness in healthy young females were investigated. The results indicated that MET can significantly increase flexibility, and decrease stiffness of hamstring. The current study results regarding the effects of MET on hamstring flexibility were consistent with those of the previous research. Ballantyne

Figure 4. Muscle energy technique treatment

Table 1. Anthropometric characteristics of the participants (n=10)

Variables	Mean±SD	Minimum	Maximum
Age (y)	22.5±2.67	19	26
Weight (kg)	64.4±8.3	52	75
Height (cm)	166.3±4.92	158	174

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Table 2. Acute effect of MET on hamstring flexibility and stiffness after one session treatment (n=10)

Categories	Before			After			P
	Min	Max	Mean+SD	Min	Max	Mean+SD	
AKE (degree)	41	67.5	59.2±8.49	52.5	80.5	71.15±8.68	0.000
Mod S & R (cm)	7.5	27	19.7±6.98	9.5	30	22.8±7.28	0.000
Stiffness (Nm/Rad)	6.09	17.87	12.87±3.13	5.09	15.72	10.27±3.02	0.000

AKE: Active Knee Extension; Mod S & R: Modified Sit-and-Reach

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et al. conducted a study on the effects of MET on hamstring flexibility. They concluded that using MET in one session increased tolerance threshold toward hamstring stretches and elongation [13].

The reported results by Smith (2008) indicated that both Greenman and Chaitow approaches in MET can increase AKE domain and their effects last for a week [12]. Waseem et al., in their investigation on the effects of MET on hamstring flexibility of males, concluded that MET may be an efficient method to increase popliteal angle [19].

Mazumdar compared the effects of MET and Mulligan traction SLR on hamstring tightness and concluded that both methods increased hamstring flexibility; however, MET was more effective than Mulligan TSLR technique [20]. Although the methodology, sample size, and even number of sessions were different in various studies, it seems that the results of the current study were consistent with those of the previous ones [19, 20]. Some studies compared MET with other techniques such as static stretch.

By a comparison made on the immediate effect of static stretching and MET on hamstring flexibility, Shadmehr et al. concluded that both techniques relatively had the same effect on increasing the flexibility [21]. Ahmed tested the effect of MET and static stretching on 45 males, and the results indicated that both methods had the same significant effect on the hamstring flexibility [22]. Although in accordance with the results of some studies, the effect of MET and static stretching may be the same, it seems that MET can create a prolonged effect, decrease the pain and discomfort, and make more changes than static stretching [13-17].

According to Shellock and Hutton, effectiveness of MET may be related to inhibitory reflexes of Golgi tendon [23]; therefore, this reflex, followed by its subsequent active isometric contraction, leads to relaxation [24, 25]. Multiple possible mechanisms are employed to explain the immediate effectiveness of MET such as viscoelastic changes in muscles or increased tolerance threshold toward stretch [26]. Generally, researchers emphasized the role of mechanical and neurophysiological factors in the effectiveness of MET on hamstring flexibility [13, 27, 28].

The results of the current study indicted significant reduction of hamstring stiffness in females after MET intervention. Blackburn conducted a study to compare the impact of gender in the amount of stiffness. He concluded that stiffness was lower in females, than males in similar conditions [29]. In fact, stiffness is a biomechanical factor that its basic amount depends on different physiological differences between females and males [30].

Based on the study by Hatano, it seems that passive stiffness is related to viscoelasticity of musculotendinous unit. In fact, the passive resistance that exists due to the joint movement can be resulted from various factors, but it is mainly attributed to the elastic components around the joint [30]. Lederman stated that the viscoelastic changes on the connective tissue were responsible for the increased flexibility [26]. Therefore, it can be said that any decrease in hamstring stiffness after MET intervention can be resulted from the viscoelastic changes in musculotendinous unit [31].

On the other hand, agonist/antagonist contraction plays an effective role in increasing the overall joint stiffness [29]. Any factors reducing the co-contraction of muscles and raising relaxation can decrease stiffness. Hence, through the Golgi tendon inhibitory reflex activated by isometric contraction followed by relaxation, MET can decrease the overall stiffness [24, 25].

In addition, according to the fact that stiffness refers to resistance and necessary power against stretch [1], it can be said that the same factor causing relaxation in muscles can reduce stiffness. In the current study, stiffness test was repeated three times before and after intervention. Due to unfamiliarity of the subjects with the machine and subsequent active contraction, which occurs in the muscle, more torques were recorded, and consequently higher amount of stiffness was measured.

Therefore, it seems that MET through Golgi tendon reflex can create relaxation in hamstring and reduce the generated torque during the test [23]. It can also reduce stiffness after the intervention based on its definition, which is the ratio of torque to angular position [29]. It is recommended to consider follow-up in further studies on the effectiveness of MET on stiffness along with the effects of multi-session MET on flexibility and stiffness. The results of the current study indicated that MET may increase hamstring flexibility and decrease its stiffness in one session.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Tehran University of Medical Sciences (code: IR.TUMS.VCR.REC.1397.194). Subjects signed informed consent forms before participation in the study.

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Authors' contributions

All authors contributed in preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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