The Acute Effect of Passive and Active Stretching on Hamstring Flexibility and Surface Electromyography Activity on Students of International Islamic University Malaysia Kuantan Campus (IIUMK)

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Abstract:

Introduction: Stretching is known for its benefits in preventing sports injury due to hamstring tightness. This study aims to examine the effect of passive and active stretching on hamstring tightness by hamstring flexibility through active knee extension (AKE) and hamstring activation through surface electromyography (EMG) evaluation. **Methods:** Analyses on correlation of range of motion (ROM) through AKE and EMG were performed. 26 subjects were recruited following the inclusion and exclusion criteria. **Results**: The results demonstrated that both passive and active stretching with mean AKE measurement value of 9.63±10.37 and 9.26±7.17 degree respectively, improves hamstring flexibility, $p<0.05$. In contrast, in terms of muscle activation, there was no significance difference in passive and active stretching with mean EMG signal amplitude value of 7.19±242.03 MVIC and -5.73±208.45 respectively. The result of AKE and EMG reported no significant difference between passive and active stretching in terms of hamstring flexibility (p=0.611) and hamstring activation (p=0.259). There was no significant correlation between AKE and EMG either in passive (r=0.061) or active stretching (r=0.220). **Conclusion:** It is hoped that this study is able to bring useful insight on potential treatments for hamstring tightness in the future.

Keywords: hamstring tightness, hamstring flexibility, passive stretching, active stretching, EMG, AKE

Introduction:

Hamstring tightness is very common among men and women regardless of their age and lifestyle. Both athletes and non-athletes are prone to this condition. The inability of the muscle to deform may reduce the range of motion (ROM) thus reducing an athelete's performance (Weerasekara et al, 2013). Nevertheless, prolonged sitting among students has shown to cause significant hamstring tightness (Chellapillai et al. 2019). Thus, hamstring tightness may occur due to a variety of factors and conditions.

According to a study conducted by Koli and Anap (2018), the prevalence of hamstring tightness among 18-25 years old is higher on the right side in both males and females. Thakur and Rose (2016) also reported that in the same age group, the prevalence of hamstring tightness is higher among females. In order to prevent this condition, muscle stretching is recommended to increase hamstring flexibility. According to Page (2012), stretching is the most suggested treatment for hamstring tightness. Thus, the current study suggests performing hamstring stretching to overcome hamstring tightness as well as provide awareness on the importance of stretching.

There are three types of muscle stretching techniques: static, dynamic, and pre-contraction stretching. The most common stretching used is static stretching which can be practiced actively or passively with a partner. In conjunction with that, this study aims to determine the effects of different types of static stretching on hamstring tightness namely static-passive and static-active stretching on active knee extension (AKE) and surface electromyography (SEMG).

Materials and Methods:

Subjects

This study was conducted from February 2020 until April 2020 at the Physiotherapy Clinic at International Islamic University Malaysia, Kuantan Campus (IIUMK). This study used descriptive analysis and paired t-test to measure the effectiveness of each stretching. The sample size was calculated using the general formula by Charan and Biswas (2013). For recruitment, an advertisement was shared through Whatsapp to all IIUM students. Those who were interested were given a link for registration. Then the researcher contacted the targeted participants to make an appointment. A total of 26 respondents with hamstring tightness was selected via purposive sampling. Hamstring tightness was confirmed using the Active Knee Extension test. A 15-degree lag knee extension was considered positive for hamstring tightness. The inclusion criteria of the study were both male and female IIUMK students with no underlying medical condition such as hypertension and heart disease. Subjects having history of back pain and acute hamstring injury were also excluded in the study. The study protocol was approved by the local institution research committee (KPGRC, 01/2020) and conducted following the ethical guidelines of the Declaration of Helsinki. All subjects were given informed consent to participate in the study.

Procedures

All subjects were informed of the procedures throughout the study. Demographic data was collected at the beginning of the study. The study consisted of two sessions. In the first session, subjects did passive stretching, followed by active stretching on the subsequent week. An interval of one week was given for washout period of the first stretching (Page, 2012). The initial reading of AKE and EMG were recorded for each session and served as the control variable. Subjects were placed in the supine lying position. A standard universal goniometer was placed aligned at the lateral epicondyle of the femur with the arm positioned stationary along the femur to greater trochanter and the moving arm along the fibula to lateral malleolus. The AKE measurement was calculated from knee flexion to the terminal knee extension. The AKE test was measured and recorded in triplicate, and the mean angle of the test result was used for analysis. SEMG was used to record electrical activity in the muscle. To obtain hamstring muscle activity using SEMG, subjects were instructed to perform the MIC of the hamstring. The subject was placed in the prone lying position with approximate 90° knee flexion. By verbal cue of knee flexion, manual resistance was applied against flexion force (Marques et al., 2013). These measurements were recorded three times and the average was calculated. All of the processes were assisted by a clinician from the IIUM Physiotherapy Clinic.

Statistical Analysis

The statistical analysis was performed using SPSS Software, Statistical Package for Social Science (version 12.0.1). The prevalence of hamstring tightness was determined through descriptive analysis. The paired T-test was used to evaluate the changes on hamstring flexibility and hamstring activation after passive and active stretching while the independent T-test was used compare the effectiveness between passive and active stretching in terms of AKE and EMG. The values were considered significant at 95% confidence of interval ($p< 0.05$). Lastly, a correlation analysis test was done to see the strength and relationship between AKE and EMG after both stretching were applied.

Results:

A total of twenty-six students age group 20-25 years old (*M*= 23) participated in the study. Four of were males (15.4%) and the rest were females (84.6%). The majority of the subjects consisted of fourth year students with 13 students (50%) followed by third year students with six participants (23.1%) and second year students with seven participants (26.9%). Most of the students came from yhe Kulliyyah of Allied Health Sciences (KAHS) (96.2%) and one student from the Kulliyyah of Dentistry (KOD) (3.8%)

Table 2 shows the descriptive analysis of the mean and standard deviation result of hamstring flexibility through AKE test from the pre and post passive stretching (Pre: M = 39.26, SD = 30.37, Post: M = 29.63, *SD* = 31.98) and active stretching (Pre: *M* = 36.30, SD = 30.27, Post: *M* = 27.04, *SD* = 32.62).

In terms of comparison of pre and post, a paired *t*-test was used to analyze hamstring flexibility for both types of stretching (Table 3). There was a significant difference between the before and after AKE measurements for both the passive and active stretching in terms of hamstring flexibility, *t*(0.001), $p < 0.05$. This showed that both passive and active stretching improved hamstring flexibility.

The second objective of the study was to evaluate the effect of passive and active stretching on hamstring muscles by SEMG., The same descriptive analysis was used to analyze the hamstring muscle activity. The data was collected and analyzed to obtain the mean and standard deviation of the group. To clarify, the outcomes of this study resulted in the mean and standard deviation value of the hamstring signal amplitude during MIC. As shown in Table 4 below, the mean and standard deviation of muscle activity during MIC passive stretching was, Pre: 39.26±30.37, Post: 29.63±31.98, and Pre: 36.30±30.27, Post: 27.04±32.62 for active stretching.

To compare the pre and post of both stretching on hamstring activation, the data collected from the EMG reading was analysed using the paired *t*-test (Table 5). The *p*-value for this paired *t*-test for passive (*M*=7.19±242.03) and active stretching (*M*=-5.73±208.45) was 0.881 and 0.890 respectively, p>0.05. Therefore, there was no significant difference between passive and active stretching in terms of hamstring muscle activation. In conclusion, this proves that there was no difference in terms of hamstring muscle activation before and after passive and active stretching.

The third objective was to identify the efficacy of both passive and active stretching in terms of hamstring flexibility (AKE) and hamstring activation (EMG). An independent *t*-test was run and the results shown (Table 6). In terms of hamstring flexibility, with 95% confidence interval, the mean of passive and active stretching was 9.62±8.71 and 9.62±7.06 respectively. The *p*-value was 0.611, thus, no significant differences were noted in passive and active stretching with regards to AKE measurement (Table 6).

An independent *t*-test was done to see the effectiveness of passive stretching (-63.08±258.55) and active stretching (5.73±208.45) in terms of muscle activity through surface electromyography (EMG). With 95% confidence interval, the *p*-value was 0.259

Table 1 Demographic characteristic of participants (n = 26)

Variables		**N (26)**	**%**
Gender	Male	4	15.4
	Female	22	84.6
Year of study	4	13	50
	3	6	23.1
	2	7	26.9
Kuliyyah	Allied Health Sciences (KAHS)	25	96.2
	Dentistry (KOD)	1	3.8

Table 2 The frequency, mean and standard deviation of AKE on pre and post passive and active stretching (n=26)

Active Knee Extension (AKE)		**Frequency**	**Mean**	**SD**
Passive	Pre	26	39.26	30.37
	Post	26	29.63	31.98
Active	Pre	26	36.30	30.27
	Post	26	27.04	32.62

Table 3 The comparison between AKE measurement value of passive and active stretching (n=26). * indicate the data is significant when p < 0.05.

Stretching	**Mean**	**SD**	**Mean Difference (95%) CI**	***p*-value**	**T-statistic**
Passive	9.63 *	10.37	2.00 (5.53, 13.73)	<0.001	4.83
Active	9.26	7.17	1.38 6.42, 12.09)	<0.001	6.71

Table 4 The frequency, mean and standard deviation of EMG on pre and post passive and active stretching

Electromyography (EMG)		**Frequency**	**Mean (MVIC)**	**SD**
Passive	Pre	26	801.04	398.81
	Post	26	793.85	335.37
Active	Pre	26	763.73	387.86
	Post	26	769.46	349.62

thus, there was no significant difference between passive and active stretching on hamstring activation, $p > 0.05$ (Table 7).

Spearman's Rank-Order Correlation was conducted to analyse the possible relationship between AKE and EMG for both passive and active stretching. The analysis revealed no significant correlation between AKE and EMG, for passive and active stretching, r = 0.061, p-value = 0.769 and r = 0.220, p-value = 0.281 respectively (Table 8).

Table 5 The comparison between EMG signal amplitude of passive and active stretching (n=26)

Stretching	Mean (MVIC)	SD	Mean Difference (95%) CI	p-value	T-statistic
Passive	7.19	242.03	47.47 (-90.56, 104.95)	0.881	0.152
Active	-5.73	208.45	40.88 (-89.93, 78.46)	0.890	-0.140

Table 6 The efficacy of passive and active stretching in terms of hamstring flexibility (AKE) (n=26)

Stretching	Mean	SD	Mean Difference (95%) CI	p-value
Passive	9.62	8.71	2.20	0.611
Active	9.62	7.06	(-4.42, 4.42)	

Table 7 The efficacy of passive and active stretching in terms of hamstring activation (EMG) (n=26)

Stretching	Mean (MVIC)	SD	Mean Difference (95%) CI	p-value
Passive	-63.08	258.55	-68.808	0.259
Active	5.73	208.45	(-199.63, 62.02)	

Table 8 The correlation of AKE and EMG in passive and active stretching (n=26)

		AKE	EMG
Passive	Correlation coefficient	1.000	0.061
	Sig (2-tailed)		0.769
	N	26	26
	Correlation coefficient	0.061	1.000
	Sig (2-tailed)	0.769	
	N	26	26
Active	Correlation coefficient	1.000	-0.220
	Sig (2-tailed)		0.281
	N	26	26
	Correlation coefficient	-0.220	1.000
	Sig (2-tailed)	0.281	
	N	26	26

Discussion:

In this study, there was a significant difference between the before and after passive and active stretching. Thus, stretching was found to give an acute effect to hamstring flexibility. This result is supported by the findings of the study by Weijer, Gorniak, and Shamus (2003), where it was reported that stretching produced a large immediate increase of muscle flexibility in their stretch and warm-up-stretch groups. Previously, Verrall et al. (2001) reported that muscle weakness, poor warm-up, increase muscle stiffness, lack of flexibility, muscle fatigue and poor lumbar posture were some common causes for a hamstring strain. Both passive and active stretching improved hamstring flexibility and should be implemented by athletes and non-athletes before to prevent hamstring strain.

In terms of flexibility, there was no significant difference between passive and active stretching applied to the subjects. Both types of stretching yielded the same effects to hamstring flexibility. Similarly, Nakao et al (2018) found that despite improving maximum muscle flexibility of the hamstring, there was no significance difference between passive and active stretch procedure. However, the difference between the two studies was that the current study compares hamstring flexibility between subjects whereby previous studies compared hamstring flexibility within subjects. Nakao et al. (2018) added that the amount of collagen fibers of the fascia differed between subjects thus leading to differences in hamstring extensibility. Another previous study by Nishikawa et al. (2015) reported that both passive and active stretching helped to improve hamstring flexibility whereby passive stretching showed slightly higher improvements compared to active stretching. According to the author, this was due to posture during active stretching. At the 10-second hold, there was a simultaneous contraction of agonist and antagonist muscles without antagonist suppression of the γ impulses. So, the subjects did not experience antagonist muscle relaxation which affected the degree of stretch stimulation in active stretching. Thus, passive stretching was found to be more effective compared to active stretching. This study practiced the 30-second hold during the active stretching to make sure the hamstring muscle stretched perfectly. According to Page (2012), static stretching was effective at increasing ROM between 15 and 30 seconds. Less than 15 second, the stretching will not affect hamstring extensibility.

Hamstring activation using SEMG showed no significant results. Similar to AKE, in terms of hamstring flexibility, there were no significant difference between passive and active stretching. In Nakamura and Kodama's (2014) study, active stretching did improve muscle flexibility but decreased the muscle output. However, this study only used isokinetic dynamometer to evaluate the muscle output. The current study used SEMG to study the effect of stretching to muscle tension or muscle activation and revealed that active stretching did not reduce muscle activation. No previous studies have investigated the correlation between muscle flexibility and muscle activation. In this study, no significant correlation was found between AKE and EMG.

Conclusion:

Based on the measurements of AKE and the reading of EMG, among IIUMK students, the findings showed that both stretching improved hamstring flexibility. However, in terms of hamstring activation, there was no change after both passive and active stretching were applied. In terms of effectiveness between the two types of stretching, this study proved that there was no significant difference between passive and active stretching to hamstring flexibility and hamstring activation. So, it can be concluded that both stretching is indeed effective to improve hamstring flexibility and hamstring activation, but between the active and passive stretching, no type was better than the other. In terms of correlation, there was no correlation between AKE and EMG neither in passive nor active stretching. This finding can be utilized by clinicians, physiotherapist, fitness trainers and athletes as a precaution especially prior to exercises to avoid any injury during activity. Besides, this stretching also can be used as treatment post exercises to regain normal muscle condition. An exercise with an optimum stretching may gave a better result to muscle condition and performance in terms of better muscle flexibility and muscle activation status.

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