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Original Article

No significant correlation between the intensity of static stretching and subject's perception of pain

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Abstract. [Purpose] The purpose of this study was to determine whether the intensity of static stretching measured quantitatively is related to subjects' perception of pain. [Subjects and Methods] Sixty-eight participants were recruited. Static stretching was performed once for 30 seconds while maintaining the knee at 0° flexion and was continued to the point where pain was recognized. The intensity of stretching exerted by the practitioner was quantitatively measured by using a handheld dynamometer (HHD). A subject's pain scaled on one's perception was measured by using the visual analog scale (VAS). [Results] No significant correlation was found between the intensity of stretching and the VAS score representing the subject's pain scaled on one's perception. In this study, the most frequent VAS score was 7, and the mean VAS score was 5.57 ± 1.77. The stretching intensity measured by using a HHD ranged from 28.4 to 133.0 N (mean, 72.04 ± 22.37 N). [Conclusion] This study showed that the intensity of stretching quantitatively measured by using HHD did not correlate with the degree of pain reported by the subjects. Therefore, subjective responses cannot guarantee a consistent application of intensity.

Key words: Dynamometer, Pain, Stretching

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INTRODUCTION

Muscle strain injuries are common in sports athletes, who demand intensive performance during a short period of athletic competition. Lower extremities have been shown to be at a higher risk of muscle strain injury than are upper extremities, with the hamstring muscles being the most commonly injured muscles in the lower extremities. Flexibility is central to reducing strain injuries and enhancing physical performance. Currently, various stretching techniques, such as static, dynamic, and proprioceptive neuromuscular facilitation, have been used to maintain or improve flexibility[1–3)].

It is known that static stretching maintains normal muscle length, prevents muscle stiffness, decreases risk of overuse injury, and enhances physical performance[4, 5)]. However, the positive effects of stretching are not guaranteed if it is not performed with the proper intensity by a skilled practitioner. Despite this importance, only limited studies have examined the difference in effect according to intensity[6, 7)].

In most cases, the intensity of stretching is not precisely described or is simply stated. In previous studies that have stated the intensity, the subject is instructed to stretch the muscle to the point of discomfort or just before discomfort is felt[7, 8)]. In some cases, the leg is extended until the moment when tightness or noticeable tension is recognized without pain[4, 9, 10)] or it is performed until the pain is recognized[11)]. In conclusion, previous studies have employed a model wherein the practitioner observes the subject's response and adjusts the intensity of stretching based. In practice, however, the intensity is also

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regulated by a practitioner's judgment based on the amount of resistance, which is the result of passive viscoelastic resistance and active contractile components, felt at the end of the range of motion. Despite the importance of applying appropriate strength to achieve the effect of stretching, it relies on the two above mentioned subjective factors (one from the subject and the other from the practitioner), which are not being measured quantitatively, and the subject's response is a major factor that determines the intensity of stretching performed during the experimental studies.

The purpose of this study was to determine whether the intensity of static stretching measured quantitatively is related to subjects' perception of pain.

SUBJECTS AND METHODS

Sixty-eight participants (45 males and 23 females, 20.6 ± 2.1 years, 171.0 ± 9.2 cm, 70.5 ± 13.4 kg) were recruited in this study. Subjects with a previous history of trunk, hip and/or lower extremity injury or any other significant disorder were excluded. This study was approved and monitored by the Institutional Review Board of Woosong University (1041549-161115-SB-34). Informed consent was obtained from all subjects prior to participating in the study.

Subjects were in the supine position with the hip and knee at 0° of flexion on a treatment table. Static stretching was performed once for 30 seconds while maintaining the knee at 0° of flexion. During stretching, contralateral lower extremity was secured on the treatment table by the belt. Static stretching was continued to the point where a pain was recognized. The intensity of stretching exerted by the practitioner was quantitatively measured by a hand-held dynamometer (HHD) (Micro-FET3, Hoggan Health Industries Co., UT, USA). The HHD was placed on the subject's heel while stretching was performed, and a value was displayed on the digital screen during stretching, which was recorded as the intensity of stretching[12]. The subject's experience of pain was self-reported using the visual analog scale (VAS), which ranged from "0: no pain" to "10: worst pain[13]." The intensity of static stretching measured by a HHD was compared with the subject's pain scaled on one's own perception using VAS. Data analysis was performed using IBM SPSS Statistics 23 (IBM Corp., Armonk, NY, USA). Spearman's rank order correlation coefficient was computed to quantify the relationship between the intensity of stretching and VAS. Statistical significance was assumed when $p<0.05$. All values are presented as the mean ± standard deviation.

RESULTS

The analysis yielded no significant correlation between the intensity of stretching and VAS representing the subject's pain scaled on one's own perception (Spearmans's rho=−0.084, p=0.497). The average of the VAS recorded in this study was 5.57 ± 1.77. The highest frequency of the VAS score was observed at 7 (eighteen subjects), while sixteen subjects reported their VAS score as 6. All VAS scores, except from 10, were reported (Table 1). The stretching intensity measured by HHD was ranged from 28.4 N to 133.0 N and the average was 72.04 ± 22.37 N. Among the ten sections, the highest frequency of stretching intensity was observed at the fourth section, ranging from 59.8 to 70.2 N (Table 2).

DISCUSSION

Numerous studies have shown static stretching technique before exercise improves the joint range of motion and physical performance, and reduces the risk of musculoskeletal injury. In sports and in clinics, the intensity of static stretching can be strongly influenced by two subjective factors: the subject's perception for pain and practitioner's experience. This study determined whether the intensity of stretching is related to the subject's perception of pain. According to the results, there

Table 1. The frequency of subjects and subject's pain scaled on one's own perception

	Visual analogue scale									
	1	2	3	4	5	6	7	8	9	10
Number of subjects (n)	1	2	8	9	7	16	18	6	1	0
% of total (%)	1.47	2.94	11.76	13.24	10.29	23.53	26.47	8.82	1.47	0.00

Table 2. The frequency of subjects and the intensity of stretching measured by hand-held dynamometer

	Intensity of stretching (N)									
	28.4–38.9	38.9–49.3	49.3–59.8	59.8–70.2	70.2–80.7	80.7–91.2	91.2–101.6	101.6–112.1	112.1–122.5	122.5–133.0
Number of subjects (n)	3	7	9	16	12	8	6	3	2	2
% of total (%)	4.41	10.29	13.24	23.53	17.65	11.76	8.82	4.41	2.94	2.94

was no significant correlation between them. That is, subject's perception might be too subjective to use as a deciding factor for determining the intensity of stretching. Additionally, a wide range of the intensity of stretching observed in this study may indicate the difficulty of applying constant intensity of stretching to different people each time.

No significant relationship between the intensity exerted by the practitioner and VAS scores representing the degree of subject's pain was observed in this study. During stretching, a practitioner decides whether to increase or decrease intensity based on the subject's response to pain. If the subject has a large appeal for discomfort at the start of stretching, the intensity of stretching can be too weakly applied to the subject. The problem is each person has a different sensory threshold for pain and stretch threshold can be variable[6, 14]. The perception of pain is highly sensitive and does not correlate with the amount of nociceptive stimulation[15]. This can be exacerbated by negative feelings, such as anxiety by hippocampal activation[16, 17]. Furthermore, subjects, even young and healthy subjects, can react differently on the day of experiment depending on their physical condition. Thus, it is difficult to maintain a constant intensity of stretching if a practitioner solely relies on the response of the subject. In conclusion, the subject's response might be insufficient to use as a factor to decide the intensity of stretching.

According to VAS scores, subjects tend to tolerate mild pain during stretching. Fifty percent of subjects participated in this study reported their VAS score as 6 or 7. That is, despite having instructed to stop when pain was experienced, many people exhibited a sense of discomfort, even when only moderate pain was felt. Depending on the person, the same instruction might be interpreted differently[6]. Notably, patients can exaggerate their level of actual pain because expressing the degree of pain does not indicate the amounts of actual pain. VAS scores varied from 0 to 9 might indicate various person characteristics of recognizing and expressing pain.

The intensity of stretching varies from 28.4 to 133.0 N. A practitioner decides the intensity of stretching based on the subjective experience. Therefore, an unwanted high-intensity of stretching or a low intensity can be performed, depending on subjects. Excessive stretching beyond normal intensity potentially induces tissue damages and/or neural changes. Askling and colleague reported that 88% of dancers who required high intensity of stretching experienced acute strain injury of the rear thigh muscles[18]. Additionally, maximally tolerable high-intense stretching decreases voluntary strength following impaired muscle activation and contractile force[19]. On the contrary, if it is too weak, stretching will not make significant changes to soft tissues and muscles[20, 21]. The quantitative measure of stretching intensity and monitoring its value during stretching might help to avoid stretching-induced tissue damage and properly produce stretching.

This study had the following limitations. This study included only healthy young adults. Therefore, findings might not be generalizable to other age groups or to individuals with diseases or disabilities. In addition, the results were limited to only hamstring muscles. Last, a further longitudinal investigation is needed to measure the changes in hamstring muscles since this study did not perform an examination to confirm the effect of stretching on the flexibility of the hamstring muscles.

Most studies have aimed to determine the most appropriate types of stretching and parameters involving frequency and duration. There are very few studies that have examined the actual intensity of stretching. Excessive stretching may induce severe strain injuries, thereby resulting in irreversible tissue damage or insufficiently weak stretching that may not be able to result in stretching. This study showed that the intensity of stretching quantitatively measured by HHD did not correlate with the degree of pain that were reported by subjects. The subjective responses cannot guarantee a consistent application of intensity. The intensity of stretching needs to be quantitatively measured and monitored during stretching.

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