J. Phys. Ther. Sci.
26: 1419–1421, 2014

Original Article

The Affect on Delayed Onset Muscle Soreness Recovery for Ultrasound with Bee Venom

Seung Kyun Kim, MS, PT[1)], Myung Chul Kim, PhD, PT[1)*]

[1)] *Department of Physical Therapy, Faculty of Health Science, Eulji University: 212 Yangji-dong, Sujeong-gu, Seongnam-si, Gyeonggi-do 461-815, Republic of Korea*

Abstract. [Purpose] The purpose of this study was to evaluate whether ultrasound alone or ultrasound with bee venom is effective in treating delayed onset muscle soreness of the biceps brachii muscle, using the visual analogue scale, range of motion test (flexion and extension), and serum creatine kinase level. [Subjects] Twenty women participated in this study. [Methods] Repeated eccentric contractions were used to induce delayed onset muscle soreness in the elbow flexor of the subjects. The subjects were randomized to be treated with ultrasound alone or ultrasound with bee venom. We evaluated the effects of treatments in the 2 groups. Individual subjects were assessed using the visual analogue scale, range of motion test, and serum creatine kinase level. The assessment parameters were evaluated 4 times: before exercise and 24, 48, and 72 hours after exercise. [Results] The visual analogue scale scores were significantly different before and after the experiment in both the group treated with ultrasound and the group treated with ultrasound and bee venom. The difference in elbow flexion and extension before and after the experiment was significantly different in both groups. No significant difference was found in the serum creatine kinase levels before and after the experiment. [Conclusion] Treatment with ultrasound and bee venom is effective for managing delayed onset muscle soreness.

Key words: Eccentric exercise, Bee venom, Ultrasound

(This article was submitted Dec. 9, 2013, and was accepted Mar. 15, 2014)

INTRODUCTION

People enjoy sports and leisure activities, but using muscles for long periods of time causes muscle soreness. Delayed onset muscle soreness (DOMS) is pain and stiffness felt in muscles several hours after resistance movement or unaccustomed, strenuous exercise. The soreness is felt most strongly 24 to 48 hours after the exercise[1, 2)] and is thought to be caused by eccentric (lengthening) exercise. DOMS is thought to be caused by neuromuscular dysfunction, such as shortened muscle length or limited range of motion (ROM) in terms of the physiological response to muscle injury. It has been attributed to the increased tension force and muscle lengthening from eccentric contraction rather than from concentric contraction[3)]. In DOMS, injury of the muscle and connective tissue affects ROM and serum creatine kinase (CK) levels[3, 4)]. The activity of muscle enzymes in blood is a useful indicator to evaluate the stress exerted with exercise. The enzyme CK is assayed in blood tests as a marker[5)]. In the study of Child and Jacobs et al., exercise was performed by 14 healthy subjects who repeated 3 sets of the exercise 10 times at 80% of maximum strength for 7 days. It was reported that the level of CK was highest at 48–72 hours after eccentric exercise[6)].

Many treatments have been used for DOMS. With regard to physical and kinematic approaches of stretching[7)], sonophoresis with ultrasound[8)] has been used for DOMS. Low-intensity ultrasound has been reported to be effective for reducing pain and swelling and for increasing the range of movement in damaged skeletal muscles[9, 10)].

To date, many studies have analyzed the clinical application of ultrasound to infiltrate various drugs through the skin[11)]. In a recent study, mixed local anesthetic and anti-inflammatory agents were used to reduce inflammation and pain[12)].

In Oriental medicine, bee venom (BV) is used as a local anesthetic and anti-inflammatory agent. Injecting BV into tissue can control inflammation and pain while reinforcing immunity. BV has the unique pharmacological function of stimulating the immune system as a biochemical foreign body[13)].

The main ingredients of BV are various enzymes, peptides, and low-molecular-weight organic substances (non-peptide substances). The main peptides in BV are melittin, apamin, and adolapin, and they have powerful anti-inflammatory and analgesic functions[13)]. Local analgesic and anti-inflammatory factors are activated in lesions by injecting BV, as the level of cortisol in blood is elevated and the biosynthesis of prostaglandin is inhibited[14)]. Doyle[15)] reported that BV had both anti-inflammatory and analgesic actions.

In those respects, the present study was aimed at verify-

*Corresponding author. Myung Chul Kim (E-mail: ptkmc@eulji.ac.kr)

ing the effectiveness of using ultrasound with BV for treatment of DOMS.

SUBJECTS AND METHODS

The subjects in this study were adult women who were 21 to 34 years old and worked in J hospitals. They were randomized into those who were treated with ultrasound and bee venom (the BVUS group; n = 10) (M±SD age 27.42±2.57 years, height 159.71±3.25 cm, weight 48.42±2.99 kg) and those who were only treated with normal ultrasound (the US group; n = 10) (M±SD age 28.85±3.62 years, height 160.71±6.10 cm, weight 50.71±5.79 kg). The women participated voluntarily and fully understood the purpose of this study. None of the subjects performed any heavy exercise for their upper extremities or were on any medication for 1 month prior to the study. They had no skeletal and neuromuscular dysfunction, no upper extremity pain or open wounds, and no history of neurosurgery or psychiatric disorders, and had a normal response in an allergic reaction test to BV. This study was approved by the Ethics Committee of the Eulji University Graduate School of Health Science.

For BV allergy testing, 0.05 mL of diluted BV (a ratio of BV:saline=1:1000) was injected intradermally into the forearm. After verification that the tested lesion resulted in a wheal with a diameter of less than 10 mm and erythema with a diameter of less than 26.5 mm after 10 to 15 minutes, subjects were cleared to participate in this study[16].

First, the maximum load for each subject was investigated for the elbow flexor using 1-repetition isometric maximum exercise. Subjects then performed eccentric resistance exercises with 70% of the 1-repetition isometric maximum (e.g., maximum load 5 kg × 7/10 = 3.5 kg). The exercises were performed 7 times with 10 repetitions, and the subjects took a break time for one minute per exercise[17]. This unit of exercise was designated 1 bout. If the muscle fatigue does not occur after repeating 1 bout, the exercise was repeated until the subjects could not exercise due to muscle fatigue. The subjects were excluded from all exercise and treatment for 24 hours after eccentric exercise of the biceps brachii muscle.

Ultrasound was applied to the belly of the biceps brachii muscle at a frequency of 1 MHz, intensity of 1.0 W/cm^2, and speed of 2.5 cm/s for 10 minutes in each session. As a coupling medium, ultrasound gel and diluted bee venom (0.001%) mixed at a ratio of 9:1 was used for the experimental group, and pure ultrasound gel was used for the control group. Ten milliliters of coupling medium was used in both groups. For this research into the impact of the treatment on DOMS, the VAS, ROM (elbow flexion and extension), and CK level were measured as the assessment parameters just before exercise and 24, 48, and 72 hours after exercise.

SPSS 18.0 was used for statistical analysis. The data were analyzed by repeated measures ANOVA to compare time following exercise in each group and the independent t-test to compare differences between pre- and post-measurement values in both groups. The level of statistical significance α was 0.05.

RESULTS

The VAS was significantly different after the experiment compared with before the experiment in both the US and BVUS groups ($p<0.05$), and there was a significant difference at 72 hours between the 2 groups using the independent t-test ($p<0.05$) (Table 1). The CK level was not significantly different before and after the experiment in both the US and BVUS groups ($p>0.05$). There was no significant difference in CK level using the independent t-test ($p>0.05$) between the 2 groups up to 72 hours (Table 1). Elbow flexion was significantly better after the experiment than before the experiment in both the US and BVUS groups ($p<0.05$), and there was a significant difference between the 2 groups at 48 and 72 hours using the independent t-test ($p<0.05$) (Table 1). Elbow extension was significantly better after the experiment than before the experiment in both the US and BVUS groups ($p<0.05$), and there was a significant difference between groups at 24 and 48 hours using the independent t-test ($p<0.05$) (Table 1).

DISCUSSION

Induced eccentric contraction is used in research simulating DOMS, because eccentric contraction in muscle is related to muscle rupture[18]. Eccentric contraction can be classified as extensible training. The reduction of locomotion caused by muscle flexibility training can last up to 4 days, and it can reach 80% of the normal level of function[19].

Craig et al.[20] reported that ultrasound significantly improved elbow flexion but had no impact on pain threshold and pain index in a study comparing elbow flexion and extension, mechanical pain threshold, and the pain index.

In this study, the reduction in pain (VAS) was significant ($p<0.05$) at 72 hours after the exercise in the US and BVUS groups. In addition, the reduction in pain was more significant in the BVUS group than in the US group due to absorption of BV. Melittin and apamin are thought to reinforce immunity with powerful anti-inflammatory and analgesic actions based on a mechanism of infiltration through intercellular lesions.

In the range of measured movements, the BVUS treatment showed significant improvement in not only elbow flexion but also elbow extension. In contrast to the study by Craig et al.[20], BVUS improved articular movement and reduced pain. Potteiger[21] reported that the level of CK significantly increased 24 hours after exercise and was a marker of muscle damage.

The level of serum CK was significantly elevated after maximum eccentric exercise of the biceps followed by a break for 24 h. This result suggested that DOMS may have been induced in the biceps, and the level of serum CK when sampled at 72 h was about 8,000 U/L.

Previous studies with ultrasound reported that ultrasound treatment with piroxicam gel was effective for recovery from muscle injury induced by eccentric exercise[22]. Hoogland[23] reported that sonophoresis with ultrasound at a frequency of 1 MHz could penetrate soft tissue to about 9 to 50 mm and that a frequency of 3 MHz could penetrate to about 2 to 16.5 mm. Based on Hoogland's[23] study, we

Table 1. A comparison of VAS, CK and elbow ROM change between the US group and BVUS group

		US group	BVUS group
VAS (score)	Pre	0.00	0.00
	After 24 h	8.40±0.59[b]	8.60±0.50
	After 48 h	7.91±0.44	8.10±0.62
	After 72 h	6.67±0.62	5.26±0.60[†]
CK (unit: U/L)	Pre	100.00[a]	100.00
	After 24 h	1883.8±393.9[b]	1663.4±248.4
	After 48 h	3340.1±287.4	3231.1±426.1
	After 72 h	8821.3±1157.2	7698.0±1115.1
Flexion (angle)	Pre	100.0[a]	100.0
	After 24 h	87.8±3.8[b]	90.8±3.1
	After 48 h	84.9±1.9	87.7±1.5**
	After 72 h	88.3±4.1	93.4±3.9*
Extension (angle)	Pre	100.0[a]	100.0
	After 24 h	77.5±2.0[b]	82.0±1.2[†]
	After 48 h	76.2±2.2	81.6±2.6[†]
	After 72 h	78.6±2.2	81.7±4.2

US, ultrasound; BVUS, bee venom ultrasound; VAS, visual analogue scale; CK, creatine kinase. [a]Normalization. [b]Mean ± SD. * $p<0.05$; ** $p<0.01$; [†]$p<0.001$

concluded that ultrasound at a frequency of 1 MHz in this study was effective enough for soft tissue when used with the BV coupling medium. In particular, the application of ultrasound with the BV coupling medium was effective for pain reduction (measured using the VAS) and recovery of flexion and extension impairment caused by DOMS. In addition, BVUS did not lower the serum CK level, but the CK level was lower at 72 hours after the exercise in the BVUS group than in the normal US group.

For recovery from DOMS, BVUS in conjunction with other physical and kinematic interventions is an effective procedure for pain relief and improving the mobility of muscle.

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