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Original Article

Analysis of electromyographic activities of the lumbar erector spinae caused by inversion traction

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Abstract. [Purpose] The purpose of this study was to analyze changes in the electromyographic activities of the lumbar erector spinae caused by inversion traction in order to verify the relaxation effect. [Subjects and Methods] The subjects included 60 healthy male adults who were equally and randomly assigned to a 30–30° group, a 30–60° group, and a 60–60° group. Inversion traction was performed for six minutes, and the electromyographic activities of the lumbar erector spinae (L2, L4) were measured before and after inversion traction. [Results] The root mean square values at the L2 and L4 levels on both sides were statistically significantly higher after inversion traction compared with before inversion traction. Before inversion traction, the root mean square values at the L2 and L4 levels on both sides in the 30–60° group and 60–60° group were significantly higher than those in the 30–30° group, while the root mean square values at the L2 and L4 levels on both sides showed no significant differences between the groups before inversion traction. [Conclusion] The findings of this study indicated that IT is more likely to elicits an increase in muscle tension and prevent relaxation of the lumbar erector spinae.

Key words: Inversion traction (IT), Muscle tension, Traction angle

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INTRODUCTION

Inversion traction (IT) is a form of spinal traction in which the body is maintained in an inverted position so that back problems can be prevented and cured[1)]. Specifically, IT provides the spinal column with traction force using the body's weight. The force of the body's weight in the IT position is usually calculated as approximately 40% of the body's overall weight[2)]; this depends on the user's body weight and the traction angle. Unlike automated mechanical traction, it is difficult in the case of IT to adjust the traction force because the traction angle is set by the users themselves. Thus, IT places excessive traction force on the spinal column.

In the IT process, the paraspinal muscles are generally stretched as the spinal column is lengthened. The muscle spindles arranged parallel to the muscle fibers are then stretched, and α-motor neurons are stimulated by the stretch stimulus signal from the muscle spindles through the Ia and II sensory nerves. Consequently, muscle contraction or tension is elicited. Although muscle tension works as a muscle guard to protect the muscles, persistent muscle guarding restricts blood flow and causes muscle fatigue[3)]. The accumulation of metabolic waste also leads to muscle pain[4)]. Thus, it is expected that IT will trigger back pain.

Recently, Wang et al.[5)] reported that IT causes muscle fatigue in the lumbar erector spinae. It can be deduced from this finding that IT prevents the lumbar erector spinae from relaxing. However, the study of Wang et al.[5)] did not provide any information on IT in the case of inversion above 30°, mainly because IT was performed at an inverted angle below 30° in the study. Moreover, previous studies insisting that IT helps to relax the lumbar erector spinae are controversial[6, 7)]. However,

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there is no doubt that IT can prevent relaxation of the lumbar erector spinae. In a study by Vernon et al.[6] on IT, 19 subjects showed increased paraspinal electromyographic activity.

Accordingly, the current study analyzed the electromyographic activities of the lumbar erector spinae resulting from the application of an IT traction angle of over 30°. Based on the results, we investigated whether IT can help in the relaxation of the lumbar erector spinae.

SUBJECTS AND METHODS

In this study, the subjects comprised 60 healthy male adults with no history of musculoskeletal or neurological system disorders. The mean age, weight, and height of the subjects were 23.02±2.10 years old, 70.77±10.14 kg, and 174.28±5.95 cm, respectively. All subjects were equally and randomly assigned to a 30–30° group, a 30–60° group, and a 60–60° group depending on the angle of IT applied. All the subjects listened to a detailed explanation about the study's methodology, safety matters concerning the progression of the study, and bio-information protection before voluntarily consenting to participate in the study. This study was approved by the bioethics committee of the Catholic University of Pusan (CUPIRB-2015-027).

IT was performed as follows. The subjects were positioned horizontally on a table-form IT device (TB2015-H1, THE BAN, Namyangju, Republic of Korea) and remained resting in a supine position for 10 minutes. After resting, the subjects' muscle activity was measured for three minutes. IT was then performed using various methods depending on the group. For example, in the case of the 30–60° group, IT was first performed at 30° of inversion for three minutes, followed by a further three minutes at 60°of inversion. Inversion was performed on the 30–30° group and the 60–60° group in the same way. To evaluate the muscle activities of the lumbar erector spinae, electromyographic signals were collected at a sampling rate of 1,000 Hz using an electromyography system (LXM3204, LAXTHA Inc., Daejeon, Republic of Korea). The root mean square (RMS) values were calculated using the TeleScan software (LAXTHA Inc., Daejeon, Republic of Korea) after being processed with a 60 Hz notch filter and a 50–500 Hz band-pass filter. The muscles were the lumbar erector spinae on both sides of the lumbar spine (L2, L4)[8].

Statistical analyses were then conducted using the SPSS version 12.0 software. The paired t-test was used to compare the significance of the differences in RMS values between the pre-IT and post-IT values. One-way ANOVA and Scheffé's post hoc test were used to compare the significance of the differences in RMS values between the groups. The significance level was 0.01.

RESULTS

The RMS at the L2 and L4 levels on both sides were statistically significantly higher after IT compared with before IT ($p<0.01$). After IT, the RMS values at the L2 and L4 levels on both sides in the 30–60° group and 60–60° group were significantly higher than those in the 30–30° group ($p<0.01$). Before IT, there were no significant differences between the groups in terms of RMS values at the L2 and L4 levels on both sides (Table 1).

DISCUSSION

Inversion traction is a widely used conservative treatment for low back pain conditions (e.g., degenerative or herniated discs, spinal stenosis, or other spinal conditions). IT provides pain relief, muscle relaxation, and distraction of vertebral

Table 1. Changes in RMS values after IT

	Group	Before IT	After IT
L2 Left (μV)	30–30°*	5.31±2.08	7.85±3.50^{a}
	30–60°*	5.65±1.84	12.70±4.15^{b}
	60–60°*	5.50±2.02	12.17±5.79^{b}
L2 Right (μV)	30–30°*	6.87±3.05	8.99±3.66^{a}
	30–60°*	6.44±1.21	13.05±3.63^{b}
	60–60°*	6.61±1.71	12.46±4.73^{b}
L4 Left (μV)	30–30°*	4.18±1.66	7.04±3.59^{a}
	30–60°*	4.38±0.78	11.78±3.85^{b}
	60–60°*	5.06±2.42	11.49±5.44^{b}
L4 Right (μV)	30–30°*	6.13±2.15	8.36±3.53^{a}
	30–60°*	5.95±1.10	12.14±3.53^{b}
	60–60°*	6.20±1.70	11.24±3.80^{b}

*$p<0.01$, Values with different letters in a column are significantly different by Scheffe's test

column[1, 6]. However, the paraspinal muscles generally provided resistance against spinal traction. A traction force of at least 25% of the body's weight is necessary to achieve distraction of the lumbar vertebrae against muscular resistance[9]. The force of IT applied is usually approximately 40% of the overall body weight[2]. The applied traction force places a direct stretching load on the paraspinal muscles, and this load elicits increasing muscle tension. Our study also produced a similar result, and we verified increased muscle activities of the lumbar erector spinae after IT. This signified that muscle tension persisted even after IT[10]. These results concur with those of a study by Wang et al.[5] showing that IT causes muscle fatigue. Although the study by Wang et al.[5] only examined an IT angle of less than 30°, it was clear from our study that IT cannot help to achieve relaxation of the lumbar erector spinae in our study. However, previous studies have clearly stated that IT can help with relaxation of the lumbar erector spinae[6, 7]. In addition, these studies noted that IT decreases electromyographic activities of the lumbar erector spinae, but this was not found in our study. Moreover, the previous studies measured electromyographic activities during IT, and this was the reason why the electromyographic activities were considered to have decreased. During the process of IT, the sustained stimulus induces accommodation. The induced accommodation, in turn, affects the response of the stretching load, and electromyographic activities decrease as time passes. For these reasons, it may appear as though muscle tension has decreased.

In this study, we compared the RMS values after IT with the RMS values before IT in order to examine changes in muscle tension. This method was used in a study by Acedo et al.[11], and like that study, we were able to obtain results showing changes in muscle tension. Moreover, we obtained another interesting result. After IT, the RMS values of the lumbar erector spinae in the 30–60° group and 60–60° group were higher than those in the 30–30° group, and there was no difference between the 30–60° group and the 60–60° group. In other words, muscle tension increased by IT was affected by the size of the traction angle rather than the process of traction angle application. In a study by Cholewicki et al.[12], there was no difference between the electromyographic activities of the lumbar erector spinae during several types of traction, when the same peak torque was applied by spinal traction. The results of their study were similar to those of our study. In the case of IT, the traction force depended on the user's body weight and on the traction angle. Accordingly, IT was affected by the size of the traction angle rather than the process of traction angle application. Therefore, the size of the traction angle should be fully taken into account and applied very carefully in prescribing IT.

In this study, the subject was comprised of healthy male adults, so the results of this study were limited to a healthy population. However, muscle tension will be increased by IT in any other population, as IT also lengthens paraspinal muscles in any other population. The aspects of the change in muscle tension will be different depending on the pathological symptoms or conditions of the subject. Therefore, we suggest that IT need not be applied if it does not aid in the relaxation of the lumbar elector spinae.

REFERENCES

1) Prentice WE: Therapeutic modalities in rehabilitation. McGraw Hill Professional, 2011.
2) Klatz R: Effects of gravity inversion on hypertensive subjects. Phys Sportsmed, 1985, 13: 85–89.
3) Simons DG, Mense S: Understanding and measurement of muscle tone as related to clinical muscle pain. Pain, 1998, 75: 1–17. [Medline] [CrossRef]
4) Sakai Y, Matsuyama Y, Nakamura H, et al.: The effect of muscle relaxant on the paraspinal muscle blood flow: a randomized controlled trial in patients with chronic low back pain. Spine, 2008, 33: 581–587. [Medline] [CrossRef]
5) Wang L, Zhao M, Ma J, et al.: Effect of combining traction and vibration on back muscles, heart rate and blood pressure. Med Eng Phys, 2014, 36: 1443–1448. [Medline] [CrossRef]
6) Vernon H, Meschino J, Naiman J: Inversion therapy: a study of physiological effects. J Can Chiropr Assoc, 1985, 29: 135–140.
7) Nosse LJ: Inverted spinal traction. Arch Phys Med Rehabil, 1978, 59: 367–370. [Medline]
8) Kang JH, Jeong BH, Jang JH: Analysis of muscle fatigue of erect spinae caused by treatment table height in ultrasound therapy. J Phys Ther Sci, 2013, 25: 881–883. [Medline] [CrossRef]
9) Quinet RJ, Hadler NM: Diagnosis and treatment of backache. Semin Arthritis Rheum, 1979, 8: 261–287. [Medline] [CrossRef]
10) Kang JH, Park TS: Changes in cervical muscle activity according to the traction force of an air-inflatable neck traction device. J Phys Ther Sci, 2015, 27: 2723–2725. [Medline] [CrossRef]
11) Acedo AA, Luduvice Antunes AC, Barros dos Santos A, et al.: Upper trapezius relaxation induced by TENS and interferential current in computer users with chronic nonspecific neck discomfort: an electromyographic analysis. J Back Musculoskeletal Rehabil, 2015, 28: 19–24. [Medline]
12) Cholewicki J, Lee AS, Reeves NP, et al.: Trunk muscle response to various protocols of lumbar traction. Man Ther, 2009, 14: 562–566. [Medline] [CrossRef]