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Original Article

An analysis on muscle tone and stiffness during sling exercise on static prone position

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Abstract. [Purpose] The purpose of this study was to examine changes in the muscle tone and stiffness of the lumbar region while individuals adopted the static prone position using sling suspension. [Subjects and Methods] The subjects were 30 healthy women in their 20s. The muscle tone and stiffness of the upper and lower lumbar regions of the sling suspension group and a control group were measured using myotonmetory as they maintained the static prone positon. [Results] The sling suspension group showed statistically significant declines in the muscle tone and stiffness of the upper lumbar region 5–10 min after adopting the initial prone position. They also showed statistically significant declines in the muscle tone and stiffness of the lower lumbar region immediately after being suspended in the slings and a statistically significant decline in the muscle tone of the lower lumbar region 5–10 min after adopting the initial prone position during which the sling suspension was applied. In contrast, the muscle tone and stiffness of the lumbar region of the control group increased while maintaining the static prone position. [Conclusion] The static prone position performed on a treatment table using sling suspension can be an effective intervention for reducing the muscle tone and stiffness of the lumbar region.

Key words: Muscle tone, Sling, Staitic prone position

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INTRODUCTION

In the presence of low back pain (LBP), the activity of paraspinal muscles can increase following voluntary and nonvoluntary changes in motor control due to psychophysiological responses generated by perceived stress[1)]. Various positions are used in physical therapy for back pain[2–4)]. The prone position is frequently adopted in sling exercise and joint mobilization interventions for musculoskeletal diseases[2–4)]. During sling exercise interventions, the therapist observes the position of the patient and changes in the muscle tone of the global muscles during exercise[2)]. In orthopedic manual therapy, the muscle tone and tension are also evaluated because soft tissue palpation of the spine is an important part of passive examinations[5)]. Muscle tone refers to the tension exhibited during involuntary contraction of motor units during muscle relaxation[6)]. In evaluations of patients with LBP, it is important to quantitatively identify muscle tone and stiffness during physical therapy evaluations, as they provide important clinical information. The prone position is frequently used in the treatment of patients with LBP. The aim of this study was to identify the effects of the static prone position on a treatment table, with and without sling suspension, on the muscle tone and stiffness of the upper and lower lumbar regions, thereby providing basic data to help determine the appropriate treatment time for patients.

SUBJECTS AND METHODS

This study involved 30 healthy community-dwelling women in their 20s. The selection criteria were as follows: those who had not undergone surgery on the lumbar region, those who had not experienced back pain over the previous year, and those

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who did not have musculoskeletal or neurological disorders. The subjects agreed to participate in this study after receiving an explanation of the study's purpose and intent. Pregnant women, those who had done muscle strengthening or aerobic exercises within the previous 5 days, or those who had pain in body regions other than the back were excluded from the study. This study was conducted after receiving approval from the Institutional Review Board of Howon University.

The 30 subjects were randomly divided into a sling group (mean ± SD: age, 21.8 ± 1.0 years; height, 159.8 ± 4.5 cm; body weight, 54.6.3 ± 7.2 kg) and a control group (mean ± SD: age, 20.9 ± 0.7 years; height, 162.6 ± 5.6 cm; body weight, 57.8 ± 6.7 kg). Each group consisted of 15 subjects. While the subjects maintained the static prone position on a treatment table using sling suspension or on a treatment table without the aid of slings, changes in the muscle tone and stiffness of their upper and lower lumbar regions were identified. All the subjects participated in one session each day. For the measurements, the subjects were instructed to wear oversized shirts and shorts to remove unnecessary pressure on the body regions.

In the sling group, the slings were attached to the head, chest, abdomen, pelvis, and both thighs and feet while the subjects performed the prone exercise on a treatment table. The control group did not wear slings and simply performed the prone exercise on a treatment table. Each subject was instructed to place her neck in a neutral position relative to the cervical spine while performing the prone exercise on the treatment table. Skin markers, located parallel to the spinous process of L1 (upper lumbar region) and spinous process of L4 (lower lumbar region), were then placed on the erector spinae on the dominant sides. The erector spinae shows myofascial continuity with the calf and hamstring muscles[7]. While adopting the above position, a measuring device (Myoton®PRO, MyotonAS, Estonia), which is highly reliable for the measurement of muscle tone and stiffness[8, 9], was placed perpendicularly on the point marked earlier. The homogeneity of the subjects was then recorded by measuring the muscle tone and stiffness of their upper and lower lumbar regions. The results revealed no statistically significant differences between the two groups. Five minutes later, the height of the treatment table used for the sling group was lowered, and the subjects were suspended in the slings. The cervical and lumbar lordosis were reduced slightly to ensure the cervical and lumbar spine were in a neutral position[2]. Changes in the muscle tone and stiffness of the upper and lower lumbar regions of the subjects in the sling group were measured 5, 10, and 15 min after they had adopted the prone position.

The subjects in the control group were instructed to place their necks in a neutral position relative to the cervical spine while adopting a relaxed static prone position on the treatment table. Changes in the muscle tone and stiffness of the upper and lower lumbar regions were measured 0, 5, 10, and 15 min after they had adopted the prone position. The muscle tone and stiffness of each muscle were measured twice, and the average of the two measured values was taken. The room temperature during the experiment was 23°.

The SPSS 21.0 statistical analysis program (SPSS Inc., USA) was used for the statistical analysis. A repeated measures analysis of variance (rANOVA) was performed to analyze changes in the muscle tone and stiffness of each group with time, and simple and repeated contrast tests were performed as post hoc tests. The independent t-test was performed to compare between-group changes in muscle tone and stiffness over time. The statistical significance level for all the statistical analyses was set at α=0.05.

In the sling group, the initial measurement (0 min) was taken while the subjects were in the prone position on the treatment table. Five minutes later, they performed the static prone exercise using sling suspension, and changes in the muscle tone and stiffness of the upper and lower lumbar regions were recorded 5, 10, and 15 min after adopting the prone position under sling suspension.

RESULTS

The results of the rANOVA and repeated contrast tests revealed a statistically significant decrease in the muscle tone and stiffness of the upper lumbar region 5–10 min after the sling suspension was applied. The muscle tone and stiffness of the lower lumbar region showed a statistically significant decline shortly after the subjects were suspended in the slings (5 min), and the muscle tone of the same region statistically significantly decreased 5–10 min after the sling suspension was applied ($p<0.05$). In contrast, the results of the statistical analysis of the control group showed statistically significant increases in the muscle tone and stiffness of the upper and lower lumbar regions 5–10 min after adopting the prone position on the treatment table ($p<0.05$).

As shown by the results of the independent t-test, the muscle tone and stiffness of the upper lumbar region of the sling group exhibited statistically significant larger declines 5–10 min after the sling suspension was applied, as compared to those in the control group. In terms of the muscle tone of the lower lumbar region, the sling group showed statistically significant larger declines than the control group at the initial measurement (0 min), shortly after the sling suspension (5 min), and 5–10 min after the sling suspension ($p<0.05$) (Table 1).

DISCUSSION

The prone position is used in a number of treatment techniques, such as mobilization of Maitland, sling exercise, McKenzie exercise, and therapeutic massage[2–5, 10–12]. The present study showed that the muscle tone and stiffness of the upper and lower lumbar regions of the sling group decreased with time. The treatment may have been more effective in relieving stiffness in the sling group than in the control group because the effects of gravity were minimized through body suspension.

Table 1. Change in muscle tone, stiffness on upper and lower lumbar region

Region	Variable	Group	0 minute	5 minutes	10 minutes	15 minutes
Upper lumbar region	Muscle tone (Hz)	Sling	14.2 ± 0.2	13.8 ± 0.2	13.5 ± 0.2*	13.6 ± 0.2
		Table	14.5 ± 0.2	14.7 ± 0.2	15.1 ± 0.3*	15.1 ± 0.3
	Stiffness (N/m)	Sling	250.6 ± 11.4	232.3 ± 13.7	223.3 ± 10.8*	226.6 ± 10.6
		Table	272.0 ± 12.4	282.8 ± 12.1	297.9 ± 14.2*	297.9 ± 14.5
Lower lumbar region	Muscle tone (Hz)	Sling	13.8 ± 0.2	12.2 ± 0.1*	12.0 ± 0.1*	12.1 ± 0.1
		Table	13.8 ± 0.2	13.8 ± 0.2	14.1 ± 0.2*	14.1 ± 0.2
	Stiffness (N/m)	Sling	214.5 ± 6.9	187.7 ± 9.9*	186.6 ± 11.3	180.7 ± 8.3
		Table	218.1 ± 8.2	217.6 ± 8.3	227.4 ± 7.9*	224.3 ± 7.4

Values are means ± SE.
$p<0.05$

In contrast, the control group showed statistically significant increases in the muscle tone and stiffness of the upper and lower lumbar regions for the first 5 min.

To achieve passive movements of lumbar segments, joint mobilization or manipulation[3, 5] and the myofascial release technique[10] are frequently performed on flat tables according to the aims of the treatments. A recent study reported that sling exercise and core exercises were effective interventions for the control of LBP[2]. Based on the results of the present study, to reduce the muscle tone and stiffness of the lumbar region, we recommend the maintenance of the static prone position during sling suspension for around 10 min. This study showed declines in the muscle tone and stiffness of the lower lumbar region shortly after the sling suspension in the static prone position. Therefore, this position can likely be used as an effective intervention in the management of LBP.

Maintaining the static prone position on a treatment table under relaxed conditions is an effective treatment method for reducing LBP. The static prone position is applied as the first step in McKenzie exercise[11]. In the present study, the muscle tone and stiffness of the upper and lower lumbar regions showed a statistically significantly increase 5–10 min after the subjects adopted the static prone position on a treatment table. However, as this study consisted of healthy women in their 20s rather than patients with LBP, maintaining the prone position may have increased the muscle tone and stiffness of the lumbar region.

Based on the results of this study, when applying therapeutic massage to healthy individuals in a prone position, the massage should be started immediately after the subject has adopted the prone position because the muscle tone and stiffness of the lumbar region have not yet increased.

This study has some limitations. As this study involved healthy individuals, its results cannot be generalized to patients with LBP. Furthermore, the findings cannot be used to draw conclusions about the effectiveness of the static prone position in specific interventions. As previous studies of muscle tone and stiffness in various treatment positions are insufficient, there is a limitation in comparing the results of this study with those of previous studies.

This quantitative study provides important clinical information of the effects of the static prone position performed using slings on a treatment table on the muscle tone and stiffness of the lumbar region. Additional studies are needed to identify the muscle tone and stiffness of individual body regions in LBP patients.

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