An analysis on muscle tone and stiffness of posterior cervical region during sling and plinth on static prone position

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Abstract. [Purpose] The purpose of this study was to quantitatively analyze changes in muscle tone and stiffness in the posterior cervical region of individuals in a static prone position in a sling or on a plinth. [Subjects and Methods] Twenty-four men in their 20s were divided into a sling group and a plinth group, and their changes in muscle tone and stiffness over time in the upper cervical region, lower cervical region, and upper trapezius muscles during a static prone position were measured. [Results] The sling group showed increases in the mean values of muscle tone and stiffness in the upper cervical region immediately after the suspension. In addition, this group exhibited statistically significant declines in the muscle tone and stiffness of the upper cervical region and a statistically significant decline in the muscle tone of the upper trapezius region. [Conclusion] The findings of this study suggest that for the treatment of the posterior upper cervical region after sling suspension in a static prone position, the time required to reduce the muscle tone and stiffness of this region should be taken into account.

Key words: Muscle tone, Posterior cervical region, Sling

INTRODUCTION

Neck pain is caused by various reasons, such as injuries or accidents, abnormal postures, and structural problems that can cause pain, stiffness, and discogenic symptoms in areas that are local or remote to the neck1, 2). Physical therapists mainly use manual therapy3, 4), sling exercise4), and combined exercises5) to treat neck pain. Therapeutic techniques such as sling exercise and joint mobilization frequently use the prone position to treat the cervical region1, 4). All therapeutic techniques commonly determine end-feels, such as a soft end-feel and hard end-feel using soft-tissue palpation during the process of patient assessment1, 3), and changes in these end-feels are observed even during treatment6). Therefore, changes in muscle tone and stiffness in a patient’s area of pain are highly important elements and the quantitative assessment of these elements is of great importance.

Myoton®PRO (MyotonAS, Estonia), which was recently developed, is equipment that can quantitatively measure changes in the muscle tone and stiffness of the peripheral soft tissues due to sports or brain injuries7–9). While quantitative data regarding the muscle tone and stiffness of the cervical region are critical information, objective information on this subject is largely limited at present.

Based on the need for research on this subject, the present study aimed to provide basic data for the assessment and treatment of neck injury patients by quantitatively analyzing changes in the muscle tone and stiffness of the posterior cervical (PC) region during a static prone position in a sling or on a plinth.

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SUBJECTS AND METHODS

This study involved 24 healthy male students in their 20s who were enrolled in H University located in Gunsan, South Korea. They were divided into a sling group (n=12) and a plinth group (n=12). In terms of the selection criteria, the subjects had not experienced neck pain over the previous year, had received no surgery in the musculoskeletal system, and had no neurological disorders. Those who had performed anaerobic and aerobic exercises within the last seven days or had previously participated in a similar study were excluded. This study was approved by the institutional review board of Howon University (1585-201611-HR-007-01) and consent was obtained from the subjects after explaining the study’s purpose and intent to them. The subjects were randomly divided into the sling group (mean ± SD: age, 21.0 ± 0.3 years; height, 176.0 ± 1.6 cm; body weight, 66.4 ± 2.9 kg) and the plinth group (mean ± SD: age, 22.3 ± 0.4 years; height, 172.0 ± 1.7 cm; body weight, 72.5 ± 2.9 kg). Using the subjects’ general characteristics and the results of the initial measurements, the Kolmogorov-Smirnov test was performed to verify each group’s normal distribution and the independent t-test was conducted to verify homogeneity between the two groups.

For the measurement, all subjects took off their tops to remove unnecessary tension, and then performed a prone position with their heads placed neutrally on a plinth. Here, the sling group performed a prone position while preparing for the suspension of the head, trunk, and both legs.

Myoton®PRO (MyotonAS, Estonia) was used to measure changes in the muscle tone and stiffness of the PC region. This is a highly reliable measurement device[9]. The muscles measured in the PC region were the dominant side muscles in the upper cervical (UC) region, lower cervical (LC) region, and upper trapezius (UT) muscle. For the UC region, the muscle located parallel to the dominant side spinous process of the third cervical spine was set as the area for measurement. For the LC region, similarly, the muscle located parallel to the dominant side spinous process of the seventh cervical spine was set as the area for measurement. In addition, the highest point of the muscle valley in each of the dominant side muscles was marked using a skin marker that was nontoxic to the human body.

The researcher instructed the subjects to stay comfortable while relaxing their muscles to the fullest, and then placed the measurement device vertically on the skin areas that had been marked earlier and began the first round of measurement. The second round of measurement was performed five minutes after the first round. In the sling group, each subject’s body was suspended with the head suspended in the sling at 90 degrees at a height horizontal to the trunk and the cervical spine adjusted to a neutral position. The plinth group continued to maintain a prone position. The third round of measurement was performed 10 minutes after the second round in the same manner as the second round. At each round of measurement, each muscle was measured twice and the mean values of muscle tone and stiffness were adopted for use.

In this study, the software package SPSS Statistics 21.0 was used for statistical processing and the statistical significance level for every statistical analysis was set at α= 0.05.

RESULTS

Each group’s changes with time were analyzed using the Wilcoxon signed-rank test. Five minutes after the suspension, the sling group showed statistically significant declines in the muscle tone and stiffness of the UC region and a statistically significant decline in the muscle tone of the UT region (p< 0.05). However, the plinth group exhibited no statistically significant changes. The differences in each group’s changes with time across the different measurement timings were analyzed using the Mann-Whitney U-test, but no statistically significant differences were found (Table 1).

DISCUSSION

In this study, the sling group showed statistically significant declines in the muscle tone and stiffness of the UC region five minutes after the sling suspension. This result indicates that even the mere intervention of suspending the body in a sling can produce the therapeutic effect of reducing the muscle tone and stiffness of the UC region in the PC region that has experienced increased muscle tone and stiffness. Indeed, sling suspension has the effect of decreasing the muscle tone and stiffness in the upper and lower lumbar regions[10]. These research results indicate that even the simple intervention of full-body suspension in a sling can be effective in reducing the muscle tone and stiffness of the muscles around the spine. However, the increases in the mean values of muscle tone and stiffness in the UC region immediately after the suspension, which were observed in this study, become an important consideration when performing sling exercise. The reasons for this finding may be twofold. First, because the anatomy of the cervical spine has the characteristic of being the most mobile among the bones that comprise the vertebral columns[2], a temporary small change in the location of the neck may have led to the increases in muscle tone and stiffness. Second, a change in the head position may have temporarily activated the vestibular system in charge of equilibrium[11], thereby resulting in the increases. Therefore, when sling exercise is applied for the treatment of neck pain in a patient, the time required for the neck muscles to adjust to the new environment immediately after the suspension of the patient’s head should be taken into account. However, the LC region had no change in muscle tone and stiffness because there was little change in body alignment during sling suspension.
By contrast, no statistically significant changes with time could be confirmed in the plinth group. The upper and lower lumbar regions tend to show increases in the muscle tone and stiffness of individuals in a static prone position on a plinth. This difference means that the levels of muscle tone and stiffness can vary depending on the body region even in the same treatment position.

In this study, statistically significant changes in muscle tone and stiffness with time were not found in the PC region during the two treatment positions. This may have resulted from the limitation of involving only healthy men in their 20s. However, the study’s quantitative data regarding the muscle tone and stiffness of the PC region for each treatment position may still be used as sound basic data for the assessment of neck pain patients and follow-up studies.

**REFERENCES**

1) Hengeveld E, Banks K, Newton M: Maitland’s vertebral manipulation: management of neuromusculoskeletal disorders volume 1, 8th ed. Elseviers, 2014.
2) Neumann DA: Kinesiology of the musculoskeletal system: foundations for rehabilitation. St Louis: Mosby, 2010.
3) Kaltenborn FM, Evjenth O, Kaltenborn TB, et al.: The spine: basic evaluation and mobilization technique. Olaf Norlis Bokhandel, 1993.
4) Yun S, Kim YL, Lee SM: The effect of neurac training in patients with chronic neck pain. J Phys Ther Sci, 2015, 27: 1303–1307. [Medline] [CrossRef]
5) Miller J, Gross A, D’Sylva J, et al.: Manual therapy and exercise for neck pain: a systematic review. Man Ther, 2010, 15: 334–354. [Medline] [CrossRef]
6) Kirkesola G: Neurac—a new treatment method for long-term musculoskeletal pain. J Fysioterapeut, 2009, 76: 16–25.
7) Wang JS, Lee SB, Moon SH: The immediate effect of PNF pattern on muscle tone and muscle stiffness in chronic stroke patient. J Phys Ther Sci, 2016, 28: 967–970. [Medline] [CrossRef]
8) Wang JS, An HJ, Kim YY: Effect of joint mobilization on improvement of knee pain, isokinetic strength, muscle tone, muscle stiffness in an elite volleyball player with knee injury. Journal of the Korea Academia-Industrial cooperation. Society, 2016, 17: 326–333.
9) Aird L, Samuel D, Stokes M: Quadriceps muscle tone, elasticity and stiffness in older males: reliability and symmetry using the MyotonPRO. Arch Gerontol Geriatr, 2012, 55: e31–e39. [Medline] [CrossRef]
10) Kim JJ: An analysis on muscle tone and stiffness during sling exercise on static prone position. J Phys Ther Sci, 2016, 28: 3440–3443. [Medline] [CrossRef]
11) Lundy-Ekman L: Neuroscience: fundamentals for Rehabilitation, 3rd ed. St. Louis: Saunders Elsevier, 2007.

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| Region                  | Variable (Hz) | Group | 0 minute | 5 minute | 10 minute |
|-------------------------|---------------|-------|----------|----------|-----------|
| Upper cervical region   | Sling         | 15.1 ± 0.3 | 15.4 ± 0.4 | 14.4 ± 0.4* |
|                         | Plinth        | 15.2 ± 0.3 | 15.5 ± 0.4 | 14.9 ± 0.4 |
|                         | Sling         | 260.0 ± 10.2 | 265.6 ± 10.6 | 240.7 ± 7.8* |
|                         | Plinth        | 247.2 ± 11.5 | 254.9 ± 11.9 | 242.2 ± 12.5 |
| Lower cervical region   | Sling         | 12.8 ± 0.4 | 12.7 ± 0.4 | 12.6 ± 0.4 |
|                         | Plinth        | 11.8 ± 0.3 | 11.7 ± 0.3 | 11.8 ± 0.3 |
|                         | Sling         | 210.2 ± 13.0 | 206.2 ± 12.8 | 205.7 ± 15.5 |
|                         | Plinth        | 173.3 ± 12.3 | 171.4 ± 14.4 | 172.1 ± 13.6 |
| Upper trapezius muscle  | Sling         | 12.8 ± 0.5 | 12.4 ± 0.2 | 11.8 ± 0.1* |
|                         | Plinth        | 11.7 ± 0.2 | 11.3 ± 0.1 | 11.3 ± 0.2 |
|                         | Sling         | 186.3 ± 6.0 | 184.0 ± 6.0 | 180.5 ± 3.2 |
|                         | Plinth        | 174.4 ± 5.5 | 168.7 ± 6.2 | 169.0 ± 6.1 |

Values are means ± SE, p<0.05.
*Significant difference between 5 minute and 10 minute.