

Original Article

Influence of Thoracic Flexion Syndrome on Proprioception in the Thoracic Spine

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Abstract. [Purpose] This study was performed to determine the difference in thoracic repositioning sense in young people with and without thoracic flexion syndrome (TFS) in target positions of half extension. [Subjects] People with TFS ($n = 15$; 7 men and 8 women) and people without TFS ($n = 15$; 7 men and 8 women) were recruited from three universities. Subjects were guided into a sitting extension target posture and were asked to move from a neutral position (2 s) to an extension target position (2 s); 10 trials were performed. [Results] People with TFS showed a significantly higher thoracic repositioning error in the extension target position than people without TFS. [Conclusion] People with TFS show a higher thoracic spine repositioning error in extension than people without TFS. A rehabilitation program to treat TFS should be implemented for individuals with decreased position sense of the thoracic spine.

Key words: Proprioception, Repositioning error, Thoracic flexion syndrome

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INTRODUCTION

Mechanical thoracic pain is usually the result of cumulative microtrauma caused by abnormalities in posture and movement patterns¹⁾. Sahrman²⁾ suggested that repeated movements and sustained postures can lead to adaptations in muscle length, strength, and stiffness; in turn, these adaptations may result in movement impairments. Above all, thoracic flexion syndrome (TFS) is associated with movements and postures that increase the flexion curvature of the thoracic spine, commonly resulting in alignment impairment such as thoracic kyphosis and posterior trunk sway³⁾. Excessive thoracic flexion leads to lengthening of the thoracic paraspinal muscles and biomechanical stress that can cause musculoskeletal pain in the thoracic spine region^{4, 5)}. In particular, people who maintain prolonged thoracic flexion may have pain or difficulty when attempting to decrease the thoracic curve and are usually unable to correct their alignment³⁾. Although a higher repositioning error may be one of the causative factors for failure of postural correction⁵⁾, no studies have investigated whether or not TFS is associated with repositioning sense in thoracic extension.

Therefore, the purpose of the present study was to compare the thoracic repositioning sense of people with and

without TFS during thoracic half-extension tasks to understand how TFS affects proprioception of the thoracic spine in the sagittal plane.

SUBJECTS AND METHODS

For this study, 30 young people (15 people with TFS and 15 people without TFS) were recruited from a local University in Gimhae, South Korea. Subjects were grouped into a TFS group and a control group based on a standardized clinical examination involving alignment and movement tests proposed by Sahrman³⁾. The signs and symptoms associated with TFS were as follows: (1) the thoracic spine alignment tended to demonstrate excessive flexion in standing, sitting, and quadruped positions; (2) the thoracic spine tended to increase in the direction of flexion with full flexion movement of the upper extremities; (3) the infrasternal angle was wider; and (4) symptoms were occasionally produced in the thoracic flexed posture or upon return to an erect posture. This study was approved by the human subjects committee of the University of Inje, and consent was obtained from all subjects.

To measure the thoracic repositioning sense, a flexible electrogoniometer (FEG) was used. After zeroing, the FEG end blocks were secured 12 cm above and below the T6–T7 interspinous space⁶⁾. Thoracic spine movement data were recorded with an MP150 data acquisition system (MP-150WSW, BIOPAC Systems, Goleta, CA, USA) and analyzed at a frequency of 100 Hz using the AcqKnowledge 4.1 software (BIOPAC Systems). Repositioning tests were performed in a chair with a 25-cm backrest to minimize or isolate posterior pelvic tilting and lumbar flexion movements in the sitting position. The subjects were seated on a stool,

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the hips and knees were positioned at 90°, both forearms were crossed over the chest, and the feet were positioned 20 cm apart. After the subjects were asked to stand up and sit down twice, the last sitting posture was recorded as the neutral sitting posture, and the thoracic spine angle was defined as the neutral thoracic angle. The target angles for repositioning were set at half extension on the way toward thoracic extension from the thoracic neutral position and at half extension. The repositioning error was calculated as the difference between the actual and participant-replicated target positions.

An unpaired t-test was used to compare the thoracic repositioning sense in the TFS group and the control group. The statistical analyses were performed using SPSS (ver. 17.0; SPSS, Chicago, IL, USA). P-values < 0.05 were considered to indicate statistical significance.

RESULTS

The thoracic repositioning sense error in the TFS group was significantly higher than that in the control group in thoracic extension ($21.12^\circ \pm 11.13^\circ$, $14.20^\circ \pm 3.23^\circ$) ($p < 0.05$).

DISCUSSION

Although people with TFS need to be instructed on how to correct the kyphotic posture of the thoracic spine while sitting, correction control is poor. A previous study suggested that lower proprioception or altered movement pattern may make it harder for people with TFS to correct the kyphotic posture³). The result shows that the people with TFS had a significantly greater reposition error than the controls during thoracic half-extension tasks.

Changes in biomechanical laxity in the spinal region, following prolonged thoracic flexion, may be related to an increased repositioning error^{7, 8}). Sustained and repeated thoracic flexion can induce elongation of ligaments and facet joint capsules of thoracic spine⁹). Flexion loading of the spinal ligament and joint capsule causes intervertebral laxity, especially creep deformation and stress-relaxation¹⁰). Deformation by creep and load relaxation can affect mechanoreceptors, and it has been shown to be associated with a decrease in reflex behavior immediately, resulting in higher repositioning error¹¹). In addition to ligaments, surrounding muscles of the spine, such as the multifidus and longissimus, have been observed to elongate as a result of a repeated or sustained flexed posture¹²). Passive elongation of spinal muscles can decrease muscle spindle excitability, inducing inhibition of reflexive muscle response¹³). There-

fore, higher repositioning errors during thoracic half-extension tasks could be due to altered afference of both muscle spindles and mechanoreceptors in the ligamentous joint capsule¹¹) and altered central processing in people with TFS compared with controls.

The present study has several limitations. First, all subjects were young; therefore, future studies should investigate the effects of age-related changes in the repositioning sense in thoracic extension in people with TFS. Second, we could not investigate the superficial and deep paraspinal muscle activities of the thoracic spine during the repositioning sense test, so future studies are needed. Third, we did not perform any radiological assessments for the subjects.

In conclusion, people with TFS had a significantly greater repositioning error in thoracic extension than the controls during thoracic half-extension tasks. This finding supports the practice of postural education for TFS to reduce the potential for proprioceptive loss and thoracic pain.

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