

Original Article

Immediate effects of stretching on trunk functions using a stretch pole half-cut

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Abstract. [Purpose] To analyze the immediate effects of stretching on respiratory and trunk functions using a stretch pole half-cut in healthy male participants. [Participants and Methods] Thirty healthy male participants with a mean age of 21.1 ± 0.8 years were recruited in this study. The participant had to lay on his back on the convex surface of the pole with the semicircle of the pole touching the surface of the platform mat. The convex of the pole was placed at the level from seventh to 10th thoracic vertebra for 4 min and was applied perpendicular (anatomically horizontal) to the body axis. Respiratory function and muscle strength using a spirometer with attached units, maximum-minimum chest wall expansion difference using a tape measure, and body alignment, such as angles obtained from the spinal mouse, were measured before and immediately after the intervention in random order. [Results] The total inclination angle was found to decrease significantly, while the thoracic kyphosis angle and maximum inspiratory pressure showed a significant increase. [Conclusion] This intervention was suggested to be easy for incorporating into day life and useful in situations where the subjects want to increase the maximum inspiratory pressure, such as in sports.

Key words: Stretch pole half-cut, Maximum inspiratory pressure, Chest wall mobility

(This article was submitted Dec. 15, 2021, and was accepted Feb. 1, 2022)

INTRODUCTION

Chest and abdominal wall mobilities are related to lung function, respiratory muscle strength, and postural stability¹⁻¹⁰⁾. Wall mobility is associated with forced vital capacity (FVC) and maximal expiratory strength in community-dwelling older men. This relationship is recognized with or without chronic obstructive pulmonary disease (COPD)^{2,3)}. The higher the axillary and thoracic circumference values in healthy individual, the greater the maximum inspiratory pressure (MIP), maximum expiratory pressure (MEP), and lung volume⁴⁾.

Burgos et al. showed that the mean difference from inspiration to expiration in the 1st thoracic vertebra (T1)-T12 physiologic kyphosis was $15.9^\circ \pm 4.6^\circ$, and the range of motion was wider in the caudal hemicurve than in the cranial hemicurve. Furthermore, a wide range of motion was found at T7-T10, which is responsible for 73% of T1-T12 sagittal movement⁵⁾.

Previous studies have reported the effects of stretch pole exercise on trunk flexibility and abdominal muscles⁶⁻¹¹⁾. There was a significant improvement in upper and lower chest expansion and MIP after exercise⁸⁾. However, in all these previous studies, the stretch pole was used along the body axis of the vertebral spine. In this study, we examined the effects of using a half-cut stretch pole. The pole was semi-circular and exhibited good stability when the bottom was placed on a mat. Therefore, safe intervention is possible, and it is worth considering these effects. The pole was set at T7-T10 with a wide range of motion perpendicular (anatomically horizontal) to the body axis.

Therefore, this study aimed to analyze the immediate effects of stretching using a stretch pole half-cut on respiratory and trunk functions in healthy male participants.

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PARTICIPANTS AND METHODS

Thirty healthy males (age: 21.1 ± 0.8 years, height: 1.71 ± 0.05 m, weight: 65.3 ± 8.3 kg, body mass index (BMI): 22.3 ± 2.2 kg/m² [mean \pm SD]) participated in this intervention study. Individuals with a history of cardiovascular and respiratory diseases were excluded. The participants gave written informed consent to be included in this study. The study was approved by the Ethics Committee of the International University of Health and Welfare (Approval No. 20-10-158).

The intervention was performed using a stretch pole half-cut (height, 7.5 cm; length, 40 cm; width, 15 cm; weight, 220 g; LPN Ltd., Aichi, Japan). The participants were positioned comfortably in the supine position and were instructed to breathe normally. The pole was placed at the level of the T7-T10 vertebra into the top of the semicircle (Fig. 1) because deep breathing appears to be highly dependent on the angular movements of the T7-T10 segment⁵). The duration of the intervention was set to 4 minutes, as described in a previous study⁷). Spirometry data, chest wall expansion difference, and body alignment, such as angles obtained from the spinal mouse, were measured before and immediately after the intervention in random order.

Respiratory function and muscle strength were measured using a spirometer (Autospiro AS-507, Minato, Osaka, Japan) and attached units (AAM377, Minato). Respiratory function parameters-vital capacity (VC), FVC, forced expiratory volume in one second (FEV1.0), FEV1.0%, and respiratory muscle strength (MEP and MIP) were measured according to the American Thoracic Society guidelines¹²). Inspiratory and expiratory muscle strength was evaluated using MIP and MEP, respectively. Respiratory function was measured first, followed by respiratory muscle strength. The maximum value obtained after three measurements was used as the representative value.

Maximum-minimum chest wall expansion difference was measured through thoracic circumferences at the level of the axilla, xiphoid process of the sternum, and 10th rib using a tape measure. The circumference at each level was measured thrice, and the maximum value was adopted as a representative value.

The spinal curvature morphology was evaluated using the spinal mouse (Idiag A G, Tokyo, Japan) in sagittal planes at three sitting positions; vertical, anterior flexion, and posterior flexion position of the trunk. The measurements were performed in a randomized order. The thoracic kyphosis angle (Thsp), lumbar lordosis angle (Lsp), sacral inclination angle (Sac/Hip), and total inclination angle (Total) were calculated throughout the spinal column.

In the statistical analysis, variables before and after treatment were compared using a paired t-test. Statistical significance was set at $p < 0.05$. All analyses were performed using IBM SPSS26.0 (IBM Corp., Armonk, NY, USA).

RESULTS

Table 1 shows the respiratory parameters, chest wall expansion difference, and body alignment obtained from the spinal mouse before and after the intervention. MIP significantly increased after the intervention. The Total was significantly decreased in the vertical position, and the Thsp was significantly increased in the posterior flexion position.

DISCUSSION

In this study, a stretch pole half-cut was placed on the participant's back under the thorax perpendicular (anatomically horizontal) to the body axis in the supine position, and we analyzed the immediate changes in respiratory function and spinal alignment.

An important finding of this study was that an increase in the degree of exertion of muscle strength was observed after the intervention using a stretch pole half-cut. After the four-minute intervention, the Total was significantly decreased, and the Thsp and MIP increased significantly.



Fig. 1. The placed pole at the level of the T7-T10 vertebra.

Table 1. Respiratory parameters, chest wall expansion difference, and body alignment before and after the intervention

	Before	After
Respiratory parameter		
VC (L)	4.27 ± 0.47	4.27 ± 0.47
FVC (L)	4.13 ± 0.45	4.17 ± 0.50
FEV _{1.0} (L)	3.66 ± 0.33	3.68 ± 0.36
FEV _{1.0%} (%)	88.6 ± 5.3	88.6 ± 6.0
MEP (cmH ₂ O)	89.7 ± 22.1	92.8 ± 24.0
MIP (cmH ₂ O)**	83.4 ± 16.6	90.7 ± 18.5
Chest wall expansion difference		
Axilla (cm)	3.8 ± 1.1	4.1 ± 1.2
Xiphoid process (cm)	5.4 ± 1.4	5.1 ± 1.3
10th rib (cm)	5.1 ± 2.6	4.6 ± 1.3
Body alignment		
Vertical position		
Sac/Hip (°)	0.3 ± 6.9	0.9 ± 6.2
Thsp (°)	32.9 ± 7.9	31.0 ± 9.0
Lsp (°)	-0.1 ± 8.9	-1.8 ± 8.7
Total (°)*	8.2 ± 3.4	6.9 ± 3.9
Anterior flexion position		
Sac/Hip (°)	4.4 ± 7.7	4.0 ± 8.8
Thsp (°)	55.4 ± 11.5	54.6 ± 13.9
Lsp (°)	25.1 ± 15.6	27.1 ± 13.2
Total (°)	39.4 ± 13.5	40.7 ± 13.0
Posterior flexion position		
Sac/Hip (°)	-3.4 ± 9.2	-4.3 ± 9.1
Thsp (°)*	23.6 ± 13.2	26.2 ± 13.0
Lsp (°)	-23.5 ± 12.7	-24.1 ± 10.0
Total (°)	-17.6 ± 6.8	-19.0 ± 7.0

Mean ± SD, *p<0.05, **p<0.01.

VC: vital capacity; FVC: forced vital capacity; FEV_{1.0}: forced expiratory volume in 1 second; MEP: maximal expiratory pressure; MIP: maximal inspiratory pressure; Sac/Hip: sacral inclination angle; Thsp: thoracic kyphosis angle; Lsp: lumbar lordosis angle; Total: total inclination angle.

By radiographically measuring changes in the sagittal profile of different thoracic segments during maximal inspiration and expiration, the non-uniform sagittal ROM of the thoracic spine could be related to the different types of anatomic rib connections in the thoracic cage. In nonuniform sagittal ROM, at T1-T7 (the true ribs), the attachment of the ribs to the sternum and spine could greatly limit the mobility of the thoracic spine, and ribs joined to T8-T10 (the false ribs) have longer costal cartilage, which attaches to other cartilage, resulting in greater mobility in this area of the rib cage⁵. Therefore, our intervention with T7-T10 may have resulted in a stretch stimulus to the rib cage, including the diaphragm.

All participants had to do was to place the pole under their trunk while lying on their back. The time required was as short as five minutes, including preparation, and no special place was needed. This intervention is easy to incorporate into everyday life and maybe useful in situations where the subjects want to increase MIP, such as in sports.

The limitation of this study is that the findings may not apply to females and older adults or, obviously, those with spine alignment conditions. Furthermore, it is necessary to consider changing the methods of the thoracic intervention.

Conflict of interest

The authors declare no conflicts of interest in this work.

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