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Effects of Spine Mobilization on Cobb's Angle and Respiratory Function in Patients with Adolescent Idiopathic Scoliosis

Background: Incorrect postures of adolescents caused by the use of smart devices have been noted as a factor causing spinal diseases.
Objectives: To examine the effect of joint mobilization and stretching on Cobb's angle and respiratory function in adolescent idiopathic scoliosis (AIS).
Design: Cluster-randomized controlled trial.
Methods: A total of 22 subjects with AIS were enrolled. They were allocated to two groups: the joint mobilization (n=11) and the stretching (n=11). All interventions were conducted for 30 minutes, three times a week for six weeks. Outcome measures were the Cobb's angle and respiratory function. The Cobb's angle and respiratory function measured using the X-ray and Micro-Quark.
Results: Joint mobilization group showed significant differences in Cobb's angle and respiratory function, but stretching group showed significant differences Cobb's angle. The differences in peak expiratory flow (PEF) between the two groups were significant.
Conclusion: This study proved that joint mobilization is a more effective intervention for AIS to improve Cobb's angle and respiratory function, when compared to stretching.

Keywords: *Adolescent idiopathic scoliosis; Joint mobilization; Stretching; Respiratory function*

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INTRODUCTION

In this competitive generation, due to increasing hours of study to achieve satisfying results from the university entrance examinations, more adolescents are frequently exposed to sedentary lifestyle, and their participation in outdoor activities and exercise is decreasing. In addition, there is a rising trend of spine diseases in adolescents with increasing use of smart phones due to retaining the same standing posture for a long period or having a habit of sitting with a poor posture.[1]

Adolescent Idiopathic Scoliosis (AIS) is the most common form of structural spinal deformities that have a radiological lateral Cobb's angle a measure of spinal curvature of $\geq 10^{\circ}$. AIS affects between 1% and 4% of adolescents in the early stages of puberty and is more common in young women than in young men. Scoliosis is one of the spine diseases that causes external problems and, if worse, it can cause negative effects on daily activities. Scoliosis is a three-dimensional deformity with the loss of normal bending state in the sagittal plane,[2] and it accompanies the bending or lateral deflection of the spinal column from the anatomical axis with rotational deformity of the body of vertebrae as well.[3,4] These deformed vertebrae and ribs create asymmetry and mobility changes due to the concave and convex surfaces.[5] The difference in concave and convex surfaces appears in the ventilation capacity of the lungs, which leads to a decrease in vital lung capacity. Since bending to the side of the spine reduces the development of thoracic cage and cardiopulmonary function, and weakens the respiratory muscles, corrective treatment and respiratory treatments are essential.[6] Respiration is caused by the volume change of the thoracic cage due to the expansion and contraction of the lungs, and the volume change is determined by the elasticity of the skeleton and soft tissues around the chest and the power of the respiratory muscles. Thus, to improve the respiratory function of scoliosis patients, corrective treatment of the thoracic cage and exercise enhancing the flexibility has to be implemented.[7] There are various interventions to improve scoliosis such as specific exercise, conservative interventions including physiotherapy and orthosis and surgical intervention.[1] However, most scoliosis patients do not require surgical treatment if it is found at an early stage.[8]

There were studies on the application of stretching or corrective exercises for AIS, but studies on the improvement on Cobb's angle and respiratory function after Joint mobilization or Stretching were insufficient. The purpose of this study suggests the effective treatment for improving the Cobb's angle and respiratory function by applying the Joint mobilization and Stretching method to the scoliosis patient.

SUBJECTS AND METHODS

Subjects

22 AIS patients, aged between 13–19 years, who had Cobb's angle between 10° to 40° were selected from the L hospital. Cobb's angle was measured by drawing a horizontal line on the upper most inclined segment and the lower part of the lower segment according to the most protruding segment when observed from the frontal plane and measuring the angle between them. Those who did not perform orthopedic surgery and treatment on the spine, those who were diagnosed with AIS, those who had no other diseases than AIS, and those who agreed to participate in this study were selected for the study. The intervention was conducted by a physiotherapist who is currently implementing treatments for scoliosis patients in clinical trials. Those who had with orthopedic disease in the rib cage, cerebrovascular diseases such as headaches, dizziness, or vomiting were excluded from this study. This study was approved by the Institutional Review Board of Youngin University (2–1040966–AB–N–01–20–1910–HMR–152–6).

Interventions

Joint Mobilization group (JMG)

The intensity of joint mobilization requires the application of three levels of strength as classified by Kaltenborn et al.[9] so that the tissue around the joint can sufficiently stretch. The patient's posture is the prone position. For joint mobility, a segment with less mobility of the posterior joint was selected, and the transverse process wedge of the lower segment was contacted. Joint mobilization of the spine is carried out between the 5th and 12th spinal segments. During joint mobilization, the participant is checked for any discomfort, and it is performed three times for 30s counted as one set for each segment (two sets, three repetitions), without any discomfort. The rest period between each joint mobilization is 3s, the movement and rest period per segment is 15s, and the rest period between sets is 30s.[9]

Stretching group (STG)

The stretching exercise program is composed of corrective exercise, spinal flexibility exercise, and spinal stability exercise.[7] This exercise is based on those suggested by Weiss and Kisner & Colby.[10,11] During Stretching, the participant is checked for any discomfort, and it is performed three times for 30s counted as one set for each segment (three sets, three repetitions), without any discomfort. The rest period between each stretching is 30s, and the rest period between sets is 20s. The total assessment time should not exceed 30min (Table 1).

Table 1. Stretching exercise method

	Training method	Time
Stretching	1) Warm up (1) Lateral stretching	5 min.
	2) Main exercise (1) Lateral strength (2) Spine articulation (3) Four point leg–arm	20 min.
	3) Cool down (1) Swan	5 min.

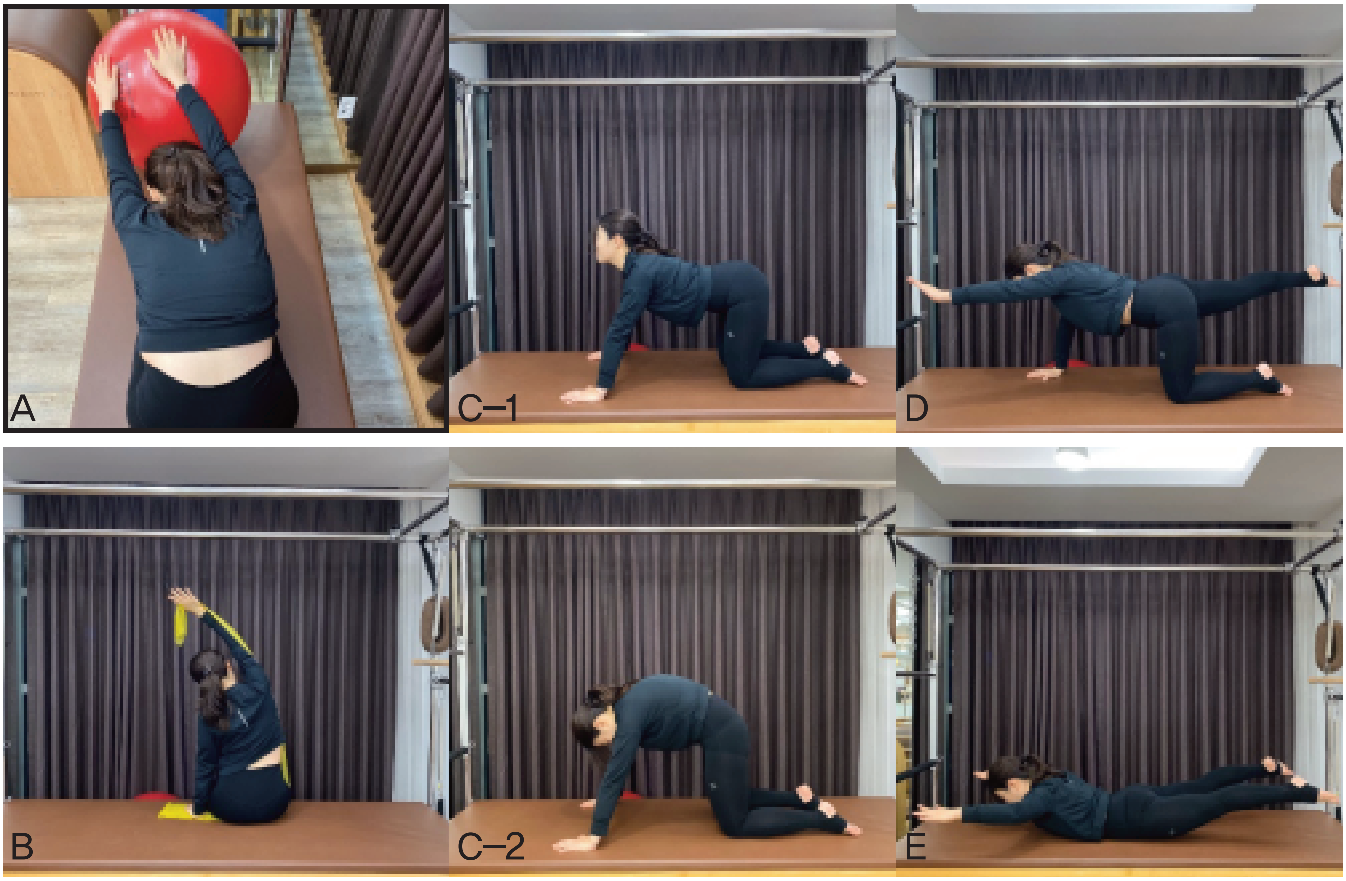

Figure 1. Stretching exercise method
A: Lateral stretching B: Lateral strength C: Spine articulation D: Four point leg–arm E: Swan

Outcome Measures

Cobb's angle measurement

The evaluation of the Cobb's angle was measured using X–ray (CR 85–X, USA). The images were taken by a professional radiologist at a specialized medical institution. Radiography with entire anterior and posterior (A–P) images of the spinal column were recorded with the patient standing in an upright position with the weight evenly distributed on both feet and about inhaling and exhaling about one–third of the breath and then holding it. The image was computerized and examined with the images stored in the picture archiving and communication system (PACS), and the angle of the chest was measured with a Cobb's angle measurement tool.[12]

Respiratory function measurement

Evaluation of the respiratory function was measured using Micro–Quark (Cosmed, Italy). The participants were asked to sit on a chair with a backrest, look in front, and blow the spirometer after their maximum inhalation. respiratory function measurements were conducted in accordance with the respiratory function test guidelines. The maximal–effort expiratory spirogram measured forced vital capacity (FVC), forced expiratory volume at one second (FEV1), and peak expiratory flow (PEF). All items were measured three times, and the average value was recorded.

Data and Statistical Analyses

All statistical data were analyzed using SPSS 21.0 software (IBM Corp., Armonk, NY, USA). Joint mobilization and Stretching groups satisfied the normal distribution. Thus, parametric tests were used. The homogeneity test between the two groups was performed using an independent t–test. The independent sample t–test and chi–square test were used for the general characteristics of the subjects. A paired t–test was performed for the effects of exercise. The within– subject factor was time (before and after the test), whereas the between–subject factor was group–by time. When significant differences were the interactions or main effects (group-by-time), t-test was used. The statistical significance level was set at α=.05.

RESULTS

General characteristics of subjects

The general characteristics of the subjects were present (Table 2).

Changes in Cobb's angle

The average value of Cobb's angle in the JMG was a statistically significant ($P<.05$). The average value of Cobb's angle in the STG was significant ($P<.05$) (Table 3).

Changes in respiratory function

In the JMG FVC was a statistically significant ($P<.05$). In the STG FVC, FEV1 and PEF was a statistically significant ($P>.05$). The differences in PEF between the two groups were significant ($P<.05$) (Table 3).

DISCUSSION

The cause of AIS is muscular imbalance due to poor posture and lack of exercise.[13] AIS usually appears in children from the age of 10 years to the end of the growth period and progresses until the end of the bone growth.[14] Overall, approximately 2-3% of the population shows a lateral (frontal plane) bending beyond 10°,[15] which induces a three-dimensional deformity that changes the shape of the body. Continuous observation and conservative treatment are required to predict a curvature.[16] Hence, this study was conducted to observe the changes in Cobb's angle and respiratory function in 22 adolescent students before and after 6 weeks of intervention and to prove its effectiveness. They were allocated to base on the type of intervention into a Joint Mobilization Group (JMG) and a Stretching Group (STG).

In our study, both groups showed significant changes in Cobb's angle and demonstrated the effectiveness of intervention. As reported that Maitland's joint mobilization reduced pain and Cobb's angle and increased trunk flexion in an adult with kyphoscoliosis.[17] This may imply that joint mobilization and stretching stimulated the thoracic cage or spine from a local region to the whole body and used both left

Table 2. Characteristics of subjects

General characteristic		JMG	STG	P
Gender	Male	4	3	.351
	Female	7	8	
Age (years)		16.64 ± 1.57	16.18 ± 1.39	.161
Height (cm)		164.01 ± 6.69	163.71 ± 5.73	.506
Weight (kg)		59.31 ± 10.81	57.52 ± 7.01	.872

JMG: Joint mobilization group, STG: Stretching group

Table 3. Comparison of Cobb's angle and respiratory function in pre and post (Mean±SD)

		Joint mobilization group (n=11)			Stretching group (n=11)			Between group change (P)
		Pre-test	Post-test	P	Pre-test	Post-test	P	
Cobb's angle		19.86 ± 3.88	17.41 ± 3.44	.036*	19.08 ± 4.83	18.37 ± 3.12	.041*	.088
Respiratory Function	FVC	4.12 ± 0.81	4.26 ± 0.84	.014*	3.91 ± .74	4.01 ± 0.74	.128	.211
	FEV1	3.34 ± 0.65	3.46 ± 0.64	.027*	3.35 ± .66	3.40 ± .64	.264	.426
	PEF	344.84 ± 34.18	352.92 ± 33.60	.023*	347.69 ± 38.09	349.70 ± 34.54	.807	.021*

*$P<.05$
FVC: Forced vital capacity, FEV1: Forced expiratory volume at 1 second, PEF: Peak expiratory flow

and right muscle movements to reduce Cobb's angle. AIS occurring from poor posture increases Cobb's angle and decreases vital lung capacity and lung volume. This may also affect the expansion of the thoracic cage and result in respiratory muscle weakness.[18] In this study, as a result of verifying the effect on changes in respiratory function between the two groups, there was a significant effect in FVC, FEV1, and PEF in the JMG before and after the intervention, while there was no notable difference in the STG. Studies that showed the effectiveness of Joint mobilization and respiratory function, as in report that the cervical sustained natural apophyseal glide was determined to effective in improving respiratory functions for patients with forward head posture.[19] This improvement in Joint mobilization and respiratory function is consistent with the results of this study. Joint mobilization stimulates helps reduce the spine or chest from local to whole body, using both left and right muscle movements to help reduce the Cobb's angle and also to improve respiratory function. In addition, there may have been no significant difference in the STG because an intervention for breathing that can stimulate the movement of thoracic cage during stretching was not accompanied.

This study effective interventions to improve Cobb's angle and respiratory function in AIS patients and proved that Joint mobilization is an effective method to improve Cobb's angle and respiratory function. Thus, a continuous study should be conducted to improve these functions of AIS patients. The limitations of the present study were the small sample size of 22 students in their 10s with limited ages and the short period of 6 weeks. In the future, increasing the exercise period and the number of subjects is needed to more fully compare in addition to Cobb's angle and respiratory function between patients with AIS treatment. A control group should also be included so that more apparent differences would be revealed.

CONCLUSION

This study validated that joint mobilization, rather than stretching, was more effective in AIS patients to improve Cobb's angle and respiratory function. Hence, positive results are expected by properly combining and applying Joint mobilization and exercise treatment to treat AIS patients who have spinal deformity due to poor posture.

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