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Case Report

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Efficacy of a 9-week Exercise Program including Rectus Abdominis Eccentric Exercise in a Girl Patient Diagnosed with Thoracic Kyphosis

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Abstract

The increase in the prevalence of thoracic kyphosis in childhood and adolescence affects the whole spine, causing posture disruption, decreased muscle strength, and increased back pain and shortness. 7-8 weeks of exercise programs in conservative treatment of thoracic kyphosis are beneficial in reducing pain and correcting posture. In this case report, 9 weeks exercise program including rectus abdominis muscle eccentric strengthening exercise was found to be beneficial in reducing back pain and shortness, increasing muscle strength and correcting posture in a 13 years old girl.

Keywords: Thoracic Kyphosis, Eccentric exercise, Spine, Pain.

INTRODUCTION

In childhood, situations like carrying bag, sitting positions in school, instinct to hide the body due to development in the female gender may cause disorders in posture [1]. Increased thoracic kyphosis and decrease in cervical lordosis due to the change of trunk posture in flexion direction is one of the common postural conditions. This conditions may cause pain, muscle weakness, shortness and postural disorders in spine [2].

The rectus abdominis muscle is responsible for flexion and stabilization of spine, filling of the abdominal-pelvic cavity and bring down the chest to help breathing with ribs. Rectus abdominis is a tendency to weaken and shorten [3, 4]. It have been reported that abdominal muscles have an effect on the craniocervical posture. Jung Gil Su *et al*. reported that the rectus abdominis and transversus abdominis muscles may help stabilize the thoracic and lumbar spine by activating craniocervical flexion [5].

Exercises are recommended in cases growing age with a Cobb's angle of less of than 40 degrees [6]. The cross-bridges in collagen tissue are more in eccentric contraction, the force produced by contraction is more than the concentric contraction, the ratio of the eccentric contraction force size in the single muscle fibril to the concentric contraction is 50-80%. The fiber length and sarcomeres in series are more increase with eccentric exercise compare to concentric exercise [7, 8].

Flexor posture occurs with the increase of thoracic kyphosis and increasing anterior fascia pulling forward [2, 6]. When the length and pulling forward to anterior of anterior fascia of the rectus abdominis muscle is considered, the eccentric contraction of the muscle increases the number of sarcomere and increases its strength by reaching the optimal sarcomere length [8], it may activate craniocervical flexion movement of the cervical region by prolonging the pull of the shortened fascia, and may be beneficial in decreasing thoracic kyphosis and increasing spinal stabilization.

In this report we aimed to investigate the effectiveness of the 9-week strengthening, stretching and spinal stabilization program including the eccentric strengthening exercise applied to the rectus abdominis muscle on pain, muscle strength and spinal region angles in a girl with thoracic kyphosis.

MATERIALS AND METHODS

Case History, Clinical History and Demographic Information

The patient who is girl, 13 years old, student of secondary school had back-neck pain last six months especially in school sitting positions. The body weight was 48 kg, height 160 cm, body mass index 22.6 kg/m^2.

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Assessments

The back pain severity was evaluated using the Visual Analog Scale (VAS), on which the subject marked the current pain with a vertical line on a horizontal line of 10 cm "0=no pain, 10: very severe pain" [9].

Tragus-wall distance was measured for cervical functional mobility. The distance between the tragus and the wall was measured with the ruler in the position where the patient leaned her back against the wall while standing upright [10].

In the measurement of shortness of the right and left shoulder internal-external rotators, the patient tried to join her hands on her back by standing one arm in an internal rotation and the other arm in an external rotation. The distance between the points to which the third fingers touched was measured [11].

The trunk lift test was used to determine the strength of the back extensors by measuring the floor-chin distance in the prone position. The patient laid on prone position and lifted her upper body from the bed, the distance between floor and chin was measured by tape measure [12].

In the evaluation of manual muscle strength of the anterior trunk flexor muscle, the patient was asked to lie on the knees flexed on the back and trunk flexion until the lower angle of the scapula was removed from the bed. In the scoring, 3 position arms were used alongside the trunk, 4 position pharaoh shaped, 5 position hands on the neck [11].

In the evaluation of manual muscle strength of the trunk extensor muscles, the patient was asked to lie on her knees and to lift her trunk from the bed. In the scoring, 3 position arms were used next to the trunk, 4 position hands were on the neck, 5 position arms above the straight position [11].

Radiographic evaluation of the spinal region was measured cervical lordosis, thoracic kyphosis, lumbar lordosis, and sacral slop angle measurements from the anteroposterior and lateral sides of the patient while standing [13].

Exercise Program

The exercise program was applied to patient for 3 days of week, 90 minute for each season in clinic. Each exercise was performed in the first 3 weeks, 10 sets in 2 repetitions, 2 sets in the second 3 weeks, 3 sets in 10 repetitions, and 5 sets in the last 3 weeks.

Exercises started with first phase spinal stabilization exercises in the form of diaphragmatic respiration, chin-tuck and transversus abdominis muscle. Spinal stabilization exercises progressed with upper and lower extremity movements and bridge building exercises. Exercises started with first phase spinal stabilization exercises in the form of diaphragmatic respiration, chin-tuck and transversus abdominis muscle. Spinal stabilization exercises progressed with upper and lower extremity movements and bridge building exercises. Strengthening exercises, back extensor strengthening exercises, eccentric strengthening exercises to the rectus abdominis muscle, teraband and dumbbell strengthening exercises to the romboid and mid-lower part trapezius muscles; exiting water and dry swimming exercises; stretching exercises to pectoral muscles, internal and external shoulder rotators; at the end of the session, it included puppet exercises in sitting and standing positions, aiming to raise all of the joints in a loose position and then to stand upright to increase body awareness [6].
The patient was advised to do all his exercises as a home program 3 times a day, 3 sets, and 10 sets each day on all days of the week.

RESULTS

The results of clinic evaluations were given in Table-1. The pain severity decreased by half after treatment. In before and after treatment the evaluations of spinal regions angles were given in Table-2 and the spinal radiological images were given in Figure-1A, 1B, 1C, 1D.

Table 1: Clinical evaluations results before and after treatment

Evaluated parameters		**Before treatment**	**After treatment**
Pain severity(VAS-cm)		6 cm	3 cm
Tragus-wall distance(cm)		15 cm	10,5 cm
Measurement of shortness of shoulder rotators(cm)	*Movement of right external rotation-left internal rotation*	6 cm	0 cm
	Movement of right internal rotation-left external rotation	7 cm	3 cm
Trunk lift test(cm)		4,5 cm	13 cm
Manual muscle strength of the anterior trunk flexor muscle		3	5
Manual muscle strength of the trunk extansor muscle		3	5

VAS: Visual Analog Scale, cm: centimeter, °: angle.

Table 2: Spinal regions angles

	Before treatment	**After treatment**
Angle of cervical lordosis	29°	19°
Angle of thoracic kyphosis	58°	36°
Angle of lumbal lordosis	59°	58°
Angle of sacral slope	32°	48°

°: angle.

Figure 1A: Radiologic image of cervical lordosis, thoracic kyphosis and lumbal lordosis angles before treatment.

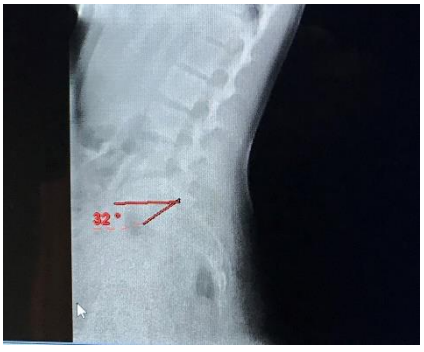

Figure 1B: Radiologic image of sacral slope angle before treatment.

Figure 1C: Radiologic image of cervical lordosis, thoracic kyphosis and lumbal lordosis angles after treatment.

Figure 1D: Radiologic image of sacral slope angle after treatment.

DISCUSSION

In our study, it was determined that angles of lower cervical lordosis and throracic kyphosis decreased, angle of sacral slope increased; back pain and muscle shortness decreased and trunk muscle strength increased after exercise programme.

In literature exercise approaches showed that thoracic kyphosis angle decreased as a result of 7 and 8 weeks exercise programme including stretching exercises for extremities, strengthening exercises for trunk and extremities in boys with thoracic kyphosis. Miller *et al*. reported that costoclavicular angle increased, back pain and thoracic kyphosis angle decreased after image corrective exercises, spinal traction and mobilization in 15 years old girl patient with thoracic kyphosis [13]. Feng *et al*. showed that thoracic kyphosis angle decreased and thoracic range of motion increased after 8 weeks functional exercise programme in 81 adolescent with thoracic kyphosis [14]. In our study is a first to include a strengthening, stretching exercise programme that included eccentric strengthening of the rectus abdominis, a trunk flexor muscle, and to evaluate the spine angle values, pain, muscle strength and shortness in thoracic kyphosis.

It is known to occur pain in spinal regions depending on thoracic kyphosis [14]. Especially carrying bag and physical changes in growth period may increase risk of experiencing pain and muscle strength may decrease depending on posture [1, 2]. In our study, it is thought that the pain caused by thoracic kyphosis is reduced and the trunk muscle strength is increased, since the proper posture allows the mechanical loads to be compensated and the stress on the tissue can be met within normal limits. These results are consistent with the literature and it is possible to say that the 9-week exercise program is beneficial in decreasing back pain and increasing muscle strength and correcting the posture.

The sagittal balance is known as a harmony between cervical, thoracic, lumbal and sacral regions [15]. Cervical lordosis begins to develop in intrauterine life and takes curvature of the natural cervical lordosis by holding the head, sitting, walking. Thoracic curvature is the primary curvature. With the development of the child, cervical and lumbar curvatures begin to develop and thoracic curvature becomes natural kyphosis curvature. The lower cervical lordosis angle in children reaches adults angle values in 14-15 years old [1, 16]. However cervical lordosis angle increase with the increase in the angle of thoracic kyphosis. The lower cervical lordosis angle (C3-C4) is mostly associated with thoracic curvature [17, 19]. Been *et al*. stated that the angle of cervical lordosis in children is 5 degrees higher than in adults. They showed that the mean values of the lower cervical lordosis angle of the girls aged 14 years were 11.5±10.6° [19]. In our results, lower cervical angle was 29° before treatment, 19° after treatment, Tragus-wall distance decreased 4,5cm. In the different studies for thoracic kyphosis angle, it was reported that 29.76°±5.39° [1], 29.5±9.8° [20], 26°±7.43° [21] in 13 years old girls. In our results, thoracic kyphosis angle was 58° before treatment, 36° after treatment. The angle of lumbal lordosis has an important role in maintaining upright posture and can be affected in relation to problems in other parts of spine. Cil *et al*. reported that lumbal lordosis angle was 54.6°±9.8° for children 13-15 years old [22], Mac-Thiong *et al*. stated 48°±11.7° for 341 children with mean age of 12 [23], Shefi *et al*. reported 39°±9° for 11-13 years old [24]. In our results, lumbal lordosis angle was 59° before treatment, 58° after treatment. The position of the lumbosacral region is important in the transition to sacral region and the sacral slope angle is an important parameter in the sagittal plan balance in the pelvis. As a result of pelvic angle changes, to maintain balance in sacrum, the lumbal lordosis angle increases and sacral slope angle decreases as compansatuar mechanism. Geneveois *et al*. reported that sacral slope angle was 39.2°±6.5° in children and adolescents with mean age of 14 years [18]. All spinal regions evaluated and it was found correlations between angle of cervical lordosis and thoracic kyphosis, between angle of thoracic kyphosis and lumbal lordosis, between angle of lumbal lordosis and sacral slope. Mac-Thiong *et al*. stated a scheme showing the relationship between spinal regions for the pediatric population [23]. In this scheme, it is stated that there are mathematical correlations between the anatomically adjacent spinal regions. It is seen that the problem in any part of spine may affect other regions. We believe that 9 week exercise programme including rectus abdominis eccentric exercise, strengthing of trunk muscle may decrease angle of thoracic kyphosis and provide directly correlation of lower cervical lordosis angle. The change in the thoracic region may also affect the angle values in the lumbar and sacral regions.

On the other hand, in all postural disorders seen in the spinal region with the increase of thoracic kyphosis, as a result of shortening of the anterior fascia and decrease of the strength of the rectus abdominis muscle, the eccentric exercise to be given to the rectus abdominis muscle is also included in the thoracic kyphosis exercise program. Although there are no US images, it is thought that it can contribute to the correction of posture by optimizing the prolonged sarcomere length and increasing the number of series sarcomere.

Limitations

There are some limitations in study. The muscle strength was evaluated manually and posture analysis couldn't evaluated with a comprehensive device. It is thought that muscle strength and posture analysis should be demonstrated more objectively and follow-up time should be considered in further studies.

Conflict of Interest

The authors declare no conflict of interest.

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