The effect of corrective exercises on the thoracic kyphosis and lumbar lordosis of boy students

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Abstract
Corrective exercises are a branch of applied science and include the identification, education, prevention, correction of wrong habits of body and motor abnormalities. The purpose of this study was to assess the effectiveness of eight-week corrective exercises on boy students with kyphosis and lordosis. 40 boy students were randomly divided into two groups with 20 subjects in each group including experimental group and control group. The experimental groups performed the corrective exercises for eight weeks with three sessions a week. Pre and post measures of kyphosis and lordosis curve were obtained using a spinal mouse. Measuring of variables was performed before (pre-test) and after (post-test) the protocol. Eight weeks corrective exercise period can be resulted in the reduction of kyphosis angle and lordosis angle boy student. In general, implementation of corrective exercise in patients with kyphosis and lordosis was a successful plan.

Keywords: Boy students, corrective exercises, lumbar lordosis, spinal mouse, thoracic kyphosis.

INTRODUCTION

The spine as the linchpin of the body is a complex structure consisting of vertebrae, discs, muscles and many ligaments (26). This weakness of spinal column extensor muscles can cause to static, dynamic and stature unbalance in persons that called faulty posture (2). Sagittal spinal alignment is found to be changing as a child grows. There is a statistically significant difference among different age groups, especially at cervicothoracic, thoracolumbar, and lumbosacral junctions. The position of the sacrum (inclination and translation), and spatial orientation, as well as the global magnitude of thoracic kyphosis, and lumbar lordosis changes with growth. These findings should be taken into consideration for the young patients who require spinal instrumentation (5). Fanuchi et al. (8) confirmed Espinoza-Navarro et al. (7) who reported an implementation of exercise program decline rates of postural abnormalities in 4-year-old children and regular involvement in specific exercise programs during childhood could promote optimal spinal alignment and tissue load during the growth spurt. Hasanvand et al. (11) reported, corrective exercises can begin with the onset of puberty. Puberty is periods of life when posture undergoes many adjustments and adaptations (23), due to changes in the body, vertebral anatomical dimensions, body height, and hormonal status. Postural changes cause deformity in children and adolescence’s posture, if improvement is not done, then the structural changes occur (14).

Physiological disorders caused by unfavorable physical status are serious. Increasing back curve of a thoracic area that recognized as kyphosis has the unfavorable result of the respiratory system by the shortness and the inflexibility of chest muscles and also the weakness of expiratory muscles. Because shortening weakness in chest muscles of aspiration cause to decreasing ribcage volume, then decreasing lung volume (24). The mechanism of kyphosis is presumed to occur through anterior thoracic compression fractures and the subsequent formation of a compensatory fat pad (6). Kyphosis is not only associated with relatively altered vertebral body shape (anterior wedging), but also with reduced bone density and fitness, as well as decreased muscle strength, and is associated with reduced survival (20). It is concluded that similar fitness and corrective exercises are possibly recommendable for mentally retarded adolescents (19). We can suggest the performance of both corrective exercises in land and water for kyphotic persons (2). The kyphosis angle
has been correlated with back extension strength, which is an important predictor of quality of life among postmenopausal women with osteoporosis (21). Our previous study (12) showed improved kyphosis, strength, and physical performance after a 12-week multidimensional exercise program.

One of the important abnormalities of this area is the increased lumbar lordosis (22). Maintenance of normal lumbar lordosis is important in the treatment of spinal disorders (25). Mackenzie believes that failure to correct these abnormalities until high school will lead to the postural changes like pains in the musculoskeletal system, joint deformation, muscular fatigue, and biomechanical imbalances (16). Hence, correcting the lifestyle which is effective on the emergence of lumbar lordosis should be taken into account (26). Lumbar lordosis is defined as the curvature assumed by the intact lumbar spine to compensate for the inclination of the sacrum, restore an upward orientation and consequently avoid forward inclination (30). Corrective exercises had the significant effect on increased lumbar lordosis especially after puberty (27).

Kyphosis is the excessive curvature of the spine in the sagittal plane. The normal back has 20° to 45° of curvature in the upper back, and anything in excess of 45° is called kyphosis. Lordosis or hyperlordosis is excessive curving of the lower spine and is often associated with scoliosis or kyphosis. It can be exaggerated by poor posture. Abnormal curvature of the spine can result from disease of the vertebral column, including trauma or imbalance of the neuromuscular system. It may be congenital. It can be produced by legs of different lengths.

In adults, kyphosis is often related to osteoporosis but in children, it can be due to injury, a tumor on the spine, or a genetic disorder, such as Hunter’s syndrome or spina bifida. Hence, the purpose of this study was to assess the effectiveness of eight-week corrective exercises on boy students with kyphosis and lordosis.

**MATERIALS & METHODS**

The 40 boy students with kyphosis and lordosis with mean and standard deviation, the age profile (17.24 ±2.84 yr.), weight (61.29±3.69 kg) and height (168.61±4.72 cm) participated in this study. The subjects were recruited from a high school. They were randomly divided into experimental (20 cases) and control (20 cases) groups. Each subject was questioned about them passed medical history and present health status. The subjects received a stipend to cover their travel expenses and time. Prior to the study, procedures and guidelines were presented orally and in written form. Subjects agreeing to participate signed an institutionally approved consent form.

Anthropometric characteristics including height and weight were measured and recorded. Measuring of variables was performed before (pre-test) and after (post-test) the protocol. The experimental group participated in corrective exercises program for eight weeks, three sessions per week and 60 minutes per session, while the control group did not participate in any corrective exercises and not to participate a regular exercise program or a sport, during the study. The Control group was also able to do the physical activity. After completion of initial measurements for the evaluation of the curvature of the kyphosis and lordosis, the experimental group participation in corrective exercises program. Corrective exercise was performed by the subjects under the supervision of the athletic trainer. On the day after the end of the corrective exercises program, the evaluation of the curvature of the kyphosis and lordosis were repeated. Evaluation of the curvature of the kyphosis and lordosis was the spinal mouse.

Spinal Mouse is a device that, combined with a computer program, assesses the curvatures of the vertebral column without applying harmful radiation. The Spinal Mouse device includes two rollers included on a mobile support that allows spinal contour tracking. This shape is recorded by three sensors. The Spinal Mouse results, emphasizing values such as hypo or hyper mobile vertebral joints or deviations from reference values.

Corrective exercises program: 1. Warm up 10 min, 2. Stretching 10 min (Improve of Flexibility and range of motion), 3. Strengthening 30 min (Increased of strength and endurance in the large muscle groups), 4. Cool down 10 min.

Combined program of stretching and strengthening includes: PNF stretching (chest stretch, groin stretch, hamstring and gluteal stretch), strengthening the abdominal muscles (Stomach crunch with legs raised, Side plank, Plank, Stomach crunch), hip flexor and extensor exercises (Bridging, Adductor Squeeze, Hip Abduction Sideling, Hip Abduction Standing, Hip Flexion), Williams exercises, strengthening of erector spine muscles.

All data were analyzed using SPSS version 19. The data were tested for normal distribution with the Shapiro-Wilk test. The paired T-test was used to
compare the differences between the pre and posttest in both groups. Significances were set at the P<0.05 level.

RESULTS

Mean and SD values of age, height and weight of two groups are shown in Table 1.

Table 1. Characteristics of subjects (mean ± SD).

| Group       | N  | Age (yr)  | Height (cm) | Weight (kg) |
|-------------|----|-----------|-------------|-------------|
| Experimental | 20 | 16.84 ± 1.84 | 168.07 ± 2.21 | 61.74 ± 0.69 |
| Control     | 20 | 17.53 ± 2.07 | 169.01 ± 2.38 | 61.02 ± 1.11 |

Table 2 shows for normal distribution with the Shapiro-Wilk test before performed exercise in both groups. The result of analysis indicated that there was no significant difference in both variables in experimental and control groups.

Table 2. The result of analysis for normal distribution with Shapiro-Wilk test.

| Curvature | Group    | P   |
|-----------|----------|-----|
| Kyphosis  | Experimental | 0.59|
|           | Control   | 0.57|
| Lordosis  | Experimental | 0.64|
|           | Control   | 0.54|

Table 3 compares for kyphosis curvature in of subjects in the pre and post-test in two groups. The result of analysis indicated that there was no significant difference in pre and post-test in control group. Significant difference found between pre and post-test in experimental groups (P < 0.05).

Table 3. Paired T-test for kyphosis curvature of subjects in the pre-test and post-test in two groups.

| Curvature | Group     | Pre test   | Post test  | df  | t     | p    |
|-----------|-----------|------------|------------|-----|-------|------|
| Kyphosis  | Experimental | 46.19 ±3. 29 | 42.38 ±1. 14 | 19  | 6.39  | 0.000*|
|           | Control   | 45.71 ±2. 94 | 45.31 ±3. 02 | 19  | 1.04  | 0.185 |

* p < 0.05.

Table 4 presents compares of pre and post-test for lordosiscurvature in both groups. Significant difference found between pre and post-test in experimental group inkyphosis curvature (P < 0/05) and between pre and post-test of subjects in control group there was no significant difference in this variable (P < 0/05).

DISCUSSION

The purpose of this study was to assess the effectiveness of eight-week corrective exercises on boy students with kyphosis and lordosis. The research shows there is an important decrease in kyphosis and lordosis angle after a particular corrective exercise in experimental group. Our results showed that curvature of kyphosis and lordosis can be improved. Findings revealed that the program had therapeutic effects and decreased thoracic kyphosis and lumbar lordosis (19). Corrective exercises decreased periodical backache and increased mental health and satisfaction of patients (9). Researchers believed strengthening exercises is a part of corrective exercise that can enhance the muscular strength of children and adolescents beyond that which is normally due to growth and development (27). Upon 8 weeks corrective exercise, the amount of the back curved decreased significantly and there was a significant increase in abdominal muscle strength and endurance, and hamstring muscle flexibility (1).

Table 4. Paired T-test for lordosiscurvature of subjects in the pre-test and post-test in two groups.

| Curvature | Group     | Pre test   | Post test  | df  | t     | p    |
|-----------|-----------|------------|------------|-----|-------|------|
| Lordosis  | Experimental | 48.23 ±1. 74 | 43.56 ±0. 97 | 19  | 7.51  | 0.000*|
|           | Control   | 48.51 ±2. 18 | 49.63 ±1. 85 | 19  | 1.17  | 0.117 |

* p < 0.05.
The results of the present research are consistent with previous findings indicating an improvement of angle of kyphosis after corrective exercises in land and water (2). Choi (4) and Lynn (15) show through corrective exercises to increase power of back extensor muscles, the kyphosis would decrease, pain relief and physical function (4,15). Hyper-kyphosis (a thoracic curvature of > 40-45°) is one of the most common human postural abnormalities and has been identified as an etiological factor of, or significant cause of, impairment in upper quadrant pathologies (10,13). The incidence of hyper-kyphosis has been shown to range from 15.3% in 11 year-old children to 38% in 20-50 year-old adults and 35% in 20-64 year-old adults depending on the dataset (28). This abnormality is often managed by manual therapists in many disciplines using a variety of techniques, including exercise prescription (28). A 7 week corrective exercise period can be resulted in reduction of kyphosis angle in hyper-kyphotic male students. But by stopping the exercises completely, the kyphosis angle may increase again (29). Regular and correct exercises may lead to increase muscular power and decrease lordosis (17).

Posture is the alignment and maintenance of body segments in certain positions such as standing, walking, lying or sitting, and is the most important factors affecting physical and mental status of individuals through their lives (31). Bad posture may be attributed to muscle and emotional issues, which could generate positional or structural deviations if the individual remains in inappropriate positions for a long time (18). Hyperkyphosis or increase in thoracic curve greater than normal range is one of prevalent spinal disorders (3). Biomechanical data suggest that an increase in the thoracic kyphosis may be associated with significantly higher spinal loads and trunk muscle force in upright stance and this might accelerate degenerative process which in turn leads to further spinal dysfunction and pain (3). Lordosis is the inward curvature of spine. In fact, it is an increased forward curve in the lumbar region. It creates problem in standing and walking. Generally imbalanced diet, improper environment improper development of muscles, obesity and diseases affecting vertebrae and spinal muscles are such causes which result in lordosis. In addition to these causes, not performing exercises and taking excessive food are also major causes of lordosis. Abnormal spinal curves can be the result of many different causes. Some children or adolescents may have a nerve or muscle disease (neuromuscular), injury or other illness that may have attributed to their spinal abnormality.

In conclusion; findings revealed that the program had therapeutic effects and decreased thoracic kyphosis and lumbar lordosis. In general, implementation of corrective exercise in boy students with kyphosis and lordosis was a successful plan.

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