The influence of elongation exercises on the anterior-posterior spine curvatures

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Summary

Introduction: Elongation exercises are designed to reduce existing pathological or increased physiological curvatures of the spine. The aim of the study was to evaluate the changes occurring in the parameters describing the anterior-posterior spinal curvatures during the performance of symmetric elongation exercises.

Material and methods: The study included 150 children aged 7–10 years: 82 girls and 68 boys. It was performed in June 2012, following prior parental and the subjects’ consent. The study design was approved by the Bioethical Committee of the Medical Faculty of Rzeszow University (number 05/07/2012). In each subject, an examination of the body posture was performed twice – first in a relaxed position and second during an elongation exercise. The Wilcoxon pair sequence test was used for statistical analysis.

Results: The lumbosacral angle was significantly higher during the performance of an elongation exercise (p < 0.001), and so was the thoracolumbar angle (p < 0.001). The angle of the upper thoracic spine (p < 0.01) was significantly reduced. In the case of parameters describing thoracic kyphosis, a significant increase was observed both for the thoracic kyphosis angle (p < 0.01) and the depth of this part of the spine. As for the parameters describing lumbar lordosis, both the lordosis angle and its depth were significantly reduced (p < 0.001 and p < 0.001).

Conclusions: 1. Elongation exercises reduce the depth of lumbar lordosis. 2. During elongation exercises thoracic kyphosis becomes deeper.

Key words: Body posture – Photogrammetric method – Elongation exercises

Introduction

Elongation exercises are exercises lengthening the spine in its axis. They activate the muscles of the spine and aim at reducing existing pathological curvatures or increased physiological curvatures of the spine. However, there is a risk of excessive flattening of these curvatures. Elongation exercises are applied in patients with idiopathic scoliosis to reduce lateral bending. They are also used in children with deepened physiological spinal curvatures (concave back, round back, round-concave back).

The aim of the study was to evaluate the changes occurring in the parameters describing anterior-posterior spinal curvatures during the performance of symmetric elongation exercises.

Material and methods

After obtaining family consent and child assent to participate, the study included 150 children aged 7–10 years: 82 girls and 68 boys. The tests were performed in June 2012. The study design was approved by the Bioethical Committee of the Medical Faculty of Rzeszow University (number: 05/07/2012). In each subject, an examination of the body posture was performed twice – first (measurement I) in a natural, relaxed position and second (measurement II) when the subjects were performing an elongation exercise. The applied exercise was a symmetric exercise consisting of lifting the upper limbs and maximal “pulling up” the spine in its axis.

The tests involved anthropometric measurements based on images of the studied surface. The child was positioned...
at a distance of 2.6 metres from the camera. The device projects lines of strictly defined parameters on the child’s back, allowing a spatial image to be obtained. These lines reach the patient’s back at a specific angle and are distorted depending on the distance to a given point from the device. Line image distortions are recorded by a computer using numerical algorithms to convert them into a contour map of the surface. In optics, the physical basis of this method is called the Moire phenomenon [1, 2]. Analysis, display, and printout of the test were performed using a computer program that allows transmission of the data to the statistical software. The study employed equipment and software from CQ Elektronik Systems [3, 4, 5]. Analyses of the obtained photographs were made without the participation of the children. This method does not require special modification of it in children. This method does not have to be modified when children are to be examined.

The examination during the performance of the exercise is presented in Figure 1.

The following parameters were used in the study:

| Parameter | Description |
|-----------|-------------|
| α αLPHA   | Inclination of the lumbosacral section of the spine. The angle calculated between S1 and the deepest place of lordosis. |
| β BETA    | Inclination of the thoracolumbar section of the spine. The angle is calculated between the transition lordosis and kyphosis at the peak of kyphosis. |
| γ GAMMA   | Upper thoracic region angle. The angle between C7 and the peak of kyphosis. |
| KPT       | Sagittal inclination of the trunk. Referred to the deviation of line C7-S1 “forward” or “backward” |
| KKP       | Angle of thoracic kyphosis. KKP = 180 – (BETA + GAMMA). |
| GKP       | Depth of thoracic kyphosis calculated between the top of kyphosis and kyphosis moving into lordosis. |
| KLL       | Angle of lumbar lordosis. KLL = 180 – (ALPHA + BETA). |
| GLL       | Depth of lumbar lordosis calculated between transition of between kyphosis in lordosis and the deepest point of lordosis. |
| GKS       | Depth of cervical spine calculated between C7 and external occipital tuberosity. |

Statistical methods

The Wilcoxon pair sequence test was used for statistical analysis. This non-parametric test was chosen due to the fact that in most cases the condition of compliance of distributions with the normal distribution, verified by the Shapiro-Wilk test, was not fulfilled. The Wilcoxon test allows for checking the intragroup variability that occurs in the study, which consists of measuring the same parameters twice (measurement I and II).

The level of statistical significance was set at $p < 0.05$. The significant results are highlighted in red. The data are presented as well as box-and-whisker plots. The study also included calculating descriptive statistics: mean, median, and standard deviation for the consecutive variables.

Results

Comparing the parameters measured before performing the exercise and during the act of performing it, a statistically significant difference between measurements I and II was found. The lumbosacral angle increased significantly during the exercise ($p < 0.001$). A similarly significant increase was observed as regards the thoracolumbar angle ($p < 0.001$). On the other hand, the angle of the upper thoracic spine significantly decreased ($p < 0.01$). In the case of parameters describing thoracic kyphosis, a significant increase was observed both for the thoracic kyphosis angle ($p < 0.01$) and the depth of this part of the spine. As for the parameters characterising lumbar lordosis, the opposite relationship was noted. Both the lordosis angle and its depth were significantly reduced while the subjects were performing the exercise ($p < 0.001$). A detailed presentation of results is contained in Table 1.
### Tab.1. Comparison of parameters obtained during both measurements.

| Variables | Measurement I | Measurement II | Wilcoxon pair sequence test |
|-----------|---------------|----------------|-----------------------------|
|           | $\bar{x}$ | Me | s | $\bar{x}$ | Me | s | Z | p |
| ALFA      | 13.50 | 10.90 | 13.09 | 16.72 | 14.10 | 14.50 | 4.2588 | 0.0000 |
| BETA      | 4.37  | 3.90  | 3.06  | 6.92  | 6.60  | 4.57  | 5.6364 | 0.0000 |
| GAMMA     | 24.47 | 15.00 | 22.35 | 20.89 | 5.10  | 28.43 | 3.4557 | 0.0005 |
| KKP       | 151.52 | 160.00 | 21.89 | 153.08 | 166.10 | 27.58 | 2.7904 | 0.0053 |
| GKP       | 4.62  | 3.80  | 9.56  | 15.82 | 14.30 | 10.33 | 8.5875 | 0.0000 |
| KLL       | 167.61 | 165.20 | 16.69 | 163.07 | 159.80 | 18.97 | 6.4368 | 0.0000 |
| GLL       | −4.95 | −4.50 | 8.99  | −0.66 | 0.00  | 7.89  | 7.3877 | 0.0000 |

### Discussion

Our results show that elongation exercises significantly influence the shape of anterior-posterior curvatures of the spine. As a result of performing such exercises, thoracic kyphosis is deepened, lumbar lordosis is reduced, and the angles of individual sections of the spine are changed.

Elongation exercises are recommended, *inter alia*, in a situation when the physiological curvatures of the spine are deepened and should theoretically reduce such curvatures. The results of our research carried out in a group of younger school-age children do not support this thesis. These results show that children perform the elongation exercise through maximum extension of the lumbar spine and backward bending of the lower part of the thoracic kyphosis in order to raise the upper limbs as high as possible. This increases the angle of the upper thoracic spine through an excessive shift of the head forward and the deepening of thoracic kyphosis [6].

Sastre *et al.*, who studied patients aged 15–35 with increased lumbar lordosis, noted a significant decrease in thoracic kyphosis while using stretching exercises based on the FED method [7]. Romano *et al.* described a decrease in the physiological curvatures of the spine in scoliosis patients during such therapy [8]. According to Ball *et al.*, elongation exercises caused decreased deepening of thoracic kyphosis with age [9]. Itoi *et al.*, studying a group of 60 women with hyperkyphosis, recorded a reduction of thoracic kyphosis after a series of stretching exercises [10]. Similar results were obtained by Morey *et al.* in a study on 210 women practising elongation exercises combined with aerobic workouts [11]. Renno *et al.* demonstrated in their study that elongation exercises combined with exercises entailing correct posture applied in a two-month cycle three times a week resulted in a decrease of thoracic kyphosis by 1.5 degrees [12]. Vanneuville *et al.* described a group of women and men performing vigorous elongation exercises and showed a significant reduction in thoracic kyphosis and lumbar lordosis, with the highest correction values obtained by women [13]. All authors have the same opinion regarding the results and effectiveness of elongation exercises in adults [14–19].

However, there are very few studies in the literature regarding the influence of elongation exercises on the anterior-posterior curvatures of children. Our findings are the first such results in the available literature, and therefore it was not possible to compare them to the results of other authors. According to the theory of biomechanics and the performance methodology of elongation exercises, such exercises should reduce the physiological curvatures of the spine. However, our study showed that children of younger school age do not perform these exercises properly, which will negatively influence the curvatures of their spines. Our study also demonstrated that exercises must be verified prior to introducing them in a given group of patients. Exercises that can be done in a methodically proper manner by adults are not always performed correctly by children. Exercises that are supposed to be of corrective nature in case of a hyper-kyphosis, in practice can increase the already increased thoracic kyphosis.

The value of the study. The discussed research is the first to show a change of posture in the course of exercising. Our findings do not apply to all elongation exercises, but only to those that are performed actively and independently by the patient. These exercises should not be done without supervision in case of younger children in order to correct the depth of thoracic kyphosis, as well as in case of kyphoscoliosis. The performance of active elongation exercises by a child in a standing position, in the correction process, should be monitored by a physiotherapist.

### Conclusions

1. Elongation exercises reduce the depth of lumbar lordosis.
2. During elongation exercises thoracic kyphosis becomes deeper.
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