EFFECT OF ISOMETRIC TRAINING AND SWIMMING FOR A STRONG MUSCULAR CORSET BUILD UP IN CHILDREN WITH SPINAL DEFORMITIS

(Preliminary communication)

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Abstract

The modern lifestyle and the reduced locomotor activity are factors promoting the appearance of abnormal posture and a variety of deformities of the spine and the thorax. The aim of the present study was to monitor the effect of isometric training and swimming in children with spinal deformities on the buildup of a strong muscular corset. Study subjects consisted of 8 children with first-degree scoliosis and marked kyphosis (first group) and 7 children with first-degree scoliosis and marked lordosis in the lumbar region (second group), all of them 10-14 years of age. In the beginning and by the end of the survey period, measurements and tests of the mobility of the spine and the thorax were made, as well as manual muscle testing of the abdominal, back and gluteal muscles; the Chizhin plantography were conducted. As a result of the training programme, the posture and gait of children were corrected, and a substantial improvement of the functional state of the entire locomotor apparatus was achieved.

Keywords: bad posture, scoliosis, lordosis, kyphosis, Chizhin plantography, thorax, training programme, general strengthening, physical exercises

INTRODUCTION

The proper posture depends on the anatomical structure of the vertebral column, the thorax and the shoulder, lower extremities and the normal functioning of the body, muscles and locomotor skills (Momchilova (Момчилова) & Yanev (Янев), 2009).

The physical development of children and adolescents correlates with their locomotor and nutritional regimen, their body constitution, their hardening, the early detection, prevention and treatment of acute and chronic growth-related disorders (Karaneshev (Каранешев) et. al., 1987). Spinal deformities are among the most common juvenile diseases. They are only partially caused by urbanization, acceleration and forced hypodynamia, proper of contemporary lifestyle. The rickets and bad posture are also possible reasons, which could enhance the appearance of a potential deformity (Karaneshev (Каранешев) et. al., 1987). The formation of scoliosis is a complex pathological event. The first appearance is the lateral curving of the vertebral column. For a single curvature, it is related only to altered intervertebral disk shape within the physiological limits of the vertebral column. This type of scoliosis is reversible and in most instances, is believed to occur as a result of static and dynamic disturbances.

Modern lifestyle creates preconditions for the high prevalence of habitual scoliosis. It is among the most common scoliosis types in infancy and adolescence, which could have an adverse evolution (Sokolov (Соколов), & Markova-Stareyshinska (Маркова-Старейшинска), 1991).

The early diagnostics, regular monitoring, treatment and proper locomotor regimen contribute to the favorable outcome of initial deformities in children. The good management of treatment measures including complex rehabilitation and swimming, as well as regular surveys of treatment outcome are of primary importance to prevent severe spinal deformities and secondary complications which could lead to significant disability.

The aim of the present research was to monitor the effect of isometric training and swimming in children with spinal deformities on posture improvement and buildup of a strong muscular corset.

METHODS

The studied subjects were 8 children with first-degree scoliosis and marked kyphosis (first group) and 7 children with first-degree scoliosis and marked lordosis in the lumbar region (second group), all of them 10-14 years of age, treated at the Kinesi-3 Rehabilitation Cen-
tre, Stara Zagora. All children underwent a 6-month treatment consisting of 30 sessions of kinesitherapy, massage and physical therapy, 40–60 min of duration, performed three times per week. Twice weekly, children practiced supervised swimming in a pool. Rehabilitation protocols of both groups were structured and described.

Research methods – in the beginning and at the end of the study period, the following measurements were performed: thoracic mobility (thoracic circumference during rest, during maximum inspiration and during maximum expiration - Hirtz, Hirtz, and Hirtz); mobility of the cervical and thoracic spine (Ott’s test; Moschkov’s quad, according to: Karaneshew (Каранешев), et. al., 1987); trunk flexion test of Tom Mayer, lumbar spine mobility test of Schober, according to: Sokolov (Соколов), Markova-Stareishinska (Маркова-Старейшинска), 1991; manual muscle testing (MMT) of abdominal, spinal and gluteal muscles (Bankov (Банков), 1985), as well as Chizhin’s plantography.

The measurements and test results in children from group I indicated: shoulder contour asymmetry with elevated right shoulder, more prominent right scapula, enhanced thoracic kyphosis and reduced anterior-posterior thoracic diameter. Positive signs of an upper crossed syndrome were present – weakness of deep cervical flexors, m. trapezius and m. serratus anterior; slightly shortened m. trapezius, m. levator scapulae, m. pectoralis major and m. pectoralis minor (Chaitov et al., 2006; Kraydzhikova (Крайджикова), 2011), weak abdominal and gluteal muscles. While standing straight and not moving, the children partially compensated the curvature. There were no signs of flat foot as confirmed by plantography.

The tests in children from the second group revealed: a slight shoulder asymmetry with elevated left shoulder, reduced anterior-posterior thoracic diameter, asymmetry of waist triangles with elevated left iliac crest, enhanced lumbar lordosis. Lower crossed syndrome signs were positive – weak abdominal and gluteal muscles, shortened m. erector spinae lumbalis, m. iliopsoas and m. rectus femoris (Chaitov et al., 2006; Kraydzhikova (Крайджикова), 2011). The abdomen is prominent, while the hip is anteriorly rotated. While standing straight and not moving, children compensated partly the scoliosis, but lordosis was enhanced. There were no signs of flat foot as confirmed by plantography.

Rehabilitation protocol applied in the second group: The emphasis was put on isometric training of weak muscles without massage and manual mobilization techniques through application of: vertebral column mobilizing exercises, in standing or supine position with flexed lower extremities; posture and gait correcting exercises; breathing exercises – dynamic and static; isometric exercises for strengthening gluteal, abdominal and spinal muscles lying on the back with flexed lower extremities, in lateral and prone positions; exercises for equilibrium and coordination from kneeling and sitting position with a large therapeutic ball /Fit-ball/ (Генчева (Генчева), 2003); stretching of shortened muscles; post isometric relaxation (PIR) for shortened muscles / lumbar spine extendors/ (Dimitrova (Димитрова), 2008); isometric exercises for upper extremities strengthening with 1-kg dumbbells; exercises for lower extremities strengthening with 2-kg weights (Koleva (Колева), 2010; 2011); physical therapy for trophic stimulation and muscle tone improvement: medium-frequency (interference) current therapy for trophic stimulation; electro stimulation for improvement of locomotor deficiency (Koleva (Колева), 2009). Swimming sessions were performed twice per week.

Methodical instructions:
The load is compliant with the physical abilities of children and age-related features. Isometric exercises were done in an anti-gravity position, but the vertebral column was not loaded (face up, face down, lateral and kneeling positions). They were combined with dynamic breathing exercises and were strictly dosed depending on individual locomotor abilities of children. Exercises were performed symmetrically for both spine halves (concave and convex) with equal muscle contraction and pause durations. In the beginning of the treatment course, isometric training of upper extremities were without weights in series of 10 repetitions, and 1-kg weights were gradually included in two series of 10 repetitions each. In the subsequent sessions, the load was increased. The training of equilibrium reactions was performed by standing on one leg only with stretched arms, recording the stay duration in seconds. The applied methodic is different from all others in that no gymnastics for spine flexibility, relaxing exercises and crawling were performed. Also, kinesitherapy and swimming within the same day were not practiced.
RESULTS AND DISCUSSION

The application of both rehabilitation programmes in the two groups resulted in substantial positive effect with regard to posture correction, strength and equilibrium reactions. As could be seen from Table 1., the scoliosis was corrected in 77% of children from the first experimental group and 55% from the second group. This provided evidence that the regular dosed loading improved muscle tone and corrected the deformity. This result was achieved by spine correction exercises and equilibrium training, combined with swimming.

Equilibrium exercises are essential for proper posture build up. They develop the sense for maintaining the vertical position of the vertebral column (Chernogorova, 1995).

The comparison of relative shares of corrected deformities in both studied groups, a statistically significant difference between them was observed (Milkov, 1996) – in this specific case, \( U=2.21 \), \( U>2.13 \), \( \alpha=0.05 \) confirmed the hypothesis that the first experimental group benefited more from the applied training.

By the end of the period, MMT showed an improvement of muscle tone of weak abdominal muscles (Table 2). Only about 10% of both groups did not improve much and exhibited MMT scores of 2. The other 63% of group I and 57% of group II exhibited MMT scores 4 and 5. This was achieved by isometric exercises for abdominal muscles, alternated with diaphragmatic resistive breathing.

Pearson’s test results for abdominal muscle MMT scores 4 and 5 (Milkov, 1996) showed a moderate correlation between groups \( r=4.8; p<0.05 \). This way, the isometric training combined with swimming contributed to the formation of a strong muscular corset.

Table 1. Correction of deformity (Percent)

<table>
<thead>
<tr>
<th></th>
<th>First group</th>
<th>Second group</th>
</tr>
</thead>
<tbody>
<tr>
<td>No correction</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>Stabilization</td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td>Correction</td>
<td>77</td>
<td>55</td>
</tr>
</tbody>
</table>

Spinal muscle tone was also improved (Table 3). The results were better in group 1, where 80% of children had MMT scores 4 and 5 as compared to the second group, where the percentage of MMT scores 4 and 5 was 68%. Therefore, the effect of isometric training for improvement of the strength of weak spinal muscles was beneficial.

The correlation between compared groups with regard to spinal MMT scores of 4 and 5 \( r=6.8; p<0.05 \) was assessed as significant in the Pearson’s test (Milkov, 1996). The rehabilitation programme combined with swimming improved considerably the muscle tone and body equilibrium.

Table 3. Spinal muscle MMT scores (Percent)

<table>
<thead>
<tr>
<th></th>
<th>First group</th>
<th>Second group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Fair</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Good</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Normal</td>
<td>45</td>
<td>28</td>
</tr>
</tbody>
</table>

The chest mobility and pulmonary function was improved by dynamic breathing exercises from various positions of the body and resistive diaphragmatic breathing (Table 4). This was observed in both experimental groups by measuring the thoracic circumferences. In the first group, the best results were those of the Hirtz measurement, whereas in the second group – of the Hirtz measurement. Thus, the systemic homeostasis was improved as well as the respiratory volume of lungs.

Table 4. Chest circumference (Percent)

<table>
<thead>
<tr>
<th></th>
<th>First group</th>
<th>Second group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hirz - 1</td>
<td>25</td>
<td>36</td>
</tr>
<tr>
<td>Hirz - 2</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Hirz - 3</td>
<td>42</td>
<td>24</td>
</tr>
</tbody>
</table>

The results about the mobility of the different parts of the spine (Table 5) are important from a practical point of view. Children from the first group exhibited improved thoracic spine flexion (Ott’s test; Moshkov’s quad, according to: Karaneshew (Karaneshews) et. al., 1987), whereas children from the second group – lumbar spine flexion (Schober’s and Tom Mayer’s tests, according to: Sokolov (Соколов), Markova-Stareishinska (Маркова-Старейшинска), 1991). In both studied groups, the spine motility was positively influenced with respect to flexion, extension and lateral slopes.

Table 5. Tests for evaluation of vertebral column mobility (Percent)

<table>
<thead>
<tr>
<th></th>
<th>First group</th>
<th>Second group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test of OTT</td>
<td>30</td>
<td>16</td>
</tr>
<tr>
<td>Test of Shober</td>
<td>33</td>
<td>34</td>
</tr>
<tr>
<td>Test of Tom Mayer</td>
<td>36</td>
<td>40</td>
</tr>
</tbody>
</table>

Comparing the relative shares of Ott’s test results in both groups (Fig. 5.), there were statistically significant differences with \( U=2.32 \), \( U>2.13; \alpha=0.05 \) between the two groups. The first group benefited more from the applied rehabilitation programme combined with swimming.
CONCLUSIONS
After the complex rehabilitation programme combined with swimming, it could be concluded that:

- The specific combination of isometric exercises contributed to enhancement of the tone of weak muscles and for the build up of a strong muscular corset in both studied groups of children;
- The dynamic breathing exercises and diaphragmatic breathing improved the mechanics of breathing and chest mobility in both studied groups;
- The special correction exercises resulted in mobilization of the vertebral column and correction of the posture and gait of children;
- The good therapeutic effect of the rehabilitation programme was achieved in combination with swimming.

The applied rehabilitation programmes in both studied groups resulted in stabilization of the equilibrium, general strengthening of the body and stimulation of the psycho-emotional tone of children. The therapeutic effect, in comparison with routine rehabilitation protocols used in children with spinal deformities, was better.

REFERENCES


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