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The effect of ORTO® thoracic lumbosacral orthosis on neurophysiological parameters, muscle strength and posture in children

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Objective of the work was to produce a comprehensive evaluation of the motor system, spine muscles and posture as effected by orthoses. **Material and methods.** 28 children with scoliosis posture (mean age of 10 ± 0.4 years). Bilateral diagnostic transcranial magnet stimulation of *m. abductor hallucis* was performed for all the patients to assess latency and amplitude of evoked motor potential, voluntary activity of thoracolumbar muscles (*m. latissimus dorsi*) recorded at three locations with surface electromyography (EMG) evaluating mean amplitude and frequency of turns of interference pattern and posture in coronal and sagittal planes using optical topography assessing deviations of the spinal axis from the central line, kyphosis and lordosis angles. The studies were carried out prior to the usage of ORTO® orthosis and in 1 to 2 days on completion within 2 weeks during 8 hours daily. **Results.** All children of the second series showed shorter latency in segmental MEPs, increased amplitude, increased amplitude of interference curve and low frequency, less deviations of the spinal axis from the central line, lordosis and kyphosis angles. **Conclusions.** Pediatric application of ORTO® thoracic lumbosacral orthosis to improve posture showed no statistically significant decline in functional activity of the spinal muscles during 2 weeks. The usage of the brace resulted in a typical response in all the cases including better motor nerve conduction at periphery, increase in functional motor neuron activity, thus, enhancing neuroplasticity.
Keywords: orthosis, scoliosis, neuroplasticity, transcranial magnetic stimulation, electromyography, optic topography

INTRODUCTION

Bracing is one of major conservative methods used to treat spinal injuries and diseases and applicable in different modes from ancient times [1].

Spinal braces are available in custom-fabricated and off-the-shelf versions designed for cervical, thoracic, lumbar and sacral spine either alone or in different combinations (lumbar-sacral, thoracic lumbosacral, etc.) [2].

Spinal orthoses are categorized as flexible, rigid and semi-rigid and functional corrective considering their specific design in classification of technical aids of rehabilitation including posture corrector, reclinators and orthopaedic bandages [3]. The usage of either rigid or semi-rigid (i.e. inelastic) bar to fix the elements providing major orthotic function of the corset makes the difference with orthopaedic bandage [1].

Spinal corset is one of high demands in treatment of several pathological conditions. There are reports concerning hypo- or atrophic muscles of spine developing with corset bracing which is discrediting for orthotics on the whole and spinal braces applied for treatment of various types of dorsopathy, and for prophylaxis of disturbed posture, in particular [4].

Imaging modalities (US, magnetic resonance imaging of muscles) and punch biopsy are used for objective assessment of muscle atrophy; overall muscle activity can be clinically evaluated with surface electromyography [5]. The method is known to be used for m.longissimus dorsi assessment before and after rehabilitation program [6, 7]. Although the standard surface EMG fails to evaluate deep muscular structures with accurate differentiation the interference curve meets the demands of overall activity review before and after rehabilitation measures [8].

Transcranial magnet stimulation (TMS) is a diagnostic and therapeutic technique that was introduced into clinical practice at the end of the last century [9]. TMS as a diagnostic tool is used for patient with epilepsy, CNS tumors, amyotrophic lateral sclerosis, spinal disorders and other pathological conditions in adults and children [10, 11].

Alternatively to surface EMG TMS allows for assessing the integrity of the central motor pathways and excitability of spinal motor neurons that is reported to be greater in scoliosis [7]. TMS applied in dynamics with different treatment techniques, robot assisted mechanotherapy for children, in particular, can provide objective information about dynamics in the functional condition of motor pathway all along the way [12].

Objective of the work was to comprehensively assess motor system condition, spine muscles and posture as effected by the usage of orthosis.

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MATERIAL AND METHODS

The study included 28 children with a mean age of 10 ± 0.4 years (range, 10 to 12 years), among them 16 girls and 12 boys. Based on orthopaedic examination and past medical history including radiograph of the spine taken within a one-year period all children were diagnosed with either scoliosis, i.e. nonstructural spine deformity that could be volitionally corrected, or idiopathic scoliosis of thoracolumbar spine of at least grade I according to V.D.Chaklin.

Three methods of comprehensive examination were performed for all children.

Diagnostic transcranial magnet stimulation (TMS) was employed to assess nerve conduction bilaterally from lumbar enlargement in the spinal cord to effector muscles of lower limbs (*m. abductor hallucis*) and functional activity of motor neurons of cervical enlargement in the spinal cord. The latency and amplitude of motor evoked potentials (MEP) were investigated.

Voluntary muscle activity at the thoracic and lumbar spine (*m. latissimus dorsi*) was studied at three sites using surface electromyography (EMG). An average amplitude and average turns frequency of interference pattern were evaluated. *Neuro-MS-D* magnetic stimulator and *Neuro-MVP-8* electroneuromyographic device (*Neurosoft*, Ivanovo) were used for TMS and EMG.

Dynamics in habitual vertical posture was assessed in coronal and sagittal planes using optical measurements of scoliotic, kyphotic and lordotic angles. *DIERS Medical* optical topography system Germany) was applied for the evaluation.

All patients underwent comprehensive examinations prior to ORTO® bracing and 1 to 2 days following the application. The daily corset usage was 8 hours during 2 weeks.

The ORTO® thoracolumbosacral orthosis used in the study is an off-the-shelf version with a bar made of inelastic textile fabrics providing semi-rigid fixation. The brace has four additional rigid adjustable planchettes, 2 for paravertebral and 2 for lumbar spine, elastic straps to focus on lumbar spine fixation and inelastic reclination straps for sagittal correction of the thoracic spine. Reclination straps are equipped with belt-loops to avoid displacement and shock-absorbing pads at axillary vascular and nerve bundle.

A written informed consent to participate in the research was obtained from parents or legal representatives with all the details explained to them.

The findings were compared between the groups using descriptive and parametric (Student's t-test) statistical methods. $P < 0.05$ was considered statistically significant. STATISTICA software package was applied for Windows.

RESULTS

Each of the children responded well to the research, no adverse effects were observed with the usage of the brace in any of the patients.

Overall neurophysiological findings are presented in **Table 1**.

Dynamics in orthopaedic measurements is presented in **Table 2**.

As seen in the tables, the dynamics in neurophysiological findings of the study pediatric group was characterized by shorter latency of segmental MEP in the second series, increase in amplitude, increase in amplitude of interference curve with lower frequency; all changes were not statistically significant ($p > 0.05$) with steadfast tendency. The set of changes was observed in all the cases indicating to the standard response of nervous and muscular system to the ORTO® thoracolumbosacral orthosis applied to correct posture in coronal and sagittal planes.

The changes in the study parameters are presented in **Figure 1**.

Table 1

Dynamics in neurophysiological findings of the study pediatric group

Value ± SD	Lat. MEP, ms	MEP amplit., mV	Average amplit. of interf. curve, mV	Average frequency of interf. curve, turns/second
First series	17.8 ± 2.66	7.63 ± 4.62	311.24 ± 53.75	306.44 ± 87.75
Second series	16.91 ± 1.14	8.54 ± 3.91	329.91 ± 47.63	280.58 ± 67.14

Note: MEP lat., latency of motor evoked potential from *m. abductor hallucis*; MEP amplit., amplitude of motor evoked potential from *m. abductor hallucis*.

Table 2

Dynamics in orthopaedic measurements of the study pediatric group

Value ± SD	Deviation from the central line, mm	Kyphosis angle, °	Lordosis angle, °
First series	20.4 ± 4.51	42.6 ± 3.04	43.8 ± 3.61
Second series	19.4 ± 3.19	39.6 ± 3.11	40.01 ± 2.56

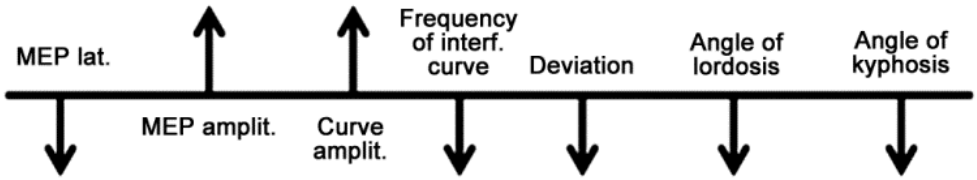

Fig. 1 Overall changes in the study values

Shorter MEP latency reflected faster conduction of motor pathways; and the increased amplitude was indicative of enhanced functional activity of motor neurons (lumbar enlargement of the spinal cord in this case), correspondingly [5, 13]. Increase in average amplitude of the MEP interference curve summed up enhanced activity of motor units with lower frequency being indicative of their less recruitment. We can suppose that greater bracing fixation to rigid/immobilization version has an adverse effect on spine muscles. No decrease in average amplitude of EMG interference curve following brace application in adult patients was reported in 35 publications of meta-analyses [4]. No statistically significant decrease in muscle strength was noted in any of the publications, moreover, several authors reported greater muscle strength after the usage of orthosis [4]. Statistically significant muscle atrophy was reported in one clinical observation with longer (more than 2 months) brace application, and the atrophic changes were shown to be reversible [14, 15]. Our findings are in line with the data obtained in meta-analyses.

Changes in orthopaedic parameters included decrease in angles of spinal axis deviation from the central line, lordosis and kyphosis that indicated to the signs of normal posture in sagittal and coronal planes.

Changes in functional condition of the spine flexor and extensor muscles due to an injury and disease are known to result in imbalance [1, 7] that entails greater energetic efforts to maintain vertical posture, faster muscle fatigue, discomfort and pains [7].

Construction elements of ORTO® orthosis with its stabilizing, unloading and corrective effects on muscles and ligaments of the spine were practical for treatment and prevention of disturbed posture and primary scoliosis eliminating muscle imbalance.

CONCLUSIONS

Based on the findings, we can draw several conclusions.

1. Orthosis used to correct pediatric posture with the ORTO® thoracolumbosacral corset within 2 weeks did not result in statistically significant decline in functional activity of the spinal muscles.

2. The usage of the brace showed a typical response in the cases including better motor nerve conduction at periphery, increase in functional motor neuron activity, thus, enhancing neuroplasticity.

3. Application of semi-rigid and less rigid orthoses was safe with regard to overall activity of skeletal musculature.

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