Application of the concept of tancegrity in the rehabilitation of children with intellectual disabilities

UDC 611.73; 612.75

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Received by the editorial office on 23.12.2023

Abstract

Objective of the study was to identify postural disorders in children with mental retardation and to develop a method of physical rehabilitation based on the positions of the tansegrity model.

Methods and structure of the study. The scientific work involved 80 children born in 2008-2009, evenly distributed into 2 groups: with mild mental retardation and healthy schoolchildren. It was proposed to use three tests: scoliometry, measurement of flexibility in forward bending and a test of visual assessment of functional shortening of muscles and muscle imbalance, to determine existing disorders according to the theory of myofascial chains of T. Myers and the concept of the **tansegrity model.**

Results and conclusions. Rehabilitation training, developed using the TRX system to correct identified disorders, showed positive results and the effectiveness of the physical rehabilitation technique. In particular, scoliometry indicators improved in 25% of children with mental retardation, flexibility increased by 5.39 cm (before the experiment -5.14±2.01, after two courses of rehabilitation 0.25±1.82), functional shortening of muscles in the form of lateral deviation corresponded to scoliometry data: when compared with the initial data, in 25% of children after the experiment there was no movement of the body beyond the midline when bending forward.

Keywords: *posturological disorders, mental retardation, rehabilitation, tansegrity, trx training.*

Introduction. The term "tancegrity" was coined by the architect Buckminster Fuller in 1962 in a statement about "integrated tension." This term refers to structures whose integrity is maintained due to the balance between constant tension forces acting simultaneously on the entire structure. “Tansegrity reflects the principle of interaction of structures in which the shape of an object is preserved due to the finite general and continuous forces of compression within the system, and not to the point forces of the components of such a structure” [2, 3].

Thomas Myers proposed applying this model to the human body, creating in 1997 the concept of anatomical trains and myofascial meridians.

This concept is based on the assumption that the muscles of the human body do not function as independent units. Instead, they are viewed as part of a tensegrity-like network spanning the entire body, with fascial structures serving as connecting components. Since fascia can transmit tension [4] and taking into account its proprioceptive and nociceptive functions, the presence of myofascial meridians may be a response to both posturological changes in the body and the irradiation of pain to distant anatomical structures of the body. The central rule for choosing meridian components is a direct linear connection between two muscles [5]. Using this structure, Myers creates 11 lines of myofascial anatomical trains that regulate movement.

According to various data and systematic reviews of domestic and foreign studies, the presence of 6 myofascial lines (meridians) is confirmed:

superficial posterior, superficial anterior, posterior functional, anterior functional lines, spiral and lateral lines.

Considering the postural characteristics of children with intellectual disabilities and analyzing the coordination and synchronization of motor actions, we built our research and methodological work around three myofascial lines: the superficial posterior line, the spiral and the lateral lines, due to the fact that the vertical position of a person is formed and maintained by adjusting the anterior imbalance, stabilization of the “front tilt” of the body, this determines the importance of the dorsal fascia in maintaining postural balance.

Objective of the study was to identify postural disorders in children with mental retardation and to develop a method of physical rehabilitation based on the positions of the tansegrity model.

Methods and structure of the study. 80 children born in 2008-2009 took part in the scientific work. from Yekaterinburg, who were divided into 2 groups: 40 children with mild mental retardation from correctional educational institutions and 40 healthy children from a comprehensive school. Physical rehabilitation was carried out in a 2-month course, once every six months, with systematic classes 2 times a week throughout the year (2 courses were conducted).

When organizing the study, written consent was obtained from parents to conduct it. To analyze postural disorders, each participant underwent 3 tests:

1. Scoliometry (Fig. 1) – assessment of spinal deformities and disorders of the musculoskeletal system in forward bending using a scoliometer. A scoliometer is a device designed to measure the angle of lateral inclination of the torso and rotation of the vertebrae during examination of a patient in a forward tilt position, allowing quantitative assessment of body deformation in the horizontal plane.

Scoliometer measurements were carried out in three zones: in the upper thoracic region (Th3–Th4), mid-thoracic region (Th5–Th12) and in the thoracolumbar region (Th12–L1 or L2–L2). A scoliometer measurement of 0 was defined as symmetry of the area under study. From 0˚ to 3˚ – borderline values, from 3˚ – asymmetry of the area.

2. Measuring flexibility in forward bend (Fig. 2). The goal was to lean forward as low as possible with your legs straight. First, the participant was asked to perform two preliminary bends; during the third bend, the participant had to bend forward as much as possible and record the result for 2 seconds. The amount of flexibility was measured in centimeters.

3. Test for visual assessment of functional muscle shortening and muscle imbalance (Fig. 3). When bending forward with straightened knees, the presence of rotation of the body and the movement of the upper body beyond the midline of the tilt was assessed. If it is available, as, for example, shown in Fig. 3, muscle shortening was recorded in the direction of inclination along the posterior or lateral myofascial lines. The results obtained were correlated with test 2 and received additional confirma-

Figure 1. Scoliometry testing

Figure 2. Flexibility testing

Figure 3. Visual assessment

Scoliometry test results, (persons)

Group	Before the experiment	After 2 stages of correction work
Schoolchildren with intellectual disabilities	32	24
Healthy schoolchildren	19	15
Forward bend test results (flexibility), (cm)		
Schoolchildren with intellectual disabilities	-5,14±2,01	0,25±1,82*
Healthy schoolchildren	3,80±1,34	5,07±1,19

tion, if available, in the case of a change in the angle of inclination on only one side across all assessment zones.

Results of the study and discussion. The presence of an angle of lateral inclination of the torso of more than 3° and rotation of the vertebrae during examination of the patient in the forward bending position in the majority of tested schoolchildren. In the context of the topic under consideration in this article, of greatest interest is the change in angle on one side of the body, which indicates muscle imbalance along the posterior myofascial lines and linear functional shortening of muscles. Thus, before the experiment, 32 out of 40 schoolchildren with intellectual disabilities had these changes on one side, while in 19 out of 40 healthy schoolchildren (see table). These changes were correlated and confirmed by visual assessment in the third test.

Testing from a standing forward bend with straight legs showed a lack of flexibility in schoolchildren with mental retardation, in average values the inability to reach the floor with their fingertips (see table), which indicates reduced functioning of the muscular-ligamentous apparatus and possible causes/consequences of posturological disorders.

It is proposed to build rehabilitation work using a multifunctional tool for working with your own weight - the TRX loop. This simulator has many advantages: training on it allows you to help strengthen and develop muscles, their endurance, improve coordination abilities, work with motor control, proprioception; and while hanging, stretch the muscles in different positions. The variability of the program can be varied; the balancing component and the absence of a specified movement along the axis of execution allow you to create exercises of a different nature.

It is proposed to formulate methodological features of training on TRX loops, including the following provisions:

1. Lesson duration 40-60 minutes.
2. Training exercises are performed with changing modes of muscle work: in a concentric mode and with a static delay of up to 5 seconds during work (for example, in one execution 10 times with a delay and 5 times without a delay; in another execution - 15 times without a delay).
3. In one lesson, 10-12 exercises are performed,

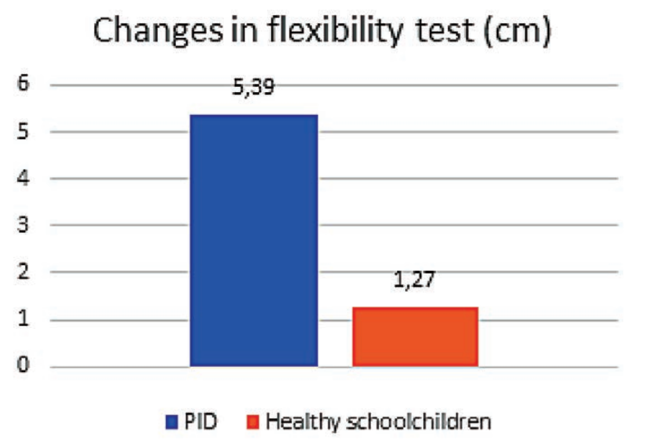

Figure 4. Changes in flexibility indicators after correctional work

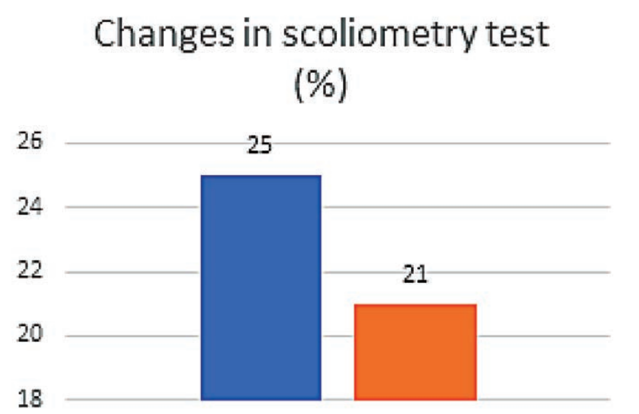

Figure 5. Changes in scoliometry parameters after correctional work

which, as training progresses, are repeated 2 approaches in the formed combinations.

4. Exercises are combined based on following functional lines, 3 exercises each. Each subsequent exercise complements the previous one according to the anatomical group of synergistic functioning. Examples of combinations of exercises:

- latissimus dorsi, rhomboids, triceps brachii;
- calf muscle, hamstring muscles, gluteal muscles;
- abductor muscles, gluteal muscles, quadratus lumborum muscle;
- trapezius muscle, deltoid, biceps brachii;
- back extensor muscles in combination with balancing exercises.

5. Combinations of exercises for antagonist muscles for switching and alternating between main exercises (grouped in 2-3 exercises). Examples:

- exercises on the abdominal muscles, the front surface of the thigh;
- exercises for the pectoral muscles, biceps brachii.

6. At the end of the session, stretch all myofascial lines for 10 seconds in each position: 8-10 exercises.

7. Mandatory lesson variability: each subsequent lesson should contain 30-40% of new exercises from the previous lesson.

After two courses of classes, schoolchildren with intellectual disabilities increased flexibility in bending forward by an average of 5.39 cm, and healthy schoolchildren by 1.27 cm (Fig. 4). According to scoliometry indicators, the number of cases of the angle of lateral inclination of the torso on the side of the same name decreased (Fig. 5) both in persons with mental retardation and in healthy schoolchildren.

Conclusions. Thus, the use of TRX training, based on the positions of the tansegrity model in the method of physical rehabilitation of children with mental retardation, has effective results in reducing posturological disorders, increases flexibility, reduces muscle asymmetries and better motor control of movements.

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