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An Assessment of Rotational Mobility of the Trunk among Teenagers with Faulty Posture

by
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Body posture is determined by many factors, including central regulation connected with anti-gravitational mechanism which develops in ontogenesis. Postural disorders arise as a result of a compensatory anti-gravitational mechanism, in which the main component is reduced postural tone (volume and distribution disorders). Compensation mechanisms consist in improper alignment of particular body segments (distribution disorders) (e.g., increase or decrease of spinal curvatures, external or internal rotation of the lower limbs, valgus and varus deformity of the knees and feet). Such disorders may constitute a reason for abnormal component development, thus limiting trunk rotational mobility.

An aim of the study was to assess the range of trunk rotational mobility.

Pupils (n=123) aged 13-15 underwent the following parameter evaluations: 1. Posture according to Kasperczyk's scoring method, 2. Postural tone volume by analysis of pelvis control in the long sitting, 3. Range of trunk rotation with use of upper tension test (muscle latissimus dorsi and thoracolumbar fascia).

Positive tension test was recorded in 32 children (21 unilateral and 11 bilateral). Diversification of statistical averages of scoring for body posture, from the lowest (x=6.41) in 91 subjects with negative tension test, to the highest (x=7.72) in 11 subjects with double-sided positive result was recorded. Statistical analyzes confirmed significance of correlation between body posture's quality and trunk's rotational mobility (r=0.286 at p=0.001), as well as between volume of postural tone and range of trunk's rotational mobility. Coefficients of correlation amount to, respectively, for tension test and free sitting position r=0.187, p=0.038; and for tension test and corrected sitting position r=0.253, p=0.05. Disorders of muscle tone volume and distribution cause limitation of trunk rotational mobility development.

Key words: *faulty posture, rotation of the trunk*

Introduction

Many functional, commonly performed movements are of a complex character. They are performed on many planes and contain a rotational component. The rotational component is present in both the movement of the limbs and the trunk. (Kabat and Knott 1948).

The rotation element, conditioning all locomotor movements in various positions, is present while changing the position of the body (e.g., rolling, going

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on all fours, sitting, attempting to stand up or walking). Rotation plays an important role in adapting the posture to voluntary movements, increasing the range of upper limbs and maintaining body balance during various movements. (Nowotny et al. 1993).

Movements along the longitudinal axis, in the ontogenetic process, develop on the basis of the tonic neck and labyrinth reflexes. (Nowotny et al.1993, Bobath 1964). Fundamental basis for the rotation movements are, however, righting reactions, mainly from "body on the body" reactions group (Touven 1978). The development of rotation movements occurs along with muscle tone integration development, and depends on it. Starting from the domination of righting and equilibrium reactions, the postural alignments develop in mobility and postural patterns. These appear successively in three planes: sagittal, frontal and transversal. (Scherzer and Tscharnuter 1982). Alignment in the transversal plane develops the latest, and gives the possibility of independent rotation or, in fact, counter-rotation of body girdles, which constitutes the last pattern of basic postural control. (Scherzer and Tscharnuter 1982, Matyja and Domagalska 2005).

The Bobath's scheme of postural tone development includes 6 phases, of which rotation appears only in the fourth phase and develops gradually during the perfection of postural tone integration. (Matyja and Domagalska 2005, Quinton 1987).

The scheme considers integrated co-operation of postural flexor and extensor muscles, which with time leads to trunk rotation movements.

1. The flexion-adduction phase lasts from the age of 0 to 2 months. The rotation between individual spine vertebrae at this age is prevented by characteristic for an infant excessive anterior-posterior kyphosis of the spine. (Banaszek 2004). 2. The flexion-abduction phase lasts from the age of 3 – 4 months. Propping on forearms and joining hands in the middle line appear but no elements of rotation can be observed. 3. The extension-abduction phase lasts from the age of 4-5 months. Rolling "en block" with hands joined together in the middle line is enabled by decreased abduction of the extremities and decreasing of the supporting surface. The roll initiates turn of the head and continues in this direction. There is, however, no rotation of the trunk. (Błaszczyk 2004) 4. The phase of strong extension with abduction appears around the age of 5-6 months, where "body on the body" righting reactions dominate. The reaction starts with a turn of the head, which causes adjustment of the shoulders, and simultaneously, a gradual counterturn of the shoulder girdle; however, both girdles align in one plane because the pelvis gradually moves in the same direction as the shoulders. (Bober 1985, Borkowska 1999). A different sequence can also frequently be seen, where the turn of the head is followed by pelvic girdle, together with lower extremities, and only then the shoulder girdle. In each case we can, however, observe a spiral movement whose constant element is, at some time, trunk rotation (counterturn of both girdles).

For the first time we deal with a complex movement. The possibility of rotation of the spine at the joints runs gradually in cephalocaudal order. Apart from the control of the head and trunk, and support-straighten reactions of the upper limbs, rotation constitutes a basic element as a starting point for future activity (Błaszczyk 2004).

The complete extension of the spine enables further development of the rotation between the vertebrae, which in turn allows free head movements – left and right – and at the end of six months leads to coordinated turn from supine to prone position. (Quinton 1987). 5. The phase of rotation along the body axis appears between the age of 7 and 8 months. At 7 months an infant gains the ability to roll, (i.e., turn from the abdomen to the back). During this apedal form of locomotion, rotational component is clearly visible. At this time a child also begins to crawl, at first backwards, then gradually forwards with the use of upper limbs, without the possibility of rotation. With time, infant starts crawling based on an amphibia reflex which uses rotation. 6. The progression phase appears between the age of 9 and 10 months and is the period of improvement of posture and mobility patterns based on rotation. By the end of 10 months we can observe efficient backwards and forwards crawling, going on all fours, turning around the body axis in sitting position and standing.

In all mentioned forms of activity rotation can be observed. Around 12 months of age, children obtain the ability to walk on all fours, supporting themselves on hands and feet - the so called "bear walk". Between the ages of 13-16 months, a child acquires an independent gait in straighten position and is able to make a turn in place. The gait is at first uncertain and performed with stiff, straight, wide standing lower limbs, with upper limbs abducted for balance. At the stage of the first steps the child does not use rotation. With time, we can observe alternating work of upper and lower limbs, connected with rotation mobility of pelvic and shoulder girdles. Rotary movement of the pelvis coaxes the opposite shoulder into a counter movement, protruding to keep the body balance. Alternating movements of shoulder and pelvic girdles, noticeable during a normal gait, are the manifestations of a normal trunk rotation component. (Bobath 1964, Touven 1978). It is worth stressing that rotation mobility development is gradual and the new locomotor skills in their early stage are made without rotation. Rotation appears during their improvement in the following manner:

- rolling en block (without rotation) - rolling with rotation
- crawling on all fours without rotation – crawling on all fours with rotation
- lateral gait without rotation
- gait with lower limbs raised without rotation
- gait with rotation

Despite the fact that during quadri- and dipedal locomotion, the rotation component is not as clearly visible as in apedal locomotion, it constitutes a constant element of all kinds of locomotion. It is, thus, definitively built in the engrams of locomotive movement coordination. (Nowotny et al. 1993, Błaszczyk 2004, Bober 1985).

Trunk rotation develops as the last component of movement thus, in pathological states it is either disturbed first or does not appear at all. Central nervous system dysfunctions always cause the appearance of decreased postural tone.

As a consequence, an incorrect anti-gravitational mechanism appears with its characteristic functional blockades in various body segments. These blockades enable stabilization in gravitational conditions, causing simultaneously disturbances of body posture, mainly in the sagittal plane (e.g., protraction – retraction of shoulder blades, increased or decreased pelvis anteversion); thereby disturbing the body alignment in this plane. The blockades enforce incorrect body posture in the sagittal plane but also cause disturbances in frontal and transverse planes, limiting dissociations between shoulder and pelvic girdles. As a result, the range of rotation mobility is limited.

Table 1

Division of the examined according to sex

Gender	Number	Percentage
Girls	60	48.78
Boys	63	51.22
Total	123	100

The goal

Faulty body posture in sagittal and frontal planes is a consequence of decreased postural muscle tone. An abnormal curvature of the spine may be treated as functional blockades limiting the development of many motor features, including rotation of the spine, which secondarily limit the development of the rotational component. Taking the above into account, the goal of the present study is:

1. to evaluate the range of rotation mobility in children with faulty posture
2. to evaluate the usefulness of the upper tension test (m. latissimus dorsi) for examining the range of rotation mobility

Material and method

School aged boys and girls (n = 123), aged 13-15, pupils of No. 13 Primary School in Bytom were examined for the purpose of the present study.

The children were examined as to evaluate:

1. Body posture, 2. Postural muscle tone, 3. The range of trunk rotation mobility

The body posture was assessed according to Kasperczyk's method (Kasperczyk 2001). These points were given for alignment and configuration in sagittal and frontal planes of the following body segments: head, shoulders, shoulder blades, chest, abdomen, spine (chest kyphosis, lumbar lordosis and scoliosis) and position of knees and arching of feet. The maximum points for faulty posture were 28, whereas the punctuation for correct posture was between 0-5 points, slightly incorrect 6-12 points and severe faults over 12 points.

Postural muscle tone has been assessed subjectively by punctuating the quality of long sitting:

0 points - correct position (long sitting), upright trunk, lower limbs straightened in knee joints (correct pelvis control); 1 point – trunk slightly humped, lower limbs straightened or slightly bent in knee joints (slight disturbed pelvis control); 2 points – faulty position, total trunk kyphosis, lower limbs bent in knee joints (significant disturbed pelvis control).(Matyja et al., 2004).

An assessment of rotation mobility was examined with use of upper tension test (latissimus dorsi muscle and thoracolumbar fascia).

Figure 1

0 pts - correct pelvis control | *1 pt – slightly disturbed pelvis control* | *2 pts - severely disturbed pelvis control*

Figure 2

Assessment of trunk rotation mobility – upper tension test

The elevation of posterior superior iliac spine in the opposite side of rotation points out the shortening of latissimus dorsi muscle and thoracolumbar fascia this is also limitation of trunk rotation. 0 pts – no tension symptoms, 1 pt – only one tension symptom (elevation of posterior superior iliac spine on one side only); 2 pts – two tension symptoms (elevation of posterior superior iliac spine both on the left and right side).

Results

Subjects were divided into 3 groups depending on the number of recorded tension symptoms in the upper tension test. The most numerous group (91 subjects) constitute teenagers without tension symptoms, the remaining 32 presented unilateral or bilateral symptoms.

The Kasperczyk's method was used to obtain assessment of normal body posture or minor defects of body posture. The statistical mean for groups divided according to the number of tension symptoms range from 6.41 - 7.72. It was observed that in teenagers with positive upper tension test, the body posture is relatively worse than in those who did not show the symptoms – directly proportional dependence was observed. (Table 3).

The analysis of correlation of the results of Kasperczyk's method and upper tension test showed statistically significant relations between these parameters (r = 0.286, p=0.001 with significance set at $p<0.05$). Thus, we can assume that in people with faulty posture, the latissimus dorsi muscle is more often subjected to contracture, and in consequence, trunk rotation mobility becomes limited.

Punctuation of individual body segments evaluated by Kasperczyk's test in three separate groups has been also analyzed. The number of points usually increases in people with tension symptoms, however, a statistically significant correlation was only recorded in relation to lordosis (r = 0.198, p = 0.029, with significance set at $p < 0.05$).

Table 2

Division of the examined according to sex

The number of tension symptoms	Number of subjects examined	Percentage
0	91	73.9
1	21	17.07
2	11	8.94
Total	123	100

Table 3

Assessment of body posture according to Kasperczyk's method based on the upper tension test

Number of tension symptoms	Number of subjects examined	Mean $\overline{x}$	Minimum	Maximum
0	91	6.41±2.25	0.00	12.00
1	21	7.00±2.50	1.00	12.00
2	11	7.72±2.10	5.00	13.00

Further analysis concerns the range of rotation mobility of the trunk in aspect of postural tone of the examined subjects. The measure of postural tone used here is the quality of pelvis control in long sitting.

Statistically significant correlation was also found between the value of postural tone and the range of rotation mobility of the trunk. The correlation coefficient for tension test amounted to r = 0.187, r = 0.038, respectively, $p < 0.05$.

Discussion

The obtained results points out the existence of a correlation between the value of body posture and the value of postural tone and the upper tension test. This implies that people with faulty posture and decreased postural muscle tone have a tendency to limit their trunk rotation. While analyzing the relation between the value of the position of individual body segments and the results of upper tension test, statistical relevance was only seen in reference to lumbar lordosis. This result may indicate that the lumbar segment of the trunk is exposed to incorrect positioning due to faulty posture and accompanying limitations of rotation mobility more often than other parts of the body. It is possible because the development runs in cephalocaudal direction, thus pelvic control (which develops last) may undergo disorders to a greater extent than the control of body segments which are situated higher.

Neuro-developmental approach to faulty posture shows that observed incorrect alignment of particular parts of the body can be analyzed in categories of disorders of postural reflex mechanism. (Matyja and Gogola 2005). The main disordered element of this mechanism is postural tone, which decreases. This in turn creates the need for compensation in order to stabilize the body. Compensations may be of a different character (active or passive), and their manifestation is an incorrect distribution of tone, which can be observed as a faulty posture. (Matyja and Gogola 2005).

Compensations, also called functional blockades, are carried out in sagittal and frontal planes which means that they obstruct the development of rotation in the transverse plane (i.e., rotation mobility) (Matyja et al. 2004, Matyja and Gogola 2005). Certainly, the blockades cause many more abnormalities, however abnormality connected with discussed here problem of rotation mobility of the trunk, was pointed out. Summing up – the limitations of rotation mobility may be a consequence of disturbed (even to a small degree) postural reflex mechanism. While attempting to correct faulty posture, one should consider normalization of postural muscle tone in such a way as to eliminate the necessity of using compensatory mechanisms. An attempt to increase rotation mobility of the trunk may not bring the expected results without removing the cause of their formation.

Table 4

Average punctuation for evaluated parts of body by Kasperczyk's test based on upper tension test results

Evaluated parts of the body	Number of tension symptoms		
	0	1	2
head	0.61	0.57	0.45
shoulders	0.94	1.00	1.18
shoulder-blades	1.02	1.04	1.09
chest	0.40	0.66	0.27
abdomen	0.78	0.85	1.09
kyphosis	0.32	0.33	0.36
lordosis	0.82	1.09	1.27
scoliosis	0.68	0.80	1.00
knees	0.52	0.42	0.63
feet	0.28	0. 28	0.36

Table 5

Assessment of quality of postural tone depending on the number of tension symptoms

Number of tension symptoms	Number of the examined	Mean $\overline{x}$	Minimum	Maximum
0	91	1.41± 0.55	0.00	2.00
1	21	1.71± 0.46	0.00	2.00
2	11	1.63 ±0.50	1.00	2.00

It is difficult to present obtained results in comparison with studies of the other authors. Many publications presenting trunk rotation issues in infants and teenagers as well as in adults have been distinguished, yet no publication concerning trunk rotation issues in children with faulty posture was found.

Trunk rotation in infants is examined mainly in relation to scoliosis and other structural dysfunctions of the spine. While examining shortening of the different muscle groups in children with structural dysfunctions of the spine (scoliosis, Scheuermann's disease) in comparison with control group – it was stated, that problem arise rather from functional shortening of the lower limbs than from the muscles of the trunk. (Białek and Kotwicki 2009)

The range of trunk rotation was also compared between girls with scoliosis who had been treated with the ortesis and those who had not used this equipment (Cobb's angle minimum 25°, maximum 40°). Ortesis have improved the range of the trunk rotation including rotational movements. (Kotwicki et al. 2007).

The range of trunk rotational mobility was assessed in subjects in the different age bracket – young aged 25-35 and older aged 65-80. It was determined, that the range of motion of the cervical region of the spine and trunk decreases with age – range of extension movement, lateral bend, and trunk rotation were included. (Effects of age and gender on maximum voluntary range of motion of the upper body joints.(Doriot and Wang 2006) Limitation of the range of rotational mobility of the trunk in obese women was established. (Menegoni et al. 2008) Part of the study concern the force of the muscles responsible for the trunk rotation depending on the angle of the hip-joints alignment – examination was carried out using David F 120 Lumbar/Thoracic Rotation device, at -30°, 0° and 30° angles for evaluation of the trunk rotation.

The optimal angle, at which the highest maximal isometric force values were found at the thoracolumbar region of the spine, was -30° for trunk rotation.(Straton and Cismaş 2009)

Analyzing literature concerning trunk rotation, title assessing range of this motion among the infants with postural faults was not found.

Conclusions

1. Teenagers with faulty posture have a limited range of rotation mobility of the trunk.
2. Upper tension test can be used to assess the range of rotation mobility of the trunk.
3. While planning the correction of the range of rotation mobility, one should consider normalization of postural tone.

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