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DEVELOPMENT OF LOW POSTURAL TONE COMPENSATORY PATTERNS – PREDICTED DYSFUNCTION PATTERNS IN UPPER PART OF THE BODY

ROZWÓJ WZORCÓW KOMPENSACJI OBNIŻONEGO NAPIĘCIA POSTURALNEGO U DZIECI – PRZEWIDYWANE WZORCE DYSFUNKCJI W GÓRNEJ CZĘŚCI CIAŁA

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Abstract

Lower postural tone is not always associated with central nervous system structures damage. There is a such kind of tone that stays within the broadly defined normal range, but is characterized by distinct decrease of tone of the deep muscles responsible for stabilization. External syndromes are features of active or passive compensation observed in the postural and motor patterns.

Active compensation of the lower muscle tone is associated with excessive use of the superficial muscles for stabilization that leads to limitation of motion in the joints and to functional shortening of some muscles. Active compensation mechanisms in the upper part of the body cause translation of the head before the line of the shoulders, high alignment of the shoulder girdle and increase of the thoracic kyphosis (spastoidal type).

Passive compensation is initiated in case of decreased tone of both deep and superficial muscles. Stabilization is kept with considerable participation of the spatial shape of bones, ligaments, meniscus and passive properties of the muscles. Tendency to hypermobility of the periarthritis elements is observed, which is manifested by the increase of the physiological range of motion in the joints. As a result in the upper part of the body postural faults develop, which are characterized by decreased thoracic kyphosis and sunken chest (atetoidal type).

These observations indicate that lower tone of the muscles responsible for stabilization triggers off the sequence of compensatory mechanisms that ultimately lead to specific postural faults.

Key words: postural tone, body stabilization, low postural tone, compensatory mechanism, posture faults

Streszczenie

Stan obniżonego napięcia posturalnego nie zawsze związany jest z uszkodzeniem struktur ośrodkowego układu nerwowego. Można wskazać taki rodzaj napięcia, który zawarty jest w obszarze szeroko pojętej normy, ale wyraźnie cechuje się obniżonym napięciem głębokich mięśni odpowiedzialnych za stabilizację. Zewnętrznym objawem są cechy kompensacji czynnej lub biernej obserwowane we wzorcach posturalnych i motorycznych.

Kompensacja czynna obniżonego napięcia wiąże się z nadmiernym wykorzystaniem do stabilizacji mięśni powierzchownych, co doprowadza do zmniejszenia zakresu ruchomości w stawach oraz do funkcjonalnego skrócenia niektórych mięśni. Mechanizmy kompensacji czynnej w górnej części ciała prowadzą do przemieszczenia głowy przed linię barków, wysokiego ustawieniem obręczy barkowej, zwiększeniem kifozy piersiowej (typ spastoidalny).

Kompensacja bierna zostaje uruchomiona w sytuacji obniżonego napięcia zarówno mięśni głębokich, jak i powierzchownych. Stabilizacja utrzymywana jest przy znacznym udziale przestrzennego kształtu kości, więzadeł, łąkotek i pasywnych właściwości mięśni. Obserwuje się wówczas tendencję do hipermobilności elementów okołostawowych, co manifestuje się zwiększeniem fizjologicznego zakresu ruchu w stawach. W efekcie w górnej części ciała dochodzi do powstania wad postawy charakteryzujących się zmniejszoną kifozą piersiową, lejkowatą klatką piersiową (typ atetoidalny).

Obserwacje wskazują, że obniżone napięcie mięśni odpowiedzialnych za stabilizację wyzwala szereg mechanizmów kompensacji, które finalnie doprowadzają do powstania specyficznych wad postawy ciała.

Słowa kluczowe: napięcie posturalne, stabilizacja ciała, obniżone napięcie posturalne, mechanizm kompensacji, wady postawy

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Observations indicate that the greatest difficulties in muscle recruitment for stabilization occur in the cervical and lumbar segments, that is, in the areas that require greater involvement of the myofascial structure. According to the cephalocaudal development, head control develops first. Even Leonardo Da Vinci when describing musculature of the cervical segment had noticed that muscles, which are situated more centrally, stabilize joint connections of the spine that is, accomplish the tasks of the segmental control. Whereas the muscles situated more peripherally work like the hawsers that are holding a mast and show a tendency to initiate movement of cervical segment, which means they are responsible for the control of the global orientation of the cervical segment (1). Contemporary reports confirm and expand the knowledge in this scope. According to Myers in the normal situation, the muscles of the shoulder girdle should be completely excused from the task of head support, which should be stabilized in greater degree by the deep muscles (longus capitis and longus colli muscles) (2).

Observation of the children with spastoidal type allows deducing that weakness of the deep muscle tone is compensated by excessive tension of the superficial neck and shoulder girdle muscles as well as muscles of the upper limbs (fig. 1, 2). Therefore, hypotonia of the deep muscles is the primal problem, and hypertonia of the superficial muscles constitutes compensatory response.

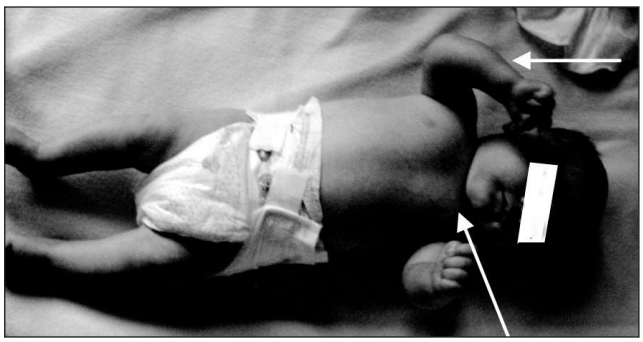

Fig. 1. Example of compensatory involvement of the superficial anatomy trains (Superficial Anterior Train of Upper Limbs) for head stabilization in infant in supine position.

Ryc. 1. Przykład kompensacyjnego zaangażowania powierzchownych taśm anatomicznych (Taśmy Powierzchownej Przedniej Kończyn Górnych) do stabilizacji głowy u niemowlęcia w pozycji supinacyjnej.

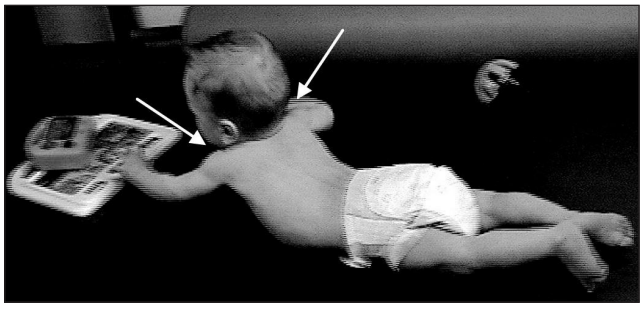

Fig. 2. Example of compensatory involvement of the superficial anatomy trains (Superficial Posterior Train of Upper Limbs) for head stabilization in infant in prone position.

Ryc. 2. Przykład kompensacyjnego zaangażowania powierzchownych taśm anatomicznych (Taśmy Powierzchownej Tylnej Kończyn Górnych) do stabilizacji głowy u niemowlęcia w pozycji pronacyjnej.

Furthermore, Myers points out that for head stabilization levator scapulae muscle, which connects transverse processes of the cervical vertebrae with shoulder blades apex, can be also used (2). The levator scapulae muscle runs parallel with the splenius muscles and it is located well enough to counteract each pull to the anterior aspect of the cervical segment or head. The problem is that the shoulder blade is not a stable supporting point and becomes pulled frequently to the posterior aspect of the cervical segment. Such situation cause in consequence protruding shoulder blades and posture with "forward thrust of the head". Myers also indicates the possibility of replacement the anterior part of trapezius muscle with sternocleidomastoid muscle (2).

When observing development of dysfunction patterns in the upper body part, it is worth noting the relationship between the tone within two pairs of the muscles, which are responsible for stabilization of the shoulder blade and which influence the shape of thoracic kyphosis. The first pair is formed by the rhomboids and serratus anterior muscles, and the second pair by the pectoralis minor muscles and the lower part of the trapezius muscles. Increase of the thoracic kyphosis is associated with the increased tone of serratus anterior muscles ("bolted in shortening") and stretching of the rhomboids ("bolted in extension"). Anterior tilt of the shoulder blade relative to the ribs is triggered off by excessive tone of the pectoralis minor muscle ("bolted in shortening") and by extension of the lower part of the trapezius muscle. These two features - increase of the thoracic kyphosis and anterior tilt of the shoulder blade - are observed in children with spastoidal type of the muscle tone (fig. 3 a, b) (2).

Specific alignment of the head, cervical segment and shoulder girdle resemble described by Janda upper crossed syndrome that cause postural overload manifested by pain syndromes in later periods of life (3, 4).

Increased kyphosis is accompanied by specific shape of the thoracic cage. Excessive activation of the global abdominal muscles, which is observed in the presence of the local muscles insufficiency cause blocking of the lower costal arches that can be a reason of widened cross section of the thoracic cage observed in this group of children (fig. 4) (1, 6, 7, 8, 9, 10).

As a consequence of abnormal activation of the latissimus dorsi muscle occurs that contributes to reduction of movement abilities of acromiohumeral complex (flexion, abduction, external rotation) (11, 12). This hinders the performance of the antigravitational movements of the upper limbs, external rotation of the shoulder joints and supination of the forearm, thereby influencing hand functions (13, 14). Because of this, the infants have a problem with antigravitational activity of the upper limbs and achieve bilateral control or reach their knees late.

In infants with atetoidal type of the muscle tone, greater participation of passive subsystem is observed, which is manifested in the upper body part by the "hung" of the head on the shoulder girdle in prone (fig. 5a). Moreover, excessive extension of the entire spine is observed and its stabilization is based in great measure on the passive structures – spatial bones shape, ligaments and intervertebral discs. Such arrangement causes rapprochement of the shoulder blades to the middle body line and perhaps imposes specific distribution of the muscle tone within the rhomboids – serratus

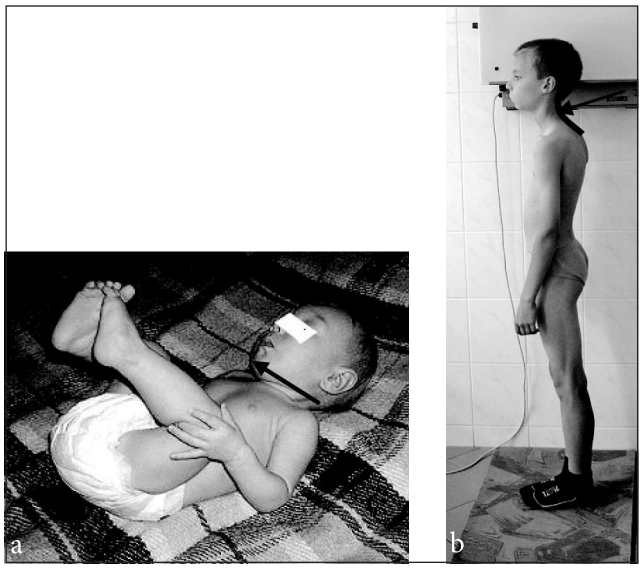

Fig. 3. Typical features of head and shoulder girdle alignment and shape of thoracic kyphosis in children with spastoidal type: a) in infant; b) in older child.

Ryc. 3. Charakterystyczne cechy ustawienia głowy, obręczy barkowej oraz kształtu kifozy piersiowej u dzieci z typem spastoidalnym: a) u niemowlęcia; b) u dziecka starszego.

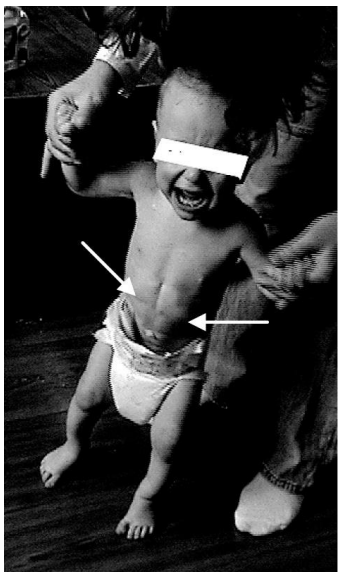

Fig. 4. Tendencja do zwiększenia obwodu klatki piersiowej na skutek nadmiernej aktywacji mięśni globalnych u dziecka z typem spastoidalnym.

Ryc. 4. Tendencja do zwiększenia obwodu klatki piersiowej na skutek nadmiernej aktywacji mięśni globalnych u dziecka z typem spastoidalnym.

Fig. 5. Comparision of head and shoulder girdle stabilization quality in two infants: a) with atetoidal tone type; b) with normal postural tone type.

Ryc. 5. Porównanie jakości stabilizacji głowy i obręczy barkowej u dwojga niemowląt: a) z atetoidalnym typem napięcia; b) z prawidłowym napięciem posturalnym.

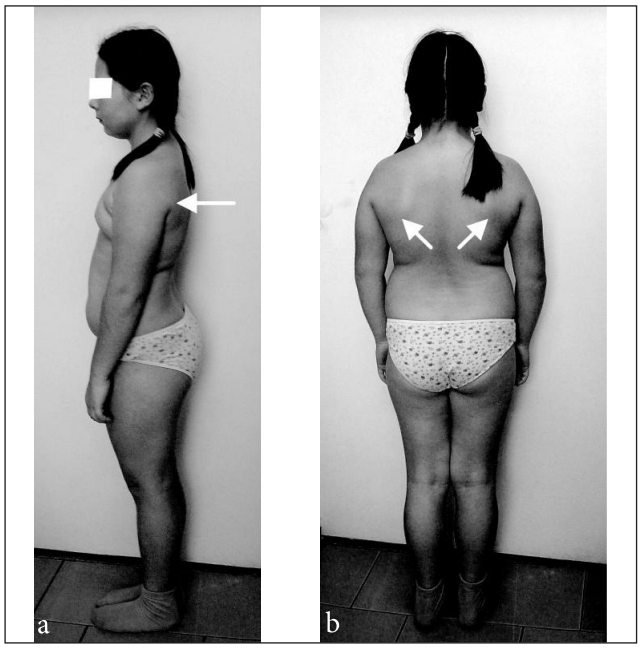

Fig. 6. Typical alignment of the shoulder blade in an older child with passive compensation type: a) in sagittal plane; b) in frontal plane.

Ryc. 6. Charakterystyczne ułożenie łopatki u dziecka starszego z typem kompensacji biernej: a) w płaszczyźnie strzałkowej; b) w płaszczyźnie czołowej.

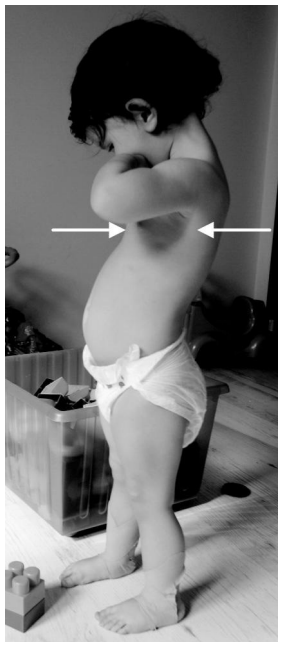

Fig. 7. Tendency toward flattened chest as a result of reduced activation of local and global muscles in the child with the atetoidal type.

Ryc. 7. Tendencja do spłaszczenia klatki piersiowej na skutek zmniejszonej aktywacji mięśni lokalnych i globalnych u dziecka z typem atetoidalnym.

anterior muscles' pair. According to Myers' theory it can be assumed that decrease of thoracic kyphosis observed in this type is associated with increased tone of the rhomboids muscles ("bolted in shortening") and stretching of serratus anterior muscles ("bolted in extension") (2).

Head and shoulder girdle control in child with atetoidal type (fig. 5a) in comparison with child with normotonia (fig. 5b) illustrate the differences in participation of the individual subsystems responsible for stabilization of the upper body part.

Above deliberations may explain adherence of the shoulder blades to the thoracic cage along with decrease of the thoracic kyphosis in older children with atetoidal type (fig. 6a, b). Such formation of the thoracic kyphosis is also associated with other mechanisms, which will be discussed in a subsequent publication.

In the atetoidal type sunken chest is observed, which is most likely associated with weak activation of the transversus abdominis muscle. In the normal conditions, this muscle manifests two-sided activity and hence decreasing abdominal cavity, in the lower part flattening it a little that leads to increase of the intra-abdominal pressure and increase of the thoracolumbar fascia and frontal fascias (1). Furthermore this muscle demonstrates strong connections with the diaphragm, which automatically increases its tone responding consistently to the activation of the transversus abdominis muscle (15-18). According to the studies presented by Hodges, the diaphragm serves postural and respiratory function simultaneously (19, 20). It can be assumed that in children with atetoidal tone type proportions between postural and respiratory function are disturbed that is manifested by specific shape of the thoracic cage (21-24). Decreased circumference of the upper parts of the thoracic cage, protruding lower costal margin and concavity within the sternum are observed (fig. 7).

Different types of muscle tone accompanied by forms of compensations were distinguished by authors based on practical observations (25-27). Based on the present knowledge supported by scientific studies, reasons of the observed abnormalities of the postural and motor patterns can be explained currently (28). Compensations of the low muscle tone include all the body, but on account of the editorial issues it was necessary to describe mechanisms acting in the upper and lower part of the body separately.

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