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BIOMECHANICAL APPROACH TO CRANIO-VERTEBRAL PATHOLOGY IN CHILDREN

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Abstract. In this article, intervertebral disc overloading in children is considered. Pathological craniovertebral changes are reported to be accompanied by static and motional malfunction of the cervical spine, resulting in pathological cervical curvature and uneven load on vertebral segments during movements.

Key words: spine, intervertebral disc overloading, cervical osteochondrosis

Nervous system diseases associated with spinal, particularly cerebral pathology rank among the most frequent neurological diseases in adults. Though this pathology in children is not clinically manifested, its initial signs and latent process can occur in childhood. Taking into account that vertebral pathology tends to progress, it is worthwhile to start its prevention as early as possible [1].

One of the prerequisites of cervical osteochondrosis in adults is intervertebral disc overloading. X-raying shows an uneven line of the posterior cervical contour during spinal flexion (Fig. 1a,b) with generally one and rarely 2 or 3 vertebral segments overloaded. The study of U. Zadvornov [2] gives evidence to high frequency of uneven load on cervical intevertebral discs. Having X-rayed 1200 normal subjects the author revealed the signs of osteochondrosis in 6% of those aged 30 to 35 years and in 90% of those aged 55 to 60 years. An uneven distribution of the load on cervical vertebral segments during flexion was observed. The author showed that the frequency of pathological disc overloading in different age groups correlated with an increasing proportion of severe osteochondrosis in elderly patients.

Intervertebral disc overloading has a complex genesis. Its main cause is regional fixation (decreased mobility) of the vertebral column. Two types of disc fixation could be differentiated: 1) unreversible osteoarticular fixation due to congenital or acquired disc concrescence and 2) muscular fixation having a reflex or adaptation character resulting from traumas, abnormal development, positional overloading, etc. Exclusion of one or several vertebral segments from the motional process results in compensatory overloading and thus to pathological mobility in the neighbouring vertebral segments [3]. In response to overloading, reflex and adaptation reactions of cervical muscles and disbalance of vertebral muscular corset on the whole increase, it affects the motional and static function of the spine.

Muscular disbalance of the cervical spine manifests in altered cervical curvature (lordosis) and uneven vertebral shift during flexion and extension. Normal physiological lordosis is characterized by a smooth moderate anterior arc (Fig. 2). Pathological cervical lordosis (Fig. 3) is characterized by its strengthening, straightening, S-shaped deformity and backward arc [7]. During flexion and extension an uneven, deformed line of the posterior contour of cervical vertebrae is observed (Fig. 1 b, c). The deformity type depends on the pathology and pathological tension of certain muscles [8].

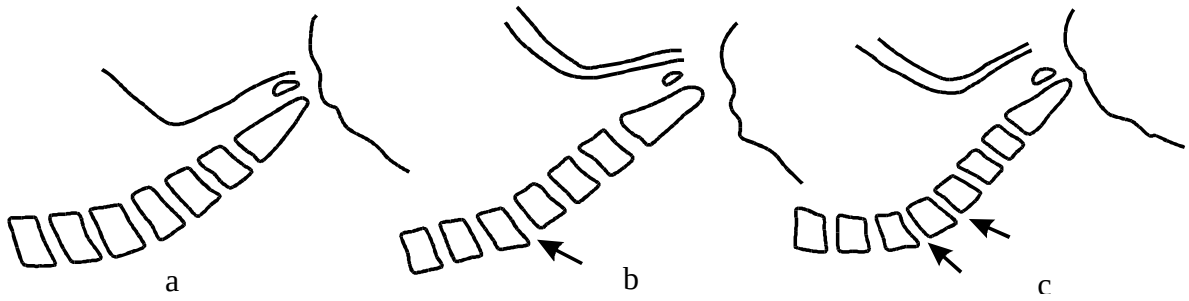

Fig. 1. a) Normally under flexion, the curve drawn over the back contour of vertebrae bodies is smooth. b,c) Pathologically, the smoothness of the curve is absent. The arrows show overloaded vertebral motive segments.

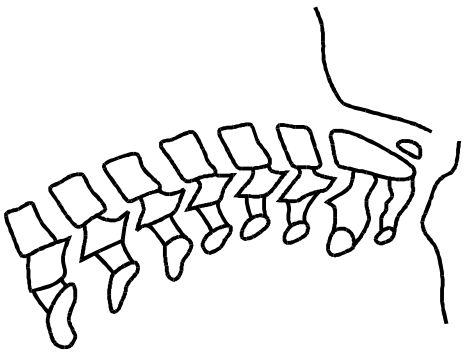

Fig. 2. Normally, the physiological cervical lordosis is moderate.

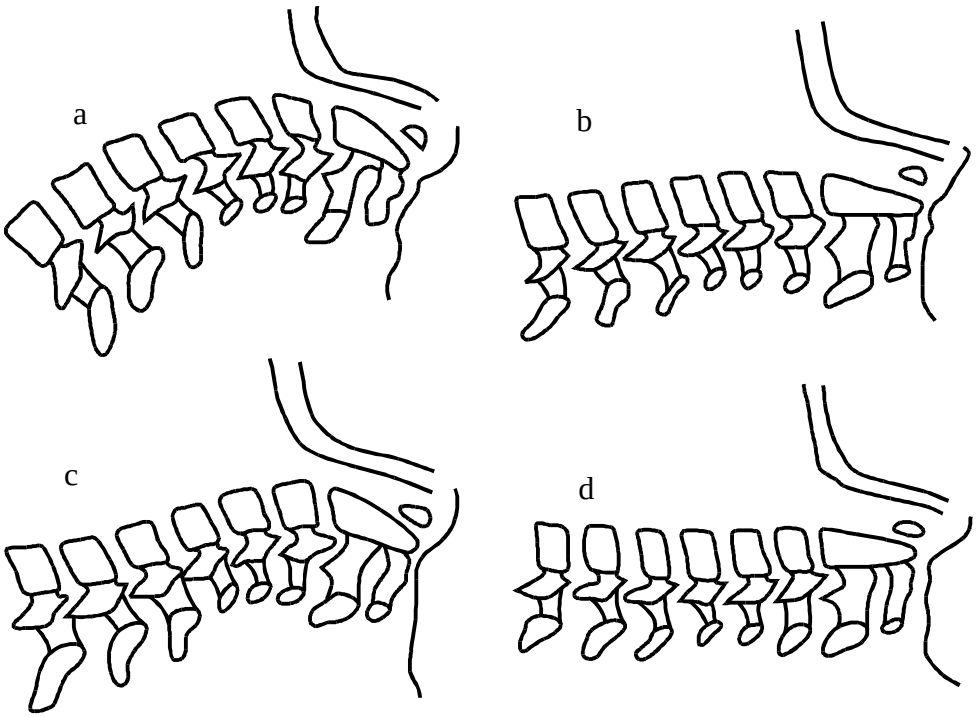

Fig. 3. Pathological forms of cervical lordosis.
a) Increase of extent of cervical lordosis.
b) Straightening of cervical lordosis.
c) S-shaped form of cervical lordosis.
d) Convex back curve.

An uneven load distribution on intervertebral discs sometimes occurs in childhood. We observed these disorders to be most frequent in craniovertebral pathology. Craniovertebral region is a transition site between the skull and vertebral column. It includes two joints: occipitoatlantoid joint between the occipital bone and the first cervical vertebra, and atlantoaxial joint between the first and the second cervical vertebrae. The region is distinguished by its complex anatomical structure and frequent abnormal development [4]. Craniovertebral region is affected more frequently during traumas than it is generally acknowledged [5,6].

Clinical examination and X-raying of 360 patients aged 4 to 16 years has shown that craniovertebral pathology is characterized by moderate or marked fixation. In 92% of children fixation was observed not only in craniovertebral joints but throughout the cervical region as well. Pathological cervical lordosis was noted in 28% of children with craniovertebral pathology. Compensatory pathological mobility of mid-cervical vertebrae was diagnosed in 39% of children as a result of craniovertebral fixation. The signs of craniovertebral articular and ligamentous distrophy were revealed in 7.5% of patients and were characteristic of children aged 11-16 years. The latter fact is indicative of progressive pathological process in craniovertebral region.

The mechanisms of static and motional dysfunctions of the cervical spine are quite complex. They are realized in some cases due to ligamentous deficiency of the cervical spine, in other cases - due to particular features of osteomuscular and nervous system anatomy and physiology. Involvement of certain muscles in the cervical spine fixation depends not only on the type of cervical trauma and particular vertebral column anatomy, but also on other factors including everyday or sports loads.

Thus, pathological craniovertebral changes are accompanied by static and motional malfunction of the cervical spine, resulting in pathological cervical curvature and uneven load on vertebral segments during movements. The result of biomechanical cervical disorders is early aging of cervical ligaments, intervertebral discs and joints.

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Патология черепно-вертебральной области у детей с позиций биомеханики

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В статье рассматриваются этиопатогенетические и рентгенологические аспекты формирования биомеханических перегрузок шейных межпозвонковых дисков у детей. На основании анализа клинико-рентгенологических данных 360 пациентов от 4 до 16 лет с патологией черепно-вертебральной области показано, что формирование неправильных нагрузок на шейный отдел позвоночника характерно для данной патологии у детей. Закономерности течения патологического процесса в черепно-вертебральной области таковы, что в макроинтервалах времени развивается фиксация этой области с формированием компенсаторной подвижности в расположенных ниже позвоночных двигательных сегментах. Повышенная двигательная функция межпозвонковых дисков в детском возрасте является одной из предпосылок к развитию остеохондроза позвоночника у взрослых. Библ. 8.

Ключевые слова: позвоночник, перегрузки шейных межпозвонковых дисков, остеохондроз

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