Wójcik Gustaw, Wójcik Ewelina, Szulc Anna. Deformation of spine – review of the literature. Journal of Education, Health and Sport. 2018;8(12):689-697. eISNN 2391-8306. DOI http://dx.doi.org/10.5281/zenodo.2529024
http://ojs.ukw.edu.pl/index.php/johs/article/view/6426

The journal has had 7 points in Ministry of Science and Higher Education parametric evaluation. Part B item 1223 (26/01/2017).
1223 Journal of Education, Health and Sport eISSN 2391-8306 7

The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 20.11.2018. Revised: 20.12.2018. Accepted: 29.12.2018.

DEFORMATION OF SPINE – REVIEW OF THE LITERATURE

DEFORMACJE KRĘGOSŁUPA – PRZEGLĄD LITERATURY

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ABSTRACT

Deformation is an undesirable change in shape, which in medicine means a pathological change that applies to all types of tissues, including bone. Spinal deformities refer to changes in the shape of individual vertebrae, which also affects changes in the entire column of the spine and consequently causes defects in posture, which is recognized as a symptom of disability.

The main changes in spinal deformation include deformations of vertebral bodies with changes in their height and formation of bone growth, changes in arches and joints processes and leaving transverse and spinous processes .

Variable number of vertebrae in individual sections of the spine is not treated as a change corresponding to the definition of deformation but as an anatomical variant.
The aim of the work was to present the most common deformities within the spine.

Key words: spine, degenerative changes, deformation vertebra, change in the curvature of the spine

STRESZCZENIE

Deformacja to niepożądana zmiana kształtu, co w medycynie oznacza zmianę patologiczną, która odnosi się do wszystkich typów tkanek, w tym kostnej. Deformacje w kontekście kręgosłupa odnoszą się do zmian dotyczących kształtu pojedynczych kręgów, co globalnie wpływa także na zmiany całej kolumny kręgosłupa i w konsekwencji wywołuje wady postawy, co uznawane jest za objaw niepełnosprawności.

Do głównych zmian deformacji kręgosłupa zaliczyć należy deformacje trzonów kręgowych ze zmianą ich wysokości i powstawaniem narośli kostnych, zmiany w łukach i odchodzących od niego wyrostkach stawowych, poprzecznych i kolczystych.

Zmienna ilość kręgów w poszczególnych odcinkach kręgosłupa nie jest traktowana jako zmiana odpowiadająca definicji deformacji lecz jako odmiana anatomiczna.

Celem pracy było przedstawienie najczęściej spotykanych deformacji w obrębie kręgosłupa.

słowa kluczowe: kręgosłup, zmiany zwyrodnieniowe, deformacja kręgu, zmiany krzywizn kręgosłupa

INTRODUCTION

According to the encyclopedia, deformation is an undesirable change in shape, which in medicine means a pathological change. Changes in shape in the disease process may refer to all organs and systems, and may even cause deformation of the entire body, which is considered a sign of disability. According to this definition, cardiac hypertrophy in cardiac failure will meet the deformation criteria, as well as the decrease in the volume of tissues, such as the reduction of muscle volume due to denervation - atrophy. Similar changes occur also in the bones, which as a result of various disease processes may deform and acquire traits of pathological tissue. The spine as a structure corresponding to the scaffolding on which the weight of the upper body rests, very often undergoes deformation.

MORFOLOGY OF SPINE

The spine of an adult human consists of 33-34 vertically arranged vertebrae forming the axial organ of movement. A single vertebra is made of several elements thanks to which it obtains considerable resistance to mechanical factors. The vertebral components include the body and arch, as well as seven processus: two transverse, one spinous and two pairs of joint processes (two lower joint processes and two upper joint processes).

The body of the vertebrae have the shape of a cylinder bounded from the top and bottom by flat border plates, which in physiological conditions should be parallel to each other, which indicates that the anterior and posterior heights of the stems are more or less equal. A deviation from this rule is the construction of the L5 vertebra, whose participation in the lumbar-sacral transition made its front edge slightly higher than the posterior one. The L5 vertebrae in the sagittal projection, physiologically has a wedge shape.

The joint processes occurring in pairs have convergent shape, and their joint surfaces are set in typical planes appropriate for particular sections of the spine. In the cervical section, the surface of the joint surfaces runs obliquely from the top towards the rear at an angle of approximately 45^{o}, in the thoracic segment in the frontal plane, and in the lumbar region in the sagittal plane. Intervertebral joints have three degrees of freedom of movement (except for the apical-occipital joint (2 degrees of freedom) and peak-rotation (1 degree of freedom) [1].

The transverse and spinal processes attach to the ligaments stabilizing the connections between the individual vertebrae and the muscles that tighten the spine into motion. Vertebrals

in the part supra-cruciate are intimately connected to each other by syndesmosis, synchondrosis and joints. Thanks to the three-point connection of individual movement segments, the spine has significant elasticity, which is the highest in the cervical and lumbar sections. The connections that enable movement include the synovial joints in the back of the spine and the synchondrosis (intervertebral disc) located in its front part.

Zakres ruchów poza ukształtowaniem powierzchni stawowych zależny jest od wysokości krążków międzytrzonowych, które najwyższe są w odcinku szyjnym i lędźwiowym. Wyższy krążek umożliwia większy zakres ruchów [1].

A correctly shaped the spine in the frontal plane should have a straight course, while in the sagittal plane it should be characterized by alternating curvatures. Innate curvature is chest kyphosis, the remaining curvatures are shaped in the child's life. Around the sixth month of the baby's life, cervical lordosis develops. It is an expression of the adaptation of the bone-muscular system of the spine to maintain vertically elevated head, thoracic kyphosis and lumbar lordosis develop in close interrelationship with each other in the 2nd year of life as an expression of adaptive changes in the kinematic chain of the spine, aiming to maintain a vertical position torso with minimal muscle energy.

1. DEFORMATION OF INTERVERTEBRAL JOINTS

Degenerative changes within the intervertebral joints are a consequence of spinal overload disease, which, due to excessive pressure, increase their surface by creating marginal bone growths - osteophytes so as to spread the pressure on the largest possible plane. Depending on the size of the deformation of the interprocessus joints, they may cause stenosis of the spinal canal and the intervertebral holes.

In individual pairs of interprocess joints, the deformation changes may also refer to the asymmetrical position of the joint surfaces, the consequence of which will be limitation of the spine movements on one side of the body relative to the other or even on both sides compared to people in whom these changes do not occur [2].

2. DEFORMATION OF THE VERTEBRAL BODY

Vertebral body deformities are associated with differences in height between the anterior and posterior part of the body, as well as between right and left sides. When the

vertebral body in the sagittal plane does not show a parallel course of border plaques, but becomes debilitated (lowering the anterior edge of the body), it predisposes to global changes affecting the physiological curvature of the spine causing deepening of kyphosis in the thoracic or cervical and lumbar sections of abduction of lordosis with a tendency to kyphotically break the long axis. Deformations of this type affect the volume of the spinal canal, in the first case causing its reduction, and in the second, increasing the volume [3].

If the deformation of the vertebral body occurs in the front view, the difference in the height of the edge between right and left sides is visible. Typically, these changes occur in several movements segments, and their consequence is structural scoliosis. These changes may occur alternately, which in turn gives a „s" curvature of the spine [3].

Distortions of the lower border plates L5 and the upper border plates of the vertebrae S1 are found in dysplastic spondylolisthesis, because it slide the lumbar spine from the sacrum [4, 5].

- **OSTEOPHYTES**

  As a result of damage to the intervertebral disc, its height is lost, which affects the loosening of the longitudinal ligament structure responsible for the axial stabilization of the vertebral bodies. It is externally embossed, thereby entailing the outer fibers of the fibrous disc ring and deforming the vertebral body to form characteristic osteophytes on its upper and lower edges. These changes cause the vertebral body in the frontal and sagittal projections to assume an elliptical shape with a narrow mid-section and wide peripheral parts. In the transverse view, there are visible layers that increase the support plane in relation to the adjacent stems [6].

- **SCHEUERMANN DISEASE**

  In Scheuermann's disease, possibly as a result of ischemic changes or overlapping micro-injuries, there are characteristic changes in the height of the vertebra body between their front and rear parts. The front parts of the vertebra body in relation to the back are losing height, which affects the deepening of thoracic kyphosis and the formation of round backs. In addition, Scheuermann's disease causes changes in border plaques that are characterized by an irregular course [7].

- **FRACTURES**

Fractures usually affect the vertebra body, because it is the weakest part of the vertebra, in which the spongy bone is dominated, surrounded by a thin bone cortex . Inverse proportions dominate in the rear part - an arch with departing seven appendages. Compression fractures most often affect one vertebral body, but they can occur in large numbers. As a result of such a fracture, the spongy substance is densified and the anterior portion of the vertebra body is lowered, and the consequences of fracture have similar consequences as in the case of Scheuermann's disease.

Compression fractures can be treated with rebuilding their heights using kyphoplasty [8,9].

3. DEFORMATION OF VERTEBRAL ARCH AND SPINAL CANAL

Deformations in the vertebral arches are associated with a change in the volume of the spinal canal. The most common changes in the case of deformation of arches are: spondylolisthesis with elongation of the lamina and deficiency of juncture arch [10].

- **CONGENITAL NON-UNION OF THE ARCH**

Congenital non-union of the arch is a condition in which the vertebral canal is incompletely closed. The arch of the vertebrae in the dorsal part does not grow up, leaving a crevice. Failure of the vertebral arch may not show any symptoms even for a very long time, and it is most often detected after X-ray examination of the spine or computed tomography (CT). Forces acting on the spine increase the risk of pain in the area of incoherent arch. The occurrence of symptoms is always related to the location of the lesion. In the majority of cases the incoagency of the arches concerns the lumbar spine at the level of L5 and S1, but it is also found in the cervical segment at the C1 level [10].

- **SPINA BIFFIDA**

Spina bifida is a developmental defect of the spine in which the rear of the arches and spinous processes of one or more vertebrae is nonproduced. This deformity is related to the spinal cord being extended beyond the spinal canal. In spina bifida some vertebrae

are not properly constructed, which may lead to spinal cord penetration outside the canal, and consequently to the formation of so-called spinal hernia. The severity of the disease depends on the part of the spine in which the cleft has occurred. Changes in individual vertebrae usually do not cause symptoms and can be detected accidentally during imaging diagnostics for a completely different reason. Changes in more numerous back injuries are accompanied by a simultaneous abnormal function of the spinal cord. There is a disturbance in the conduct of nerve impulses to various parts of the body. Muscles deprived of innervation disappear, they do not have the strength to work, which causes flaccidity, which leads to deformation of the skeletal system [11].

- **SPONDYLOLISTHESIS**

The spondylolisthesis is a disease state that involves the vertebral body moving in relation to other vertebra. The upper located vertebra moves forward in relation to the vertebra below.

The deformation changes in the vertebral arches are most often associated with the occurrence of spinal differs. In these changes, the arcing lamels are elongated, which lengthen, becoming thinner and less resistant to external forces. At the lesion level, an increase in the volume of the spinal opening is observed [4, 5].

4. DEFORMATION OF SPINOUS PROCESSES

- **MORBUS BASTRUPP**

Bastrupp's disease involves overgrowth of spinous processes, damage to the interspinous ligaments and contact between these processes. For this reason, this condition is called the disease of kissing spines syndrome , although it has nothing to do with the pleasure of kissing. Rubbing against each other is quite painful and causes their overgrowth (sclerotization), which in the frontal view looks as if the edge of one spinous process sawed the furrow in the other. In imaging studies, these changes look like matching joint surfaces, hence they are called pseudo-joints [12].

5. DEFORMATION KYPHOSIS AND LORDOSIS

Distortions of individual vertebrae do not only cause local changes but cause deformations of the entire column of the spine. In the sagittal plane, physiological curvatures can be seen on X-rays, which under the pathology conditions may undergo shallowness or deepening. The softening of physiological curvatures has a strong association with the stenosis of the spinal canal. Patients looking for an analgesic position subconsciously position the spine to increase its capacity. Deepening the physiological curvatures is associated with the pelvic position compensation in the anteversion, which is often found in women in advanced pregnancy, as well as in women who wear high-heeled shoes.

In the frontal plane, pathological curvature of the spine are also known as scoliosis, i.e. lateral bending of the spine. Scoliosis can be functional and structural, with the latter being more difficult to treat [13].

REFERENCES

1. Bochenek A, Reicher M, Anatomia człowieka. Tom 1. Wydawnictwo Lekarskie PZWL, Warszawa 2002; s. 222-232.

2. Wójcik G, Pocztarska A. Variations in morphology of lumbar spinal canal in degenerative discopathy. Health Problems of Civilization, 2016; 10(4): 47-53.

3. Wójcik G. Effect of intervertebral disc disease on scoliosis in the lumbar spine. Current Issues in Pharmacy and Medical Sciences 2014, 27(3): 155-158

4. Wójcik G. Epidemiolologia i klasyfikacja kręgozmyków odcinka lędźwiowo-krzyżowego. Journal of Education Health and Sport, 2017; 7(7): 572-579.

5. Wójcik G. Epidemiologia i klasyfikacja kręgozmyków odcinka lędźwiowo-krzyżowego, Część II. Journal of Education, Health and Sport 2017; 7(8): 367-377.

6. Wong SH, Chiu KY, Yan CH. Review Article: Osteophytes. J Orthop Surg (Hong Kong). 2016; 24(3): 403-410.

7. Wójcik G, Baj-Korpak J, Szulc A. Choroba Szcheuermanna – diagnostyka i rehabilitacja. Conference paper of VI Ogólnopolska Konferencja Naukowo-Szkoleniowa LUBELSKIE DNI PROMUJĄCE ZDROWIE „Medyczno-społeczne i prawne aspekty opieki nad dzieckiem”, Lublin 2018.

8. Wójcik G, Szulc A, Skalska-Izdebska R, Piwoński P, Żmuda-Pałka M. Rehabilitacja osób po zabiegach kyfoplastyki w następstwie złamań osteoporotycznych kręgosłupa lędźwiowego. IX Międzynarodowe Dni

Rehabilitacji. Rzeszów, Conference paper 2017.

9. Wójcik G, Szulc A. Leczenie tradycyjne a wertebro- i kyfoplastyka u pacjentów po złamaniach kompresyjnych trzonów kręgów - możliwości postępowania rehabilitacyjnego. III Ogólnopolska Konferencja Naukowa : Innowacyjna Fizjoterapia - neurologia, pediatria, sport. Conference paper, Lublin 2017.

10. Wójcik G, Sokołowska B, Urbańczuk M, Amarowicz M. Evaluation of the frequency of occurrence of some changes and birth defects of lumbar-sacral spine among patients registering for CT examination due to the back pain. Forum Med. Rodz. 2015, 9(3): 206-208.

11. Urrutia J, Cuellar J, Zamora T. Spondylolysis and spina bifida occulta in pediatric patients: prevalence study using computed tomography as a screening method. Eur Spine J. 2016; 25(2): 590-5.

12. Alonso F, Bryant E, Iwanaga J, Chapman JR, Oskouian RJ, Tubbs RS. Baastrup's Disease: A Comprehensive Review of the Extant Literature. World Neurosurg. 2017; 101: 331-334.

13. Kalichman L. et all. Association between computed tomography-evaluated lumbar lordosis and features of spinal degeneration, evaluated in supine position. Spine J. 2011; 11: 30.