

Adamovych O.O.,
Kryvko Yu.Ya.,

Danylo Halytsky Lviv National Medical University, Lviv, Ukraine

ANALYSIS OF THE OSSEOUS TISSUE DENSITY OF THE ATLAS ANTERIOR ARCH AND THE BODIES OF THE CERVICAL VERTEBRAE IN JUVENILE MEN AND GIRLS OF THE PRECARPATHIAN REGION

Abstract. *The use of computed tomography to study the peculiarities of complicated anatomical areas opens up new possibilities both for clinical work and conducting scientific research.*

Objective of our investigation was to study the indices of the osseous tissue density of the cervical vertebrae and regularities of their correlation in juvenile females and males, residents of the Precarpathian region. In the course of carrying out the study we have analyzed computed tomograms of practically healthy individuals aged from 18-25 (12 males and 9 females). The investigations were performed according to medical indications (not associated with the condition of the osseous tissue and vertebral column) by means of the fourth generation computed tomography scanner TSX-101A Aquilion 16. In the process of the study the osseous tissue density of the atlas anterior arch and the bodies of every cervical vertebra in three areas were measured (along the upper border, in the center and along the lower border) in the direct view applying the standard computer program K-Pacs-Lite.

The indices of the osseous tissue density were found to be the lowest on the level of the middle of vertebral bodies in all the adolescents irrespective of the sex. The second, third, fourth and seventh vertebrae in young men possess the highest density along the upper border of their bodies, and the anterior arch of the atlas and the fifth and sixth cervical vertebrae – along the lower border. In girls the highest indices of density are found along the upper border of the atlas anterior arch and bodies of all the cervical vertebrae except the sixth one. Absolute density indices of all the structures examined on all the levels except the middle of the anterior arch of the first cervical vertebra are higher in young men than in girls. Considering a high individual variability of the indices examined as well as characteristics of different apparatus used for CT examination in case of primary or screening examination, comparison of the indices of the osseous tissue density in different areas of every separate vertebra appears to be the most objective diagnostic criterion. While comparing the indices of the osseous tissue density in different areas of the vertebrae it is reasonable to evaluate the parameter examined on the middle level of the body of every vertebra and anterior arch of the atlas as 100%, and the parameters of the upper and lower borders should be determined relative to it. The osseous tissue density detected along the upper and lower borders of the vertebral bodies is 11-76% higher than in the middle in young men and 15-63% higher in girls. At the same time, in young men the most significant difference of the density indices in different areas is found in the osseous tissue of the anterior arch of the atlas, bodies C₂ and C₄, and in girls – the bodies C₂, C₄ and C₅. For other cervical vertebrae the difference of the osseous tissue density in the middle, upper and lower areas does not exceed 30%.

Key words: *computed tomography, vertebrae, osseous tissue density, juvenile age.*

Introduction. The use of computed tomography to study the peculiarities of complicated anatomical areas opens up new possibilities both for clinical work and conducting scientific research with the aim to find certain standard parameters of the quality of the structures examined for individuals of different age, sex, constitution etc. [8, 9, 10, 11, 12, 13]. To

evaluate the quality of structures visualized by means of computed tomography the Hounsfield units (HU) scale is used (the scale of attenuation of X-ray radiation) with visual black-and-white image reflection on the monitor [6]. The range of the scale units corresponds to the degree of attenuation of X-ray radiation by anatomical body structures and constitutes in an average from –

1024 to + 1024. The Hounsfield units scale is rather informative while conducting differentiated diagnosis of similar diseases as well as foreseeing the progress of pathological processes [2, 3, 4, 5, 7]. Although in practical application these indices differ while examining patients on different apparatus [8, 10, 11]. Therefore, to make the evaluation of the organs and tissues examined more objective it is not reasonable to compare absolute density indices of certain areas with the standard ones, but the correlation of density of different structures visualized on tomogram within the borders of one organ and their comparison with the age standard [1, 2, 6].

Objective of our investigation was to study the indices of the osseous tissue density of the cervical vertebrae and regularities of their correlation in juvenile females and males, residents of the Precarpathian region.

Materials and methods. In the course of carrying out the study we have analyzed computed tomograms of practically healthy individuals aged from 18-25 (12 males and 9 females). All the examined individuals were residents of Lviv region. The investigations were performed according to medical indications (not associated with the condition of the osseous tissue and vertebral column) by means of the fourth generation computed tomography scanner TSX-101A Aquilion 16. In the process of the study the osseous tissue density of the atlas anterior arch and the bodies of every cervical vertebra in three areas were measured (along the upper border, in the center and along the lower border) in the direct view applying the standard computer program K-Pacs-Lite.

Results and discussion. To detect qualitative characteristics of the osseous tissue of the atlas

anterior arch and bodies of the cervical vertebrae computed tomograms of the cervical spine of juvenile individuals were studied. Their density was detected in the direct view along the upper border, in the middle and along the lower border of the structures examined (Figure).



Figure. Detection of the osseous tissue density of the bodies of the cervical vertebrae according to the findings of CT examination (direct view).

Analysis of the data obtained was indicative of the fact that both in young men and girls the index examined was the lowest on the middle level of the vertebral bodies (Tables 1, 2). While comparing the density of different areas of every certain vertebra it was found that the second, third, fourth and seventh vertebrae in young men possess the highest density along the upper border of their bodies, and the anterior arch of the atlas and the fifth and sixth cervical vertebrae – along the lower border (Table 1).

In girls the highest parameters of density are found along the upper border of the atlas anterior arch and bodies of all the cervical vertebrae except the sixth one (Table 2).

Table 1

Osseous tissue density of the cervical vertebra bodies and the atlas anterior arch of young men according to CT examination findings (direct view) (UH) (M±m)

	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	C ₇
Upper border	764,4± 116,5	628,2± 128,9	555,7± 76,4	566,6± 107,0	461,9± 65,8	428,3± 66,7	401,3± 65,2
Middle	450,8± 94,8	419,4± 86,5	444,8± 79,9	416,2± 68,8	397,4± 67,4	354,2± 64,8	312,2± 29,5
Lower border	795,5± 141,0	516,5± 96,5	497,9± 85,2	521,0± 68,9	477,2± 49,0	448,4± 40,0	358,5± 32,8

p ≤ 0,05

Table 2

Osseous tissue density of the cervical vertebra bodies and the atlas anterior arch of girls according to CT examination findings (direct view) (UH) (M±m)

	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	C ₇
Upper border	676,0± 158,1	446,3± 73,5	496,6± 78,3	469,0± 90,1	443,3± 57,9	380,0± 40,8	330,1± 56,0
Middle	557,4± 143,1	272,2± 61,8	389,7± 59,2	351,5± 40,6	334,2± 38,0	304,6± 36,8	271,1± 34,7
Lower border	649,4± 164,0	394,9± 64,0	463,8± 63,9	422,9± 47,4	401,8± 26,8	396,1± 32,9	313,2± 35,9

p ≤ 0,05

Absolute density indices of all the structures examined on all the levels except the middle of the anterior arch of the first cervical vertebra are higher in young men than in girls.

Considering a high individual variability of the indices examined we consider that in case of primary or screening examination comparison of the indices of the osseous tissue density in different areas of every separate vertebra appears to be the most objective diagnostic criterion. Therefore, to make the results of analysis of the osseous tissue density of the structures examined along the upper border, in the middle and along the lower border more objective, we compared them evaluating the osseous tissue density on the middle level of the body of every vertebra and anterior arch of the atlas as 100%. The results of the comparison were indicative of the fact that the osseous tissue density detected along the upper and lower borders of the vertebral bodies is 11-76% higher than in the middle in young men and 15-63% higher in girls. At the same time, in young men the most significant difference of the density indices in different areas is found in the osseous tissue of the anterior arch of the atlas – its density along the upper border was 169,57+25,8%, 169,57+25,8%, and along the lower one - 176,46+31,3% as compared to the indices of the middle area. The indices of the osseous tissue density of different areas of the body C₂ were 149,79+30,5% and 123,15+22,9% for the upper and lower borders respectively, and C₄ - 136,14+25,7% and 125,18+16,3% respectively. In girls the most significant difference of the osseous tissue density indices of different areas of the body was found for the second cervical vertebra – the index examined along the upper border of C₂ was 136,14+25,7% i 125,18+16,3% , along the lower border - 145,08+23,5% as compared to the

index of the middle of the body. Considerable difference of the osseous tissue density indices was found for different areas of the body in C₄ - 133,43+25,6% along the upper border and 120,31+13,3% along the lower one, and in C₅ - 132,65+14,1% and 120,23+7,7% respectively. For other cervical vertebrae the difference of the osseous tissue density in the middle, upper and lower areas does not exceed 30%.

Conclusions. 1. The indices of the osseous tissue density were found to be the lowest on the level of the middle of vertebral bodies in all the adolescents irrespective of sex.

2. The second, third, fourth and seventh vertebrae in young men possess the highest density along the upper border of their bodies, and the anterior arch of the atlas and the fifth and sixth cervical vertebrae – along the lower border. In girls the highest indices of density are found along the upper border of the atlas anterior arch and bodies of all the cervical vertebrae except the sixth one.

3. Absolute density indices of all the structures examined on all the levels except the middle of the anterior arch of the first cervical vertebra are higher in young men than in girls.

4. Considering a high individual variability of the indices examined as well as characteristics of different apparatus used for CT examination in case of primary or screening examination, comparison of the indices of the osseous tissue density in different areas of every separate vertebra appears to be the most objective diagnostic criterion.

5. While comparing the indices of the osseous tissue density in different areas of the vertebrae it is reasonable to evaluate the index examined on the middle level of the body of every vertebra and anterior arch of the atlas as 100%,

and the indices of the upper and lower borders should be determined relative to it.

6. The osseous tissue density detected along the upper and lower borders of the vertebral bodies is 11-76% higher than in the middle in young men and 15-63% higher in girls. At the same time, in young men the most significant difference of the density indices in different areas is found in the osseous tissue of the anterior arch of the atlas, bodies C2 and C4, and in girls – the bodies C2, C4 and C5. For other cervical vertebrae the difference of the osseous tissue density in the middle, upper and lower areas does not exceed 30%.

Prospects of further studies. The results of examination of age and gender peculiarities of the vertebral column as well as its separate areas and vertebrae by means of radiologic methods of diagnostics enabling to detect the density of the structures examined can form the foundation to improve the diagnostic methods of progressing pathological processes in different areas of the vertebral column in early terms before occurring their clinical manifestation.

References:

1. Адамович О.О. Особливості будови шийного відділу хребта у осіб юнацького віку / О.О. Адамович // Морфологічні дослідження – виклики сучасності – 2014 – Суми – С. 11-13
2. Генік І.Д. Дослідження кореляційної залежності показників щільності кісткової тканини від вікових, антропометричних та біохімічних чинників у осіб чоловічої та жіночої статі зрілого віку Прикарпатського регіону / І.Д.Генік // Український морфологічний альманах – 2010. – № 3. – С. 11-12.
3. Савочкіна Н.Л. Гетерогенність змін мінеральної щільності кісткової тканини у жінок з остеоартрозом в постменопаузальному періоді з різним індексом маси тіла / Н.Л. Савочкіна // Укр. мед. альманах. – 2005. – Т. 8, № 2. – С. 122-124.
4. Смирнов В.В. Лучевая диагностика травматических повреждений шейного отдела позвоночника / В.В. Смирнов, Н.П.Елисеєв, Г.М. Раковская // Мануальная терапия. – 2009. – №3 (35). – С. 81-91.
5. Спужак М.І. Рентгенодіагностика травматичних ушкоджень шийного відділу хребта у дітей / М.І. Спужак, О.П. Шармазанова // Український радіологічний журнал. – 2000. – N 3. – С. 291-297.
6. Хоффер М. Компьютерная томография. Базовое руководство. – 3-е изд. – М.: Медицинская литература, 2011. - 232 с.
7. Adamovych O. Association between osteoporosis and no-related metabolic disorders in rats / O. Zayachkivska, O. Kordiyak, A. Safonov // Abstracts "5th international symposium of clinical and applied anatomy and 1st paneuropean meeting of anatomists", Graz, Austria, 24-26 May 2013. – P. 97
8. Adams J.E. Quantitative computed tomography / J.E. Adams // Eur. J. Radiol. – 2013. – № 71 (3). – P. 415-424.
9. Ct of the lumbosacral spinae: importance of tomographic planes parallel to vertebral end plate / J.C. Hirschy, W.M. Leue, W.H. Berninger [et al.] // American Journal of Roentgenology. – 2008. – 136. – P. 47-52.
10. Gunas I. V. Methodological aspects of computed tomography odontomorphometry of boys and girls with the physiological bite / V Gunas, NA Dmitriev, AV Marchenko // Journal of Education, Health and Sport. – 2015. – Т.5., № 11. – P. 345-355.
11. Gunas I. V. Mrrelation computed tomography sizes of lumbar spine on the median-sagittal sections with anthroposomatotypological parameters in healthy girls of Podillya / I Gunas, S Pinchuk, A Shayuk // Вісник морфології/Reports of morphology.- 2015. – Т. 21., №1. – P. 126-130.
12. Naaga J.R. Computed tomography and magnetic-resonance imaging of the whole body / J.R. Naaga. – Mosby, 2003. – 2229 p.
13. Imaging quality and diagnostic reliability of low-dose computed tomography lumbar spine for evaluating patients with spinal disorders / Y. Cheng-Hui, W. Tung-Hsin, C. Yi-You [et al.] // The Spine Journal. – 2014. – Vol. 11, № 14. – P. 2682-2690.