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Age-related changes of pubic symphysis parameters in men in the early adulthood, early and middle old age according to computed tomography data

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Abstract
Aim – to study the dynamics of pubic symphysis parameters in men in the early adulthood, early and middle old age according to computed tomography (CT) data.
Material and methods. In the study, we used the results of a CT examination of 80 men without bone or pelvic organ pathology. All participants gave their consent to routine examination to exclude possible pathology of the pelvic bones. The CT investigation included the measurement of the height, width and thickness of the pubic symphysis in 3D reconstruction mode. The subjects were divided into three groups according to anatomical age classification. The first group included 25 early adulthood men (21 to 35 years old); the second group included 29 early old age men (56 to 74 years old); the third group included 26 middle old age men (75 to 88 years old).
Results. When comparing the parameters of height, width and thickness of the pubic symphysis, their statistically significant decrease by middle old age was revealed. Its height decreased from the early adulthood to early old age by 7.1% ($t = 12.82$, $p < 0.01$) and further remained unchanged in middle old age. The width of the pubic symphysis was decreasing by 22.7% ($t = 8.3$, $p < 0.01$) from the early adulthood to early old age and by 26.5% ($t = 8.32$, $p < 0.01$) from early to middle old age. The symphysis thickness was growing from the early adulthood to early old age by 6.4% ($t = 6.10$, $p < 0.01$) and from early to middle old age – by 1.1% ($t = 1.08$, $p > 0.05$).
Conclusion. The results obtained in this study can be helpful for doctors of such specialties as traumatology, sports medicine and rehabilitation, forensic science, forensic medicine and many others.
Keywords: pubic symphysis, computed tomography, morphometry, men.
Conflict of interest: nothing to disclose.

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Возрастная динамика параметров лобкового симфиза мужчин в первом периоде зрелого возраста, в пожилом и старческом возрасте по данным компьютерной томографии

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Аннотация
Цель – изучить динамику параметров лобкового симфиза у мужчин в первом периоде зрелого возраста, в пожилом и старческом возрасте по данным компьютерной томографии.
Материал и методы. В основу работы положены результаты КТ-исследования 80 мужчин без патологии костей и органов малого таза. Все обследуемые дали согласие на исследование, проводимое по показаниям для исключения возможной патологии костей таза. КТ-исследование заключалось в определении высоты, ширины и толщины лобкового симфиза в режиме 3D-реконструкции. Обследуемых разделили на три группы согласно анатомической классификации возраста. Первая группа включала 25 человек первого периода зрелого возраста (от 21 до 35 лет); вторая группа – 29 человек пожилого возраста (от 56 до 74 лет); третья группа – 26 человек старческого возраста (от 75 до 88 лет).
Результаты. При сравнении показателей высоты, ширины и толщины лобкового симфиза выявлено их статистически достоверное уменьшение к старческому возрасту. Его высота уменьшилась от первого периода зрелого возраста к пожилому возрасту на 7,1% ($t=12.82$, $p<0,01$), далее к старческому возрасту она изменений не претерпевала. Ширина лобкового симфиза от первого периода зрелого возраста к пожилому возрасту стала меньше на 22,7% ($t=8.3$, $p<0,01$) и от пожилого к старческому возрасту – на 26,5% ($t=8.32$, $p<0,01$). При этом наблюдалось утолщение симфиза от первого периода зрелого возраста к пожилому возрасту на 6,4% ($t=6.10$, $p<0,01$) и к старческому возрасту на 1,1% ($t=1.08$, $p>0,05$).
Заключение. Полученные данные могут быть использованы врачами таких прикладных специальностей, как травматология, спортивная медицина и реабилитация, криминалистика, судебная медицина, и многих прочих.
Ключевые слова: лобковый симфиз, компьютерная томография, морфометрия, мужчины.
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INTRODUCTION

Pubic symphysis is a unique anatomic structure localized between two articular facets of pubic bones. Under the various physiological movements, the fibrocartilagenous disk that is its basis resists the compressive and the tensile forces at the same moment. It is particularly noteworthy that for professional athletes, this joint is of paramount importance, as it sustains the primary biomechanical load during most axial movements. However, the investigation of this anatomical structure is not only of interest to sports medicine specialists but also to traumatologists, criminologists, forensic pathologists, and other related professionals [1].

In recent years, there has been a significant trend in the healthcare industry towards personalized medicine. The strength of this individualized approach lies in its capacity to tailor specific decisions towards the most effective treatment for each patient, thereby reducing financial and time expenditures while enhancing the quality of care [2].

This approach has catalyzed new trends in clinical research, particularly regarding the impact of a patient's age and gender on management strategies [3–5]. There is a growing demand among specialists for the establishment of a "morphofunctional standard" to delineate clearly the normative parameters across different age and gender groups, as evidenced by numerous contemporary biomedical studies [6–9].

It should be noted that older individuals, particularly men, are increasingly in demand in the labor market, and the number of socially active older citizens is rapidly growing [10, 11]. These trends present new challenges for the healthcare sector.

AIM

To investigate the dynamics of pubic symphysis parameters in men during early adulthood, middle age, and old age using computed tomography data.

MATERIAL AND METHOD

The study is based on the results of computed tomography (CT) examinations of 80 men without bone or pelvic organ pathology, conducted between 2022 and 2023. All participants provided consent for routine examinations to exclude potential pathology of the pelvic bones. The study received ethical approval from the Ethics Committee of Perm State Medical University named after Academician E.A. Wagner (No. 10, dated 27.11.2019.)

CT scans were performed using the OPTIMA CT 520 unit (“General Electric Healthcare”) equipped with a built-in licensed software kit. The CT examination involved the identification of the height, width, and thickness of the pubic symphysis using 3D reconstruction mode. (**Fig. 1**).

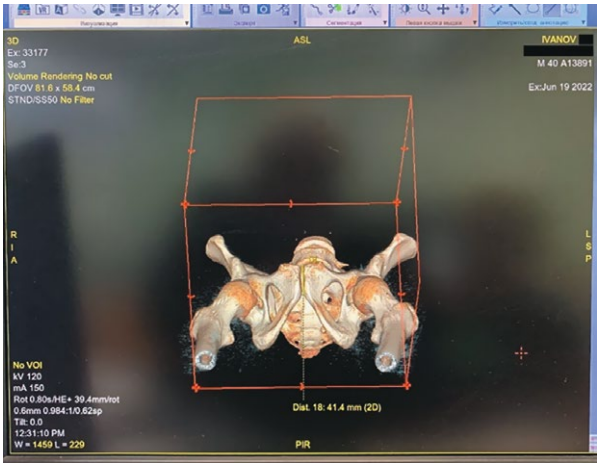

Figure 1. *3D CT-reconstruction of the male pelvis and measurement of the pubic symphysis.*

Рисунок 1. *3D КТ-реконструкция таза мужчины и измерение размеров лобкового симфиза.*

The subjects were divided into three groups based on the anatomical classification of age (Moscow, 1969). The first group consisted of 25 individuals in the first period of adulthood (21 to 35 years); the second group included 29 elderly individuals (56 to 74 years); and the third group comprised 26 older adults (75 to 88 years).

Statistical analysis was conducted using Microsoft Excel 2014. The results were presented as the arithmetic mean (M) and standard error (m), median, and coefficient of variation. The parametric Student's t-test was employed to assess the equality of means in the two samples. Statistical significance was set at $p < 0.05$.

RESULTS

The data on the parameters of pubic symphysis of men in the age periods under investigation are presented in Tables 1–3.

Upon comparing the height, width, and thickness of the pubic symphysis, a statistically significant decrease was observed in old age. E.g., its height reduced from the first period of adulthood to elderly age by 7.1% ($t=12.82$, $p<0.01$,) then it had no changes in the old age. The width of the pubic symphysis reduced from the first period of adulthood to elderly age by 22.7% ($t=8.3$, $p<0.01$) and from elderly to old age, by 26.5% ($t=8.32$, $p<0.01$). At the same time, an increase in the thickness of the symphysis was observed from the first period of adulthood to elderly age by 6.4% ($t=6.10$, $p<0.01$) and to old age by 1.1% ($t=1.08$, $p>0.05$.)

Age period	M±m	Max	Min	σ	Cv	Me
First period of adulthood (n=25)	40,8±0,16	43,1	39,6	0,82	0,02	40,8
Elderly age (n=29)	37,9±0,16	39,8	36,5	0,87	0,02	37,9
Old age (n=26)	37,9±0,15	39,1	36,6	0,75	0,01	37,9

Table 1. *Height of pubic symphysis in males at the studied ages according to CT-scanning (mm, n = 80)*

Таблица 1. *Высота лобкового симфиза у мужчин в исследуемых возрастных периодах по данным КТ-исследования (мм, n = 80)*

Age period	M±m	Max	Min	σ	Cv	Me
First period of adulthood (n=25)	4,4±0,08	5,0	3,8	0,41	0,04	4,4
Elderly age (n=29)	3,4±0,09	4,3	2,7	0,46	0,06	3,4
Old age (n=26)	2,5±0,06	3,1	2,1	0,28	0,03	2,5

Table 2. *Pubic symphysis width in males at the studied age periods according to CT-scanning (mm, n = 80)*

Таблица 2. *Ширина лобкового симфиза у мужчин в исследуемых возрастных периодах по данным КТ-исследования (мм, n = 80)*

Age period	M±m	Max	Min	σ	Cv	Me
First period of adulthood (n=25)	17,3±0,10	18,4	16,7	0,52	0,02	17,3
Elderly age (n=29)	18,4±0,15	19,7	17,1	0,82	0,04	18,4
Old age (n=26)	18,6±0,11	19,6	17,2	0,67	0,02	18,3

Table 3. *Thickness of pubic symphysis in males at the studied ages according to CT-scanning (mm, n = 80)*

Таблица 3. *Толщина лобкового симфиза у мужчин в исследуемых возрастных периодах по данным КТ-исследования (мм, n = 80)*

DISCUSSION

The observed decrease in the linear dimensions of the pubic symphysis in old age is hypothesized to be attributed to biochemical changes occurring within the cartilage tissue at the molecular-cellular level. Two significant points warrant attention: firstly, cartilage tissue is characterized by its mesodermal origin and is largely devoid of high-quality innervation and microvasculature, which distinguishes it from other tissues in the human body. Secondly, it is noteworthy that the chondrocyte is the sole representative responsible for the cellular structure of cartilage tissue. These chondrocyte bodies are embedded within the extracellular matrix, which, according to the literature, accounts for up to 98% of the total volume of cartilage. These intricacies of the histoarchitecture of cartilage significantly influence the biochemical regulation of tissue homeostasis. The primary natural chondroprotector is transforming growth factor β (TGFβ), a protein tasked with maintaining homeostatic balance. Its protective function is extensive; it not only enhances the survival of chondrocyte cells but also regulates biochemical processes within the extracellular matrix [12]. It is unsurprising that in the elderly and old age, once genetically programmed processes are initiated, the synthesis of TGFβ decreases. This leads to an imbalance in the biochemical cascade of cartilage tissue, negatively affecting all stages of proteostasis. This mechanism is vital for the optimal functioning of cells, and its disruption results in decreased proliferation speed of chondrocytes and a mass transition of cells to apoptosis [12–14].

The explanation for the increase in thickness of the pubic symphysis, in our opinion, may be elucidated by the findings of a study conducted by L. Waltenberger et al. (2022). The authors concluded that the anatomical characteristics of the human pelvis undergo changes throughout life, directly influenced by sex and age. During the early stages of life, the anatomical configuration of the pelvis and its osteochondral components are influenced by hormones. However, in the elderly period, when hormone synthesis decreases, changes in the structure of the pelvic bone are predominantly influenced by mechanical factors [15]. Consequently, the pelvis becomes relatively "fragile", massive yet less mobile [16].

CONCLUSION

The findings from this study regarding the dynamics of pubic symphysis parameters in men at various ages may serve as a foundation for further practical developments of both scientific and clinical significance. This data holds potential utility for medical professionals in various applied specialties, including traumatology, sports medicine, rehabilitation, criminology, forensic medicine, and others.

ADDITIONAL INFORMATION	ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ
Study funding. The study was the authors' initiative without external funding.	***Источник финансирования.*** Работа выполнена по инициативе авторов без привлечения финансирования.
Conflict of Interest. The authors declare that there are no obvious or potential conflicts of interest associated with the content of this article.	***Конфликт интересов.*** Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с содержанием настоящей статьи.
Contribution of individual authors. I.A. Balandina – developed the study concept, performed detailed manuscript editing and revision; A.S. Terekhin, A.V. Klimets – has been responsible for scientific data collection, its systematization and analysis, wrote the first draft of the manuscript; A.A. Balandin – manuscript editing. All authors gave their final approval of the manuscript for submission, and agreed to be accountable for all aspects of the work, implying proper study and resolution of issues related to the accuracy or integrity of any part of the work.	***Участие авторов.*** И.А. Баландина – разработка концепции исследования, редактирование текста; А.С. Терехин, А.В. Климец – сбор и обработка научного материала, написание текста; А.А. Баландин – редактирование текста. Все авторы одобрили финальную версию статьи перед публикацией, выразили согласие нести ответственность за все аспекты работы, подразумевающую надлежащее изучение и решение вопросов, связанных с точностью или добросовестностью любой части работы.

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