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**МОРФОМЕТРИЧЕСКОЕ ИССЛЕДОВАНИЕ ТРАХЕИ И ГЛАВНЫХ
БРОНХОВ ЧЕЛОВЕКА ИСПОЛЬЗУЯ ПО ДАННЫМ МАГНИТНО-
РЕЗОНАНСНОЙ ТОМОГРАФИИ**

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**MORPHOMETRIC STUDIES OF THE HUMAN TRACHEA AND MAIN BRONCHI
USING MAGNETIC RESONANCE IMAGING**

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Резюме. В статье представлены данные морфологического и морфометрического исследования трахеи и главных бронхов по данным магнитно-резонансной томографии 29 взрослых человек. Выявлены особенности положения трахеи, представлены морфометрические данные исследованных органов, определены углы бифуркации трахей, определены закономерности положения трахеи.

Ключевые слова: трахея, главные бронхи, бифуркация трахеи, человек.

Resume. The article presents morphometric analysis of the trachea, the right and the left bronchi of 29 adult humans. The features of the special position, the diameters of the studied organs and the angles of bifurcation are revealed. The regularities of the trachea position are determined.

Keywords: trachea, main bronchi, tracheal bifurcation, human.

Objective. The peculiarities of the morphology of the trachea and the main bronchi are a relevant topic in surgical care of the mediastinum, taking under consideration the spatial orientation. The obtained data can be useful for advanced and precise invasive operations, while minimizing damage to healthy tissues. These measurements should be useful in the detection of tracheal abnormalities and in endotracheal intubation, endoscopy, and tracheostomy [1, 2, 3]. In addition, knowledge of a correlation, or lack of it among these parameters may reduce the need for unnecessary invasive diagnostic procedures by providing doctors with preliminary estimates of relevant parameters [4].

Aim: to find morphometrical peculiarities of the trachea and the bronchi in adult human.

Material and methods. The study was performed in 29 adult humans using Magnetic Resonance Imaging. At the study features of the trachea location were noted. During the study the following measurements were taken: the anterior-posterior (AP) diameter of right main bronchi, AP diameter of left main bronchi, AP diameter of the trachea at the level of jugular notch (pic. 1), the distance between the center of the tracheal bifurcation and the supraspinal ligament, the distance between the tracheal bifurcation and the sternum, the angle of the tracheal bifurcation on the frontal plane (pic.2), the angle of the tracheal bifurcation on the horizontal plane (pic. 3). The data obtained were checked for normality of distribution. Descriptive statistics were used and median values were set. Differences between the groups were analyzed using the nonparametric Mann-Whitney

test. Differences were considered significant at $P < 0.05$. A correlation analysis was performed by the Spearman's rank-order correlation.

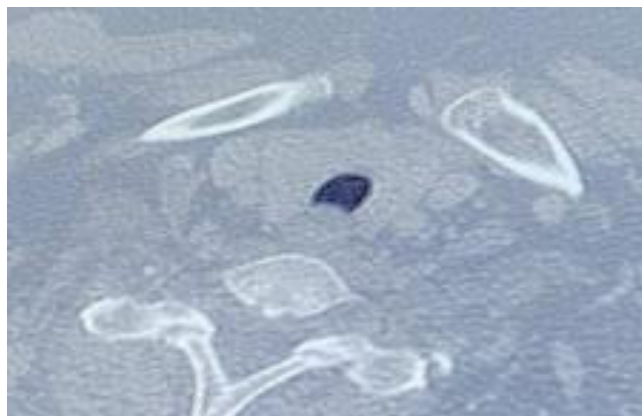


Fig. 1 - Measurement of the AP diameter at the level of the jugular notch

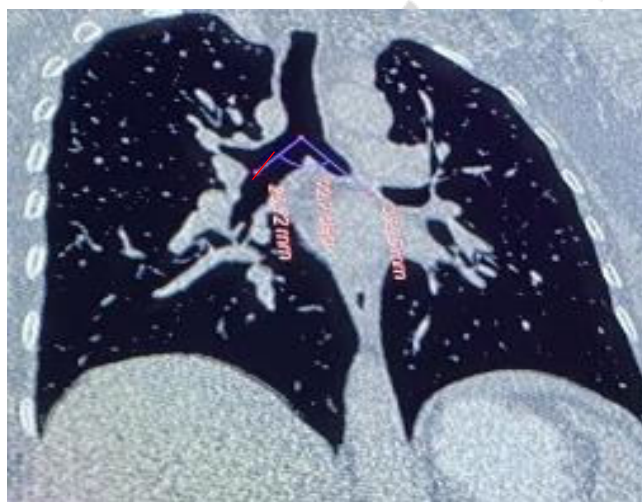


Fig. 2 - Measurement of the angle of the tracheal bifurcation on the frontal plane

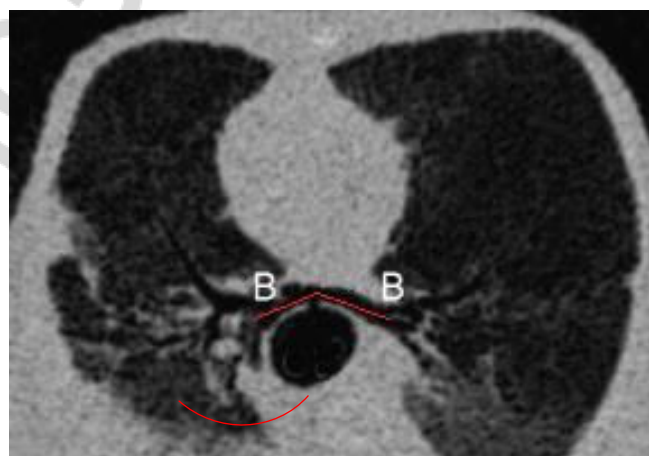


Fig. 3 - Measurement of the angle of the tracheal bifurcation on the horizontal plane

Results and discussion. During the research the following morphometrical data was obtained for both genders: the AP diameter right main bronchi 13,39 (11,58-15,65)mm, the AP diameter left main bronchi 12,03 (10,27-13,47)mm, the inferior diameter of trachea level of jugular notch 17,23 (15,37-21,96)mm, the distance between the tracheal bifurcation and the supraspinal ligament 87,87 (85,53-100,06)mm, the distance of tracheal bifurcation to the sternum 97,67 (88,51-111,95)mm, the frontal angle of bifurcation 88,40 (75,90-98,00)deg, the horizontal angle of bifurcation 137,30 (129,00-153,40) deg.

The mean values of all the measured tracheobronchial parameters were higher for the males than those of the females(table 1).It was established that there is a gender difference in AP diameter of the right main bronchi. AP diameter of the right main bronchi for male 13,90 (12,48 - 16,41) mm, for female 12,05 (10,32- 13,44) mm (Mann–Whitney U = 52,00, z=2,427, P < 0.05 two-tailed). There is also a gender difference in AP diameter of the left main bronchi. The AP diameter of the left main bronchi for male 12,36 (11,66-13,82) mm, for female 10,27 (9,29-11,79) mm (Mann–Whitney U = 43,50, z=2,414, P < 0.05 two-tailed). The angle of the horizontal bifurcation is larger in males 151,75 (136,40-165,10) mm, than in females 129,00(121,10-137,30) mm Distributions in the two groups differed significantly (Mann–Whitney U = 11.5, z=2,25, P < 0.05 two-tailed).

Table 1.The morphometrical differences by gender

	Males	Females
AP diameter of right main bronchi	13,90 (12,48-16,41) mm	12,05 (10,32-13,44) mm*
AP diameter left main bronchi	12,36 (11,66-13,82) mm	10,27 (9,29-11,79) mm*
Inferior diameter of trachea level of jugular notch	20,77 (17,33-23,27) mm	15,64 (14,68-16,43) mm
The distance between the center of the tracheal bifurcation and the supraspinal ligament	89,17 (87,00-100,82) mm	87,50 (76,56-90,94) mm
The distance between the tracheal bifurcation and the sternum	99,68 (97,40-115,88) mm	88,05 (79,40-92,22) mm
The angle of the tracheal bifurcation on the frontal plane	86,60 (78,00-95,80) deg	88,40 (75,90-108,90) deg
The angle of the tracheal bifurcation on horizontal plane	151,75 (136,40-165,10) deg	129,00 (121,10-137,30) deg*

*Significantly lower than males.

According to the obtained result in most of the parameters: AP diameter of the right main bronchi, AP diameter of the left main bronchi, inferior diameter of trachea level of jugular notch, the distance between the center of the tracheal bifurcation and the supraspinal ligament, the distance between the tracheal bifurcation and the sternum, the angle of the tracheal bifurcation on horizontal plane, the median values that were obtained in males are greater than in females. The similar findings regarding the male-female differences in tracheal dimensions from the age of 16 till the age of 20 were found in the articles: N. Thorne Griscom“Dimensions of the Growing Trachea Related to Age and Gender” (1986) [2] and “CT Measurement of the Tracheal Lumen in Children and Adolescents” (1991) [3]. Since both of the articles are dealing with population until the age of 20, and the significant difference between the AP diameters of the trachea can be

seen from the age of 16. It is probable to assume the following research proves this male-female differences in tracheal dimensions in adults once again.

A Spearman's rank-order correlation was run to determine relationships. The result shows statistically significant very strong positive correlation between AP diameter of right main bronchi and AP diameter of left main bronchi, ($r_s = 0.80, p < 0.05$), strong positive correlation between AP diameter of right main bronchi and the AP diameter of the trachea at the level of jugular notch ($r_s = 0.69, p < 0.05$), strong, positive correlation between AP diameter of right main bronchi and the distance between the center of the tracheal bifurcation and the supraspinal ligament ($r_s = 0.63, p < 0.05$), strong, positive correlation between AP diameter of left main bronchi and AP diameter of the trachea at the level of jugular notch ($r_s = 0.62, p < 0.05$), strong, positive correlation between AP diameter of left main bronchi and the distance between the center of the tracheal bifurcation and the supraspinal ligament ($r_s = 0.52, p < 0.05$), strong positive correlation between distance between the tracheal bifurcation and the sternum and AP diameter of the trachea at the level of jugular notch ($r_s = 0.58, p < 0.05$).

Conclusions: as a result of a correlation study, it was found that the greater the AP diameter of the right main bronchi, the greater the AP diameter of the left main bronchi. The greater the AP diameter of the right main bronchi, the greater is the AP diameter of the trachea at the level of the jugular notch. The greater is the AP diameter of the right main bronchi, the greater is the distance between the tracheal bifurcation and the supraspinal ligament. The greater the AP diameter of the left main bronchi, the greater is the AP diameter of the trachea at the level of the jugular notch. The greater the AP diameter of the left main bronchi, the greater the distance between the center of the tracheal bifurcation and the supraspinal ligament. The greater the distance between the tracheal bifurcation and the sternum, the greater AP diameter of the trachea at the level of jugular notch.

The AP diameter of the right main bronchi, the AP diameter left main bronchi, the angle of the horizontal bifurcation of the bronchi is significantly larger in males than in females.

The AP diameter of trachea level of jugular notch, distance between the center of the tracheal bifurcation and the supraspinal ligament and distance between the tracheal bifurcation and the sternum are slightly bigger in males than in females.

The trachea of young people goes backwards and downwards, while in older people the trachea is deviating to the right. In most of the cases the angle of the horizontal bifurcation was larger, in older people. Presumably because of the morphological changes of the heart, that is happening with age.

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