

CBCT ANALYSIS OF THE MORPHOLOGY OF THE TEMPORAL-MANDIBULAR JOINT IN NORTH-EASTERN POPULATION OF ROMANIA

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Abstract: The aim of this study is to examine the morphology, such as the inclination of the articular slope, as well as the dimensions of the articular space, and volume of the mandibular condyle, using a modern imaging method, such as cone beam computed tomography (CBCT). In this study were included randomly selected patients who were investigated for diagnosing various pathologies in the oro-maxillofacial area using CBCT, between 2018-2019. The evaluation was performed on a number of 35 patients, on both sides of the temporal-mandibular joint, of which 15 men and 20 women. Regarding the realization of the CBCT, the Planmeca Promax 3D Mid device (Planmeca OY, Helsinki, Finland) was used. Linear and volumetric measurements were performed on the sections for each part of the joint, right – left, by using Romexis 4.0 (Planmeca, Helsinki, Finland). The data collected in this study may be a useful reference for the clinical evaluation of mandibular condyle positions in subjects with normal functional joints.

Keywords: temporo-mandibular joint, morphology, cone beam computed tomography

Introduction

The temporomandibular joint (TMJ) has a complex anatomy composed of the mandibular condyle, temporal bone, and articular disk. Additionally, the TMJ is surrounded by bony structures. Because of these characteristics, the

TMJ cannot be easily visualized with traditional 2-dimensional radiography. For 3-dimensional (3D) evaluation of the TMJ, computed tomography (CT) and magnetic resonance imaging (MRI) have been suggested previously [1, 2]. MRI is commonly used for assessment of

soft tissue structures, whereas CT is used to assess the osseous components of the TMJ [3]. A relatively new and promising radiologic examination method for the osseous structures of the TMJ is cone beam computed tomography (CBCT) [4], its imaging modality has been found to be superior than conventional radiographical examinations as well as MRI for assessment of the osseous destructive changes in TMJ [5]. Cone-beam computed tomography (CBCT) can overcome the limitations of conventional CT, such as high cost, difficulties in access to equipment, and relatively high radiation dose [3]. However, CBCT has limited low-contrast resolution due to various physical and technical factors, which can limit its usefulness in soft tissue evaluations [6]. The highly scattered radiation during image acquisition adversely affects the contrast in the projection data and the final reconstructed images [7]. Despite these limitations, CBCT has become a highly preferred imaging modality for evaluation of the osseous structures of the TMJ [8]. The aim of this study is to examine the morphology and volume of the mandibular condyle, the inclination of the articular slope, as well as the dimensions of the articular space, using a modern method of radiographic imaging, namely, conical beam CT (CBCT) in north-eastern population of Romania.

Materials and methods

Patient selection in the study group

This study included randomly selected patients who were investigated for diagnosing various pathologies in the oro-maxillofacial area using CBCT, within a private Dento-Maxillofacial Imaging Center in Iasi, between 2018-2019 .

The evaluation was performed on a number of 35 patients, on both sides of the temporal-mandibular joint, of which 15 men and 20 women, with an age range of 10-78 years, with an average of 44 years . The study was a retrospective one.

The exclusion criteria were the inflammatory, congenital and developmental disorders of the temporo-mandibular joint, traumas located at the level of the temporo-mandibular joint, as well as the tumor affections affecting the area of the joint and the patients examined imaginically in the dynamic (open mouth).

CBCT imaging examination protocol

Regarding the realization of the CBCT, the Planmeca Promax 3D Mid device (Planmeca OY, Helsinki, Finland) was used. Prior to the CBCT scan, patients were fully informed about the purpose of this study and the associated risks in performing CBCT. All CBCTs were analyzed on a personal computer with the software Romexis 4.0 (Planmeca, Helsinki, Finland), performing reconstructions in axial, sagittal and coronal sections, with a thickness of 3 mm and a distance of 1 mm.

Analysis by linear measurements of the temporal-mandibular joint

The obtained digital images were transferred directly from the CT scanner to a personal computer, using Planmeca Romexis software, for processing and storing the images in a special form (DICOM - Digital Imaging and Communication in Medicine).

Linear measurements were performed on the sagittal sections for each part of the joint, right – left. All CBCTs were analyzed by an examiner, an oral and maxillo-facial surgeon.

From this sagittal section, the length and height of the mandibular condyle, the inclination of the articular tubercle and the joint space in 3 points, respectively, anteriorly, superiorly and posteriorly, were measured, in both parts of the temporal-mandibular joint, right - left. A 2D sagittal section was selected in which the mandibular condyle, the slope of the joint tubercle and the joint space were very well highlighted. So, the following landmarks were analysed:

- the length of the mandibular condyle was measured from the anterior point of the condyle to the most posterior point, to determine the maximum antero-posterior diameter;
- the height of the mandibular condyle was measured using the tangent from the highest point of the condyle to a horizontal line

constructed through the lowest point of the sigmoid incision;

The position of the condyle was determined by measuring the joint space at 3 different points. The linear markers and measurements of the joint space between the mandibular condyle and the glenoid cavity were determined:

- the superior articular space was measured from the highest point of the mandibular condyle to the lowest point of the roof / tip of the glenoid cavity;
- anterior articular space was measured from the anterior point of the mandibular condyle to the most prominent point on the slope of the articular tubercle;
- posterior articular space was measured from the most posterior point of the mandibular condyle to the lowest and posterior point of the glenoid cavity.

The inclination of the articular tubercle slope was measured using the angle constructed by the line passing through the lowest point of the glenoid cavity roof and the most prominent point / tangent to the slope of the articular tubercle with the horizontal line passing through the lowest point of the external auditory conduit;

Analysis by volumetric measurements of the mandibular condyle

The mandibular condyle was evaluated and segmented, right - left, and its 3D model was realized in multi-level reconstruction, using the tool "Free region grow tool", within the program Romexis. The volume of the mandibular condyle was determined by manual segmentation into several axial sections of it, having as references: the upper limit of the condylar head, determined at the appearance of the first radioopaque point in the articular space, then scrolling the axial image from the upper limit, we reach the lower limit. which was determined when the sigmoid incision, located between the mandibular condyle and the coronoid process, disappeared. (Then, the separation of the structures around the condyle was made.) After segmentation of the mandibular condyle, 3D reconstruction and volumetric evaluation (cm³) was performed using the "Create region" function.

Statistical analysis

In this study, for the statistical data storage and processing, the Microsoft Office Excel program was used in 2010. The main parameters were discussed, calculating the mean, minimum, maximum and significant difference between the parameters. The arithmetic mean calculated by us is not, more often than not, an empirical average and not an absolute (real) average, because we do not research the totality of the community, but only a sample, a greater or lesser part of the total. For these reasons, the

sample studied may not correspond to the structure with the whole community or if the choice was well made, there may be some differences (the error of the arithmetic mean).

Results

The evaluation was performed on a number of 35 patients, on both sides of the temporal-mandibular joint, of which 15 men and 20 women, with an age range of 10-78 years, with an average of 44 years. In determining the antero-posterior diameter (length) of the mandibular condyle, on the sagittal section, of the whole group of patients the following average values were obtained: right - 6.7 mm, and left - 6.9 mm, with no significant difference right - left, with a maximum value of: right - 10.4 mm, left - 10 mm and a minimum value of: right - 3.8 mm, left - 4.4 mm. Following the determination of the antero-posterior diameter (length) of the mandibular condyle, a difference of the average values was observed, between men and women, being higher in men. Regarding the dimensions of the articular space, in the sagittal plane, it was evaluated in 3 different points: anterior, superior and posterior, right - left. As a result of the measurements on the whole group of patients, no significant difference of the mean values, right-left, was observed in the 3 different points.

In men and women, the dimensions of the joint space on the sagittal section show no significant differences, except in the upper point, where the

values are in favor of men. In women, the lowest values are found in the posterior point and increase in order: anteriorly, then superiorly, as well as in men. In determining the height of the mandibular condyle, on the sagittal section, on the whole group of patients, the following average values were obtained: right - 16.5 mm, left - 16.5 mm, without any significant difference of the average values, with a maximum value of: right - 23.9 mm, left - 26.4 mm and a minimum value of: right - 9.5 mm, left 10.4 mm.

Following the determination of the height of the mandibular condyle between men and women, a difference of the average values was observed, being higher in men, as well as a difference between the left and the right condyle, in which in the right men it is greater than the left, and in women the left is larger than the right.

In determining the inclination of the slope of the articular tubercle, on the sagittal section, of the whole group of patients, the following average values were observed: right - 45.2 °, left - 41.5 °. As you can see the right slope has a slope more pronounced than the left, with a maximum value of: right - 62.3 °, left - 57.3 ° and a minimum value of: right - 25.2 °, left - 22.4 °. The average value of the slope of the articular tubercle in men exceeds that of women, the men having articulated slopes more pronounced than women. In both women and

men, the right slope has higher values than the left.

Regarding the slope of the joint tubercle, his inclination on age groups was taken into account. We notice that the lowest values are found in the age range 10-20 years, rising up to 40 years, then becoming relatively constant until 80 years. In determining the volume of the mandibular condyle by axial section of the whole group of patients, the following average values were obtained: right - 1.135 cm³, left - 1.130 cm³, without any significant difference right - left, with a maximum value of: right - 2.096 cm³, left - 2,047 cm³ and a minimum value of: right - 0.400 cm³, left - 0.454 cm³. Following the determination of the volume of the mandibular condyle, a difference of the average values between men and women was observed, being higher in men, without any significant difference right - left in men, respectively women.

Discussions

The temporo-mandibular joint is a complex joint system that is located between the temporal bone and the mandible and is difficult to evaluate with conventional techniques due to the overlap of the underlying dense temporal bone. In particular, panoramic radiographs and conventional tomography can give disappointing results. The CT has been used

since its development to evaluate the oromaxillofacial bone structures. However, CT has many limitations in dental medicine, and CBCT addresses these limitations and offers many benefits. The articular tubercle is located in front of the glenoid cavity, and its posterior slope varies among humans [9] and is exposed to the functional demands resulting from the chewing process, together with other structures of the temporal-mandibular joint, and these stresses influence its morphology [10].

In this study, we observed that the inclination values of the articular tubercle slope were lower in patients aged 10 - 20 years, reaching maximum values in those aged 20 - 40 years, then decreasing after the age of 40 years and remaining relatively constant up to 80 years, which is in accordance with the study of Sumbullu et al., [11]. The amount of functional forces required by the temporal-mandibular joint varies between men and women, causing morphological differences regarding sex. In the literature, there are few studies that have found differences in the inclination of the articular eminence according to sex [12]. But some studies have found gender differences in the inclination of the articular tubercle [13]. Jasinevicius et al., [14], mentioned that they did not find gender differences in the inclination of the articular tubercle. In the present study, the inclination values of the articular tubercle were higher in men than in women, which corresponds to the study of Sumbullu et al.,

[11], but these values were not statistically significant. This may be due to the small number of men in the study. At the same time, in this study, the inclination of the right joint slope has higher values, both in men and women, probably to the preference of unilateral mastication or malocclusion. These anatomical data may be useful for a better understanding of the anatomy of the articular eminence.

According to the literature, the most significant alterations of the morphology and the asymmetric positions of the structures of the temporal-mandibular joint are related to the absence of teeth, dental abrasion, premature occlusal contacts, mandibular deviations, posterior unilateral occlusion and dento-skeletal asymmetries [15].

In the study of May Al-Koshab et al., [16], no significant differences were found between men and women regarding the length of the mandibular condyle, which is not consistent with the present study, in which men have higher mean values. higher than women. In addition, the mean values of the height and volume of the mandibular condyle are higher in men than in women in this study. The same results were reported by May Al-koshab et al., [16] and they also mentioned that the width of the mandibular condyle is higher in men than in women, not consistent with this study, where there were no differences in mean values between the sexes, probably due to the small number of patients included in the study.

In the studies of Simona Tecco et al., [15] and Matteo Saccucci et al., [17], they showed the same results regarding the volume of the mandibular condyle that is higher in men than in women. In this study, no significant differences in mean values were found between the right and left sides in terms of volume, length, and width of the mandibular condyle. The same result also relates to Matteo Saccucci et al., [17] regarding the volume of the mandibular condyle, but in the study of Simona Tecco et al., [15] the volume of the right mandibular condyle was higher than the left one. In contrast, the height of the mandibular condyle in the present study is higher on the left than on the right, similar results being reported by May Al-Koshab et al., [16]. This could be explained by the presence of different types of malocclusions in our sample. Regarding the dimensions of the articular space, in the present study, the average values of the superior articular space were the highest in both sexes, followed by the internal / medial, external / lateral joint space, then the anterior and

posterior ones. Without considering the anterior and posterior articular space, these results are according to the studies of Zahra Dalilli et al., [18]. May Al-Koshab et al., [16] also reported that upper joint space values were highest in both sexes. In this study, only the upper articular space showed significant differences in average values between the sexes, being in agreement with Dalilli et al., [18], men having higher values than women.

Conclusions

An X-ray examination is part of the routine evaluation of the clinical conditions of the temporal-mandibular joint, and the main objective is to check the degenerative bone changes in the joint structures and the amplitude of the condylar trips. The evaluation of the joint spaces should be done independently, on the right and on the left. Therefore, the data collected in this study may be a useful reference for the clinical evaluation of mandibular condyle positions in subjects with normal functional joints.

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Figures

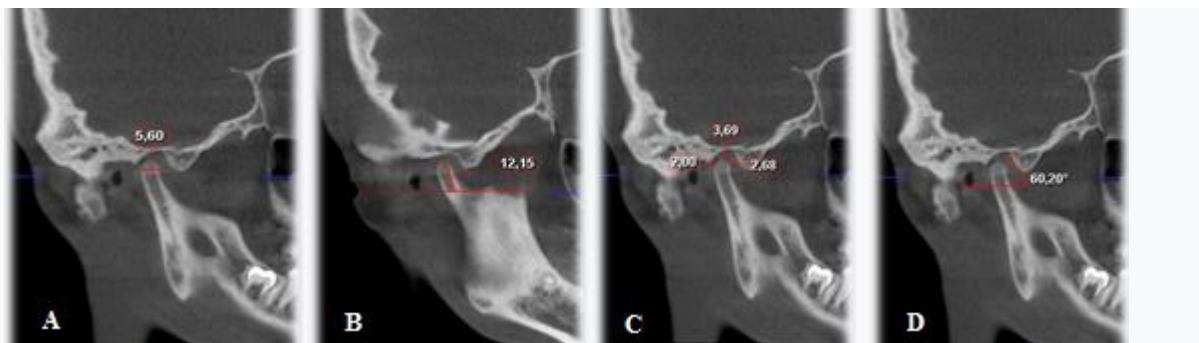


Fig. 1 Liniar measurements showing the anteroposterior diameter of condyle (A), height of the condyle (B), dimensions of the joint space in 3 different points: anterior, superior and posterior (C), and the inclination of the articular tubercle (D).

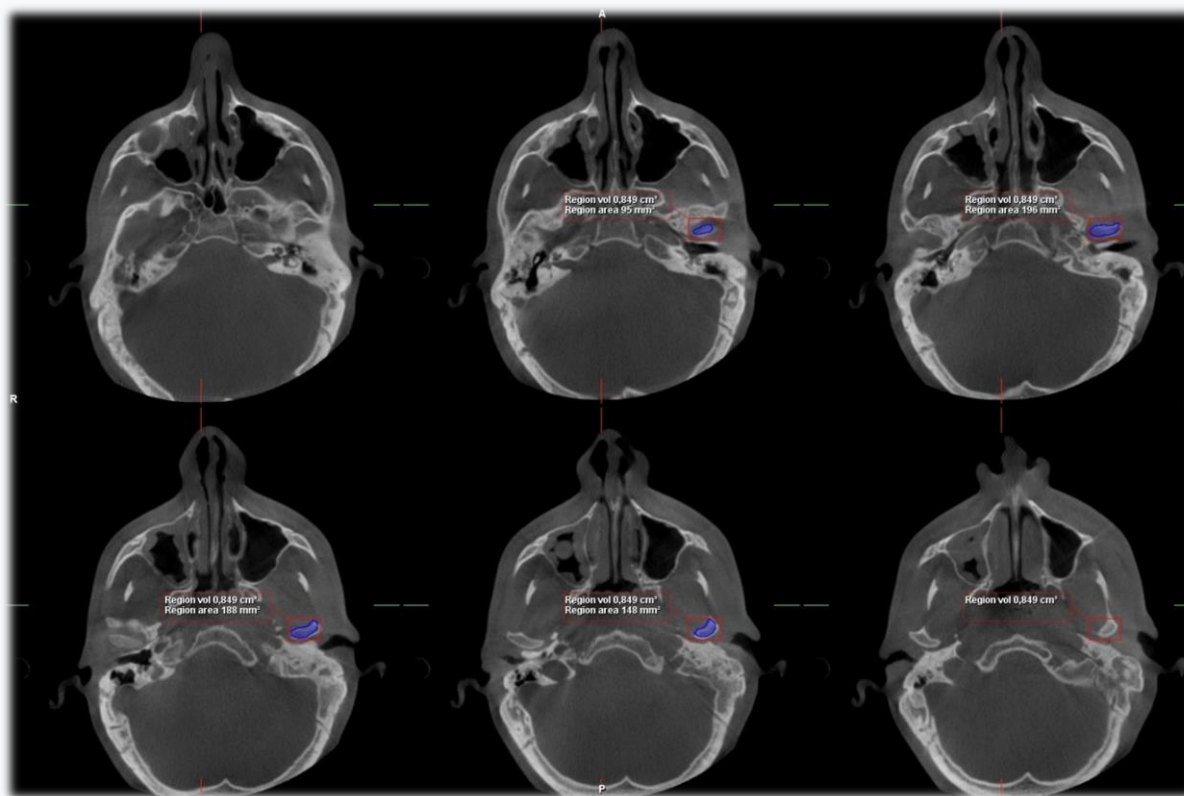


Fig. 2 Measurement on axial reconstruction of the volume of the left mandibular condyle.

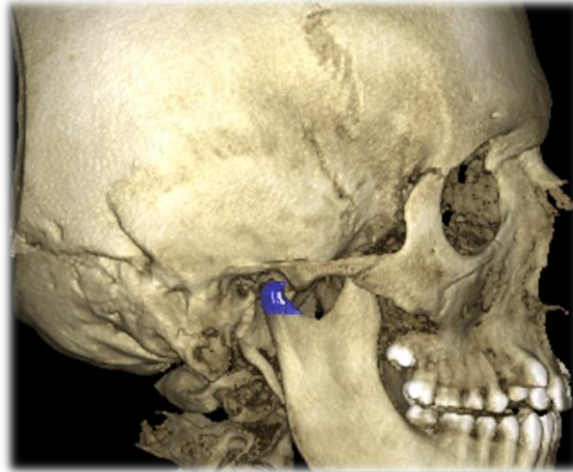


Fig. 3 Three-dimensional (3D) representation of the volume of the right mandibular condyle.

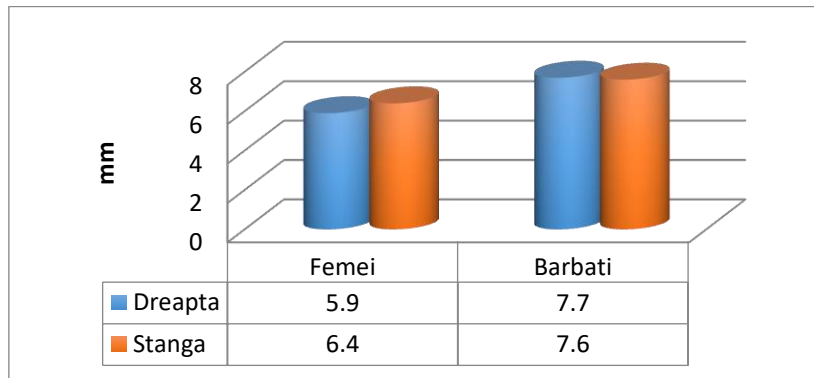


Fig. 4 The mean values (expressed in mm) of the antero-posterior diameter of the mandibular condyle in men and women.

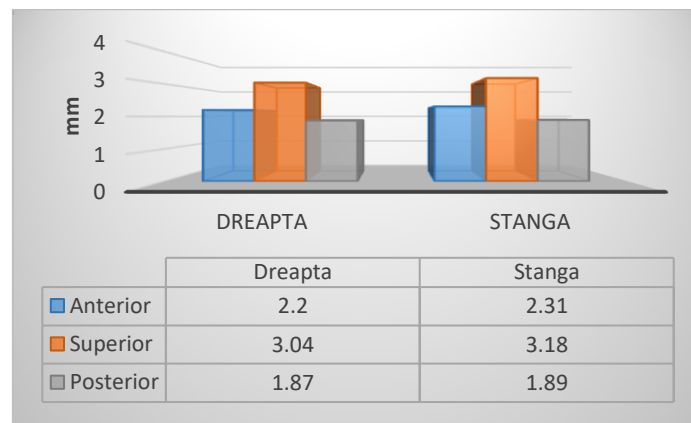


Fig. 5 The average values (expressed in mm) of the joint space dimensions for the whole group of patients.

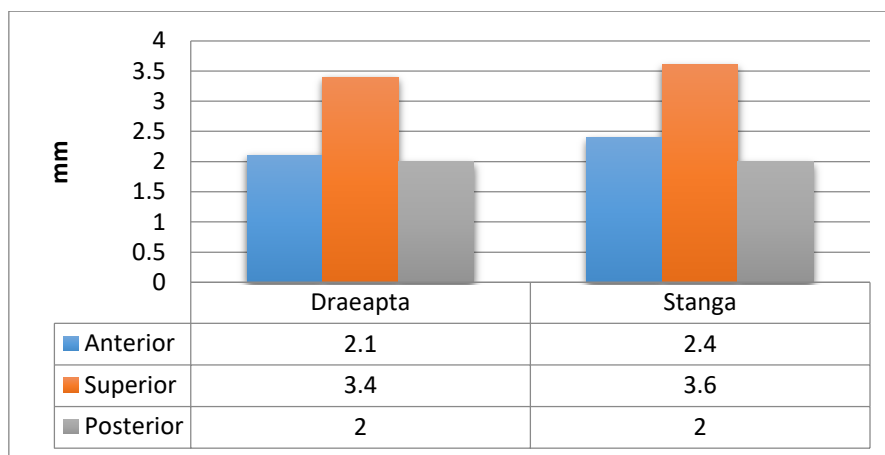


Fig. 6 The average values (expressed in mm) of the dimensions of the joint space in 3 different points, in men, in the sagittal plane.

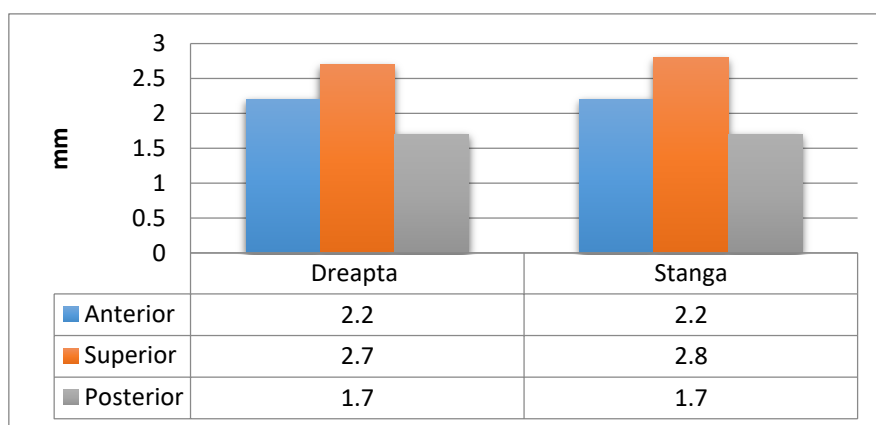


Fig. 7 The average values (expressed in mm) of the dimensions of the joint space in 3 different points, in women, in the sagittal plane.

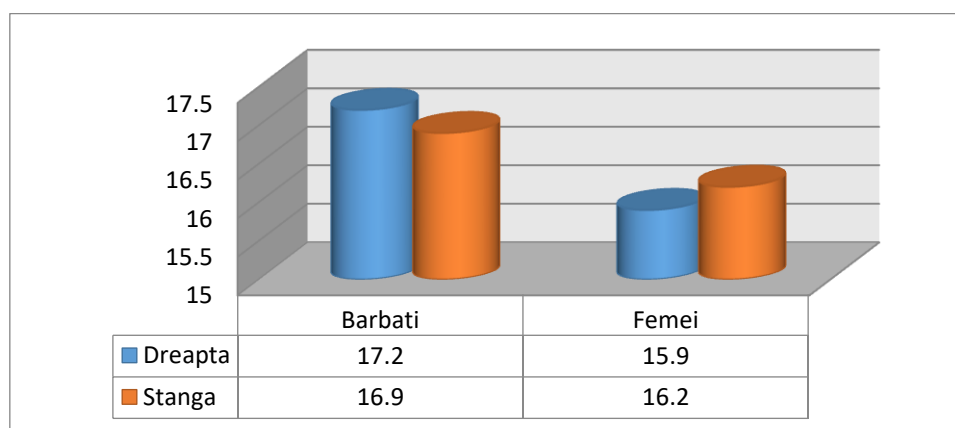


Fig. 8 The average values (expressed in mm) of the height of the mandibular condyle in women and men, right-left, sagittal plane.

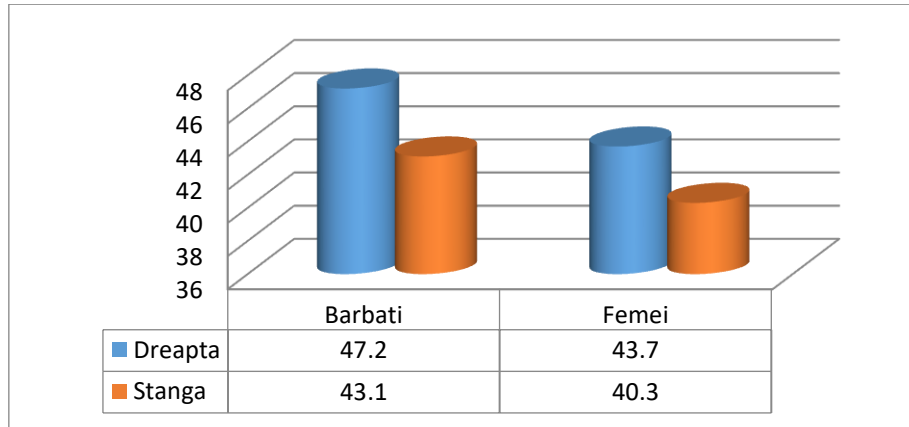


Fig. 9 The average values (expressed in degrees) of the slope of the articular tubercle in women and men, in sagittal plane.

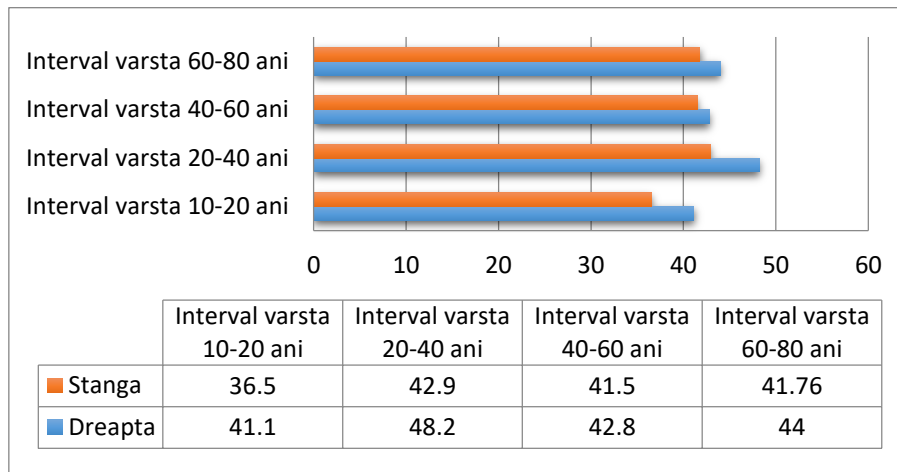


Fig. 10 The average values grouped by age (expressed in degrees) of the inclination of the slope of the articular tubercle, in the sagittal plane.

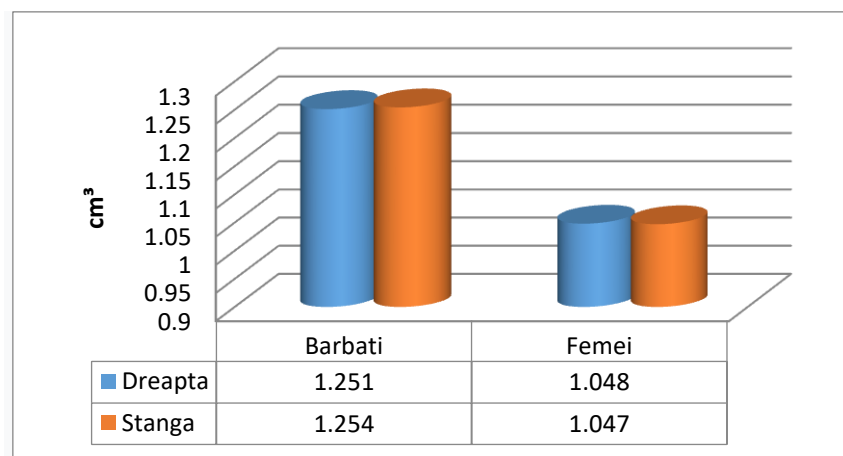


Fig. 11 The average values (expressed in cm³) of the volume of the mandibular condyle in women and men.