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LINEAR AND VOLUMETRIC ANALYSIS OF CONDYLAR MORPHOLOGY IN ADULTS: A CONE-BEAM COMPUTED TOMOGRAPHY STUDY

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INTRODUCTION

The study of anthropometric data has always been of great scientific interest. In the clinic of orthopedic dentistry, anthropometric diagnostic methods are widely used, initially proposed by Garson (1910), Williams (1913), Gofung (1938), Martin (1957), Kurlyandsky (1958) and others.

One of the most important parts of the dento-maxillary system is the temporomandibular joint (TMJ). Determination of linear and volumetric parameters of the TMJ constituent elements on a patient during a clinical examination is difficult due to objective reasons. The difficulty in studying the structural organization, function and diagnosis of TMJ diseases is explained by its small size, different density of constituent elements, localization near the base of the skull, late manifestation of clinical and diagnostic signs of dysfunction with a long latency period. At the same time, the development of X-ray examination methods, particularly CBCT, makes it possible to study these parameters with high accuracy. Data on the average parameters of the TMJ can be used to draw the line between norm and pathology in the course of complex patient treatment.

The attention of the authors of the present study was drawn to the bone structures of the temporomandibular joint, namely to the linear and volumetric parameters of the mandibular condyle (CM), as the most stable element of the TMJ. The depth of the glenoid fossa, the inclination of the articular tubercle are strongly dependent on the strength and direction of the chewing pressure, they change significantly with the loss of teeth. The CM is also exposed to these changes, but at the same time its shape, volume, longitudinal and transverse dimensions are relatively constant. (Kulakov A., Robustova T., 2015).

Keywords: temporo-mandibular joint, mandibular condyle, morphology, computed tomography, condylar volume

AIM OF THE STUDY

The purpose of the study was to analyze the available literature and to determine linear and volumetric parameters of the CM in adults using cone-beam computed tomography (CBCT).

MATERIAL AND METHODS

Using the search engines Pubmed, Springer, Google Scholar were selected scientific articles dedicated to the study of TMJ using CBCT. The original study was carried out on the basis of 41 CBCT in patients aged 25 to 58 years, without TMJ pathology. The study consisted in measuring the linear and volumetric parameters of 82 mandibular condyles. All CBCTs were performed in specialized radiological centers in Chisinau in diagnostic purpose of dental treatment, so none of the patients was exposed to an additional dose of radiation. Patients with age less than 25 years, with presence of any craniofacial anomalies or syndromes, and as well TMJ dysfunction were excluded from the study group. Measurements and statistical processing were performed using Slicer 3D and Microsoft Excel software.

The study of CBCT and the determination of the quantitative values of the parameters of interest were carried out in the Slicer 3D version 4.11 according to the conventional method [2]:

1) Automatic segmentation of a 3D model of the lower jaw with manual correction and smoothing - Fig. 1;
2) Manual determination of the cephalometric landmarks Porion and Orbitale, which determine the Frankfurt plane for the right and left side;
3) Manual determination of the cranial, medial and distal poles of the left and right condyle - the most distant points in the corresponding directions.
4) Manual determination of the caudal point of the sigmoid notch (InfSig) for the right and left side – Fig. 2;
5) Separation of the condyle volume by a plane parallel to the Frankfurt plane passing through the caudal point of the sigmoid notch - Fig. 3;
6) Automatic calculation of the height, width and volume of the CM with the built-in tools of the Slicer 3D program - Fig. 3, 4.

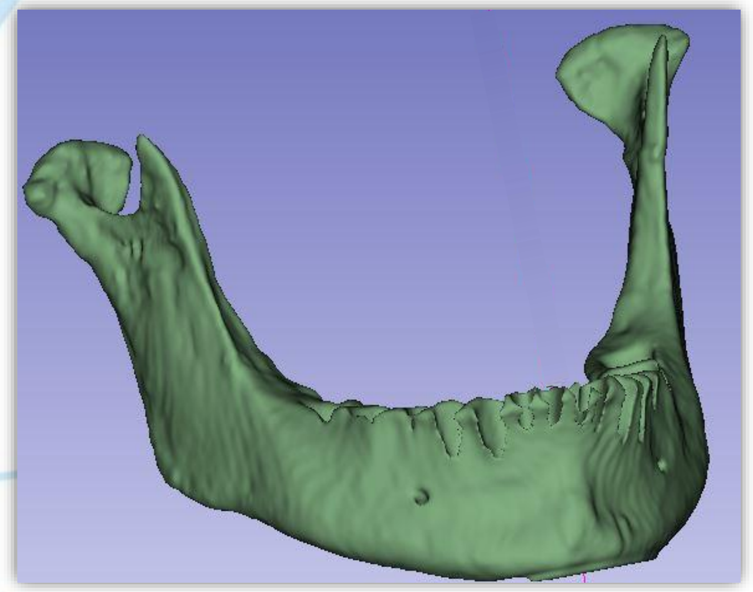

Fig. 1. Segmentation of mandible (3D render)

Fig. 2. Caudal point of the sigmoid notch

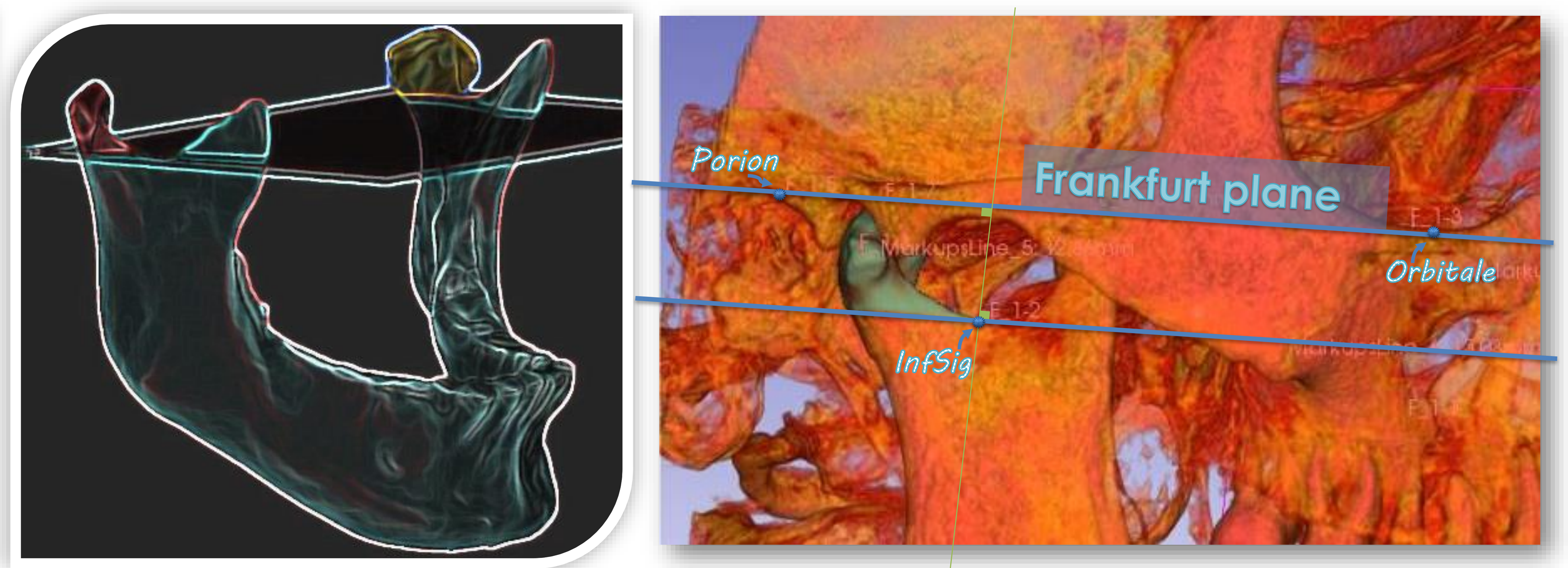

Fig. 3. Separation of the condyle volume (scheme & render)

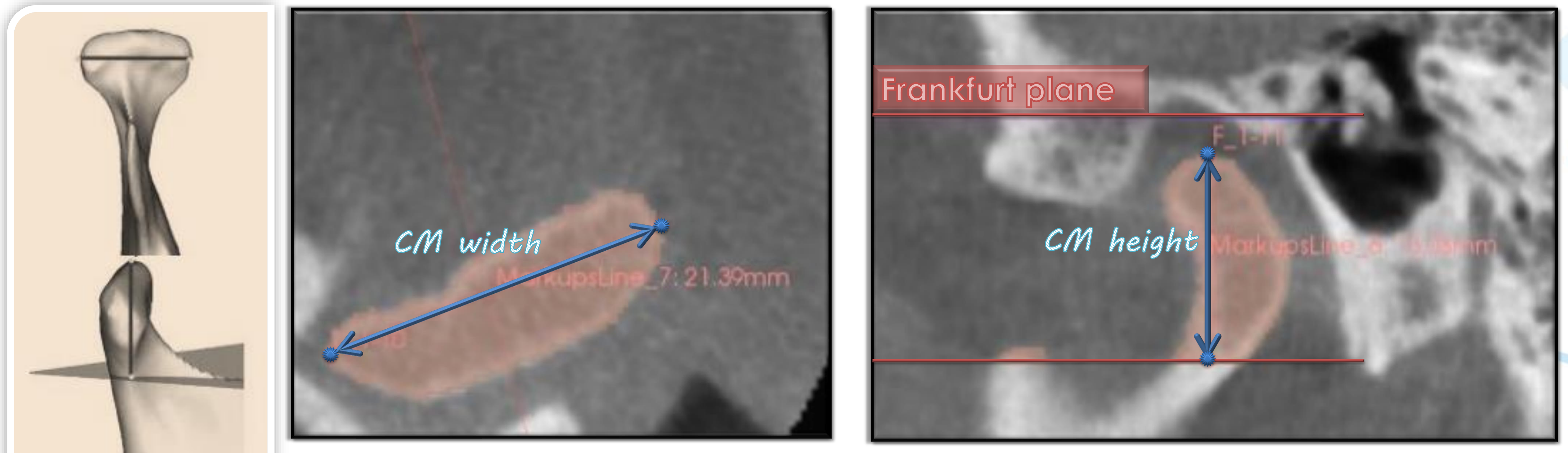

Fig. 4. CM height and width measurement

RESULTS AND DISCUSSIONS

The research results are presented in tables №1 and №2. The mean CM volume in the study group - 1759 ± 88.7 mm^3, the CM height - 18.65 ± 0.54 mm, and the CM width - 19.79 ± 0.45 mm (95% confidence interval). The obtained results are close to the values of the other authors studies. According to Santander, P. et al., 2020 [1], the width of CM is 19,5 mm on average, and the height is 17,3 mm. At the same time, the authors note the largest size of the condyle in skeletal class III. In the work of Mendoza, L.V., (2018) [2] the measured mean CM volume for the right and left sides was 1932.7 and 1881.6 mm^3, respectively.

The difference in volume between the right and left condyle in the same patients averaged 7.78±1.95%, ranging from 0 to 25%. Such differences can be explained on the basis of the asymmetry seen in all structures of the body. In the work of Tecco, S. (2010) [3] the difference in volume between the right and left sides averaged 3.9%, and the difference in the condyle surface was 5.45%.

When using the obtained data in clinical practice, many factors must be taken into account. The results of the study depend on the measurement technique, the size of the CBCT voxel, the contrast possibilities of the CT scanner, the degree of calcification of the bone structures, the accuracy of the operator's manual segmentation, ethnic and racial differences in the study group.

Table №1. Means (M), standard deviations (SD), 95% confidence intervals (CI) in the whole sample

	№	Mean	SD	95% CI
Condyle volume, mm^3	82	1758.98	410.2	88.78
Condyle height, mm	82	18.65	2.53	0.54
Condyle width, mm	82	19.79	2.08	0.45

Table №2. Means (M), standard deviations (SD) and 95% confidence intervals (CI) according to right and left side

	№	Mean	SD	95% CI	Min	Max
Condyle volume, mm^3						
- right	41	1767.13	439.05	134.39	1045,2	2635,52
- left	41	1750.83	384.79	117.69	1082,4	2589,5
Condyle height, mm						
- right	41	18.89	2.52	0.77	12,86	25,68
- left	41	18.41	2.55	0.78	12,96	25,41
Condyle width, mm						
- right	41	19.84	2.17	0.66	15,54	25,31
- left	41	19.73	2.01	0.61	15,44	24,84

CONCLUSIONS

A complete 3D analysis of the morphology of the mandibular condyle emphasizes its versatility. In the assessment of symmetries between the condyles, they are asymmetrical and therefore each condyle must be evaluated separately. The volume, size and position of the condyle can be an important indicator of TMJ disease. To identify the relationship between linear and volumetric parameters of the condyle and TMJ dysfunction, further study of functionally healthy joints is necessary in order to obtain stable and repeatable data.

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