

## Anatomic X-ray features of the temporomandibular joint elements with a decrease in the interalveolar distance

Irina V. Silkina-Voytiatskaya<sup>1</sup>, Aleksandr V. Tsimbalistov<sup>2\*</sup>, Maria G. Gayvoronskaya<sup>1</sup>, Alexander A. Kopytov<sup>1</sup>, Yury A. Minyaylo<sup>1</sup>

### ABSTRACT

This paper presents data on the anatomical and radiological features of the dentoalveolar system and especially the temporomandibular joint (TMJ) elements in patients with major dental diseases accompanied by a decrease in the interalveolar distance.

Radiographically, there is a distal displacement of the lower jaw heads observed in the habitual occlusion with signs of a decreased height of occlusion. When optimizing the ratio of the jaws, the mandible heads occupy a harmonious front position, which leads to a decrease in the compression of the TMJ bilaminar zone, significantly reduces the likelihood of developing musculo-articular dysfunction in the dentoalveolar apparatus and improves the activity of other organs and systems.

The study of the topography of the stony-tympanic gap using cranoscopy methods identified two extreme variants of its location relative to the mandibular fossa, which is of fundamental importance in the development of TMJ diseases and determines the nature of their clinical manifestations.

**KEY WORDS:** Bilaminar zone, Decrease of interalveolar distance, Deep occlusion syndrome, Dentistry, Functional-physiological test method for jaw ratio, Multilayer spiral computed tomography, Stony-tympanic gap, Temporomandibular joint anatomy, Temporomandibular joint dysfunction

### INTRODUCTION

A decrease in interalveolar distances (IAD) developed against the background of the main dental diseases, such as increased erosion of hard tissues of the teeth, chronic generalized periodontitis, partial loss of teeth of different length and localization, often leads to disruption of the anatomical and functional interrelations of the neuromuscular and articular complex of the maxillofacial region and other body systems.<sup>[1]</sup>

Dysfunction of the temporomandibular joint (TMJ) is a pathology that includes a cascade of anatomical and functional disorders consisting of the joint, muscle, and occlusal components. With a reduced bite, the manifestations of the TMJ dysfunction are explained by the involvement of the areas bordering the joint,

in particular by stimulation of the chorda tympani, tympanic plexus, eustachian tube dysfunction caused by vascular disorders, compression, or trauma of the neurovascular bundle passing in the stony-tympanic gap.<sup>[2-5]</sup>

Temporomandibular disorders, leading to various dysfunctions of the elements of the chewing apparatus, can occur simultaneously with the clinical manifestations of the underlying dental disease. Many researchers agree that the emergence of dysfunction of chewing musculature is largely promoted by anatomical features of the structure and location of the TMJ.<sup>[6,7]</sup>

Individual features of the TMJ structure play a significant role (significant inconsistency of the shape of the mandibular fossa and mandibular head, flattening of the mandibular fossa, small dimensions of the mandible heads (its aplastic changes), a flattened or emphatically convex-concave shape of the articular disc), which ultimately aggravates the course

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<sup>1</sup>Department of Pediatric and Prosthetic Dentistry, Belgorod State National Research University 85, Belgorod, 308015, Russia, <sup>2</sup>Military Medical Academy Named after S.M. Kirov, Academician Lebedev St., 6, 194044, St. Petersburg, Russia

\*Corresponding author: Aleksandr V. Tsimbalistov, Department of Pediatric and Prosthetic Dentistry, Belgorod State National Research University 85, Pobedy St., Belgorod, 308015, Russia. E-mail: [Tsimbalistov@bsu.edu.ru](mailto:Tsimbalistov@bsu.edu.ru)

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of the dysfunction in the presence of any etiological factors, for example, in the development of basic dental diseases.<sup>[8-10]</sup>

## MATERIALS AND METHODS

We examined 395 people aged from 32 to 68 years, with major dental diseases of a dentofacial system. 293 (74.2%) patients of the total examined persons had signs of deep occlusion and formed the main group, and 102 (25.8%) patients with no signs of deep occlusion formed the control group. The main group included 228 (77.8%) women and 65 (22.8%) men. The main dental diseases having resulted in a change in the jaw relationships were: Increased abrasion of hard tissues of teeth in 138 (47.1%) patients, chronic, generalized periodontitis in 125 (42.6%) patients, and partial loss of teeth in 260 (88.7%) patients. 174 (59.4%) patients had a combination of major dental diseases revealed. We performed the determination of diseases using international classification of diseases, 10<sup>th</sup> edition of 1997 (ICD-10).

### Methods

**Radial method:** Multilayer spiral computed tomography (MSCT) was used to determine the position of the mandible heads in patients with major dental diseases, accompanied by a decrease in the IAD.

**Instrumental method:** The functional-physiological test method (FPTM) for the jaw ratio was used to assess the rehabilitation capabilities of the dentoalveolar apparatus.

**Morphological methods:** Cranioscopic examination was used to study the location of the stony-tympanic gap with respect to the mandibular fossa.

**Statistical methods:** Statistical processing of the material was performed on a computer using a standard package of statistical analysis programs (Statistica for Windows v. 6.0). The critical level of the probability of a zero statistical hypothesis (the absence of significant differences or factor influences) was taken equal to 0.05.

**Nonparametric comparison methods** were also used: The Mann–Whitney U-test for two independent groups and the Wilcoxon paired t-test – when assessing the values dynamics during prosthodontic treatment. Differences at  $P \leq 0.05$  were considered statistically significant.

The functional-physiological method with the use of the “AOTsO” apparatus allows determining the optimal interposition of the anatomical structures of the dento-maxillary apparatus involved in maintenance of the relationship of the jaws in various planes, evaluating

the activity of the masticatory muscles, neck muscles, and TMJ elements, both statically and during compression of the jaws. The FPTM allows taking into account the individual functional capabilities of the patient regardless of the level and severity of the damage of the elements of the dentoalveolar system and revealing the features of the response of the strength characteristics of the masticatory muscles to the increase of the IAD.

We performed an assessment of four functional indicators of dentofacial system in all 293 (74.2%) dental patients of the main group with impaired jaw relationships of different origin: The value of the IAD decrease, the integrated value of the maximum jaw compression force, horizontal and sagittal displacement of the mandible, compression of the jaws with a consequent change in IAD.

102 (25.8%) patients of the control group had no reduction in the occlusal vertical dimension.

Based on the results of MSCT, the patients of the main and control groups were measured the width of the joint gap in the following sections of the anterior, upper and posterior parts of the joint space.<sup>[11,12]</sup>

Measurements were conducted in habitual occlusion, in the state of open and closed mouth, with registers fixing the central ratio of jaws, and before and after treatment. During the research, multiplanar 2D reconstructions were used.

The object for craniological examination was 138 certificated skulls with lower jaws. 67 (48.5%) of the skulls were male and 71 (51.4%) female. 108 (78.3%) of the skulls were with intact dentition and 30 (21.7%) skulls with complete loss of teeth. We considered the complete absence of teeth as a variant of a “deep occlusion.”

The skulls belonged to people of the first and second periods of adulthood (from 23 to 65 years) according to the age periodization of the Institute of Age Physiology of the Russian Academy of Medical Sciences (1969), inhabitants of the Northwest region of the Russian Federation, and represented a homogeneous object of study and had no signs of mechanical damage or systemic diseases of the skeleton.

The sectional material investigated was from the craniological collection of the fundamental museum of the Department of Normal Anatomy of the SEI HVE Military “S.M. Kirov Medical Academy” of the Ministry of Defense. Craniological research methods were used to study the morphofunctional features of various forms of the human skull structure. They were subdivided into descriptive (cranioscopic) and measuring (craniometric) methods. To identify

the main prerequisites for the emergence of painful dysfunction of the TMJ, the features of the location of the stony-tympanic gap with respect to the mandibular fossa were studied using cranoscopic methods.<sup>[13-15]</sup>

## RESULTS AND DISCUSSION

All patients with signs of a decreased IAD after determining the constructive relationship of the jaws underwent radiation diagnosis of the position of the lower jaw in the mandibular fossa in habitual occlusion (with a decrease in IAD) and in optimal occlusion with the use of MSCT, which made it possible to evaluate the bone contours of the TMJ elements, determine the width of the anterior, upper and posterior sections of the joint space [Table 1].

The data in Table 1 show that the width of the upper and posterior sections of the joint gap in optimal occlusion increased significantly, and the asymmetry indices significantly decreased. This circumstance allows us to state that after the restoration of the ratio of jaws, the optimal forward position of the mandible heads was observed. The definition of the boundaries of the posterior part of the joint space is extremely important since this section is highly innervated and abundantly supplied with blood vessels. The process of distal displacement of the mandible heads with decreasing IAD may be accompanied by compression of the bilaminar zone, the development of vascular disorders, a violation of the function of the statokinetic tract and the visual analyzer. The condition of the TMJ elements was characterized by a decrease in the width of the upper (up to  $3.04 \pm 0.07$  mm) and posterior (up to  $2.22 \pm 0.1$  mm) sections of the joint gap, which reflected an upper-posterior displacement of the mandible heads in the joint fossa and was accompanied by a pronounced asymmetry ( $P_{\text{asymm}} > 0.20$ ).

After restoring the ratio between the jaws - in optimal occlusion after treatment, the width of

the upper and posterior sections of the joint gap increased significantly, and the asymmetry parameters significantly decreased, while the width of the anterior section did not change reliably [Table 1]. This circumstance allows us to state that after the restoration of the ratio of the jaws, the optimal position of the mandible heads was observed.<sup>[4,16]</sup>

To determine the degree of severity of the deep occlusion syndrome (DOS), the size of the joint gap in habitual occlusion was assessed with a decrease in IAD and the position of the optimal interrelation of the jaws. X-ray signs of DOS, according to MSCT, are a decrease in the width of the upper part ( $< 3.61 \pm 0.12$  mm) and the posterior part of the joint gap ( $< 3.02 \pm 0.1$  mm), with a pronounced asymmetry (asymmetry index more than 0.20), which significantly differs from the control group.

In the control group, the mandibular heads were in the optimal position in the joint fossa of the TMJ, which reflects their adequate positioning. The dimensions of the anterior, upper, and posterior joint space corresponded to the parameters of the optimal ratio of jaws with optimal occlusion [Table 2]. The dimensions of the anterior, upper, and posterior parts of the joint space are comparable with those obtained in the patients of the main group in the position of optimal occlusion after treatment.

According to the protocol of radiation methods of research, none of the methods of diagnosis in medical practice allows objectively evaluating the following:

1. In which part of the joint gap of the TMJ a stony-tympanic gap is located;
2. Whether the chorda tympani passes inside the bone structures or it is open for compression effects during the posterior displacement of the mandible.

For this purpose, a craniological study was conducted to justify the evaluation of the location of the stony-

**Table 1: Width of the anterior, superior and posterior sections of the joint gap and the asymmetry index in the patients of the main group according to MSCT before and after treatment (n=293)**

Jaw gap sections	In habitual occlusion		In optimal occlusion	
	Width, mm	Asymmetry index	Width, mm	Asymmetry index
Anterior	2.13±0.13	0.21±0.06	2.24±0.11	0.18±0.05
Upper	3.04±0.07	0.25±0.04	4.45±0.05***	0.12±0.02**
Posterior	2.22±0.1	0.26±0.02	4.14±0.10***	0.13±0.03*

\* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ . MSCT: Multilayer spiral computed tomography

**Table 2: Dimensions of the anterior, superior and posterior sections of the joint space in patients of control group according to MSCT (n=102)**

Jaw gap section	Right, mm	Left, mm	P <sub>asymm</sub> , mm
Anterior	2.11±0.05	2.13±0.08	$P_{\text{asymm}} < 0.20$
Upper	4.19±0.07	4.15±0.06	$P_{\text{asymm}} < 0.20$
Posterior	3.59±0.07	3.54±0.01	$P_{\text{asymm}} < 0.20$

$P_{\text{asymm}}$  - asymmetry index. MSCT: Multilayer spiral computed tomography

tympanic gap in the TMJ fossa and the occurrence of possible stimulation of the chorda tympani or its damage.

To study the location of the stony-tympanic gap with respect to the mandibular fossa, a cranoscopic study was used. As a result of the study, two variants of the location of the stony-tympanic gap with respect to the mandibular fossa were established. The location of the stony-tympanic gap along the posterior margin of the mandibular fossa was regarded as the first variant of topography when the stony-drum slot of the mandibular fossa intersected through the medial third - as the second variant of topography.

Comparing the data of MSCT on the displacement of the mandible heads in the upper and the backward direction with a decrease in IAD with the results of craniological studies, we assume that with the first variant of the stony-tympanic gap, namely, at the posterior margin of the mandibular fossa, there is less probability of compression of the chorda tympani. The presence of this morphological feature leads to compression of the posteroluminal space (bilaminar zone), which, in turn, can reflexively change the hemodynamic parameters of macro- and micro-circulation in the region of the head and neck.

The second version of the topography of the stony-tympanic gap with its location in the medial third of the mandibular fossa should be regarded as a prerequisite to irritation of the chorda tympani. With a significant steepness of the articular tubercle, the absence of a covering of the nerve trunk with a bone plate, a distal displacement of the mandible and the extension of the joint capsule, irritation of the chorda tympani and the branches of the ear-temporal nerve is possible.

This increases the likelihood of the formation of clinical signs of the syndrome of TMJ painful dysfunction. This circumstance leads to a violation of the sensitivity of the facial nerve fibers, which can be accompanied by the development of paresthesias in the oral mucosa, changes in the quality and quantity of saliva, and other clinical manifestations of painful dysfunction of the TMJ.

## SUMMARY

1. After normalization of the IAD by functional-physiological method, the ratio of jaws in the horizontal plane became optimized in 225 (76.8%) patients, which is manifested by the centering of the mandible along the line of the central incisors of the upper and lower jaws, as confirmed by the MSCT study.
2. With the use of MSCT in 231 (78.8%) patients with violations of the ratio of jaws, the width of the upper part of the joint gap was <3.06 mm, and the

posterior part was <2.41 mm, with the expressed dimensional asymmetry ( $P_{\text{asymm}} > 0.20$ ). The anterior section changed insignificantly. This circumstance may indicate a possible compression of the bilaminar zone, which leads to the development of pathological changes in macro- and micro-circulation

3. After normalization of the ratio of the jaws, there was an increase in the width of the upper and posterior sections of the joint junction of the TMJ, with a significant decrease in the asymmetry index ( $P_{\text{asymm}} > 0.20$ ), which indicates the optimal position of the mandible heads in the joint fossa of the TMJ. This circumstance may indicate a forward displacement of the lower jaw when its position is optimized, and the compression of the TMJ bilaminar zone is reduced in the position of optimal occlusion, which will significantly reduce the possibility of developing musculo-articular dysfunction in the dentofacial apparatus.
4. In the case of the location of the stony-tympanic gap along the posterior margin of the mandibular fossa, a DOS develops without manifestation of pain symptoms in the region of the TMJ. The location of the anatomical structures of the TMJ elements, namely, the topography of the stony-tympanic gap, is of fundamental importance for the appearance of pathological conditions in this area, which determines the nature of clinical manifestations.

In the case of the location of the stony-tympanic gap along the posterior margin of the mandibular fossa, a DOS develops without manifestation of pain symptoms in the region of the TMJ; in the case of its location in the medial third of the mandibular fossa, as the IAD decreases and the lower jaw head shifts in the upper and the backward direction, the chorda tympani becomes irritated. Accordingly, the topography of the stony-tympanic gap largely determines the nature of clinical manifestations in the TMJ diseases.

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