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ABSTRACT

THE RELATIONSHIP BETWEEN MALOCCLUSION AND CRANIOFACIAL PROFILE PATHOLOGY

Introduction. In orthodontic patients often together with malocclusion there are disorders of the craniofacial structures that make orthodontic treatment difficult. Many accompanying pathologies that can be detected on Cone Beam Computed Tomography of the skull by accident and defined as findings, which are not related to the clinical indications for conducting this study, but may affect the result of orthodontic treatment.

The purpose of this study was to identify the incidental findings of no interest to the orthodontist in the pathology of the craniofacial profile and cervical spine during the analysis of the CBCT of the skull and to evaluate their frequency and relationship with malocclusion in the sagittal, vertical and transverse planes.

Materials and methods. A total of 280 patients with malocclusion were studied with CBCT. An X-ray evaluation of the CBCT of the craniofacial profile was carried out for pathological changes or anomalies in the development of anatomical structures of the skull. The cephalometric characteristics of the sagittal and vertical skeletal pattern were carried out according to Steiner, Transverse skeletal pattern was carried out according to Ricketts.

Results. The most common pathology in patients with malocclusion is the curvature of the nasal septum in 61.4%. Cysts of the maxillary sinuses were observed in 31.1% of cases, thickening of the mucous membrane of the maxillary sinuses in 25% of cases. A statistically significant relationship of hypoplasia of the maxillary sinuses with skeletal class III and hyperdivergent growth type was established.

Conclusions. CBCT provides basic information for further necessary studies of related pathologies. Correct identification of these findings will reduce further diagnostic errors and allow choosing an appropriate treatment plan based on a multidisciplinary approach.

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Keywords: Cone-beam computer tomography, dentofacial abnormality, incidental findings; paranasal sinus, skeletal class, facial pattern.

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ЗВ'ЯЗОК ЗУБО-ЩЕЛЕПНИХ АНОМАЛІЙ ТА ПАТОЛОГІЇ КРАНІОФАЦІАЛЬНОЇ ДІЛЯНКИ

Актуальність. В ортодонтичних пацієнтів часто разом із зубощелепними аномаліями виникають порушення черепно-лицевих структур, які ускладнюють ортодонтичне лікування. Багато супутньої патології може бути виявлена за допомогою конусно-променевої комп'ютерної томографії черепа випадково і визначаються як знахідки, які не пов'язані з клінічними показаннями для проведення даного дослідження, але можуть впливати на результат ортодонтичного лікування.

Метою цього дослідження було виявити при аналізі конусно-променевої комп'ютерної томографії черепа випадкові знахідки поза інтересом для лікаря-ортодонта патології краніофаціальної ділянки та шийного відділу хребта та оцінити їх частоту та взаємозв'язок із зубощелепними аномаліями в сагітальній, вертикальній та трансверзальній площинах.

Матеріали і методи. Всього досліджено комп'ютерних томограм 280 пацієнтів із зубощелепними аномаліями. Проведена рентгенологічна оцінка краніофаціальної ділянки на предмет патологічних змін або аномалій розвитку анатомічних структур черепа. Цефалометрична характеристика сагітального та вертикального скелетного малюнку проведена за Steiner, трансверзальну характеристику проведено за Ricketts.

Результати. Найпоширенішою патологією в пацієнтів із зубощелепними аномаліями є викривлення носової перегородки у 61.4 %. Кісти гайморових пазух спостерігались в 31.1 % випадків, потовщення слизової оболонки гайморових пазух в 25 % випадків. Встановлено статистично значущий зв'язок гіпоплазії гайморових пазух із скелетним III класом та гіпердивергентним типом росту.

Висновки. Конусно-променева комп'ютерна томографія дає базову інформацію для подальших необхідних досліджень суміжних патологій. Правильна ідентифікація цих знахідок зменшить подальші діагностичні помилки та дозволить вибрати відповідний план лікування з урахуванням мультидисциплінарного підходу.

Ключові слова: Конусно-променева комп'ютерна томографія, патологія прикусу, випадкова знахідка, параназальні пазухи, скелетний клас, тип обличчя.

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ABBREVIATIONS
CBCT – Cone-Beam Computed Tomography
MIP – Maximum Intensity Projection

INTRODUCTION / ВСТУП

Malocclusion is a clinical change in the maxillofacial area that occur as a result of disturbances in the process of formation and teething. Both genetic factors and heredity, as well as environmental and socio-economic factors contribute to the emergence and development of malocclusion [1, 2].

According to Lombardo et al. [3] the average prevalence of malocclusion worldwide is 56 %, with a prevalence of 100 % in hearing-impaired children [4].

The impact of general somatic pathology on dental diseases has been noted in many studies [5-7]. Orthodontic patients with malocclusion often have disorders of the craniofacial structures that complicate orthodontic treatment [8, 9].

Recently, Cone-Beam Computed Tomography (CBCT) is increasingly used for diagnostics in dentistry and orthodontics [10-11]. CBCT provides three-dimensional information about the anatomical features of skull development and the ability to accurately diagnose pathology [12].

Many comorbidities that do not have clinical symptoms can be detected on CBCT incidentally and are defined as findings that are not related to the clinical indications for this study. Therefore, doctors should study the anatomy of the head and neck and correctly interpret incidental findings to avoid mistakes in diagnosis [13, 14].

Quite often, malocclusion is accompanied by diseases of the paranasal sinuses and nasal cavity. The deviation of the nasal septum, which is observed in approximately 80 % of the population, can limit the flow of air and impair the growth of paranasal sinuses [15]. As a result, the ciliary activity of the mucous membrane decreases and bacterial invasion develops, which leads to inflammatory processes of the paranasal sinuses [16]. Thickening of the mucous membrane of the ethmoid sinus and the maxillary sinus [17] are frequent anomalies. According to Festa et al. [18] in children with otorhinolaryngology pathology and oral type of breathing, the presence of malocclusion was 81.4 %.

There are also data on the connection between malocclusion and other pathologies of craniofacial area, respiratory tract, the connection between malocclusion and posture [19-21] and others. Therefore, the study of the relationship between malocclusion and pathology of the craniofacial area is relevant.

The purpose of this study was to identify the incidental findings of no interest to the orthodontist in the pathology of the craniofacial region and cervical spine during the analysis of the CBCT of the skull and to evaluate their frequency and relationship with malocclusion in the sagittal, vertical and transverse planes.

MATERIALS AND METHODS

The research protocol was approved by the biomedical ethics commission of Poltava State Medical University № 227 dated 05/23/2024. The research was conducted with the written consent of the participants. The materials of the work comply with the Rules of humane treatment of patients in accordance with the requirements of the Tokyo Declaration of the World Medical Association, international recommendations of the Helsinki Declaration on Human Rights, the Convention of the Council of Europe on Human Rights and Biomedicine, the Laws of Ukraine, orders of the Ministry of Health of Ukraine and the requirements of the Code of Ethics of the Doctor of Ukraine.

At the first stage, we retrospectively evaluated the radiographic data of 289 patients who applied to the Department of Postgraduate Education of Orthodontists of the Poltava State Medical University and underwent CBCT studies in 2018–2024.

Inclusion criteria

Patients who had malocclusion.

Exclusion criteria

Persons with a history of injuries or surgical interventions, congenital facial defects or "syndromal" pathology and previously treated orthodontically.

Based on the selection results, 7 patients with congenital defects and 2 individuals with genetic syndromic pathology were excluded.

A total of 280 patients with malocclusion with an average age of 17.5±6.64 years, 100 men, an average age of 16.1±6.54 years, 180 women, an average age of 18.2±6.58 years, were included in the study.

CBCT images were obtained using the “Veraview X800” device (J. Morita, Japan), voltage in the tube 90 kV, current in the tube 5-10 mA, scanning time 20-30 s, slice thickness 1 mm. CBCT studies were performed according to a standardized scanning protocol, with the patient positioned horizontally and instructed to keep their mouth closed and remain still throughout the scan. Files in DICOM format were imported into “EZ3D+” software (Vatech, USA) for further analysis.

X-ray assessment

Two radiologists of the highest category with 20 and 15 years of experience independently conducted a CBCT analysis of the craniofacial area in the axial, coronal, and sagittal planes for pathological changes or abnormalities in the development of anatomical structures of the skull. In case of a disputed situation, the final decision was made on the basis of consensus. The experts examined only the CBCT and did not have access to any other patient data during the radiographic examination procedure.

Cephalometric analysis

For the cephalometric analysis, a 2D lateral reconstruction from a 3D CBCT was first obtained [22]. After that, the 2D reconstruction was saved in JPG format. Then the cephalogram was loaded into the software for cephalometric analysis "Audax Ceph" v. 6.6 (Slovenia).

In the sagittal plane, all patients were divided into three skeletal classes of malocclusion depending on the ANB angle according to Steiner. Anteroposterior skeletal pattern: Class I – ANB angle between 0° and 4°, Class II – ANB>4°, Class III – ANB<0° (Fig. 1).

Depending on the type of growth of the facial pattern in the vertical plane, all patients were divided into three groups depending on the SNGoGn angle according to Steiner. Vertical skeletal pattern: Normal – SNGoGn angle between 28° and 36°; Hyperdivergent – SNGoGn>36°; Hypodivergent – SNGoGn<28°.

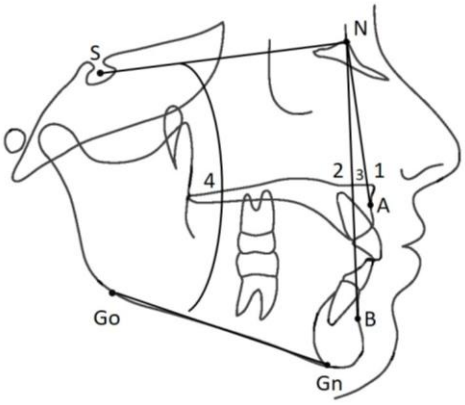

Figure 1 – Characteristics of the skeletal pattern in the sagittal and vertical planes: 1 – SNA angle, 2 – SNB angle, 3 – ANB angle, 4 – SNGoGn angle

The characteristics of the bite in the transverse plane were studied according to the Ricketts method. To do this, in the 3D window of the CBCT, the skull reconstruction was placed in the «Anterior» position and switched to the Maximum Intensity Projection (MIP) mode. To study the relationship between the upper and lower jaws, linear measurements of JR_JL, AGoR_AGoL were performed with the "Ruler" tool, and the Mx/Md ratio index was calculated (Fig. 2).

Transverse skeletal pattern: if the Mx/Md ratio is greater than or equal to the normal indicator, there is no narrowing, if the Mx/Md ratio is less than the norm, there is a narrowing [23].

Statistical analysis

In order to reduce fluctuations in the accuracy of measurements, the study of cephalometric parameters was conducted by two orthodontists with 30 and 15 years of experience. The resulting data were used to estimate intra-operator error using a paired-samples t-test. The results showed that intra-operator error was not statistically significant.

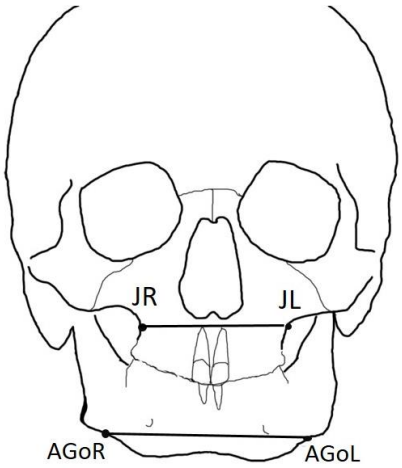

Figure 2 – Transverse skeletal analysis: JR-JL – effective width of the upper jaw, AGoR-AGoL – effective width of the lower jaw

All incidental findings of the pathology of the structures of the craniofacial area and malocclusion were analyzed using descriptive statistics in percentage (%). The relationship between malocclusion and detected pathology was assessed using Pearson's $\chi 2$ test. A value of $p<0.05$ was considered statistically significant. Statistical data processing was carried out in open statistical software for the desktop Jamovi v. 2.3.28.0 free license [24].

RESULTS

Table 1 presents the summary data of the frequency of detected pathology of the maxillofacial area observed among the study participants. Statistically significant relationships were established in hypoplasia of the maxillary sinuses in patients with class III and hyperdivergent type of growth.

The most common pathology observed in our study was the deviation of the nasal septum in 61.4 % of cases. Among the group of patients according to the anteroposterior skeletal pattern, this pathology was almost equally distributed between the I and II classes, although, in percentage terms, it is most common in the III class. In the vertical skeletal pattern group, it prevailed in patients with a hyperdivergent type of growth and was more common in patients with inconsistency of transverse ratios of the transverse skeletal pattern group.

Next in prevalence is the pathology of the maxillary sinuses. Cysts of the maxillary sinuses were observed in 31.1 % of cases and thickening of the mucous membrane of the maxillary sinuses in 25 % of cases, were more common in patients with skeletal class III and prevailed

Table 1 – Distribution of craniofacial pathology among orthodontic patients

Pathology	Total	Anteroposterior skeletal pattern				Vertical skeletal pattern				Transverse skeletal pattern		
		Class I	Class II	Class III	p-value	Hypo-divergent	Normal	Hyper-divergent	p-value	No discrepancy	Discrepancy	p-value
	n (%)	n (%)	n (%)	n (%)		n (%)	n (%)	n (%)		n (%)	n (%)	
Thickening of the mucous membrane of the maxillary sinus												
Absent	210 (75.0)	91 (75.2)	92 (75.4)	27 (73.0)		92 (78.0)	90 (72.6)	28 (73.7)		39 (76.5)	171 (74.7)	
Present	70 (25.0)	30 (24.8)	30 (24.6)	10 (27.0)	0.954	26 (22.0)	34 (27.4)	10 (26.3)	0.614	12 (23.5)	58 (25.3)	0.789
Cyst of the maxillary sinus												
Absent	193 (68.9)	83 (68.6)	85 (69.7)	25 (67.6)		81 (68.6)	81 (65.3)	31 (81.6)		30 (58.8)	163 (71.2)	
Present	87 (31.1)	38 (31.4)	37 (30.3)	12 (32.4)	0.966	37 (31.4)	43 (34.7)	7 (18.4)	0.166	21 (41.2)	66 (28.8)	0.085
Maxillary sinus hypoplasia												
Absent	279 (99.6)	121 (100)	122 (100)	36 (97.3)		118 (100.0)	124 (100)	37 (97.4)		51 (100.0)	228 (99.6)	
Present	1 (0.4)	0 (0.0)	0 (0.0)	1 (2.7)	0.037*	0 (0.0)	0 (0.0)	1 (2.6)	0.041*	0 (0.0)	1 (0.4)	0.636
Thickening of the mucous membrane of the sphenoid sinus												
Absent	267 (95.4)	114 (94.2)	117 (95.9)	36 (97.3)		109 (92.4)	120 (96.8)	38 (100.0)		49 (96.1)	218 (95.2)	
Present	13 (4.6)	7 (5.8)	5 (4.1)	1 (2.7)	0.686	9 (7.6)	4 (3.2)	0 (0.0)	0.091	2 (3.9)	11 (4.8)	0.787
Cyst of the sphenoid sinus												
Absent	273 (97.5)	116 (95.9)	120 (98.4)	37 (100)		114 (96.6)	121 (97.6)	38 (100)		49 (96.1)	224 (97.8)	
Present	7 (2.5)	5 (4.1)	2 (1.6)	0 (0.0)	0.267	4 (3.4)	3 (2.4)	0 (0.0)	0.506	2 (3.9)	5 (2.2)	0.472
Thickening of the mucous membrane of the ethmoid sinus												
Absent	257 (91.8)	110 (90.9)	113 (92.6)	34 (91.9)		104 (88.1)	117 (94.4)	36 (94.7)		47 (92.2)	210 (91.7)	
Present	23 (8.2)	11 (9.1)	9 (7.4)	3 (8.1)	0.888	14 (11.9)	7 (5.6)	2 (5.3)	0.164	4 (7.8)	19 (8.3)	0.915
Thickening of the mucous membrane of the frontal sinus												
Absent	262 (93.6)	116 (95.9)	113 (92.6)	33 (89.2)		108 (91.5)	117 (94.4)	37 (97.4)		49 (96.1)	213 (93.0)	
Present	18 (6.4)	5 (4.1)	9 (7.4)	4 (10.8)	0.298	10 (8.5)	7 (5.6)	1 (2.6)	0.395	2 (3.9)	16 (7.0)	0.420
Cyst of the frontal sinus												
Absent	278 (99.3)	120 (99.2)	121 (99.2)	37 (100)		117 (99.2)	123 (99.2)	38 (100)		50 (98.0)	228 (99.6)	
Present	2 (0.7)	1 (0.8)	1 (0.8)	0 (0.0)	0.858	1 (0.8)	1 (0.8)	0 (0.0)	0.853	1 (2.0)	1 (0.4)	0.242

Continuation of Table 1

Pathology	Total	Anteroposterior skeletal pattern				Vertical skeletal pattern				Transverse skeletal pattern		
		Class I	Class II	Class III	p-value	Hypo-divergent	Normal	Hyper-divergent	p-value	No discrepancy	Discrepancy	p-value
	n (%)	n (%)	n (%)	n (%)		n (%)	n (%)	n (%)		n (%)	n (%)	
Osteoma of the frontal sinus												
Absent	278 (99.3)	119 (98.3)	122 (100)	37 (100)	0.266	117 (99.2)	124 (100)	37 (97.4)	0.236	51 (100)	227 (99.1)	0.503
Present	2 (0.7)	2 (1.7)	0 (0.0)	0 (0.0)		1 (0.8)	0 (0.0)	1 (2.6)		0 (0.0)	2 (0.9)	
Frontal sinus hypoplasia												
Absent	268 (95.7)	113 (93.4)	118 (96.7)	37 (100)	0.169	113 (95.8)	119 (96.0)	36 (94.7)	0.947	49 (96.1)	219 (95.6)	0.887
Present	12 (4.3)	8 (6.6)	4 (3.3)	0 (0.0)		5 (4.2)	5 (4.0)	2 (5.3)		2 (3.9)	10 (4.4)	
Nasal septum deviation												
Absent	108 (38.6)	48 (39.7)	47 (38.5)	13 (35.1)	0.884	44 (37.3)	52 (41.9)	12 (31.6)	0.482	22 (43.1)	86 (37.6)	0.459
Present	172 (61.4)	73 (60.3)	75 (61.5)	24 (64.9)		74 (62.7)	72 (58.1)	26 (68.4)		29 (56.9)	143 (62.4)	
Bony spur of the nasal septum												
Absent	238 (85.0)	96 (79.3)	108 (88.5)	34 (91.9)	0.061	97 (82.2)	110 (88.7)	31 (81.6)	0.3	41 (80.4)	197 (86.0)	0.308
Present	42 (15.0)	25 (20.7)	14 (11.5)	3 (8.1)		21 (17.8)	14 (11.3)	7 (18.4)		10 (19.60)	32 (14.0)	
Concha bullosa												
Absent	230 (82.1)	102 (84.3)	101 (82.8)	27 (73.0)	0.281	100 (84.7)	98 (79.0)	32 (84.2)	0.479	43 (84.3)	187 (81.7)	0.654
Present	50 (17.9)	19 (15.7)	21 (17.2)	10 (27.0)		18 (15.3)	26 (21.0)	6 (15.8)		8 (15.7)	42 (18.3)	
Osteoartros of the atlanto-axial joint												
Absent	264 (94.3)	113 (93.4)	117 (95.9)	34 (91.9)	0.558	109 (92.4)	118 (95.2)	37 (97.4)	0.439	49 (96.1)	215 (93.9)	0.542
Present	16 (5.7)	8 (6.6)	5 (4.1)	3 (8.1)		9 (7.6)	6 (4.8)	1 (2.6)		2 (3.9)	14 (6.1)	
Asymmetry of the atlanto-axial joint												
Absent	255 (91.1)	106 (87.6)	113 (92.6)	36 (97.3)	0.141	108 (91.5)	112 (90.3)	35 92.1	0.921	47 (92.2)	208 (90.8)	0.764
Present	25 (8.9)	15 (12.4)	9 (7.4)	1 (2.7)		10 (8.5)	12 (9.7)	3 (7.9)		4 (7.8)	21 (9.2)	
Adenoid Vegetation												
Absent	224 (80.0)	98 (81.0)	97 (79.5)	29 (78.4)	0.926	95 (80.5)	97 (78.2)	32 (84.2)	0.71	37 (72.5)	187 (81.7)	0.141
Present	56 (20.0)	23 (19.0)	25 (20.5)	8 (21.6)		23 (19.5)	27 (21.8)	6 (15.8)		14 (27.5)	42 (18.3)	

NOTE: * – $p<0.05$

in patients with transverse inconsistency, and were most characteristic of patients with a normal growth type.

According to the results of our study, a statistically significant relationship of hypoplasia of the maxillary sinuses with skeletal III class (p=0.037) and hyperdivergent type of growth (p=0.041) in orthodontic patients was established.

DISCUSSION

In the current study, based on the analysis of CBCT of the skull, we observed numerous non-dental pathological conditions of the craniofacial area and cervical spine.

The most common pathology was the deviation of the nasal septum 61.4 %, which, in general, coincides with the data of other researchers [25]. Such anomaly can be asymptomatic and be discovered by chance during X-ray examinations. Unilateral nasal congestion, epistaxis, obstructive sinusitis, and/or pain symptoms may occur. This pathology is almost equally distributed among all groups of patients, according to which the distribution of bite in three planes was carried out, although the highest indicators were established in patients with III skeletal class (65 %) and hyperdivergent type of growth (68 %).

Also, in the pathology of the nasal passages, quite high rates of concha bulesis and bony spur of the nasal septum were established, 17.9 % and 15 %, respectively. Inflammation, hypertrophy of the nasal conchas lead to difficulty in nasal breathing, which can lead to impaired development of the jaws, primarily the upper jaw.

Next in prevalence are pathological processes of the paranasal sinuses, namely maxillary sinus cysts and maxillary sinus mucosal thickening. Such conditions can result from harmful actions caused by trauma, infections, chemical agents, foreign body reactions, neoplasms, or respiratory diseases such as allergies, rhinitis, or asthma. The limit point at which thickening is considered pathological is 3 mm.

According to the data of a number of studies, among all the paranasal sinuses, inflammatory processes of the Maxillary sinus have the highest frequency and make up 31.7-55.4 % [13, 14].

According to the systematic review of Ata-Ali et al. [26] the prevalence of thickening of the mucous membrane of the maxillary sinuses ranged from 35.1 to 66 %.

According to the results of our study, thickening of the mucous membrane of the maxillary sinuses of various genesis and X-ray picture was established in 25% of cases, and together with cysts of the maxillary sinuses (31%), the pathology of this anatomical area reaches 56%. Mucosal cysts are a common incidental finding on imaging studies and are not associated with symptoms of chronic rhinosinusitis. These pathological conditions are also evenly distributed between types of bite in all planes.

Pathological processes in the maxillary sinuses and nasal passages have not only clinical significance from the point of view of bite pathology, but are also related to breathing function. Such conditions can potentially affect the dynamics of the air flow in the nasal passages, and their rather high prevalence rates have an indirect effect on the formation of malocclusion. On the other hand, there are studies in which it is claimed that malocclusion itself can contribute to a decrease in the airflow of the nasal passages [27].

Among the anatomical variations, hypoplasia of the frontal and maxillary sinuses should be noted. According to the results of our study, hypoplasia of the frontal sinuses was 4.3 %, the highest frequency was found in pathology of the I skeletal class with a hyperdivergent type of growth. According to Abate et al. [28] established statistically significant relationships between the volume of the frontal sinus and the position of the lower jaw and an increase in the front pattern, which is also characteristic of the hyperdivergent type of growth.

According to the results of our study, the prevalence of hypoplasia of the maxillary sinuses was 0.4 %, which is most typical for patients with skeletal III class (p=0.037) and hyperdivergent type of growth (p=0.041).

Nasopharyngeal obstructions also affect the type of breathing and the formation of malocclusion [29]. According to Florez et al [30], nasopharyngeal cephalometric size and pharyngeal tonsil hypertrophy were associated, in contrast to oropharyngeal cephalometric size and palatine tonsil hypertrophy, which were not. The authors also indicate that the type of bite anomalies does not correlate with the nature of breathing and changes in the upper respiratory tract, with the exception of the severity of nasal septum deviation and bite anomalies in class III, which, in general, coincides with the results of our study, highlighted earlier in the analysis of associated pathology of the nasal passages and malocclusion.

Regarding adenoid vegetations, the prevalence in our study was 20 %, but no statistically significant relationship with malocclusion was established. At the same time, the highest frequency was established in patients with the III skeletal class – 21.6 %. Kose et al. [25] also found no significant correlation between various malocclusions and the presence of adenoid vegetations, despite a higher prevalence in the class III malocclusion group. Although there is a number of studies that show that with adenoid hypertrophy, there is a decrease in the angle of the convexity of the face and the nasolabial angle, that is, parameters that affect the profile and aesthetics of the face [31]. There are also data that with adenoid hypertrophy there was a narrower width of the posterior respiratory space and an increased height of the palate [32].

Therefore, the development of the facial pattern and its relationship with the pathology of the nasopharyngeal area are influenced by anatomical variations and chronic inflammatory processes in the paranasal sinuses and the presence of adenoid vegetation.

Malocclusion and the condition of the musculoskeletal system, the cervical spine, the position of the head in space, which depends on the atlanto-axial connection, can also be related. Thus, Smaglyuk et al. [21], during the study revealed a functional imbalance of all structural elements of the musculoskeletal system in patients with a cross bite. Sandoval et al. [33] found that in class III compared to class II, the cervical spine is moved forward and shorter.

Other researchers evaluated the relationship between cervical spine abnormalities and malocclusion types [34]. Although the obtained results showed the absence of a direct influence of the type of malocclusion on the anomalies of the cervical vertebrae, the prevalence of this pathology was set at a fairly high level - 45.7 %.

Usually, C1-C3 cervical vertebrae are clearly visible on the CBCT scan of the facial skeleton, so we analyzed these structures and the atlanto-axial junction. Thus, the asymmetry of the atlanto-axial joint is established in almost 9 % of cases, it is more common in patients with I skeletal class 12.4 % and in the group with disproportion in the transverse plane 9.2 %. Osteoarthrosis of the atlanto-axial joint was detected in 5.7 % of cases, more often in patients with class III.

We also want to note the pathology, according to the results of the CBCT study, can be found by chance. We are talking about such benign formations as osteoma of the paranasal sinuses. In particular, we found frontal sinus osteoma in 2 patients (0.7%). Although they may be asymptomatic, when detected, it is necessary to refer such patients for consultation to the appropriate specialist.

Finally, we would like to say that this study has certain limitations that should be taken into account when interpreting its results. Primarily because the study is based on the radiological picture of the specified pathology, which did not include any clinical symptoms and findings and did not evaluate the soft tissues. In most of the works analyzed by us, the emphasis was placed on anatomical variations in the structure of the paranasal sinuses, which requires considerable qualification of the relevant specialist, first of all, an otorhinolaryngologist. In our study, the work is based on the pathology for which the qualification and knowledge of the orthodontist is sufficient in the analysis of the CBCT of patients with malocclusion. This analysis serves as a guide for further research, highlighting the need for broader and comprehensive research in this area.

CONCLUSIONS

CBCT provides basic information for further necessary studies of related pathologies.

A statistical relationship of malocclusion with hypoplasia of the maxillary sinuses in patients with class III and hyperdivergent type of growth was established. The most common pathology that was found in different groups of malocclusion is the deviation of the nasal septum.

Although most incidental findings may be asymptomatic, they may require a change in the treatment plan, so orthodontists should be aware of incidental findings and anatomic variations. Correct identification of these findings will reduce unnecessary further diagnostic errors and allow for a more appropriate treatment plan based on a multidisciplinary approach.

AUTHOR CONTRIBUTIONS / ВКЛАД АВТОРІВ

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A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article.

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CONFLICT OF INTEREST / КОНФЛІКТ ІНТЕРЕСІВ

The authors declare no conflict of interest.

ARTIFICIAL INTELLIGENCE DISCLOSURE / ВИКОРИСТАННЯ ШТУЧНОГО ІНТЕЛЕКТУ

The authors confirm that no artificial intelligence-based technologies were utilized in the writing or editing of the manuscript.

REFERENCES/СПИСОК ЛІТЕРАТУРИ

1. George AM, Felicita AS, Milling Tania SD, Priyadharsini JV. Systematic review on the genetic factors associated with skeletal Class II malocclusion. Indian J Dent Res. 2021;32(3):399-406. https://doi.org/10.4103/ijdr.IJDR_59_20
2. Vyzhenko YeYe, Kuroiedova VD, Korobov PS, Halych LB. The influence of chronic stress on periodontal tissues in orthodontic patients in conditions of martial law. *Medicni perspektivi*. 2024;29(1):127-134. https://doi.org/10.26641/2307-0404.2024.1.300783
3. Lombardo G, Vena F, Negri P, Pagano S, Barilotti C, Paglia L, et al. Worldwide prevalence of malocclusion in the different stages of dentition: A systematic review and meta-analysis. *Eur J Paediatr Dent*. 2020;21(2):115–22. https://doi.org/10.23804/ejpd.2020.21.02.05
4. Sokologorska-Nykina YuK, Kuroiedova VD, Stasiuk OA, Korobov PS. Electromygraphic Potential of Mastication Muscles of Patients with Hearing Deprivation and Dental Anomalies. *Journal of International Dental &Medical Research*. 2024; 17.1: 239-246.
5. Smaglyuk LV, Voronkova HV, Karasiunok AY, Liakhovska AV, Solovei KO. Interdisciplinary approach to diagnostics of malocclusions (review). *Wiadomosci lekarskie*. 2019;72(5 cz 1):918–922.
6. Liakhovska TYu, Hromova AM, Ketova OM, Smagliuk LV, Liakhovska AV. Features of physical and sexual development and the state of bone tissue in adolescent girls. *Ukrainian Journal of Perinatology and Pediatrics*. 2023:96(4):91–99.
7. Skrypnyk M, Petrushanko T, Neporada K, Petrushanko V, Skrypnyk I. Changes in the periodontium against the background of systemic vascular reactions in young individuals with obesity. *Dent Med Probl*. 2024;61(2):197-207. https://doi: 10.17219/dmp/157294.
8. Chen W, Zeng H, Wang X, Xu Q, Liu P, Zhang L, et al. A structural equation modeling approach to determine the correlation between the vertical and sagittal skeletal patterns and posterior basal bones mismatching in patients with skeletal Class III malocclusion. *Am J Orthod Dentofacial Orthop*. 2022;162(6):e277–94. https://doi.org/10.1016/j.ajodo.2022.08.015
9. Tian Y, Mao B, Cui S, Guo Y, Zhao N, Zhang Y, et al. Effects of orthodontic camouflage treatment vs orthodontic-orthognathic surgical treatment on condylar stability in Class II hyperdivergent patients with severe temporomandibular joint osteoarthrosis: a retrospective observational study. *Angle Orthod*. 2023;93(4):458–66. https://doi.org/10.2319/090622-622.1
10. Abdelkarim A. Cone-Beam Computed Tomography in Orthodontics. *Dent J (Basel)*. 2019;7(3):89. https://doi:10.3390/dj7030089
11. Korobeinikova YuL, Korobeinikov LS. Cone-Beam Computed Tomography in Dental Practice: Literature Review and Own Observations. *Journal of International Dental and Medical Research.* 2023;16(4):1747- 1752.
12. Stasiuk AA, Vyzhenko YY, Makarova AN, Kuroiedova VD, Sokolohorska-Nykina YK. The evaluation of heads of temporomandibular joint (TMJ) position in patients with malocclusion. *New Armenian Medical Journal*. 2020;14(1):48-53.
13. Avsever H, Gunduz K, Karakoç O, Akyol M, Orhan K. Incidental findings on cone-beam computed tomographic images: paranasal sinus findings and nasal septum variations. *Oral radiology*. 2018;34(1):40–8. https://doi: 10.1007/s11282-017-0283-y
14. Ali AHA, Serhan OO, Alsharif MHK, et al. Incidental detection of paranasal sinuses abnormalities on CT imaging of the head in Saudi adult population. *PLoS One*. 2022;17(9):e0270764. https://doi:10.1371/journal.pone.0270764
15. Akay G, Yaman D, Karadağ Ö, Güngör K. Evaluation of the Relationship of Dimensions of Maxillary Sinus Drainage System with Anatomical Variations and Sinusopathy: Cone-Beam Computed Tomography Findings. *Med Princ Pract*. 2020;29(4):354-363. https://doi: 10.1159/000504963
16. de Carvalho AB, Ferreira Costa AL, Fuziy A, de Assis AC, Castro Veloso JR, Coutinho Manhães LR, et al. Investigation on the relationship of dimensions of the maxillary sinus drainage system with the presence of sinusopathies: a cone beam computed tomography study. *Arch Oral Biol*. 2018;94:78–83. https://doi.org/10.1016/j.archoralbio.2018.06.021
17. Gruszka K, Aksoy S, Różyło-Kalinowska I, Gülbeş MM, Kalinowski P, Orhan K. A comparative study of paranasal sinus and nasal cavity anatomic variations between the Polish and Turkish Cypriot Population with CBCT. *Head Face Med*. 2022;18:37.
18. Festa P, Mansi N, Varricchio AM, Savoia F, Calì C, Marraudino C, et al. Association between upper airway obstruction and malocclusion in mouth-breathing children. *Acta Otorhinolaryngol Ital*. 2021;41(5):436–42. https://doi.org/10.1186/s13005-022-00340-3
19. Hasanin M, El-Naghy R, Olson D, Al-Jewair T. Three-dimensional analysis of upper airway and craniofacial morphology in orthodontic adolescents with Attention Deficit Hyperactivity Disorder (ADHD): A comparative retrospective study. *Int*

Orthod. 2021;19(4):622–32. https://doi.org/10.1016/j.ortho.2021.08.005
20. Nowak M, Golec J, Wieczorek A, Golec P. Is There a Correlation between Dental Occlusion, Postural Stability and Selected Gait Parameters in Adults? *Int J Environ Res Public Health*. 2023;20(2):1652. https://doi.org/10.3390/ijerph20021652
21. Smaglyuk , Karasiunok A, Kulish N, Liakhovska A, Voronkova H, Bilous A, Smaglyuk V. Optimization of the clinical diagnostic examination algorithm of patients with a cross bite complicated by cranio-mandibular dysfunction and postural disorder. *Pol Merkur Lekarski*. 2024;52(2):203-207. doi: 10.36740/Merkur202402109. https://doi.org/10.36740/Merkur202402109
22. Kuroiedova VD, Vyzhenko EE, Makarova OM, Stasiuk O.A. Scientific justification of the use of cone-beam computerized tomography (cbct) for cephalometric analysis in the «Audaxceph» programm. *Ukrainian Dental Almanac*. 2019;4:52–56.
23. Amer NM, Aboalnaga AA, Salah Fayed MM, Labib AH. Transverse Malocclusion and Temporomandibular Disorders: Verification of the Controversy. *J Oral Facial Pain Headache*. 2019;33(4):355–61. https://doi.org/10.11607/ofph.2286
24. The jamovi project (2022). jamovi. (Version 2.3) [Computer Software]. Retrieved from https://www.jamovi.org
25. Kose SK, Aksoy S, Onder M, Oz U, Orhan K. Association among Orthodontic Malocclusions, Paranasal Sinuses Anatomic Variations and Adenoid Vegetation in Children Using CBCT. *Children (Basel)*. 2023;10(9):1549. https://doi.org/10.3390/children10091549
26. Ata-Ali J, Diago-Vilalta JV, Melo M, Bagán L, Soldini MC, Di-Nardo C, Ata-Ali F, Mañes-Ferrer JF. What is the frequency of anatomical variations and pathological findings in maxillary sinuses among patients subjected to maxillofacial cone beam computed tomography? A systematic review. *Med Oral Patol Oral Cir Bucal*. 2017;22(4):e400-e409. https://doi.org/10.4317/medoral.21456
27. Occasi F, Perri L, Saccucci M, Di Carlo G, Ierardo G, Luzzi V, De Castro G, Brindisi G, Loffredo L, Duse M, et al. Malocclusion and rhinitis in children: An easygoing relationship or a yet to be resolved paradox? A systematic literature revision. *Ital. J. Pediatr*. 2018;44:100. https://doi.org/10.1186/s13052-018-0537-2
28. Abate A, Gaffuri F, Lanteri V, Fama A, Ugolini A, Mannina L, et al. A CBCT based analysis of the correlation between volumetric morphology of the frontal sinuses and the facial growth pattern in caucasian subjects. A cross-sectional study. *Head Face Med*. 2022;18(1):4. https://doi.org/10.1186/s13005-022-00308-3
29. Lin L, Zhao T, Qin D, Hua F, He H. The impact of mouth breathing on dentofacial development: A concise review. *Front Public Health*. 2022;10:929165. https://doi.org/10.3389/fpubh.2022.929165
30. Florez BM, Tagawa DT, Inoue DP, Yamashita HK, Aidar LA de A, Dominguez GC. Associations between skeletal discrepancies, breathing pattern, and upper airway obstruction in Class III malocclusions. *Int J Pediatr Otorhinolaryngol*. 2023;166:111471. https://doi.org/10.1016/j.ijporl.2023.111471
31. Cheng B, Mohamed AS, Habumugisha J, Guo Y, Zou R, Wang F. A Study of the Facial Soft Tissue Morphology in Nasal- and Mouth-Breathing Patients. *Int Dent J*. 2023;73(3):403–9. https://doi.org/10.1016/j.identj.2022.09.002
32. Lan Y, Chen J, Chen S, He Y, Huang F. Influences of Adenoid Hypertrophy on Children's Maxillofacial Development. *Healthcare (Basel)*. 2023;11(21):2812. https://doi.org/10.3390/healthcare11212812
33. Sandoval C, Díaz A, Manríquez G. Assessing cervical spine and craniofacial morphology in Class II and Class III malocclusions: A geometric morphometric approach. *Cranio*. 2024 Jul;42(4):450–60. https://doi.org/10.1080/08869634.2021.1987040
34. Adisen SR, Adisen MZ, Ozdiler FE. The evaluation of the relationship between cervical vertebral anomalies with skeletal malocclusion types and upper airway dimensions. *Cranio*. 2020;38(3):149–57. https://doi.org/10.1080/08869634.2018.1503136

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