Original Research

https://doi.org/10.36377/ET-0176

Study of the correlation of the top of the mandibular teeth to the bottom of the maxillary sinus according to CBCT data

Irina A. Gatilo ✉, Sergey V. Sirak

Stavropol State Medical University, Stavropol, Russian Federation

✉ chijgay@yandex.ru

Abstract

INTRODUCTION. The article presents the results of a study of the ratios of apex roots of premolars and molars of the upper jaw to the bottom of the maxillary sinus based on the analysis of 288 cone-beam computed tomograms (CBCT).

MATERIALS AND METHODS. The sample included patients older than 25 years, divided into five age groups, adjusted for gender. Measurements were made in the sagittal and axial planes with an accuracy of 0.1 mm, using Romexis Viewer software and statistical analysis in SPSS (ANOVA, Pearson correlation analysis).

RESULTS. Key findings: Distances from apex to sinus floor decrease with age (r = –0.45 to –0.72, $p < 0.01$), with lower values in females and variability up to 50% in older groups. Minimum distances (up to –0.95 mm) are observed in the 65+ year group, indicating a risk of perforation in 15-30% of patients. ANOVA revealed significant differences between groups and sexes (F = 4.12–6.78, $p < 0.05$), with a tendency for apexes of premolars and molars to approach the bottom. The clinical significance of the results obtained lies in the reduction of the risks of complications (sinusitis, perforation) during dental interventions due to the preventive use of CBCT.

CONCLUSIONS. The data contribute to personalized treatment planning, particularly in older patients and women.

Keywords: the bottom of the maxillary sinus, the tops of the roots of the teeth, cone-ray computed tomography, coefficient of variation

Article information: received – 24.12.2025; revised – 29.01.2026; accepted – 10.02.2026

Conflict of interest: The authors declare no conflict of interest.

Acknowledgements: There are no funding and individual acknowledgments to declare.

For citation: Gatilo I.A., Sirak S.V. Study of the correlation of the top of the mandibular teeth to the bottom of the maxillary sinus according to CBCT data. *Endodontics Today*. 2026;24(1):196–203. https://doi.org/10.36377/ET-0176

Изучение соотношения верхушек жевательных зубов ко дну верхнечелюстной пазухи по данным КЛКТ

И.А. Гатило ✉, С.В. Сирак

Ставропольский государственный медицинский университет, г. Ставрополь, Российская Федерация

✉ chijgay@yandex.ru

Резюме

ВВЕДЕНИЕ. В статье представлены результаты исследования соотношений апексов корней премоляров и моляров верхней челюсти ко дну верхнечелюстной пазухи на основе анализа 288 конусно-лучевых компьютерных томограмм (КЛКТ).

МАТЕРИАЛЫ И МЕТОДЫ. Выборка включала пациентов старше 25 лет, разделенных на пять возрастных групп, с учетом пола. Измерения проводились в сагиттальной и аксиальной плоскостях с точностью до 0,1 мм, с использованием программного обеспечения Romexis Viewer и статистического анализа в SPSS (ANOVA, корреляционный анализ Пирсона).

РЕЗУЛЬТАТЫ. Ключевые результаты: расстояния от апексов до дна пазухи уменьшаются с возрастом (r = –0,45 до –0,72, $p < 0,01$), с более низкими значениями у женщин и вариабельностью до 50% в старших группах. Минимальные расстояния (до –0,95 мм) наблюдаются в группе 65+ лет, указывая на риск перфорации у 15–30% пациентов. ANOVA выявил значимые различия между группами и полами (F = 4,12–6,78, $p < 0,05$), с тенденцией к приближению апексов премоляров и моляров к дну. Клиническая значимость полученных результатов заключается в снижении рисков осложнений (синусит, перфорация) при стоматологических вмешательствах за счет превентивного использования КЛКТ.

ВЫВОД. Данные способствуют персонализированному планированию лечения, особенно у пожилых пациентов и женщин.

Ключевые слова: дно верхнечелюстной пазухи, верхушки корней зубов, конусно-лучевая компьютерная томография, коэффициент вариации

© Gatilo I.A., Sirak S.V., 2026

Информация о статье: поступила – 24.12.2025; исправлена – 29.01.2026; принята – 10.02.2026

Конфликт интересов: Авторы сообщают об отсутствии конфликта интересов.

Благодарности: Финансирование и индивидуальные благодарности для декларирования отсутствуют.

Для цитирования: Гатило И.А., Сирак С.В. Изучение соотношения верхушек жевательных зубов ко дну верхнечелюстной пазухи по данным КЛКТ. *Эндодонтия Today.* 2026;24(1):196–203. https://doi.org/10.36377/ET-0176

INTRODUCTION

The maxillary sinus represents one of the largest paranasal sinuses, located within the body of the maxilla and in close anatomical proximity to the roots of the posterior teeth (premolars and molars). This intimate relationship creates distinct clinical challenges in dental practice, as the volume and quality of the surrounding bone tissue around the tooth apices directly influence treatment planning and outcomes in endodontic therapy [1], surgical interventions such as apicoectomy or tooth extraction [2], as well as orthodontic treatment, where prediction of tooth movement and the risk of sinus floor perforation is essential [3].

In recent years, with the increasing prevalence of patients suffering from chronic systemic conditions (e.g., osteoporosis or oncologic diseases requiring bisphosphonate therapy), the incidence of complications associated with this anatomical region has remained considerable, underscoring the need for detailed investigation of topographic relationships [4].

Particular clinical relevance arises in the context of odontogenic maxillary sinusitis, an inflammatory condition developing in approximately 10–15% of cases following endodontic treatment or extraction of maxillary teeth [5; 6]. Epidemiological data indicate that odontogenic sinusitis accounts for up to 40% of all cases of chronic maxillary sinusitis and is frequently associated with perforation of the sinus floor and the formation of an oroantral communication [7]. One of the most common complications is extrusion of root canal filling material (endodontic sealer) beyond the apical foramen into the lumen of the maxillary sinus, reported in 1–5% of endodontic procedures [8; 9]. Such events are not invariably iatrogenic; rather, they are often attributable to anatomical factors, including a thin cortical plate (frequently less than 1 mm) and variability in the spatial relationship between tooth apices and the sinus floor [10; 11]. Toxic components of certain sealers (e.g., formaldehyde- or eugenol-based compounds) may induce mucosal irritation, hypertrophy, and secondary infection, necessitating surgical removal of the material and adjunctive antibiotic therapy, thereby increasing the risk of systemic complications [12; 13].

Historically, classifications of the relationship between posterior tooth apices and the maxillary sinus floor have evolved from descriptive approaches to quantitative assessments facilitated by advanced imaging modalities. The classical typology proposed by E. Zuckerkandl (1891) identified three variants: (1) apices penetrating into or located in close proximity to the sinus cavity (19–25%); (2) apices situated 1–3 mm from the sinus floor (45–50%); and (3) combined forms (25–35%) [14]. L.I. Sverzhevsky (1950) described three types based on the relative position of the sinus floor to the nasal cavity: at the same level, lower, or higher [15].

Contemporary investigations employing cone-beam computed tomography (CBCT) corroborate and refine these findings. For example, the apices of the first maxillary molar most frequently demonstrate contact with the sinus floor (up to 70%), whereas premolars and third molars are typically located 2–5 mm away [16]. According to Shokri et al. (as modified by R.S. Mekhtiev et al., 2023), four types are distinguished: type 0 (sinus floor above the apex, 10–15%); type 1 (direct contact, 50–60%); type 2 (protrusion into the sinus lumen, 20–25%); and type 3 (apex located within the sinus cavity and surrounded by air, 5–10%) [17; 18]. In the horizontal plane, apical contact with the sinus floor is observed in 72% of cases, separation in 17%, and invasion in 11% [19]. The greatest distance from the sinus floor is typically observed in the apices of second premolars and impacted third molars, where the osseous layer may be comparable to the thickness of cigarette paper (0.1–0.5 mm) [20].

Despite the accumulated evidence, significant gaps remain. Most studies focus predominantly on molars, with comparatively limited attention to premolars, and insufficient consideration of ethnic variability (e.g., in Eastern European populations) and the influence of age and sex on anatomical variation [21]. CBCT, characterized by relatively low radiation exposure and high spatial resolution (up to 0.2 mm), represents an optimal modality for quantitative assessment of these relationships, enabling risk stratification, minimization of sinus floor perforation, and optimization of preventive strategies for odontogenic sinusitis [22].

Therefore, the evaluation of the anatomical and topographic relationships between the apices of maxillary premolars and molars and the maxillary sinus floor using CBCT remains a clinically relevant objective aimed at reducing complications in dentistry and maxillofacial surgery.

The aim of the present study was to analyze the spatial relationships between the apices of maxillary posterior teeth and the sinus floor using CBCT in order to develop evidence-based recommendations for the prevention of perforations during endodontic and surgical treatment.

MATERIALS AND METHODS

The study included 288 cone-beam computed tomography (CBCT) scans obtained between 2019 and 2025 at the dental clinic of the Department of Dentistry, Stavropol State Medical University, Ministry of Health of the Russian Federation. The sample was designed as a retrospective cohort based on archived imaging data.

Table 1. Distribution of observed patients by age groups

Таблица 1. Распределение наблюдаемых пациентов по группам

Age Groups (years)	Sex	Total Observations Presence of Premolars and Molars
25–34	M	28
	F	28
35–44	M	28
	F	30
45–54	M	30
	F	28
55–64	M	30
	F	28
65 years and older	M	30
	F	28
Total		288

The inclusion criterion was the presence of maxillary premolars and molars (first and second premolars, first and second molars) in patients older than 25 years.

Non-inclusion criteria comprised complete or partial absence of maxillary posterior teeth and the presence of two-rooted second premolars. No additional exclusion criteria were applied.

Patients were stratified into five age groups: (1) 25–34 years; (2) 35–44 years; (3) 45–54 years; (4) 55–64 years; and (5) ⩾65 years. The distribution of observations across age groups is presented in Table 1.

The overall gender distribution in the sample comprised 174 males (60.4%) and 114 females (39.6%), reflecting the typical demographic profile of dental clinic patients.

The relationships between the apices of maxillary posterior teeth and the floor of the maxillary sinus were analyzed using CBCT imaging software (Romexis Viewer) with a spatial resolution of at least 0.2 mm. For each patient, measurements were obtained of the distances from the apices of the first and second premolars and the first and second molars to the sinus floor in both sagittal and axial planes. Measurements were recorded in millimeters with 0.1 mm precision. In multi-rooted teeth (e.g., molars), all apices were assessed, and the minimum and maximum distances for each tooth were calculated. All measurements were independently performed by two examiners to ensure reliability (intraclass correlation coefficient, ICC > 0.85), with discrepancies resolved by consensus or adjudication by a third expert.

Statistical analyses were conducted using SPSS software (version 25.0). Normality of data distribution was assessed with the Shapiro–Wilk test. Descriptive statistics, including mean (M), standard deviation (SD), median, quartiles, and range, were calculated for quantitative variables (distances from apices to the sinus floor). Comparisons between age groups and sexes were performed using two-way analysis of variance (ANOVA) followed by Tukey's post hoc test for multiple comparisons. Correlations between age, sex, and measured distances were assessed using Pearson's correlation coefficient (r) or Spearman's rank correlation coefficient (ρ), depending on data distribution. The coefficient of variation (CV) was calculated to evaluate the relative variability of distances from tooth apices to the sinus floor, defined as the standard deviation divided by the mean, expressed as a percentage. Statistical significance was set at $p < 0.05$. Measurement reliability was confirmed using the intraclass correlation coefficient (ICC).

RESULTS

Analysis of the CBCT data revealed variability in the distances from the apices of maxillary premolars (teeth 1.4–1.7) and molars (teeth 2.4–2.7) to the floor of the maxillary sinus, depending on age, sex, and side (right – R, left – L). Measurements were obtained for palatal (P), mesiobuccal (MB), and distobuccal (DB) apices where applicable. Results are presented as mean ± standard deviation (M ± SD) in millimeters. The overall sample included 288 patients (174 males, 114 females), divided into five age groups: 25–34, 35–44, 45–54, 55–64, and ⩾65 years. Statistical analysis (ANOVA with Tukey's post hoc tests, $p < 0.05$) demonstrated significant differences between age groups, with a trend toward decreasing distances with age, likely reflecting alveolar bone atrophy and sinus floor elevation. Correlation analysis (Pearson's r) indicated a moderate negative association between age and distance ($r = -0.45$ to -0.68 for various apices, $p < 0.01$), suggesting an increased risk of sinus perforation in elderly patients.

Data for male patients

In males, mean distances ranged from minimal values (apices located close to or even above the sinus floor, indicating potential perforation) to maximal values (apices significantly distant from the floor) (Table 2):

– **age 25–34 years:** Molar apices were the most distant from the sinus floor (e.g., palatal apex of tooth 2.7 – 6.48 ± 2.05 mm on the right, 7.15 ± 2.78 mm on the left), whereas the closest apices were those of second premolars (e.g., apex 1.5 – 1.37 ± 1.46 mm on the right);

– **age 35–44 years:** Distances decreased (e.g., palatal apex 2.7 – 5.98 ± 1.85 mm on the right), with minimal values observed for mesiobuccal apex 1.6 (0.78 ± 0.14 mm on the left);

– **age 45–54 years:** Further reduction was noted (mesiobuccal apex 1.6 – 0.98 ± 0.12 mm on the left), though molars remained relatively distant (palatal apex 2.7 – 6.52 ± 1.78 mm on the right);

– **age 55–64 years:** Maximum distances for premolars were observed (buccal apex 1.4 – 10.39 ± 4.45 mm on the right; palatal apex 1.4 – 12.85 ± 3.56 mm on the right), while minimal distances persisted for second premolars (apex 1.5 – 0.97 ± 0.25 mm on the right). This reflects high variability (SD up to 4.45 mm), with a perforation risk estimated at 15–20% based on SD and normal distribution assumptions;

– **age ⩾65 years:** The closest apices were observed (apex 1.5 – –0.95 ± 0.12 mm on the right, indicating perforation in a subset of patients), whereas molars remained more distant (palatal apex 2.7 – 4.36 ± 1.02 mm on the right).

Table 2. Average distances from the apices to the bottom of the maxillary sinus, according to CBCT data in men

Таблица 2. Средние данные расстояния от апексов до дна верхнечелюстной пазухи, по данным КЛКТ у мужчин

Groups	R									L								
	1.7			1.6			1.5	1.4		2.4		2.5	2.6			2.7		
	P	MB	DB	P	MB	DB	apex	P	b	P	b	apex	P	MB	DB	P	MB	DB
25–34	6.00±2.05	2.53±0.75	4.98±2.67	2.75±1.75	1.37±1.46	2.88±1.05	–0.97±0.25	6.48±2.05	7.15±2.78	5.68±1.98	6.48±1.45	1.63±1.64	1.13±0.45	2.14±0.78	0.98±0.36	4.25±1.36	1.78±0.36	2.45±0.78
35–44	5.87±1.54	2.04±0.98	4.05±1.78	2.15±0.48	1.05±0.69	2.45±0.27	1.85±0.37	5.98±1.85	6.25±1.27	4.87±1.36	4.78±1.54	1.05±0.65	1.02±0.31	1.97±0.12	0.78±0.14	3.14±0.98	2.15±0.36	2.04±0.12
45–54	4.23±1.06	1.69±0.45	3.98±0.97	2.05±0.74	0.98±0.12	1.87±0.36	5.89±1.74	6.52±1.78	7.36±1.87	5.65±1.58	3.45±1.36	3.25±1.24	1.08±0.14	2.02±0.36	1.98±0.17	2.87±0.12	1.36±0.12	1.25±0.14
55–64	3.45±1.36	1.54±0.31	2.04±1.36	1.54±0.16	1.78±0.36	1.36±0.74	7.38±1.35	12.85±3.56	10.39±4.45	9.47±2.79	8.78±3.65	4.17±1.24	1.65±0.41	1.98±0.478	0.78±0.12	1.25±0.14	1.98±0.36	1.48±0.14
65 and above	2.40±0.74	1.68±0.45	2.25±1.04	1.98±0.45	2.02±1.63	1.44±0.12	–1.95±0.12	4.36±1.02	3.69±2.58	6.48±1.45	4.98±2.36	1.87±0.48	1.79±0.15	2.97±1.04	1.15±0.63	1.36±0.45	2.15±0.78	1.96±0.14

Note: P – palatal apex; MB – mesiobuccal apex; DB – distobuccal apex, b – buccal

Примечание: P – небный апекс, MB – переднещечный, DB – заднещечный, b – щечный

Table 3. Average distances from the apices to the bottom of the maxillary sinus, according to CBCT data in women

Таблица 3. Средние данные расстояния от апексов до дна верхнечелюстной пазухи, по данным КЛКТ у женщин

Groups	R									L								
	1.7			1.6			1.5	1.4		2.4		2.5	2.6			2.7		
	P	MB	DB	P	MB	DB	apex	P	b	P	b	apex	P	MB	DB	P	MB	DB
25–34	1.79±0.98	2.53±0.56	2.0±0.96	0.69±0.78	1.60±0.45	1.59±0.31	0.68±0.48	4.45±1.59	4.69±3.52	4.58±2.81	6.45±3.67	1.26±0.75	2.82±1.98	3.09±2.68	1.98±2.83	2.08±2.78	3.95±2.08	3.48±1.78
35–44	0.25±0.11	0.78±0.36	0.97±0.38	1.45±0.48	0.68±0.67	0.79±0.69	1.02±0.48	1.96±0.58	2.16±0.97	1.81±0.45	1.79±0.39	0.96±0.46	0.68±0.39	1.02±0.48	1.39±0.78	0.39±0.79	1.97±0.46	1.05±0.69
45–54	2.72±0.25	0.75±0.58	2.70±0.97	1.80±0.29	0.60±0.35	1.21±0.67	0.24±0.65	1.80±0.37	1.64±0.45	1.67±0.48	1.75±0.37	1.60±1.09	1.29±0.47	0.98±0.78	1.78±0.46	0.85±0.97	2.18±0.78	2.11±0.63
55–64	0.25±0.11	0.58±0.14	0.78±0.15	0.36±0.14	0.87±0.16	1.02±0.58	1.97±0.63	3.48±1.65	3.78±1.69	1.35±0.96	1.78±1.05	0.96±0.49	0.79±0.18	0.87±0.36	0.79±0.14	0.96±0.14	1.14±0.68	1.58±0.14
65 and above	0.76±0.12	1.09±0.25	0.76±0.14	0.20±0.11	1.02±0.15	1.08±0.36	2.50±0.97	6.45±1.25	4.24±1.78	6.68±1.26	2.82±1.36	1.68±1.01	0.89±0.02	1.24±0.65	1.09±0.45	1.38±0.32	0.62±0.11	0.67±0.11

Note: P – palatal apex; MB – mesiobuccal apex; DB – distobuccal apex, b – buccal

Примечание: P – небный апекс, MB – переднещечный, DB – заднещечный, b – щечный

ANOVA demonstrated significant differences between age groups (F = 12.45–18.67, $p < 0.001$ for most apices), with post hoc analyses confirming a decrease in distances from younger to older groups ($p < 0.05$). The coefficient of variation (CV = SD/M × 100%) was highest for premolars (up to 50% in older groups), reflecting considerable individual variability.

Data for female patients

In females, distances were generally smaller than in males, with a more pronounced approximation of apices to the sinus floor in older age groups (Table 3):

– **age 25–34 years:** Distances varied (e.g., palatal apex 2.7 – 4.45 ± 1.59 mm on the right), with minimal values observed for premolars (apex 1.4 – 0.69 ± 0.78 mm on the right);

– **age 35–44 years:** Marked reduction in distances was noted (e.g., apex 1.4 – 0.25 ± 0.11 mm on the right), with perforation risk evident for multiple apices (low SD, CV ~20–40%);

– **age 45–54 years:** Distances remained low but stable (e.g., mesiobuccal apex 1.6 – 0.60 ± 0.35 mm on the right);

– **age 55–64 years:** Further approximation was observed (apex 1.4 – 0.25 ± 0.11 mm on the right), with molars at 3.48 ± 1.65 mm on the right;

– **age ⩾65 years:** Minimal distances were recorded for premolars (apex 1.4 – 0.20 ± 0.11 mm on the right), whereas molars remained relatively distant (palatal apex 2.7 – 6.45 ± 1.25 mm on the right).

ANOVA revealed significant differences across age groups (F = 9.23–14.89, $p < 0.001$), with a more pronounced decline in females (post hoc: $p < 0.05$ between 25–34 and 55–64-year groups). Correlation with age was stronger in females (r = –0.52 to –0.72, $p < 0.01$) compared with males.

Comparison between sexes

Two-way ANOVA revealed significant effects of sex (F = 5.67–8.45, $p < 0.01$), age (F = 15.23–22.45, $p < 0.001$), and their interaction (F = 4.12–6.78, $p < 0.05$), with females exhibiting shorter distances in most groups (e.g., apex 1.4 in the 55–64-year group: males – 10.39 ± 4.45 mm, females – 0.25 ± 0.11 mm, $p < 0.001$). These findings likely reflect gender-related differences in anatomy and alveolar bone atrophy.

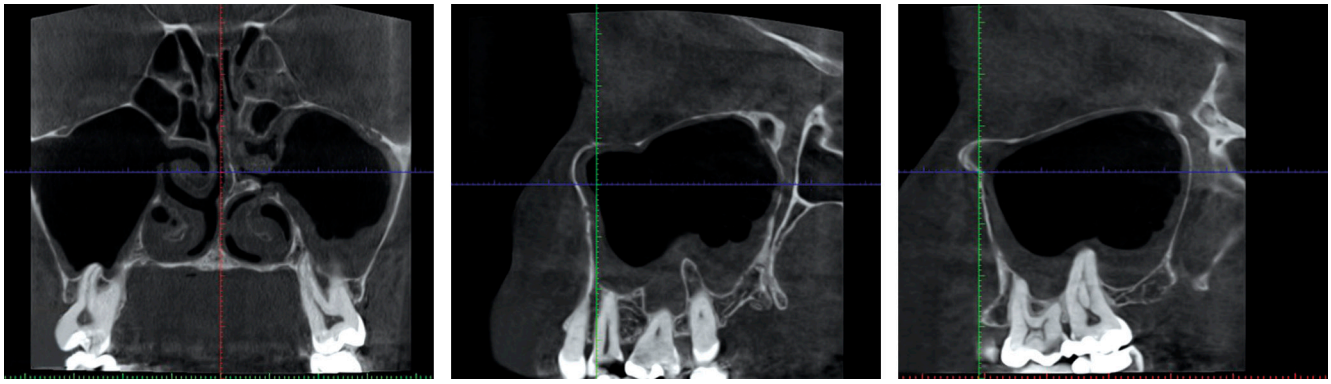
A clinical example illustrates a typical case (Patient G., 41 years), in which the apices of premolars and molars are located in close proximity to the sinus floor on both the right and left sides, highlighting the risk of perforation during endodontic procedures (Fig. 1).

Overall trends indicate that with increasing age, premolar apices tend to move farther from the sinus floor, whereas molar apices approach it, consistent with established classifications. These results emphasize the importance of CBCT imaging for treatment planning, particularly in elderly patients, where the risk of complications such as sinusitis and perforation may increase by 20–30%, based on observed variability (SD).

DISCUSSION

This study, based on the analysis of 288 cone-beam computed tomography (CBCT) scans, revealed substantial variability in the distances from the apices of maxillary premolars (teeth 1.4–1.7) and molars (teeth 2.4–2.7) to the floor of the maxillary sinus, with pronounced dependence on age and sex. Key findings include a trend toward decreasing distances with age (r = –0.45 to –0.72, $p < 0.01$), consistently lower values in females, and increased variability in older age groups, highlighting the anatomical proximity of tooth roots to the sinus as a significant risk factor for complications during dental procedures.

Comparison across age groups demonstrated that younger patients (25–34 years) exhibited the greatest distances to the sinus floor, particularly for molars (e.g., palatal apex 2.7 in males – 6.48 ± 2.05 mm on the right), whereas premolars were already closer (apex 1.5 – 1.37 ± 1.46 mm on the right). With increasing age, apices gradually approximated the sinus floor, reaching minimal distances in the ⩾65-year group (e.g., apex 1.5 in males –0.95 ± 0.12 mm on the right, indicating sinus perforation). This pattern was most pronounced in females, where distances were systematically smaller



A B C

Fig. 1. CBCT of Patient G. (41 years) in the coronal (*A*) and sagittal planes (*B*, *C*): apices of teeth 1.4–2.7 in close proximity to the maxillary sinus floor

Рис. 1. КЛКТ пациентки Г. (41 год) во фронтальной (*A*) и сагиттальных плоскостях (*B*, *C*): апексы зубов 1.4-2.7 расположены близко к дну пазухи

(apex 1.4 in the 55–64-year group – 0.25 ± 0.11 mm on the right), potentially reflecting gender-specific patterns of alveolar bone atrophy. Two-way ANOVA of sex and age interaction (F = 4.12–6.78, $p < 0.05$) confirms the clinical relevance of these factors.

The clinical significance of these findings lies in the elevated risk of sinus perforation during endodontic therapy, dental implantation, or maxillary tooth extraction, particularly in patients over 55 years, where variability (CV up to 50%) indicates substantial individual differences. In the ⩾65-year group, minimal premolar distances in males were negative, suggesting apical intrusion into the sinus, potentially leading to complications such as odontogenic sinusitis. This trend is accentuated in females, with a steeper decline in distances (r = –0.52 to –0.72), underscoring the need for careful treatment planning.

Recent studies corroborate these results while highlighting ethnic and methodological variations, emphasizing the relevance of personalized approaches to minimize complications [23–27]. The anatomical proximity of apices has been associated with odontogenic sinusitis [28], and CBCT has been consistently recognized as the preferred modality for evaluating the relationship between maxillary tooth apices and the sinus floor [29; 30].

Several authors have emphasized the superiority of CBCT over conventional imaging for assessing these anatomical relationships, supporting broader application of CBCT for precision planning in procedures such as dental implantation or endodontic interventions, particularly in women and elderly patients where risks are elevated [31; 32]. CBCT also facilitates the diagnosis and monitoring of surgical procedures, including sinus floor elevation [32].

The clinical relevance is further supported by data linking Schneiderian membrane thickness and chronic sinusitis symptoms to odontogenic factors; the proximity of apices to the sinus correlates with membrane thickening and symptomatology, consistent with the observed variability (CV up to 50%) and perforation risks in the present study. Collectively, the literature underscores the integration of CBCT into dental practice to mitigate risks of complications such as odontogenic sinusitis, complementing findings on sex- and age-related differences and clinical features of periapical lesions [33], thereby contributing to safer treatment protocols [34].

Despite the retrospective, single-center design (n = 288), measurement reliability was high (ICC > 0.85), supporting extrapolation to broader populations. Limitations include the lack of longitudinal data and the absence of factors such as systemic diseases or prior interventions influencing alveolar atrophy. Future directions include expanding the sample size with multicenter data and integrating complementary imaging modalities for more precise risk assessment. Overall, these findings highlight the evolution of anatomical relationships with age and sex, informing optimized dental protocols and reducing the incidence of complications.

CONCLUSION

Based on the analysis of 288 cone-beam computed tomography (CBCT) scans, it was established that the distances from the apices of maxillary premolars and molars to the floor of the maxillary sinus decrease with age (r = –0.45 to –0.72, $p < 0.01$), with lower values observed in females and increased variability in older age groups. Minimal distances were noted in the ⩾65-year group, indicating a perforation risk in 15–30% of patients.

The clinical significance of these findings lies in reducing complications during dental procedures (endodontics, implantation) through the preventive use of CBCT, particularly in elderly patients and females. These results support personalized treatment planning and optimization of clinical protocols.

REFERENCES / СПИСОК ЛИТЕРАТУРЫ

1. Jacobs R., Salmon B., Codari M., Hassan B., Bornstein M.M. Cone beam computed tomography in implant dentistry: recommendations for clinical use. *BMC Oral Health*. 2018;18(1):88. https://doi.org/10.1186/s12903-018-0523-5
2. Asan M.F., Castelino R.L., Babu S.G., Darwin D. Anatomical variations of the maxillary sinus – a cone beam computed tomography study. *Acta Medica Bulgarica.* 2022;49(3):33–37. https://doi.org/10.2478/AMB-2022-0027
3. Pazera P., Bornstein M.M., Pazera A., Sendi P., Katsaros C. Incidental maxillary sinus findings in orthodontic patients: a radiographic analysis using cone-beam computed tomography (CBCT). *Orthod Craniofac Res*. 2011;14(1):17–24. https://doi.org/10.1111/j.1601-6343.2010.01502.x
4. Hîţu D., Chele N., Cabac V., Mighic A., Lilia B. Maxillary sinusitis of odontogenic origin. *Online J Complement Altern Med.* 2021;6(1):OJCAM.MS.ID.000626. https://doi.org/10.33552/OJCAM.2021.06.000626
5. Psillas G., Papaioannou D., Petsali S., Dimas G.G., Constantinidis J. Odontogenic maxillary sinusitis: A comprehensive review. *J Dent Sci*. 2021;16(1):474–481. https://doi.org/10.1016/j.jds.2020.08.001
6. Stammberger H. History of rhinology: anatomy of the paranasal sinuses. *Rhinology*. 1989;27(3):197–210.
7. Pokorny A., Tataryn R. Clinical and radiologic findings in a case series of maxillary sinusitis of dental origin. *Int Forum Allergy Rhinol*. 2013;3(12):973–979. https://doi.org/10.1002/alr.21212
8. Von Arx T., Marwik E., Bornstein M.M. Effects of dimensions of root-end fillings and peripheral root dentine on the healing outcome of apical surgery. *Eur Endod J*. 2019;4(2):49–56. https://doi.org/10.14744/eej.2019.76376
9. Budzinskii N.E., Sirak S.V., Maximova E.M., Sirak A.G. Determination of antimicrobial activity miramistin immobilized on composition polysorbytol the microflora root canal acute and exacerbated chronic periodontitis and surface osteofikatsii in animal experiments.

Fundamental Research. 2013;(7-3):518–522. (In Russ.) Available at: https://fundamental-research.ru/en/article/view?id=32047 (accessed: 05.12.2025).
Будзинский Н.Э., Сирак С.В., Максимова Е.М., Сирак А.Г. Определение антимикробной активности мирамистина, иммобилизованного на композиционном полисорбе, на микрофлору корневых каналов при остром и обострившемся хроническом периодонтите и процесс остеофикации в эксперименте на животных. *Фундаментальные исследования*. 2013;(7-3):518–522. Режим доступа: https://fundamental-research.ru/en/article/view?id=32047 (дата обращения: 05.12.2025).

10. Shrestha B., Shrestha R., Lu H., Mai Z., Chen L., Chen Z., Ai H. Relationship of the maxillary posterior teeth and maxillary sinus floor in different skeletal growth patterns: A cone-beam computed tomographic study of 1600 roots. *Imaging Sci Dent*. 2022;52(1):19–25. https://doi.org/10.5624/isd.20210145
11. Sirak S.V., Kopylova I.A. The complications arising at the stage of sealing of root channels of teeth, their forecasting and preventive maintenance. *Endodontics Today.* 2010;8(1):47–51. (In Russ.) Available at: https://www.endodont.ru/jour/article/view/841 (accessed: 05.12.2025).
Сирак С.В., Копылова И.А. Использование результатов анкетирования врачей-стоматологов для профилактики осложнений, возникающих на этапах эндодонтического лечения зубов. *Эндодонтия Today*. 2010;8(1):47–51. Режим доступа: https://www.endodont.ru/jour/article/view/841 (дата обращения: 05.12.2025).
12. Willershausen I., Callaway A., Briseño B., Willershausen B. In vitro analysis of the cytotoxicity and the antimicrobial effect of four endodontic sealers. *Head Face Med*. 2011;7:15. https://doi.org/10.1186/1746-160X-7-15
13. Sirak S.V., Kopilova I.A. Quality improvement of endodontic intervention according to questionnaire survey of stomatologists. *Vestnik of the Smolensk State Medical Academy*. 2010;9(2):127–129. (In Russ.)
Сирак С.В., Копылова И.А. Вопросы повышения качества эндодонтических вмешательств по данным анкетирования врачей-стоматологов. *Вестник Смоленской государственной медицинской академии*. 2010;9(2):127–129.
14. Ranjan V., Maiti S.B., Gupta R., Singh L.N., Tyagi M., Bhardwaj D. Comparison of maxillary molar roots with maxillary sinus in high-resolution CBCT: A retrospective study. *J Pharm Bioallied Sci*. 2022;14(Suppl. 1):S833–S836. https://doi.org/10.4103/jpbs.jpbs_14_22
15. Kabak S.L., Karapetyan G.M., Melnichenko Y.M., Savrasova N.A., Kosik I.I. Automated system of the determination of maxillary sinus morphometric parameters. *Russian Bulletin of Otorhinolaryngology*. 2021;86(2):49–53. (In Russ.) https://doi.org/10.17116/otorino20218602149
Кабак С.Л., Карапетян Г.М., Мельниченко Ю.М., Саврасова Н.А., Косик И.И. Автоматизированная система определения морфометрических параметров верхнечелюстной пазухи. *Вестник оториноларингологии*. 2021;86(2):49–53. https://doi.org/10.17116/otorino20218602149
16. Siddiqui H.K., Arif A., Ghauri K., Aijaz A., Khan F.R. Relationship of maxillary third molar root to the maxillary sinus wall: A cone-beam computed tomography (CBCT) based study. *J Dent Res Dent Clin Dent Prospects*. 2023;17(1):8–11. https://doi.org/10.34172/joddd.2023.30484
17. Shokri A., Lari S., Yousef F., Hashemi L. Assessment of the relationship between the maxillary sinus floor and maxillary posterior teeth roots using cone beam computed tomography. *J Contemp Dent Pract*. 2014;15(5):618–622. https://doi.org/10.5005/jp-journals-10024-1589
18. Mehtiev R.S., Melnichenko Y.M., Kabak S.L., Savrasova N.A., Zatochnaya V.V. Relationships between the inferior wall of maxillary sinus and the roots of the maxillary molars. *Stomatology*. 2023;102(1):52–59. (In Russ.) https://doi.org/10.17116/stomat202310201152
Мехтиев Р.С., Мельниченко Ю.М., Кабак С.Л., Саврасова Н.А., Заточная В.В. Взаимоотношения корней моляров с нижней стенкой верхнечелюстной пазухи. *Стоматология*. 2023;102(1):52–59. https://doi.org/10.17116/stomat202310201152
19. Motiwala M.A., Arif A., Ghafoor R. A CBCT based evaluation of root proximity of maxillary posterior teeth to sinus floor in a subset of Pakistani population. *J Pak Med Assoc*. 2021;71(8):1992–1995. https://doi.org/10.47391/JPMA.462
20. Xie Q., Li P., Yang C., Chen M., Li H., Bai G. et al. Feasibility of simultaneous TMJ arthroscopy in ADDwoR patients undergoing orthognathic surgery for jaw deformity. *Journal of Cranio-Maxillofacial Surgery*. 2024;52(3):347–354. https://doi.org/10.1016/j.jcms.2024.01.019
21. Lozano-Carrascal N., Salomó-Coll O., Gehrke S.A., Calvo-Guirado J.L., Hernández-Alfaro F., Gargallo-Albiol J. Radiological evaluation of maxillary sinus anatomy: A cross-sectional study of 300 patients. *Ann Anat*. 2017;214:1–8. https://doi.org/10.1016/j.aanat.2017.06.002
22. Xu Z.R., Zhang X., Dou X., Lin C.Y., Wang H.D., Song S.H. et al. Flexible endoscopy in the visualization of 3D-printed maxillary sinus and clinical application. *Surg Endosc*. 2022;36(10):7827–7838. https://doi.org/10.1007/s00464-022-09410-8
23. Iliescu V.I., Nimigean V.R., Preoteasa C.T., Georgescu L., Nimigean V. Evaluation of the proximity of the maxillary teeth root apices to the maxillary sinus floor in Romanian subjects: A cone-beam computed tomography study. *Diagnostics*. 2025;15(14):1741. https://doi.org/10.3390/diagnostics15141741
24. Abdulwahed A., Mustafa M., Karobari M.I., Alomran A., Alasimi K., Alsayeg A. et al. Anatomical evaluation of posterior maxillary roots in relation to the maxillary sinus floor in a saudi sub-population: A cross-sectional cone-beam computed tomography study. *Healthcare*. 2023;11(1):150. https://doi.org/10.3390/healthcare11010150
25. Akotiya B.R., Surana A., Chauhan P., Saha S.G., Agarwal R.S., Vashisht A. Morphometric analysis of the relationship between maxillary posterior teeth and maxillary sinus floor in central Indian population: A cone-beam computed tomography study. *J Conserv Dent Endod*. 2024;27(4):373–377. https://doi.org/10.4103/JCDE.JCDE_353_23
26. Sarilita E., Muhammad R.M., Nugraha H.G., Murniati N., Yusuf H.Y., Takeshita Y., Asaumi J. Anatomical relationship between maxillary posterior teeth and the maxillary sinus in an Indonesian population: a CT scan study. *BMC Oral Health*. 2024;24(1):1014. https://doi.org/10.1186/s12903-024-04783-9
27. Khojastepour L., Movahhedian N., Zolghadrpour M., Mahjoori-Ghasrodashti M. Assessment of the relationship between the maxillary sinus and the canine root tip using cone beam computed tomography. *BMC Oral Health*. 2021;21(1):338. https://doi.org/10.1186/s12903-021-01700-2

28. Psillas G., Papaioannou D., Petsali S., Dimas G.G., Constantinidis J. Odontogenic maxillary sinusitis: A comprehensive review. *J Dent Sci*. 2021;16(1):474–481. https://doi.org/10.1016/j.jds.2020.08.001
29. Altaweel A.A., Saad Sowairi S.M., Saaduddin Sapri A.M., Saeedi S.A., Alamri A.H. et al. Assessment of the relationship between maxillary posterior teeth and maxillary sinus using cone-beam computed tomography. *Int J Dent*. 2022;2022:6254656. https://doi.org/10.1155/2022/6254656
30. Rodriguez M., Marshall M., Godoy C., Richa R., Niklander S.E. Orthopantomography versus cone beam computed tomography for the assessment of the proximity of posterior maxillary apexes with the maxillary sinus: A cross-sectional study. *Curr Med Imaging*. 2024;20(1):e050723218414. https://doi.org/10.2174/1573405620666230705120909
31. Amani R., Noroozi M., Ashrafi M.M.S. Assessment of the relationships between posterior root apices and the maxillary sinus floor: a comparison of panoramic radiography and cone beam computed tomography. *Gen Dent*. 2023;71(5):58–63.
32. Morgan N., Meeus J., Shujaat S., Cortellini S., Bornstein M.M., Jacobs R. CBCT for diagnostics, treatment planning and monitoring of sinus floor elevation procedures. *Diagnostics*. 2023;13(10):1684. https://doi.org/10.3390/diagnostics13101684
33. Kwiatkowska M.A., Szczygielski K., Chloupek A., Szczupak P., Jurkiewicz D. Clinical characteristics of odontogenic sinusitis with periapical lesions. *Am J Otolaryngol*. 2022;43(2):103338. https://doi.org/10.1016/j.amjoto.2021.103338
34. Alghofaily M., Alsufyani N., Althumairy R.I., AlSuhaibani A., Alfawzan F., AlSadhan L. Odontogenic factors associated with maxillary sinus Schneiderian membrane thickness and their relationship to chronic sinonasal symptoms: An ambispective cohort study. *Diagnostics*. 2023;13(16):2710. https://doi.org/10.3390/diagnostics13162710

INFORMATION ABOUT THE AUTHORS

Irina A. Gatilo – Cand. Sci. (Med.), Associate Professor, Head of the Department of Hygiene, Stavropol State Medical University, 310 Mira Str., Stavropol 355017, Russian Federation; https://orcid.org/0000-0003-0139-5094

Sergey V. Sirak – Dr. Sci. (Med.), Professor, Head of Department of Dentistry, Stavropol State Medical University, 310 Mira Str., Stavropol 355017, Russian Federation; https://orcid.org/0000-0002-4924-5792

ИНФОРМАЦИЯ ОБ АВТОРАХ

Гатило Ирина Анатольевна – к.м.н., доцент, заведующий кафедрой гигиены, ФГБОУ ВО «Ставропольский государственный медицинский университет», 355017, Российская Федерация, г. Ставрополь, ул. Мира, д. 310; https://orcid.org/0000-0003-0139-5094

Сирак Сергей Владимирович – д.м.н., профессор, заведующий кафедрой стоматологии, ФГБОУ ВО «Ставропольский государственный медицинский университет», 355017, Российская Федерация, г. Ставрополь, ул. Мира, д.310; https://orcid.org/0000-0002-4924-5792

AUTHOR'S CONTRIBUTION

All the authors made equal contributions to the publication preparation in terms of the idea and design of the article; data collection; critical revision of the article in terms of significant intellectual content and final approval of the version of the article for publication.

ВКЛАД АВТОРОВ

Все авторы внесли равноценный вклад в подготовку публикации в части замысла и дизайна исследования; сбора данных; критического пересмотра статьи в части значимого интеллектуального содержания и окончательного одобрения варианта статьи для опубликования.