ORIGINAL RESEARCH ARTICLE

Jurnal Radiologi Dentomaksilofasial Indonesia August 2025, Vol. 9, No. 2: 71-75
P-ISSN.2685-0249 | E-ISSN.2686-1321

http://jurnal.pdgi.or.id/index.php/jrdi/index

Assessment of the distance of maxillary posterior tooth roots to the maxillary sinus using Cone Beam Computed Tomography Images

Dwina Lathifah Ramadhani Wirahadi Subrata[1*], Intan Farizka[2], Sariyani Pancasari Audry Arifin[3], M. Novo Perwira Lubis[4], Anggraeny Putri Sekar Palupi[5], Rizki Tanjung[6]

[1]Faculty of Dentistry, Universitas Trisakti, Jakarta Barat, Indonesia 11410

[2]Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Universitas Trisakti, Jakarta Barat, Indonesia 11410

[3]Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Universitas Trisakti, Jakarta Barat, Indonesia 11410

[4]Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Universitas Trisakti, Jakarta Barat, Indonesia 11410

[5]Department of Oral Surgery, Faculty of Dentistry, Universitas Trisakti, Jakarta Barat, Indonesia 11410

[6]Department of Forensic Odontology, Faculty of Dentistry, Universitas Trisakti, Jakarta Barat, Indonesia 11410

[*]Correspondence to:
Intan Farizka
intanfarizka@trisakti.ac.id

Received on: February 2025
Revised on: July 2025
Accepted on: August 2025

ABSTRACT

Objectives: This research aims to determine the variation in the distance of maxillary posterior tooth roots to the maxillary sinus.

Materials and Methods: This research employed a descriptive observational design using 68 samples of CBCT radiographs of individuals aged 20–40 years from Dental Radiology Installation of Dental & Oral Hospital, Faculty of Dentistry, Universitas Trisakti. The distance assessed in this study is the shortest vertical distance from the apices to the maxillary sinus floor of all roots in first premolars, second premolars, first molars and second molars. The measurements were performed using i-Dixel 2.2 software (Morita-Japan).

Results: The result showed the mesiobuccal root of the second molar was the closest to the maxillary sinus, with a mean distance of -0.24 ± 1.23 mm. Conversely, the buccal root of the first premolar was the farthest, with a mean distance of 4.72 ± 3.11 mm.

Conclusion: The proximity order of roots relative to the maxillary sinus, from closest to farthest, is as follows: mesiobuccal root of the second molar, distobuccal root of the second molar, palatal root of the first molar, distobuccal root of the first molar, mesiobuccal root of the first molar, palatal root of the second molar, palatal root of the second premolar, the single root of the second premolar, buccal root of the second premolar, palatal root of the first premolar, the single root of the first premolar, buccal root of the first premolar.

Keywords: *Cone Beam Computed Tomography, maxillary sinus, posterior teeth roots*
Cite this article: Subrata DLRW, Farizka I, Arifin SPA, Lubis MNP, Palupi APS, Tanjung R. *Assessment of the distance of maxillary posterior tooth roots to the maxillary sinus using Cone Beam Computed Tomography Images*. Jurnal Radiologi Dentomaksilofasial Indonesia 2025;9(2)71-75. https://doi.org/10.32793/jrdi.v9i2.1353

INTRODUCTION

The maxillary sinus is a pyramidal-shaped paranasal sinus with a base formed by the alveolar process and the palatine process of the maxilla, which serves as a boundary between the maxillary sinus and the oral cavity.[1] The maxillary sinus is also the first paranasal sinus to develop, starting to appear on the 17th day of pregnancy and fully developing around the age of 20 years with the eruption of the third molars.[2,3] The maxillary sinus is a vital anatomical structure closely associated with the roots of posterior maxillary teeth. The apex of molar roots is closer to the sinus floor compared to the apex of other posterior tooth roots.[4,5]

The approximation or proximity of the maxillary sinus floor to the apex of posterior tooth roots may be associated with maxillary sinus diseases. It can influence various dental procedures, such as tooth extraction.[6] Oroantral Communication (OAC) is a complication that may occur during tooth extraction procedures. If left untreated, OAC can develop into Oroantral Fistula (OAF).[7] The proximity between posterior tooth roots and the maxillary sinus can also affect root canal treatments. One case reported an orbital abscess caused by the rapid exacerbation of periapical inflammation following endodontic treatment of the maxillary first molar.[8]

Studies have shown that the buccal roots of maxillary molars frequently protrude into the maxillary sinus. In terms of the average distance between the maxillary sinus floor and root tips, the greatest distance is found in the palatal roots of the first and second maxillary molars and the buccal roots of the first premolar. Meanwhile, the shortest distance is observed in the mesiobuccal root of the maxillary first molar and the palatal root of the maxillary second premolar.[8] However, other studies have indicated that the mesiobuccal root of the maxillary second molar is the closest to the sinus floor, followed by the distobuccal root of the maxillary second molar and the palatal root of the maxillary first molar.[9]

To assess the distance between the maxillary

sinus and posterior maxillary tooth roots, radiographic examinations can be conducted. One commonly used method is panoramic radiography, which is often utilized for preoperative assessment of the distance between the maxillary sinus floor and posterior tooth roots. However, panoramic radiography, which only provides two-dimensional images, has several limitations, including image distortion, magnification, superimposition, and the inability to visualize the buccal-palatal dimensions of posterior tooth roots.[3,10] These limitations can make it difficult to assess the distance between each posterior tooth root and the maxillary sinus.

Therefore, the advance of Cone Beam Computed Tomography (CBCT), as an evolution of imaging technology, has addressed the limitations of conventional two-dimensional radiography. CBCT provides three-dimensional images, making it a valuable tool for evaluating pathological lesions and anatomical structures, including the maxillary sinus, in detail. With the three-dimensional radiographic images produced by CBCT, anatomical variations of the maxillary sinus can be evaluated comprehensively, especially for assessing the distance between the sinus and posterior maxillary tooth roots more precisely than with panoramic radiography.[11] CBCT enhances the role of imaging as a guide for diagnostic decision-making and treatment planning. Based on the background, it is essential to conduct a study on the variation in the distance between the roots of maxillary posterior teeth and the maxillary sinus.[12]

MATERIALS AND METHODS

This study employed a descriptive observational design and was conducted at the Dental Radiology Installation of Oral & Dental Hospital Faculty of Dentistry Universitas Trisakti, from August 2024 to November 2024. This study uses 68 samples, consisting of CBCT images of patients aged 20 – 40. The inclusion criteria were CBCT radiographs of patients aged 20–40 years, complete posterior dentition up to the second molars, fully formed posterior tooth roots, and all roots of the first premolar to the second molar. Radiographs with metal artifacts, image noise, pathological lesions on the roots or apices of posterior teeth, impacted third molars, and the presence of orthodontic appliances were excluded from these studies.

Measurements were conducted using i-Dixel software version 2.2 (Morita, Japan). Data collection involved the retrieval of CBCT radiographs from the Radiology Department, which were then reviewed and selected based on the inclusion criteria. The distance assessed on this study is the shortest vertical distance from the apices to the maxillary sinus floor of all roots in first premolars, second premolars, first molars and second molars. Measurements were performed using the measurement distance feature by drawing the nearest vertical line from the apex of the buccal and palatal roots in premolars, and from the mesiobuccal, distobuccal, and palatal roots in molars, to the most inferior border of the maxillary sinus floor. These measurements were conducted on the right side, and only the coronal plane was analyzed, as previous CBCT studies have shown no significant difference between coronal and sagittal views in measuring root–sinus distances.[13] The results obtained can be a negative value if the apex protrudes into the floor of the sinus (Figure 1).

Data analysis was performed using SPSS software, with results presented as mean, standard deviation, minimum, and maximum values. Inter-observer reliability was assessed using the Technical Error of Measurement (TEM) on 20% of the data to ensure measurement accuracy and consistency.[9] Statistical tests were conducted to validate the findings, and all results were summarized in tabular form for ease of interpretation. Ethical approval was obtained from the Faculty of Dentistry Ethics Committee, Universitas Trisakti, under approval number 825A/S1/KEPK/FKG/12/2024.

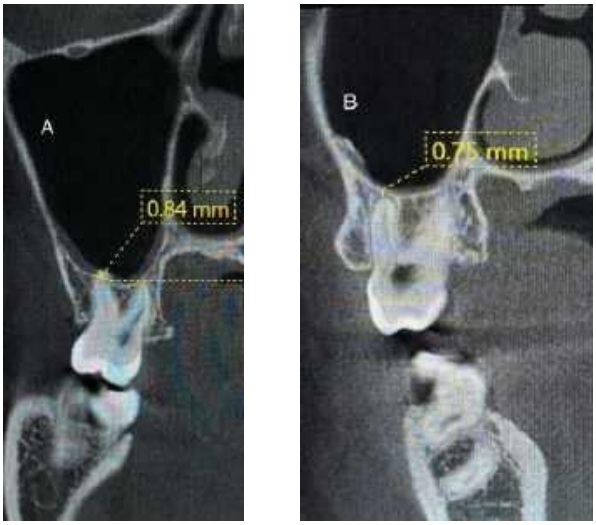

Figure 1. Example of data measurement. (A) Coronal view, negative value; (B) Coronal view, positive value

RESULTS

The study describes the distances between the roots of maxillary posterior teeth and the maxillary sinus in tables containing minimum, maximum, mean, and standard deviation values. Prior to data analysis, reliability testing was conducted through inter-observer measurements in collaboration with a dental radiology specialist from the Faculty of Dentistry, Trisakti University. The reliability test was performed using the Technical Error of Measurement (TEM).

Table 1. The result of the Technical Error of Measurement (TEM) reliability test.

	n	p	notes
Second molar - Distobuccal	13	0.055	No difference
Second molar - Mesiobuccal	13	0.254	No difference
Second molar - Palatal	13	0.139	No difference
First molar - Distobuccal	13	0.500	No difference
First molar - Mesiobuccal	13	0.054	No difference
First molar - Palatal	13	0.096	No difference
Second premolar - Single root	13	0.104	No difference
First premolar - Double roots - Buccal	13	0.165	No difference
First premolar - Double roots - Palatal	13	0.165	No difference

Based on the result of the Technical Error of Measurement reliability test (Table 1), a comparison was conducted by assessing the difference in evaluations between two observers against a test value of zero (0). The test results yielded significance values (p) for each data point, with the highest p-value found in the distobuccal root of the first molar (p = 0.500), while the lowest p-value was observed in the mesiobuccal root of the first molar (p = 0.054). The test results showed p-values greater than 0.05 (p > 0.05), indicating no significant difference in the evaluations between the two observers.

The mean and standard deviation of the apical distance of each maxillary posterior tooth root to the maxillary sinus floor have been measured (Table 2). The results indicate that the root closest to the maxillary sinus is the mesiobuccal root of the second molar, with a mean value of -0.24 ± 1.23 mm and a minimum and maximum of -4.08 mm and 2.50 mm, respectively. This is followed by the distobuccal root of the second molar, with a mean value of 0.04 ± 1.24 mm and a minimum and maximum of -4.00 mm and 3.17 mm, and the palatal root of the first molar, with a mean value of 0.12 ± 1.96 mm and a minimum and maximum of -5.22 mm and 6.69 mm. Negative values in the measurements indicate that the root extends into the maxillary sinus.

The first premolar has two root types: a single root, which is fused, and double roots with buccal and palatal divisions. The buccal root of the first premolar is the farthest from the maxillary sinus, with a mean value of 4.72 ± 3.11 mm and a minimum and maximum of -3.51 mm and 11.69 mm, followed by the single-rooted first premolar, with a mean value of 4.12 ± 2.68 mm and a minimum and maximum of 0.58 mm and 11.21 mm. Meanwhile, the palatal root of the first premolar has a mean value of 3.04 ± 3.23 mm and a minimum and maximum of -3.92 mm and 9.25 mm.

For the second premolar with double roots, including buccal and palatal roots, the palatal root shows a mean value of 0.72 ± 1.17 mm and a minimum and maximum of -1.17 mm and 3.25 mm. The buccal root of the second premolar shows a mean value of 2.63 ± 1.95 mm and a minimum and maximum of 0.19 mm and 6.25mm. For single-rooted second premolars, the mean value is 1.56 ± 1.64 mm, with a minimum and maximum of -1.33 mm and 6.50 mm.

Table 2. The distance values between the posterior tooth roots and the maxillary sinus.

	n	Mean (mm)	St. deviation (mm)	Minimum (mm)	Maximum (mm)
M2 P	68	1,0069	2,23945	-1,08	10,83
M2 DB	68	0,0412	1,24872	-4,00	3,17
M2 MB	68	-0,2474	1,23565	-4,08	2,50
M1 P	68	0,1225	1,96645	-5,22	6,69
M1 DB	68	0,6457	1,48335	-4,22	3,95
M1 MB	68	0,8741	1,63557	-3,08	7,84
P2 –Single root	55	1,5660	1,64229	-1,33	6,50
P2 B	13	2,6392	1,95497	0,19	6,25
P2 P	13	0,7200	1,17070	-1,17	3,25
P1 B	40	4,7230	3,11828	-3,51	11,69
P1 P	40	3,0443	3,23579	-3,92	9,25
P1 –Single root	28	4,1296	2,68371	0,58	11,21

Jurnal Radiologi Dentomaksilofasial Indonesia 2025; 9 (2); 71-75 | DOI: 10.32793/jrdi.v9i2.1353

DISCUSSION

This study was conducted to determine the distance of each posterior tooth root from the maxillary sinus, which plays a crucial role in avoiding errors in treatment planning. Understanding the proximity between the maxillary posterior tooth roots and the maxillary sinus is essential, not only for surgical procedures such as tooth extractions and dental implant placements but also for recognizing the spread of pulp infections into the maxillary sinus and orthodontic movements like tooth intrusion.[9] The floor of the maxillary sinus often expands around the posterior tooth roots or even extends below them, creating significant proximity between the roots and the sinus.[14]

Maxillary sinus pneumatization, a natural process where the sinus cavity enlarges, often occurs after the extraction of posterior teeth in the upper jaw. This expansion may cause the sinus to come closer to or even directly contact the remaining posterior tooth roots. The close relationship between the maxillary sinus and the posterior tooth roots of the upper jaw has significant clinical implications. This proximity increases the risk of complications during dental procedures, such as tooth extraction or root canal treatment.[11] CBCT was used in this study to assess the distance between posterior tooth roots and the maxillary sinus due to its proven advantages over panoramic radiographs, which are more commonly used. CBCT can assess anatomical structures more accurately because it provides images in three-dimensional aspects. In addition, it produces high-resolution images with lower radiation exposure compared to CT scans. Therefore, this study chose CBCT to evaluate the distance between maxillary posterior tooth roots and the maxillary sinus.[15]

The farthest root from the sinus was the buccal root of the first premolar, followed by the fused root of the first premolar and the palatal root of the first premolar (Table 2). This finding is consistent with the research conducted by Fry R et al., which reported that the farthest root from the maxillary sinus was the palatal root of the first and second molars, followed by the buccal root of the first premolar. Similarly, Liao W.'s study stated that the farthest root was the fused root of the first premolar.[8,16]

The closest root in this study was the mesiobuccal root of the second molar, followed by the distobuccal root of the second molar and the palatal root of the first molar (Table 2). This result aligns with a previous study by Altaweel et al., which reported that the closest root was the mesiobuccal root of the second molar.[9] However, differing results were noted in the study by Fry R et al., which found that the mesiobuccal root of the first molar, followed by the palatal root of the second premolar, was the closest to the floor of the maxillary sinus.[4,8] These variations may occur due to anatomical differences between individuals, age, and the degree of maxillary sinus pneumatization.[4,17,18]

This study did not differentiate between the right and left sides of the maxillary sinus, gender, or bone growth patterns. This was because no significant differences were observed between the right and left sides of the maxillary sinus, as stated in a study by Shrestha B et al., which found no significant differences between the right and left sides of the maxillary sinus. However, Shrestha B et al. also stated that bone growth patterns and gender influence the distance between posterior tooth roots and the floor of the maxillary sinus.[19] Based on the research conducted by Motiwala, MA et al., which studied the population in Pakistan, it was found that the distance between posterior tooth roots and the floor of the maxillary sinus decreases with age.[20] In this study, the age range was limited to 20–40 years, as this range is assumed to encompass individuals with fully developed tooth roots and stabilized maxillary sinus development.[21] This differs from the study by Lijie T., which included subjects over 21 years with no maximum age limit. Such differences could affect study results, as in this study, the farthest root was the buccal root of the first premolar, whereas in Lijie T.'s study, the farthest root was the root of the second premolar.[22]

Based on the findings of this study, the closest root was the mesiobuccal root of the second molar, while the farthest root was the buccal root of the first premolar. This finding can be explained by anatomical considerations. The floor of the maxillary sinus usually extends most inferiorly in the region of the second molar, placing the mesiobuccal root apex in close proximity to, or sometimes projecting into, the sinus cavity. In the premolar region, the sinus is often less pneumatized anteriorly, which results in the first premolar roots, particularly the buccal root, being positioned farther away from the sinus.[23,24] This is consistent with a study by Kaushik P et al., which stated that the first premolar root had the farthest distance from the floor of the maxillary sinus, and the palatal root of the first molar was the closest to the maxillary sinus.[25] Based on this study result (Table 2), the closer the posterior tooth roots are to the maxillary sinus, the higher the risk of complications. Therefore, understanding the average distance between maxillary posterior tooth roots and the maxillary sinus is an important consideration in treatment planning.

CONCLUSION

The study concludes that the distance between the maxillary posterior tooth roots and the maxillary sinus varies. The closest root to the sinus is the mesiobuccal root of the second molar, followed by the distobuccal root of the second molar, the palatal root of the first molar, the distobuccal root of the first molar, the mesiobuccal root of the first molar, and the palatal root of the second molar. The sequence continues with the palatal root of the second premolar, the single root of the second premolar, the buccal root of the second premolar, the palatal root of the first

premolar, the single root of the first premolar, and lastly, the buccal root of the first premolar.

ACKNOWLEDGMENTS

The authors would like to express their deepest gratitude to all parties who have provided assistance and contributions to this research.

FOOTNOTES

All authors have no potential conflict of interest to declare for this article.

REFERENCES

1. Anter E, Helaly Y, Samir W. Assessment of Proximity of Maxillary Molars Roots to the Maxillary Sinus Floor in a Sample from the Egyptian Population using Cone-beam Computed Tomography (Hospital Based Study). Egypt Dent J. 2019;65(4):3427-3438. doi:10.21608/edj.2019.74791
2. Shawneen M. Gonzalez. Prinsip Dasar Interpretasi Cone Beam Computed Tomography. (Nana Rianti, ed.). EGC; 2016. p. 2-44.
3. Dehghani M, Motallebi E, Navabazam A, Montazerlotfelahi H, Ezoddini F, Ghanea S. The Relation Between Maxillary Sinus Floor and Posterior Maxillary Teeth Roots Using Panoramic and Cone Beam Computed Tomography. J Dentomaxillofacial Radiol Pathol Surg. 2017;6(3):49-60. doi:10.29252/3dj.6.3.49
4. Ramadhanty A, Farizka I. Prevalensi Tipe Hubungan Akar Gigi Posterior Terhadap Sinus Maksilaris Ditinjau Dari Radiografi Panoramik. JKGT. 2022;4(1):41-45.
5. Ragab MH, Abdalla AY, Sharaan MES. Location of the Maxillary Posterior Tooth Apices to the Sinus Floor in an Egyptian Subpopulation Using Cone-beam Computed Tomography. Iran Endod J. 2022;17(1):7-12. doi:10.22037/iej.v17i1.34696
6. Lopes LJ, Gamba TO, Bertinato JVJ, Freitas DQ. Comparison of Panoramic Radiography and CBCT To Identify Maxillary Posterior Roots Invading The Maxillary Sinus. Dentomaxillofac Radiol. 2016;45(6):20160043. doi:10.1259/dmfr.20160043
7. Belmehdi A, El Harti K. Management of Oroantral Communication Using Buccal Advanced Flap. Pan Afr Med J. 2019;34:69. doi:10.11604/pamj.2019.34.69.19959
8. Fry R, Patidar D, Goyal S, Malhotra A. Proximity of Maxillary Posterior Teeth Roots to Maxillary Sinus and Adjacent Structures Using Denta scan ®. Indian J Dent. 2016;7(3):126. doi:10.4103/0975-962X.189339
9. Altaweel AA, Saad Sowairi SM, Saaduddin Sapri AM, et al. Assessment of the Relationship between Maxillary Posterior Teeth and Maxillary Sinus Using Cone-Beam Computed Tomography. Int J Dent. 2022;2022:1-7. doi:10.1155/2022/6254656
10. Mohammed A, Reem A, Rawan A. Assessing The Proximity of the Roots of Maxillary Molars and Premolars to the Maxillary Sinus in UAE Residents. Open Dent J. 2022;16(1):1-7. doi:10.2174/18742106-v16-e221124-2022-59
11. Prativi SA. Diagnosis Pneumatisasi Sinus Maksilaris Menggunakan Cone-Beam Computed Tomography (CBCT). MKGK. 2020;6(1):24-31. doi:https://doi.org/10.22146/mkgk.49157
12. Kapshe N, Pujar M, Jaiswal S. Cone Beam Computed Tomography: A review. Int J Oral Health Dent. 2020;6(2):71-77. doi:10.18231/j.ijohd.2020.017
13. Pei J, Liu J, Chen Y, Liu Y, Liao X, Pan J. Relationship between maxillary posterior molar roots and the maxillary sinus floor: Cone-beam computed tomography analysis of a western Chinese population. Journal of International Medical Research. 2020;48(6):1-17. doi:10.1177/0300060520926896
14. Khater S, Fouad D, Ahmed D. Assessment of Relationship between Maxillary Sinus Floor and Maxillary Posterior Teeth Root Tips Position in a Sample of Egyptian Population using CBCT: An Observational Cross-Sectional Study. ADJC. 2024;6(1):122-138. doi:10.21608/adjc.2023.217621.1344
15. Shahbazian M, Vandewoude C, Wyatt J, Jacobs R. Comparative assessment of periapical radiography and CBCT imaging for radiodiagnostics in the posterior maxilla. Odontology. 2015;103(1):97-104. doi:10.1007/s10266-013-0144-z
16. Liao WC, Chang SH, Chang HH, et al. An analysis of the relevance and proximity between maxillary posterior root apices to the maxillary sinus and the buccal cortical bone plate. J Dent Sci. 2024;19(4):1972-1982. doi:10.1016/j.jds.2024.07.019
17. Suntana MS, Trisusanti R, Quasima SZ. Hubungan antara Dasar Sinus Maksilaris dengan Apikal Akar Gigi M1 Maksila Ditinjau Menggunakan Radiograf Panoramik. e-GiGi. 2023;12(2):213-220. doi:10.35790/eg.v12i2.51331
18. Kosasih DN, Supriyadi S, Prasetyarini S. Radiomorfometri Sinus Maksilaris pada Anak Usia 7-12 Tahun menggunakan Radiograf Sefalometri Lateral. Jurnal Kedokteran Gigi Universitas Padjadjaran. 2024;36(1):65-73. doi:10.24198/jkg.v36i1.52363
19. Shrestha B, Shrestha R, Lu H, et al. 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. doi:10.5624/isd.20210145
20. Momina Anis Motiwala, Aysha Arif, Robia Ghafoor. A CBCT based evaluation of root proximity of maxillary posterior teeth to sinus floor in a subset of Pakistani population. JPMA. Published online April 19, 2021;71(8):1992-1995. doi:10.47391/JPMA.462
21. Najem S, Safwat W, ELAziz R, Gaweesh Y. Maxillary Sinus Assessment for Gender and Age Determination Using Cone Beam Computed Tomography in An Egyptian Sample. Alexandria Dental Journal. 2021;46(2):63-69. doi:10.21608/adjalexu.2020.88457
22. Tang L, Xu L, Liu H. A retrospective study on the relationship between maxillary posterior teeth and maxillary sinus floor using cone-beam computed tomographic images. J Anat Soc India. 2019;68(4):253. doi:10.4103/JASI.JASI_81_19
23. Sarilita E, Muhammad RM, Nugraha HG, et al. 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. doi:10.1186/s12903-024-04783-9
24. Cıhan ÖF, Can H, Yalçın ED. Investigation of the relationship of the maxillary sinus floor with maxillary posterior teeth using cone beam CT. Folia Morphol (Warsz). Published online April 17, 2024;83(4):858-867. doi:10.5603/fm.99268
25. Kaushik M, Kaushik P, Mehra N, Sharma R, Soujanya E, Kumar U. Anatomical relationship between roots of maxillary posterior teeth and maxillary sinus using cone-beam computed tomography. Endodontology. 2020;32(3):124. doi:10.4103/endo.endo_25_20