

Radiomorphometric Analysis of the Greater Palatine Canal and the Pterygopalatine Fossa Using Cone Beam Computed Tomography: A Retrospective Study

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Background & Objectives: The Greater Palatine Foramen (GPF), is a vital anatomical landmark for palatal nerve blocks. Hence imaging of this structure to understand its anatomy is important. Our study aimed to explore the radiomorphometric parameters of the greater palatine canal and pterygopalatine fossa using CBCT images in different age groups and gender.

Subjects, Materials and Methods: 100 CBCT images showing both right and left maxillary sinus region were analysed for length of the greater palatine canal, the upper and lower opening diameters, and the intra-canal curvature. The recorded values were statistically analysed.

Results: The right greater palatine canal length was significantly shorter in individuals >25 years (Mean = 31.72 mm, SD = 4.30 mm, p-value = 0.021). The left upper opening diameter increased significantly with age (Mean = 5.90 mm, SD = 1.47 mm, p-value = 0.006). Males exhibited longer canals (Avg. length mean = 33.23 mm, SD = 4.19 mm, p-value = 0.095). And larger lower opening diameters (Avg. mean = 5.69 mm, SD = 1.18 mm, p-value = 0.073) than females. Canal curvature was predominantly curved across both the age groups, but age group 18–25 years showed a significantly higher prevalence of curved canals on both sides.

Conclusion: The present study showed significant variations in the morphology of the greater palatine foramen and canal curvature with respect to age and sex. Variations in GPC length, diameter, and curvature can influence the success of palatal nerve blocks, that reduce the risk of injury to the greater palatine nerve. Recognizing these differences through preoperative CBCT enables accurate anesthesia delivery, safer flap design, and precise osteotomy planning.

Keywords: greater palatine canal, pterygopalatine fossa, intra-canal curvature, cone beam computed tomography

Introduction

The greater palatine canal (GPC) and pterygopalatine fossa (PPF) are anatomically significant regions of the skull that are often studied in the context of cranial nerve pathways, maxillofacial surgeries, and the spread of malignancies.¹ The pterygopalatine fossa (PPF) is a key anatomical region connecting multiple skull structures and serving as a passage for vital neurovascular components, like the maxillary artery, vein, and nerve. GPC extending from the PPF to the greater palatine foramen (GPF), carries the greater palatine nerve and descending palatine artery.² This canal is crucial in regional anesthesia for dental and surgical procedures involving the maxillary posterior and hard palate.³ Anesthesia of the hard palate is crucial, especially for surgeries in the maxillary region.² A common method to achieve this is through an injection into the foramen (GPF), which allows the anesthetic to reach the maxillary nerve known as greater palatine canal (GPC)

block. Incorrect techniques in this procedure result in risks, like damage to surrounding tissues, complications like bleeding or infection.^{4,5} However, anatomical variations in these can impact the effectiveness and safety of nerve blocks. To minimize these risks, it's important that a clear understanding of its various anatomic factors is necessary.

The various factors that can influence the successful treatment of greater palatine nerve block anesthesia are location and the morphology of greater palatine foramen, canal length, canal opening diameter etc. Effective use of the canal for anesthesia depends on accurately inserting the needle to the appropriate depth. Recommended needle lengths range from 25 mm for sinus surgery to 32–39 mm for maxillary anesthesia.^{6,7} Longer canals may result in insufficient numbing. In contrast, short canals can increase the risk of complications if standard lengths are used.⁶ Therefore, understanding the average canal length is crucial for optimizing anesthesia and minimizing procedure risks.⁷ Studies have demonstrated that length of the canal varies based on age and sex. This canal is crucial in regional anesthesia for dental and surgical procedures involving the maxillary posterior and hard palate.^{4,8–10}

Greater Palatine Foramen (GPF) is found near the lateral and posterolateral palatal borders, as well as medial or opposite to the 3rd maxillary molar, highlighting the importance of these anatomical landmarks for clinicians. An adequate opening diameter ensures the unimpeded passage of these neurovascular structures, which is essential for maintaining normal oral and palatal function.¹⁰ Variations in the diameter can directly influence the effectiveness of local anesthesia during dental procedures, particularly in maxillary treatments.¹¹ If the canal is too narrow, there may be a higher risk of nerve injury or insufficient anesthetic distribution, leading to patient discomfort.

Computed Tomography (CT) remains the most widely used imaging modality for visualizing the bony structures of the greater palatine canal (GPC) and pterygopalatine fossa (PPF). It offers excellent spatial resolution and enables multiplanar reconstruction, making it ideal for detailed evaluation of bony anatomy, including the dimensions and trajectory of the GPC. While highly beneficial in preoperative planning for maxillofacial surgeries, dental implant placement, and palatal injections, CT is associated with higher radiation exposure and is relatively costly. Cone Beam Computed Tomography (CBCT), on the other hand, is increasingly popular among oral and maxillofacial surgeons and dentists for assessing head and neck pathologies. Studies by Nasseh et al (2016) and Swirzinski et al (2010) utilized CBCT to examine the morphology of the greater palatine foramen and canal, providing valuable anatomical insights that aid clinicians in precisely locating the foramen for effective local anesthesia during maxillary procedures.^{12,13} In the present study, we analyzed the anatomical structures of the greater palatine canal and pterygopalatine fossa using CBCT imaging, highlighting anatomical variations to improve clinical outcomes in surgical and anesthetic interventions.

Materials and Methods

This retrospective study was conducted in the Department of Oral Medicine and Radiology, Manipal College of Dental Sciences, Manipal, after obtaining ethical clearance from the Institutional Ethics Committee (Approval No. IEC 361–2023). The study analysed archived cone-beam computed tomography (CBCT) images taken between January 2017 and December 2023. A total of 100 CBCT images belonging to South Indian population were selected based on predefined inclusion and exclusion criteria.

Sample Size Calculation

Sample size estimation was done using Gpower software. Based on the results of Christy et al¹² (Greater palatine canal length), an effect size of 0.69 was obtained. The sample size of 68 was obtained, with a power of 80% and alpha of 5%. Considering four additional variables (Upper opening diameter, lower opening diameter, curvature of canal and age), a 10% excess was added for each variable. The sample size was inflated and rounded to 100.

The inclusion criteria comprised CBCT scans of patients above 18 years of age, of both genders, and scans taken using a large field of view (FOV) measuring 16 cm × 13 cm that clearly captured both right and left maxillary sinus regions. Exclusion criteria included scans with incomplete or absent coverage of the maxillary region, poor image clarity, or presence of artifacts that could interfere with accurate measurements. Additionally, scans showing pathological changes such as cysts, tumours, or fractures obscuring the maxillary region were also excluded.

All the CBCT images were acquired using an i-CAT 17–19 imaging system (Imaging Sciences International LLC, USA) with a scan time of 26.9 seconds, a voxel size of 0.125 mm, and a large FOV of 16 cm × 13 cm. All scans were

evaluated using Invivo 5 version 5.3 software (Anatomage Inc., USA). Following calibration by the principal radiologist, the selected CBCT scans were reviewed, and the relevant measurements were recorded by the principal student investigator using a predesigned proforma to maintain consistency.

Morphometric Measurements on CBCT

Parameters were measured on both right and left side of the maxilla were length of the greater palatine canal, the diameters of its upper and lower openings, and the presence and degree of intra-canal curvature.

Although the sagittal view was most suitable for evaluating these parameters, variations in anatomical orientation meant that not all features could be visualized in a single sagittal section. Therefore, the images were reoriented in axial, coronal, and sagittal planes to generate a single, clear sagittal view that depicted all relevant anatomical landmarks. Final measurements and interpretations were taken from one optimized view as shown in [Figure 1](#).

Length of the Greater Palatine Canal

To evaluate the length of the greater palatine canal (GPC), the superior limit was defined by the upper bony margin of the pterygopalatine fossa (PPF), while the inferior limit was marked at the posterior point of the lower opening of the canal, corresponding to the location of the greater palatine foramen (GPF) as shown in [Figure 2](#). The canal was visualized using cross-sectional CBCT images, and measurements were taken.

Upper and Lower Opening Diameter of the GPC

The upper opening diameter of the GPC was measured at the superior bony aspect of the PPF, while the lower opening diameter was measured at the level of the GPF near the posterior region of the hard palate [[Figure 3](#)].

The Intra canal Curvature

The intra-canal curvature was also assessed in cross-sectional views after proper reorientation. The curvature was classified as either “straight” or “curved” based on visual evaluation. To aid in clarity and consistency, the type of curvature observed was marked on the images using a yellow arrow for accurate identification and documentation [[Figure 4](#)].

Inter observer reliability was evaluated wherein the Principal Investigator (SP) reviewed 10% of the CBCT images twice on two different occasions, and the findings were compared to evaluate intra-observer variability. The intraclass correlation coefficient (0.815–0.996) confirmed the good intra-observer agreement, ensuring measurement reliability. The study proceeded only after achieving consistency in recordings. Inter-examiner reliability was also assessed where an independent

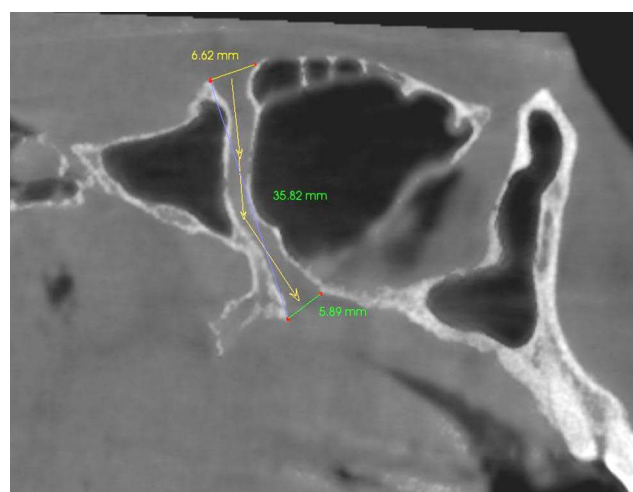


Figure 1 The most suitable sagittal section showing the entire greater palatine canal on left side (Yellow line shows Upper opening diameter; Green line shows lower opening diameter; Yellow arrows show canal curvature and Purple line shows canal length).

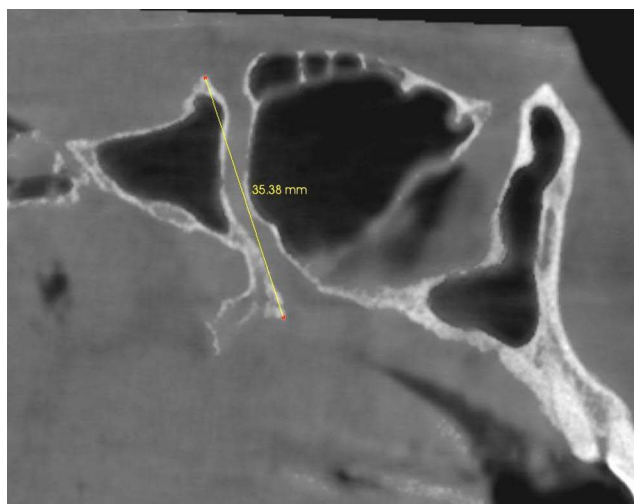


Figure 2 The measurement of greater palatine canal length using a linear measurement tool given in yellow line.

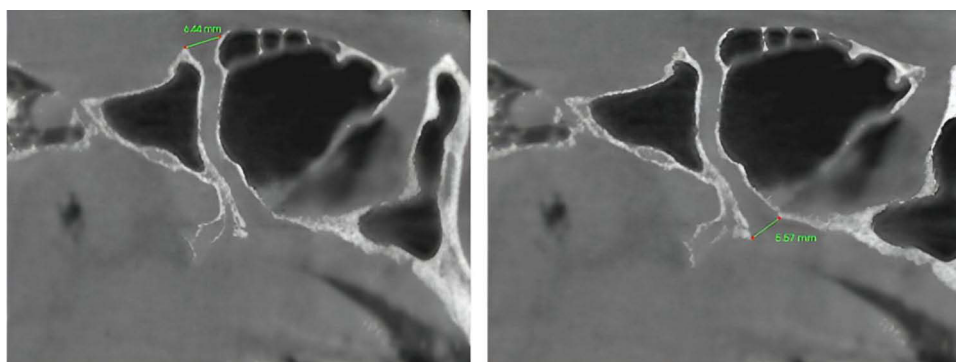


Figure 3 The measurement of upper opening and lower opening diameter of the greater palatine canal using linear measurement tool (Green line at superior aspect shows upper opening diameter and green line at the inferior aspect shows lower opening diameter).

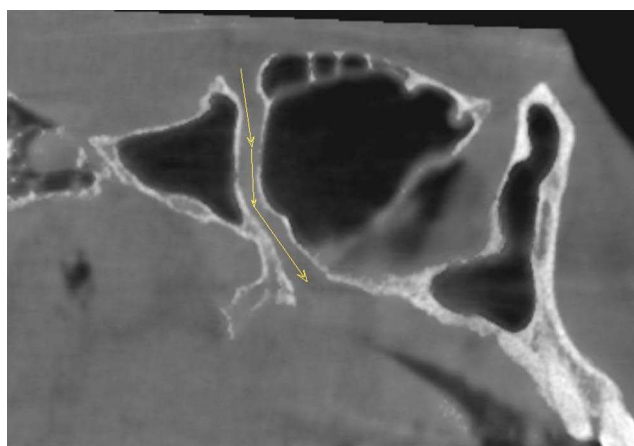


Figure 4 The type of intracanal curvature of the greater palatine canal marked in yellow arrows.

examiner (VP) evaluated 10% of the scans on different occasions. The interclass correlation coefficient (0.58 –0.985) confirmed the good inter-observer agreement, ensuring measurement reliability.

Statistical Analysis

Statistical analysis was performed using SPSS version 25, with significance set at $p < 0.05$. The Kolmogorov–Smirnov test was used to assess data normality. Descriptive statistics summarized age, gender, canal lengths, and diameters. Paired *t*-tests compared left and right sides, while independent *t*-tests analyzed gender differences. The Mann–Whitney *U*-test was used for non-parametric comparisons, and the Chi-square test evaluated curvature distribution. Descriptive statistics were used to present demographic details and measurements, including age, gender, diameters, and the lengths between GPC and PPF. A paired *t*-test compared left and right-side measurements, while independent *t*-tests analyzed gender-based differences.

Results

200 greater palatine canals were analyzed bilaterally for the length of the GPC, upper and lower diameter of the GPC, and the canal curvature from 100 CBCT images. The minimum age was 18 years to a maximum of 65 years, with a mean of 31.51 years. Further the sample was age-wise grouped as 18–25 and > 25 years based on the median split for comparison between various parameters measured. Regarding sex distribution, there were 61 males (61%) and 39 females (39%) in the study. Table 1 shows further analysis of age group distribution within sex that showed no significant difference in the distribution of males and females between different age groups ($P=0.111$).

Table 2 presents a comparison of morphometric measurements of the greater palatine canal (GPC) between genders. Although the mean canal lengths (left side, right side, and average) were slightly higher in males than females, the differences were not statistically significant ($p > 0.05$). The upper opening diameters (left side, right side, and average) also showed no significant gender differences between sexes. But the lower opening diameter showed statistically significant results. The left lower opening was significantly wider in males (mean = 4.93 mm) compared to females (mean = 4.31 mm) with $p = 0.006$. The average lower opening diameter was also significantly greater in males (mean = 4.86 mm) than in females (mean = 4.51 mm), with $p = 0.044$.

Table 3 compares the morphometric measurements of the greater palatine canal (GPC) between two age groups (18–25 years and >25 years) using the Mann–Whitney *U*-test. The results revealed significant age-related differences in several parameters. The right canal length was significantly longer in the 18–25 age group (mean = 34.03 mm) compared to individuals over 25 years (mean = 31.72 mm), with $p = 0.021$. The average canal length also showed a significant difference ($p = 0.043$), indicating a tendency for longer canals in age group 18–25 years. For the upper opening diameters, the left upper opening and the average upper opening were significantly larger in the >25 age group ($p = 0.006$ and $p = 0.007$, respectively), suggesting possible age-related expansion or remodelling in this region. No significant differences were found in the lower opening diameters across age groups.

Table 1 Analysis of Age Group Distribution Within Sex Showed No Significant Difference in the Distribution of Males and Females Between Different Age Groups ($P=0.111$)

		Sex				P-value
		Male		Female		
		N	%	N	%	
Age group	18-25	26	42.6%	23	59.0%	0.111
	>25	35	57.4%	16	41.0%	

Note: *Chi-square test.

Table 2 Comparison of Morphometric Measurements of the Greater Palatine Canal (GPC) Between Genders, Analyzed Using the Mann–Whitney U-Test

Parameters Measured	Sex Wise Distribution				P-value
	Males		Females		
	Mean	SD	Mean	SD	
Left length of canal	33.01	4.67	31.52	4.06	0.188
Right length of canal	33.45	4.64	31.92	4.02	0.063
Average length of canal	33.23	4.19	31.72	3.54	0.095
Left upper opening of canal	5.59	1.29	5.50	1.35	0.522
Right upper opening of canal	5.79	1.45	5.27	1.31	0.052*
Average upper opening diameter of canal	5.69	1.18	5.39	1.10	0.073
Left lower opening of canal	4.93	1.27	4.31	1.33	0.006*
Right lower opening of canal	4.78	1.37	4.69	1.18	0.456
Average lower opening of canal	4.86	0.96	4.51	0.86	0.044*

Note:*Statistically significant at P<0.05.

Table 3 Comparison Between the Morphometric Measurements of the Greater Palatine Canal (GPC) Between Two Age Groups (18–25 years and >25 Years) Using the Mann–Whitney U-Test

Parameters Measured	Age Wise Distribution				P-value
	18-25		>25		
	Mean	SD	Mean	SD	
Left length of canal	32.76	4.22	32.11	4.73	0.372
Right length of canal	34.03	4.34	31.72	4.30	0.021*
Average length of canal	33.40	3.84	31.92	4.06	0.043*
Left upper opening of canal	5.19	1.01	5.90	1.47	0.006*
Right upper opening of canal	5.37	1.31	5.80	1.50	0.094
Average upper opening diameter of canal	5.28	0.88	5.86	1.31	0.007*
Left lower opening of canal	4.67	1.40	4.71	1.26	0.831
Right lower opening of canal	4.88	1.29	4.62	1.30	0.374
Average lower opening of canal	4.78	0.89	4.67	0.98	0.647

Note:*Statistically significant at P<0.05.

Table 4 shows the comparison of Greater Palatine Canal Curvature between age groups and gender for left and right sides. On the left side in the 18–25 age group, 95.9% had a curved left canal, 4.1% had straight canal. In > 25 years 82.4% showed curved canals and 17.6% showed straight canals. This was statistically significant $p=0.03$. On the right side, all

Table 4 Comparison of Greater Palatine Canal Curvature Between Age Groups and Gender for Left and Right Sides Analyzed Using Chi-Squared or Fishers Exact Test

		Age				P-value	Sex				P-value
		18-25		>25			Males		Females		
		N	%	N	%		N	%	N	%	
Curvature of canal on left side	Curved	47	95.9%	42	82.4%	0.03*	53	86.9%	36	92.3%	0.398
	Straight	2	4.1%	9	17.6%		8	13.1%	3	7.7%	
Curvature of canal on right side	Curved	49	100.0%	45	88.2%	0.027*	56	91.8%	38	97.4%	0.4
	Straight	0	0.0%	6	11.8%		5	8.2%	1	2.6%	

Note:*Statistically significant at P<0.05.

CBCT images (100%) within 18–25 years had curved canals and none presented with straight canal which was statistically significant $p=0.027$. The differences were statistically significant ($p = 0.03$ left, $p = 0.027$ right), indicating more straight canals in age group >25 years. On the left side, 86.9% of males (53 out of 61) had a curved canal, while 13.1% (8 individuals) had a straight canal. Among females, 92.3% (36 out of 39) had a curved canal, and only 7.7% (3 individuals) had a straight canal. On the right side, 91.8% of males (56 out of 61) had a curved canal, with 8.2% (5 individuals) showing a straight canal. In females, 97.4% (38 out of 39) had a curved canal, and 2.6% (1 individual) had a straight canal.

Discussion

A maxillary nerve block anesthetizes the maxillary division (V2) of the trigeminal nerve, essential for maxillofacial surgeries, dental procedures, and pain management in trigeminal neuralgia. The V2 nerve supplies the midface, maxillary teeth, palate, and sinus. Approaches to block this nerve include the high tuberosity, infrazygomatic, and greater palatine canal (GPC) techniques. The GPC approach provides comprehensive anesthesia to the entire V2 region and understanding the morphological variations of the greater palatine canal is crucial for preventing neurovascular complications during maxillofacial and oral surgical procedures. Shorter or wider canals increase the likelihood of injuring the greater palatine nerve or descending palatine vessels during implant placement, Le Fort I osteotomy, or palatal flap elevation. Variations in canal curvature and angulation can complicate surgical navigation and needle placement for palatal nerve blocks, potentially leading to inadequate anesthesia or postoperative sensory deficits. Recognizing age- and sex-related differences allows surgeons to anticipate anatomical challenges and adapt surgical approaches accordingly. High-resolution CBCT imaging can therefore play a vital role in preoperative planning to enhance safety and procedural success. Imaging is crucial for accurate nerve block placement, and CBCT is preferred over CT due to its higher spatial resolution, lower radiation exposure, and superior visualization of the GPC and pterygopalatine fossa (PPF). CBCT also allows precise identification of anatomical landmarks, minimizing complications and improving procedural accuracy. Due to these advantages, CBCT was chosen to evaluate the GPC and PPF anatomy in our study.

Many researchers studied the GPC-PPF in different ways and populations. Some of them on dry skulls,^{13,14} the others using the imaging technology (CT, CBCT).¹⁵ A study by Aoun et al (2016) conducted on Lebanese population using CBCT to assess the anatomical characteristics of the GPC and PPF.¹¹ González et al (2017) analyzed CBCT images to identify anatomical variations in the GPC.¹⁶ Swirzinsk et al (2010) examined the length and geometric patterns of the GPC using CBCT.¹⁷ Our study was conducted to evaluate the morphometric parameters of GPC and PPF using 100 CBCT images belonging to 61 males and 39 females. We considered 100 CBCT images showing full right and left maxillary sinus. Our samples were age-wise grouped as 18–25 and > 25 years based on the median split for comparison between various parameters measured. Tomaszewska et al (2015) analyzed 1500 head CT scans (783 females, 717 males, mean age 42.1) to assess gender-based morphometric differences in the GPC. Swirzinski et al (2010) studied 500 CBCT scans (ages 18–73) to identify geometric variations of the GPC. Sheikhi et al (2013) evaluated 138 CBCT scans (65 females, 73 males, ages 18–76) to measure GPC length and pathways relevant to nerve blocks. Güzel et al (2023) categorized 100 patients into three age groups (<20 , 20–60, >60) to study age-related GPC variation. Alotaibi et al (2018) analyzed 182 CBCT scans (mean age 39.79) in Saudi patients to study the GPC and greater palatine foramen (GPF).¹⁸

In our study, the average GPC length was 33.23 mm in males and 31.72 mm in females, with an overall mean of 32.63 mm, highlighting a gender-based difference. Sheikhi et al (2015) reported a similar mean GPC length of 31.8 mm but did not analyze gender-based differences.⁴ Haghanifar et al (2022) found slightly lower values, with 29.62 mm in males and 30.02 mm in females.⁵ Mraiwa et al (2004) reported a mean of 29.38 mm, also without significant gender differences.⁶ Liang et al (2009) observed a notable gender-based variation with a mean length of 30.1 mm in males and 28.5 mm in females.⁷ Aoun et al (2016) found nearly symmetrical lengths on both sides (30.64 mm right, 30.60 mm left) with no gender differences, while Aminoshariae et al (2014) reported a general average of 29 mm (± 3 mm) without gender-specific data.⁸

Our study also compared GPC lengths by age group, noting a significant reduction in canal length in individuals over 25 years, especially on the right side. Sheikhi et al (2013) reported age-related reductions across three groups, with the most noticeable changes occurring after age 40.⁴ Liang et al (2009), however, found no significant difference between the

20–30 and 31–40 age groups. Collectively, these studies support the observation that while GPC length is relatively stable in younger adults, it may reduce with advancing age, particularly on the right side, consistent with our findings.

The average upper opening diameter was 5.69 mm in males and 5.39 mm in females, with age-based measurements of 5.28 mm in the 18–25-year age group and 5.86 mm in those over 25 years. Although the upper diameter was larger in the age group >25 years, the difference was not statistically significant. This was consistent with previous studies, such as Haghanifar et al (2022), Ghaffar et al (2014), and Baciliero et al (2020), who also reported slightly larger diameters in males (approximately 4.5–4.6 mm) than females (4.3 mm), with no significant age-related differences.^{9,19}

Regarding the lower opening diameter, our study found that males had larger measurements than females, with a more noticeable difference on the left side (4.93 mm in males vs 4.31 mm in females). The overall average was 4.86 mm in males and 4.51 mm in females. Ilayaperuma et al (2015) also observed higher diameters in Sri Lankan males compared to females,²⁰ while Singh et al (2015) found nearly identical values across sexes in an Indian population.²¹ Tomaszewska et al (2015) reported an average range of 4.5 to 5.3 mm, aligning with our findings.²² In contrast, Martins et al (2025) noted a higher average (5.35 mm) in Portuguese individuals, suggesting population-specific differences.²³ Das et al (2006) found higher values in females on the left side,²⁴ while Fahrioglu et al (2024) reported significantly larger diameters in North Cypriot males.²⁵ Cagimni et al (2017) observed balanced measurements between sides but did not provide sex-specific data.²⁶ Piagkou et al (2012) reported a marked sex difference in Greek individuals, with males showing much higher values (5.30–5.40 mm) than females (2.60–2.70 mm).²⁷

Age-wise, our study found no statistically significant changes in the lower opening diameter between age groups. Slight increases or decreases were noted between the sides and groups, but none were significant. This finding is consistent with Güzel et al (2023), who found slight increases in elderly individuals due to bone resorption.²⁸ Rathod et al (2022) also observed no significant age-related differences.¹⁰ Kalmin et al (2020) reported measurements in a younger Russian cohort (20–35 years) without age-group comparisons.²⁹ Aoun et al (2016) found values above 5.6 mm but did not stratify by age.¹¹

We also assessed GPC curvature and found that curved canals were more prevalent in age group 18–25 years. On the left, 95.9% of those aged 18–25 years had curved canals, compared to 82.4% in those over 25. On the right, 100% of the age group 18–25 years and 88.2% of the age group >25 years had curved canals. Gender-wise, 86.9% of males and 92.3% of females had curved left canals, while 91.8% of males and 97.4% of females had curved right canals, with no significant sex-based differences. Aoun et al (2016) analysed curvature at various levels (upper, middle, lower, and straight) and reported comparable distributions between sexes.¹¹ Tomaszewska et al (2014) described three main curvature types—inferior-lateral to inferior-medial (40.7%), anterior-inferior (68.4%), and negligible straight canals.²² However, most studies did not categorize GPC as straight or curved, making our study unique in this regard. Our exclusive focus on intra-canal curvature and its comparison across age and gender groups provides a novel contribution to anatomical research and has important implications for surgical and anaesthetic procedures involving the GPC. However, we acknowledge that our study has a limitation of smaller sample size due to the inadequate availability of full FOV CBCT images showing greater palatine canals bilaterally within the given time period. Hence, studies with larger sample size are required to further validate and extrapolate these results to general population. Also studies using different Artificial Intelligence tools for identification and measurement of GPC can also be evaluated.

Various genetic and developmental factors influence the anatomy of maxillary and palatine bone which predominantly affects the variations of greater palatine canal. This also results in interindividual differences in canal orientation, length, and configuration. Age-related remodelling of palatal bone is also influenced by hormonal changes and patterns of dental loading which may further contribute to subtle canal curvature changes or dimensional shifts over time. Studies using CBCT and dry skulls have highlighted significant variations in the GPC, that are critical to recognize. Clinically, these differences carry meaningful implications like shorter or wider canals heighten the risk of injuring the descending palatine vessels and greater palatine nerve during implant placement or palatal flap elevation. Curved or atypically angulated canals complicate surgical navigation. High-resolution imaging, such as CBCT, becomes indispensable for preoperative identification of these variations—enabling optimized flap design, precise osteotomy planning, and effective intraoperative avoidance of neurovascular complications.^{16,22}

Conclusion

Our study evaluated the morphological parameters like length of canal, diameter of the canal and curvature of the greater palatine canal and pterygopalatine fossa using Cone Beam Computed Tomography images. We noted that greater palatine canal morphology varied with age and sex. Individuals with >25 years showed shorter canal lengths and wider upper opening diameter. Males also had larger upper opening diameter on right side and lower opening diameters on the left side. Curved canal was the most common curvature overall, but straight canals were more frequent in the age group >25 years and seen more in males. Present study showed some variations in GPC length, opening diameter, and its curvature. An understanding of these variations can clinically influence the success of palatal nerve blocks, reduce the risk of injury to the greater palatine nerve. Recognizing these differences through CBCT images enables accurate anesthesia delivery, safer flap design, and precise osteotomy planning and other surgeries involving maxilla.

Institutional Review Board Statement

This research was conducted after obtaining permission from the Kasturba Medical College and Kasturba Hospital Institutional Ethics Committee (IEC: IEC 361-2023, Date 18-07-2023). All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki. Informed consent was taken from all the participants prior to commencement of the study.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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