Evaluation of characteristics and morphology of Nasopalatine Canal – A Cone Beam Computed Tomographic Prospective Study.

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Abstract:
Background: An essential anatomical feature of the anterior mid-maxilla is the Nasopalatine Canal (NPC). Given the increasing use of implants in dentistry, significant landmarks in this area must be identified.
Aim & Objectives: To assess characteristics and different morphologic patterns of NPC in Cone Beam Computed Tomography & to correlate them withother age groups and gender.
Material & Methods:In the current investigation, which was prospective, 120 CBCT scans of the maxilla in people 18 years of age and older revealed full NPC. Trauma, impacted teeth in the maxillary central incisor (CI) region, and any canal-related disorders were not included. Length, mesiodistal and labio-palatal widths, the angle of the NPC, the bone anterior to the NPC, and the various morphological patterns of the NPC—such as funnel, hourglass, spindle, and cylindrical shapes—were assessed in sagittal sections of the scan pictures.
Results: The average age of the subjects considered ranged from 37.53±10.96 years. The average ± standard deviation of labio-palatal width was 4.03±0.45, mesio distal width 4.01±0.41, length 10.87±0.63, width of anterior bone 10.69±0.52 and angle of NPC was 119.21±2.54. The most common morphologic pattern was cylindrical and the least was spindle shape.
Conclusion: The diversity observed in the morphology and other aspects of the nasopalatine canal—a critical landmark for the settlement of dental implants in the maxillary frontal region—is highlighted in the current study.
Keywords – Nasopalatine canal, Incisive foramen, Cone beam computed tomography, Implants

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I.   Introduction:

The incisive canal, alsotermed the anterior palatine canal or the nasopalatine canal (NPC), is a long, thin passageway that links the palate to the nasal cavity floor in the frontal maxilla's midline.[1]The canal continues as the Stenson foramina, typically two in number, in the nasal cavity and as a single incisive foramen to the CI teeth in the oral cavity. The nasopalatine (incisive) nerve, the culmination branch of the descending nasopalatine artery, fat, fibrous connective tissue, and even tiny salivary glands are all located in the canal.[2]

Recent years have seen a significant increase in the clinical significance of immediate implant placement, which necessitates a deep understanding of key anatomic structures in the relevant area.[3]Because of anatomical differences in the size of the incisive canal (IC) & foramen (IF), implant implantation in the maxillary CIprovince is frequently difficult. When an implant is placed in an IC, it causes non-osseointegration of the implant, damage to the nerve tissue, and sensory impairment.[4]

Before implant implantation in the front maxilla, a clear picture of the IC and IF is crucial because it can reveal information about the morphology and location of the canal concerning the surrounding

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structures.[5]Previously, the accessible techniques were two-dimensional imaging (intraoral and panoramic radiography) and cross-sectional techniques (spiral and computed tomography).[6]CBCT, on the other hand, has just lately been suggested as a useful three-dimensional imaging method in dentistry. When compared to spiral tomography, CBCT offers the advantages of superimposition removal and excellent resolution.[7]Furthermore, CBCT has numerous advantages over computed tomography (CT), such as a lower radiation dose, a shorter imaging time, and excellent resolution (less than a millimeter). The precise three-dimensional valuation of the bone amount and the location of the NPC in the frontal maxilla has been made possible using CBCT technology.[1, 8]In light of this, the current study used CBCT images to identify the characteristics of the maxillary incisive canal.

Aim: To assess the geomorphology and its characteristics of NPC in CBCT images.

1.   Objectives:
2.   To assess the length & width of NPC in CBCT
3.   To assess the shape disparities of NPC in CBCT
4.   To assess the angle of NPC in CBCT
5.   To assess forward bone width to NPC in CBCT
6.   To correlate the length, width, anterior bone width, and angle of NPC in CBCT with age & gender.

II.   Material & Methods:

The 120 systemically healthy dentulous and/or partially edentulous patients in this prospective study, who were scheduled for pre-CBCT evaluation of the frontal maxilla during routine dental procedures, were of either gender and aged between 18 and 61 (average age of 37.53 years) taken from the private CBCT centre. The assessment was based on random selection criteria. A power analysis was established using G*power, version 3.0.1 (Franz Faul Universität, Kiel, Germany). A sample size of 120 patients has 95% supremacy to notice significant differences, with an effective size of 0.3 and a significance level of 0.05.

Written informed consensus was gained from all the patients and the Ethical Committee approved this study (IEC/239/2023/07). Subjects with missing/fractured maxillary incisors, with evident nasopalatine pathology, developmental deformities, impacted teeth in the area of interest, and images with poor quality are excluded. All CBCT scans were obtained with 1mm slice thickness and the tomographic scanner Care Stream CBCT machine –90 kVp, 15 mA, 10-13 sec, and 10x15cm image field area was used to obtain CBCT scan. A software program, Care Stream 3D Imaging software, was used to reconstruct the images - in sagittal & axial views and perform the measurements.

Different Parameters Evaluated in CBCT Images: The following characteristics of incisive were evaluated:[8-10]

1) Length of the canal (Figure 1): Measured in the sagittal portion of the CBCT scan lengthways the long axis of the canal amid the level of the hard palate and the floor of the nasal fossa.

2) Nasopalatine canal width (Figures 2a & b): labio-palatally on sagittal section and mesio distal width on axial section measurements were made.

3)Shape of the canal (Figures 3a, b, c & d) - The canal's morphology was noted in the sagittal section, and it was categorized using the standards provided by Thakur AR, et al., 2013[9] as stated below:

Sl No.	Type	Description
i.	Cylindrical shape	A cylindrical shape created by the NPC's parallel labial and palatal walls [Figure 1a].
i.	Slant/Funnel shape	A rising anteroposterior measurement of the NPC from the nasal fossa to the hard palate forms a funnel-shaped structure. [Figure 1b].
i.	Hourglass shape	An hourglass shape with the NPC's narrowest anteroposterior dimension at the equal of the nasal fossa & hard palate levels relative to each other [Figure 1c].
v.	Spindle shape	A spindle shape where the nasal fossa & hard palate levels' dimensions were smaller than the NPC's mid-level anteroposterior dimension.

4) Angle of canal (Figure 4): This is the anterior NP angle, which is situated between the palate and the axis of NPC.

5) Measuring Bone Anterior to NPC (Figure 5): This is the distance, measured at the middle level, between the labial cortex and the anterior wall of the NPC.

Additionally, a comparison of male & female characteristics was made, along with an association with age.

Statistical Analysis: An Excel spreadsheet was used to compile the data that was collected. For statistical analysis, IBM SPSS version 23.0 for Windows was used. Frequencies and percentages were used to summarize the qualitative data, while statistical tests, average and standard deviation were used to summarize the quantitative data. The chi-square test was used to identify relationships between gender and age groups in various shapes, and the student-independent t-test was used to identify substantial differences between gender

length and to identify a significant difference in age groups' length, a one-way ANOVA test was used; the difference was deemed significant at p-value < 0.05.

III.   Results:

120 CBCT scans were randomly selected and evaluated for various anatomical variations and different characteristics of NPC.With a minimum age of 20 years and a maximum age of 61, the average age of the study cases was 37.53 ± 10.96 years. The average labio-palatal width (mm) was 4.03 ± 0.45 mm, the average mesio distal width (mm) was 4.01 ± 0.41 mm, the average length of the NPC (mm) was 10.87 ± 0.63 mm, the average width of the anterior bone to the canal (mm) was 10.69 ± 0.52 mm, and the average angle of the NPC (degrees) was 119.21 ± 2.54 degrees. (Table 1). There was no distinct difference between the male and female individuals when comparing them, that is when the influence of gender was taken into account (Table 2). High statistically significant values with positive correlation were found when average labio-palatal width, mesio distal width, length, anterior bone width to the canal, and angle of NPC (degrees) were compared between different age groups. (Table 3)

A maximum of 73.9% of the 92 male instances in our study had an NPC form that was one of four: cylindrical, slanted/funnel, hourglass, and spindle, in decreasing order. On the other hand, out of 28 female cases, the most common NPC shape was cylindrical (57.1%), which was followed by slanted/funnel, hourglass, and spindle-shaped NPCs. NPC forms did not significantly change between age groups or between gender groups (p=0.185). (Graphs 1 and 2)

TABLE 1- Descriptive Statistics

| Descriptive Statistics					
	Number	Minimum	Maximum	Average	Std. Deviation
Age	120	20.0	61.0	37.53	10.96
Labio palatal width (mm)	120	3.0	4.9	4.03	0.45
Mesio distal width (mm)	120	3.1	4.9	4.01	0.41
Length of NPC (mm)	120	10.0	12.2	10.87	0.63
Width of anterior bone to canal (mm)	120	10.0	12.1	10.69	0.52
Angle of NPC (degrees)	120	115.0	125.0	119.21	2.54

TABLE-2: Comparison of averageLabio palatal width (mm), Mesio distal width (mm), Length of NPC (mm), Width of anterior bone to canal (mm),and Angle of NPC (degrees) in between Male and Female Group.

Variables	Gender	Number	Average	Std. Deviation	P-Value
Labio palatal width (mm)	**Male**	92	4.05	0.43	0.455#
	Female	28	3.98	0.52	0.504#
Mesio distal width (mm)	**Male**	92	4.02	0.38	0.738#
	Female	28	3.99	0.50	0.774#
Length of NPC (mm)	**Male**	92	10.84	0.59	0.297#
	Female	28	10.98	0.74	0.359#
Width of anterior bone to canal (mm)	**Male**	92	10.71	0.52	0.727#
	Female	28	10.67	0.54	0.733#
Angle of NPC (degrees)	**Male**	92	119.37	2.59	0.2333
	Female	28	118.71	2.34	0.212#

#statistically not significant

TABLE-3: Comparison of averageLabio palatal width (mm), Mesio distal width (mm), Length of NPC (mm), Width of anterior bone to canal (mm),and Angle of NPC (degrees) in between different age groups.

Variables	Age Group(in years)	Number	Average	Std. Deviation	P-Value
Labio palatal width (mm)	**≤ 30 Yrs**	42	3.80	0.46	<0.001*

	31-40 Yrs	30	4.00	0.40	
	41-50Yrs	32	4.18	0.33	
	>51 Yrs	16	4.43	0.33	
Mesio distal width (mm)	**≤ 30 Yrs**	42	3.80	0.39	<0.001*
	31-40 Yrs	30	4.00	0.37	
	41-50Yrs	32	4.14	0.35	
	>51 Yrs	16	4.36	0.35	
Length of NPC (mm)	**≤ 30 Yrs**	42	10.59	0.61	<0.001*
	31-40 Yrs	30	10.91	0.66	
	41-50Yrs	32	11.07	0.60	
	>51 Yrs	16	11.15	0.38	
Width of anterior bone to canal (mm)	**≤ 30 Yrs**	42	10.42	0.39	<0.001*
	31-40 Yrs	30	10.64	0.47	
	41-50Yrs	32	10.92	0.55	
	>51 Yrs	16	11.09	0.44	
Angle of NPC (degrees)	**≤ 30 Yrs**	42	118.33	2.20	<0.001*
	31-40 Yrs	30	119.23	2.28	
	41-50Yrs	32	119.59	2.88	
	>51 Yrs	16	120.75	2.35	

*statistically significant.

GRAPH 1: Comparison of Shape of NPC in Male and Female Group.
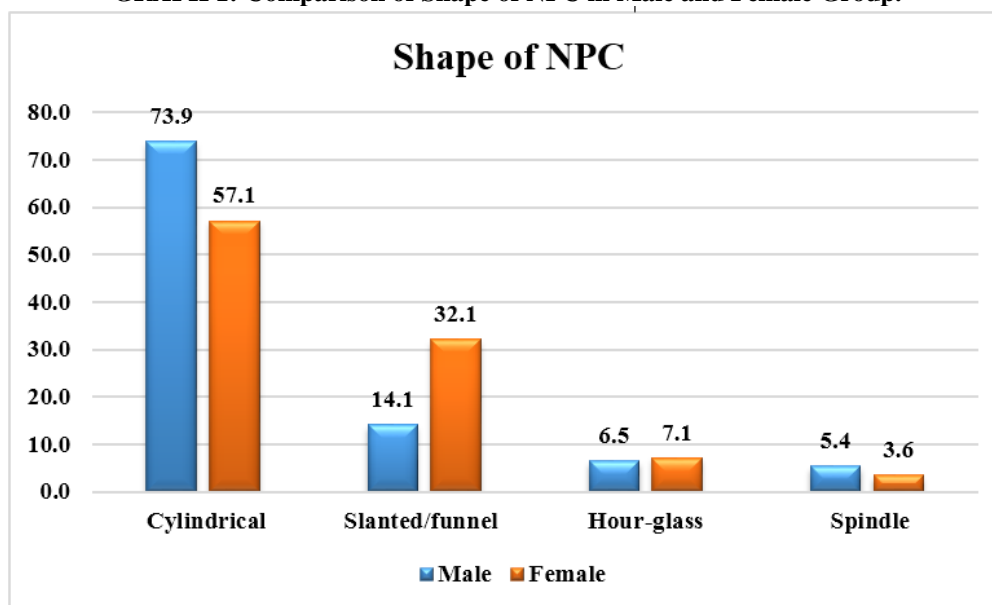
GRAPH 2: Comparison of Shape of NPC in different age Groups.

Shape of NPC
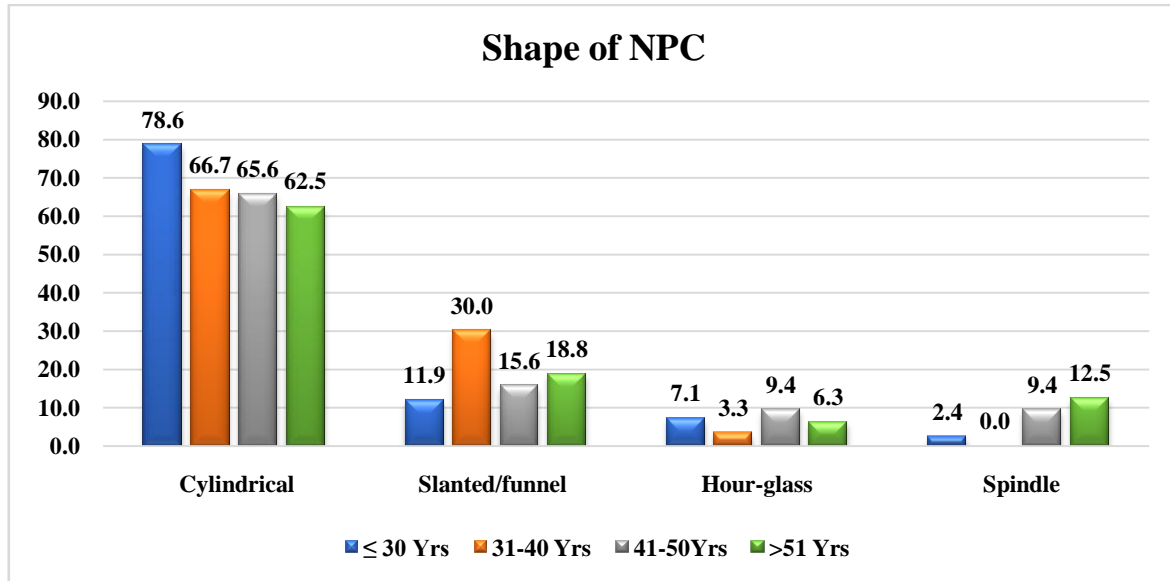
IV. Discussion:

NPC is a portion of the frontal maxilla. The disease of this bone may have an impact on the NPC.[11]Furthermore, an in-depthconsiderate of the frontal maxilla is obligatory for the planning of surgical treatments in this area. diverse people have diverse foramina in terms of size, shape, location, and quantity. The location of an implant may be nearly impossible in this area due to the presence of broader foramina and thin alveolar bone anterior to the canal.[12]For the anterior maxilla's lost teeth to be successfully replaced with implants, exact preoperative planning, and pertinent radiographic tests are necessary. Researchers have examined the NPC in great detail in a variety of methods employing dry skulls and imaging techniques such as two- or three-dimensional radiography (CBCT).[13]

According to this prospective investigation, there was a lot of variation in the physical look and size of the NPC. In the current investigation, 92 males outnumbered 28 females in terms of the various NPC features.

The research cases in this investigation had an average age of 37.53 ± 10.96 years. NPC had anaverage length of 10.87 ± 0.63 mm. The study conducted by Soumya P et al.[10] revealed that the average canal length was 18.63 ± 2.35 mm, which was slightly longer than the current study. Additionally, Salemi F. et al. (2016)[14]showed that as people aged, the canal's width grew and its length reduced, with men having longer and wider canals. In contrast, Sudheer A et al.[8] found that length increased in those under 25, 26–35, and 36–45 years old, and gradually declined with age.

The average labio-palatal and mesio distal canal widths, according to our research, were 4.03 ± 0.45 and 4.01 ± 0.41, respectively. These results were analogous to those of a study by Soumya P et al. that examined width in the axial and sagittal regions of the CBCT. In a related investigation, Tozum et al. assessed the average foramen width at the superior and inferior orifices, and the results showed that it was 2.76 ± 1.40 mm and 2.93 ± 1.01 mm. The measures were significantly bigger than those of the Tozum et al.[15]study, which might be linked to differences in the anatomical features of the Indian populace.

The anterior bone to canal thickness (mm) was 10.69 ± 0.52 on average. When comparing females to males, the difference in the slightly thinner bone plate before the incisive canal was not statistically significant. This result was in line with the findings of Soumya P. et al.[10] The diameter of the incisive foramen was discovered to be significantly influenced by age by Chatzipetros E et al. in 2023, with average values typically rising with age.[16]

NPC had a average angle of 119.21 ± 2.54 (degrees). There was no distinctvariance between the male and female subjects when comparing them, that is when the influence of gender was taken into account. This result was in line with what Bajoria AA et al.[17] found. In the sagittal plane, Bashi I et al.[18] assessed the NPC angle to be 74.28° ± 7.72°, and they found a statistically significant difference amongst the genders. This result was in line with the current investigation.

According to the current study, both boys and females have cylindrical NPCs more frequently than other shapes. The spindle form was determined to be the least prevalent shape, and there was no distinctdiscrepancy in NPC shapes between age groups or gender groupings. The outcomes of the study conducted by Thakur et al. (2013),[9] Mraiwa et al. (2013),[19] Bashi I et al. (2019),[18]and Sudheer A et al. (2020)[8] are comparable to these findings. Etoz and Sisman[20]have also mentioned other shapes of the canal, such as cone, banana, and tree-branch shapes.

The demographic disparity and variations in the assessing methodologies and criteria employed to measure the NPC could be the cause of the study's varied characteristic outcomes.

Limitations:
- Unequal distribution of gender and age.
- Inequality in distribution for several NPC parameters.
- Subject selected at random

Prospects: More comprehensive longitudinal and multicentric research using bigger sample sizes can yield more precise information regarding the aging-related modifications of significant anatomical landmarks.

V.   Conclusion:

Anatomically, the NPC is a very changeable unit of the frontal maxilla. 3D imaging methods are the sole way to evaluate these anatomic variances. CBCT is a highly regarded diagnostic method in the arena of Oral and Maxillofacial Imaging. In implant dentistry, it makes it possible to determine the volume and topography of the anterior maxilla and to customize surgical techniques for each patient in this intricate area. This work emphasizes the significance of NPC morphology in surgical operations like implant planning. To undertake anterior maxilla surgery and further limit problems, an in-depthconsiderate of the morphological variability of NPC is therapeutically important.

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Conflict of interest – None

References:

[1].   Friedrich RE, Laumann F, Zrnc T, Assaf AT. The nasopalatine canal in adults on cone beam computed tomograms–A clinical study and Review of the literature. In vivo 2015;29(4):467-86.
[2].   Iamandoiu AVMs, A.N.; Rusu MC. Detailed Morphology of the Incisive or Nasopalatine Canal. Anatomia 2022. p. 75–85.
[3].   Bornstein MM, Horner K, Jacobs R. Use of cone beam computed tomography in implant dentistry: current concepts, indications and limitations for clinical practice and research. Periodontology 2000 2017;73(1):51-72.
[4].   Nasseh I, Aoun G, Sokhn S. Assessment of the nasopalatine canal: An anatomical study. Acta Informatica Medica 2017;25(1):34-8.
[5].   Al-Amery SM, Nambiar P, Jamaludin M, John J, Ngeow WC. Cone beam computed tomography assessment of the maxillary incisive canal and foramen: considerations of anatomical variations when placing immediate implants. PloS one 2015;10(2):e0117251-67.
[6].   Kajan ZD, Kia J, Motevasseli S, Rezaian SR. Evaluation of the nasopalatine canal with cone-beam computed tomography in an Iranian population. Dental research journal 2015;12(1):14-9.
[7].   Özçakır-Tomruk C, Dölekoğlu S, Özkurt-Kayahan Z, İlgüy D. Evaluation of morphology of the nasopalatine canal using cone-beam computed tomography in a subgroup of Turkish adult population. Surgical and Radiologic Anatomy 2016;38(1):65-70.
[8].   Sudheer A, Rani K, Kumari A, et al. Morphological variation of the nasopalatine canal: A cone-beam computed tomography study. Journal of Indian Academy of Oral Medicine and Radiology 2020;32(1):27-30.
[9].   Thakur AR, Burde K, Guttal K, Naikmasur VG. Anatomy and morphology of the nasopalatine canal using cone-beam computed tomography. Imaging science in dentistry;43(4):273-81.
[10].   Soumya P, Koppolu P, Pathakota KR, Chappidi V. Maxillary incisive canal characteristics: a radiographic study using cone beam computerized tomography. Radiology research and practice 2019;2019(1):6151253-8.
[11].   Milanovic P, Selakovic D, Vasiljevic M, et al. Morphological characteristics of the nasopalatine canal and the relationship with the anterior maxillary bone—a cone beam computed tomography study. Diagnostics 2021;11(5):915-28.
[12].   Magat G, Akyuz M. Are morphological and morphometric characteristics of maxillary anterior region and nasopalatine canal related to each other? Oral Radiology 2023;39(2):372-85.
[13].   Mishra R, Thimmarasa V, Jaju PP, Mishra R, Shrivastava A. Influence of gender and age on nasopalatine canal: A cone-beam computed tomography study. Journal of Dental Implants 2017;7(1):15-9.
[14].   Salemi F, Moghadam FA, Shakibai Z, Farhadian M. Three-dimensional assessment of the nasopalatine canal and the surrounding bone using cone-beam computed tomography. Journal of Advanced Periodontology & Implant Dentistry 2016;8(1):1-7.
[15].   Tözüm TF, Güncü GN, Yıldırım YD, et al. Evaluation of maxillary incisive canal characteristics related to dental implant treatment with computerized tomography: a clinical multicenter study. Journal of Periodontology 2012;83(3):337-43.
[16].   Chatzipetros E, Tsiklakis K, Donta C, Damaskos S, Angelopoulos C. Morphological assessment of nasopalatine canal using cone beam computed tomography: A retrospective study of 124 consecutive patients. Diagnostics 2023;13(10):1787-97.
[17].   Bajoria AA, Kochar T, Sangamesh N, et al. Nasopalatine canal revisited: an insight to anterior maxillary implants. Open J of Stomatol 2018;8(01):1-15.
[18].   İ. Bahşi MO, P. Kervancioğlu, E.D. Yalçin, A.M. Aktan. Anatomical evaluation of nasopalatine canal on cone beam computed tomography images. Folia morphologica 2019;78(1):153-62.
[19].   Mraiwa N, Van Cleynenbreugel J, Sanderink G, et al. The nasopalatine canal revisited using 2D and 3D CT imaging. Dentomaxfac Radiol 2004;33(6):396-402.
[20].   S. Hakbilen GM. Evaluation of anatomical and morphological characteristics of the nasopalatine canal in a Turkish population by cone beam computed tomography. Folia morphologica 2018;77(3):527-35.

Figure 1: CBCT Sagittal section showing measurement of the incisive canal length.
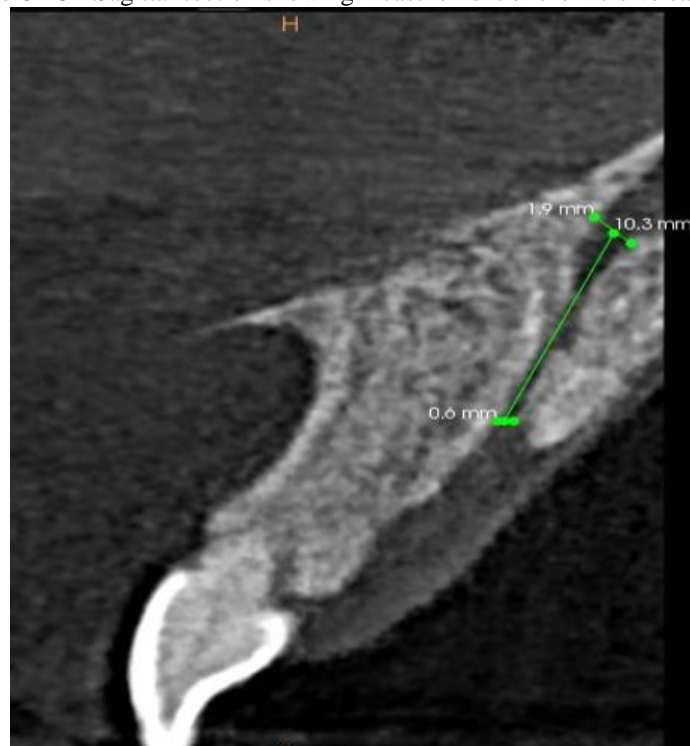
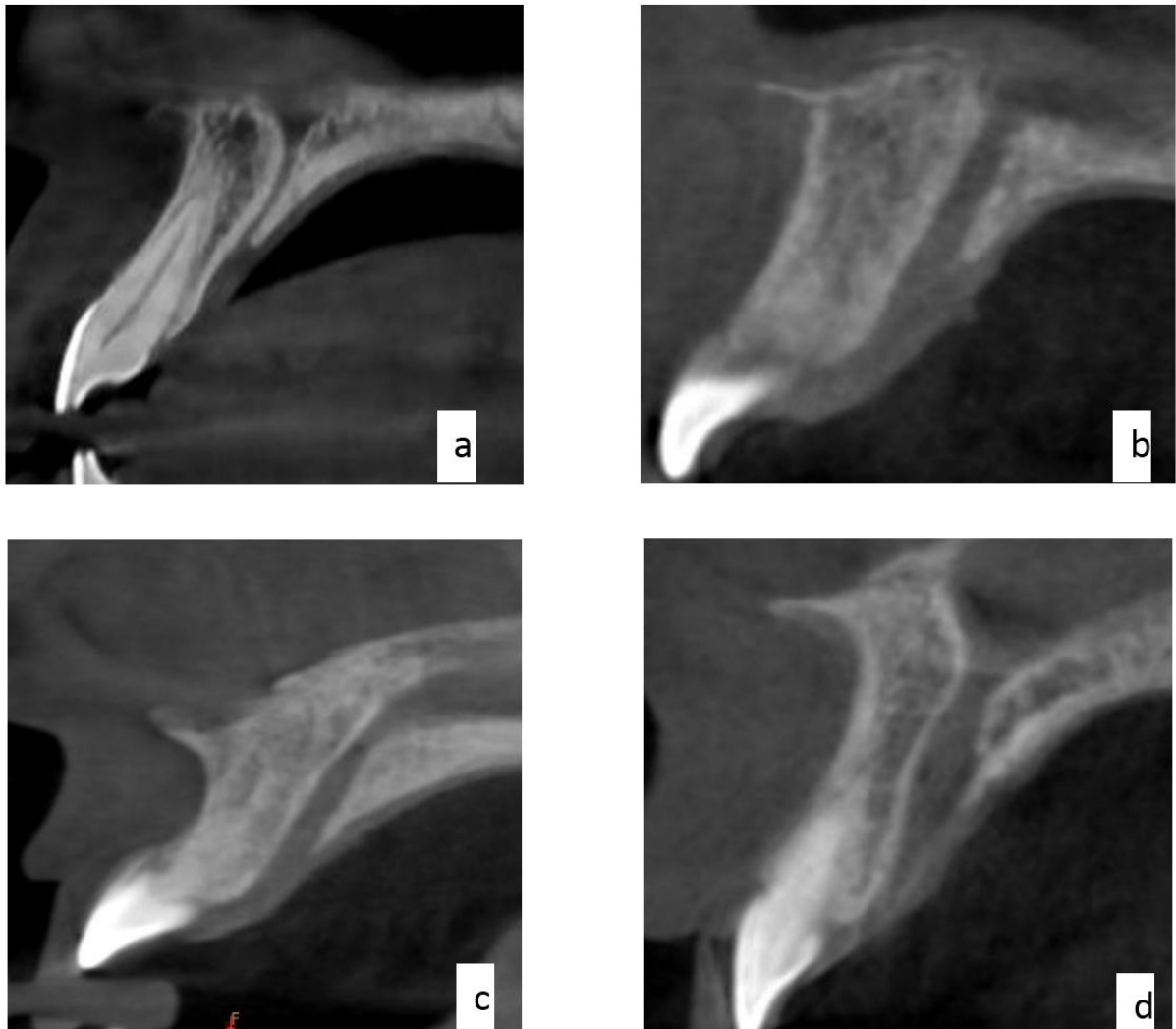**Figure 2:**2a – CBCT Axial section showing measurement of mesiodistalwidth of the incisive foramen, 2b – CBCT Sagittal section showing measurementof labio-palatal width of the incisive foramen.
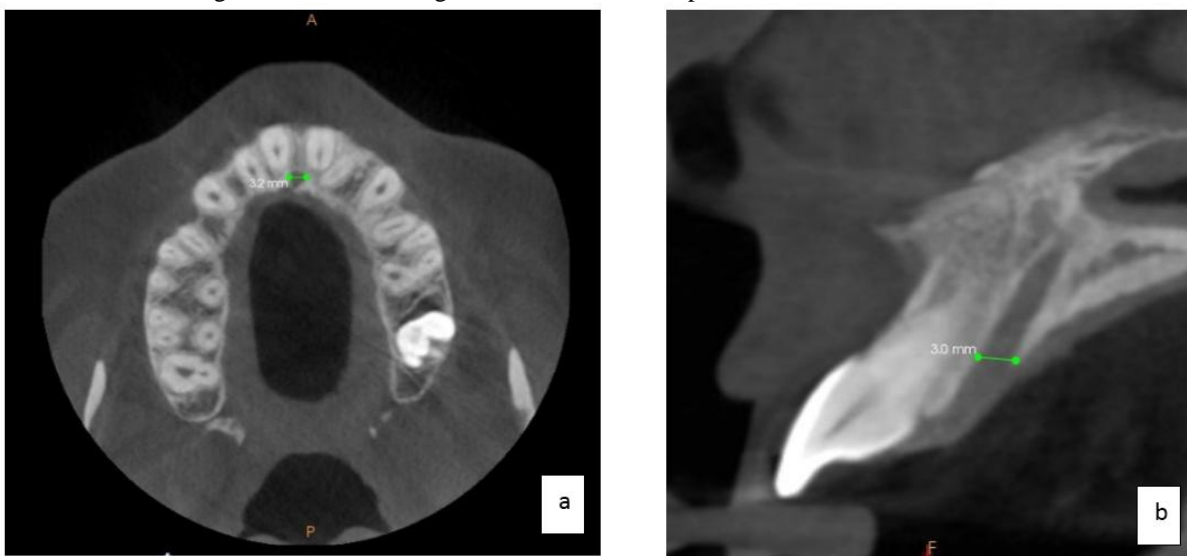
Figure 3 a, b, c, d – 3a - Cylindrical shaped incisive canal in sagittal view, 3b - Slanted/Funnel shaped incisive canal in sagittal view, 3c - Hour-glass shaped incisive canal in sagittal view, 3d – Spindle shaped incisive canal in sagittal view

Figure 4 – CBCT Sagittal section showing measurement of the incisive canal angle.

Figure 5 – CBCT Sagittal section showing measurement of anterior bone width of the incisive canal