Original

Radio-Anatomical Evaluation of the Nasopalatine Canal and its Clinical implication

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Abstract

Background: Nasopalatine canal (NPC), also known as incisive canal is in the anterior part of the hard palate posterior to the maxillary incisor and serves as a channel between the oral and nasal cavities. Incisive foramen is the distal opening of the incisive canal on the hard palate. This study evaluated the nasopalatine canal and its morphological variations amongst Nigerians.

Method: This cross-sectional research was done in Radiology department of Rivers State University Teaching Hospital, Nigeria. One hundred computed tomography images of adults (≥18years) were studied. Data were analyzed using SPSS version 22.0. Independent t- test, ANOVA, paired t - test were used for comparison. A $p<0.05$ was considered statistically significant.

Result: Cylindrical shape of NPC was most prevalent 43(23%), males had more cylindrical shape 38(27.6%), females had more funnel shape 26(24.8%). NPC length for males and females were 16.31+2.904mm and 13.92+2.638mm respectively and is statistically significant. The diameter of the incisive canal was 3.17±1.17mm and 3.24±1.10mm; males and females respectively, not statistically significant. Incisive foramen had no significant correlation as regards age and gender; double foramina was also observed in four female subjects.

Conclusion: Knowledge of this structure and its morphological variations will help surgeons operating in that region in avoiding injury to neurovascular and other related structures. This study also found double foramina in four female subjects.

Keywords: Nasopalatine canal, incisive foramen, cylindrical, funnel.

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Introduction

The incisive canal, also known as nasopalatine canal, is situated in the anterior aspect of the hard palate posterior to the maxillary incisor and serves as a passage between the oral and nasal cavities. It accommodates soft tissue and neurovascular structures, namely, the nasopalatine nerve and sphenopalatine artery which traverses the length of this canal. Computed tomography (CT) studies have revolutionized craniofacial imaging and aided in understanding the anatomical and morphometric variability of the incisive canal.[1] Studies of the incisive canal using CT have shown, for example, that age, sex, ethnicity, tooth loss, and trauma alter the metrics of the incisive canal.[2] The anatomical structures traversing this canal include the nasopalatine nerve, the posterior septal branch of the sphenopalatine artery and the greater palatine artery. The incisive canal terminates at the incisive fossa in the oral cavity, posterior to the maxillary incisors and beneath the incisive papilla. Superiorly, it extends to the nasal cavity on each side of the nasal septum as nasal foramina or Stenson's foramina. The incisive canal also exists as parallel canals that do not coalesce at any point, thus defining the type B formation. Lastly, there may be multiple terminal points alongside the nasal septum, defining the type C morphology.[3] Detailed knowledge about the nasopalatine canal morphology is very important especially in the planning of surgery involving the maxillae, in the treatment of nasopalatine cyst, palatal pathologies that require a surgical intervention.[4,5] The study of Nasopalatine Canal on formaline fixed cadaver does not fully reveal all the delicate structures as embalming process and embalming fluid may have affected the morphology of these structures, hence the need for CT scan study which provides a three dimensional (3D) view of these structures on living subjects. Knowledge of the Nasopalatine canal morphology is very essential in the planning of oral/maxillofacial surgeries and also for aesthetic purposes. There is also paucity of data as regards this study amongst Nigerians, hence the need for this study. The aim of this study was to evaluate the morphology and morphometry of the nasopalatine canal amongst Nigerians.

Method

This study was a cross-sectional retrospective study conducted in the Radiology department of the Rivers State University Teaching Hospital. Ethical approval was obtained from the ethical committee of the Rivers State University Teaching Hospital. CT scans were done using GE evolution 64 slice 2018 version, films were retrieved from the archives, 100 skull CT images of 100 Nigerians including males and females were studied. The nasopalatine area was inspected in axial, coronal and sagittal planes to find the nasopalatine canal and the incisive and Stenson foramina. The following parameters were analysed on sagittal; Shape of the nasopalatine canal (cylindrical, funnel shaped, hourglass, spindle-shaped and banana shape), nasopalatine canal length as the distance from the midpoint of the nasal foramen to the midpoint of the incisive foramen, diameter of nasal opening of the nasopalatine canal (Stenson foramen) as the distance between the anterior and posterior borders of the nasopalatine canal at the nasal opening. Diameter of oral opening of the nasopalatine canal (incisive foramen) as the distance between the anterior and posterior borders of the nasopalatine canal at the oral opening of the canal.

The following parameters were evaluated on axial sections; Shape of incisive foramen (round, oval, lobular, heart-shaped), number of incisive foramina.

The following parameters were evaluated on coronal sections: Nasopalatine canal length: distance from the midpoint of the nasal opening diameter of the canal to the midpoint of the oral opening diameter of the canal. Data was analysed with Statistical Package for the Social Sciences (SPSS) version 22, values are reported as the mean (standard deviation) independent t- test, ANOVA, paired t - test were used for comparison of quantitative data between gender, and correlation coefficient was used to access the correlation between dimension and different age groups. All frequencies and pie chart were analysed using descriptive frequency, $p<0.05$ was considered statistically significant and 95% confident level was used for all the tests.
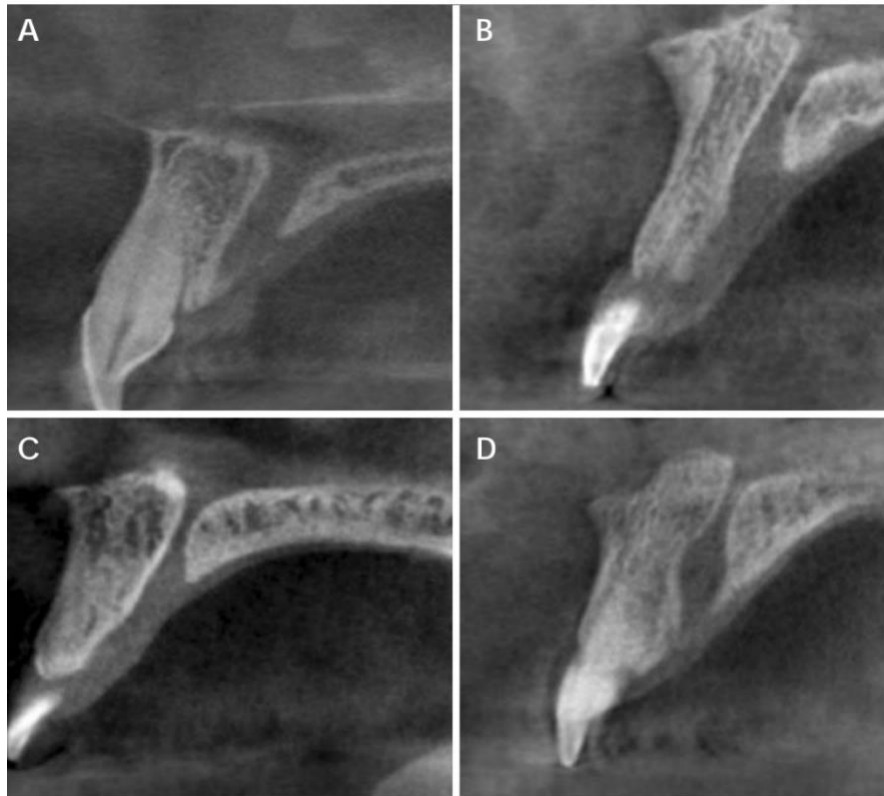
Figure 1: Morphologies of the Nasopalatine canal (sagittal view)[25]
A. Cylindrical shape; B. Funnel shape; C. Hourglass shape; D. Spindle shape
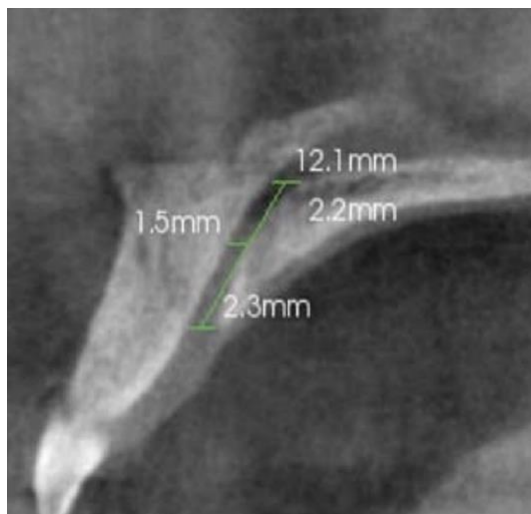

Figure 2: Measurement of the Nasopalatine canal length, stencil foramen, incisive foramen (sagittal view)
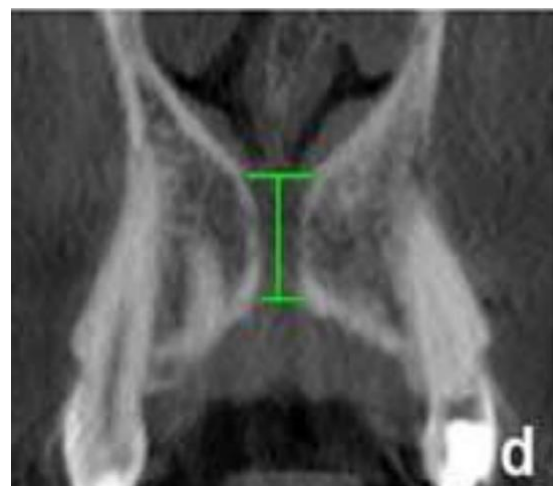

Figure 3: Measurement of the Nasopalatine canal length (corona view)

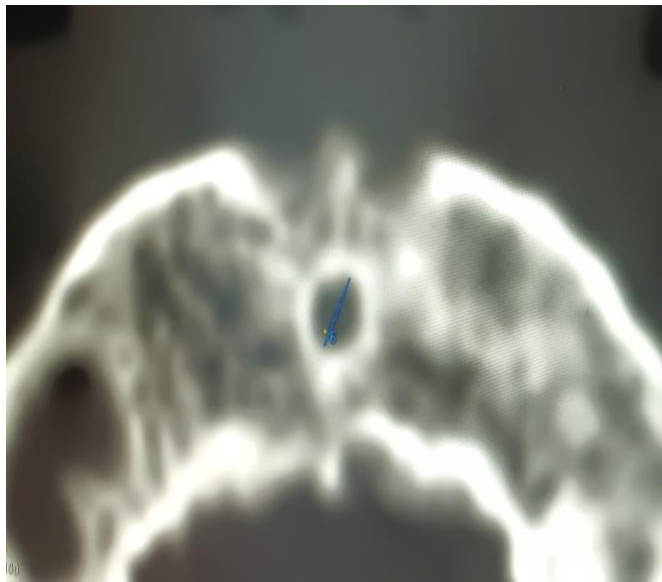**Figure 4:** Measurement of palatal bone diameter (sagittal view)

Figure 5: Measurement of incisive foramen (axial view)

Result

Table 1: Shape frequency

Shapes	Frequency	(%)
NPC Sagittal view		
Cylindrical	46	23.0
Funnel	34	17.0
Hourglass	8	4.0
Spindle	10	5.0
Banana shape	2	1.0
AXIA VIEW of IC diameter		
Circular	53	26.5
Oval	34	17.0
Heart	8	4.0
Teardrop	5	2.5

Table 2: Gender Wise Morphological Comparison (Sagittal view)

Shapes	Male (freq)	(%)	Female (freq)	(%)
Funnel	9	8.6	26	24.8
Cylindrical	38	27.6	17	16.2
Spindle	7	6.7	3	2.9
Hourglass	4	3.8	4	3.8
Banana	2	1.9	0	0.0

Table 3: Gender Wise Morphological Comparison (Axial view)

Shapes	Male (freq)	(%)	Female (freq)	(%)
Oval	18	17.1	16	15
Circular	24	22.9	30	28
Teardrop	3	2.9	1	1.0
Heart	5	4.8	3	2.9

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Table 4: Age wise comparison of all parameters

Parameters	18-35(years)	36-55(years)	>56(year)	t-test	P-value
NPC* palatal bone thickness	6.85±3.47	6.69±1.39	7.37±1.07	0.218	0.80
NPC Coronal length	13.68±2.77	13.54±14.1.95	14.15±2.16	0.197	0.12
I C* foramen axial diameter	3.17±1.23	3.23±1.06	3.42±1.17	-153	0.70
NPC Oral width	2.79±0.86	3.53±.09	3.67±0.82	1.052	0.38
NPC nasal width	3.17±1.50	3.54±1.49	4.37±1.63	-758	0.24
NPC Sagittal length	14.27±3.11	13.61±2.46	14.48±2.83	0.708	0.78
NPC mid sagittal width	1.94±0.82	1.81±0.67	1.86±0.66	-1.099	0.31

* Nasopalatal canal, Icissive foramen.

Table 5: Gender wise comparison of all parameters

Parameters	Male	Female	t-test	P-value
NPC Nasal width	3.84±1.58	3.56±1.53	0.84	0.405
NPC sagittal length	16.31±2.90	13.92±2.63	3.91	0.001
NPC Palatal sagittal width	3.63±0.87	3.34±0.97	1.41	0.163
IC Axial diameter	3.17±1.17	3.24±1.10	-334	0.740
NPC Coronal length	16.05±2.56	13.66±2.20	4.37	0.001
NPC mid sagittal width	1.85±0.68	1.81±0.64	0.26	0.791
NPC buccal bone diameter	8.36±1.60	6.82±2.12	3.56	0.001

Discussion

In this study the NPC shape in the sagittal plane was classified into five groups of cylindrical, funnel-shaped, hourglass, banana and spindle shaped.

This result was in line with another study.[6] Another similar study reported that hourglass form had the highest frequency of canal shape in the sagittal plane.[7] A study done among North Eastern Romanians and reported that cylindrical, whereas banana shape was the least seen.[8] This is similar to the result of this present study. Milanovic and Vasiljevic[9] reported that funnel shape was most prevalent in males, whereas cylindrical shape was more in females. Banana shape was lowest in both males and females. This is slightly different from the present study; in this present study, females had more funnel shaped NPC, males had more cylindrical shape NPC. Banana shape was lease in both genders. Hakbilen et. al[10] in related research amongst Turkish population reported that hourglass shape was most prevalent. This is dissimilar to the result found in this study. Kajan et. al[11] evaluated the NPC amongst Iranian population, the cylindrical form had the most frequency (57%) whereas the banana form (1.5%) had the least frequency. This is similar to this present study. Thakur et. al[12] found cylindrical shape to be most common and spindle shape as the least common.

In this study also, males had more cylindrical shape, whereas females had more funnel shaped NPC. This disagrees with Pavle et. al[9] who reported more cylindrical shape in females and more funnel shape in males. Hakbilen et al[10] also reported conical shape to have

occurred more in females and hourglass shape more in men. These differences may be due to racial or genetic factors.

Moreso, the mean nasopalatine canal length was greater in males compared to females. This agrees with previous studies done by Sekerci et. al.[12,13,14] This may be due to the larger craniocaudal measurements of the dentofacial complex noticed in males when compared with females. The nasopalatine canal length in both sagittal and coronal plane had no significant correlation with age (p=0.078 and p=0.120) respectively this agrees with panda et al.[15] However with increase in age, the NPC diameter increases and the length decreases due to the bone resorption.[4,16,17,18,19] This present study did not detect any statistical significant difference in canal dimensions in subjects of various age groups. Linjawi et al[20] reported longer IC length among the younger group (less than 20 years) which can be explained by the fact that they have not experienced enough remodeling at the nasal and oral cavity which can shorten the NPC length. However, this is in contrast with present study, older persons (>56yrs) had longer NPC length. Mohammed et al[21] reported that males had longer NPC length in males compared to females. This agrees with this present study.

NPC palatal bone thickness was significantly greater in males than in females (p<0.001) but had no significant correlation with age (p=0.80). Also, there was no significant age and gender correlation as regards incisive (IF) diameter axial plane in this study.

Double foramen was seen in four females in this study, however, Sicher reported six separate foramina.[22] However, Song et al. and Jacob et al. reported only two foramina and questioned foramina of scarpa as real additional nasopalatine foramina.[23, 24]

Implications of the findings of this study
This study revealed the possible anatomical variants of the nasopalatine canal amongst Nigerians and the sexually dimorphic features amongst Nigerians. This information will be of help to surgeons as regards avoiding injury to neurovascular and other related structures.

Strengths and Limitations of the Study
The CT films were studied using various views and measurements were also taken using well defined anatomical landmarks. Hence, the results from this study have provided data for the Nigerian population. The sample size of 100 may be a possible limitation.

Conclusion
The result of this present study shows the various anatomical variations of the NPC amongst Nigerians. It also showed that there is sexual dimorphism as regards the NPC length, morphology palatal bone thickness amongst our Nigerian population. The results of the present study show the various anatomical variations of the NPC amongst Nigerians. This study also reveals that there is sexual dimorphism as regards the NPC length, morphology palatal bone thickness. Therefore, knowledge of this structure and its morphological variations will help surgeons operating in that region in avoiding injury to neurovascular and other related structures.

Declarations
Ethical Consideration: Ethical approval was obtained from the ethical committee of the Rivers State University Teaching Hospital.

Authors' Contribution: The Authors' Contribution to the paper is as follows: study conception and design: Erekosima, B. U. Analysis of CT films and data collection: Robinson E. D, Horsfall, A. U, Israel, J. Analysis and interpretation of results: Erekosima, B. U., Didia, M. K., Draft of manuscript preparation: Erekosima, B. U. All authors reviewed the results and approved the final version of the manuscript.

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References
1. Venkatesh E, Elluru SV. Cone beam computed tomography: basics and applications in dentistry. J Istanb Fac Dent. 2017;;51(3):102-121, doi: 10.17096/jiuf
2. Salemi F, Moghadam FA, Shakibai Z, Farhadian M. Three-dimensional assessment of the nasopalatine canal and the surrounding bone using cone-beam computed tomography. J Periodontol Implant Dent. 2016;8(1):1-7.
3. Bornstein MM, Balsiger R, Sendi P, von Arx T. Morphology of the nasopalatine canal and dental implant surgery: A radiographic analysis of 100 consecutive patients using limited cone-beam computed tomography. Clin Oral Implants Res; 2011; 22:295-301.
4. Asaumi R, Kawai T, Sato I, Yoshida S, Yosue T. Three-dimensional observations of the incisive canal and the surrounding bone using cone-beam computed tomography. Oral Radiol 2010; 26:20-8.
5. Chatriyanuyoke P, Lu CI, Suzuki Y, Lozada JL, Rungcharassaeng K, Kan JY, et al. Nasopalatine canal position relative to the maxillary central incisors: a cone beam computed tomography assessment. J Oral Implantol. 2012;38(6):713-717.
6. Safi Y, Moshfeghi M, Rahimian S, Kheirkhahi M, Manouchehri ME. Assessment of nasopalatine canal anatomic variations using cone beam computed tomography in a group of Iranian population. Iran J Radiol. 2017;14(1)e37028
7. Etoz M, Sisman Y. Evaluation of the nasopalatine canal and variations with cone-beam computed tomography. Surg Radiol Anat. 2014;36(8):805-812
8. Nemtoi, A., Sirghe, A. E., Nemtoi, A, Dobrovat, B., Popescu, R. and Haba, D. CBCT analysis of the morphology and anatomical variants of the nasopalatine canal in northeastern population of Romania. Romanian journal of oral rehabilitation. 2019;11(4), 213-227.
9. Milanovic, P & Vasiljevic. Gender differences in the morphological characteristics of the nasopalatine canal and anterior maxillary bone-CBCT study. Experimental and applied biomedical research, 1-10, doi: https//doi.org/10.2478/sjecr-2021-0029
10. Hakbilen S, Magat G. Evaluation of anatomical and morphological characteristics of the nasopalatine canal in a Turkish population by cone beam computed tomography. Folia Morphol (Warsz). 2018; 77(3): 527-535.
11. Kajan ZD, Kia J, Motevasseli S, Rezaian SR. Evaluation of the nasopalatine canal with cone-beam computed tomography in an Iranian

population. Dent Res J (Isfahan). 2015;12(1):14-19. doi: 10.4103/1735-3327.150289.

12. Thakur AR, Burde K, Guttal K, Naikmasur VG. Anatomy and morphology of the nasopalatine canal using cone-beam computed tomography. Imaging Sci Dent. 2013;43(4):273-281.

13. Sekerci AE, Buyuk SK, Cantekin K. Cone-beam computed tomographic analysis of the morphological characterization of the nasopalatine canal in a pediatric population. Surg Radiol Anat. 2014;36(9):925-932.

14. Fernández-Alonso A, Suárez-Quintanilla JA, Muinelo-Lorenzo J, Varela-Mallou J, Smyth Chamosa E, Suárez-Cunqueiro MM. Critical anatomic region of nasopalatine canal based on tridimensional analysis: cone beam computed tomography. Sci Rep. 2015; 5:12568.

15. Panda M, Shankar T, Raut A, Dev S, Kar AK, Hota S. Cone beam computerized tomography evaluation of incisive canal and anterior maxillary bone thickness for placement of immediate implants. J Indian Prosthodont Soc.2018; 18(4): 356-.363.

16. Bornstein MM, Balsiger R, Sendi P, von Arx T. Morphology of the nasopalatine canal and dental implant surgery: A radiographic analysis of 100 consecutive patients using limited cone-beam computed tomography. Clin Oral Implants Res; 2011; 22:295-301

17. Liang X, Jacobs R, Martens W, Hu Y, Adriaensens P, Quirynen M, et al. Macro and micro-anatomical, histological and computed tomography scan characterization of the nasopalatine canal. J Clin Periodontol. 2009; 36(7):598-603.

18. Mardinger O, Namani-Sadan N, Chaushu G, Schwartz-Arad D. Morphologic changes of the nasopalatine canal related to dental implantation: a radiologic study in different degrees of absorbed maxillae. J Periodontol. 2008;79(9):1659-1662

19. Artzi Z, Nemcovsky CE, Bitlitum I, Segal P. Displacement of the incisive foramen in conjunction with implant placement in the anterior maxilla without jeopardizing vitality of nasopalatine nerve and vessels: A novel surgical approach. Clin Oral Implants Res; 2000; 11:505-10.

20. Linjawi, A., et al. (2021). "Morphological evaluation of the incisive canal with reference to gender and age: A cone-beam computed tomography study." Nigerian Journal of Clinical Practice. 2021; 24(11): 1596.

21. Mohammed, D. A. Anatomical variation in the dimension of nasopalatine canal on cone beam computed tomography CBCT images among Sulaimani population. *Acta Medica Internation.* 2016; 3(2): 82-87, Doi:10.5530/ami.2016.2.18

22. Sicher H. (1962). Anatomy and oral pathology. Oral Surg Oral Med Oral Pathol. 15:1264–9.

23. Jacobs R, Lambrichts I, Liang X, Martens W, Mraiwa N, Adriaensens P, et al. Neurovascularization of the anterior jaw bones revisited using high-resolution magnetic resonance imaging. Oral Surg Oral Med Oral Pathol Oral Radiol Endod.2007;103(5):683–93.

24. Song WC, Jo DI, Lee JY, Kim JN, Hur MS, Hu KS, et al. Microanatomy of the incisive canal using three-dimensional reconstruction of microCT images: an ex vivo study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009;108(4):583–90. doi: 10.1016/j.tripleo.2009.06.036

25. 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.

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