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Anatomical Variation in the Dimension of Nasopalatine Canal on Cone Beam Computed Tomography CBCT Images among Sulaimani Population

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ABSTRACT

Objective: This study was conducted to find anatomical variation of nasopalatine canal (NPC) and nasopalatine foramen (NPF) in different age and gender groups among Sulaimani population on cone beam computed tomography (CBCT) images.
Subjects and Methods: The study included one hundred CBCT images obtained from patients visiting privet clinics with specialty in dental and maxillofacial radiology in Sulaimani city extended from 2014 to 2016. Subjects were divided into three age groups (18-34, 35-49, 50-75) years old. First group included 15 males and 15 females, second group 20 males and 20 females, and the third group included 15 males with 15 females. PaX i vatech digital CBCT machine, were used to obtain the images by the radiographers. The following measurements were estimated; number of openings of NPC at nasal fossa, mesio-lateral diameter 0f NPF at nasal fossa (axial section), mesio-lateral diameter of NPF at palatine fossa, antero-posterior dimension of NPC at: its upper boarder; middle level, and lower boarder, and lastly the height of NPC in sagittal section.
Results: 100 subjects (50 males and 50 females) with age range 31 year were included in this study. 69% had single NPF at the nasal fossa. 23% had two openings and 8% had three openings. Mean and standard deviation (SD) of mesio-lateral diameter of NPF at nasal fossa, and palatine fossa were 2.60±0.69 mm, and 4.11±2.09 mm respectively. NPF diameter at the palatine fossa showed significant differences between genders (P value less than 0.05). But age group differences did not reach the significant level (P value more than 0.05). The means and SD of antero-posterior dimension of NPC was 3.46±1.53 mm. There were no significant difference between genders and among age groups concerning this dimension (P value was greater than 0.05). Mean and SD of height of NPC was 13.14±3.11 mm. Males demonstrated significantly greater length of NPC than females (P value was less than 0.05).
Conclusion: It is concluded that there is anatomical variation in morphology and various parameters of NPC among sulaimani population. This should be considered in preoperative planning and to reduce the number of complications in implant and other maxillofacial surgeries in anterior palatine area. CBCT has important role to obtain accurate measurements of NPC different dimensions which has importance to differentiate between normal and abnormal NPC.

INTRODUCTION

Nasopalatine canal (NPC) is funnel shaped opening in the bone of the oral hard palate opens through the incisive foramen in the oral cavity, and into the nasal cavity as the foramina of Stenson.[1] The location of the foramen is also variable and it can be seen going from the apical portion of central incisors up to the adjacent alveolar crest.[2] NPC communicate between the oral and nasal cavities. The main structures that are passing through this canal are descending palatine artery, and nasopalatine nerve. These two structures are joint the sphenopalatine artery, and greater palatine nerve respectively. Knowledge about the variation in the anatomical appearance and exact location of NPC

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is very important for both maxillofacial surgeons and or implantologists prior performing any surgical procedure, administrating local anesthesia, and inserting implants in the incisor area, since the neurovascular contents inside the NPC may be injured and traumatized during these surgical procedures.[3] Authors found that there will be some difficulty in localization of the NPC relating to the upper central incisor implant.[4]

Impair osseointegration after performing dental implants in the maxillary incisor area may be due to contact of the implant with NPC neurovascular bundles and this may affect sensory function.[3] Authors showed that in case of severe bone loss in anterior maxillary area, the dental implant inside the NPC may be a good treatment.[5] The clinical implications of the existence of the human NPC, whether patent or blind, make it an important subject for study. Studies about the NPC has remained relatively low or nearly ignored.[6] Evidence suggests that the canal in human adults is rarely patent and likely exists as a vestigial remnant which is often consider as the sites of pathologic conditions, and therefore it is important in clinical practices. Studies have been done regarding variation in anatomy, morphology and other different parameters of the NPC in other countries population,[7] while little or no researches done on Kurdish people. Hence we conducted this study as a demand and highly need for implant surgery and rehabilitation of edentulous areas especially in the anterior maxillary segment.

Panoramic radiograph (PAN) is an extraoral radiographic technique widely used by many implantologists, oral and maxillofacial surgeons. However, the reliability of measurements obtained by this method is low due to distortion and magnification inherent in the technique.[8] PAN accuracy to identify the anterior extension of the NPC has been described as being limited[9] besides being poorly documented and therefore the only use of PAN images for implant placement is not safe.[10,11] On the other hand, cone beam computed tomography (CBCT) has arrived to replace PAN in implantology because it allows analyzing X-ray images in three-dimensions. Oral radiologists obtain high rates of identification of NPC when CBCT images are used, hence it should be considered as essential preoperative planning before anterior maxillary and mandibular implants.

Some pathological lesions may occur inside NPC like nasopalatine cyst which appears as a radiolucent shadow on CBCT films. It is not easy to decide whether the radiolucency is cystic lesion or it is within the normal range of the canal size. Authors mentioned that antero-posterior dimension of NPC within 8-10 mm range considered as normal radiolucency.[12] while radiolucencies exceeding 14 mm is considered as a cystic lesion and required a surgical removal.[13]

Aim of this study was to find the anatomical variation regarding different measured parameters of NPC using CBCT images, and also to correlate these findings with age and gender factors among Sulaimani people.

MATERIALS AND METHODS

A total of 110 CBCT digital images, previously made over past two to three years between (2014-2016), were included for evaluation in this prospective study. To follow ethics, the protocol of this study was approved by the ethics board of the school of dentistry, the faculty of medical sciences of Sulaimani University (protocol number; 2014). Source of the data were taken by two ways, first from the patients those were referring to the specialist in dental and maxillofacial radiology privet clinics for various treatment needs such as initial screening or oral surgery. Second from the volumetric patients that were presented by us to the privet dental radiologists to take CBCT images for this specific area related to our study. The purpose and importance of the study were explained for the participant and a written consent taken from them. PaX i vatech digital CBCT machine, Korean type were used to make the images by the radiographers. The exposure parameters varied according to the patients anatomical structures (tube potential: 65-75 kV, tube current: 10-12 mA). Among the 110 participants only 100 of them were selected to be a part of this study, while 10 of them did not reach the inclusion criteria regarding this paper. Included subjects were patients with normal NPC, presence of both maxillary central incisors, absence of anterior implants, impacted incisor teeth, previous fractures and any pathological lesions at the site of the study. Also CBCT images without adequate resolution, contrast and accuracy were excluded from the study. Patients less than 18 years old also excluded from the study. 100 subjects (50 males and 50 females) were divided into three age groups: (18-34) years age as young persons, (35-49) years age as middle age persons, and (50-75) years age as oldest persons, as shown in (Table 1). For adequate and precise drawing and measurements of the points and lines on the CBCT images, Photoshop and Auto CAD programs were used. The magnification factors reported by the manufacturers were 1.2 (Real value = estimated value/1.2).

Table 1: Distribution of the subjects in the study (age and gender)

Groups	Age (year)	Number of subjects		Percentage
		Male	Female	
1	18-34	15	15	30
2	35-49	20	20	40
3	50-75	15	15	30
Total		100		100

All the measurements were recorded in millimeter (mm). The following data were collected from the images for both male and female participants as measured in axial and sagittal sections and shown in (Figure 1):

1. Number of opening of NPC at nasal fossa.
2. Diameter of NPC opening at nasal fossa in axial plane (foramen stenson).
3. Diameter of NPC opening at anterior incisal fossa in axial plane (Palatine fossa).
4. Anter-oposterior dimension of NPC at upper boarder (nasal fossa level).
5. Antero-posterior dimension of NPC at middle level.
6. Antero-posterior dimension of NPC at lower boarder (incisal fossa level).
7. Length or height of NPC in sagittal plane.

To check for the intraexaminer reliability, a total of 45 samples (fifteen from each group) were selected randomly and measured after a gap of two weeks and the values were compared using the unpaired *t*-test. The results showed no significant difference in all the measurements.

Statistical Analysis

The values obtained were tabulated; and the mean average and standard deviations were calculated for all distances studied. Data analysis was performed by using Statgraphics plus 40 programs, the correlation among different variables were assessed in simple and multiple liner regression analysis. t-test was applied to find the correlation between the means, P value equal or less than (0.05) regarded statistically as a significant at 95% confident level.

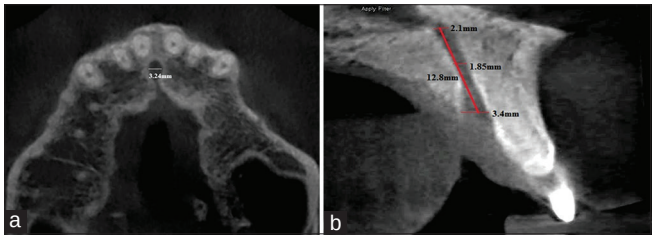

Figure 1: (a) Nasopalatine foramen in axial section, (b) Nasopalatine canal in sagittal section

Figure 1 Showing length of NPC between floor of nasal cavity and incisal fossa, also Antero-Posterior dimension of NPC at its upper, middle, and lower levels.

RESULTS

Among 100 subjects (50 males and 50 females) between 18-75 years old ages, participated in this cross sectional study as shown in Table 1. 69% had single nasopalatine foramen (NPF) at the nasal fossa (NF). 23% had two openings and the remaining subjects 8% had three openings. Distribution of the subjects according to the number of NPF at nasal fossa in different genders and age groups are shown in Table 2.

The mean mesio-lateral diameter and standard deviation (SD) of NPF at nasal fossa were 2.47±0.52 mm and 2.73±0.71 mm for males and females respectively (overall means for both sexes was 2.60±0.69 mm) as shown in Table 3 and Figure 2. There were no significant differences between genders and among different age groups concerning this dimension (P value was more than 0.05).

The mean and SD of mesio-lateral diameter of NPF at palatine fossa were 4.65±2.16 mm and 3.57±1.21 mm for males and females respectively (overall means for both sexes was 4.11±2.09 mm). There were significant differences between genders (P value less than 0.05). But age group differences did not reach the significant level (P value was

Table 2: Distribution of subjects according to number of NPF at nasal fossa

Age groups (year)	Genders	Number of opening at nasal fossa		
		One opening	Two openings	Three openings
18-34	Male	9	4	2
	Female	10	4	1
35-49	Male	14	5	1
	Female	15	4	1
50-75	Male	11	3	1
	Female	10	3	2
Total of the three groups	Male	34	12	4
	Female	35	11	4

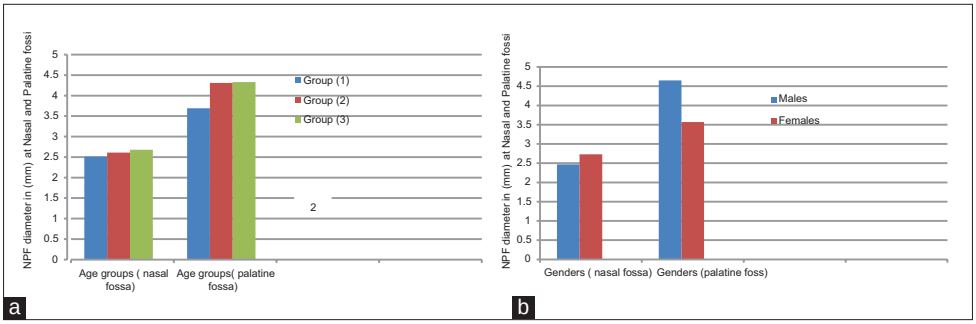

Figure 2: Correlation between mesio lateral diameter of NPF at nasal and at palatine fossi with (a) Age groups, (B) Genders

Table 3: Mean with standard deviation of Mesio lateral diameter of NPF at nasal and palatine fossi in mm (axial section)

Age groups (year)	Genders	Mesio-Lateral diameter of NPF (in mm)			
		Nasal fossa	Mean of males and females	Palatine fossa	Means of males and females
18-34	Male	2.45±0.51	2.51±0.54	4.11±2.10	3.69±1.61
	Female	2.57±0.56		3.28±1.11	
35-49	Male	2.47±0.52	2.61±0.71	4.95±2.31	4.31±2.01
	Female	2.75±0.87		3.68±1.98	
50-75	Male	2.49±0.60	2.68±0.82	4.91±2.27	4.33±2.10
	Female	2.88±0.91		3.75±1.99	
Means of three groups	Male	2.47±0.52	2.60±0.69	4.65±2.16	4.11±2.09
	Female	2.73±0.71		3.57±1.21	

Table 4: Mean with standard deviation of Antero-posterior dimension of NPC at different levels in mm (sagittal section)

Age groups	Genders	Antero-posterior dimension of NPC (in mm)				
		Upper boarder	Middle	Lower boarder	Mean of three levels	Means of males and females
18-34	Male	3.87±1.43	2.55±0.65	3.29±1.45	3.24±1.37	3.16±1.32
	Female	3.65±1.29	2.43±0.48	3.16±1.32	3.08±1.15	
35-49	Male	4±2.02	2.81±0.86	3.79±1.79	3.53±1.48	3.47±1.62
	Female	3.95±1.51	2.75±0.78	3.54±1.65	3.41±1.54	
50-75	Male	4.8±2.71	2.93±0.98	3.98±1.96	3.9±1.58	3.75±1.79
	Female	4.37±2.58	2.81±0.87	3.64±1.74	3.6±1.28	
Means of three groups	Male	4.22±2.43	2.76±0.79	3.69±1.77	3.56±1.51	3.46±1.53
	Female	3.99±1.59	2.66±0.73	3.45±1.51	3.36±1.39	

Table 5: Mean with standard deviation of length (height) of NPC in mm (sagittal section)

Age groups	Genders	Nasopalatine canal length (mm)	Means of both genders
18-34	Male	13.39±3.16	12.77±2.99
	Female	12.15±2.74	
35-49	Male	13.89±3.35	13.11±3.11
	Female	12.34±2.79	
50-75	Male	14.21±3.98	13.53±3.19
	Female	12.85±3.01	
Means of all groups	Male	13.83±31	13.14±3.11
	Female	12.44±2	

more than 0.05). Previous results are shown in Table 3 and Figure 2.

The means and SD of antero-posterior dimension of NPC as measured in sagittal section were 3.56±1.51 mm and 3.36±1.39 mm for males and females respectively (overall mean was 3.46±1.53 mm) as shown in Table 4. There were no statistically significant difference between genders and among age groups concerning this parameter (P value was greater than 0.05). Regarding the length or the height of NPC, means and SD value which was measured between nasal flower and incisive fossa; were 13.83±31 mm and 12.44±2.83 mm for males and females respectively (overall mean was 13.14±3.11 mm) as shown in Table 5.

Significant differences were noticed between males and females (P value was less than 0.05). Males demonstrated significantly greater length NPC than females.

DISCUSSION

Cone beam computed tomography has been widely used in dentistry because of its ability to produce adequately accurate two and three dimensional images.[14] Furthermore it require a relatively low radiation dose compared with conventional medical computed tomography.[15] Moreover, linear measurements made from CBCT images were not significantly different from the actual direct measurements of anatomic structures in the dentomaxillo facial area.[14]

In spite of large number of researches that have been done on the diseases and pathological conditions affecting the NPC area, the variation in the morphology and various dimensions of this anatomically important area did not well known and poorly documented. This study found that majority of the subjects (%69) has one opening of NPC at nasal fossa, this is in accordance with the finding of,[16] but disagree with some other researchers whom finding two openings at the nasal fossa.[17,18] However some authors found between 3 and 4 foramina at nasal floor level.[3,19,20]

The mean and SD of mesio-lateral diameter of NPF at the nasal fossa in the present study was 2.60±0.69 mm (range between 0.9 mm and 4.4 mm), which is higher than those reported by some other authors[19,20] whom recorded this measurement as 1.75±0.77 mm and 2.2±0.61 mm respectively.

This study clarify that the mean and SD of mesio-lateral dimension of the NPF at palatine fossa was 4.11±2.09 mm

which is lower than those recorded by[20] that found this value as 4.65±2.35 mm. But it was higher than those reported by[3] whom recorded 3.4±1.86 mm. Mesio-lateral dimension of NPF at palatine fossa were ranged as 2.3 mm to 5.9 mm, which was acceptable normal value. Usually when NPF diameter is higher than 8 mm it means presence of lesion within the canal like nasopalatine cyst.[20] Hence knowledge about the normal value of the NPC and NPF is very important to differentiate between normal and abnormal canals.

Over all mean and SD of antero-posterior dimension of NPC in sagittal section which found in this study was 3.46±0.89 mm. This was higher than found by[16,19] whom recorded 3.21±2.3 mm and 2.78±0.85 mm respectively. This study found that the overall mean of length of the NPC was 13.14±2.83 mm. This was higher than reported by[16,19] whom reported 12.84±2.88 mm and 10.08±2.25 mm respectively.

Concerning the findings of this study there were no significant differences among different age groups concerning various measured parameters of the NPC except for the length of the canal. The differences between the finding of this paper and the previous published papers may be due to the uses of various imaging techniques, choosing different population and sample size. Also it may be due to racial difference. Dentate status of the anterior maxillary segment also affects the NPC parameters measurements. This can be illustrated by that the edentulous anterior maxillary area will increase NPC parameters measurements.

It is concluded that there were significant differences between genders regarding the length of NPC and males have greater value than females in the all age groups. This may be due to the larger cranio caudal measurements of the dentofacial complex noticed in boys when compared with girls. It is found that there is anatomical variation regarding the various dimensions of the NPC, therefore having adequate knowledge about the various NPC parameters and its contents is very important to avoid future complications especially when we plan for performing any surgical procedures like implant insertion in anterior maxillary segment. Sensation disturbances and disosseointegration may occur by contacting the implant with NPC.[3]

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REFERENCES

1. 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: 1659–62.
2. White SC, Pharoah MJ. Principles and Interpretation. 6th ed. St Louis: Mosby Co; Oral Radiology, 2009: 152–8.
3. 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: 598–603.
4. Kraut RA, Boyden DK. Location of incisive canal in relation to central incisor implants. Implant Dent. 1998; 7:221–225.
5. 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; 11:505–510.
6. Suma Jacob, PhD; BethanneZelano, BA; Anil Gungor, MD; David Abbott, MD; Robert Naclerio, MD; Martha K. McClintock, PhD. Location and Gross Morphology of the Nasopalatine Duct in Human Adult. Arch Otolaryngol Head Neck Surg. 2000; 126(6):741-748.
7. Bornstein MM, Balsiger R, Sendi P, vonArx 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.
8. P. A. Monsour and R. Dudhia, "Implant radiography and radiology," Australian Dental Journal, 2008; 53:11–25.
9. R. Jacobs, N. Mraiwa, D. van Steenberghe, G. Sanderink, and M. Quirynen, "Appearance of the mandibular incisive canal on panoramic radiographs," Surgical and Radiologic Anatomy, 2004; 26: 329–333.
10. O. Mardinger, G. Chaushu, B. Arensburg, S. Taicher, and I. Kaffe, "Anatomic and radiologic course of the mandibular incisive canal," Surgical and Radiologic Anatomy, 2000; 22:157–161.
11. Ricardo Raitz, Elisabeth Shimura, Israel Chilvarquer, and Marlene Fenyo-Pereira. Assessment of the Mandibular Incisive Canal by Panoramic Radiograph and Cone-Beam Computed Tomography. http://dx.doi.org/10.1155/2014/187085,6.
12. Shear M, Speight P. Cysts of the oral and maxillofacial regions. 4th ed. Oxford: Blackwell; 2007; 108–118.
13. Bodin I, Isacsson G, Julin P. Cysts of the nasopalatine duct. Int J Oral Maxillofac Surg, 1986; 15:696–706.
14. Lascala CA, Panella J, Marques MM. Analysis of the accuracyof linear measurements obtained by cone beam computed tomography (CBCT-New Tom). DentomaxillofacRadiol, 2004; 33:191–194.
15. Hashimoto K, Arai Y, Iwai K, Araki M, Kawashima S,Terakado M., A comparison of a new limited cone beam computedtomography machine for dental use with multi detector row helicalCT machine. Oral Surg Oral Med Oral Pathol Oral RadiolEndod, 2003; 95:371–377.
16. Zahra DaliliKajan, JavadKia, SafaMotevasseli, and SamanRokhRezaian. Evaluation of the nasopalatine canal with cone-beam computed tomography in an Iranian population. Dent Res J (Isfahan). 2015; 12(1): 14–19.
17. 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 RadiolEndod, 2009; 108:583–590.
18. Jacob S, Zelano B, Gungor A, Abbott D, Naclerio R, McClintock MK.

Location and gross morphology of the nasopalatine duct in human adults. Arch Otolaryngol Head Neck Surg. 2000; 126:741–748.

19. ArpitaRai Thakur, Krishna Burde, KruthikaGuttal,Venkatesh G. Naikmasur. sAnatomy and morphology of the nasopalatine canal using cone-beam computed tomography. Imaging Sci Dent.2013; 43(4): 273–281.
20. Mraiwa N, Jacobs R, Van Cleynenbreugel J, Sanderink G, Schutyser F, Suetens P, et al. The nasopalatine canal revisited using 2D and 3D CT imaging. DentomaxillofacRadiol, 2004; 33: 396–402.

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