Journal of Research in Medical and Dental Science
2021, Volume 9, Issue S1, Page No: 50-58

Available Online at: www.jrmds.in
eISSN No. 2347-2367: pISSN No. 2347-2545

Anatomical and Morphological Characterization of Nasopalatine Canal Using Focused Small Field of View on Cone-Beam Computed Tomography

Vikash Ranjan[1*], Soumendu Bikash Maiti[2], Pratyush Sharma[2], Vinay Kumar Mathadey[2], Tasaduq Ahmad Wani[2], Garima Sharma[2]

[1]Department of Dentistry, Oral Medicine and Radiology, Maharashtra

[2]Department of Oral Medicine and Radiology, DivyaJyoti College of Dental Sciences and Research, Modinagar

ABSTRACT

Background and Aim: Present retrospective study was performed to evaluate the general anatomy, size, shape, angulations, and curvature of the nasopalatine canal using focused small field of view On Cone-Beam Computed Tomography (CBCT) and to determine the correlation of these variability with different age groups and gender.

Materials and Methods: The retrospective study included 45 subjects aged between 14 and 79 years who further divided into the following 3 group's i.e.14-35 years, 36-57 years, 58-79years. Out of 45 subjects 30 were male and 15 were females. CBCT was performed using a standard exposure and patient positioning protocol. The data of the CBCT images were sliced in three dimensions. Image planes on the three axes (X, Y, and Z) were sequentially analyzed for the location, morphology and dimensions of the nasopalatine canal. The correlation of age and gender with all the variables was evaluated.

Results: The present retrospective study evaluated all the parameters relating NPC with respect to age and gender which showed gender wise significant differences in the length of the canal in sagittal section and did not reveal statistically significant differences in shape and size of incisive fossa in axial section, opening of Stenson's foramen in coronal section and shape, length, angulations and curvature in the sagittal section.

Conclusion: The present retrospective study highlighted importance of anatomy and morphology of the nasopalatine canal and its importance and complications for implant placement in anterior maxilla.

Key words: Nasopalatine canal, Cbct, Morphology, Anatomy

HOW TO CITE THIS ARTICLE: Ranjan V, Maiti SB, Sharma P, et al., Anatomical and Morphological Characterization of Nasopalatine Canal Using Focused Small Field of View on Cone-Beam Computed Tomography, J Res Med Dent Sci, 2021, 9(S1): 50-58.

Corresponding author: Vikash Ranjan

e-mail✉**:** drvikashomdr@rediffmail.com

Received: 02/07/2021

Accepted: 17/07/2021

INTRODUCTION

The Nasopalatine Canal (NPC), is also known as the incisive canal is a long slender passage present in the midline of the anterior maxilla that connects the palate to the floor of the nasal cavity. The canal continues in the oral cavity as a single incisive foramen posterior to the central incisor teeth and in the nasal cavity as the foramina of Stenson's. Anatomical appearances and variation of the NPC is essential prior to surgical procedures like implant placement [1].

Complications of implant rehabilitation include non-osseo integration of the implant due to contact with nervous tissue or sensory dysfunction [2]. Various studies have also shown that implants in the naso-palatine canal may be a viable treatment approach for the rehabilitation of the severely atrophied maxilla [3-5].

The nasopalatine duct cyst occurs in the nasopalatine or incisive canal, and it may be difficult to interpretate on a radiograph whether radiolucency in that area is a cyst or a large incisive foramen. Various authors reported different dimensions of radiolucency as diagnostic of the cyst. According to Shear, a radiographic shadow with antero-posterior dimensions of as much as 10 mm in the incisive fossa region may be within the normal limit. The introduction of the 3D imaging modality CBCT based planning and measurements have been advantageous for evaluating the nasopalatine canal.

AIM

The aim of present retrospective study was to determine and identify the anatomic variations, size, shape, angulations, curvature of the nasopalatine canal and any significant correlations of these variables with different age group and gender.

MATERIALS AND METHODS

Present retrospective study was carried out from the data collected from a dental diagnostic center, an

exclusive maxillofacial imaging center with details of date of birth and gender from January to April 2015. The study material included 45 CBCT images that included the entire NPC in all three planes (X, Y and Z). The CBCT had been advised for evaluation of teeth and bone in the anterior maxilla for various diagnostic purposes. The CBCT scans from the subject with nasopalatine canal pathology or impacted teeth in the region were excluded from the present study. The subjects were informed about the methods applied, and informed consent was obtained. Among the 45 subject with an age range of 14 to 79 years, 30 were males and 15 were females. Further the subject was divided into 3 age groups; first age group was from 14-35 years, second age group was from 36-57 years, third age group was from 58-79 years of age. Out of 45 subject 19 subject were from age group 14-35years in which 12 (63.2%) were male and 7 (36.8%) were females, 18 subject were from age group 36-57years in which 12 (66.7%) were male and 6 (33.3%) were female, 8 subject were from age group 58-79 years in which 6 (75.0%) were male and 2 (25.0%) were female (Table 1).

The CBCT examinations were made using a Kodak 9000 C digital imaging system (Care stream Dental LLC, Atlanta, GA, USA). The Occlusal plane was positioned horizontally to the scan plane. The mid-sagittal plane was centered. The images were obtained at 74kvp, 10mA, 10.80 sec, voxel size of 75 µm, resoluation of 75 µm, range of exposure 236 mGy.cm3 and the small Field of View (FOV) size of 5 cm × 3.75 cm. The Kodak Dental Imaging Software CS 3D imaging V3.5.7.0 (Carestream Health Inc., St. Rochester, NY, USA) was used. The data of the CBCT images were sliced in three dimensions (X, Y and Z).

The shape, medio-lateral diameter of the incisive fossa were evaluated in axial section and number of openings of Stenson's at the nasal fossa were evaluated in the coronal sections, while the shape of the canal, curvature, angle of curvature, length of the canal (antero-posterior and medio lateral) diameters were assessed in the sagittal slices. (Figure 1 and Figure 2) The data were analyzed and observed by two trained radiologist.

TABLE 1: Age GRP * sex cross tabulation.

			Sex		Total
			1	2	
Age GRP	14-35 years	Count	12	7	19
		% within Age GRP	63.20%	36.80%	100.00%
	36-57 years	Count	12	6	18
		% within Age GRP	0.667%	0.333%	1%
	58-79 years	Count	6	2	8
		% within Age GRP	0.75%	0.25%	1%
Total		Count	30	15	45
		% within Age GRP	66.70%	33.30%	100.00%

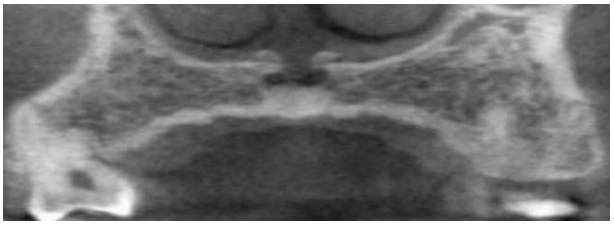

Figure 1: Coronal section shows openings of Stenson's foramina.

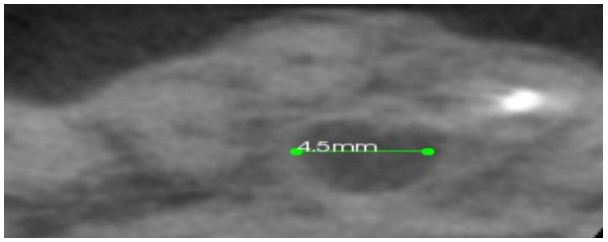

Figure 2: Axial section at the level of the incisive fossa shows the shape and medio-lateral diameter of the incisive fossa.

Statistical analysis

The data were entered into the computer database. The response of frequencies were calculated and analyzed by using statistical software Statistical Package of Social Sciences(SPSS) version 17.0 IBM, U.S. The probability value $p<0.05$ considered as significant, and $p<0.001$ were considered as highly significant and value $p>0.05$ was considered as not significant.

RESULTS

Foramina of Stenson's

Foramina of Stenson's (Number of openings) in the present retrospective study, was observed and most subjects 32 (71.1%) had 2 openings 7 (15.6%) of the subject had 3 openings, while 4 (8.9%) had four opening, and only 2 (4.4%) had 1 openings. The distribution of the number of openings at the nasal fossa by age and gender is shown in Tables 4 and 5. Maximum number of opening was observed in the age group of 14-35 years having 19 subject (42.2%) out of total 45 subject and p value was 0.901 *i.e.* more than 0.05. Two opening were observed in males 22 (73.3%) more than females having 10 (66.7%) and p value was 0.882 *i.e.* more than 0.05. so, no statistically significant differences among males and females and the different age groups with respect to the number of openings of Stenson's were observed in the present study (Table 2 and Table 3).

Incisive Foramen

In the present retrospective study out of 45 subject 28 (62.2%) having heart shape incisive foramen was observed. Maximum subject were observed in the age group of 14-35 years of age having 19 (42.2%) and out of 19 subject 10 subject (52.6%) of heart shape were observed having p value 0.588 which was greater than 0.05. Gender wise out of 45 subject 28 cases, *i.e* 62.2% (21 male, 70.0% and 7 female, 46.7%) had heart shape incisive foramen having p value 0.296 which was more than 0.05. So, no statistically significant differences among males and females and the different age groups with respect to the shape and size of incisive foramen were observed in the present study (Table 4 and Table 5).

Size of incisive fossa in axial section ranged from 2.20 mm to 7.60 mm, and the mean value for male was 3.863 mm (± 1.1306, p value 0.200), for female 3.427 mm (± 0.8964, p value 0.168). Age group wise mean value for 1st age group was 3.547 (± 0.9002) for 2nd age group 3.861(± 0.9166), and for 3rd age group 3.800 (± 1.7063). Among different gender and age groups, no statistically significant differences in the medio lateral length of the

TABLE 2: Foramina of Stenson's (number of openings)

			Number of Stenson's Foramen (NOSF)				Total
			1	2	3	4	
Age GRP	14-35 yrs	Count	1	13	2	3	19
		% within Age GRP	5.30%	68.40%	10.50%	15.80%	100.00%
	36-57 yrs	Count	1	13	3	1	18
		% within Age GRP	5.60%	72.20%	16.70%	5.60%	100.00%
	58-79 yrs	Count	0	6	2	0	8
		% within Age GRP	0.00%	75.00%	25.00%	0.00%	100.00%
Total		Count	2	32	7	4	45
		% within Age GRP	4.40%	71.10%	15.60%	8.90%	100.00%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson chi-square	3.210a	6	0.782	0.869		
Likelihood ratio	4.081	6	0.666	0.872		
Fisher's exact test	3.087			0.901		
Linear-by-linear association	.283b	1	0.595	0.668	0.357	0.102
N of valid cases	45					

a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .36.
b. The standardized statistic is -.532.

TABLE 3: Foramina of Stenson's (number of openings)

			Number of Stenson's Foramen (NOSF)				Total
			1	2	3	4	
Sex	Male	Count	1	22	4	3	30
		% within Sex	3.30%	73.30%	13.30%	10.00%	100.00%
	Female	Count	1	10	3	1	15
		% within Sex	6.70%	66.70%	20.00%	6.70%	100.00%
Total		Count	2	32	7	4	45
		% within Sex	4.40%	71.10%	15.60%	8.90%	100.00%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson chi-square	.723a	3	0.868	0.937		
Likelihood ratio	0.705	3	0.872	0.937		
Fisher's exact test	1.213			0.882		
Linear-by-linear association	.023b	1	0.879	1	0.538	0.177
N of valid cases	45					

a. 6 cells (75.0%) have expected count less than
5. The minimum expected count is .67.
b. The standardized statistic is -.152.

TABLE 4: Incisive foramen.

			Shape of Incisive Fossa (SIF)			Total
			1	2	3	
Age GRP	14-35 yrs	Count	10	3	6	19
		% within Age GRP	52.60%	15.80%	31.60%	100.00%
	36-57 yrs	Count	13	3	2	18
		% within Age GRP	72.20%	16.70%	11.10%	100.00%
	58-79 yrs	Count	5	2	1	8
		% within Age GRP	62.50%	25.00%	12.50%	100.00%
Total		Count	28	8	9	45
		% within Age GRP	62.20%	17.80%	20.00%	100.00%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson chi-square	3.070a	4	0.546	0.592		
Likelihood ratio	3.026	4	0.553	0.628		
Fisher's exact test	3.017			0.588		
Linear-by-linear association	1.347b	1	0.246	0.266	0.152	0.053
N of valid cases	45					

a. 7 cells (77.8%) have expected count less than
5. The minimum expected count is 1.42.
b. The standardized statistic is -1.161.

TABLE 5: Incisive Foramen

			Shape of Incisive Fossa (SIF)			Total
			1	2	3	
Sex	Male	Count	21	4	5	30
		% within sex	70.00%	13.30%	16.70%	100.00%
	Female	Count	7	4	4	15
		% within sex	46.70%	26.70%	26.70%	100.00%
Total		Count	28	8	9	45
		% within sex	62.20%	17.80%	20.00%	100.00%

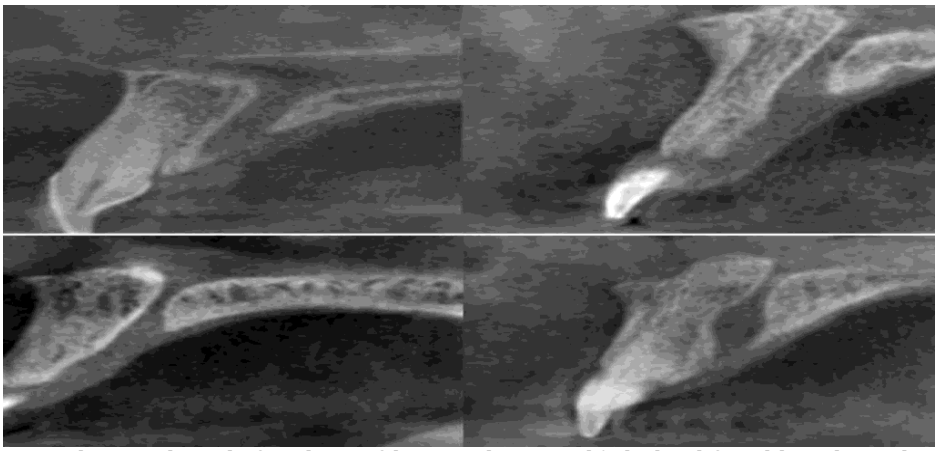

Figure 3: Sagittal section shows the four shapes of the nasopalatine canal (cylindrical, funnel, hourglass and spindle).

TABLE 6: Nasopalatine canal.

			Shape of Nasopalatine canal (SNPC)				Total
			1	2	3	4	
Age GRP	14-35 yrs	Count	8	5	3	3	19
		% within age GRP	42.10%	26.30%	15.80%	15.80%	100.00%
	36-57 yrs	Count	11	5	2	0	18
		% within age GRP	61.10%	27.80%	11.10%	0.00%	100.00%
	58-79 yrs	Count	3	3	2	0	8
		% within age GRP	37.50%	37.50%	25.00%	0.00%	100.00%
Total		Count	22	13	7	3	45
		% within age GRP	48.90%	28.90%	15.60%	6.70%	100.00%

Chi-square tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson chi-square	5.991a	6	0.424	0.45		
Likelihood ratio	6.983	6	0.322	0.446		
Fisher's exact test	5.06			0.547		
Linear-by-linear association	.814b	1	0.367	0.397	0.217	0.059
N of valid cases	45					

a. 8 cells (66.7%) have expected count less than 5. The minimum expected count is .53.
b. The standardized statistic is -.902.

incisive fossa were observed (Tables 10-13).

Nasopalatine canal

The shape and curvature of the NPC differed among cases in the sagittal view. The NPCs were thus classified into 4 categories according to their shape viewed on the sagittal sections: cylindrical, funnel, spindle and hourglass (Figure 3). The most commonly encountered shape was the cylindrical shape 22 (48.9%), and the least common was the spindle shape, seen in 3 (6.7%) subjects. Maximum cylindrical shape 11 (61.1%) was observed in age group of 36-57 years having p value 0.547. Gender wise out of 22 cylindrical shape females 8 was more common (53.3%) than male 14 (46.7%) having p value 0.235. Statistically significant differences between the genders and between the different age groups with respect to the shape of the NPC were not observed (Table 6 and Table 7).

The NPCs were further classified according to their curvature. The nasal floor was regarded as the "horizontal" plane. 10 degree from the vertical were regarded to be "slanted," and those whose course changed by 10 degree from vertical were regarded as "vertical" (Figure 4).

TABLE 7: Shape of nasopalatine canal.

			Shape of Nasopalatine Canal (SNPC)				Total
			1	2	3	4	
Sex	Male	Count	14	11	3	2	30
		% within sex	46.70%	36.70%	10.00%	6.70%	100.00%
	Female	Count	8	2	4	1	15
		% within sex	53.30%	13.30%	26.70%	6.70%	100.00%
Total		Count	22	13	7	3	45
		% within sex	48.90%	28.90%	15.60%	6.70%	100.00%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson chi-square	3.761a	3	0.288	0.296		
Likelihood ratio	3.903	3	0.272	0.371		
Fisher's exact test	3.866			0.235		
Linear-by-linear association	0.112b	1	0.738	0.869	0.428	0.123
N of valid cases	45					

a. 5 cells (62.5%) have expected count less than 5.
The minimum expected count is 1.00.
b. The standardized statistic is .335.

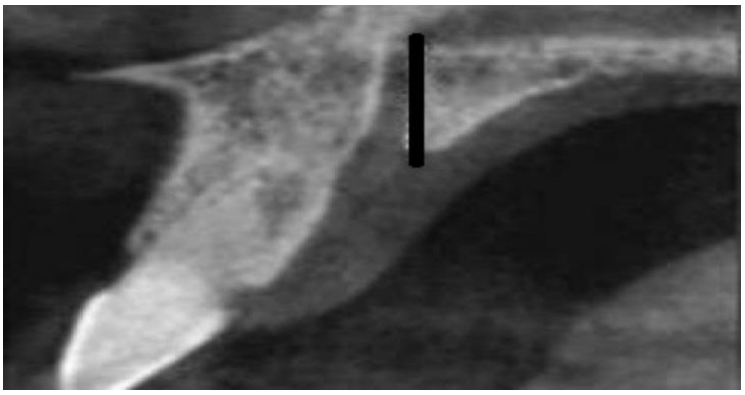

Figure 4: Sagittal section show the curvature of the nasopalatine canal (slanted, slanted-curved, vertical and vertical-curved).

TABLE 8: NPCs were further classified according to their curvature

			Curvature of Nasopalatine Canal (CNPC)				Total
			1	2	3	4	
Age GRP	1	Count	13	2	2	2	19
		% within age GRP	68.40%	10.50%	10.50%	10.50%	100.00%
	2	Count	13	1	2	2	18
		% within age GRP	72.20%	5.60%	11.10%	11.10%	100.00%
	3	Count	6	1	0	1	8
		% within age GRP	75.00%	12.50%	0.00%	12.50%	100.00%
Total		Count	32	4	4	5	45
		% within age GRP	71.10%	8.90%	8.90%	11.10%	100.00%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson chi-square	1.327a	6	0.97	0.982		
Likelihood ratio	2.046	6	0.915	0.982		
Fisher's exact test	1.871			1		
Linear-by-linear association	.073b	1	0.787	0.85	0.439	0.074
N of valid cases	45					

a. 9 cells (75.0%) have expected count less than
5. The minimum expected count is .71.
b. The standardized statistic is -.270.

Four types of NPCs based on curvature were noted: vertical, vertical-curved, slanted, and slanted curved. Most commonly, the NPC was found to be slanted 32 (71.1%), and only 4 subjects (8.9%) was found to have a slanted-curved and vertical curvature. Maximum cases 19 were observed in the age group of 14-35 yrs out of

which (68.4%) was slanted curvature. From slanted type maximum cases was observed in the age group of 14-35 and 36-57 yrs having p value 1.000. Gender wise out of 32 slanted curvature female predominant 11 (73.3%) and 21 (70.0%) males having p value 0.113. Statistically significant differences between the genders and between the different age groups with respect to the shape of the NPC were not observed (Table 8 and Table 9)

Angulations of the NPC

The slanting angle of the NPC was the angle measured between the floor of the nasal fossa and long axis of the NPC, which was considered to be the line joining the midpoint of the antero-posterior diameter at the nasal fossa level and the midpoint of the antero-posterior diameter at the level of the hard palate.

Overall, the slanting angle of the NPC ranged from 40 degree to 84 degree in reference to the "horizontal" plane. The mean angle for male was 62.63 (± 10.794, p value 0.212) and for female mean angle was 58.20 (± 11.632, p value 0.228). Age wise mean value for 1st age group was 63.00(± 10.530), 2nd age group mean value was 60.94 (± 12.859) and for 3rd age group 57.25 (± 8.242) p value between the group was 0.481. None of the subjects demonstrated negative values, which means that in all cases, the incisive foramen was located anterior to the nasopalatine foramina. Statistical analysis failed to show the correlation of the slanting angle of the NPC with age or gender (Tables 10-13).

Length of the NPC

As viewed on the sagittal plane, the length of the NPC was measured between the level of the nasal fossa and the level of the hard palate along the long axis of the canal. It ranged from 5.70 mm to 18.90 mm, and the mean value for male was 11.123 mm (± 3.4383, p value 0.041), for female 58.20 mm (± 11.632, p value 0.022). Age group wise mean value for 1st age group was 10.074 (± 2.8996) for 2nd age group 10.544 (± 2.7813), and for 3rd age group 11.513 (± 4.1474). Among different age groups, statistically significant differences in the length of the NPC were not observed. However, there was a statistically significant difference in the length of the canal between males and females were observed.

The mean antero-posterior diameter from the nasal fossa NPC as viewed in sagittal plane was 2.567 (± 1.5180, p value 0.780) for male and for female 2.447(± 0.9023, p value 0.742). Age wise distribution of mean for 1st age group was 2.579 (± 1.2921), 2nd age group was 2.439 (± .3303) and for 3rd age group 2.600 (± 1.6036), p value between the group was 0.939. The mean antero-posterior diameter from hard palate NPC as viewed in sagittal plane was 3.587 (± 1.2456, p value 0.319) for male and for female 3.200(± 1.1433, p value 0.308). Age wise distribution of mean for 1st age group was 3.279 (± 1.0283), 2nd age group was 3.472 (± 1.3314) and for 3rd age group 3.850 (± 1.4031), p value between the group was 0.546. The differences in the values between males and females and among the different age groups were not found to be statistically significant (Tables 10-13).

TABLE 9: NPCs were further classified according to their curvature

			Curvature of Nasopalatine Canal (CNPC)				Total
			1	2	3	4	
Sex	Male	Count	21	1	3	5	30
		% within sex	70.00%	3.30%	10.00%	16.70%	100.00%
	Female	Count	11	3	1	0	15
		% within sex	73.30%	20.00%	6.70%	0.00%	100.00%
Total		Count	32	4	4	5	45
		% within sex	71.10%	8.90%	8.90%	11.10%	100.00%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson chi-square	5.766a	3	0.124	0.138		
Likelihood ratio	7.105	3	0.069	0.127		
Fisher's exact test	5.194			0.113		
Linear-by-linear association	1.443b	1	0.23	0.297	0.148	0.061
N of valid cases	45					

TABLE 10: Angulations of the NPC.

	Sex	N	Mean	Std. Deviation	Std. Error Mean
Length of Incisive fossa (LIF)	Male	30	3.863	1.1306	0.2064
	Female	15	3.427	0.8964	0.2314
Length of Nasopalatine Canal Ant-Post (LNPCAP)	Male	30	11.123	3.4383	0.6277
	Female	15	9.307	1.671	0.4314
Length of Nasopalatine Canal Medio Lateral(nasal fossa) (LNPCML1)	Male	30	2.567	1.518	0.2772
	Female	15	2.447	0.9023	0.233
Length of Nasopalatine Canal Medio Lateral(hard palate) (LNPCML2)	Male	30	3.587	1.2456	0.2274
	Female	15	3.2	1.1433	0.2952
Angulation of Nasopalatine Canal (ANPC)	Male	30	62.63	10.794	1.971
	Female	15	58.2	11.632	3.003

TABLE 11: Angulations of the NPC.

		Levene'stest for equality of variances		75						
		F	Sig.	t	df	P value	Mean difference	Std. Error Difference	95% Confidence interval of the difference	
									Lower	Upper
LIF	Equal variances assumed	0.522	0.474	1.303	43	0.2	0.4367	0.3352	-0.2394	1.1127
	Equal variances not assumed			1.408	34.57	0.168	0.4367	0.3101	-0.1932	1.0665
LNPCAP	Equal variances assumed	4.122	0.049	1.928	43	0.041	1.8167	0.9424	-0.0839	3.7173
	Equal variances not assumed			2.385	42.996	0.022	1.8167	0.7617	0.2805	3.3528
LNPCML1	Equal variances assumed	5.363	0.025	0.281	43	0.78	0.12	0.4265	-0.7402	0.9802
	Equal variances not assumed			0.331	41.521	0.742	0.12	0.3621	-0.6109	0.8509
LNPCML2	Equal variances assumed	0.03	0.864	1.008	43	0.319	0.3867	0.3837	-0.3871	1.1604
	Equal variances not assumed			1.038	30.383	0.308	0.3867	0.3726	-0.374	1.1473
ANPC	Equal variances assumed	0.071	0.79	1.266	43	0.212	4.433	3.502	-2.629	11.496
	Equal variances not assumed			1.234	26.297	0.228	4.433	3.592	-2.947	11.813

TABLE 12: NPC with age or gender.

		N	Mean	Std. Deviation	Std. Error	95% Confidence interval for mean		Minimum	Maximum
						Lower bound	Upper bound		
LIF	14-35 years	19	3.547	0.9002	0.2065	3.113	3.981	1.5	5.7
	36-57 years	18	3.861	0.9166	0.216	3.405	4.317	2.7	6
	58-79 years	8	3.8	1.7063	0.6033	2.374	5.226	2.2	7.6
	Total	45	3.718	1.0684	0.1593	3.397	4.039	1.5	7.6
LNPCAP	14-35 years	19	10.074	2.8996	0.6652	8.676	11.471	6.1	18.9
	36-57 years	18	10.544	2.7813	0.6556	9.161	11.928	5.7	17.8
	58-79 years	8	11.513	4.1474	1.4663	8.045	14.98	6.4	19.1
	Total	45	10.518	3.0709	0.4578	9.595	11.44	5.7	19.1
LNPCML1	14-35 years	19	2.579	1.2921	0.2964	1.956	3.202	0.8	5.3
	36-57 years	18	2.439	1.3303	0.3135	1.777	3.1	0.7	5.8
	58-79 yrs	8	2.6	1.6036	0.5669	1.259	3.941	0.6	5.4
	Total	45	2.527	1.3346	0.1989	2.126	2.928	0.6	5.8
LNPCML2	14-35 years	19	3.279	1.0283	0.2359	2.783	3.775	1.3	4.7
	36-79 years	18	3.472	1.3314	0.3138	2.81	4.134	1	6.1
	58-79 years	8	3.85	1.4031	0.4961	2.677	5.023	2.2	5.8
	Total	45	3.458	1.2135	0.1809	3.093	3.822	1	6.1
ANPC	14-35 years	19	63	10.53	2.416	57.92	68.08	49	85
	36-57 years	18	60.94	12.859	3.031	54.55	67.34	40	84
	58-79 years	8	57.25	8.242	2.914	50.36	64.14	42	68
	Total	45	61.16	11.15	1.662	57.81	64.51	40	85

TABLE 13: NPC with age or gender.

		Sum of squares	Df	Mean square	F	Sig.
LIF	Between groups	0.976	2	0.488	0.416	0.662
	Within groups	49.25	42	1.173		
	Total	50.226	44			
	Total	39.2	44			
LNPCAP	Between groups	11.676	2	5.838	0.608	0.549
	Within groups	403.25	42	9.601		
	Total	414.926	44			
LNPCML1	Between groups	0.234	2	0.117	0.063	0.939
	Within groups	78.134	42	1.86		
	Total	78.368	44			
LNPCML2	Between groups	1.842	2	0.921	0.615	0.546
	Within groups	62.948	42	1.499		
	Total	64.79	44			
ANPC	Between groups	187.467	2	93.733	0.745	0.481
	Within groups	5282.444	42	125.772		
	Total	5469.911	44			

DISCUSSION

The retrospective study indicated that the nasopalatine canal showed a great deal of variability with regard to its dimensions as well as to its morphological appearance. The present study found one to four foramina at the level of the nasal floor. This was in accordance with the previous studies by Mraiwa et al. and Thakur et al. they also reported one to four foramina at the level of the nasal floor. However, Song et al observed only two foramina in their respective studies. This variability in results could be due to sample differences and the various imaging techniques used in different studies. The mean inner diameter of the incisive foramen in the present study was ranged from 2.20 mm to 7.60 mm, and the mean value for male was 3.863 mm (± 1.1306, p value 0.200), for female 3.427 mm (± 0.8964, p value 0.168). Age group wise mean value for 1st age group was 3.547 (± 0.9002) for 2nd age group 3.861(± 0.9166), and for 3rd age group 3.800 (± 1.7063). These values were lower than those reported in the study by Mraiwa et al. [6] (4.6 mm) but comparable to those reported by Liang et al. [2] (3.4 mm). In the present study out of 45 subject 28 (62.2%) having heart shape incisive foramen was observed which was in accordance with Thakur et al.

Previous studies have reported that a cylindrically shaped NPC was most commonly observed [5,6]. In accordance with this, in our study, the cylindrical shape was found in most of the subjects. In contrast to Song et al who reported the predominance of the vertical type of NPC in their study, in present study, slanted canals were more commonly observed than vertical ones. Liang et al have previously reported the mean angulation of the NPC from the horizontal as 77.4 degree (± 8.9). In present study the slanting angle of the NPC ranged from 40 degree to 84 degree in reference to the "horizontal" plane. The mean angle for male was 62.63 (± 10.794, p value 0.212) and for female mean angle was 58.20 (± 11.632, p value 0.228). Age wise mean value for 1st age group was 63.00(± 10.530), 2nd age group mean value was 60.94 (± 12.859) and for 3rd age group 57.25 (± 8.242) p value between the group was 0.481. Song et al have reported the length of the NPC to be 12.0 mm (8.4-15.8 mm) in maxilla, Mraiwa et al. have reported a mean length of 8.1 (±3.4) mm, and Liang et al. [2] in their study assessed the length of the NPC as 9.9 (± 2.6) mm. In the present study, the mean length of the NPC was found to be 10.08 mm (± 2.25). It ranged from 5.70 mm to 18.90 mm, and the mean value for male was 11.123 mm (± 3.4383, p value 0.041), for female 58.20 mm (± 11.632, p value 0.022). Age group wise mean value for 1st age group was 10.074 (± 2.8996) for 2nd age group 10.544 (± 2.7813), and for 3rd age group 11.513 (± 4.1474). Among different age groups, statistically significant differences in the length of the NPC were not observed. However, there was a statistically significant difference in the length of the canal between males and females were observed [7].

The mean antero-posterior diameter from the nasal fossa NPC as viewed in sagittal plane was 2.567 (± 1.5180, p value 0.780) for male and for female 2.447(± 0.9023, p value 0.742). Age wise distribution of mean for 1st age group was 2.579(± 1.2921), 2nd age group was 2.439 (± 1.3303) and for 3rd age group 2.600 (± 1.6036), p value between the group was 0.939. The mean antero-posterior diameter from hard palate NPC as viewed in sagittal plane was 3.587(± 1.2456, p value 0.319) for male and for female 3.200(± 1.1433, p value 0.308). Age wise distribution of mean for 1st age group was 3.279 (± 1.0283), 2nd age group was 3.472 (± 1.3314) and for 3rd age group 3.850 (± 1.4031), p value between the group was 0.546. In this study, statistically significant differences in the assessed parameters could not be observed among the different age groups and gender [8]. This could be attributed to the population chosen for this study. The greater length of the NPC in the males could be ascribed to the relatively larger cranio-caudal dimension of the face observed in the males as compared to the females. Similar findings have been previously reported by Liang et al.

CONCLUSION

In conclusion, this retrospective study highlighted the anatomic variability of several parameters such as general anatomy, size of incisive fossa, shape of incisive fossa, Number of opening of Stenson's, size, shape, angulations, curvature of nasopalatine canal in single study and their correlation with different age group and sex of the subjects. Study also emphasizing the role of CBCT imaging and assessment of this anatomical landmark in treatment planning of this area for implant placement or assessment of pathologies in this region. The shape, curvature, and angulations of the canal and its antero-posterior dimensions are the most significant parameters for placement of implants in the maxillary incisor region. Additionally, the number of openings, medio-lateral dimensions, length of the canal, and level of its division may prove important when implants within the nasopalatine canal are being considered.

REFERENCE

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(9): 1659-62.
2. 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.
3. Kraut RA, Boyden DK. Location of incisive canal in relation to central incisor implants. Implant Dent 1998; 7(3): 221-225.
4. Cavalcanti MG, Yang J, Ruprecht A, Vannier MW. Accurate linear measurements in the anterior maxilla using orthoradially reformatted spiral computed tomography. Dentomaxillofac Radiol 1999; 28(3): 137-140.
5. Shear M, Speight P. Cysts of the oral and maxillofacial regions. (4th ed.). Oxford: Blackwell; 2007. p. 108-18.
6. 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. Dentomaxillofac Radiol 2004; 33(6): 396-402.

7. Thakur RA, Burde K, Guttal K, Naikmasur GV. Anatomy and morphology of the nasopalatine canal using cone-beam computed tomography. Imaging Sci Dent. 2013; 43(4): 273-281.
8. 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.