Original Article

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Morphometric Evaluation of Nasolacrimal Canal in Indian Ethinics: A Cone Beam Computed Tomography Study

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Abstract

Objective: This study aims at age and sex related changes in mediolateral diameter,antero-posterior diameter and length of nasolacrimal duct. The mathmetical equations derived from linear regression analysis on the basis of mediolateral diameter,antero-posterior diameter and length of nasolacrimal duct is used in determination of age of study subjects however sex of study subjects can be predicted on the basis of length of nasolacrimal duct by discriminant function analysis using Fischer's exact test. *Material and Methods:* The CBCT images of 216 study subjects were analysed prospectively. All the CBCT images are obtained at 90 Kvp,4 mA for 11.3 seconds at FOV(17"x13.5") voxel size of 300. The mediolateral diameter, antero-posterior diameter and length of nasolacrimal duct are measured by using Trophy Dicom Ink software programme on axial and mid-sagittal images (DICOM images). *Results:* The study population consists of 216 study subjects aged between 10 and 84 years with a mean age of 34.28±17.357 years.The t test showed that the length of nasolacrimal duct is statistically significantly ($p<0.001$). The mean of length of nasolacrimal duct is slightly higher in males than females. The mean of length of nasolacrimal duct is slightly higher in males than females. The mediolateral diameter, length of nasolacrimal duct, antero-posterior diameter were not significant ($p>0.05$) in the age groups. *Conclusion:* The age and sex issues in medico-legal cases and forensic anthropology can be resolved by measurements of nasopalatine duct.

Keywords: Nasopalatine Duct; Cone Beam Computed Tomography; Maxilla.

Introduction

The nasopalatine canal (NPC) also known as the incisive canal or anterior palatine 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, which are usually two in number. Through each of them passes the terminal branch of the descending palatine artery and the nasopalatine nerve, to communicate with the posterior septal branch of the spheno-palatine artery and greater palatine nerve, respectively. Thorough knowledge of the anatomical appearances and variation of the NPC is essential prior to surgical procedures like implant placement and local anesthesia in the anterior maxilla. Difficulties and anatomic limitations regarding the location of the nasopalatine canal in relation to the maxillary central incisor implants have been reported [1].

The nasopalatine canal commences towards the front of the floor of each nasal cavity. Each canal opens into the midline incisive foramen on the median plane of the palatine process of the maxilla, posterior to the central incisors and transmits nasopalatine vessels and nerves, branches of the maxillary division of the trigeminal nerve and the maxillary artery. The nasopalatine canal exists of one, two or multiple canals [2,3].

The maxillary incisive canal (IC) is a Y-shaped passage that is between 4 and 26mm in length, depending on the surrounding maxillary bone height [2,4]. It develops from the fusion of the right and left IC respectively with the anterior palatine

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canal to form the common IC [5]. It is located about 12–15 mm from the anterior nasal spine, usually closer to the nasal septum [4]. It connects the roof of the oral cavity with the floor of nasal cavity [5]. The IF and the incisive fossa form the inferior part of this canal while superiorly, the nasal septum in the nasal floor divides the opening into 2 foramina, namely the nasopalatine foramen or the foramen of Stensen [6,7]. Two accessory minor openings, termed the foramina of Scarpa are sometimes seen. These additional canals may also transmit the nasopalatine nerve [2]. Nasal foramen (NF) is the collective term that is usually used to describe the nasal openings located on the nasal floor. In addition to nerve bundles, the naso-(spheno) palatine artery also shares a course along this canal to supply the oral cavity [5]. The maximum width and standard deviation of the NF was reported to be 4.9 (1.2) mm.[2]

Anatomy of the NPC. The paired NPC is localized in the anterior maxilla, close behind the central incisors [8]. The NPC forms a tube connecting soft tissues of the nasal and oral cavities [9,10]. The oral aperture of the NPC lies in the anterior palatine bone, just dorsal to the roots of the upper central incisors [10]. The funnel-shaped opening to the oral cavity is defined as the incisive foramen or fossa [8]. Inside the bone, the NPC divides in the cranial course into two tubes that run separately to the nasal aperture, termed nasal foramina [11-14]. The NPC contains fibrillary connective and adipose tissues [13], minor salivary glands [15,16], and the nasopalatine nerve and artery [17,18]. During its osseous passage, the artery maintains anastomoses with the major palatine artery [19]. Occasionally, two additional small channels are found in the incisive bone medial to the NPC (canals of Scarpa). These channels carry further nerve filaments of the nasopalatine nerve, terminating in the incisive foramen as Scarpa's foramina. In the oral cavity, the left supplementary channel opens anteriorly and the right posteriorly to the oral opening of the NPC [10,20].

Materials and Methods

This study was an observational study in which CBCT images of Head of 216 subjects aged between 10 and 84 years were chosen. The CBCT images of subjects having no history of trauma, pathology diagnosed as normal have been included in study. Any CBCT with obvious pathology, trauma and facial asymmetry were excluded from this study. All the patients were examined on CS9300 carestream CBCT machine. The axial and mid-sagittal images were obtained at 90 Kvp,4 mA for 11.3 seconds at FOV(17"x13.5")voxel size of 300. . Linear measurements of nasopalatine duct in the mid-sagittal plane and axial planes were done by using Trophy Dicom Ink software programme. All the measurements are done in millimeters. The medio-lateral diameter of the incisive fossa and foramen of Stenson and the number of openings at the nasal fossa were evaluated in the axial sections while the shape of the canal, curvature of the canal, angle of curvature, length of the canal and antero-posterior diameters were assessed in the sagittal slices (Figure 1,2,3,4).

Statistical Analysis

Categorical variables will be presented in number and percentage (%) and continuous variables will be presented as mean and SD. Qualitative variables will be compared using Chi-Square test/Fisher's exact test as appropriate. Quantitative variables will be compared using Unpaired t-test between two groups and ANOVA between three groups. The data were analyzed by the discriminant function analysis using Fischer exact test. Pearson correlation coefficients were used to determine the relationship between two scale parameters. A p value of <0.05 will be considered statistically significant. The data will be entered in MS EXCEL spreadsheet and analysis will be done using Statistical Package for Social Sciences (SPSS) version 21.0.

Results

The study population consists of 216 study subjects aged between 10 and 84 years with a mean age of 34.28±17.357 years (Table 1). Majority of the study subjects were between 18 to 35 years of age (Table 2). The sex ratio in our study population showed that male proportion was higher than female i.e. 65.7 % and 34.3% respectively (Table 3). The study parameters i.e mediolateral diameter, length of nasolacrimal duct, antero-posterior diameter (canine Fossa, at mid level and palatal) characteristics of males and females are summarised in Table 5. Comparing the mean of clinical characteristics of two groups (males and females), t test showed that the length of nasolacrimal duct is statistically significantly ($p<0.001$). The mean of length of nasolacrimal duct is slightly higher in males than females. However, rest of study parameters were not differed ($p>0.05$) between the males and females i.e. found to be

Table 1: Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Age	216	74	10	84	34.28	17.357

Table 2:

Sex	N	%
Male	142	65.7
Female	74	34.3
Total	216	100.0

Table 3:

Age intervals	N	%
Below 18 years	34	15.7
18 to 35 years	106	49.1
36 to 50 years	30	13.9
51 to 65 years	32	14.8
More than 65 years	14	6.5
Total	216	100.0

Table 4: Group Statistics

	Sex	N	Mean	Std. Deviation	P value
Mediolateral diameter	Male	142	3.837	1.1848	0.738
	Female	74	3.782	1.0560	
Length of nasolacrimal duct	Male	142	11.662	2.4287	0.001
	Female	74	10.573	2.1787	
AP Canine Fossa	Male	142	4.557	5.4021	0.538
	Female	74	4.128	3.5371	
AP Mid level	Male	142	2.837	2.5241	0.668
	Female	74	2.705	1.0616	
AP Palatal	Male	142	4.632	7.9576	0.223
	Female	74	3.518	1.7014	

Table 5:

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		P value
						Lower Bound	Upper Bound	
Mediolateral diameter	Below 18 years	34	3.571	1.0356	.1776	3.209	3.932	
	18 to 35 years	106	3.791	1.3331	.1295	3.534	4.047	
	36 to 50 years	30	3.710	.7993	.1459	3.412	4.008	.226
	51 to 65 years	32	4.097	.9400	.1662	3.758	4.436	
	More than 65 years	14	4.229	.5690	.1521	3.900	4.557	
	Total	216	3.819	1.1401	.0776	3.666	3.971	
length of nasolacrimal duct	Below 18 years	34	11.291	2.2723	.3897	10.498	12.084	
	18 to 35 years	106	11.324	2.3910	.2322	10.863	11.784	
	36 to 50 years	30	10.567	2.2905	.4182	9.711	11.422	0.208
	51 to 65 years	32	12.003	2.4730	.4372	11.112	12.895	
	More than 65 years	14	10.936	2.6270	.7021	9.419	12.452	
	Total	216	11.289	2.3976	.1631	10.967	11.610	
AP Canine Fossa	Below 18 years	34	4.838	8.9005	1.5264	1.733	7.944	
	18 to 35 years	106	4.315	4.7079	.4573	3.408	5.222	
	36 to 50 years	30	4.150	1.0126	.1849	3.772	4.528	.946
	51 to 65 years	32	4.203	1.0353	.1830	3.830	4.576	
	More than 65 years	14	5.121	1.0678	.2854	4.505	5.738	
	Total	216	4.410	4.8402	.3293	3.761	5.059	
AP Mid level	Below 18 years	34	2.682	1.1730	.2012	2.273	3.092	
	18 to 35 years	106	2.579	1.0365	.1007	2.380	2.779	
	36 to 50 years	30	2.860	1.0849	.1981	2.455	3.265	0.376
	51 to 65 years	32	3.428	4.9316	.8718	1.650	5.206	
	More than 65 years	14	3.071	1.1006	.2942	2.436	3.707	
	Total	216	2.792	2.1365	.1454	2.506	3.079	
AP Palatal	Below 18 years	34	6.865	15.8673	2.7212	1.328	12.401	
	18 to 35 years	106	3.697	1.8754	.1822	3.336	4.058	
	36 to 50 years	30	4.463	1.8341	.3349	3.778	5.148	0.133
	51 to 65 years	32	3.681	1.7578	.3107	3.047	4.315	
	More than 65 years	14	2.929	1.4725	.3936	2.078	3.779	
	Total	216	4.250	6.5415	.4451	3.373	5.127	

statistically the same. The mediolateral diameter, length of nasolacrimal duct, antero-posterior diameter(canine fossa , at mid level and at palatal level are compared in age groups shows that study parameters were not differed (p>0.05) between the age groups i.e. found to be statistically the same (Table 5).

The pearsons correlation coefficient (r) between age and study parameters shows no significant correlation between age with length of nasolacrimal duct, antero-posterior diameter at canine fossa level and antero-posterior diameter at palatal level. However mediolateral diameter and antero-posterior diameter at mid level were directly associated with age and demonstrate a significant positive relation (r=0.166, p=0.015) in mediolateral diameter, significant positive relation (r=.147*, p=030) in antero-posterior diameter at mid level (Table 6). The equations derived by linear regression analysis is used in determination of age of an individual if any of study parameters is known (Table 7). The mean comparison of parameters according to their gender using discriminant function analysis using Fisher exact test was done.Higher mean were observed in mediolateral diameter and length of nasolacrimal duct of males in compariosion of females however statistically significant difference were observed in length of nasolacrimal duct (P<0.05) (Table 8). The sex could be determined from calculations using the equations given below(Table 9).

D of Male

22.076+ 3.837 (Mediolateral diameter) + 2.451 (length of nasolacrimal duct)

D of Females

19.964+ 3.719 (Mediolateral diameter) + 2.243 (length of nasolacrimal duct)

Sex was accurately determined in 139 cases out of 142 male with prediction accuracy rate of 97.9% in male population however in female population sex was accurately determined in 5 cases out of 74 female with an accuracy rate of 6.8% (Table 10).

Table 6:

		Age	Mediolateral diameter	Correlations length of nasolacrimal duct	AP diameter at Canine Fossa level	AP diameter at AP Mid level	AP diameter at Palatal level
Age	Pearson Correlation	1	.166*	-.005	.017	.147*	-.087
	Sig. (2-tailed)		.015	.938	.801	.030	.201
	N	216	216	216	216	216	216

*. Correlation is significant at the 0.05 level (2-tailed).

Table 7: Pearson correlation with Age of patients

	Pearson correlation coefficients (r)	P value	Linear Regression analysis equations
Mediolateral diameter	.166*	.015	Age =24.653+2.521*(Mediolateral diameter)
Length of nasolacrimal duct	-.005	.938	Age =34.715+(-.039)*(length of nasolacrimal duct)
Antero-posterior diameter at canine fossa level	.017	.801	Age =34.006+(.062)*(AP diameter Canine Fossa)
Antero-posterior diameter at at mid level	.147*	.030	Age =30.933+(1.198)*(AP diameter Mid level)
Antero-posterior diameter at palatal level	-.087	.201	Age =35.262+(-.232)*(AP diameter Palatal)

**. Correlation is significant at the 0.05 level (2-tailed)

Table 8:

	Male		Female		F value	P value
	Mean	Std. Deviation	Mean	Std. Deviation		
Mediolateral diameter	3.837	1.1848	3.782	1.0560	.112	.738
length of nasolacrimal duct	11.662	2.4287	10.573	2.1787	10.479	.001*

Table 9: Classification Function Coefficients

	Sex	
	Male	**Female**
Mediolateral diameter	3.837	3.719
length of nasolacrimal duct	2.451	2.243
(Constant)	-22.076	-19.964
Fisher's linear discriminant functions		

Table 10:

		Sex	**Predicted Group Membership**		**Total**
			Male	**Female**	
Original	Count	Male	139	3	142
		Female	69	5	74
	%	Male	97.9	2.1	100.0
		Female	93.2	6.8	100.0

a. 66.7% of original grouped cases correctly classified

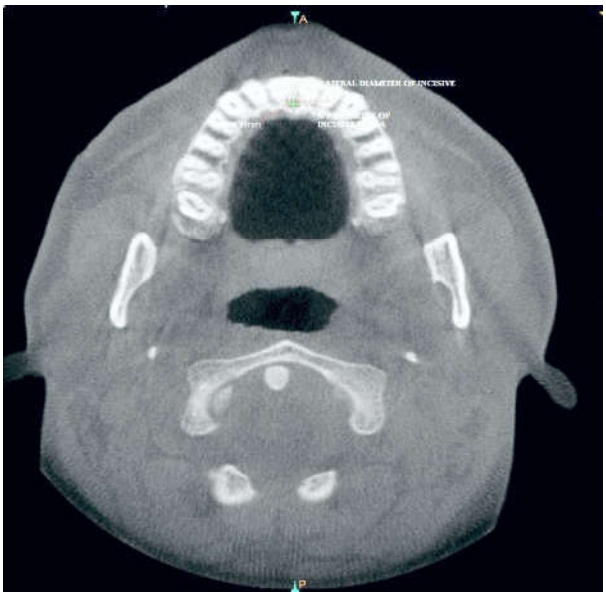


Fig. 1: Axial section (CBCT) showing mediolateral diameter of nasopalatine fossa in male subject.

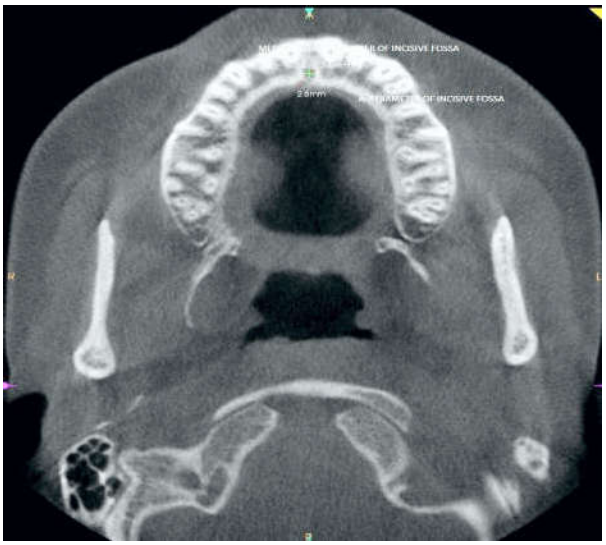


Fig. 2: Axial section (CBCT) showing mediolateral diameter of nasopalatine fossa in female subject

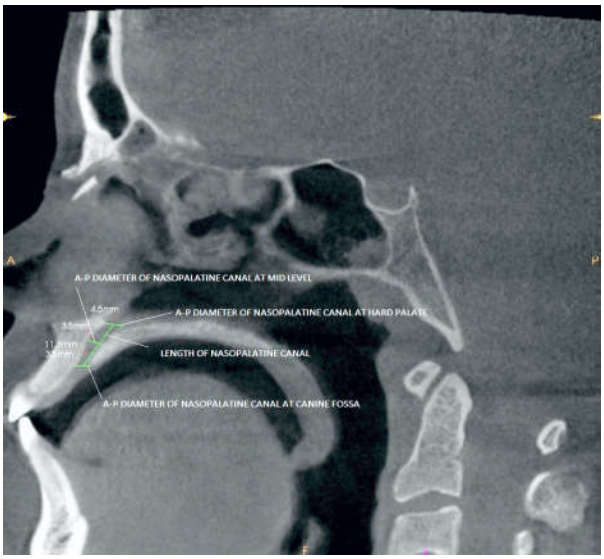


Fig. 3: Sagittal section (CBCT) showing length of nasopalatine duct and anteroposterior diameter at 3 levels(Hard palate level, mid-level, Canine fossa level) in male subject.

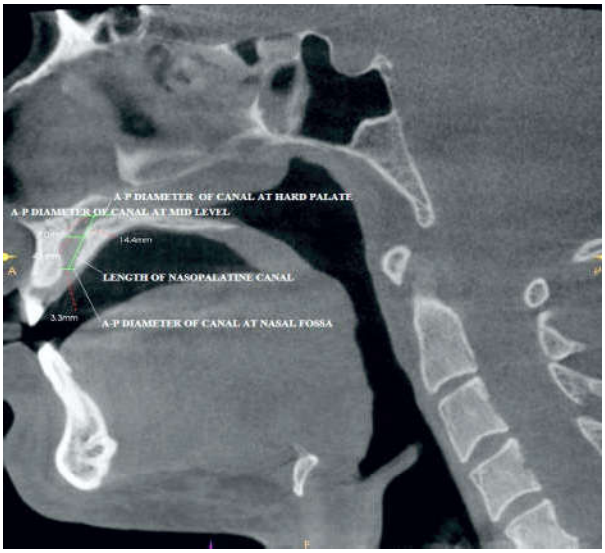
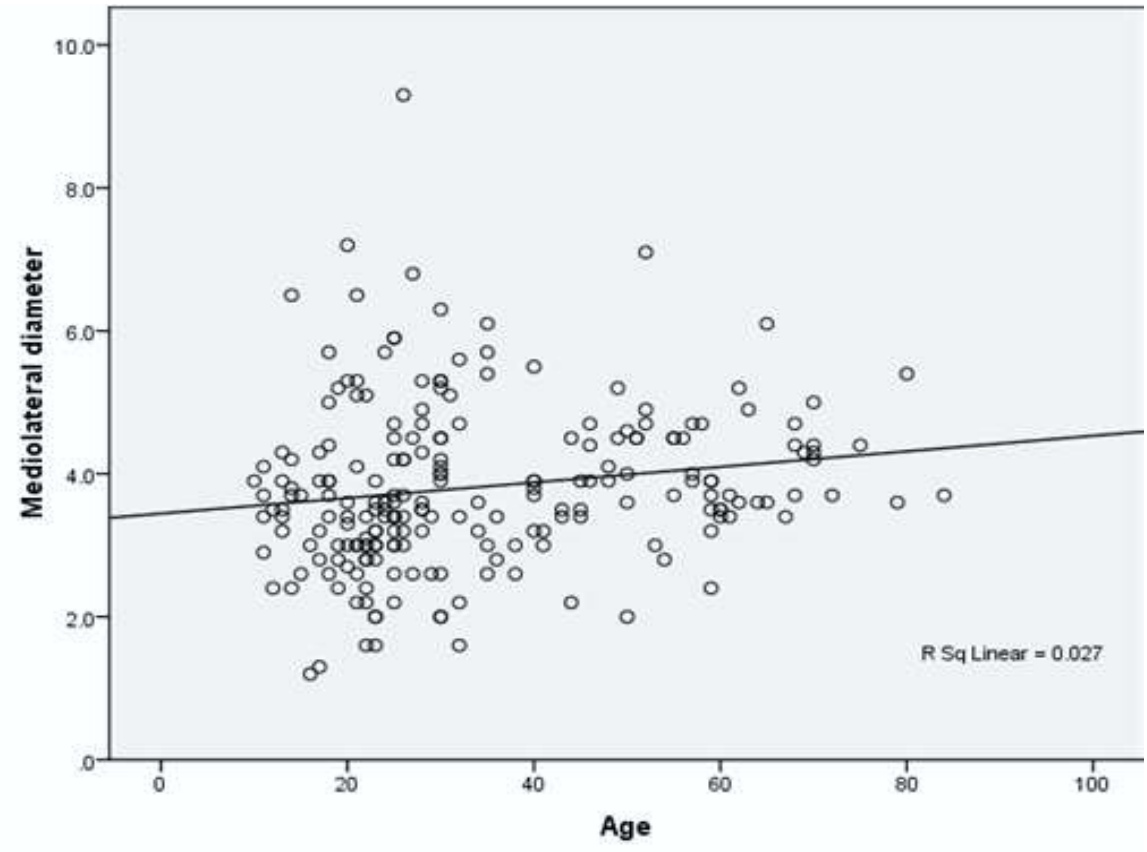
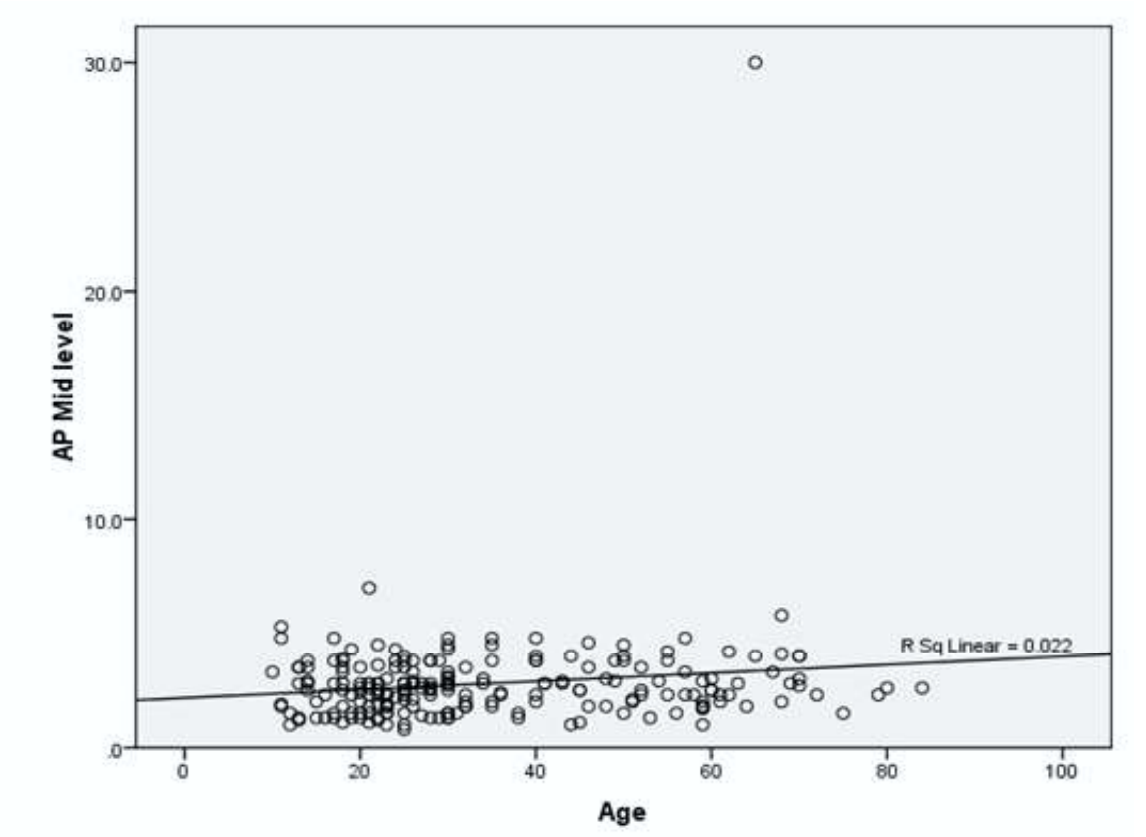


Fig. 4: Sagittal section (CBCT) showing length of nasopalatine duct and anteroposterior diameter at 3 levels (Hard palate level, mid-level, Canine fossa level) in female subject.



Graph 1



Graph 2

Discussion

Several previous reports have dealt with the pathology of the nasopalatine canal region. The anatomical variations in the dimensions and morphology of this canal remain poorly documented. The present study indicated that the nasopalatine canal showed a great deal of variability with regard to its dimensions as well as to its morphological appearance.

Thakur A et al [21] stated that the mean inner diameter of the incisive foramen was 3.61 (±0.94). These values were lower than those reported in the previous study by Mraiwa et al [22](4.6 mm) but comparable to those reported by Liang et al [23] (3.4 mm). He also stated that the diameter of the incisive fossa ranged from 1.40 mm to 5.90 mm. Mraiwa et al [22] also stated the diameter of the incisive foramen is usually considered to be below 6 mm; when it exceeds 10 mm,pathological conditions should be considered.

Song et al [24] have reported the length of the NPC to be 12.0 mm (8.4-15.8 mm) in dentulous maxillae, Mraiwa et al [22] have reported a mean length of 8.1 (±3.4) mm, and Liang et al [3] in their study assessed the length of the NPC as 9.9 (±2.6) mm.Thakur et al [1] had reported that the mean length of the NPC was found to be 10.08 mm (±2.25).

Liang et al [23] stated that there were some dimensional variabilities related to the samples' age, gender and dental status. The canal diameter enlarged with age. But as the number of edentulous cases was also significantly increased by age, the enlarged diameter might also be caused by edentulism and bone resorption, even if there was no obvious significant difference on the canal diameter between the dentate and the edentulous group. The latter is confirmed by Mardinger et al [25] who detected a significant enlargement of the nasopalatine canal diameter by tooth loss.

Iordanishvili et al [26] found evidence of age- and gender-linked differences in the mean length of the nasopalatine canal using craniometric investigation on human skulls.

Guler et al [27] reported that men had significantly bigger canals by measuring on panoramic radiographs.S M Al -Amery et al [28] stated that the mean labiopalatal and mesiodistal widths of the IF were 2.80mm and 3.49mm respectively. This was close to the average of 2.90mm reported for the Caucasians/Arabs population conducted by T.F Tozum et al [29] and 3.49mm for the Korean population that was conducted by GT Kim et al [30] on the same parameters measured. However, it was lower than the 3.8mm size for labiopalatal width and 3.7mm for mesiodistal width reported for the Japanese population that was conducted by R Asaumi et al [31]. Bornstein et al [32] and Güncü et al [33] reported that male had significantly larger mean canal diameter as compared to female.

Where as in our study we compare the mean of clinical characteristics of two groups (Males and Females), t test showed that the length of nasolacrimal duct is statistically significantly ($p<0.001$). The mean of length of nasolacrimal duct is slightly higher in males than females. However, rest of study parameters were not differed ($p>0.05$) between the males and females i.e. found to be statistically the same. The mediolateral diameter, length of nasolacrimal duct, Antero-posterior diameter (canine fossa, at mid level and at palatal level are compared in age groups shows that study parameters were not differed ($p>0.05$) between the age groups i.e. found to be statistically the same.

We found that there was no significant correlation between age with length of nasolacrimal duct, antero-posterior diameter at canine fossa level and antero-posterior diameter at palatal level. However mediolateral diameter and antero-posterior diameter at mid level were directly associated with age and demonstrate a significant positive relation ($r=0.166$, $p=0.015$) in mediolateral diameter, significant positive relation ($r=.147^{*}$, $p=030$) in antero-posterior diameter at mid level.

We derived the equations by using linear regression analysis that was used in determination of age of an individual if any of study parameters is known.

We observed the higher mean in mediolateral diameter and length of nasolacrimal duct of males as compare to females however statistically significant difference were observed in length of nasolacrimal duct ($P<0.05$). We also stated that sex was accurately determined in 139 cases out of 142 male with prediction accuracy rate of 97.9% in male population however in female populationsex was accurately determined in 5 cases out of 74 female with an accuracy rate of 6.8%.

Conclusion

The Nasopalatine duct is a good dimorphic tool to assess the age and sex of an individual in forensic anthropology and medicolegal cases having dispute of identification and age.

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: 659-62.
2. Mraiwa, N., Jacobs, R., Van Cleynenbreugel, J., Sanderink, G., Schutyser, F., Suetens, P., van Steenberghe, D. & Quirynen, M. The nasopalatine canal revisited using 2D and 3D CT imaging. Dentomaxillofacial Radiology 2004; 33:396–402.
3. White, S.C. & Pharoah, M.G. Oral Radiography Principles and Interpretation, 5th edition. St. Louis: C.V. Mosby Company, 2004.p.174.
4. Scortecci GM. The completely edentulous maxilla. In: Scortecci G.M., Misch C.E., Benner K.U. & Benner K.U. eds. Implants and Restorative Dentistry. London: Martin Dunitz. 2001.p.265–310.
5. Ennis LM, Berry HM, Phillips JE. Normal anatomical landmarks. Dental Roentgenology. Philadelphia: Lea & Febiger: 1967.p.334–345. pmid: 5587837.
6. Jacobs R, Lambrichts I, Liang X, Martens W, Mraiwa N, 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; 103:683–693. pmid:17320428.
7. Standring S, Ellis H, Healy J, Jhonson D, Williams A, et al. Gray's anatomy: the anatomical basis of clinical practice. Edinburgh: Churchill Livingstone. 2005.p.538–584. pmid:2527521.
8. von Lanz T and Wachsmuth W: Praktische Anatomie. Vol. 1. Springer, Berlin-Heidelberg-New York, 1985.p.186-188.
9. Knecht M, Kittner T, Beleites T, Hüttenbrink KB, Hummel T and Witt M: Morphological and radiologic evaluation of the human nasopalatine duct. Ann Otol Rhinol Laryngol 2005; 114:229-232.
10. Jacobs R, Lambrichts I, Liang X, Martens W, Mraiwa N, Adriaensens P and Gelan J: Neurovascularization of the anterior jaw bones revisited using high-resolution magnetic resonance imaging. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007; 103: 683-693.
11. Abrams AM, Howell FV and Bullock WK: Nasopalatine cysts. Oral Surg 1963; 16:306-332.
12. Krüger E: Lehrbuch der chirurgischen Zahn-, Mund- und Kieferheilkunde. Quintessenz, Berlin, 1988; 1:132.
13. Meyer W: Die Zahn-, Mund- und Kieferheilkunde, Histologie der Mundhöhle. Urban, München, 1958.p.247.
14. Pasler FA and Visser H. Taschenatlas der Zahna¨rztlichen Radiologie, Thieme, Stuttgart, 2003.p.72.
15. Keith DA: Phenomenon of mucous retention in the incisive canal. J Oral Surg 1979; 37:832-834.
16. Noyes HJ: Nasopalatine duct and Jacobson's organ in newborn infants. J Dent Res 1935; 15:155.
17. Hill WC and Darlow HM: Bilateral perforate nasopalatine communication. J Laryngol 1945; 60: 160-165.
18. Sieglbauer F: Lehrbuch der normalen Anatomie des Menschen. Urban, München, 1963.
19. Schumacher GH: Anatomie für Zahnmediziner, Lehrbuch und Atlas. Third Edition, Hüthig, Heidelberg, 1997.p.524.
20. Bornstein MM, Balsiger R, Sendi P and von Arx T: Morphology of the nasopalatine canal and dental implant surgery. A radiographic analysis of 100 consecutive patients using limited. Clin Oral Implants Res 22: 295–301
21. Thakur, A. R., Burde, K., Guttal, K., & Naikmasur, V.G. Anatomy and morphology of the nasopalatine canal using cone-beam computed tomography. Imaging Science in Dentistry, 2013; 43(4):273–281.
22. 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; 33:396-402.
23. 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.
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; 108:583-90.
25. 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. Journal of Periodontology 2008; 79:1659–1662.
26. Iordanishvili, A.K. Age-related characteristics and sex differences in the anatomical structure of the incisive canal. Stomatologiia 1991; 71:25–27.
27. Guler, A. U., Sumer, M., Sumer, P. & Bic¸er, I. The evaluation of vertical heights of maxillary and mandibular bones and the location of anatomic landmarks in panoramic radiographs of edentulous patients for implant dentistry. Journal of Oral Rehabilitation 2005; 32:741–746.
28. Al-Amery, S. M., Nambiar, P., Jamaludin, M., John, J., & Ngeow, W.C. 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). https://doi.org/10.1371/journal.pone. 0117251.

29. Tözüm TF, Güncü GN, Yildirim YD, Yilmaz HG, GalindoMoreno P, et al. Evaluation of maxillary incisive canal characteristics related to dental implant treatment with computerized tomography: a clinical multicenter study. J Periodontol 2012; 83:337–343. doi: 10.1902/jop.2011. 110326. pmid:21910596.
30. Kim GT, Hwang EH, Lee SR. A study of incisive canal using a cone beam computed tomography. Korean J Oral Maxillofac Radiol 2004; 34:7–12.
31. Asaumi R, Kawai T, Sato I, Yoshida S, Yosue T. Threedimensional observations of the incisive canal and the surrounding bone using conebeam computed tomography. Oral Radiology 2010; 26:20–28.
32. 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.
33. Güncü GN, Yýldýrým YD, Yýlmaz HG, GalindoMoreno P, Velasco Torres M, et al. (2013) Is there a gender difference in anatomic features of incisive canal and maxillary environmental bone? Clin Oral Implants Res 2013; 24:1023-1026.