

## Morphometric Evaluation of Nasolacrimal Canal in Paediatric Population of North India: A CBCT Study

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### Abstract

*Objective:* This study aims at age and sex related changes in mediolateral diameter of nasolacrimal duct. The mathematical equations derived from linear regression analysis on the basis of mediolateral diameter of nasolacrimal duct is used in determination of age of study subjects however sex of study subjects can be predicted on the basis of mediolateral dimension of nasolacrimal duct by discriminant function analysis using Fischer's exact test. *Material and Methods:* The CBCT images of 154 pediatric subjects were analysed prospectively. All the CBCT images are obtained at 90 Kvp, 4 mA for 11.3 seconds at FOV (17"×13.5") voxel size of 300. The mediolateral diameter of nasolacrimal duct are measured by using Trophy Dicom Ink software programme on axial images (DICOM images). *Results:* The study population consists of 154 pediatric subjects aged between 6 and 17 years with a mean age of 12.38±3.07 years. The mediolateral dimensions in male and female was statistically not significant ( $P > .05$ ). The mean mediolateral dimension was statistically not significant ( $P > .05$ ) in age groups. M/L diameter of nasopalatine duct is directly associated with age and demonstrate a significant positive relation. *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.

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### Introduction

The nasopalatine canal 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 sphenopalatine 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 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

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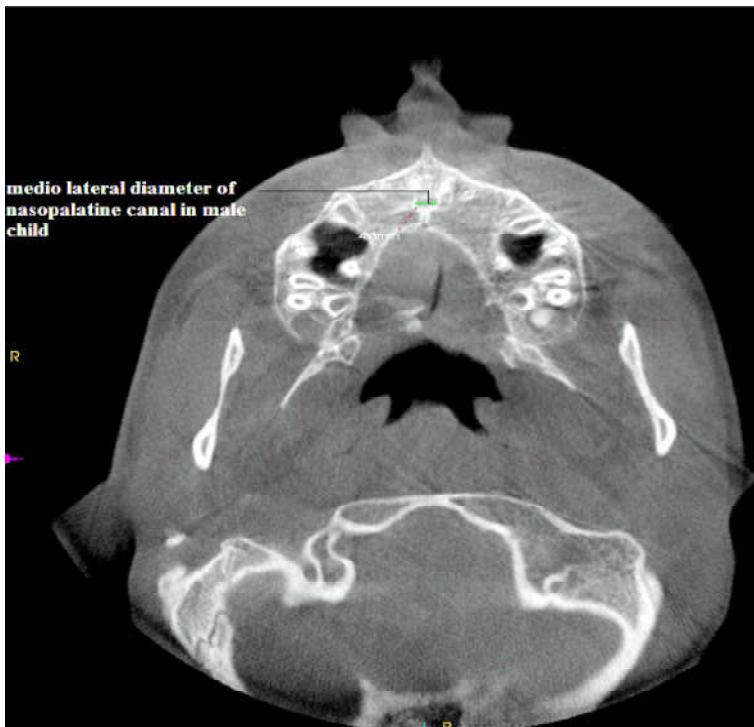
fossa form the inferior part of this canal while superiorly, the nasal septum in the nasal floor divides the opening into 2 foramina, namely the nasopalatine foramen or the foramen of Stensen [6,7]. Two accessory minor openings, termed the foramina of Scarpa are sometimes seen. These additional canals 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.<sup>2</sup>

**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 154 paediatric subjects aged between 6 and 17 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 antero-posterior diameter and length of nasolacrimal duct cannot be appreciated in coronal section of CBCT in paediatric population due to developmental aberrations however the mediolateral diameter in all paediatric subjects were clearly appreciated in axial sections of CBCT. So only mediolateral dimension is studied in paediatric population. The axial 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 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



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

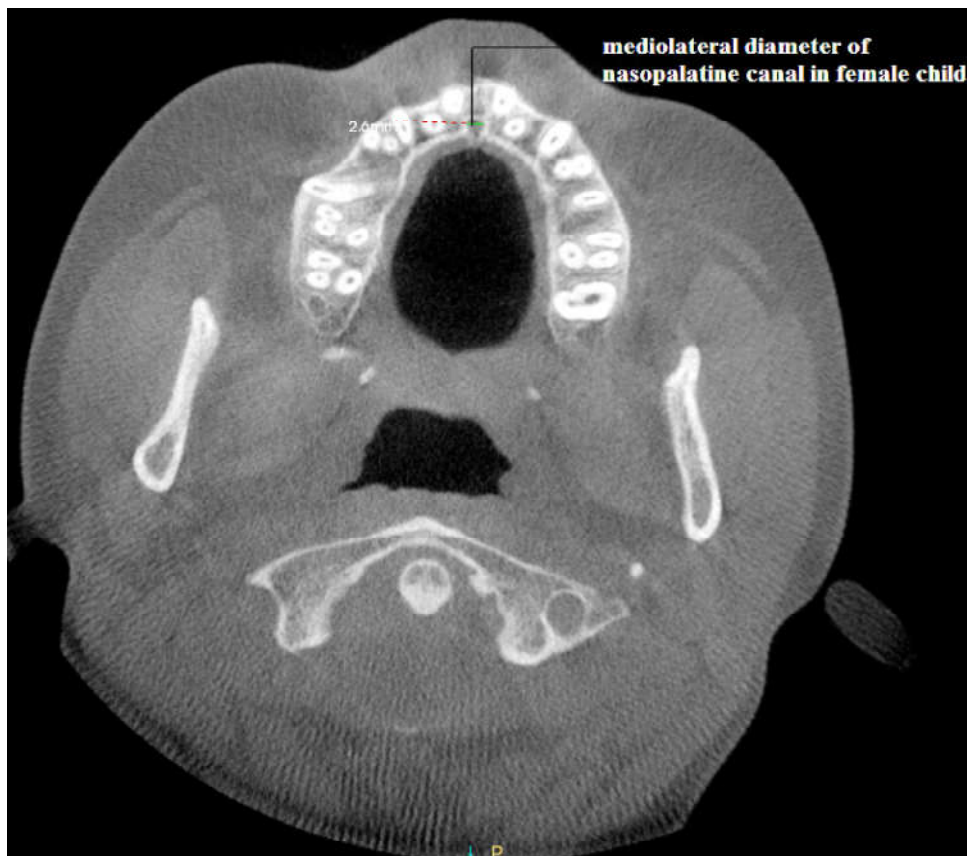


Fig. 2: Axial section (CBCT) showing mediolateral diameter of nasopalatine fossa in female subject

in the axial sections (Figure 1 & 2).

### Statistical Analysis

Categorical variables will be presented in number and percentage (%) and continuous variables will be presented as mean and SD. Unpaired t test were used for two group comparison and one way ANOVA were used for three group comparison. 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 while correlation was defined as a measure of the strength of a linear relationship between two variables. A p value of  $<0.05$  will be considered statistically significant. The data will be entered in MSEXCEL spreadsheet and analysis will be done using Statistical Package for Social Sciences (SPSS) version 21.0.

### Results

The study population consists of 154 pediatric subjects aged between 6 and 17 years with a mean

age of  $12.38 \pm 3.07$  years (Table 1). Majority of the subjects were between 11 to 15 years of age (47.4%) (Table 2). The sex ratio in our study population showed that proportion of female subjects were higher than male i.e. 52.6 % and 47.4% respectively (Table 3). The antero-posterior diameter and length of nasolacrimal duct cannot be appreciated in coronal section of CBCT in paediatric population due to developmental aberrations however the mediolateral diameter in all paediatric subjects were clearly appreciated in axial sections of CBCT. So only mediolateral dimension is studied in paediatric population.

Using unpaired t-test, the mean mediolateral dimensions is compared gender wise. The mediolateral dimensions in male and female was statistically not significant ( $P > .05$ ). However male have slightly higher mean mediolateral; dimensions. (Table 4). The association between age groups and mediolateral dimension was evaluated by one way ANOVA. It was found that the mean mediolateral dimension was statistically not significant ( $P > .05$ ) in age groups (Table 5). The pearsons correlation coefficient (r) between age and mediolateral diameter shows that M/L diameter is directly associated with

age and demonstrate a significant positive relation ( $r=0.177$ ,  $p=0.028$ ). (Table 6). The mathematical equation derived by linear regression analysis is used in determination of age of an individual if mediolateral dimension is known-  $\text{Age} = 9.995 + .705 * (\text{mediolateral dimension})$  (Graph 1). The mean comparison of parameters according to their gender using discriminant function analysis using Fisher exact test was done. It's shows that higher mean were

observed in Males compare to females. Statistically significant difference were observed in all parameters ( $P < 0.05$ ) (Table 7).

The sex could be determined from calculations using the equations given below (Table 8):

D of Male:  $-10.750 + 5.820 * (\text{Mediolateral Diameter})$

D of Female:  $-10.075 + 5.621 * (\text{Mediolateral Diameter})$  Sex was accurately determined in 37 cases out of 73 with prediction accuracy rate of 50.7% in

**Table 1:**

	N	Minimum	Maximum	Mean	Std. Deviation
Age	154	6.00	17.00	12.3896	3.07065
M/L diameter	154	1.80	5.90	3.3942	.77039

**Table 2:**

Age intervals	N	Percent
6 to 10 years	47	30.5
11 to 15 years	73	47.4
Above 15 years	34	22.1
Total	154	100.0

**Table 3:**

Gender	N	Percent
Male	73	47.4
Female	81	52.6
Total	154	100.0

**Table 4:** Mean comparison of mediolateral diameter according to their gender

	Gender	N	Mean	Std. Deviation	P value
M/L diameter	Male	73	3.4562	.73899	0.345
	Female	81	3.3383	.79806	

Applied unpaired t test for significance

**Table 5:** Mean comparison of mediolateral diameter according to their age groups

	N	Mean	Std. Deviation	P value
6 to 10 years	47	3.1872	.71706	0.087
11 to 15 years	73	3.4849	.81848	
Above 15 years	34	3.4853	.69680	

Applied one way ANOVA test for significance

**Table 6:** Correlation between ages with mediolateral diameter

		Age	M/LDIAM
Age	Pearson Correlation	1	.177*
	Sig. (2-tailed)		.028
	N	154	154

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

**Table 7:**

	Male Mean	Male Std. Deviation	Female Mean	Female Std. Deviation	F value	P value
Mediolateral Diameter	3.456	0.738	3.338	0.798	0.899	0.345

Table 8:

	Gender	
	Male	Female
Mediolateral Diameter (Constant)	5.820	5.621
	-10.750	-10.075

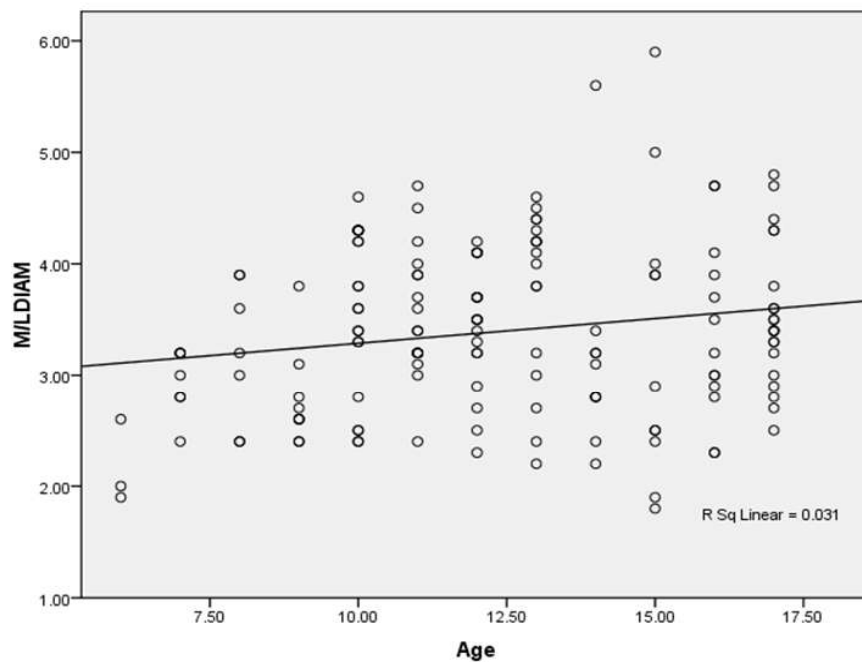
Fisher's linear discriminant functions

Table 9:

	Gender	Classification Result <sup>a</sup>		Total
		Predicted Group	Membership	
Original	Count	Male	Female	
		37	36	73
		40	41	81
	%	50.7	49.3	100.0
		49.4	50.6	100.0

a. 50.6% of original grouped cases correctly classified

Graph 1:



male population however in female population, sex was accurately determined in 41 cases out of 81 female with an accuracy rate of 50.6% (Table 9).

### 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 ( $\pm 2.25$ ).

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 mediolateral diameter were not differed ( $p > 0.05$ ) between the males and females i.e. found to be statistically the same. The mediolateral diameter 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 derived the equations by using linear regression analysis that was used in determination of age of an individual if mediolateral is known.

Sex was accurately determined in 37 cases out of 73 with prediction accuracy rate of 50.7% in male population however in female population, sex was accurately determined in 41 cases out of 81 female with an accuracy rate of 50.6%.

## 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 age and gender identification.

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