

Morphological Assessment of Nasopalatine Canal for Dental Implant Placement in Anterior Maxillary Region: A Cone Beam Computed Tomography Study

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ABSTRACT

Objective: The objective of the current study was to utilise cone-beam computed tomography (CBCT) to determine the length of nasopalatine canal (NPC) and diameter of incisive foramen to provide useful data regarding implant placement.

Material and Method: In this descriptive cross-sectional study, 204 patients (131 female and 73 male) were retrospectively evaluated. Sagittal sections of CBCT were used to determine the length of NPC and diameter of incisive foramen. For statistically significant data, Kruskal-Wallis test was used to compare among different age groups. In addition, Mann-Whitney U-test was done to compare between the gender. Finally, Spearman's correlation was done to determine the relationship of age with diameter of incisive foramen and length of nasopalatine canal respectively.

Result: The mean \pm SD of the nasopalatine canal length was 12.93 ± 2 ; no statistically significant difference were detected between genders ($P=0.05$). The overall mean \pm SD of the incisive foramen diameter was 3.78 ± 0.9 ; statistically significant difference were detected between genders ($p=0.021$). The diameter of the incisive foramen showed a weak correlation with age (Spearman's $\rho=0.176$, $p=0.012$), whereas the correlation between canal length and age was negligible (Spearman's $\rho=0.044$, $p=0.532$).

Conclusion: The current study demonstrates the variability of length of NPC and diameter of incisive foramen. A through CBCT analysis is recommended to avoid invasion of incisive foramen and nasopalatine canal and to reduce post-operative complication in implant dentistry.

Keywords: Cone beam computed tomography, Implants, Nasopalatine canal, Incisive foramen

INTRODUCTION

In cases where teeth are absent, removable partial dentures (RPD) or fixed partial dentures (FPD) were traditionally utilised for replacement. Nevertheless, both options come with their own set of drawbacks.¹

Citation

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Patients receiving RPD may experience discomfort due to the soft tissue impingement caused by components of the denture, leading to localised ulcers. Although this issue has been addressed with FPD, the preparation of natural teeth anterior and posterior to the missing teeth is required, resulting in sensitivity in the prepared abutment teeth which is the primary drawback of these treatment options.²

The dental implant has been universally acknowledged as the foremost technique for substituting missing teeth, demonstrating proficiency in meeting the concurrent demands of both functional restoration and aesthetic enhancement for patients. The strategic placement of implants proffers distinct advantages, notably the attainment of aesthetically pleasing results devoid of the necessity for crown preparation, a departure from the conventional paradigm observed in fixed partial dentures (FPD). Despite its increasing popularity among dentists, complications arising from dental implant placement remain a significant challenge.³

The success of dental implantation in the maxillary anterior region hinges on the precise positioning and angle of the implant. Maintaining an optimal distance between the implant and anatomical structures is paramount. The Nasopalatine Canal (NPC), serving as a bony link between the nasal and oral cavities, houses a neurovascular bundle. A comprehensive understanding of anatomical variations in the NPC is crucial to prevent potential damage to the neurovascular bundle.⁴

Two-dimensional (2D) imaging techniques, including intraoral periapical radiographs and panoramic radiographs were constraints in implant planning, ultimately contributing to the occurrence of implant failures.⁵ The introduction of Cone Beam Computed Tomography (CBCT) has successfully

addressed this constraint. CBCT, offering three-dimensional imaging which delivers high spatial resolution and involves lower patient exposure compared to full-mouth radiographs and traditional CT scans. CBCT images become indispensable, especially when dealing with areas in close proximity.⁶ The present study was conducted to determine diameter of incisive foramen and length of nasopalatine canal with the help of CBCT images.

MATERIAL AND METHOD

Study proposal was approved by the Institutional Review Committee (IRC) of Kantipur Dental College Teaching Hospital & Research Center and ethical clearance was obtained. The CBCT scans were studied from the database of the Oral Radiology Unit, over a period of nine months from July 2022 to April 2023. All CBCT scans were obtained with one mm slice thickness and the tomographic scanner CS 9300C 3D CBCT scanner with exposure settings of 120 kV, 15 mA, and 12-inch field of view was used to obtain CBCT scan. A software program, Care stream 3D Imaging software, was used to reconstruct the images and perform the measurements.

Sample size was estimated based on the prevalence rate in a previous study done by Fawaghi ALAli et al.⁷ in which overall means of labial bone thickness of maxillary central incisor was 0.92 ± 0.36 . In our study we opted to have 5% desired margin of error. Thus taking the standard deviation (σ) = 0.36, Margin of error (ME) = 0.05

Now, sample size (n) = $Z^2\sigma^2/ME^2$ (value of $Z=1.96$ at 95% confidence interval)

$$\begin{aligned} \text{So, } n &= (1.96)^2 \times (0.36)^2 / (0.05)^2 \\ &= 3.8416 \times 0.1296 / 0.0025 \\ &= 0.4978 / 0.0025 \\ &= 199.1485 \end{aligned}$$

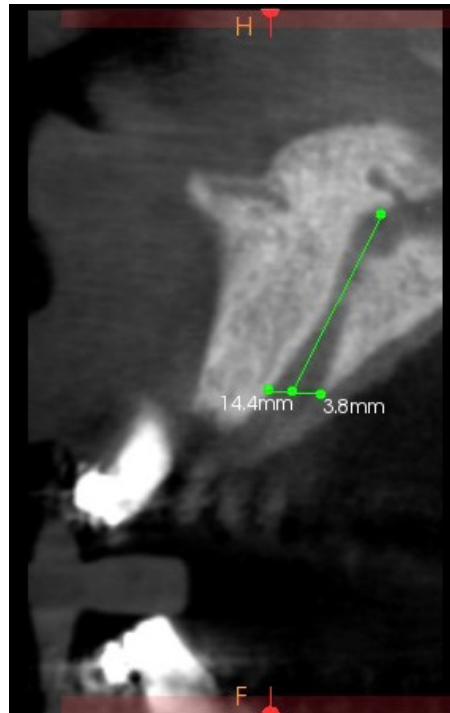


Figure 1: Sagittal slice of CBCT image showing landmarks for determination of length of NPC and diameter of incisive foramen.

However, we included, 204 patients in this study. All participants were informed about the study, and written consent was obtained. Inclusion criteria were patients above 18 years of age. However, patients with edentulous maxilla, cleft lip/ palate, impacted teeth, and any pathology of NPC were excluded from the study.

All CBCT images were assessed for NPC dimensions (sagittal sections) and anatomy (coronal sections). Expert radiologist performed the analysis. Sagittal sections of CBCT images were used for the measurements of dimensions of the NPC. Following measurements were carried out for measuring diameter of incisive foramen and length of the nasopalatine canal. The observation was made as follows:

1. The length of NPC: The measurement of mean length of NPC was made by marking in sagittal plane the nasal and oral opening of the canal corresponding to its upper and lower limits.

2. Diameter of incisive foramen: Measurement was calculated by measuring antero-posterior distance of oral entrance of the canal. (Figure 1)

Kolmogorov-Smirnov test was used to test the normality of the data. For statistically significant data, Kruskal-Wallis test was used to compare among different age groups. In addition, Mann-Whitney U-test was done to compare between two genders. Finally, Spearman's correlation was done to determine the relationship of age with diameter of incisive foramen and length of nasopalatine canal respectively. Statistical Package for the Social Sciences (SPSS) version 17.0 (SPSS, Inc., Chicago, Illinois, USA) was used for data analysis.

RESULT

The study was conducted in CBCT images of 204 patients (131 females and 73 males) and mean age of the participants was 36.38 ± 12.69 years ranging from 18 to 75 years. A comparison of the diameters of the incisive foramen and the lengths of

Table 1: Comparison of diameter of incisive foramen and length of nasopalatine canal between two gender.

Variables	Male (n=131)		Female (n=73)		Total sample (n=204)		P value
	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	
Diameter	3.89±0.9	3.9(1.2)	3.6±0.6	3.7(0.9)	3.78±0.9	3.8(1.1)	0.021
Length	13.06±2.05	13.3(3.0)	12.70±2.18	12.5(2.9)	12.93±2.1	13.1(3.0)	0.085

Table 2: Comparison of diameter of incisive foramen and length of nasopalatine canal in different age groups.

Variables	<30 years (n=72)		31 – 50 years (n=101)		>50 years (n=31)		p-value
	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	
Diameter	3.44±0.81	3.4(1.1)	4.08±0.83	4.2(1.0)	3.58±0.74	3.7(0.8)	<0.001
Length	12.68±2.1354	12.75(3.1)	13.18±2.0431	13.3 (2.8)	12.72±2.1697	12.2 (3.3)	0.252

the nasopalatine canal between males and females is detailed in (Table 1). The table reveals that the mean ± standard deviation (SD) diameter of the incisive foramen was 3.89±0.9 in males and 3.6±0.6 in females. The overall mean ± SD of the incisive foramen diameter was 3.78±0.9, and the overall mean ± SD of the nasopalatine canal length was 12.93±2.1. The Mann-Whitney U test indicated a statistically significant difference (p=0.021) with the median diameter of males being higher than that of females. However, the length of the nasopalatine canal did not show statistical significance between genders (p=0.05).

The diameter of the incisive foramen showed a weak correlation with age (Spearman’s rho=0.176, p=0.012), whereas the correlation between canal length and age was negligible (Spearman’s rho=0.044, p=0.532). Grouping the population in three age categories carried out further association with age. The Kruskal-Wallis H test revealed differences in the diameter of the incisive foramen among various age groups, while the variation

in length did not statistically significant, as demonstrated in (Table 2).

DISCUSSION

Maxillary anterior teeth play an important role in the development of esthetics of an individual. These teeth are more vulnerable to get fractured. With the advent of implants in dentistry, the replacement of missing maxillary anterior teeth has become easy. It has also become patient’s preferred choice of treatment. For the placement of dental implant in anterior region, the exact location and morphology of NPC are the foremost requirements.⁸ Several previous studies have studied the pathology in regard to NPC region, but the anatomical disparity in the dimensions and morphology of NPC remain poorly acknowledged. The present study was conducted to determine the morphology of NPC.

Song et al.⁹ have demonstrated that the length of the NPC is 12.0 mm (8.4–15.8 mm) in dentulous maxillae, and Mraiwa et al.¹⁰ have reported a mean length of 8.1±3.4 mm. In our study, we included 204

patients of both genders. The mean length of NPC was 13.06 ± 2.05 mm in males and 12.70 ± 2.18 mm in females. Males showed more length as compared with females but statistically not significant. Our results are not in agreement with Safi et al.¹¹ We found the effect of gender on measured dimensions of NPC. It was found that diameter of incisive foramen were significantly higher in males as compared with females. This is in agreement with Acar and Kamburoğlu.¹²

Kajan et al.¹³ in their study on Iranian population found that mean values for oral opening of NPC were 3.53 ± 1.01 , whereas in the present study, it was 3.89 ± 0.9 in males and 3.6 ± 0.6 in females.

Age of the patient did not have a significant influence on the length of the nasopalatine canal and diameter of incisive foramen. Similarly, Tozum et al.¹⁴ and Mriawa et al.¹⁰ reported that age of the subjects did not have significant relationship with diameter of incisive foramen and length of nasopalatine canal.

Cone beam computed tomography has revolutionarily changed the dental implant success

rate. The complexity of NPC can be well visualised by the three-dimensional imaging modality, such as CBCT. It has the advantage of providing fine details in all three sections, such as sagittal, coronal, and axial. Thus, the placement of dental implant in maxillary anterior region is no more a complex procedure.

CONCLUSION

Analysis of diameter of incisive foramen and length of NPC carries high importance to avoid neurovascular damage to the nasopalatine artery and nerve. The exact diameter of incisive foramen and length of NPC can be determined with the help of CBCT images. All three sections, especially sagittal and coronal views, provide useful information. These dimension can be considered as an important parameter when implants within the NPC are being considered.

Conflict of interest: None.



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