

Anthropometric Dimensions of Nasopalatine Canal measured by Cone Beam Computed Tomography among Kurdish population



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Abstract

Background: The purpose of this study was to find anatomical variation of nasopalatine foramen (NPF) and nasopalatine canal (NPC) in different age and gender groups among Kurdish people on cone-beam computed tomography (CBCT) images.

Materials and Methods: This research included one hundred CBCT images obtained from patients visiting private clinics with a specialty in dental and maxillofacial radiology in Sulaimani, Hawler, and Dhok governorates within a period between 2014 to 2016. Subjects were divided into three age groups (18-34, 35-49, 50-75) years old. The first group were included 15 males and 15 females, the second group 20 males and 20 females, and the third group included 15 males with 15 females. PaX i vatech digital CBCT machine was used to obtain the images by radiographers. The following measurements were estimated; number of openings of NPC at nasal fossa, mesio-lateral diameter of NPF at nasal fossa (axial section), mesio-lateral diameter of NPF at palatine fossa, anteroposterior dimension of NPC at: its upper border; middle level, and lower border, and lastly the height of NPC in sagittal section.

Results: 100 subjects (50 males and 50 females) with age range 31 years 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 the 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 ($P < 0.05$). But age group differences did not reach the significant level ($P > 0.05$). The means and SD of the anteroposterior dimension of NPC were 3.46 ± 1.53 mm. There were no significant differences between genders and among age groups concerning this dimension ($P > 0.05$). Mean and SD of the height of NPC was 13.14 ± 3.11 mm. Males demonstrated the significantly greater length of NPC than females ($P < 0.05$).

Conclusion: It is concluded that there is variation in the anatomy and morphology regarding various parameters of NPC among Kurdish population. This should be considered in mind in preoperative planning to reduce the number of complications in implant and other maxillofacial surgeries in the anterior palatine area. Also, it's obvious that CBCT has an important role in obtaining accurate measurements of NPC different dimensions which have importance to differentiate between normal and abnormal NPC and NPF.

Keywords: *Nasopalatine foramen, CBCT, dental implant, maxillofacial surgeries.*

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Introduction:

Nasopalatine Canal (NPC) is funnel shaped opening in the bone of the 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 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 the 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⁾. Researchers showed that in the case of severe bone loss in the 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 considered 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 has been performed in 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 this 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 a cystic lesion or it is within the normal range of the canal size. Authors mentioned that anteroposterior dimension of NPC within 8-10mm range considered as normal radiolucency⁽¹²⁾. While radiolucencies are exceeding 14mm is considered as a cystic lesion and required a surgical removal⁽¹³⁾.

The 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 Kurdish 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

Vice President of Sulaimani University for Scientific Affairs and Postgraduate Studies (protocol number 186 at 7/6/2015). The source of the data was taken by two ways, first, from the patients, those were referring to the specialist in dental and maxillofacial radiology private clinics for various treatment were needs such as initial screening or oral surgery. Second from the volumetric patients that were presented by us to the private 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 patient's 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 ten of them did not reach the inclusion criteria regarding this paper. Included subjects were patients with normal NPC, presence of both maxillary central incisors, the absence of anterior implants and 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). All the measurements were recorded in millimeter (mm). The following data were collected from the images for both genders participants as measured in axial and sagittal sections as shown in (Figure 1).

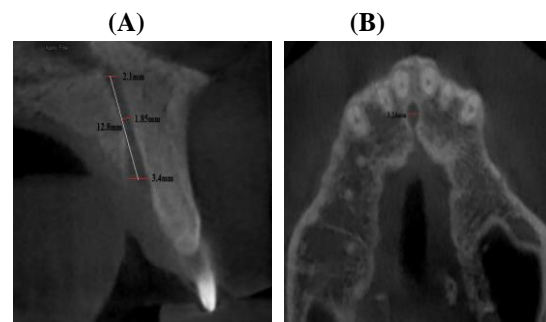


Figure 1 : (A) Nasopalatine foramen in axial section. (B) Nasopalatine Canal in sagittal section showing the length of NPC between the floor of the nasal cavity and incisal fossa, also the anteroposterior dimension of NPC at its upper, middle and lower levels

1. Number of the opening of NPC at nasal fossa.
2. The diameter of NPC opening at nasal fossa in the axial plane (foramen Stenson).
3. The diameter of NPC opening at anterior incisal fossa in the axial plane (Palatine fossa).
4. Anteroposterior dimension of NPC at the upper border (nasal fossa level).
5. The anteroposterior dimension of NPC at the middle level.
6. Antero-posterior dimension of NPC at the lower border (incisal fossa level).
7. Length or height of NPC in the 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; the mean and standard deviations were calculated for all the distances measured in this study. Data analysis was performed by using Statgraphics plus 40 programs, the correlation among different variables was assessed in simple and multiple linear 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.

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 $2.47\pm 0.52\text{mm}$ and $2.73\pm 0.71\text{mm}$ for males and females respectively (overall means and SD for both genders were $2.60\pm 0.69\text{mm}$) as shown in Table (3) and Fig (2). There were no significant differences between genders and among different age groups concerning this dimension ($P > 0.05$).

The mean and SD of the mesio-lateral diameter of NPF at palatine fossa were $4.65\pm 2.16\text{mm}$ and $3.57\pm 1.21\text{mm}$

for males and females respectively (overall means and SD for both genders were $4.11\pm 2.09\text{mm}$). There were significant differences between genders ($P < 0.05$). But age group differences did not reach the significant level ($P > 0.05$). Previous results are shown in Table (3) and Fig(2).

The means, and SD of the anteroposterior dimension of NPC as measured in the sagittal section were $3.56\pm 1.51\text{mm}$ and $3.36\pm 1.39\text{mm}$ for males and females respectively (overall mean, and SD was $3.46\pm 1.53\text{mm}$) as shown in Table (4). There were no statistically significant differences between genders and among age groups concerning this parameter ($P > 0.05$).

Regarding the length or the height of NPC, means and SD value which was measured between nasal flower and incisive fossa; were $13.83\pm 31\text{mm}$ and $12.44\pm 2.83\text{mm}$ for males and females respectively (overall mean, and SD was $13.14\pm 3.11\text{mm}$) as shown in Table (5). Significant differences were noticed between males and females ($P < 0.05$). Males demonstrated significantly greater length NPC than females.

Table (1): Distribution of the subjects in the study

| 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 |

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 |

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

| Age groups (year) | Genders | Mesio-Lateral Diameter of NPF (in mm) at: | | | |
|-----------------------|---------|---|---------------------------|----------------|---------------------------|
| | | Nasal fossa | Mean of males and females | Palatine fossa | Means of males and female |
| 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 in mm (sagittal section)

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

Table (5): Mean with a 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 | |
| | Female | 12.15±2.74 | 12.77±2.99 |
| 35-49 | Male | 13.89±3.35 | |
| | Female | 12.34±2.79 | 13.11±3.11 |
| 50-75 | Male | 14.21±3.98 | |
| | Female | 12.85±3.01 | 13.53±3.19 |
| Means of all groups | Male | 13.83±3.1 | |
| | Female | 12.44±2 | 13.14±3.11 |

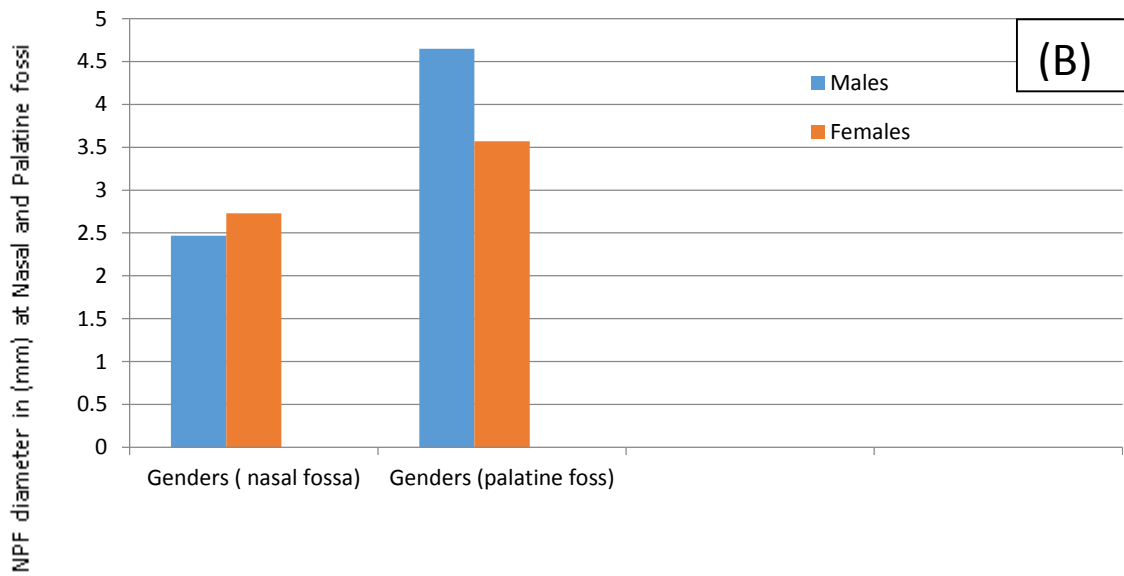
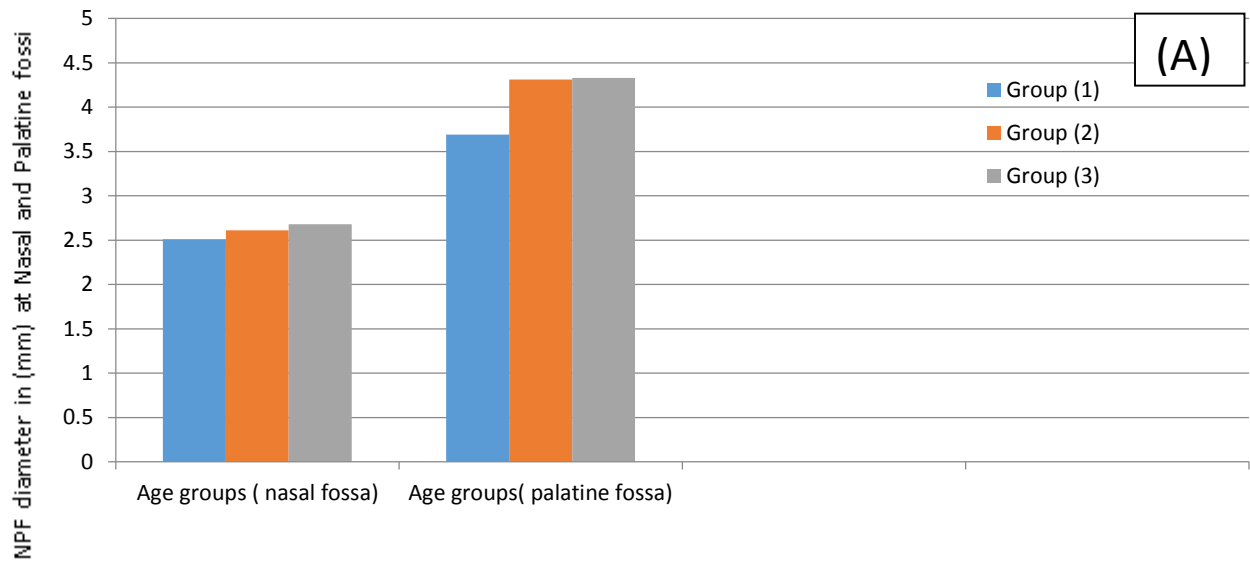


Fig (2): Correlation between mesio lateral diameter of NPF at nasal and at palatine fossi with:

A- Age groups. B- Genders.

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 requires 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 dentomaxillofacial area⁽¹⁴⁾.

In spite of a 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 who find two openings at the nasal fossa^(17,18). However, some authors found between 3 and four foramina at nasal floor level^(3,19,20).

The mean and SD of the mesio-lateral diameter of NPF at the nasal fossa in the present study was 2.60 ± 0.69 mm (ranged between maximum as 0.9mm and minimum as 4.4mm), which is higher than those reported by some other authors^(19,20) who recorded this measurement as 1.75 ± 0.77 mm and 2.2 ± 0.61 mm respectively. This study clarifies that the mean and SD of the 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⁾ who recorded 3.4 ± 1.86 mm. The mesio-lateral dimension of NPF at palatine fossa was ranged from 2.3mm to 5.9 mm, which was acceptable normal value. Usually when NPF diameter is higher than 8 mm it means the presence of lesion within the canal like a nasopalatine cyst⁽²⁰⁾. Hence knowledge about the normal value of the NPC and NPF is crucial to differentiate between normal and abnormal canals.

Overall mean and SD of anteroposterior dimension of NPC in the sagittal section which found in this study was 3.46 ± 0.89 mm. This was higher than found by^(16,19) who 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) who 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 previously 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 all age groups. This may be due to the larger craniocaudal 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 to perform any surgical procedures like implant insertion in the anterior maxillary segment. Sensation disturbances and disosseointegration may occur by contacting the implant with NPC⁽³⁾.

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preparing and analyzing the CBCT images and recording accurate measurements of the chosen parameters. Lastly many thanks to Dr. Nzar Muhammad for their help in statistical analysis.

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