

Morphological Evaluation of Incisive Foramen According to Age, Gender and Edentulous Status

İnsiziv Foramenin Yaş, Cinsiyet ve Dişsizlik Durumuna Göre Morfolojik Değerlendirilmesi

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ABSTRACT

Objective: Evaluation of the change in incisive foramen (IF) diameter and localization according to age, gender, edentulous status and other anatomical landmarks by cone beam computed tomography (CBCT).
Method: 162 patients (81 females, 81 males, mean age 41.1±15.2) were included in the study. IF diameter, distance between IF and the greater palatine foramen (GPF) and distance between IF and the most posterior of the median palatine bone (PNS: posterior nasal spine) were measured. The measurement values of the patients were compared with the Independent t-test according to gender and dental status. The relationship between age and measurements was examined with the Pearson correlation test.

Results: The mean IF diameter of the patients was 3.78±0.95 mm. The mean IF diameter ($P<.001$), the distance between the right GPF and the IF ($P=.023$) and the distance between the IF and the PNS ($P=.039$) of the dentate patients were found to be significantly lower than the edentulous patients.

Conclusion: The IF diameter and the IF - GPF distance were found to be lower in dentulous patients than in edentulous patients. It was determined that the IF diameter and the IF-GPF distance increased with age.

Keywords: Incisive foramen, greater palatine foramen, CBCT

ÖZ

Amaç: İnsiziv foramen (İF) çap ve lokalizasyonunun yaş, cinsiyet, dişsizlik durumu ve diğer anatomik landmarklara göre değişiminin konik ışınli bilgisayarlı tomografi (KİBT) ile değerlendirilmesidir.

Yöntem: Çalışmaya 162 hasta (81 kadın, 81 erkek, yaş ort. 41.1±15.2) dahil edildi. İF çapı, İF ile palatinum majus mesafesi ve İF ile palatinanın posterioru arasındaki mesafe ölçüldü. Cinsiyet ve diş durumuna göre hastaların ölçüm değerleri Independent t-test ile karşılaştırıldı. Yaş ile ölçümler arasındaki ilişki Pearson korelasyon test ile incelendi.

Bulgular: Hastaların ortalama İF çapı 3.78±0.95 mm idi. Dişli hastaların ortalama İF çapı ($P<.001$), sağ palatinum majus ile İF mesafesi ($P=.023$) ve palatinanın en posterioru ile İF mesafesi ($P=.039$) dişsiz hastalara göre anlamlı düzeyde düşük saptandı.

Sonuç: Dişli hastalarda İF çapı ve İF ile palatinum majus mesafesi dişsiz hastalara göre daha düşük bulundu. İF çapının ve İF - palatinum majus mesafesinin yaşla birlikte arttığı belirlendi.

Anahtar Kelimeler: İnsiziv foramen, palatinum majus, KİBT

INTRODUCTION

The incisive foramen (IF), where the nasopalatine canal terminates and opens into the oral cavity, is located on the intermaxillary suture and posterior to the maxillary anterior teeth.¹ Nasopalatine duct contains the nasopalatine nerve, the terminal branch of the nasopalatine artery, fibrous connective tissue, sebaceous and minor salivary glands.² Therefore, both the IF and the nasopalatine canal are important landmarks in surgical procedures involving the maxillary anterior region or closely related to the maxillary anterior region.^{1,3,4} The morphology of the alveolar bone in the maxillary anterior region has gained more importance due to implant surgery applications that have become widespread in recent years.^{1,4} As the maxillary alveolar crest undergoes morphological changes according to age, gender, and edentulous state, shape and localization changes can also be observed in the IF.

The aim of this study is to evaluate the change of the IF diameter and localization according to age, gender, edentulous status, and other anatomical landmarks by cone beam computed tomography (CBCT).

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METHOD

Ethics committee approval was received from Alanya Alaaddin Keykubat University Clinical Research Ethics Committee for this study (05/10/2022:09-04). Using the retrospective data, the individuals included in the study were informed that their personal information would be kept confidential, and signed consent was obtained from the patients.

Maxillary cone beam tomography (CBCT) images taken from patients >18 years of age who applied to Alanya Alaaddin Keykubat University Faculty of Dentistry for various reasons were analyzed retrospectively. If there are artifact, history of implant surgery or pathologies such as infection, cyst, in the relevant region in the examined CBCT images, or if the imaging in the relevant region is of low quality (the presence of metal artifact due to prosthetic restorations) was not included in the study. Age and gender information of the patients were recorded. In addition, the patients were divided into two groups according to their edentulous status. If both maxillary central teeth were present in the mouth, the patient was considered dentulous. If at least one of the maxillary central teeth was not present in the mouth, the patient was considered edentulous.

Measurements were made by one observer (YYS). The widest length of the foramen in CBCT axial sections was used to measure the IF diameter. Since the IF and right-left GPF are located in different axial sections, the spatial measurement feature in the CBCT software was used to measure the distance between them. CBCT sagittal sections were used to measure the distance between the IF and the PNS (Figure 1).

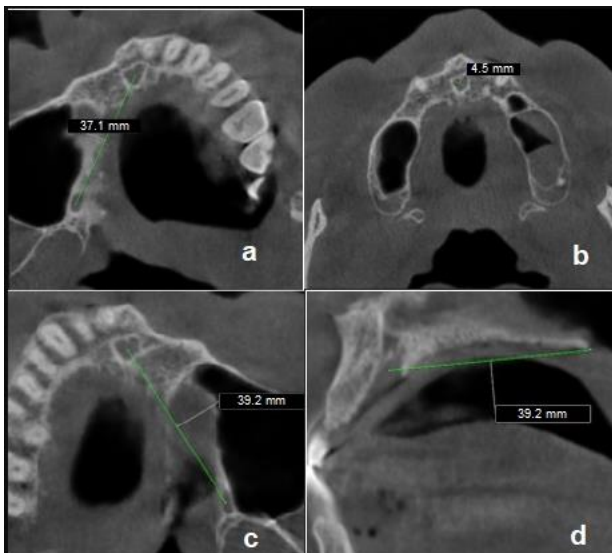


Figure 1. Measurement of the IF - GPF distance in CBCT axial section (a,c). Measurement of the IF diameter (b). Measurement of the distance between the IF and the PNS (d).

Statistical analysis

SPSS 23.0 (IBM SPSS, Inc., Armonk, NY, USA) program was used for statistical analysis. The conformity of the data to the assumption of normal distribution was checked with the Shapiro Wilk test. Data obtained according to gender and edentulous status were analyzed by Independent t-test. The relationship between age and IF measurements were evaluated with the Pearson correlation test. Statistically, $P < .05$ was considered significant.

RESULTS

162 patients (81 males, 81 females) were included in the study. The mean age of all patients was 41.1 ± 15.2 . 127 patients (78.4%) were in the dentulous patient group. The mean IF diameter of the patients was measured as 3.78 ± 0.95 mm. The distance between the right and left GPF and the IF was 38.8 ± 2.35 and 38.97 ± 2.54 mm, respectively. The distance between the IF and the PNS was determined as 40.6 ± 3.03 mm (Table 1).

While the mean IF distance to the right and left GPF in males was 39.56 ± 2.03 and 39.86 ± 2.36 mm, and in females it was 38.05 ± 2.41 and 38.08 ± 2.41 mm, respectively. The distance on both sides was statistically higher in males than in females ($P < .001$). Although the mean IF diameter was higher in males than in females, no statistically significant difference was found ($P = .078$). Although the mean distance between the IF and the PNS was higher in males than in females, no statistically significant difference was found ($P = .402$) (Table 2).

The mean IF diameter of the dentulous patients ($P < .001$), the distance between the right GPF and the IF ($P = .023$) and the distance between the IF and the PNS ($P = .039$) were found to be significantly lower than the edentulous patients. The mean distance between the left GPF and the IF was lower in the dentulous patients, and it was not found statistically significant ($P = .075$) (Table 3).

A weak positive correlation was observed between age and the IF diameter ($r = 0.315$; $P < .001$) and the right GPF and the IF distance ($r = 0.262$; $P = .001$). A very weak positive correlation was found between age and the left GPF - IF distance ($r = 0.161$; $P = .041$) and the IF - PNS distance ($r = 0.162$; $P = .039$) (Table 4).

The changes in measured distances with age in the subgroups (female/male, dentulous/edentulous) are shown graphically (Figure 2). In this graph, it is observed that the IF - GPF distance and the IF - PNS distance increased slightly for each group on trend line. The mean values and the minimum-maximum values of the distances measured in the subgroups are presented in Table 5.

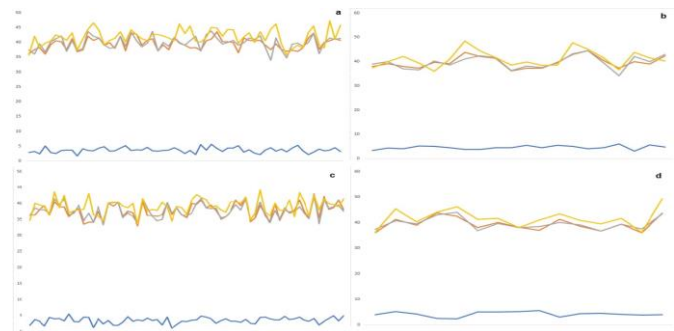


Figure 2. Changes with age in IF diameter (blue), the IF - right GPF distance (orange), the IF - left GPF distance (gray) and the IF - PNS distance (yellow) in the dentulous males (a), the edentulous males (b), the dentulous females (c) and the edentulous females (d)

Table 1. Patient characteristics

		All patients (n=162)
Age (years), mean±S.D.		41.1±15.2
Gender, n(%)	Male	81 (50)
	Female	81 (50)
Edentulous status, n(%)	Dentulous	127(78.4)
	Edentulous	35(21.6)
Measurements (mm), mean±S.D.	IF diameter	3.78±0.95
	IF - right GPF	38.8±2.35
	IF - left GPF	38.97±2.54
	IF - PNS	40.6±3.03

Table 2. Measurements according to gender

Measurements (mm), mean±S.D.	Males (n=81)	Females (n=81)	P
IF diameter	3.91±0.92	3.65±0.95	.078
IF - right GPF	39.56±2.03	38.05±2.41	<.001
IF - left GPF	39.86±2.36	38.08±2.41	<.001
IF- PNS	40.8±3.01	40.4±3.06	.402

Independent t-test

Table 3. Measurements according to edentulous status

Measurements (mm), mean±S.D	Dentulous (n=127)	Edentulous (n=35)	P
IF diameter	3.61±0.9	4.4±0.87	<.001
IF - right GPF	38.58±2.28	39.6±2.45	.023
IF - left GPF	38.79±2.53	39.65±2.49	.075
IF- PNS	40.35±3.05	41.54±2.8	.039

Independent t-test

Table 4. Correlation between age and measurements

Measurements	r	P
IF diameter	0.315	<.001
IF - right GPF	0.262	.001
IF - left GPF	0.161	.041
IF - PNS	0.162	.039

Pearson correlation test

Table 5. Measurements according to edentulous status with gender

Measurements (mm), mean (min-max)	Dentulous males (n=61)	Dentulous females (n=66)	Edentulous males (n=20)	Edentulous females (n=15)
IF diameter	3.70 (2.2-5.6)	3.53 (2.2-5.5)	4.56 (3.4-6)	4.17 (2.3-5.5)
IF - right GPF	39.50 (36-43.1)	37.67 (33-42.2)	39.73 (36.1-44.5)	39.42 (36-43.8)
IF - left GPF	39.91 (33.9-43.8)	37.72 (33.6-41.6)	39.69 (34.1-44.5)	39.58 (36.7-44)
IF- PNS	39.24 (35.7-47.2)	39.04 (33.5-44.2)	41.78 (36.6-48.5)	41.66 (36.2-49.2)

DISCUSSION

The IF - GPF distance and the IF- PNS distance were found to be significantly higher in males. Although the IF diameter was numerically higher in males than in females, no statistically significant difference was found. A statistically significant increase was observed in all measurements with age. While numerical measurements increased in the edentulous status, all values except the left IF - GPF distance were statistically significantly higher than in the dentulous status.

In a study where the IF morphological analysis was performed with CBCT in South Korea, edentulous status was determined by grouping patients with central incisors and patients without at least one central incisor, as in present study.⁵ In the previous study, the IF diameter was measured lower in the patients with central incisors than in the edentulous patients, but no statistically significant difference was found. In present study, the IF diameter of the patients in the dentulous group was lower and there was a statistically significant difference. Again, in the previous study, it was determined that IF diameter tended to increase with age, but the change was not significant and males had the higher IF diameter than females.⁵ In present study, a positive correlation was found between age and the IF diameter. Although the IF diameter of males was higher than that of females, no statistically significant difference was found. Although the statistical results are similar, the variables between the numerical distributions of the two studies can be explained by ethnic differences.

In another study in 2019, it was determined that the IF diameter increased with age in both the mesio-distal and anterior-posterior directions.⁶ In present study, since a criterion was applied to measure the largest distance detected for the IF diameter measurement, no comment could be made about the changes in the directions. However, high similarity results were obtained with this study in the literature both in terms of the findings of the IF diameter change with age and in terms of the fact that the IF diameter of males was higher than that of females without significant difference.⁶ However, in a study in Brazil, it was determined that IF measurements of males were statistically significantly higher than females in many parameters, including diameter width in the mesio-distal direction.⁷

In studies conducted in Africa⁹ and in India,¹⁰ the mean IF diameter was found to be 3.56 mm and 3.62 mm, respectively. Although the diameter was larger in males than in females in both studies, no statistically significant difference was found between genders. In the study of Panda et al,¹⁰ it was stated that the IF diameter did not show a significant correlation with age and gender. It has been stated in the literature that the numerical variability in study findings may be due to ethnic differences. In addition, the fact that these authors only included patients with both anterior incisors in their study and did not examine the change in edentulous patients may have affected their results.

In their study, Bornstein et al³ found that the IF diameter in males was higher than in females, but there was no significant difference between genders. The authors,³ who found a decrease in the IF diameter with age, stated that these findings were contradictory with the study of Mardinger et al.¹¹ The findings of the present study were consistent with the results of Mardinger et al.¹¹ Bornstein et al³ attributed the difference in their findings with other study¹¹ to the edentulous criteria in patient selection and the difference in the mean age of the patients included in the study.

In a study in China in which the localization of the foramina in the jaws and their distance from each other were measured, the distance between the IF and the GPF was measured as 43.17±2.55 mm.⁸ In present study, the mean IF - GPF distance was found to be lower (Table 1). While the mean age of the patients included in present study was 41.1, the mean age of the patients included in the previous study⁸ was 46.8. Although it was determined that the distance between IF - GPF increased with age in present study, no information is given about the correlation between IF - GPF distance and age in the previous study.⁸ Therefore, the difference between the two studies in terms of the IF - GPF distance may be due to age distribution and/or ethnicity of the patients. In addition, the positive correlation between age and the IF - GPF distance in our study suggests that the IF may tend to shift anteriorly and the GPF shift postero-laterally when considered in the spatial plane.

In another study conducted in Italy,¹² the IF-GPF distance was found to be 40.4 mm and 38.8 mm in males and females, respectively. These results are quite compatible with present study. While interpreting the study results, Gibelli et al¹² emphasized that the distance of the GPF to anatomical landmarks depends on gender.

In a study including a meta-analysis which conducted in Poland, the GPF-IF distance was found to be significantly higher in males than in females.¹³ When the meta-analysis data are evaluated, the results obtained in present study are compatible with the measurement ranges determined in the studies in the literature (33.2-41.1 mm). It has been stated that the GPF can be localized more easily in edentulous patients and that the distance between the GPF and the borders of the palatal bone may be related to the difference in growth levels and growth direction.¹³ In the present study, only the presence of maxillary anterior teeth was used as a criterion when determining edentulous status. However, edentulism in the maxillary posterior teeth may also affect the IF -GPF distance. In the present study, considering the difficulty of interpretation that may be caused by the diversity of criteria, classification was made only on the basis of anterior teeth, and this can be considered a limitation of the study.

In another similar study conducted with CBCT in Lebanon, the mean distance between the GPF and the anterior nasal spine (ANS) in males and females was found to be 47.3 and 49.3 mm, respectively.¹⁴ Although it is consistent with the result of a significant difference between genders, the numerical values obtained are higher than the present study, which may be related to the ANS being positioned anatomically more anterior than the IF in the axial section.

Since the present study was a cross-sectional study, it was not possible to reveal the effect of bone structure or age-related changes in the same individual at different times. For this reason, it would be more appropriate to conduct a longitudinal study to observe the changes of the foramen more clearly with respect to each other and to the spatial plane. Since the measurements were made by only one observer (YY) in present study, the possibility of subjectivity increases. In similar studies planned to be done, choosing more than one observer, and repeating the same measurements to each observer with a certain time interval can be suggested as a preferable method to increase the reliability of the data. In addition, when the subgroups are evaluated according to gender and edentulism, the reason why the change with age cannot be revealed more clearly may be related to the decrease in the number of samples and narrowing of the age range when the groups are separated. For this reason, the number of patients included in the study can be increased and the relationship between gender - foramen diameter and the IF - GPF distance can be evaluated in more detail by performing it in larger populations.

CONCLUSION

The IF diameter and the IF - GPF distance were found to be lower in the dentulous patients than in the edentulous patients. It was determined that the IF diameter and the IF - GPF distance increased with age. The size and location of the anatomical foramen may differ across ethnic groups with age and gender. It may be useful to evaluate the morphological features of anatomical formations in dentists' intervention areas, such as IF and GPF, with studies with larger participation and different demographic information. Dentists should consider patients' data such as age, gender and edentulous status in surgical procedures involving maxillary anatomical landmarks such as IF or GPF.

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REFERENCES

- Hakbilen S, Mağat G. Nazopalatin kanal ve klinik önemi: Derleme. *Selcuk Dent J* 2019;6(1):91-97. doi:10.15311/selcukdentj.348841.
- Gönül Y, Bucak A, Atalay Y, et al. MDCT evaluation of nasopalatine canal morphometry and variations: An analysis of 100 patients. *Diagnostic Inter Imaging*. 2016;97(11):1165-1172.
- 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 Implant Res*. 2010;22(3):295-301. doi:10.1111/j.1600-0501.2010.02010.x.
- Liang X, Jacobs R, Martens W, et al. Macro- and micro-anatomical, histological and computed tomography scan characterization of the nasopalatine canal. *J Clin Periodontol*. 2009;36(7):598-603. doi:10.1111/j.1600-051x.2009.01429.x.
- Kim YT, Lee JH, Jeong SN. Three-dimensional observations of the incisive foramen on cone-beam computed tomography image analysis. *J Periodont Implant Sci*. 2020;50(1):48.
- Soumya P, Koppolu P, Pathakota KR, Chappidi V. Maxillary Incisive Canal Characteristics: A Radiographic Study Using Cone Beam Computerized Tomography. *Radiol Res Practic*. 2019;2019:1-5. doi:10.1155/2019/6151253.
- Neto ISA, Cruz WHS, De Castro Ribeiro I, et al. Morphometric study of incisive canal and its anatomic variations in brazilian individuals. *CRANIO®*. 2021;42(1):94-101. doi:10.1080/08869634.2021.1887610.
- Wu B, Li H, Fan Y, et al. Clinical and anatomical study of foramen locations in jaw bones and adjacent structures. *Medicine*. 2020;99(2):e18069. doi:10.1097/md.00000000000018069.
- Sarna K, Estreed MA, Sonigra KJ, et al. Anatomical Patterns of the Nasopalatine Canal and Incisive Foramen in an African Setting: A Cross-Sectional Study. *Craniofac Trau Reconstruct*. 2022;16(3):222-233. doi:10.1177/19433875221100943.
- Panda M, Shankar T, Raut A, Dev S, Kar A, Hota S. Cone beam computerized tomography evaluation of incisive canal and anterior maxillary bone thickness for placement of immediate implants. *J Indian Prosthodont Soc*. 2018;18(4):356. doi:10.4103/jips.jips_167_18.
- 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):1659-1662.
- Gibelli D, Borlando A, Dolci C, Pucciarelli V, Cattaneo C, Sforza C. Anatomical characteristics of greater palatine foramen: a novel point of view. *Surg Radiol Anatomy*. 2017;39(12):1359-1368. doi:10.1007/s00276-017-1899-7.
- Tomaszewska IM, Tomaszewski KA, Kmiotek EK, et al. Anatomical landmarks for the localization of the greater palatine foramen—a study of 1200 head CTs, 150 dry skulls, systematic review of literature and meta-analysis. *J Anatomy*. 2014;225(4):419-435.
- Aoun G, Nasseh I, Sokhn S, Saadeh M. Analysis of the greater palatine foramen in a Lebanese population using cone-beam computed tomography technology. *J Int Soc Prevent Community Dent*. 2015;5(8):82. doi:10.4103/2231-0762.171594.