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The Greater Palatine Foramen Situation in Tunisian Population: An Anatomical Study through CBCT

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Original Research Article

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Abstract: The greater palatine canal (GPC) is a vascular nerve tunnel which should be respected during any surgical act around this area. The aim of this study was to evaluate the position of the greater palatine foramen (GPF) in Tunisian patients using Cone Beam Computed Tomography (CBCT). In this cross-sectional assessment, 150 CBCT of Tunisian patients were used providing anatomical information for the GPF. Patients aged more than 17 years with second or third upper molars were included, while those with history of pathology or trauma in the maxillary region were excluded. The position of the GPF was evaluated referring to two axes: X (between the second and third upper molars) and Y (in the middle of the occlusal table of those teeth). ANOVA and Chi square tests were used for statistical analysis. The result was considered significant at $p<0.05$.
The sample involved 56.7% females and 43.3% males (sex ratio=0.76). The GPF was: mesially and distally located to the X axis in 4.70% and 48%, respectively; mesially and distally tangent in 0.70% and 24%, respectively and, finally, centered in 22.70%. No significant differences were found between the GPF position and the age neither the gender ($p>0.05$). As for the form, The GPF had either a rounded or an oval shape in 48.6% and 51.4%, respectively. However, a significant variation between the GPF form and the gender was recorded ($p=0.001$) and a significant variation according to the gender was found in the distance between the inter-maxillary suture and the GPF ($p<0.0001$).The present study shows that the GPF was mostly related to the third upper molar and between the second and the third molars. Any surgery in these areas should be performed cautiously to prevent the damage to this vascular-nerve complex.
Keywords: Greater palatine foramen, Greater palatine canal, Third upper molar, Second upper molar, Cone Beam Computed Tomography, Axial reconstruction.

INTRODUCTION

The greater palatine canal is a communication between the pterygo-palatine fossa and oral cavity. It results from the articulation between the perpendicular portion of the palatine and maxillary bones. the GPC contains: the greater palatine artery which is a branch of maxillary artery and the greater palatine nerve (GPN) and lesser palatine nerve which are branches of the maxillary nerve. The GPN innerves the palatine mucosa except the canine incisor area. It innerves also the palatal root of the first upper molar. The arterial blood supply of the palate is provided by the greater palatine artery. It runs through a groove lateral to the GPN and submits branches to the palatal mucosa and the gingiva, continuously decreasing its diameter. Then, it runs through the incisor canal [1-2].

The risk of the damage of the greater palatine complex while performing surgeries around this area cannot be denied. It is crucial to take precautions during the excision of pleomorphic adenoma, the placement of the tuberosity dental implant, the use of the lateral site of the palate as a donor for the sub-epithelial connective tissue graft, in order to avoid excessive bleeding and to maintain nerve supply to the maxillary [3-4-5].

The aim of this study was to evaluate the position of the greater palatine foramen (GPF) in Tunisian population using Cone Beam Computed Tomography (CBCT).

MATERIALS AND METHODS

This cross-sectional study enrolled 150 Tunisian patients consulting the Outpatients and Implantology Department at Dental Clinic in Monastir (Tunisia) between March 2015 and June 2016. One hundred and fifty maxillary Cone Beam Computed Tomography (CBCT) of all patients were used. These CBCT were

obtained by using settings Sirona Galileos unit (Sirona, Germany) and the images were performed with Galileos implant software. Scanning parameters were 85 kVp, 24 seconds, 5-7 mA, a voxel size of 0.15 mm or 0.3 mm and a field of view of 15 cm×15 cm with exposure times of 6 seconds and radiation dose of 29 µSv. The analysis was carried out using the distance measuring tools of this software. Males and females aged more than 17 years with second or third upper molars were included, while those with history of pathology or trauma in the region of the maxilla were excluded. For statistical analysis, we used the SPSS 20.0 Software: ANOVA test to compare the means of quantitative parameters and Chi square test to compare the frequency of qualitative parameters with gender/age ($p<0.05$).

In order to localize the greater palatine foramen (GPF), firstly, an axial reconstruction was used in the side of the enamel cement junction: a tangent X was drawn inter-proximally to the face of the second and third upper molars. Besides, a vertical axis Y was drawn in the middle of the occlusal table of those teeth. Then, the following distances were measured to localize the greater palatine foramen referring to these axes (figure 1).

- D1 was the distance between the nearest point of the GPF and Y axis.
- D2 was the distance between the farthest point of the GPF and Y axis.
- D3 was the distance between the nearest point of the GPF and X axis.
- D4 was the distance between the nearest point of the GPF and the intersection of X and Y axes.
- D5 was the distance between the farthest point of the GPF and the intersection of X and Y axes.
- D6 was the distance between the nearest point of the GPF and the intermaxillary suture.
- D/M°L was the medio-lateral diameter of the GPF.
- D/A°P was the antero-posterior diameter of the GPF.

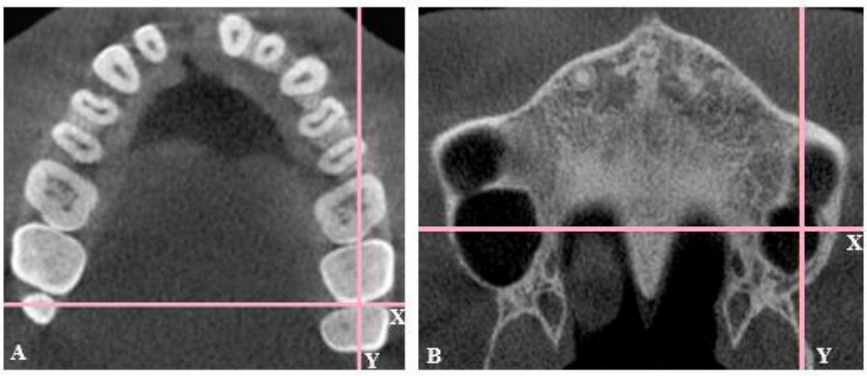

Fig-1: Axial reconstructions of Cone Beam Computed Tomography. A: in the side of the enamel cement junction, B: in the side of the greater palatine foramen, X axis: interproximal to the second and third upper molars, Y axis: in the middle of the occlusal table of the second and third upper molars.

RESULTS

The sample involved 150 patients (43.3% males/56.7% females) with sex ratio 0.76. Eight percent of patients were aged less than 20 years, 72% between 21 and 40 years and 20% more than 41 years. The GPF was: mesially and distally located to the X axis in 4.70% and 48%, respectively; mesially and distally tangent in 0.70% and 24%, respectively and, finally, centered in 22.70%. Moreover, the GPF had a rounded shape in 48.60% and an oval shape in 51.40% (figure 2). It was double in 3.40% and unique in 96.60% (figure 3).

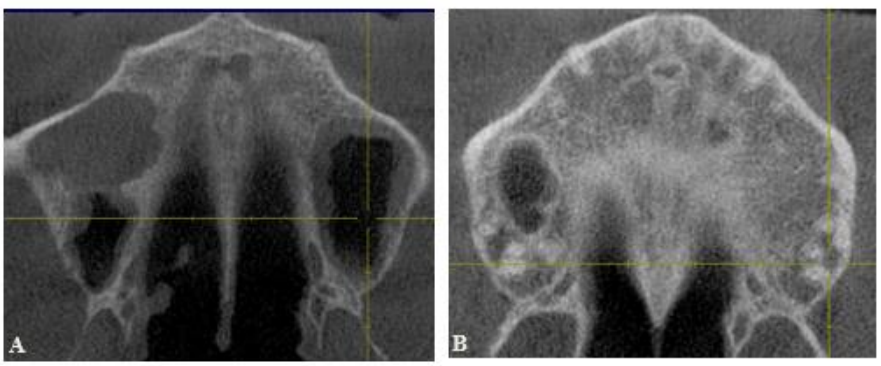

Fig- 2: Axial reconstructions of Cone Beam Computed Tomography showing the form of the greater palatine foramen. A: an oval shape, B: a rounded shape.

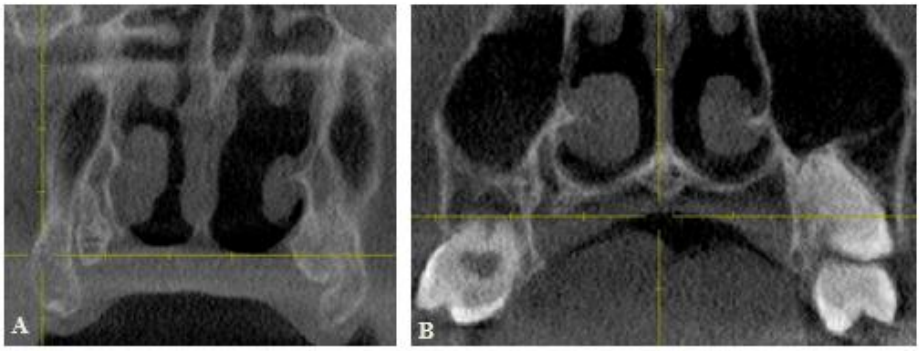

Fig- 3: Coronal reconstructions of Cone Beam Computed Tomography showing the number of the greater palatine canal. A: double, B: unique.

According to the gender, the GPF was mesially located to the X axis in 1.33% for females and 33.33% for males, mesially tangent to X axis for none females and 0.70% males, centered to X axis in 11.30% for both females and males, distally tangent to X axis in 14% for females and 10% for males. It was distally located to X axis in 30% for females and 18% for males (p=0.266). Besides, the GPF had a rounded shape in 34% for females,14.80% for males and an oval shape in 22.60% for females and 28.60% for males. There were significant differences between its form and the gender (p=0.001). It was rounder for females and more oval for males. The following table shows the mean of D1, D2, D3, D4, D5, D6, the medio-lateral diameter and the antero-posterior diameter for males and females and the value of p.

Table-1: The distribution of quantitative parameters according to the gender in the study population (N=150)

	Total			**Males**			**Females**			**p**
	n	m	SD	n	m	SD	n	m	SD	
D1	150	8.87	1.89	65	8.68	2.22	85	9.01	1.60	0.28O
D2	150	11.04	1.89	65	11.28	2.07	85	10.86	1.74	0.181
D3	150	2.48	2.63	65	2.95	3.05	85	2.12	2.21	0.055
D4	150	10.48	1.87	65	10.54	2.20	85	10.43	1.59	0.721
D5	150	11.65	2.45	65	11.93	2.60	85	11.43	2.32	0.210
D6	150	14.02	1.30	65	14.58	1.30	85	13.58	1.13	<0.0001
D/M°L	150	2.02	0.60	65	2.30	0.57	85	1.81	0.54	<0.0001
D/A°P	150	4.51	1.22	65	4.98	1.07	85	4.15	1.20	<0.0001

* **SD :** Standard-Deviation, **D1:** the distance between the nearest point of the GPF and Y axis, **D2:** the distance between the farthest point of the GPF and Y axis, **D3:** the distance between the nearest point of the GPF and X axis, **D4:**the distance between the nearest point of the GPF and the intersection of X and Y axes, **D5:** the distance between the farthest point of the GPF and the intersection of X and Y axes, **D6:** the distance between the nearest point of the GPF and the intermaxillary suture, **D/M°L:** the medio-lateral diameter of the greater palatine foramen, **D/A°P:** the antero-posterior diameter of the greater palatine foramen.

Moreover, the greater palatine foramen localization referred to the X axis for each group of age in the study population is shown in the figure 4. There were no significant differences between the position of the GPF to the X axis and the age (p=0.983).

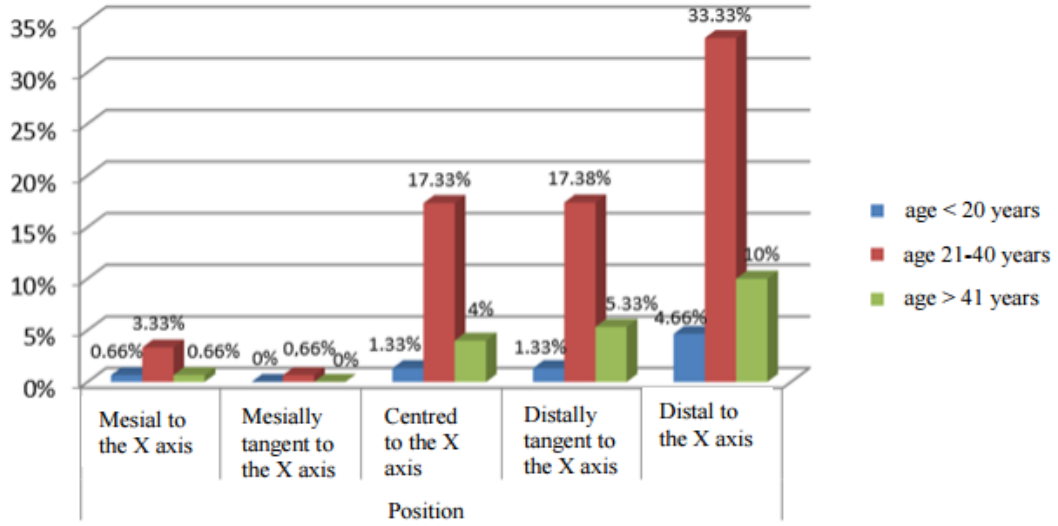

Fig-4: The greater palatine foramen localization referred to the X axis for each group of age in the study population (N=150)

Besides, for patients aged less than 20 years, the GPF was round in 5.33% and oval in 2.66%. Between 20 and 40 years, it was 35.35% round and 36.66% oval. For those aged more than 40 years, it was round in 8% and oval in 12% (p=0.291). The distribution of D1, D2, D3, D4, D5, D6, D/M°L, D/A°P according to the age in the study population and the value of p are shown in the table 2. There were no significant differences between the gender and D1(p=0.909), D2(p=0.510), D3(p=0.644), D4(p=0.399), D5(p=0.207), D6(p=0.327). However, significant differences between the age and the medio-lateral diameter (p<0.0001) and the antero-posterior diameter (p=0.002) using ANOVA test.

Table-2: The distribution of quantitative parameters according to the age in the study population (N=150)

	Total			**<20**			**21-40**			**>41**			**p**
	n	m	SD	n	m	SD	n	m	SD	n	m	SD	
D1	150	8.87	1.89	12	8.74	1.09	108	8.91	1.86	30	8.77	2.26	0.909
D2	150	11.04	1.89	12	10.78	1.44	108	10.97	1.87	30	11.38	2.14	0.510
D3	150	2.48	2.63	12	2.95	2.17	108	2.36	2.69	30	2.73	2.60	0.644
D4	150	10.48	1.87	12	10.35	1.33	108	10.37	1.92	30	10.89	1.88	0.399
D5	150	11.65	2.45	12	11.81	1.39	108	11.44	2.55	30	12.33	2.34	0.207
D6	150	14.02	1.30	12	14.45	1.52	108	13.93	1.16	30	14.17	1.65	0.327
D/M°L	150	2.02	0.60	12	1.85	0.58	108	1.92	.55	30	2.48	0.61	<0.0001
D/A°P	150	4.51	1.22	12	3.88	1.04	108	4.40	1.20	30	5.16	1.09	0.002

* **SD :** Standard-Deviation, **D1:** the distance between the nearest point of the GPF and Y axis, **D2:** the distance between the farthest point of the GPF and Y axis, **D3:** the distance between the nearest point of the GPF and X axis, **D4:**the distance between the nearest point of the GPF and the intersection of X and Y axes, **D5:** the distance between the farthest point of the GPF and the intersection of X and Y axes, **D6:** the distance between the nearest point of the GPF and the intermaxillary suture, **D/M°L:** the medio-lateral diameter of the greater palatine foramen, **D/A°P:** the antero-posterior diameter of the greater palatine foramen.

DISCUSSION

We should have an accurate knowledge of the anatomic palatal side of the maxillary molar region and it is crucial to take precautions while performing surgeries around the greater palatine foramen area such as: the excision of pleomorphic adenoma, the use of the lateral site of the palate as a donor for sub-epithelial connective tissue graft and the placement of tuberosity dental implant as an alternative for the treatment of patients with insufficient bone volume in the maxillary region [3-4-5].

The aim of this study was to assess the position of the greater palatine foramen in Tunisian patients using Cone Beam Computed Tomography.

Most studies regarding the GPF position were performed on dry skulls. The CBCT image analysis has the advantage to add information about age/sex and ethnicity. As the CBCT provides precise measurements. It was used to determine distances, diameters and GPF characteristics.

In this study, the GPF was, in 48%, opposite to the distal portion of the third upper molar or distal to this

tooth, in front of the mesial portion of the third molar in 24%, between the second and the third upper molars in 22.7% and it was opposite to the distal portion of the second upper molar in 5.40%. No significant differences were found between The GPF position and the age neither the gender ($p>0.05$). This result is in accordance with the majority of the consulted literature. Tomaszewska et *al* mentioned that the GPF was mainly located opposite to the third upper molar in 74.7%, distal to this tooth in 2.20%, absent in front of the mesial portion of the second molar. Whereas, it was between the second and third upper molars in 6.80% and in 16.3%, in front of the distal portion of the second molar [6-7-8-9-10-11-12-13]. In another study using dry skulls, Methathrathip et *al* found that in 5.6%, the GPF was opposite to the second molar, between the second and the third molars in 23.1% and opposite to the third molar in 64.4% [14]. However, Wang et *al* found that the GPF was mainly located between the second and third molars [15]. Therefore, the region which is beginning from the mesial portion of the second upper molar is safer to harvest a connective tissue graft.

In this study, the GPC was double in 0.05% and unique in 99.95%. The study of Cagimni et *al* mentioned that the GPC was unique in 81%, double in 13%, but, triple in 2% [16].

In addition, the distances: D1, D2, D3, D4, D5 were not described in the literature. They were measured in this study in order to achieve accurate localizations of the GPF referred to X and Y axes. The mean of D6 which was the distance between the intermaxillary suture and the nearest point of the GPF was 14.02 ±1.30 mm. Carla et *al* found a similar result: 15.2 mm. This parameter could be used with edentulous patients when the surgeon will use the lateral site of the palate as a donor for sub-epithelial connective tissue graft [17]. A significant variation, according to the gender, was found in the distance between the inter-maxillary suture and the GPF ($p<0.0001$). This distance was more important for males (14.58mm) than females (13.58mm).

The GPF had a rounded shape in 48.60% and an oval shape in 51.40%. A significant variation between the GPF form and the gender was recorded ($p=0.001$). It was more round for females and more oval for males.

Moreover, the mean of the medio-lateral and antero-posterior diameters was 2.02 ±0.60mm and 4.5 ±1.22mm, respectively. Pinar et *al* found a similar result: 2.55 and 3.01mm, respectively [18,19]. A significant variation was recorded between the diameter and either the gender and the age. It was more important for males and increased with age.

Therefore, this study may help clinicians to plan the connective tissue graft harvesting zone to avoid excessive bleeding and to maintain nerve supply to the maxillary.

CONCLUSION

The greater palatine foramen was mostly located opposite to the third upper molar and between the second and the third molars. Any surgery in these areas should be performed cautiously to prevent damage to this vascular-nerve complex and to insure the patient satisfaction during and after surgery.

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