

# Cone-Beam, Computerized Tomography (CBCT) as a novel pre-op non-invasive method to determine the location of Greater Palatine Foramen

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## ABSTRACT

**Aim:** To determine the greater palatine foramen position with reference to Maxillary molar teeth among patients presenting in a tertiary care hospital in Lahore by using cone beam computed (CBCT).

**Method:** In this cross sectional study which was conducted at Fatima Memorial Hospital located in Lahore, in which a total of 80 patients were included. Informed consents and demographic details were noted. Cone beam computed tomography was taken in Planmeca Promax 3D Mid (60-120 kV; 9-33 s; 200  $\mu$ m voxel size) of all subjects. As per operational definitions, linear measurements for location of greater palatine foramen were measured. All the information was recorded in a specifically designed form.

**Results:** On average the age of patients in this study was  $39.35 \pm 11.19$  years, 38 (47.50%) patients were male. On left and right side the most common position was between middle and mesial face of third molar noted in 45 (56.25%) and 43 (53.75%) patients respectively.

**Conclusion:** The most common position both sides was the position between middle and mesial face of third molar followed by position between distal face and middle of third molar in patients reporting in a tertiary care hospital located in Lahore by using cone beam computed tomography (CBCT)

**Keywords:** Greater palatine foramen, cone beam, CT,

## INTRODUCTION

Gingival recession is a common periodontal condition. Free gingival soft tissue grafts and sub-epithelial connective soft tissue grafts are most common treatment modalities for management of gingival recession<sup>1</sup>. Palate is a main donor area for these soft tissue grafts and free gingival grafts<sup>2</sup>. The size of these grafts depends on the position of neurovascular bundle present at or near the donor site<sup>1</sup>. The possibility of haemorrhagic complication limits clinicians from harvesting the optimum sized grafts required for the treatment demands<sup>3</sup>.

Greater palatine neurovascular bundle is an important structure to be identified during harvesting of sub-epithelial connective tissue palatal graft<sup>4</sup>. Branches of the greater palatine nerve course along the greater palatine artery, which innervates the hard palate and gingiva of maxillary teeth<sup>2</sup>. The greater palatine foramen is present adjacent to lateral border of hard palate behind the palate-maxillary suture near the upper third molar tooth and its location differs as the anterior to posterior dimension of arch increases with the eruption of molar teeth<sup>5,6</sup>.

Issues concerning the anatomical position of greater palatine canal are still controversial: e.g. the asymmetry of location of the greater palatine foramen, which may cause clinical and surgical complications<sup>7</sup>. Usually the dentists use teeth as an indirect reference to locate the greater palatine foramen during or before surgical procedure<sup>8</sup>. The maxillary molars along with maxillary midline suture are anatomical landmarks that are used as references while localising the location of greater palatine foramen (GPF). In previous studies, location of Greater palatine foramen (GPF) was found to be 41.38% between mesial and distal line angles of 3<sup>rd</sup> molars, 29.31% were distal to 3<sup>rd</sup> molar, 27.59% were mesial to 3<sup>rd</sup> molar and distal to 2<sup>nd</sup> molar, and 1.72% were present between mesial and distal of 2<sup>nd</sup> molar. It was found at a distance of 16.228 mm and 14.907 mm from maxillary midline suture on right and left sides respectively<sup>9</sup>.

Numerous cadaver and radiological studies have recommended safe distances from the adjacent teeth to greater palatine foramen to guide the clinicians to determine the surgical

borders of palatal donor sites while graft harvesting<sup>3</sup>. Few studies evaluate the position and topography of the neurovascular bundle by soft tissue dissection of cadavers<sup>2</sup>. Most of the studies in the past were performed on dry skulls. One major limitation of these studies is the unknown gender of the skulls which resulted in average values that does not apply to male and female population due to sexual dimorphism<sup>9</sup>.

Cone beam computed tomography (CBCT) is one of the technological breakthrough of medical and dental imaging techniques that has proven to be an alternative for detailed and accurate assessments<sup>9</sup>. One advantage of this approach is the opportunity to analyse the similar anatomical parameters in a population, with information about gender, age, and clinical history, whereas the studies performed on skulls perform assessment of archaeological material and unsexed individuals<sup>7</sup>.

## METHODOLOGY

This study was carried out at the Department of Periodontology at Fatima Memorial Hospital College of Medicine and Dentistry located in Lahore, from 01-09-2020 to 29-02-2021. 80 Periodontally healthy subjects of both genders aged between 18 and 80 years, having all upper molars and requiring CBCT for dental implants or any other dental treatment were included in this study. Patients having Periodontal disease, pathologic bone disease, history of surgery on palate or tuberosity region and Pregnant patients were not included in this study. Approval from institutional review board (IRB) of Fatima memorial hospital was acquired. Every patient signed the consent form. The demographic information of all the patients was noted, history of medical and dental conditions and treatments were explored and complete dental evaluations were performed. Cone beam computed tomography (CBCT) was taken in Planmeca Promax 3D Mid (60-120 kV; 9-33 s; 200  $\mu$ m voxel size) of all subjects. As per operational definitions, linear measurements for location of greater palatine foramen were measured. All the information was recorded in a specifically designed form by a single researcher. Collected data was put and analysed in computer program i.e. SPSS (Ver. 20). Quantitative variables like age and radiographic measurements on cone beam computed tomography (CBCT) was presented as mean & also standard deviation. Frequencies & percentages for gender were

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calculated and side Data was calculated for gender, age, and right or left quadrants in reference to Maxillary molar teeth. Taking P-Value < 0.05 as significant, the post-stratification chi-square test was used.

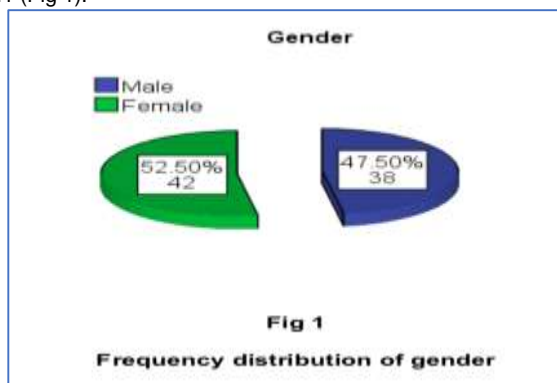
**RESULTS**

Mean age of the patients in this study was found to be 39.35±11.19 years with minimum and maximum ages of 20 & 64 years respectively.

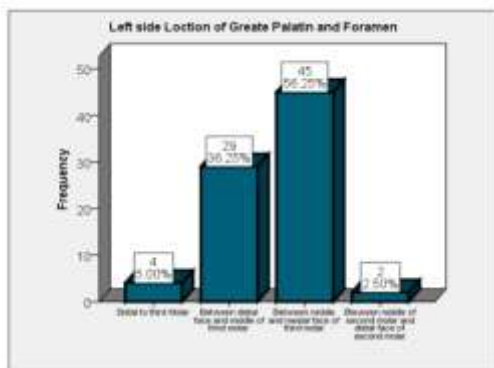
Table 1

n	80
Age (Years)	
Mean	39.35
Standard Deviation	11.19
Minimum	20
Maximum	64

In this study 38(47.50%) patients were males and 42(52.50%) patients were females. Male patients to female patients ratio was 0.9:1 (Fig 1).

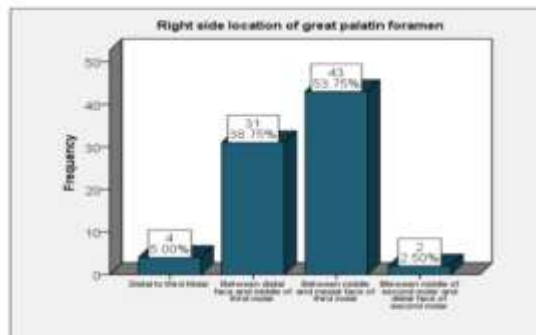


According to this study on left side distal to third molar location of great palatine and foramen was noted in 4(5.0%) patients, between distal face and middle of third molar was noted in 29(36.50%) patients, between middle and mesial face of third molar was noted in 45(56.25%) patients and between middle of second molar and distal face of second molar was noted in 2(2.50%) patients (Fig 2).



In this study on right side distal to third molar location of great palatine and foramen was noted in 4(5.00%) patients, between distal face and middle of third molar was noted in 31(38.75%) patients, between middle and mesial face of third molar was noted

in 43(53.75%) patients and between middle of second molar and distal face of second molar was noted in 2(2.50%) patients (Fig 3).



In patients having age ≤ 40 years, distal to third molar right side location of great palatine and foramen was found in 3(6.7%) patients and in patients having age >40 years the distal to third molar left side location of great palatine and foramen was found in 1(2.9%) patients. In patients having age ≤ 40 years, between distal face and middle of third molar left side location of great palatine and foramen was found in 18(40.0%) patients and in patients having age >40 years between distal face and middle of third molar left side location of great palatine and foramen was found in 11(31.4%) patients. In patients with age ≤ 40 years, between middle and mesial face of third molar was present in 24(53.3%) patients and in patients having age >40 years between middle and mesial face of third molar was found in 21(60%) patients. This difference found was statistically insignificant. i.e. p-value=0.125.

Table 2

Comparison of left side location of great palatine and foramen stratified by age

Left side location of great palatine and foramen	Age groups		Total	p-value
	≤ 40	>40		
Distal to third Molar	3	1	4	0.125
Between distal face and middle of third molar	18	11	29	
Between middle and mesial face of third molar	24	21	45	
Between middle of second molar and distal face of second molar	0	2	2	
<b>Total</b>	<b>45</b>	<b>35</b>	<b>80</b>	
	100.0%	100.0%	100.0%	

In patients having age ≤ 40 years, distal to third molar right side location of great palatine and foramen was found in 3(6.7%) patients and in patients having age >40 years the distal to third molar left side location of great palatine and foramen was found in 1(2.9%) patients. In patients having age ≤ 40 years, between distal face and middle of third molar left side location of great palatine and foramen was found in 20(44.4%) patients and in patients having age >40 years between distal face and middle of third

molar left side location of great palatine and foramen was found in 11(31.4%) patients. In patients with age ≤ 40 years, between middle and mesial face of third molar was found in 22(48.9%) patients and in patients having age >40 years Between middle and mesial face of third molar was present in 21(60%) patients. This difference was not statistically significant. i.e. p-value=0.066 (Table 3).

**Table 3**  
Comparison of right side location of great palatine and foramen stratified by age

Right side location of great palatine and foramen	Age groups		Total	p-value
	≤ 40	>40		
Distal to third Molar	3	1	4	0.066
	6.7%	2.9%	5.0%	
Between distal face and middle of third molar	20	11	31	
	44.4%	31.4%	38.8%	
Between middle and mesial face of third molar	22	21	43	
	48.9%	60.0%	53.8%	
Between middle of second molar and distal face of second molar	0	2	2	
	0.0%	5.7%	2.5%	
Total	45	35	80	
	100.0%	100.0%	100.0%	

**Table 4**  
Comparison of right side location of great palatine and foramen stratified by gender

Right side location of great palatine and foramen	Gender		Total	p-value
	Male	Female		
Distal to third Molar	2	2	4	0.839
	5.3%	4.8%	5.0%	
Between distal face and middle of third molar	13	18	31	
	34.2%	42.9%	38.8%	
Between middle and mesial face of third molar	23	20	43	
	60.5%	47.6%	53.8%	
Between middle of second molar and distal face of second molar	0	2	2	
	0.0%	4.8%	2.5%	
Total	38	42	80	
	100.0%	100.0%	100.0%	

In male patients, distal to third molar left side location of great palatine and foramen was found in 2(5.3%) patients and in female the distal to third molar left side location of great palatine and foramen was found in 2(4.8%) patients. In male patients, between distal face and middle of third molar left side location of great palatine and foramen was found in 13(34.2%) patients and in female patients between distal face and middle of third molar left side location of great palatine and foramen was found in 16(38.1%) patients. In male patients, between middle and mesial face of third

molar was found in 23(60.5%) patients and in female patients, between middle and mesial face of third molar was found in 22(52.4%) patients. This difference was not statistically significant. i.e. p-value=0.895 (Table 4).

In male patients, distal to third molar right side location of great palatine and foramen was found in 2(5.3%) patients and in female the distal to third molar right side location of great palatine and foramen was found in 2(4.8%) patients. In male patients, between distal face and middle of third molar left side location of great palatine and foramen was found in 13(34.2%) patients and in female patients between distal face and middle of third molar right side location of great palatine and foramen was found in 18(42.9%) patients. In male patients, between middle and mesial face of third molar was found in 23(60.5%) patients and in female patients, between middle and mesial face of third molar was found in 20(47.6%) patients. This difference was not statistically significant. i.e. p-value=0.839

### DISCUSSION

This present cross sectional study was performed at Department of Periodontology, Fatima Memorial Hospital located in Lahore to determine the greater palatine foramen position with reference to Maxillary molars among patients reporting to a tertiary care hospital in Lahore by using cone beam computed (CBCT).

While performing anaesthesia of maxillary nerve while using Greater palatine canal approach, a perfect 3D orientation of location, direction and dimensions of this canal is required. The initial step is identifying the GPF. When numerous anatomical landmarks are used to identify GPF, the accuracy is enhanced while minimising the injecting anaesthetic drug complications<sup>13</sup>.

In this study on left side distal to third molar location of great palatine and foramen was noted in 4(5.0%) patients, between distal face and middle of third molar was noted in 29(36.50%) patients, between middle and mesial face of third molar was noted in 44(56.25%) patients and between middle of second molar and distal face of second molar was noted in 2(2.50%) patients. Similarly on right side distal to third molar location of great palatine and foramen was noted in 4(5.00%) patients, between distal face and middle of third molar was noted in 31(38.75%) patients, between middle and mesial face of third molar was noted in 43(53.75%) patients and between middle of second molar and distal face of second molar was noted in 2(2.50%) patients. In past, the studies have been performed on dried skulls belonging to different ethnic populations and the GPF has been found to be present on opposite to the third molars most commonly<sup>10,11,16-18</sup>. However, this number has been reported to vary between 47.5% and as high as 92% which highlights the significant variability<sup>8</sup>.

The majority of research has suggested a significant predilection towards the third molar region but not towards mesial or distal to it, with proportions reaching more than 70%, and has been reported in approximately 50% of published studies<sup>18</sup>.

In previous studies, location of the Greater palatine foramina was found to be 41.38% between mesial and distal line angles of 3<sup>rd</sup> molars, 29.31% were distal to 3<sup>rd</sup> molar, 27.59% were mesial to 3<sup>rd</sup> molar and distal to 2<sup>nd</sup> molar, and 1.72% were present between mesial and distal of 2<sup>nd</sup> molar. It was found at a distance of 16.228 mm and 14.907 mm from maxillary midline suture on right and left sides respectively<sup>9</sup>. As reported in a study by Slavkin et al<sup>19</sup> the GPF is present at a distance of 1 to 3 mm distally to the maxillary third molars of adult corpses skulls. Westmoreland & Blanton found 6% of GPF distal to the maxillary 3<sup>rd</sup> molars. In another study by Ajmani<sup>20</sup>, 48% GPF in the Nigerian population and 64% GPF in the Indian Skulls were located medially or opposite to the maxillary third molars. Saralaya and Nayak<sup>10</sup> reported this location in approximately 74.6% skulls. Study carried out on Nigerian skulls showed 13.6% of foramina located opposite to the maxillary second molars<sup>20</sup> as compared to only 4% reported by Saralaya & Nayak<sup>10</sup>.

Westmoreland and Blanton<sup>21</sup> reported 9.7% of GPF medial to the second maxillary molar. In a study carried out on Kenyan skulls, about 76% cases had GPF located opposite to the upper third molars<sup>22</sup>. In another study performed on Chinese skulls, the foramen was most commonly present between the maxillary second and third molars<sup>23</sup>. The most frequent location of GPF in relation to the maxillary third molar has been reported in Kenyan, East Indian, Negroid, Indian and skulls Nigerian<sup>20,21,24</sup>.

BR Chrcanovic et al<sup>11</sup> found the location of GPF can be variable, as reported in previously discussed studies. In 54.87% of the skulls the GPF was located opposing to the maxillary third molar, 38.94% of foramina were present distal side of maxillary third molars, while 6.19% of foramina between the maxillary 2nd and 3<sup>rd</sup> molars.

According to a study by Ahmed Sayed Awad et al<sup>25</sup> the presence of GPF on both sides was a constant finding in all of the examined CT scans. The foramen was located opposite to M3 (41%) in majority of the cases. On other hand, the less frequent locations were distal to M3 (25.8%), Inter-proximal area mesial to M3 and Distal to M2 (23.2%), and lastly opposite to M2 (10%). This similar common location i.e. opposite to M3, was also found by Shalaby et al<sup>26</sup> in their study carried out on Egyptian skulls (84%). Varalakshmi et al<sup>27</sup> and Beetge et al<sup>28</sup> concluded that GPFs are present close to the third maxillary molar in 69.8% and 66.65% of their studies, respectively. This stands in agreement as concluded by Tomaszewska et al. in his study<sup>14</sup> who showed GPF to be most commonly located medially to M3 (74.7%), both in European population and worldwide. Wang et al<sup>23</sup> performed a study on Chinese showed that the most common location of GPF was between upper 2<sup>nd</sup> and 3<sup>rd</sup> molars, on the other hand the Klosek and Rungruang<sup>12</sup>, in Thais, reported the most common location to be opposite to the second molars. After all this research and studies on patients and skulls, there is no consensus on the location of GPF. The diversity in GPF position might be due to the differences in quality of procedures that were performed and also due to approach to relate the GPF and maxillary molars<sup>14,28</sup>.

## CONCLUSION

This study concluded that the greater palatine foramen position showed constant finding on the both left and right side. The most common position both sides was the position between middle and mesial face of third molar, followed by position between distal face and middle of third molar in patients presenting to Fatima Memorial Hospital in Lahore, which is a tertiary care hospital, by using cone beam computed tomography (CBCT).

**Conflict of interest:** Nil

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