

## ANATOMICAL STUDY ON LOCATION OF GREATER PALATINE FORAMEN IN DRIED ADULT HUMAN SKULL: KEY TO SUCCESSFUL MAXILLARY NERVE BLOCK

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### ABSTRACT

**Background:** The greater palatine foramen (GPF) conducts greater palatine nerve, responsible for the innervation of posterior part of the hard palate. Anaesthetic block for greater palatine nerve is highly recommended for surgical practices involving upper molar, maxillary sinus and nasal region. But the practical problem associated with anaesthesia is difficulty in locating the exact position of greater palatine foramen, leading to delivering insufficient anaesthetic solution. The greater palatine neurovascular structures enter the oral cavity through the greater palatine foramen so this foramen should be approached carefully during any surgical procedures to avoid damage to these neurovascular structure.

**Materials and methods:** 126 dried adult skull bones of unknown sex, obtained from the department of anatomy, MVJ Medical College and Research Hospital were used to locate the exact position of greater palatine foramen in relation to bony landmarks. On both side, the distance of greater palatine foramen from midline maxillary suture, posterior border of hardpalate, incisive fossa and lesser palatine foramen were measured with digital vernier caliper. Location of GPF in relation to molar or premolar tooth was also noted. The data obtained were analyzed statistically by calculating mean and standard deviation. The percentage was calculated for the location of GPF in relation to molar or premolar tooth.

**Result:** In the present study of anthropometric analysis of greater palatine foramen of 126 dried skulls, it was observed that the most common location of greater palatine foramen was opposite to the third molar tooth. The mean distance between greater palatine foramen to mid maxillary suture was 13.71mm on right side and 13.72mm on left side and posterior border of hard palate on right side was 4.62mm and 4.49mm on left side. The mean distance between greater palatine foramen and incisive fossa was 36.73mm and 36.66mm on the right and left side respectively. The mean distance between greater palatine foramen and lesser palatine foramen was 1.47mm on right side and 1.49 mm on left side.

**Conclusion:** Results of present study may contribute greatly to the successful outcome of maxillofacial and oral surgeries regional anaesthesia.

**KEY WORDS:** Greater palatine foramen, Hard palate, Incisive fossa, Lesser palatine foramen, Mid maxillary suture.

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## INTRODUCTION

The greater palatine foramen (GPF) is situated medial to the third molar teeth, near to the lateral border of hard palate. It transmits greater palatine nerves and vessels [1]. The greater palatine foramen is an essential anatomical structure with great clinical significance mainly for dentists, maxillofacial surgeons and plastic surgeons [2]. The exact topographical location of this foramen is utmost important to accomplish the block anesthesia of greater palatine nerve in minor oral surgeries, periodontics and general dentistry as it supplies the posterior part of hard palate [3].

The common surgical procedures involving greater palatine foramen include closure of oroantral or nasal fistulas, harvesting palatal masticatory mucosa for grafting procedures, orthognathic Le Fort 1 osteotomies, surgeries on removal of palatal tumors or extraction of molar teeth [4]. Maxillary nerve blocks for maxillofacial surgeries can be achieved through two intraoral approaches-high tuberosity approach and the greater palatine canal approach. Studies have shown that the high tuberosity approach usually associated with complications such as inadequacy of profound anaesthesia and high risk of haematoma due to its proximity to pterygoid venous plexus. The most common and successful approach is through greater palatine canal, which can be reached through greater palatine foramen, will block the maxillary nerve as it passes through pterygopalatine fossa [5]. But the common problem documented in this approach is operator's inability to precisely locating the greater palatine foramen.

In view of lack of description on precise location of greater palatine foramen in standard text books of anatomy and anesthesiology and limited anthropometric studies, the present study was aimed to determine the position of greater palatine foramen in relation to anatomical landmarks. This will help the dentist and anesthetist to perform their surgeries in a successful manner by avoiding unnecessary damage to greater palatine nerves and vessels.

## MATERIALS AND METHODS

The study of morphometric analysis of location

of greater palatine foramen was conducted on 126 dried adult skull bones of unknown sex obtained from the department of anatomy, MVJ Medical College and Research Hospital, were used to locate the exact position of foramen in relation to bony landmarks. The dried skulls with fully erupted third molar tooth without any pathological deformity or changes such as malposition of teeth or edentulous alveolus arches were used for the study. Following parameters were measured with digital vernier caliper with 0.01 mm precision symmetrically, right and left side.

- i) Distance between the GPF and midline maxillary suture.
- ii) Horizontal distance between the GPF and posterior border of hard palate
- iii) Distance between the GPF and incisive fossa
- iv) Vertical distance between the GPF and lesser palatine foramen.
- v) Location of GPF in relation to molar or premolar tooth.

**Fig. 1:** Skull with arrows showing the distance of greater palatine foramen from anatomical landmarks. (1: Distance between the GPF and midline maxillary suture, 2: Distance between the GPF and posterior border of hard palate, 3: Distance between the GPF and incisive fossa 4: Vertical distance between the GPF and lesser palatine foramen.)



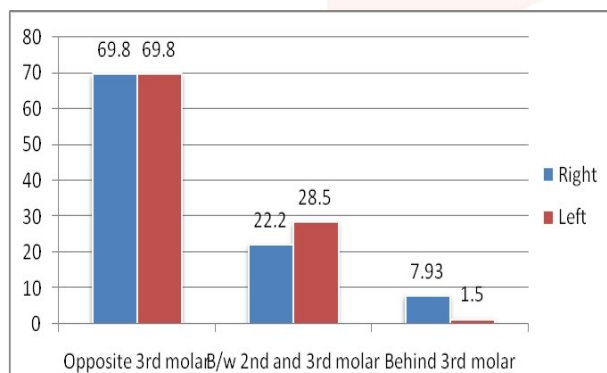
All measurements were taken with single observer to avoid inter-observer error. The data obtained were analysed statistically by calculating mean and standard deviation. The percentage was calculated for the location of

GPF in relation to molar or premolar tooth.

## RESULTS

In the present study of anthropometric analysis of greater palatine foramen of 126 dried skulls, it was observed that the most common location of greater palatine foramen was opposite to the third molar. On the right side, 88 skulls (69.8%) greater palatine foramen was located opposite to the 3<sup>rd</sup> molar and in 28 skulls (22.2%) it was located between second and third molar and 10 (7.93%) behind the third molar tooth. On the left side, 88 skulls (69.8%) greater palatine foramen was located opposite to the 3<sup>rd</sup> molar and in 36 skulls (28.5%) it was located between second and third molar and 2 (1.58%) behind the third molar tooth.

**Fig. 2:** Bar diagram showing the percentage of location of Greater palatine foramen in relation to molar tooth on right and left sides.



The mean distance between greater palatine foramen to mid maxillary suture was 13.71mm on right side and 13.72mm on left side. The mean distance between greater palatine foramen to posterior border of hard palate on right side was 4.62mm and 4.49mm on left side. The mean distance between greater palatine foramen and incisive fossa was 36.73mm and 36.66 mm on the right and left side respectively. The mean distance between greater palatine foramen and lesser palatine foramen was 1.47mm on right side and 1.49mm on left side.

**Table 1:** Distance of greater palatine foramen from anatomical land marks.

Parameters	Right side		Left side	
	Mean (mm)	Standard deviation	Mean (mm)	Standard deviation
Distance between GPF-mid maxillary suture	13.71	±2.15	13.72	±1.66
Distance between GPF-posterior border of hard palate	4.62	±1.52	4.49	±1.64
Distance between GPF-incisive fossa	36.73	±3.43	36.66	±1.92
Distance between GPF-lesser palatine foramen	1.47	±1.19	1.49	±1.32

## DISCUSSION

Identification of greater palatine foramen is of prime value for dentist and oral and maxillofacial surgeons. It is difficult to identify the precise location of greater palatine foramen. But at the same time it is also important to locate it precisely to perform the maxillary nerve block to achieve the profound anaesthesia of hemi maxilla [6]. The importance of GPF is not only confined to the successful outcome of oral and maxillofacial surgeries, it is also reported that stimulation of pterygopalatine ganglion through this foramen is utilized for relieving the effects of paralysis in paralytic patients and also for patient interventions in cases of cerebral vasospasm or cluster and migraine headache [7].

Standard text book of anatomy and anesthesiology mention the location of GPF as behind or posterolateral to the alveolar process of maxilla. In the present study the most common location of greater palatine foramen was opposite to the third molar tooth. Matsuda first identified and described the location of GPF in 1927 [4]. In the study by Bruno et al 54.8% of skulls it is located opposite the third molar and 38.9% distal to third molar and 6.19% between second and third molar teeth. Same like present study not even single skull had GPF behind the second molar tooth [8]. Satya Priya et al conducted study on 132 adult dry skulls and observed that in 74.6% of skulls GPF is located opposite the third molar tooth, 24.6% of skulls between second and third molar teeth and in 0.4% skulls GPF is located opposite the second molar tooth [9]. Similar to our study, Sathiyaraj et al noted that out of 100 skulls studied 68.5% skulls had GPF opposite the third molar, 22.5% skulls between second and third molar and 8% skulls behind the third molar. In 1% of skulls GPF was behind second molar tooth [10]. So the results of majority of studies like Vinay et al, Antony Sylvan D, Nidhi Sharma have shown that the common location of GPF is opposite third molar tooth followed by between second and third molar teeth [11-13]. Mia Michaela et al conducted a micro CT study on 77 human skulls scanned at South Africa and observed that the most common location of greater palatine foramen is near to third molar tooth in 66.7 % of skulls [4].



In our study the distance of GPF to mid maxillary suture on the right side is  $13.71 \pm 2.15$  mm on right side and  $13.72 \pm 1.66$  mm on left side. Namitha et al observed the distance between GPF and mid maxillary suture is  $14.78 \pm 1.38$  mm on right side and  $14.41 \pm 1.39$  mm on left side [5]. Nidhi Sharma et al observed a wide variation in the distance between GPF and mid maxillary suture ranging from 13.12 mm to 15.51 mm [13]. Jafar and Hamadah conducted a study on Iraqi skulls, observed the distance as 15.7 mm and study on Thai skull showed the distance as 16.2 mm [14]. The study on Indian skulls showed that the above distance is less as compared to that of other ethnic groups may be due to the embryological factors of variable sutural growth occurring between the maxilla and palatine bone [13].

The distance between greater palatine foramen and posterior border of hard palate was  $4.62 \pm 1.52$  mm on right side and  $4.49 \pm 1.64$  mm on left side. Saralaya et al conducted a study on 132 dry skulls and observed that the same distance is  $4.2 \pm 0.139$  mm and  $4.2 \pm 2.1$  mm on right and left side respectively [15]. In a study by Methrathip et al conducted on Thai skulls it was observed that the same distance less compared to Indian skull with an average of  $2.1 \pm 1.3$  mm. However together a conclusive finding on racial difference more skulls with different races, ethnic groups and geographical distribution should be studied [16].

In the present study the distance of incisive fossa from GPF was of  $36.73 \pm 3.43$  mm on the right side and  $36.66 \pm 1.92$  mm from left side. Murali et al recorded the same distance as  $36.54 \pm 1.91$  mm on right side and  $36.68 \pm 1.92$  mm on left side. The finding of our study closely correlates with the finding of study by Ajay et al which showed the distance of GPF to incisive fossa is  $36.6 \pm 2.20$  mm on right side and  $35.7 \pm 3.94$  mm on left side [17,18]. In our study, the distance of GPF from lesser palatine foramen is  $1.47 \pm 1.19$  mm on right side and  $1.49 \pm 1.32$  mm on left side. In a study by Ajay et al the distance is  $1.2 \pm 0.53$  mm on right side and  $1.3 \pm 0.53$  mm on left side [18].

Viveka S et al conducted similar morphometric study on 44 CT scans belonging to individuals from South Indian origin. GPF was located at

38.38 mm from incisive fossa, 17.6 mm from posterior nasal spine (PNS), 18.38 mm from intermaxillary suture, 5.03 mm from second molar and 5.28 mm from third molar. In 25 (56.8%) cases GPF was located closer to third molar. In 7 cases it was closer to second molar and in 12 cases, GPF was located at the junction of second and third molar. Posterior location of GPF, posterior to third molar was not observed. The author concluded that utilization of multiple anatomical reference points, such as the incisive foramen, the intermaxillary suture, and the second and third molars simplifies identification of GPF. This in turn untangles the task of greater palatine approach anaesthesia and reduced complications [5].

## CONCLUSION

The present study evaluated the position of greater palatine foramen in relation to anatomical landmarks which is useful for an anesthetist to locate the foramen better. The topographical location of greater palatine foramen in relation to molar tooth is important because many clinical conditions like palatal tumor or abscess or any dental procedures need greater palatine nerve block to obtain complete anesthesia of palate. The finding from the study can also be used for comparing the skulls with those from various other races and geographical distribution.

**Conflicts of Interests: None**

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