

*Original Research Article*

Analysis of position of greater palatine foramen in central Indian adult skulls: a consideration for maxillary nerve block

Dr. Vaibhav P. Anjankar^{1*}, Dr. S. D. Gupta², Dr. Shema Nair¹, Naresh Thaduri³, Dr. G. N. Trivedi⁴, Dr. Virendra Budhiraja⁴

¹ Assistant Professor, Department of Anatomy, L. N. Medical College & Research Centre, Bhopal, India.

² Associate professor, Department of Anatomy, L. N. Medical College & Research Centre, Bhopal, India.

³ Demonstrator, Department of Anatomy, L. N. Medical College & Research Centre, Bhopal, India.

⁴ Professor, Department of Anatomy, L. N. Medical College & Research Centre, Bhopal, India.

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ABSTRACT

To anaesthetize posterior part of soft palate for various surgical procedures, knowledge of the position of the greater palatine foramen (GPF) is very important. Blocking of maxillary division of trigeminal nerve or its branches for local anaesthesia is common practice for maxillofacial surgeries. Objective: this study was aimed to determine the morphology of greater palatine foramen in relation to certain fixed points. Methodology: this study was conducted on 86 dry adult Indian skulls. All the measurements were done with vernier caliper accurate to 0.1 mm. Using flexible stainless steel wire direction of opening of GPF into oral cavity was noted. Results: In 73.26% cases, GPF is located opposite third maxillary molar tooth. Mean distance from GPF to the incisive fossa (IF) was found to be 35.9 mm. The mean distance between posterior margins of GPF to posterior border of hard palate was 3.4 mm. The distance between the GPF to the midline maxillary suture was 15.3 mm. In 74.42% cases, direction of opening of GPF was located antero-laterally. Arched palatal vault was found in 66.28% skulls. Conclusion: The location of greater palatine foramen is variable still in most of the cases it is located opposite third molar tooth and is directed antero-later.

1. Introduction

The greater palatine foramen is important anatomical landmark in relation to the hard palate; the reason being the structures transmitting through it, i.e. greater palatine nerve, one of the branches of the maxillary division of the trigeminal nerve. Greater palatine nerve innervates the posterior part of hard palate. Greater palatine foramen (GPF) is of critical importance to dentists, ENT surgeons and maxillofacial surgeons who perform a number of procedures in this region like dental implant placements, local anesthetic administration, Le Forte osteotomies, sinonasal surgeries etc [1]. Evaluation of the relative position of GPF is important for injection of local anaesthetic for optimal pain control in maxillofacial and dental surgeries [2]. Maxillary divisions of the trigeminal nerve or its branches are usually blocked by administering anaesthesia in the greater palatine canal. The most common problem here is the location of the greater palatine foramen. Most of the textbooks fail to give the exact location of the greater palatine

foramen. First description of its location was given by Matsuda [3] in 1927. Grays Anatomy [4] states that GPF lies near the lateral palatal border of the transverse palatal suture. Variations in position of GPF pose difficulties in identifying the emergence of the greater palatine artery within the oral cavity, which represents important information in the surgery of palatal free vascular flaps, cleft palate, or maxillary sinus [5]. For performing operative procedures in the region of posterior part of hard palate, anaesthesia of this region is done by injecting greater palatine foramen where the nerve with the same name penetrates, responsible for the innervation of the reported area. The present study was carried out to locate the anatomical position, direction and other variations of the greater palatine foramen with respect to other anatomical landmarks, which will be useful to maxillofacial surgeons and anaesthetists to administer local anaesthesia. We also tried to correlate the results of our study with other researchers to compare our values of Indian population with others.

2. Material and methods

This study was carried out on 86 dry human adult skulls from central India having fully erupted third molar tooth. The data was collected from skulls obtained from department of anatomy and forensic medicine of L. N. medical college & research centre, Bhopal. Skulls with bony abnormalities were excluded from the study. All measurements were taken with a vernier caliper accurate to 0.1 mm. Using flexible stainless steel wire direction of opening of GPF into oral cavity was noted. All measurements were tabulated and analyzed using statistical software SPSS.

The following observations were made.

- Relationship of the greater palatine foramen (GPF) with maxillary molar teeth (MM)
- Distance between the centre of GPF and the incisive fossa (IF)
- Distance between posterior margin of GPF to posterior border of hard palate (PBHP)
- Perpendicular distance measured between the medial margin of GPF to midline maxillary suture (MMS)
- Direction of opening of the GPF into the oral cavity

3. Results

The relationship of the GPF to the maxillary molar teeth (MM) is very critical. Table I is explaining the data of our results. Maximum i.e. in 63 (73.26%) cases, GPF is located opposite third maxillary molar tooth.

Table I: showing relationship of GPF to maxillary molar teeth (MM):

Relation to maxillary molars	Right side (%)	Left side (%)	Both sides (%)
Opposite second molar	6 (6.98%)	6 (6.98%)	6 (6.98%)
Between second and third molar	14 (16.27%)	14 (16.27%)	14 (16.27%)
Opposite third molar	63 (73.26%)	63 (73.26%)	63 (73.26%)
Distal to third molar	3 (3.49%)	3 (3.49%)	3 (3.49%)
Total	86 (100%)	86 (100%)	86 (100%)

Table II: showing various distances calculated from GPF (in mm)

Various distances in mm	Right side	Left side	Mean of both sides
GPF to incisive fossa (IF)	36.2	35.7	35.9
GPF to posterior border of hard palate (PBHP)	3.5	3.3	3.4
GPF to midline maxillary suture (MMS)	15.4	15.1	15.3

Table II depicts that mean distance from GPF to the incisive fossa (IF) was found to be 36.2 mm on right side and 35.7 mm on left side. The mean distance between posterior margins of GPF to posterior border of hard palate was 3.5 mm on right

side and 3.3 mm on left side. The distance between the GPF to the midline maxillary suture was higher on right side as compared to left side.

The direction of opening of GPF into oral cavity was found to be anterolateral in 64 (74.42%) cases, anteriorly in 13 (15.12%) cases, anteromedially in 6 (6.98%) cases and vertically in 3 (3.48%) cases.

The shape of palatal vault was arched in 57 (66.28%), flat in 14 (16.28%) and 15 (17.44%) cases.

In 7 skulls, we found multiple lesser palatine foramina. Lesser palatine foramen was absent bilaterally in one skull. Average number of lesser palatine foramen was 1.2 on right and 1.1 on left side.

4. Discussion

Prompt anesthesia of the palate is achieved by inserting a needle into the canal through the greater palatine foramen. This allows the anaesthetic solution to reach the pterygopalatine fossa, where the ramification of the trigeminal nerve and the trunk of the maxillary nerve lie down. This study is useful for obtaining trigeminal nerve second division block is needed, when posterior palatine anaesthesia is required, and as alternative to posterior nasal packing and arterial ligation in cases of epistaxis. It is also important for prosthetic dentistry and comparative racial studies [7].

The position of maxillary molar is one of the most commonly used criteria for determining the location of GPF. In the present study, 73.26% GPF are located opposite the third maxillary molar. Kumar A et al [8] noted that 85% GPF are located opposite third molar tooth. Study by Wang et al [9] in Chinese population found GPF between 2nd and 3rd molar in 48.5% and opposite third molar in 33.5% cases. Comparison between the findings of our study and other authors is depicted in table III.

Table III: showing percentage of opening of GPF in relation to the maxillary molars:

Researchers	Population studied	Opposite 2 nd molar	Between 2 nd and 3 rd molar	Opposite 3 rd molar	Distal to third molar
Jaffar & Hamadah ⁷ (2003)	Iraqi	12	19	55	14
Saralaya & Nayak ¹² (2007)	Indian	0.4	24.2	74.6	0.8
Chrcanovic & Custodio ¹⁰ (2010)	Brazilian	00	6.19	54.87	38.94
Kumar A et al ⁸ (2011)	Indian	5	9	85	1
Vinay KV et al ² (2012)	South Indian	3.67	19	76	1.33
Present study	Central Indian	6.98	16.27	73.26	3.49

The mean distance measured between the centre of GPF and the incisive fossa (IF) in the present study was 35.9 mm. Kumar et al [8] noted the same distance as 36.6mm and 35.7 mm respectively on right and left side in Indian population. Vinay KV et al [2] also observed this distance as 36.6 mm and 35.9 mm respectively in south Indian population. We can say that our findings correlate well with other Indian authors. Study on Brazilian population by Chrcanovic and Custodilo [10] noted as 36.21 and 36.52 mm on right and left side respectively. Teixeira et al [6] studied same length in Brazilian population and noted the values as 3.93 and 3.91 cm on right and left side respectively. So we can conclude that the values in Brazilian population vary in different studies.

The mean value of distance between the posterior margin of GPF to posterior border of hard palate (PBHP) also differs greatly in different studies. We found this mean value as 3.4mm in our study. In Indian population; Ajmani [11] found it

as 3.7 mm, Kumar et al [8] found as 3.58 mm. Vinay et al [2] found as 3.56 mm on the right side and 3.58 mm on the left side. This concludes that our values match with other Indian authors. But Saralaya and Nayak [12] found this slightly on higher side; 4.2 mm. Slavikin et al [13] had quoted that possible variations in the location of foramen may be due to sutural growth occurring between the maxilla and palatine bones. They further add that antero-posterior dimensions of the palate increases with the eruption of the posterior teeth.

We found that mean perpendicular distance measured between the medial margin of GPF to midline maxillary suture (MMS) is 15.3 mm (Table II). This measurement largely depends on the time of fusion of interpalatine suture. Table IV shows that our values are very similar to Jaffar & Hamadah [7]. But other Indian authors Kumar A et al [8] and Vinay KV et al [2] found slightly lower values. Data recorded by other authors is depicted in table IV.

Table IV: comparison between various parameters in our & other studies:

Researchers	Population studied	GPF to PBHP	GPF to MMS
Westmoreland and Blanton ¹⁴ (1982)	Indian	1.9	15
Wang et al ⁹ (1988)	Chinese	4.11	16
Jaffar & Hamadah ⁷ (2003)	Iraqi	4.86	15.7
Saralaya & Nayak ¹² (2007)	Indian	4.2	14.7
Chrcanovic & Custodio ¹⁰ (2010)	Brazilian	3.39	14.5
Kumar A et al ⁸ (2011)	Indian	5.58	14.3
Vinay KV et al ² (2012)	South Indian		14.8
Present study	Central Indian	6.98	15.3

Table V: Direction of opening of GPF in oral cavity in percentage:

Researchers	Population studied	Antero-lateral	Anterior	Antero-medial	Vertical
Wang et al ⁹ (1988)	Chinese	---	90.5	---	9.5
Jaffar & Hamadah ⁷ (2003)	Iraqi		36	60	04
Saralaya & Nayak ¹² (2007)	Indian	46.2	41.3	---	---
Chrcanovic & Custodio ¹⁰ (2010)	Brazilian	---	69.38	18.75	11.87
Kumar A et al ⁸ (2011)	Indian	73	01	19	07
Vinay KV et al ² (2012)	South Indian	11.67	41.66	43	3.67
Nimigeen et al ⁵ (2013)	Caucasian European	00	13	82	05
Present study	Central Indian	74.42	15.12	6.98	3.48

In order to probe the GPF to deliver injections, the direction of the greater palatine canal should be kept in mind [6]. We found that maximum i.e. 74.42% foramina are directed anterolaterally. This value is very close to that found by Kumar A et al [8] in Indian population. Brazilian population studied by Chrcanovic & Custodio [10] noted maximum i.e. 69.38% are directed anteriorly. Jaffar & Hamadah [7] in Iraqi population found 60% directed antero-medially. This shows that direction of opening of GPF is different in different populations studied. These variations are responsible for occasional problems to insert a needle into GPF and pterygopalatine canal. The variations in the direction of the greater palatine foramen are critical, either for the anesthetic approach to the maxillary division of the trigeminal nerve or for the injecting with vasoconstrictor anesthetic solution of the pterygo-palatine fossa aiming to reduce bleeding in maxillary sinus surgeries [5]. Slavikin et al [13] had further added that frequency of anatomical obstruction of needle further increases with the age [8].

5. Conclusion

This study will prove very important to compare Indian skulls with skulls of other ethnic groups and other regions. This will further help anaesthetics to exactly locate the position of GPF. Knowledge of variations of GPF will help clinicians to improve the results of surgeries.

Conflict of interest statement

We declare that we have no conflict of interest.

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