

Assessment of the relative location of greater palatine foramen in adult Indian skulls: Consideration for maxillary nerve block

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Detailed knowledge of the position of the greater palatine foramen (GPF) is important for enhancing the anesthetic injection technique in the posterior palate for optimal pain control in maxillofacial and dental surgeries. The morphometric measurements of GPF along with distances from midline maxillary sutures were recorded, which are helpful for nerve block.

The morphometric study was carried out on 100 adult dry human unsexed skulls in the Punjab state. These skulls had fully erupted third molar teeth, and were free of any pathological changes. The measurements were taken with the help of Vernier caliper.

The statistical analysis indicated that there were no significant differences in the measurements between the right and left sides with regards to the distances of the GPF to the midline maxillary suture, the GPF to the incisive fossa and the GPF to the posterior border of the hard plate. In 75% of cases, the direction of opening of the GPF into the oral cavity was inferiorly in an anterolateral direction. The most common position of the foramen (85%) was found to be opposite the 3rd maxillary molar. A bilateral bony projection similar to mandibular linguala was observed, extending from the posterior margin of the foramen in one of the 200 separate foramina examined. The bilateral symmetry between the sides of skulls

studied was remarkable. Several parameters studied for the GPF and other parameters can provide professionals with anatomical references in order to block the maxillary division of the trigeminal nerve through the GPF.

Key words: Greater palatine foramen – Hard palate – Skull anatomy – Molar teeth

INTRODUCTION

Blocking of the maxillary division of the trigeminal nerve or its branches for local anesthesia is a common practice in maxillofacial surgery. The route utilized in the oral cavity is through the greater palatine foramen (GPF) to enter the palatine canal, which contains palatine nerves and vessels.

The ability to better predict and easily anesthetize the maxillary nerve and its branches with a single injection could make it possible to perform surgical procedures such as maxillary sinus elevation for dental implants in the posterior maxilla as routine procedures in private clinics (Schawartz-Arad et al., 2004).

A common problem encountered with the use of maxillary nerve block is the inability to obtain profound anesthesia, which is frequent-

ly encountered by the operator's inability to find the GPF (Mercuri, 1979). That is why description of the location of the GPF is important. With the proper anatomical knowledge this can be achieved easily.

Most text books locate the GPF in general way e.g., near the lateral plate border in the posterolateral border (Gardner et al., 1975) medial to the last molar (Moore, 1980) or opposite the last molar (Romanes, 1981). Text books on anesthesia say that it is opposite the second maxillary tooth (Selden HM 1948), opposite the maxillary third molar, or anywhere between the maxillary second and third molar (Shane, 1975).

MATERIAL AND METHODS

The present study was conducted at the Department of Anatomy, Dayanand Medical College & Hospital, Ludhiana (Punjab). The dry human skulls with a fully erupted 3rd molar tooth were collected from the Medical Institutes of Ludhiana Punjab (India). Skulls with any bone pathology were excluded from the collection. Finally, anatomical measurements were taken in 100 specimens, using a Vernier caliper accurate to 0.1mm. The direction of the opening of the GPF into the oral cavity was found with the help of a flexible steel wire. All the measurements were taken bilaterally and the shape of palatal vault was also noted in each skull. The findings were tabulated and analyzed statistically using Student's *t* test. Side differences were analyzed using the Pearson's Chi-square test. Statistical differences were considered significant when the P value was less than 0.05. Each skull was examined for the following (Fig. 1):

Shortest perpendicular distance of the GPF to midline (Line b)

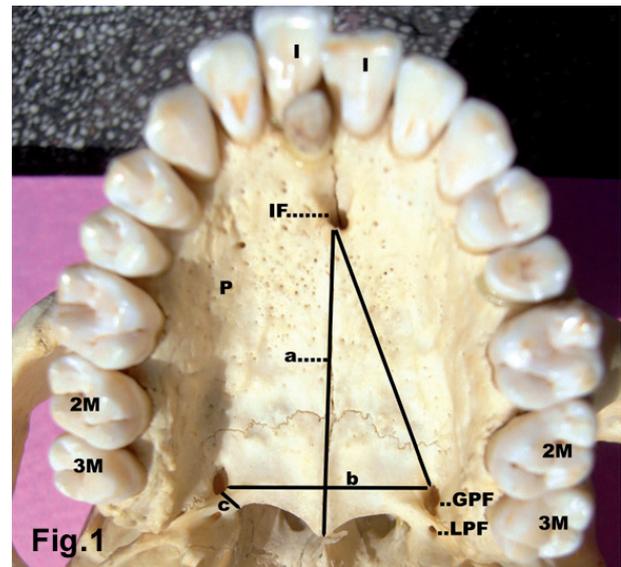


Fig. 1. Parameters measured.

1. Line a: Midline maxillary suture
2. Shortest perpendicular distance of the GPF to the midline maxillary suture (Line b)
3. Distance of the GPF from the incisive fossa (IF)
4. Distance of the GPF from the posterior border of the hard palate (Line c)
5. LPF: Lesser palatine foramina
6. I: Incisor teeth
7. 2M: Second molar
8. 3M: Third molar
9. P: Palate
10. n_: number of specimen

Distance of the GPF from the incisive fossa (IF)

Distance of the GPF from the posterior border of the hard palate (Line c)

Relationship of the GPF with maxillary molars

Direction of opening of the GPF into the oral cavity

Shape of the palatal vault

Number of lesser palatine foramina (LPF)

Table 1. Table showing various distances of GPF (n=100).

Right & left sides	Right		Left		Total	
n-100	Mean	±SD	Mean	±SD	Mean	±SD
GPF to MMS(mm)	14.3	1.42	14.4	1.27	14.3	1.34 P= .822 ns
GPF to incisive fossa(mm)	36.6	2.20	35.7	3.94	36.2	3.21 P= .071 ns
GPF to posterior border of hard palate(mm)	3.57	.92	3.59	.92	3.58	.90 P= .889 ns
Lesser palatine foramina	1.2	.53	1.3	.53	1.2	.50 P= .816 ns

RESULTS

There were no statistically ($p < 0.05$) significant differences in the measurements between the right and left side with regard to the distance of the GPF to the midline maxillary suture (MMS), the GPF to the incisive fossa, and the GPF to the posterior border of the hard palate (Table 1). In majority of skulls (85%), the GPF was found opposite the maxillary third molar tooth. 9% of the GPF was located between second and third molar teeth. 5% of the foramen is opposite the second molar and only 1% is behind the third molar (Table 2). The numbers of LPF on both sides were not symmetrical and varied from one to three. In one skull LPF was absent on the right side and there were three on the left side. In most skulls (73%), the direction of the foramen was anterolateral and in 19% the direction was anteromedial (Table 3). 69% of the palates were observed to be arched, whereas in 20% the shape of palatal vault was flat and in 11% it was highly arched (Table 4).

DISCUSSION

The results of the present study indicate that the location of the GPF is variable. The landmark used in here for the identification of the GPF can be readily located in living subjects.

According to Westmoreland et al. (1982) only 6% of the GPF is located opposite the third maxillary tooth. In the study done by Ajmani (1994), 48 % of foramina in Nigerians and 64% in Indian skulls were located opposite the third maxillary molar. Saralaya et al. (2007) observed this in 74.6 % of skulls. In Nigerian skulls (Ajmani, 1994), 13.1% of the foramina were opposite the second maxillary molar as compared to Saralaya et al. (2007) results, and Westmoreland et al. (1982) found 9.7% of foramina medial to the maxillary second molar. Ajmani (1994) found no foramina opposite the second molar in Indian skulls. Wang et al. (1988) reported the GPF was commonly located between the maxillary second and third molars. In the present study the majority of the skulls (85%) the GPFs were opposite the third maxillary molar (Table 2).

The distance from the midline to the GPF (b in Fig. 1) and from the GPF to the posterior border of the hard palate (c in Fig. 1) varies in the literature. According to Westmoreland et al. (1982) the distance from the GPF to the midline on the right had a mean of 14.8mm and 15.0mm on left. Ajmani (1994) reported a distance 14.7mm on the right and 14.6mm on the left side in Indian skulls. Saralaya et al. (2007) found 14.7mm on both sides. Wang et al. (1988) reported a value of 16mm. Methathrathip et al. (2005) found 16.2mm in

Table 2. Table showing the relation of the GPF to the maxillary molars (n=100).

Relation to maxillary molars	Right side n_ (%)	Left side n_ (%)	Total side n_ (%)
Second molar	5 (5)	5 (5)	10 (5)
Between second and third molar	9 (9)	9 (9)	18 (9)
Third molar	85 (85)	85 (85)	170 (85)
Behind third molar	1 (1)	1 (1)	2 (1)
Total	100 (100)	100 (100)	200 (100)

Table 3. Table showing the direction of the GPF into the oral cavity (n=100).

Direction of the foramen	Right side n_ (%)	Left side n_ (%)	Total side n_ (%)
Anterior	1 (1)	1 (1)	2 (1)
Antero lateral	73 (73)	73 (73)	146 (73)
Antero medial	19 (19)	19 (19)	38 (19)
Vertical	7 (7)	7 (7)	14 (7)

Thai skulls. The mean distance in the present study was 14.3mm and 14.4mm on right and left side respectively (Table 1).

The distance from the posterior border of the hard palate to the GPF was 3.5mm and 3.7mm in Nigerian and Indian skulls, respectively. Ajmani (1994) and Westmoreland et al. (1982) found a mean distance of 1.9 mm from the posterior border of the hard palate, Wang et al. (1988) 4.11mm, Saralaya et al. (2007) 4.2mm, and Methathrathip et al. (2005) 2.1mm. In the present study this value on the right side was 3.57 and on left side it was 3.59 (Table 1). The variability in the location of foramen may be due to sutural growth occurring between the maxilla and palatine bones. The anteroposterior dimensions of the palate increases with the eruption of the posterior teeth (Slavikin et al., 1966).

In order to probe the GPF to deliver injections, the direction of the greater palatine canal should be kept in mind. Ajmani (1994) reported that the opening was directed inferiorly in the anteromedial direction in 58.7% Nigerian and 91.4 % of Indian skulls. Saralaya et al. (2007) found it was forward and medially directed in 46.2% and forward in 41.3%. Westmoreland et al. (1982) reported that the opening of the foramen was directed inferiorly from the hard palate in 82% skulls. In the present study 73% of the skulls exhibit an anterolateral direction of the foramen (Table 3). The variation may explain the occasional difficulty encountered while attempting to insert the point of needle into the GPF and pterygopalatine canal. Moreover, the frequency of anatomical obstruction of the needle increases with age (Slavikin et al., 1966). Saralaya et al. (2007) revealed that the distance from the GPF to the incisive fossa was 37.3 mm on the left side and 37.2 mm on the right side. In the present study, it was 35.7mm on the left side and on the right side it was 36.6 mm (Table 1).

In our study, 69% of the skulls showed an arched palatal vault; 20% were flat palates and 11% showed very highly arched palate (Table 4). Palatal growth takes place in length in the sagittal plane anterior to the GPF (Sejrsen et al., 1996).

Bilateral symmetry in the number of LPF was seen in 76% of the skulls. In the rest of the skulls the number varied from one to three or even may be absents. In the present study a bilateral bony projection similar to the mandibular linguala was observed extending

Table 4. Table showing shape of the palatal vault (n=100).

Shape of palate	Number of skulls (%)
Arched	69 (69)
Flat	20 (20)
Highly Arched	11 (11)
Total	100 (100)

from the posterior margin of the foramen in one of the 200 separate foramina examined. A similar finding was also observed by Westmoreland et al. (1982) in 16 % of the 600 foramina examined. Ajmani (1994) observed a similar type of bony projection in 24.6% Nigerian and 35.3% of Indian skulls. Compared to these studies our percentage is much lower.

Since different results were found in studies from different region of world, this may indicate that, anthropologically, the positions of the GPF differ among ethnic groups. Even in studies carried out in India (Westmoreland et al., 1982; Ajmani, 1994; Saralaya et al., 2007) in different regions of the country, variations are seen among the different parameters. This indicates that a large anatomical variation may also exist in the same population.

In order to block the maxillary division of trigeminal nerve the present data can provide anatomical references to professionals, since it is important to locate the exact position of the GPF for many surgical procedures in the maxilla. These data should be helpful in comparing the Indian skulls with those from several other regions as well as comparing the skulls of different races.

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