Morphological Study of Greater Palatine Foramen  
In Adult Human Skull Bones

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ABSTRACT

Background: Greater Palatine Foramen (GPF) is located medial to the upper third molar tooth and may vary with the sutural growth occurring between palatine and maxillary bones. The precise knowledge about the morphometry of GPF is essential for the clinicians while performing the maxillary nerve block, failure of which leads to the damage of greater palatine nerve.  
Aim: To determine the morphometry of GPF and its variations if any.  
Materials and Methods: One hundred (100) adult dry human skull bones irrespective of sex and age were studied. The position, shape, direction and distance of greater palatine foramen with its variations were noted on both sides.  
Results: In 68.5% skulls GPF was located opposite to the third molar, in 22.5% skulls between second and third molar, in 8% skulls distal to the third molar and in 1% skulls opposite to second molar tooth. In 89.5% skulls the shape of the foramen was found to be oval whereas in 10.5% skulls it was round. In 69% skulls the foramen was directed anteromedial, in 23% skulls anterolateral and in 8% skulls it was directed anteriorly.  
Conclusion: The present study helps the clinicians to locate GPF for giving local anaesthesia in molar tooth extraction, palatal surgeries and also helps to avoid post extraction haemorrhage of greater palatine vessels.  
Keywords: Skull bone, greater palatine foramen, position, direction.

INTRODUCTION:

The greater palatine foramen located in the hard palate, is also called as foramen palatinum majus (or) anterior palatine foramen because it is the more prominent opening seen anterior to the opening of Lesser Palatine Foramen (LPF).

The palate is an essential structure formed by the Y-shaped fusion of primitive and permanent palate that separates nasal and the oral cavity. The ventral three-fourth of the palate gets ossified to form hard palate and the dorsal one-fourth remains unossified as soft palate.¹

The hard palate is formed by the fusion of the palatine processes of maxillae in its anterior two-third and by the horizontal plates of palatine bones in its posterior one-third, separated by a cruciform suture. The cruciform suture is formed by intermaxillary, interpalatine and palatomaxillary sutures. The Greater Palatine Foramen (GPF) is situated close to the lateral border of hard palate just behind the palatomaxillary suture medial to the upper third molar tooth and its location varies as the

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The accuracy of 0.01 mm. All measurements were recorded twice to reduce observer bias. The following measurements were taken symmetrically on right and left side as shown in Fig. 1.

1) Distance between the anterior margin of GPF to the posterior border of incisive foramen (IF)
2) Distance between the medial margin of GPF to the midline maxillary suture (MMS)
3) Distance between the posterior margin of GPF to the posterior border of hard palate (PBHP)

Results were tabulated, descriptive analysis was done using SPSS 16 software. Data obtained from both sides were compared by Student's paired t – test and Chi square test.

RESULTS:

Results are shown in the Tables: 1, 2 & 3. In the majority of the skulls the position, shape and the direction of GPF were similar on both sides whereas in few it was dissimilar. In 5/100 skull bones, the position of GPF was distal to the third molar on right side and opposite to the third molar on left, in 2/100 skulls the position of GPF was similar on right side lying opposite to the third molar whereas on the left side showed variations of being distal to the third molar in 1 skull and between second and third molar in the another skull. In 1/100 skull, GPF was located between second and third molar on right side and distal to the third molar on the left side. In 9/100 skulls, the shape of GPF was round on right side but oval on left. In 4/100 skulls it was oval on right side, round on left (Fig. 2). By using student's paired sample t test, statistically significant difference was observed between GPF to MMS on both sides (p-0.002). Since p value is not significant for the values obtained on right and left side with regards to the measurements taken from GPF to IF and PBHP, we are accepting the null hypothesis that there is no statistically significant differences observed between these values (Table 3).
**DISCUSSION:**

In the present study the position of GPF varies in relation to molar teeth, the most common position was found to be opposite to the third molar with an incidence of 67% on right side and 70% on left side. The second most common position was between second and third molar in 22% skull on right side and 23% on left side. In 10% it is distal to the third molar on right side and 6% on left side. In 1% skull, the position of GPF was opposite to the second molar on both sides (Fig-1). ML Ajmani on comparing the location of GPF between Nigerian and Indian skulls, found no significant relations, since the p-value was greater than 0.053. According to Vinay KV et al., in 76% skulls GPF was opposite to third molar tooth, 19% between second and third molar, 3.67% opposite to the second molar and only in 1.33% distal to the third molar. Vaibhav P Anjankar et al., observed 73.26% skulls with the location of GPF opposite to the third molar, 16.27% between second and third molar, 6.98% opposite to the second molar and in 3.49% distal to the third molar. Badal Jotania et al., reported that in 71.67% and 85% cases the GPF was opposite to the third molar on right and left side respectively, between second and third molar in 23.33% on right side.
and 11.67% on left side, opposite to the second molar in 5% skulls on right and 3.33% on left side. Abu Ubaida Siddiqui et al., found that in 72.44% skulls GPF was opposite to the third molar, in 23.9% between second and third molar and in 3.06% distal to the third molar. Antony Sylvan D Souza et al., showed that in 73.75% skulls GPF was opposite to the third molar, in 23.75% between second and third molar and in 2.5% opposite to the second molar. Nidhi Sharma et al., found that in 71.21% GPF was opposite to the third molar, in 24.75% between second and third molar, in 4.04% distal to the third molar.

In our study, the shape of GPF was found to be oval in the majority of the skulls showing 87% on right side with 92% on left side whereas round shape was observed in 13% skulls on right side and 8% on left side. As reported by Varun Chopra et al., the shape of GPF was oval in 95.91% cases on right side and 97.95% on left side, the remaining was observed to have crescent shape with 4.08% and 2.15% on right and left side respectively. V Nimigean et al., observed that in 84% skulls the shape was oval and in 16% skulls it was circular. According to Susobhana et al., the study conducted in North Indian population showed presence of oval shaped GPF in 74% of the skulls, round shape in 23% skulls and irregular shape in 3% skulls.

With regards to the direction of GPF into the oral cavity, it was anteromedial in 69% skulls, anterolateral in 23% skulls and anterior in 8% skulls. Vertically directed GPF was not observed in our study. Vinay KV et al., reported that GPF was directed anteromedial in 43.33% skulls, anterolateral in 12% skulls, anterior in 41.33% skulls and vertical in 3.34% skulls. But Vaibhav P Anjankar et al., study showed that in the majority, 74.42% skulls the GPF was directed anterolateral, 15.12% skulls as anterior, in 6.98% skulls anteromedial and in 3.48% skulls as vertical. Abu Ubaida Siddiqui et al., described that in 69.4% skulls it was directed forward and medial, in 23.4% directed forwards and in 7.2% skulls forward and lateral. The study of Nidhi Sharma et al., found to be correlated with our study since most common direction was anteromedial in 60.10% skulls, anterolateral in 8.09% skulls, anterior in 31.81% skulls and vertical in 0% skulls. V Nimigean et al., observed that in 82% skulls the direction was anteromedial, anterior in 13% skulls and vertical in 5% skulls. Renu C reported the direction of GPF in North Indian skulls as vertically downwards, downwards and forwards in 93.5% and 6.5% cases respectively.

In the present study, the mean distance measured from GPF to IF, MMS and PBHP was 34.92±2.22mm, 13.39±1.13mm, 3.57±0.91mm (Right side) and 34.83±2.19mm, 13.19±1.11mm, 3.57±0.97mm (Left side) respectively as shown in the Table-3. Comparison of the right and left side showed significant difference between GPF to MMS on both sides (p-0.002). But there was no statistically significant difference observed between the values obtained on right and left side with regards to the measurements taken from GPF to IF and PBHP (Since p-0.326 and 0.913 respectively). According to Vinay KV et al., the mean distance from GPF to IF was 36.6±2.2mm on right side, 35.9±3.94mm on left side, GPF to MMS was 14.8±0.16mm on right side, 14.8±0.15mm on left side and GPF to PBHP was 3.56±0.91mm on right side, 3.58±0.92mm on left side. Vaibhav P Anjankar et al., found that the mean distance measured from GPF to IF, MMS and PBHP was 35.9mm, 15.3mm, 3.4mm respectively. Abu Ubaida Siddiqui et al., reported that mean distance measured from GPF to IF, MMS and PBHP was 28mm, 12mm, 3.4mm (Right side) and 32mm, 18mm, 3.4mm (Left side). Antony Sylvan D Souza et al., measured only the mean distance...
measured from GPF to MMS was $14.6\pm1.47$mm on right side, $14.4\pm1.40$mm on left side. Nidhi Sharma et al., in their result reported that the mean distance from GPF to IF was $37.74\pm2.39$mm on right side, $37.89\pm2.83$mm on left side, GPF to MMS was $14.82\pm1.34$mm on right side, $14.79\pm1.57$mm on left side and GPF to PBHP was $4.39\pm1.73$mm on right side, $4.53\pm1.23$mm on left side. Bruno R Chrcanovic studied in Brazilian skull and found that there was no significant difference in the measurement (From GPF to IF, MMS and PBHP) between two sides since the $P<0.01$. The mean distance measured from GPF to IF was $36.21\pm3.16$mm on right side, $36.52\pm3.34$mm on left side, GPF to MMS was $14.68\pm1.56$mm on right side, $14.44\pm1.43$mm on left side and GPF to PBHP was $3.39\pm1.11$mm on both sides. The location and direction (anteromedial and vertical) of GPF in our present study correlates with the study of Nidhi Sharma et al whereas the shape correlates with the study of V Nimigean et al. The mean distance measured from GPF to IF, MMS and PBHP correlates with Vinay KV et al. The reasons for variations in present study from other studies may be due to the samples which were procured from the South Indian population.

**CONCLUSION:**

The present study helps the clinicians to locate GPF accurately, even in the absence of third molar teeth by taking measurements from the fixed bony landmarks as described above. The present study inferred that around 68.5% skulls GPF was located opposite to the third molar with an oval shape in 89.5% skulls and the GPF was directed anteromedial in 69% skulls. So, a thorough knowledge about GPF is necessary for the clinicians while giving anaesthesia of palate for a successful outcome of palatal repairs because variations are not uncommon.

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