International Journal of Basic and Applied Medical Sciences ISSN: 2277-2103 (Online)
An Online International Journal Available at http://www.cibtech.org/jms.htm
2012 Vol. 2 (3) September - December, pp.5-8/ Vinay et al.

Research Article

MORPHOMETRIC ANALYSIS OF THE GREATER PALATINE FORAMEN IN SOUTH INDIAN ADULT SKULLS

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ABSTRACT

The knowledge of the position of the greater palatine foramen (GPF) is important for maxillofacial and dental surgeons, since posterior palate is anaesthetised for various surgical procedures. The present study was conducted on 150 dry adult South Indian adult skulls. The shortest perpendicular distance from GPF to midline maxillary suture (MMS), the distance of GPF from the incisive fossa (IF) and the distance of GPF from the posterior border of the hard palate (PBHP) were measured using a stainless steel Vernier caliper. The relationship of the GPF with maxillary molars and the direction of the opening of the GPF into the oral cavity were also noted. The results revealed that the mean distance of GPF to MMS was 14.8± 0.16 mm on the right side and 14.8± 0.15 mm on the left side. The mean distance of the GPF from IF was 36.6± 2.2 mm on the right side and 35.9± 3.94 mm on the left side. The mean distance of GPF from the PBHP was 3.56±0.91 mm on the right side and 3.58±0.92 mm on the left side. There was no statistically ($p < 0.05$) significant differences in the measurements between the right and left side with regard to the distance of GPF to the MMS, the GPF to the IF and the GPF to the PBHP. The most common location of GPF was opposite the 3rd maxillary molar (76 %) and least common was GPF beyond 3rd molar (1.33%). The most common direction of the opening of the GPF into the oral cavity was antero-medial (43%) and anterior (41.66%). The findings of the present study will be helpful to the clinicians, maxillofacial surgeons and anaesthetics as ready references to the position of GPF.

Key Words: *Greater Palatine Foramen, Skull, Osteometry*

INTRODUCTION

The greater palatine foramen (GPF) conducts the greater palatine nerve, responsible for the innervation of the posterior part of hard palate. Evaluation of the relative position of GPF is important for injection of local anaesthetic for optimal pain control in maxillofacial and dental surgeries. 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 GPF to enter the palatine canal, which contains palatine nerves and vessels. A common problem encountered with the use of maxillary nerve block is the inability to obtain profound anesthesia, which is frequently encountered by the operator's inability to find the GPF (Mercuri, 1979). Most text books locate the GPF in a 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). The text books on anaesthesia mention that GPF is opposite the 2nd maxillary tooth (Selden, 1948), opposite the maxillary 3rd molar, or anywhere between the maxillary 2nd and 3rd molars (Shane, 1975). The morphometric knowledge of the location of GPF is essential in the anaesthetic interventions required in oral and maxillofacial surgical procedures. The aim of the present study was to evaluate the location and direction of the opening of GPF into the oral cavity in dry adult skulls from South India. This study is aimed at determining the relative distance, direction and variations location of GPF to the midline.

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MATERIALS AND METHODS

The present study was done on dry human South Indian adult skulls with a fully erupted 3rd molar tooth. The skulls with bony abnormalities were excluded from the study. The measurements were done on 150 skulls using a stainless steel Vernier caliper. All the measurements were taken bilaterally. The shortest perpendicular distance from GPF to midline maxillary suture (MMS) (Line B), the distance of the GPF from the incisive fossa (IF) (Line A) and the distance of the GPF from the posterior border of the hard palate (PBHP) (Line c) were measured (Figure 1). The relationship of the GPF with maxillary molars and the direction of the opening of the GPF into the oral cavity were also noted. All the findings were tabulated and analyzed statistically using Student's *t* test. Differences between sides were analyzed using the Pearson's Chi-square test. The statistical differences were considered significant when the P value was less than 0.05.

RESULTS

The table-1 shows the mean and standard deviation (SD) of the distances of GPF from the MMS, from the IF and from the PBHP on the right and left side The mean distance of GPF to the MMS on the right and left sides were equal. The mean distance of GPF to IF was more on the right side than on the left side. While the distance of the GPF from the PBHP on the left side was more than on the right side. There were no statistically ($p< 0.05$) significant differences in the measurements between the right and left sides with regard to the distance of GPF to MMS, the GPF to IF and the GPF to PBHP.

Table- 2 shows the relationship of GPF to the maxillary molars. In majority of the skulls (76%), the GPF was found opposite the maxillary 3rd molar tooth. In 19% of the skulls, the GPF was located between 2nd and 3rd molar teeth. In 3.67% of the skulls, the GPF was opposite the 2nd molar and only 1.33% was behind the 3rd molar tooth. Table- 3 shows the direction of opening of GPF into oral cavity. In about 43 % of the skulls, the direction of the foramen was anteromedial and in 41.66 % of the skulls, the direction was anterior. In only 3.67% of the skulls, the direction was vertical.

DISCUSSION

The results of the present study indicate that the location of the GPF is highly variable. According to Westmoreland *et al.,* (1982) the distance from GPF to MMS on the right side was 14.8 mm on the right side and 15.0 mm on the left side. Ajmani (1994) reported a distance 14.7 mm on the right and 14.6 mm on the left side in Indian skulls. Saralaya *et al.,* (2007) found 14.7 mm on both the sides. Wang *et al.,* (1988) reported a value of 16mm. Methathrathip *et al.,* (2005) found 16.2mm in Thai skulls. The mean distance of GPF to MMS in the present study was 14.8 mm on right side and 14.8 mm on the left side (Table -1). This shows that the mean distance between MMS to GPF in our study was less when compared to other studies. The distance of GPF from PBHP was 3.5 mm in Nigerian and 3.7mm in Indian skulls (Ajmani, 1994). Westmoreland *et al.,* (1982) found a mean distance of 1.9 mm GPF from the PBHP, Wang *et al.,* (1988) 4.11mm, Saralaya *et al.,* (2007) 4.2 mm, and Methathrathip *et al.,* (2005) 2.1mm. In the present study the distance on the right side was 3.56 mm and on the left side it was 3.58 mm (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). Saralaya *et al.,* (2007) revealed that the distance from

Table 1: Table showing various distances of GPF

	Right		Left	
	Mean	**SD**	**Mean**	**SD**
GPF to midline maxillary suture	14.8	.155	14.8	.147
GPF to incisive fossa	36.6	2.2	35.9	3.94
GPF to posterior border of hard palate	3.56	.91	3.58	.92

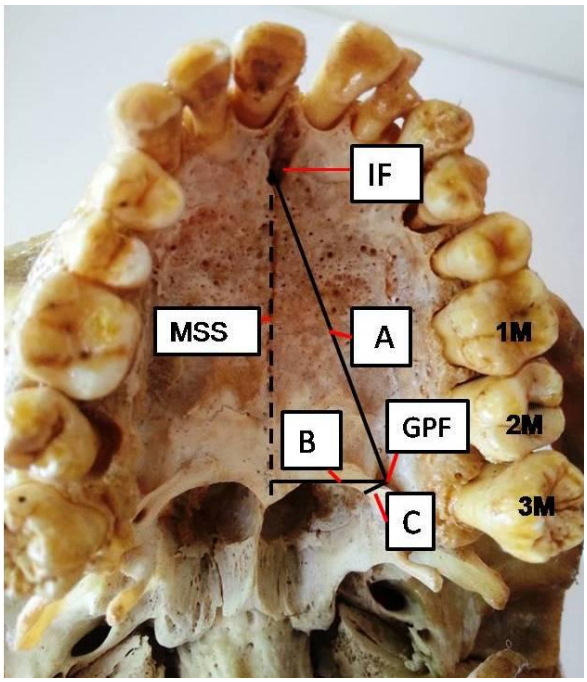

Figure 1: IF- Incisive fossa, **MMS-** Midline maxillary suture, **GPF-** Greater palatine foramen, **A-** Line joining Incisive fossa and Greater palatine foramen, **B-** Line showing the distance between Greater palatine foramen and Midline maxillary suture, **C-** Line showing the distance between Greater palatine foramen and posterior border of hard palate,**1M-** 1st molar , **2M-** 2nd molar, **3M-** 3rd molar.

the GPF to the IF was 37.3 mm on the left side and 37.2 mm on the right side. In the present study, it was 35.7 mm on the left side and on the right side it was 36.6 mm (Table 1). The mean distance of the present study was slightly less than the distance in the study by Saralaya *et al.,* (2007).According to Westmoreland *et al.,* (1982) only 6% of GPF are located opposite the 3rd maxillary molar tooth. In the study done by Ajmani (1994) about 48 % of GPF in Nigerians and 64% in Indian skulls were located opposite the 3rd maxillary molar. Saralaya *et al.,* (2007) observed this in 74.6 % of the skulls. In Nigerian skulls 13.1% of GPF were opposite 2nd maxillary molar (Ajmani, 1994). Westmoreland et al. (1982) found 9.7% of GPF medial to the maxillary second molar. Ajmani (1994) found no GPF opposite 2nd molar in Indian skulls. Wang *et al.,* (1988) reported that the GPF was commonly located between the maxillary 2nd and 3rd molars. In the present study, in majority of the skulls (76%) the GPF was opposite to 3rd maxillary molar (Table 2).

Table 2: Table showing the relationship of GPF to Maxillary molars

Relation to maxillary molars	Right side n (%)	Left side n (%)	Total
Opposite to 2nd molar	5 (3.33)	6 (4)	11 (3.67)
Between 2nd and 3rd molar	28 (18.67)	29 (19.33)	57 (19)
Opposite to 3rd molar	115 (76.67)	113 (75.34)	228 (76)
Behind 3rd molar	2 (1.33)	2 (1.33)	4(1.33)
Total	150 (100)	150 (100)	300 (100)

In order to probe the GPF to deliver injections, the direction of the GPF should be kept in mind. Ajmani (1994) reported that the opening was directed inferiorly in the anteromedial direction in 58.7% of Nigerian and 91.4 % of the 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, in about 43% of

the skulls the GPf was directed anteromedially and in 41.66% of the skulls, the opening was directed anteriorly (Table 3).

Table 3: Table showing the direction of GPF

Direction of GPF	Right side n (%)	Left side n (%)	Total
Anterior	62 (41.33)	63 (42)	125 (41.66)
Antero lateral	18 (12)	17 (11.33)	35 (11.67)
Antero medial	65 (43.33)	64 (42.67)	129 (43)
Vertical	5 (3.34)	6 (4)	11 (3.67)
Total	150 (100)	150 (100)	300 (100)

The variation may explain the occasional difficulty encountered while attempting to insert the point of the needle into the GPF. Moreover, the frequency of anatomical obstruction of the needle increases with age (Slavikin *et al.,* 1966). Since different results were found in studies from different region of the world. The data for each particular region should be determined. The present data can provide anatomical references to professionals, since it is important to locate the exact position of GPF for many surgical procedures in the maxilla.

Conclusion

The present study evaluated the relative position of the GPF in the adult skulls of South India. The findings of the present study will be helpful to the clinicians, maxillofacial surgeons and anaesthetics as ready references to the position of greater palatine foramen.These data will also be helpful in comparing the South Indian skulls with those from other regions as well as comparing the skulls of different races.

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