

ORIGINAL RESEARCH

An integrative anatomical evaluation of Greater palatine foramen in human skull base in north Indian population with clinical implications

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Abstract

Background: Greater palatine foramen is located in posterior part of hard palate. Knowledge of anatomical limitations of greater palatine foramen are crucial for injecting anaesthetic drugs along greater palatine nerve and for maxillary nerve block.

Aim: Aim of the study was to provide anatomical data regarding number, possible shape, variability in location of greater palatine foramen and its relation to nearby landmarks.

Material and methods: Study included 100 dry human skulls that assessed 200 greater palatine foramina. Various parameters were measured by using digital Vernier caliper.

Results: Shape of GPF was oval in 57% on right & 51% on left side. It was directed anteromedial in 56% & 44% on right & left sides. Its position was at 3rd molar in 49% on right and 56% on left side. Mean of anteroposterior, transverse diameters & penetrability were 4.96mm, 3.37mm & 13.07mm on right and 4.78mm, 3.17mm & 12.15mm on left side respectively. Mean of distance between GPF of two sides was 31.23mm. The mean of distance of GPF from IF, IPS and PPB were 38.76, 15.58mm and 4.68mm on right side and 38.46mm, 15.33mm and 4.41mm on left side respectively.

Conclusion: All metric observations were more on right as compared with left side. Present study will provide the required baseline data for various dental procedures and development of tools.

Key words: Greater palatine foramen, Anesthesia, Greater palatine nerve.

Key message: Detailed knowledge of greater palatine foramen will avoid risks and errors in performing corrective surgeries or various other dental procedures.

Introduction

Greater palatine foramen is present on posterior part of hard palate opposite the last molar tooth, behind the palatomaxillary suture and in front of the palatine crest. It is representing the lower end of the greater palatine canal which connects the oral cavity with the pterygopalatine fossa. It transmits greater palatine vessels and nerves that supply palate in posterior region. ^[1, 2] It can be approached intraorally. So, it is imperative to study its anatomical relationship to nearby structures.

In dentistry procedures such as Caldwell-luc procedure, periodontal treatment, endodontic methods, or maxillofacial pain treatment, palatoplasty or maxillary tooth extraction general

anaesthesia administration is contraindicated. In such procedures, the dental and oral maxillofacial surgeons prefer greater palatine canal for greater palatine nerve block. [3]

In all these & other, greater palatine nerve block is given by injecting anaesthetic drug through greater palatine foramen. This foramen is the most efficient route with least complications because of short needle course. However, this foramen is difficult to locate because of variability in its location. [4]

There have been confusions regarding the location of greater palatine foramen in the previous literature. [5] Thus a comprehensive study was needed to shed more light to this concept. It is also said to be helpful to ease the symptoms of paralysis in patients and to relieve symptoms of various types of headaches. Its morphometry is advantageous for the purposes of craniofacial reconstruction surgeries. [6]

While surgically repairing nasal septum, sinuses or in septorhinoplasty, greater palatine artery is approached through greater palatine canal to stop the bleeding. [7, 8] Oro-antral fistula is closed by taking palatal flap. In this procedure, greater palatine artery needs to be moved. This makes localization of greater palatine foramen extremely significant. [9, 10]

Therefore, the present study was conducted with aim to find exact location, shape, and other parameters of greater palatine foramen.

Material and methods

Study design

Present study was a descriptive cross-sectional study conducted on 100 dry human skulls in a period of four years in department of Anatomy, Government medical college Amritsar.

Ethical clearance

The study on human skulls was approved by institutional ethical committee of Govt. medical college Amritsar via letter no. 1446 dated 23.06.2017.

Sample size

North Indian skulls were target population for the study. Due to less availability of skulls and dropping number of cadavers in anatomy department, the study was carried out on 100 human dry skulls collected from department of Anatomy, Govt. Medical College Amritsar.

Inclusion and exclusion criteria

Human skulls without any damage or pathological deformity and complete in all aspects were included in the study. Another key criterion for inclusion was dentulous or partially dentulous skulls. Skulls of children, damaged or malformed skulls were excluded from the study.

Procedure

Non-metric parameters number, shape, direction, and position were observed and noted. The measurements were made with the digital Vernier caliper to the nearest count of 0.01mm.

Following metric parameters of greater palatine foramen were measured and noted:

1. Anteroposterior (AP) diameter: Between anterior and posterior margins of GPF as **A** in fig. 1.
2. Transverse (TV) diameter: Between medial and lateral margins of GPF as **B** in fig. 1.
3. Penetrability: A steel wire was inserted into Greater palatine foramen (GPF), a point was marked, and length of inserted part was measured with the help of Vernier caliper.

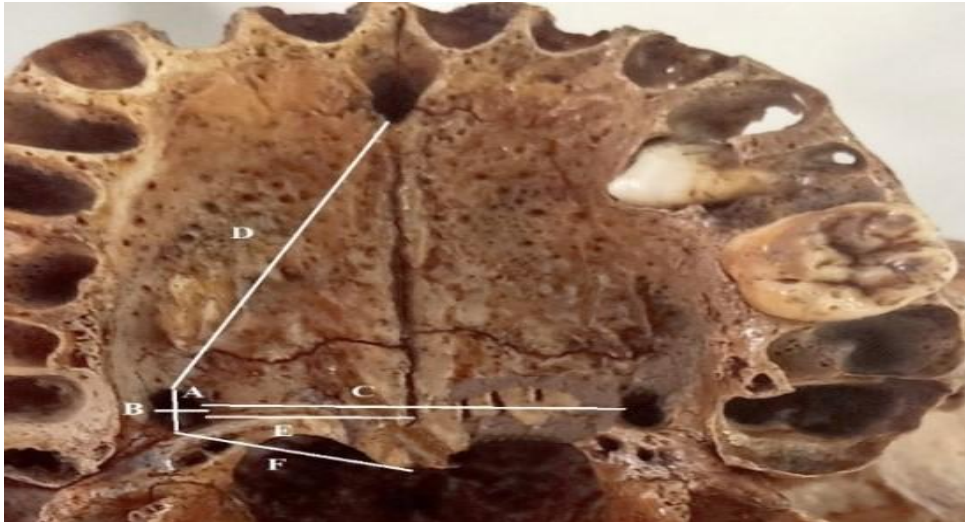


Figure 1: Showing morphometric parameters of GPF: A- Anteroposterior diameter of GPF, B- transverse diameter, C- distance between 2 GPF (right & left), D- distance between GPF-incisive fossa, E- distance between GPF-IPS, F- distance between PPB.

1. **Distance between two GPFs (GPF-GPF):** Between the medial margins of GPFs of right and left side as C in fig. 1.
2. **Distance between GPF and Incisive fossa (GPF-IF):** Between the anterior margin of the GPF and posterior margin of the IF as D in fig. 1.
3. **GPF-Interpalatine suture (GPF-IPS):** Shortest distance between medial margin of the GPF and IPS and measured as E in fig. 1.

Statistical analysis

Chi square test was applied for non-metric parameters. Mean, standard deviation and range were calculated for metric parameters. Right and left sides were compared by applying t test. P value less than 0.05 was considered significant.

Results

Single foramen was found in all the specimens on both sides. Apparently, no duplication of greater foramen was seen. Shape, position, and direction of greater palatine foramen observed bilaterally in the present study. Predominant shape of greater palatine foramen was oval found in 57% on right & in 51% on left. It was followed by rounded shape observed in 39% on right & in 43% on left side. Rarely observed shapes are mentioned in Table 1. Greater palatine foramen was directed anterior-medially in 56% and anteriorly in 44% of skulls on right side. Same incidence of direction was noticed on left side that was anteromedial in 56% and anterior in 44%.

Table 1. Shape, position, and direction of greater palatine foramen

Sr. no.	Parameter	Observation	Incidence (%)	
			Right	Left
1	Shape of GPF	Oval	57%	51%
		Rounded	39%	43%
		Semilunar	2%	4%
		Slit	1%	-
		Square	-	1%
		Triangular	1%	1%
2	Direction of GPF	Ant	44%	44%

		Ant-med	56%	56%
3	Position of GPF in relation to molars	M2	3%	6%
		M2-3	43%	32%
		M3	49%	56%
		M3P	5%	6%

In the study it was observed that in majority of skulls, position of greater palatine foramen was at the level of third molar which was in 49% on right and in 56% on left side. Second most common position was in between second, and third molar tooth and it was seen in 43% on right & in 32% on left side. It was seen at the level of some other landmarks which are shown in Table1.

Mean of AP and TV diameters and penetrability was calculated. Mean value of distance of GPF to opposite GPF, IF, IPS and PPB was also calculated. Mean on the right side was found higher than that on the left side. The difference was analyzed by applying t test. P value indicated that the difference was insignificant. Results of these parameters are shown in table 2.

Table 2. Metric parameters of greater palatine foramen

Sr. No.	Parameter	Mean(mm)		Range (mm)		P value
		Right	Left	Right	Left	
1	AP diameter	4.96±0.89	4.78±0.81	3.04 - 8.32	3.0 - 7.23	0.13
2	TV diameter	3.37±0.84	3.17±0.76	1.45 - 5.93	1.29 - 5.01	0.09
3	Penetrability	13.07±3.75	12.15±3.36	6.53 - 26.28	3.26 - 23.01	0.07
4	GPF- GPF distance	31.23±3.12		22.06 - 37.45		-
5	GPF-IF distance	38.76±3.27	38.46±2.90	29.8 - 48.09	31.29 - 47.1	0.49
6	GPF-IPS distance	15.58±1.72	15.33±1.59	11.45 - 19.2	11.2 - 19.2	0.29
7	GPF-PPB distance	4.68±1.09	4.41±1.10	2.87 - 8.34	2.11 - 8.03	0.08

Discussion

Greater palatine foramen leads into greater palatine canal which opens in pterygoid fossa. Anaesthetic agent can be given in pterygoid fossa through greater palatine foramen & it will achieve complete block of maxillary nerve. ^[3] Therefore, normal and variant anatomy of greater palatine foramen is necessary for injecting anaesthesia in various dental procedures. The present study compiles morphological and morphometric features of greater palatine foramen.

Shape

Different shapes were found in our study which are illustrated in fig. 2 A-D. Results in the present study was in agreement to Sarilita & Soames but higher than the incidences observed by Ilayperuma et al and Shalaby et al. ^[10, 3, 11]

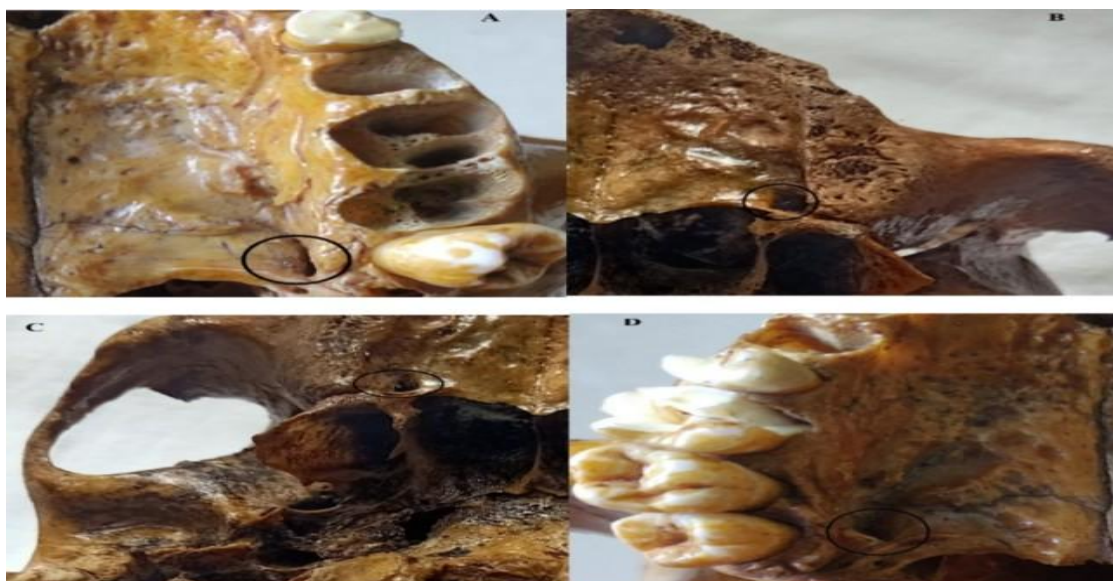


Figure 2: Showing shapes of GPF: A- slit shape, B- Square shape, C- triangular shape, D- semilunar shaped

Direction

Knowledge of direction of the greater palatine foramen is crucial before injecting needle in greater palatine canal. Shalaby et al and Vinay et al found it anteromedial in 69% & 43%, anterior in 28% and 41.66% and anterolateral in 3% & 11.67% respectively. ^[11, 5] Ilayperuma et al found anteromedial direction in 48.53% (right side) and 51.47% (left side), anterior in 42.65% (right side) and 44.2% (left side) while anterolateral in 8.82% (right) and 4.41% (left) respectively. Findings of present study agree with findings of left side by Ilayperuma et al. ^[3]

Position

Localization of greater palatine foramen is crucial for proceedings in various dentistry procedures. Position of greater palatine foramen varies in relation to molar tooth. It may be due to growth of palatomaxillary suture. Our study results were similar to the results of Sarilita & Soames as evident from table 4. ^[10] It differed hugely from results of Sharma & Garud. ^[12]

Table 3. Comparison of studies on position of GPF

Sr. no.	Author name	Position of Greater palatine foramen			
		At M3 (%)	M2-M3 (%)	At M2 (%)	Beyond M3 (%)
1	D'souza et al ^[13]	73.75	23.75	2.5	0
2	Vinay et al ^[5]	76	19	3.67	1.33
3	Sharma & Garud ^[12]	73.38	-	8.63	17.99
4	Jotania et al ^[14]	78.3	17.50	4.17	-
5	Ilayperuma et al ^[3]	77.2	21.68	0.74	0.74
6	Sarilita & Soames ^[10]	58.7	37.3	4	-
7	Shalaby et al ^[11]	84	9	2	6
8	Present study (2021)	49 (R) 56 (L)	43 (R) 32 (L)	3 (R) 6 (L)	5 (R) 6 (L)

Anteroposterior & transverse diameter

To access maxillary nerve through greater palatine foramen, concerned dental surgeon should be aware of the various diameters of greater palatine foramen and its relationship to nearby

bony landmarks. Present study is providing data regarding these parameters. P value for mean of AP and TV diameter on right & left side in the present study was 0.13 and 0.09 respectively which indicated that no statistically significant difference was observed in right and left sides. Our findings were congruent with results of Shalaby et al. ^[11]

Penetrability

It is needed to assess the depth up to which needle can be inserted while giving anaesthesia. P value was found to be 0.07 which was advisable of no statistical difference in right & left side. Our study coincided with study of Urbano et al who reported 16.05mm penetrability on right side and 15.67mm on left side. ^[15]

Distance from the opposite GPF

With eruption of posterior teeth, dimensions of palate also change. ^[3] Relationship of greater palatine foramen to its nearby structures also change consequently. Therefore its morphometry is of utmost importance. Our results showed that opposite greater palatine foramina were located 31.23 ± 3.12 mm away from each other. Our results agreed to results of Urbano et al that was 32.74mm but higher than the results study by Sarilita & Soames that was 27.6 ± 2.8 mm. ^[15, 10]

Distance of GPF from IF

Distances of Greater palatine foramen from incisive foramen, interpalatine suture/ midmaxillary suture & posterior border of hard palate given in previous studies are presented in Table 4. Statistically there was no significant difference found in both sides as P value was 0.49. The results were close to that of Shalaby et al and Vinay et al ^[11, 5] whereas results were lower than that found in studies by Ilayperuma et al as depicted from Table 4. ^[3]

Table 4: Comparison of studies on distance of GPF from IF, IPS & PPB

Sr. no.	Author name	GPF-IF		GPF-IPS/ MMS (in mm)		GPF-PPB (in mm)	
		Right	Left	Right	Left	Right	Left
1	Urbano et al ^[15]			16.63	16.39	4.5	4.56
2	Piagkou et al ^[9]	-	-	15.3		4.6	4.7
3	D'souza et al ^[13]	-	-	14.6± 1.47	14.4± 1.404	-	-
4	Vinay et al ^[5]	36.6±2.2	35.9±3.94	14.8± 0.16	14.8± 0.15	3.56± 0.91	3.58± 0.92
5	Sharma & Garud ^[12]	35.42	35.66	14.71	14.41	3.42	3.88
6	Ilayperuma et al ^[3]	42.2±1.1	-	15.20± 1.24	15.28± 1.06	4.52± 1.86	4.50± 1.03
7	Sarilita & Soames ^[10]	-	-	13.8± 1.47	-	-	-
8	Rao et al ^[16]	-	-	14.78± 1.08	14.75± 1.03	-	-
9	Shalaby et al ^[11]	35.93±3. 5	36.04±3.7	14.25± 1.7	14.17± 1.6	3.89± 0.9	3.99± 0.9
10	Present study	38.76±3. 26	38.46± 2.90	15.58± 1.71	15.33± 1.59	4.68± 1.09	4.41± 1.10

Distance of GPF from IPS

In previous studies by other authors, same distance was taken as distance between greater palatine foramen and midmaxillary suture. On comparison between two sides no 0.29 significant difference was found. The result was close to findings of Piagkou et al and Ilayperuma et al.^[9,3] but lower than that of Urbano et al (Table 4).^[15]

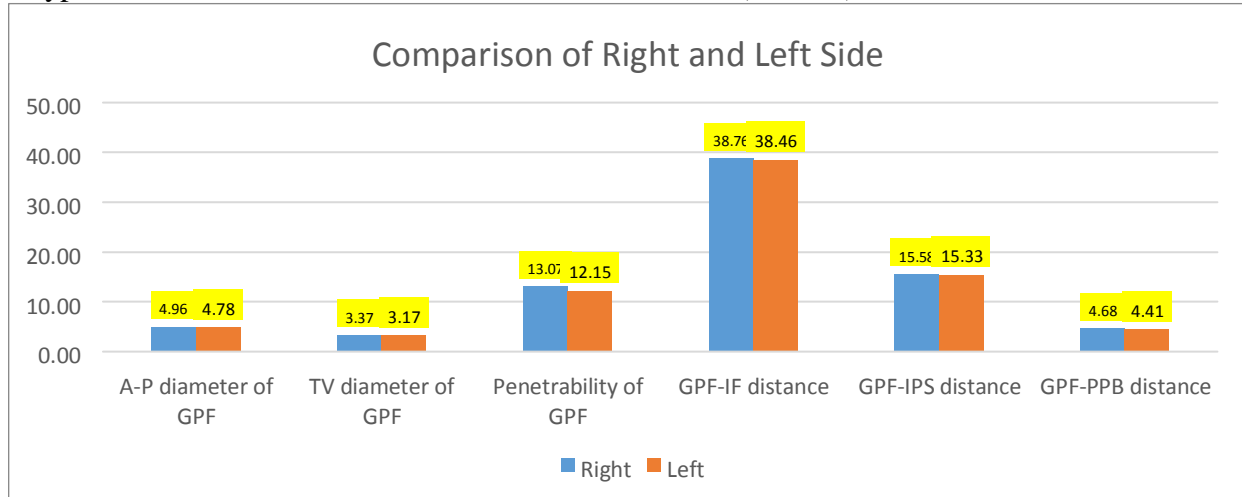


Figure 3: Showing comparison of mean of various parameters of GPF on right and left side

Distance of GPF from PPB: Our results were in line with results of Urbano et al, Piagkou et al and Ilayperuma et al as depicted from Table 4.^[15,9,3] Figure 3 portrays that in the study, results of metric parameters were higher on right side than that on the left side. The mean of these values of both sides were compared to each other by applying t- test to find P value and was found to be 0.08. It was found that P value was <0.05 . Hence, this difference was statistically insignificant.

Conflicts of interest

None

Funding resources

None

Conclusion

The present study concluded the anatomical data of greater palatine foramen in a comprehensive manner in north Indian skulls. The important observation of the study was that all morphometric parameters had higher value on right side as compared with left side. Though on statistical analysis the difference was found insignificant. But clinicians operating in this region should be aware of this difference for easy and unobstructed insertion of needle into the greater palatine foramen. The study will be helpful for comparison studies for future researchers. Furthermore, the results will be helpful for the oral maxillofacial surgeons, dentists and other clinicians operating in this region.

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