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Palatine Morphometry, Morphology and Position of the Greater Palatine Foramen with Reference to Various Anatomical Landmarks of Sri Lankans with Reference to Sex

Morfometría Palatina, Morfología y Posición del Foramen Palatino Mayor en Relación con Diversos Puntos de Referencia Anatómicos de los Esrilanqueses en Relación con el Sexo

Chandimal K. M.[1]; Ihalage W. I. S. M.[1]; Edirisinghe E. A. S. T.[2]; Priyadarshani, K. M. W. W.[1]; Weerasooriya S.D.[2]; Bowatte P. G. C. S.[3]; Dissanayake K.[4]; Dissanayake P. H.[2] & Yasawardene S. G.[2]

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SUMMARY: A precise understanding of the anatomy of the palate and the greater palatine foramen (GPF) is crucial for successful dental, anesthetic, and surgical procedures. This study assessed palatal dimensions, palatine morphologies, and GPF positioning in Sri Lankans using 70 adult dry skulls from various regions. Sri Lankan males exhibited larger palatal dimensions than females. The palatine index ranged from 67.47 to 91.16 in males and 69.53 to 91.54 in females. Males predominantly showed leptostaphyline (narrow palate) morphology (78,3 %), while females had a lower frequency (48,48 %). The least common morphology in both sexes was brachystaphyline (wide palate). GPF most frequently had an oval outline. Males showed significantly greater distances from the GPF to landmarks like the mid-sagittal plane, incisive foramen, posterior nasal spine, and the nearest molar compared to females. In females, the GPF was located medial to the third maxillary molar in 92.86 % of cases, while in males, this prevalence was 72.00 %. The least common GPF position, posterior to the third molar, was observed only in males. The GPF was predominantly located in the M2 region in both sexes (males: 72.00 %, females: 92.86 %), with the M1 region showing very low prevalence in males (4.00 %) and no occurrences in females. This study highlights the racial and sex differences in palatine morphology and GPF positioning, emphasizing the need for thorough preoperative evaluations for maxillofacial surgeries and regional block anesthesia.

KEY WORDS: Greater palatine foramen; Palatal morphology; Sex differences; Sri Lankan population; Maxillofacial surgery.

INTRODUCTION

The palate is a structural barrier that separates the oral cavity and the nasal cavity by forming the roof of the oral cavity and the floor of the nasal cavity. The palate comprises two parts namely, the immobile hard palate which is located anteriorly, and the mobile soft palate which is located posteriorly (Helwany & Rathee, 2023). The hard palate is innervated by the greater palatine nerve, while the soft palate is supplied by the lesser palatine nerve both of which are branches of the maxillary nerve of the trigeminal nerve. The greater palatine nerve passes through the greater palatine foramen (GPF) and the lesser palatine nerve traverses the lesser palatine foramen. (Tomaszewska *et al*., 2015; Ortug & Uzel, 2019). A precise understanding of the anatomy of the GFP is essential for successfully carrying out various dental, anesthetic, and surgical procedures in the region (Tomaszewska *et al*., 2015).

The maxillary tooth was commonly used as an indirect guide to locate the GPF. The second maxillary molar too was mostly used as an anatomical guide in administering anesthesia for greater palatine nerve block (Ikuta *et al*., 2013). The greater palatine nerve block is widely recommended for various surgical procedures involving maxillo-facial surgeries (Kang *et al*., 2012). Therefore, the precise location of the GPF concerning various anatomical landmarks of the surroundings is also important in various surgical procedures (Monnet-Corti

[1] Department of Anatomy, Faculty of Medicine, Wayamba University of Sri Lanka.
[2] Department of Anatomy, Faculty of Medical Sciences, University of Sri Jayewardenepura Sri Lanka.
[3] Department of Medicine, Faculty of Medicine, Wayamba University of Sri Lanka.
[4] Department of Anatomy, Faculty of Medicine, University of Peradeniya, Sri Lanka.

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et al., 2006). Anatomical studies on the location and morphologies of the greater palatine foramen (GPF) have been carried out across various Asian populations, including Chinese Indians and Thais (Wang *et al*., 1988; Methathrathip *et al*., 2005; Saralaya & Nayak, 2007). A previous study conducted in southern Sri Lankans using dry skulls assessed the shape and the location of GPF concerning maxillary molar teeth. They concluded that the most common position for the GPF relative to the maxillary molars was found to be in line with the third maxillary molar (77.2 %), followed by a position between the second and third maxillary molars (21.68 %) (Ilayperuma *et al*., 2014). Another study conducted in Sri Lanka assessed the size and position of the GPF using a limited number of samples of 50 cone beam computed tomography of patients by measuring the commonly used distances concerning surrounding anatomical landmarks and reported that a significant difference was observed in the distance from the anterior nasal spine to the GPF on both right and left sides, as well as in the GPF diameters between males and females (Fonseka *et al*., 2019).

Morphometry and morphology of the palate form the fundamental basis for the treatment planning of maxillo-facial surgeries such as orthognathic surgeries, maxillary dental implants, Hemi- maxillectomy, Le Fort fracture management, cleft palate surgery and are also useful for preoperative evaluation of patients with uvulopalatoplasty, pharyngoplasty, etc. Palatine morphometry and palatine morphologies are different among even males and females within the same population and different ethnic groups in the globe. The palatine index (PI) is the ratio of palatal width to palatal length, presented as a percentage that determines the palatine morphologies (Wahane & Nandanwar, 2019). Palatine morphologies vary among humans concerning sex and ethnicity. According to the palatine indices different palatine morphologies such as leptostaphyline (PI < 80 %), mesostaphyline 80 < PI >85, and brachystaphyline PI >85 were identified among different ethnic groups in the world (Wahane & Nandanwar, 2019).

The proper location of GPF immensely impacts the success of surgical procedures and morphometry and morphology of the palate also heavily affect the surgical procedures of the maxillofacial region and anesthetic nerve blocks, which in turn would invariably reduce the potential complications encountered during clinical procedures (Malamed & Trieger, 1983; Methathrathip *et al*., 2005). In contrast, the location of the GPF in Sri Lanka was studied in a small area of the country with reference to commonly used distances from the GPF. The palatal index and palatal morphologies of the Sri Lankan population have not been studied. Therefore, in this context, the aim of the present study was to determine the location of the GPF with reference to different methodologies among Sri Lankans representing different regions of the country and to determine the population specific palatine morphometry and determine the prevalence of different palatine morphologies among Sri Lankans.

MATERIAL AND METHOD

Data collection was conducted using 70 adult dry human skulls with intact palatine bones representing different regions of Sri Lanka. All these processed dry bony skulls were taken from cadavers donated to state medical faculties by voluntary donors with prior consent to death for medical education and research. Twenty-five (25) skulls from the Department of Anatomy, Faculty of Medicine, University of Peradeniya (central part of the Sri Lanka), 25 skulls from the Department of Anatomy, Faculty of Medicine, Wayamba University of Sri Lanka (northwestern part of Sri Lanka) and 20 skulls from Department of Basic Principles, Gampaha Wickramarachchi University (western part of the Sri Lanka) were included in the present study. The sex of the selected skulls was determined based on standard sex determining morphological characteristics of the skull in the literature before taking measurements (Bass, 2005). The age of each skull was determined by observing the dental attrition pattern of upper molar teeth available in the upper jaw with reference to age determining standard attrition pattern described in Bass (2005).

To calculate the palatine index, measurements of maximum palatal length and palatal width were taken with reference to landmarks shown in Figure 1. Each measurement was repeated three times, and the mean value was employed to determine the palatine index. The palatine index was calculated using the following formula.

$$\text{Palatine index} = \frac{\text{Palatal width}}{\text{Palatal length}} \times 100$$

The palatine morphology of each skull was determined using a calculated palatine index. Based on the palatine index, palatine morphologies were classified as follows: those with an index less than 80 were categorized as leptostaphyline, those with an index between 80 and 85 as mesostaphyline, and those with an index of 85 or greater as brachystaphyline (Wahane & Nandanwar, 2019).

A- palatine length B – palatine width. To determine the location of the GPF several methodologies in the literature were employed. The direct measurements were taken from different anatomical landmarks nearer to the GPF to determine its location as a first method as described in Ortug & Uzel (2019). Following distances: from the GPF to the incisive foramen (IF), from the GPF to the mid-sagittal plane (SP),

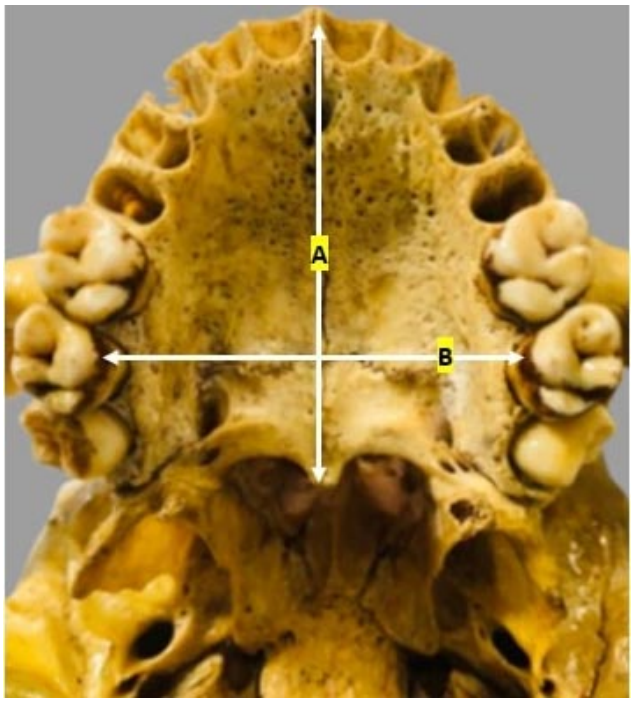

Fig. 1. Anatomical landmarks for palatal measurements , A- Palatal length, B - Palatal Width.

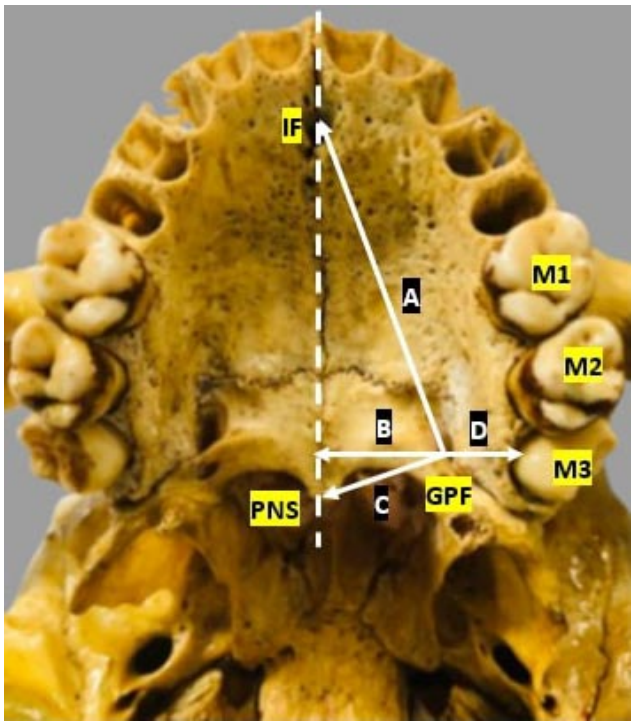

Fig. 2. Distances to GPF from various anatomical landmarks of palate. IF- incisive foramen, PNS - posterior nasal spine, M1 – first maxillary molar tooth, M2 - second maxillary molar tooth, M3 – third maxillary molar tooth. A - distance from the GPF to the incisive foramen, B – distance from the GPF to the mid sagittal plane, C - distance from the GPF to the posterior nasal spine, D – distance from the GPF to the nearest maxillary molar

from the GPF to the posterior nasal spine (PNS), and from the GPF to the nearest maxillary molar (M3) (Fig. 2) were measured bilaterally. Each measurement was repeated three times, and the mean value was calculated for data analysis.

The location of the GPF was observed with reference to maxillary molar teeth as the second method. The location GPF was identified in three different loci: medial to the second maxillary molar tooth, medial to the third maxillary molar tooth, and behind to the third maxillary molar tooth. The location of GPF in relation to maxillary molar teeth is located grossly on the foremen and it does not produce a very accurate location. Therefore the location of the GPF was observed in detail with reference to nine regions drawn over the palate as the third method (Narayan & Ghosh, 2021). In this method, the surface of the hard palate was divided into 9 regions by drawing imaginary lines described in Figure 3.Using anatomical planes and anatomical landmarks (Fig. 3). The exact location of GPF was observed with reference to nine regions and recorded bilaterally and the prevalence of the location of GPF in each region was analyzed by using SPSS software version 23.0.

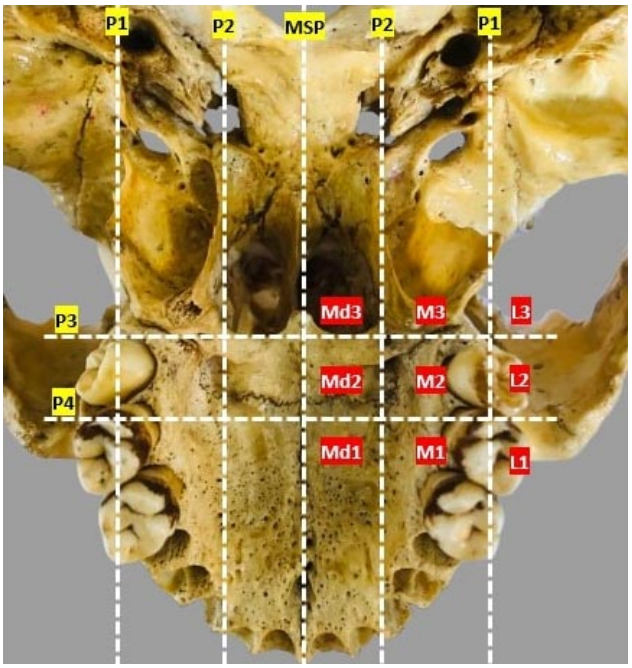

Fig. 3. Anatomical landmarks and imaginary lines which produce nine regions of the palate. MSP - the line runs through the posterior nasal spine and the midpoint between the incisors; P1 - the line that runs anteriorly along the midpoint of the third maxillary molar (if present) or the midpoint of the second maxillary molar (if absent), P2 - the line that runs lateral to and parallel to MSP along the mean distance between MSP and GPF, P3 - the line that runs along the third maxillary molar's posterior margin, P4 - the line that runs halfway between the posterior margin of the third maxillary molar and the anterior margin of the second maxillary molar tooth.

The shape of each GPF was observed and they were classified as round or oval by comparing them to the reported literature (Ortug & Uzel, 2019). Two examiners independently determined the shape of the GPF, and the results were compared to reach a conclusion.

Data analysis was carried out using SPSS software version 23.0. The means were compared by sex using the independent samples t-test to assess sex differences in each measurement and the palatine index.

RESULTS

Out of the 70 skulls examined in this study, 37 were male and 33 were female. Based on the examined attrition pattern of maxillary molar teeth found in the skulls, the age range of the analyzed skulls is 60–80 years old. The mean palatal length and width of male Sri Lankans is higher than that of females. The mean palatal index of males is lower than that of female Sri Lankans. There are no significant differences in the palatal measurements and palatal indices among sexes (Table I).

Male Sri Lankans show Leptostaphyline (narrow) palatine morphology, whereas females show Mesostaphyline (middle) palatine morphology, based on the calculated mean value of palatal indices. Based on prevalence analysis, Leptostaphyline (narrow) is the most common palatine morphology seen among Sri Lankan females, whereas brachystaphyline (broad) is the least common type. The leptostaphyline (narrow) palate is most common among Sri Lankan men, whereas the brachystaphyline (broad) palate is the least common type among them (Table II).

Table III displays the mean and ranges of each linear distance from GPF to several closer palate anatomical landmarks. Despite this, there is a notable bilateral symmetry in these measurements, with no significant difference between the sides ($P>0.05$). GPF to PNS (both right and left) and GPF to IF distances for both sides show notable sex differences ($P<0.05$) in distance values. Linear distances between sexes are not significant for other studied linear distances.

Table I. Mean and ranges of palatal length, width and palatal index of male and female Sri Lankans.

Measurement	Male (Mean ± SD) (mm)	Range (Min-Max)	Female (Mean ± SD)	Range (Min-Max)	p value
Palatal length	51.07 ± 4.81	41.97-61.61	48.24 ± 4.41	42.90-59.41	0.076
Palatal width	39.04 ± 2.81	34.86-45.21	38.63 ± 2.25	35.11-42.97	0.643
Palatine index	76.96 ± 7.95	67.47-91.16	80.53 ± 6.84	69.53-91.54	0.162

Table II. Prevalence of palatine morphologies among male female Sri Lankans.

Type	Sex		Total
	Female	Male	
Leptostaphyline (narrow)	16 (48.48 %)	29 (78.34 %)	45 (64.29 %)
Mesostaphyline (medium)	10 (30.30 %)	5 (13.51 %)	15 (21.43 %)
Brachystaphyline (wide)	7 (21.21 %)	3 (8.11 %)	10 (14.28 %)
Total	33	37	70

Table III. Mean and ranges of distances from GPF to nearer anatomical landmarks. IF- incisive foramen, SP – mid sagittal line, PNS – posterior nasal spin, MM – nearer maxillary molar teeth.

Measurements	Male (Mean ± SD) (mm)	Range (Min-Max)	Female (Mean ± SD) (mm)	Range (Min-Max)	p value
GPF - IF (R)	42.35 ± 3.46	36.93-50.28	39.79 ± 2.89	34.97-45.85	0.023
GPF – IF (L)	42.38 ± 2.99	36.57-47.20	40.27 ± 2.34	35.91-44.12	0.026
GPF – SP (R)	15.82 ± 1.6	13.22- 19.62	15.09 ± 1.64	12.73-18.65	0.183
GPF - SP (L)	16.08 ± 1.31	13.25-18.56	15.40 ± 1.77	12.42-18.88	0.181
GPF – PNS (R)	17.57 ± 1.87	14.90-20.76	16.33 ± 1.46	12.92-19.39	0.035
GPF – PNS (L)	17.69 ± 1.71	15.43-21.83	16.59 ± 1.6	13.80-20.62	0.049
GPF – MM (R)	4.77 ± 1.44	2.05-8.63	4.77 ± 1.45	2.47-7.52	0.99
GPF – MM (L)	4.54 ± 1.24	2.88-6.93	4.51 ± 1.27	2.99-7.53	0.96

The predominance of GPF position concerning maxillary molar teeth is shown in Table IV. For both sexes, the right GPF is mostly found medial to the third molar teeth in Sri Lankans (males: 72.00 %, females: 92.86 %) and with a low incidence in the medial to second molar teeth.

The location of GPF with reference to nine regions of the palate is shown in Table V. The location of GPF is more abundant in the M2 region bilaterally for both sexes. There is the very least availability of GPF bilaterally in the palate among male Sri Lankans.

The prevalence of GPF shape among Sri Lankans is shown in Table VI. GPF differs in form between sexes and even between the right and left sides of the palate among. Round shapes are the least common among Sri Lankan women, while oval shapes are more common. In males, oval shape is predominant in right side while round shape is predominant in left.

Table IV. Prevalence of location of GPF with reference to maxillary molar teeth.

Situation of GPF in relation to maxillary molar teeth	Prevalence of male (R)	Prevalence of male (L)	Prevalence of female (R)	Prevalence of female (L)
Medial to third molar	72.00 %	72.00 %	92.86 %	92.86 %
Behind to third molar	24.00 %	24.00 %	7.14 %	7.14 %
Medial to second molar	4.00 %	4.00 %		

Table V. Prevalence of location of GPF with reference nine region of palate.

Quadrant	Right side		Left side	
	Male	Female	Male	Female
Md1	-	-	-	-
Md2	-	-	-	-
Md3	-	-	-	-
M1	4.00 %	-	4.00 %	-
M2	72.00 %	92.86 %	72.00 %	92.86 %
M3	24.00 %	7.14 %	24.00 %	7.14 %
L1	-	-	-	-
L2	-	-	-	-
L3	-	-	-	-

Table VI. Shape of the GPF among Sri Lankans.

Shape	**Male**		**Female**	
	Right	**Left**	**Right**	**Left**
Oval	60.87 %	47.83 %	80 %	86.67 %
Round	39.13 %	52.17 %	20 %	13.33 %

DISCUSSION

Palatine morphometry serves as the basis for treatment planning for maxillo-facial procedures, such as hemi-maxillectomy, orthognathic surgeries, maxillary dental implants, Le Fort fracture treatment, and cleft palate surgery. Patients undergoing pharyngoplasty, uvulopalatoplasty, and other surgeries benefit from its preoperative examination as well. When performing certain surgical and clinical procedures, such as nasopharyngoscopy and nasogastric intubation, it is also essential to have a thorough understanding of the normal morphometry and morphology of the palate. This information is also necessary when designing the equipment used to analyze the region. In many surgical procedures involving greater palatine nerve block, the precise positioning of the GPF about numerous anatomical landmarks of the surrounding area is also crucial. To provide relevant information for surgical and clinical settings, this study provides Sri Lankan palatine measurements, palatine indices, palatine morphologies, shape of GPF, and position of GPF using various approaches. In this study, Leptostaphyline type (narrow palate) was found in the palates of the majority of Sri Lankans (64.29 %) irrespective of sex, and in the majority of males (78.38 %) and females (48.48 %). Without taking sex into account, the predominance of each palatine type in Sri Lankans is as follows: leptostaphyline, 64.29 %, mesostaphyline, 21.43 %, and brachystpahyline, 14.28 %. Similar to this study,

central Indians had the highest proportion of leptostaphyline type (63 %) (Dave *et al*., 2013). Shalaby *et al*, (2015) showed the same distribution pattern of Egyptians [leptostaphyline -64 %, mesostaphyline-24 %, brachystpahyline-12 %).

Kenyans also showed 43.2 % leptostaphyline, 33.1 % brachystpahyline, and 23.7 % mesostaphyline, with the leptostaphyline palate type predominating, according to Hassanali & Mwaniki (1984). In another study, south Indians showed that brachystaphyline (40 %) was the most prevalent form, followed by mesostaphyline (22.5 %) and leptostaphyline (37.5 %) (D'Souza *et al*., 2012). 86.9 % of south Indians have the Brachystaphylin type (wide palate), according to Kulkarni & Ramesh (2017). The results of the present study are in contrast to the brachystaphyline type seen in 50.0 % of male turkeys (Ortug & Uzel, 2019). The predominance of Sri Lankan palatine indices and morphologies in this study differs from that of nearby ethnic groups living in India and other worldwide ethnic groups, as demonstrated by these comparisons.

Although the studies of palatine dimensions of Sri Lankans prove that males have higher mean values and ranges than females, the studied palatine dimensions are not significantly different among sexes. The mean length (51.07 mm ± 4.81 in males and 48.24 mm ± 4.41 in females) and width (39.04 mm ± 2.81 in male and 38.3 mm ± 2.25 in female) of the palate in this study is greater than that of previous study conducted on central Indian palates (males were 50.28 ±3.56, females 47.45 ±3.68, mean palatal width in males was 37.17 ±2.88 mm and 35.50 ±3.07 in females) (Patel, 2012). Findings of the mean values of palatine length and width of males and females in this study are higher than that of south Indian males and females (length - male 39.8mm ± 0.44, female – 37. 2 ± 0.54 width -male 35.3 ±0.40, female 32.3 ±0.45) (Jacob *et al*., 2016). These comparisons prove that palatine measurements in this study are different even from the nearer ethnic groups residing in India.

Findings comparing the palatine morphology and measurements of Sri Lankans worldwide to those of other ethnic groups demonstrate how ethnicity plays a significant role in these variances. Therefore, it is necessary to take into account the ethnically specific palatine measurements and morphologies of Sri Lankans in order to reduce challenges during maxillofacial surgeries, such as palatine repairs and diagnostic procedures, etc.

Maxillary nerve block is widely used to give hemi-maxillary anesthesia in clinical odontology and maxillofacial surgery. The exact position of the greater palatine foramen (GPF) must be determined in order for the greater palatine canal method to successfully block the maxillary nerve. There have been studies and reports on the anatomical variations in GPF position across various ethnic groups worldwide. Therefore, the success of the greater palatine canal technique of maxillary nerve block may depend on the precise position of GPF.

In this study, the location of GPF was observed with reference to nearer anatomical landmarks of the palate as a first method. The mean distance of all studies nearer anatomical landmarks to GPF was higher in Sri Lankan males than females, and there were significant differences in distance from incisive foremen and posterior nasal spine to GPF in males than females bilaterally. The study conducted on southern Sri Lankans showed the lower mean distance of mid-sagittal plane to GPF (L - 15.20 mm ±1.24 R - 15.28 mm ±1.06) without considering the sex than that of male (L - 16.08 ± 1.31, R- 15.82 ± 1.6) and females (L - 15.04 ± 1.77, R- 15.09 ± 1.64) in this study (Ilayperuma *et al*., 2014). The obtained mean value in this study was lower than those reported in Chinese (8) and Thais (10), whereas the findings of this study are higher than those reported for South Indians (9) and Brazilians (Chrcanovic & Custódio, 2010).

The mean distance from incisive foremen to GPF of southern Sri Lankans without considering the sex reported (L 41.20 mm ±1.10) was higher than the mean distance obtained from this study's findings (male L - 42.38 ± 2.99, male R- 42.35 ± 3.46) (female L - 40.27 ± 2.34, female R- 39.79 ± 2.89) (Ilayperuma *et al*., 2014). These findings prove that the location of GPF concerning nearer anatomical landmarks varies within the population of the same country and among different ethnic groups globally. This study presents a detailed sex comparison, whereas the prior Sri Lankan study did not address the sex discrepancies.

The location of GPF was observed with reference to molar teeth as the second method in this study. The location of GPF is mostly found in the medial to the third maxillary tooth in both sexes for both the right and left sides in this study (Table IV). The least prevalence of location of GPF is found in medial to second molar teeth of males and no location of GPF in females medial to second molar tooth. This study's findings were compared with a previous study done on Sri Lankan skulls collected from southern Sri Lanka (Ilayperuma *et al*., 2014). The location of GPF in southern Sri Lanka showed that GPF location was mostly found medial to the third molar tooth for both sexes as in this study. The second prevalence of the location of GPF in male individuals in this study was behind the 3rd molar teeth and contrasts with the study findings of

southern Sri Lanka in which the GFP location behind the third molar was 0.74 %. The low prevalence of GPF location of males which is medial to second molar in this study is higher than that of study findings of the previous study done on South Sri Lankans (0.74 %); this study proves that when the population is represented with several areas of the country, gives more informative figures on the GPF locations in comparison to the previous study (Ilayperuma *et al*., 2014).

Table VII. Comparison of shape and position of GPF between present study and previous studies.

Previous Study	Number of Samples	Study Population	Shape of GPF	Position of GPF in relation to Maxillary Molar Teeth
Langenegger *et al*., 1983.	100	South African	Not Reported	Opposite third molar – 35 % Distal to third molar – 36 % Behind third molar – 29 %
Hassanali and Mwaniki, 1984.	125	Kenyan	Not Reported	Opposite third molar – 76 % Between second and third molar – 13.6 % Opposite second molar – 10.4 %
Wang *et al*., 1988.	100	Chinese	Not Reported	Opposite third molar – 33.5 % Between second and third molar – 48 % Opposite second molar – 17 %
Ajmani, 1994.	65	Nigerian	Not Reported	Opposite third molar – 48.5 % (Nigerian Skulls) Opposite third molar – 64.7 % (Indian Skulls)
Jaffar & Hamadah, 2003.	50	Caucasian	Oval (100 %)	Opposite third molar – 55 % Opposite second molar – 12 % Between second and third molar – 19 % Behind the third molars – 14 %
Methathrathip *et al*., 2005.	105	Thai	Oval (100 %)	Opposite third molar – 64.4 % Between second and third molar – 23.1 % Opposite second molar – 5.6 %
Sujatha *et al*., 2005	71	Indian	Not Reported	Opposite third molar – 85.95 % Between second and third molar – 13.15 % Opposite second molar – 0.88 %
Saralaya & Nayak, 2007.	132	Indian	Not Reported	Opposite third molar – 73.5 % Between second and third molar – 25 % Opposite second molar – 0.8 %
Piagkou *et al*., 2012.	71	Greek	Oval (100 %)	Opposite third molar – 75.5 % Opposite second molar – 17 % Behind third molar – 7.5 %
Ilayperuma *et al*., 2014.	136	Sri Lankan Southern part	Oval (82.35 %) Round (17.65 %)	Opposite third molar – 77.2 % Between second and third molar – 21.68 % Opposite second molar – 0.74 % Behind third molar – 0.74%
Ortug & Uzel, 2019.	97	Turkish	Oval (62.8 %) Round (37.2 %)	Opposite third molar – 62.7 %
Narayan &Ghosh, 2021.	35	Indian	Round (85.7 %) Oval (14.3 %)	Opposite third molar – 68.5 % Behind third molar – 8.5 % Behind second molar – 22.8 % (Only in absence of third molar)
Present study	37	Sri Lankan (Male) Right side	Oval - 60.87 % Round - 39.13 %	Medial to third molar – 57.69 % Behind to third molar - 38.46 % Medial to second molar - 3.85 %
	37	Sri Lankan (Male) Left side	Oval - 47.83 % Round - 52.17 %	Medial to third molar – 53.84 % Behind to third molar - 42.31 % Medial to second molar - 3.85 %
	33	Sri Lankan (Female) Right side	Oval – 80 % Round – 20 %	Medial to third molar – 92.86 % Behind to third molar - 7.14 % Medial to second molar – 0.00 %
	33	Sri Lankan (Female) Left side	Oval - 86.67 % Round - 13.33 %	Medial to third molar – 92.86 % Behind to third molar - 7.14 % Medial to second molar - 0.00 %

The study findings of the prevalence of location of GPF in this study are compared with the prevalence of location of other ethnic groups globally, such as African, Turkeys, Chinese, Thai, Indians, Greek, etc. (Hassanali & Mwaniki, 1984; Wang *et al*., 1988; Methathrathip *et al*., 2005; Saralaya & Nayak, 2007; Ortug & Uzel, 2019; Narayan & Ghosh, 2021). Table VII shows the prevalence of location GPF with reference to second and third maxillary molar teeth in different ethnic groups. The higher prevalence of GFP for most of the ethnic groups is located opposite/medial to the third molar tooth and the least prevalence was reported behind to the third molar tooth. The higher prevalence of location of GPF opposite to the third molar tooth in female Sri Lankan (92.86 %) in this study has not been reported in previous studies. Kenyan and Greek ethnic groups who showed the highest prevalence of GPF among the other ethnic groups in the globe are smaller than Sri Lankan women (Table VII). The prevalence of GPF opposite/medial to the third molar tooth in male Sri Lankans in this study is comparatively equal to the other ethnic groups in the world. The second dominant prevalence of the location of GPF behind the third molar male in this study is in contrast with previous study findings and Caucasians and South Africans show higher prevalence same as in this study (Table VII).

Location of GPF concerning nine regions of the palate was studied as the third method in this study. For the first time in the literature, Narayan & Ghosh (2021) reported the location of GPF with reference to nine regions in the hard palate of Indians. This is the second time in the literature the location of GPF with reference to nine regions in the palate is reported. The location of GPF in this study is high in the M2 region for both male and female Sri Lankans and the M1 region shows a lower prevalence among other regions. In M1 region shows a very low prevalence of location of GPF in male Sri Lankans andno GPF was found in Sri Lankan females. The GPF location in the Md2 and Md3 was not found in this study. This study's findings contrast with the previous study done on Indians, the prevalence of location of GPF was reported as high in Md2 (L -51.8, R - 40.7), M2 (L - 37.03, R - 48.14) regions and low in M3 (L – 7. 4, R - 11.1) and Md3 (L - 3.7) without considering the sex. The prevalence of location of GPF in the M3 region in female Sri Lankans in this study (7.14 %) also is in agreement with the Indian study in which the right side shows 7.4 % and the left side shows 11.1 % (Narayan & Ghosh, 2021).

The results of this study prove that the palatine dimensions, morphology, and position of GPF differ between sexes within the same population as well as various ethnic groups worldwide. Genetic, environmental, and embryological factors appear to contribute to the variations in palatine morphometry, morphology, and position of GPF (Chrcanovic & Custódio, 2010). The positioning of the GPF may be impacted by sutural development between the maxilla and palatine bones and the expansion of the anteroposterior dimensions of the palate that occurs with the eruption of posterior teeth (Slavkin *et al*., 1966). Population-specific palatometry and palatine morphology would reduce the complications expected in surgeries and other medical applications in the area, and findings of population-specific positioning of GFP with reference to nearer anatomical landmarks would minimize the damage to the neurovascular bundle that exits through GPF in anesthetic procedures (Malamed & Trieger, 1983; Chrcanovic & Custódio, 2010).

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RESUMEN: Una comprensión precisa de la anatomía del paladar y del foramen palatino mayor (FPA) es crucial para el éxito de los procedimientos dentales, anestésicos y quirúrgicos. Este estudio evaluó las dimensiones palatinas, las morfologías palatinas y la posición del GPF en esrilanqueses utilizando 70 cráneos secos adultos de varias regiones. Los hombres de Sri Lanka exhibieron dimensiones palatinas mayores que las mujeres. El índice palatino varió de 67,47 a 91,16 en hombres y de 69,53 a 91,54 en mujeres. Los hombres mostraron predominantemente morfología leptostafilina (paladar estrecho) (76 %), mientras que las mujeres tuvieron una frecuencia menor (47 %). La morfología menos común en ambos sexos fue braquistafilina (paladar ancho). El GPF tuvo con mayor frecuencia un contorno ovalado. Los hombres mostraron distancias significativamente mayores desde el GPF a puntos de referencia como el plano sagital medio, el foramen incisivo, la espina nasal posterior y el molar más cercano en comparación con las mujeres. En las mujeres, el GPF se localizó medial al tercer molar maxilar en el 92,86 % de los casos, mientras que en los hombres, esta prevalencia fue del 72,00 %. La posición menos común del GPF, posterior al tercer molar, se observó únicamente en hombres. El GPF se localizó predominantemente en la región M2 en ambos sexos (hombres: 72,00 %, mujeres: 92,86 %), con una prevalencia muy baja en la región M1 en hombres (4,00 %) y nula en mujeres. Este estudio destaca las diferencias raciales y de sexo en la morfología palatina y la posición del GPF, lo que enfatiza la necesidad de evaluaciones preoperatorias exhaustivas para cirugías maxilofaciales y anestesia regional por bloqueo.

PALABRAS CLAVE: Foramen palatino mayor; Morfología palatina; Diferencias por sexo; Población de Sri Lanka; Cirugía maxilofacial.

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Corresponding author:
Edirisinghe E.A.S.T
Department of Anatomy
Faculty of Medical Sciences
University of Jayewardenepura
Gangodawila
SRI LANKA

E-mail: edirisinghe@sjp.ac.lk