ORIGINAL RESEARCH

Morphometric Assessment of the Stylomastoid Foramen in Sri Lankan Skulls and Its Surgical Significance

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Abstract

Objective: To determine the morphometric relationships of the stylomastoid foramen with adjacent bony landmarks in male and female Sri Lankan skulls and to assess bilateral and sex-related variations.

Methods: A descriptive morphometric study was conducted on 50 adult human dry skulls obtained from three anatomy departments in Sri Lanka. 32 male and 18 female skulls were included. Four linear measurements were recorded bilaterally using a digital Vernier caliper: P1-centre of submandibular fossa (SMF) to mastoid tip; P2-upper end anterior border of mastoid process; P3-jugular foramen; P4-root of styloid process. Measurements were taken 3 times and mean value obtained for analysis. Descriptive statistics were calculated, and bilateral differences were assessed using paired-samples t-tests, while sex-related differences were assessed using independent-samples t-tests. Statistical significance was set at $p < 0.05$.

Results: A significant bilateral difference was observed for P3 among females, with the right-sided measurement greater than the left (17.52 ± 1.57 mm vs. 16.46 ± 1.95 mm; $p = 0.027$). Sex-related comparison demonstrated a significantly greater right P1 in males than females (18.87 ± 2.07 mm vs. 17.22 ± 2.46 mm; $p = 0.043$). The remaining bilateral and sex-related comparisons were not statistically significant. The greatest individual variation was observed for left P1 in males, ranging from 12.43 to 23.26 mm.

Conclusion: The SMF demonstrated predominantly bilateral symmetry in the Sri Lankan skulls examined, with significant bilateral asymmetry limited to the SMF–jugular foramen distance in females and a significant sex-related difference in the right SMF–mastoid tip distance. The considerable individual variation observed, particularly in P1, indicates that the SMF should not be localized using a single fixed distance.

Keywords: stylomastoid foramen; facial nerve; morphometry; sexual dimorphism; Sri Lankan skulls; Surgical application

DOI: https://doi.org/10.4038/slaj.v10i2.339

Sri Lanka Anatomy Journal 2026; 10(II): 80–92

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Received 25/08/2026 *Revised version accepted 18/10/2026* *Published 11/11/2026*

Introduction

The stylomastoid foramen (SMF) is an important anatomical landmark located on the inferior aspect of the temporal bone, between the mastoid and styloid processes. It represents the extracranial exit of the facial nerve (cranial nerve VII) from the facial canal and therefore has considerable importance in clinical anatomy and surgery. The stylomastoid foramen also transmits the stylomastoid artery and vein and therefore represents an important neurovascular landmark at the skull base (1, 2). The anatomical position of the stylomastoid foramen in relation to surrounding bony landmarks is particularly important during surgical procedures involving the temporal bone, mastoid region, parotid gland and skull base. Identification of the facial nerve trunk is a critical step during parotidectomy, mastoidectomy, facial nerve decompression and other otologic and neurotologic procedures. The mastoid process, styloid process, posterior belly of the digastric muscle and tympanic plate are commonly used as landmarks for locating the facial nerve and its exit from the skull. Consequently, knowledge of the normal morphometric relationship between the stylomastoid foramen and these landmarks may facilitate accurate localization of the facial nerve and reduce the risk of iatrogenic nerve injury (2–4).

The stylomastoid foramen is also clinically relevant in regional anesthesia. The Nadbath facial nerve block is performed in the vicinity of the stylomastoid foramen, and accurate knowledge of the position of the foramen is essential for effective blockade while minimizing the possibility of injury to adjacent structures. A morphometric study of 100 dry skulls demonstrated considerable variation in the position of the centre of the stylomastoid foramen relative to the mastoid process and jugular foramen and emphasized that precise localization is important for facial nerve block procedures (5). Similarly, a study of 58 dry skulls reported mean distances from the centre of the stylomastoid foramen to the mastoid tip of approximately 16 mm and to the upper end of the anterior border of the mastoid process of approximately 14 mm, demonstrating the usefulness of these bony landmarks in locating the foramen (6).

The anatomical relationship of the stylomastoid foramen with the jugular foramen is also of surgical significance. The jugular foramen is an important skull-base opening transmitting the glossopharyngeal, vagus and accessory nerves together with the internal jugular vein. Consequently, the distance between the stylomastoid and jugular foramina provides an important spatial relationship when operating in the posterolateral skull base. Variations in this relationship may become particularly important during skull-base approaches, especially when normal anatomical landmarks are distorted by pathological processes, trauma or previous surgery (6, 7).

Morphometric characteristics of the stylomastoid foramen are not necessarily uniform across human populations. Differences have been reported in the position of the foramen in relation to the mastoid process, jugular foramen and other surrounding structures. A previous study reported significant right–left differences in the distance between the stylomastoid foramen and mastoid tip, as well as in its relationship with the jugular foramen (5). Another morphometric investigation of dry skulls demonstrated that the position, dimensions and anatomical relationships of the stylomastoid foramen can vary among individuals, emphasizing the importance of population-

specific anatomical data (8). More recently, a study of Serbian skulls investigated the morphometric characteristics, position and shape of the stylomastoid foramen and assessed their association with sex and body side, further demonstrating the value of population-specific reference data (9).

Sexual dimorphism and bilateral asymmetry are additional factors that may influence the anatomical position of the stylomastoid foramen. Differences in cranial dimensions between males and females can result in variation in the spatial relationships between foramina and adjacent processes. However, the magnitude and statistical significance of such differences are inconsistent among populations. Therefore, measurements derived from one ethnic or geographical population should not necessarily be assumed to represent another population. Establishing population-specific morphometric standards is particularly valuable when these anatomical relationships are used as surgical landmarks.

Several studies have investigated the morphometry of the stylomastoid foramen in Indian, Turkish, Brazilian and European populations (5, 6, 9, 10). However, information concerning the morphometric relationships of the stylomastoid foramen in Sri Lankan skulls remains limited. Sri Lanka represents a distinct South Asian population with its own demographic and biological characteristics, and locally derived anatomical reference values may therefore provide useful information for clinical anatomy, surgery, radiology and forensic anthropology. The absence of comprehensive Sri Lankan reference data represents an important gap in the anatomical literature.

In the present study, linear relationships of the stylomastoid foramen with nearer bony landmarks were investigated bilaterally. These measurements were selected because they describe the spatial relationship of the stylomastoid foramen with readily identifiable bony landmarks that may be encountered during surgical procedures.

Accordingly, the present study aimed to establish morphometric reference values for the location of the stylomastoid foramen in a sample of Sri Lankan adult skulls and to determine whether these measurements demonstrate significant bilateral or sex-related variation. The findings are expected to contribute to the anatomical database of the Sri Lankan population and provide clinically relevant reference measurements for procedures involving the facial nerve, temporal bone, mastoid region and lateral skull base.

Materials and Methods

A descriptive morphometric study was conducted using adult human dry skulls obtained from the Department of Anatomy, Faculty of Medicine, University of Peradeniya, Department of Anatomy, Faculty of Medicine, Wayamba University of Sri Lanka and, Department of Basic Sciences, Gampaha Wickramarachchi University of Indigenous Medicine. This study sites are located in three different geographical locations in the country Central, Northwestern and Western province of the country. A total of 50 skulls were considered for the study. Skulls exhibiting fractures, pathological deformities, severe erosion, congenital anomalies, or any gross anatomical abnormalities that could interfere with the identification of anatomical landmarks or accurate morphometric measurements were excluded. The sex of each skull was determined before data collection using standard osteological criteria described

in *Gray's Anatomy* (1). The age of the death was determined by teeth wear pattern described in Bass as all skulls belonging to adults. Following sex determination, the skulls were categorized into male and female groups for subsequent analysis.

The stylomastoid foramen (SMF) was identified bilaterally in each skull, and its centre was used as the reference point for obtaining the linear measurements. Four anatomical distances described in figure 1 were measured on both the right and left sides.

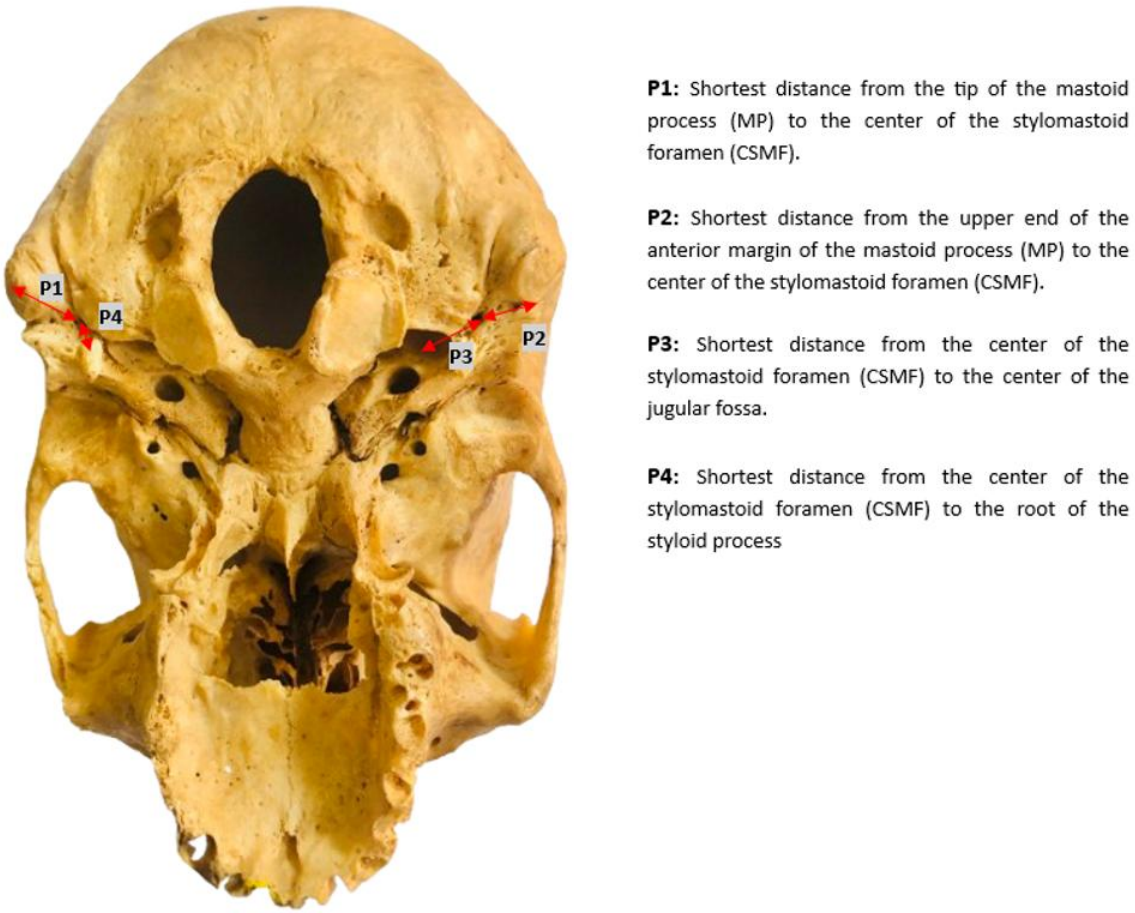


Figure 1: Landmarks for the measurements around the stylomastoid foramen

These measurements were selected to describe the spatial relationship of the stylomastoid foramen with clinically relevant bony landmarks of the temporal and skull-base regions.

P1 represented the distance from the centre of the stylomastoid foramen to the tip of the mastoid process; P2 represented the distance from the centre of the stylomastoid foramen to the upper end of the anterior border of the mastoid process; P3 represented the distance from the centre of the stylomastoid foramen to the jugular foramen; and P4 represented the distance from the centre of the stylomastoid foramen to the root of the styloid process.

All morphometric measurements were obtained by a single observer using a digital Vernier caliper and recorded in millimeters up to two decimals. The relevant anatomical landmarks, including the tip of the mastoid process, upper end of the anterior border of the

mastoid process, jugular foramen and root of the styloid process, were identified before measurement. The same measurement definitions and procedures were applied consistently to the right and left sides of each skull. Each measurement was repeated three times, and the mean value was used for subsequent analysis. Measuring instruments were calibrated before data collection to maintain accuracy and reliability.

All data were entered into Microsoft Excel and analyzed using the Statistical Package for Social Sciences (SPSS) version 23.0. Descriptive statistics were calculated separately for males and females and for the right and left sides. For each of the four morphometric parameters (P1, P2, P3 and P4), the mean, standard deviation (SD), minimum, maximum and range were calculated and expressed in millimeters. The normality of the continuous variables was assessed before inferential analysis. Since the right- and left-sided measurements were obtained from the same skulls, bilateral differences were evaluated using a paired-samples t-test. The mean values of the corresponding measurements between male and female skulls were compared separately for the right and left sides using an independent-samples t-test. Mean differences and corresponding 95% confidence intervals were calculated where appropriate. A two-tailed p-value < 0.05 was considered statistically significant. The statistical analysis was undertaken to determine bilateral asymmetry and sex-related variation in the morphometric relationships of the stylomastoid foramen.

The study was conducted in accordance with accepted ethical principles governing the use of human skeletal materials for research and education. The specimens were obtained from legally donated cadavers maintained by the respective anatomy departments. Institutional permission was obtained from the relevant authorities of the Faculty of Medicine, University of Peradeniya, the Faculty of Medicine and, Wayamba University of Sri Lanka and Gampaha Wickramarachchi University of Indigenous Medicine prior to the commencement of the study.

Results

Studies sample belonging to 32 male and 18 females. The age of the skull belonging to ranges of 65-75 years with reference to wear pattern observed. Descriptive analysis was performed separately for the right and left sides in male and female skulls and right and left side separately for gender wise comparison. Four measurements were evaluated: P1, representing the distance from the centre of the stylomastoid foramen to the tip of the mastoid process; P2, the distance from the centre of the stylomastoid foramen to the upper end of the anterior border of the mastoid; P3, the distance from the centre of the stylomastoid foramen to the jugular foramen; and P4, the distance from the centre of the stylomastoid foramen to the root of the styloid process.

Table 1 presents the descriptive statistics for the four anatomical measurements (P1, P2, P3 and P4) recorded from the right and left sides of male skulls. The mean, standard deviation, minimum, maximum and range are presented separately for each side. Among males, the mean values were generally comparable between the two sides, although P2 was slightly higher on the left, while P1, P3 and P4 showed slightly higher values on the right.

In males, there was no statistically significant bilateral difference in any of the four measurements. P1, P3 and P4 were slightly greater on the right, whereas P2 was slightly

greater on the left. The greatest bilateral difference in the male group was observed for P2, with the left side exceeding the right by approximately 0.46 mm. However, this difference was not statistically significant. The greatest range was observed for left P1, followed by left P3.

Table 1: Bilateral comparison within males — mean, SD, minimum, maximum and range for every parameter and side

Parameter	Side	Mean ± SD (mm)	Minimum	Maximum	Range	p-value
P1	Right	18.87 ± 2.07	14.65	22.94	8.29	0.657
	Left	18.64 ± 2.68	12.43	23.26	10.83	
P2	Right	22.62 ± 2.34	18.65	27.25	8.60	0.459
	Left	23.08 ± 2.51	19.28	27.55	8.27	
P3	Right	17.12 ± 1.83	14.13	21.26	7.13	0.358
	Left	16.58 ± 2.20	11.61	20.36	8.75	
P4	Right	4.94 ± 1.68	2.93	9.51	6.58	0.713
	Left	4.80 ± 1.24	2.79	7.30	4.51	

Table 2 compares the right and left measurements within female skulls to assess bilateral variation. P1, P2 and P4 did not demonstrate significant bilateral differences. However, P3 showed a statistically significant right-sided predominance, with a mean difference of 1.06 mm between the right and left sides.

The female group demonstrated a pattern like males for P1, P2 and P4, with no statistically significant right–left differences. However, P3 showed a significant bilateral difference. The right P3 measurement was 17.52 ± 1.57 mm, compared with 16.46 ± 1.95 mm on the left, representing a mean right-sided excess of approximately 1.06 mm. Thus, P3 represents the only measurement showing statistically significant bilateral asymmetry in either sex.

Table 3 presents the comparison of the anatomical measurements between male and female skulls separately for the right sides. Males showed significantly greater right-sided P1 measurements than females. The left-sided P1 measurement was also greater in males, although the difference did not reach statistical significance ($p = 0.056$). Male P2 values were greater than female values on both sides, but these differences were not statistically significant. P3 measurements were comparable between males and females on both sides. In contrast, P4 measurements were greater among females than males on both sides, although these differences were not statistically significant.

The most important sex-related finding was P1. Males demonstrated a significantly greater right P1 measurement than females. P2 was also greater in males by approximately 1.29 mm, but this did not reach statistical significance ($p = 0.094$). Interestingly, females

Table 2: Bilateral comparison within females: mean, SD, minimum, maximum and range for every parameter and side

Parameter	Side	Mean ± SD (mm)	Minimum	Maximum	Range	p-value
P1	Right	17.22 ± 2.46	13.80	22.07	8.27	0.460
	Left	16.95 ± 2.45	13.07	21.85	8.78	
P2	Right	21.32 ± 2.17	17.67	24.34	6.67	0.244
	Left	22.04 ± 2.35	18.36	26.93	8.57	
P3	Right	17.52 ± 1.57	15.07	20.07	5.00	0.027
	Left	16.46 ± 1.95	13.04	19.51	6.47	
P4	Right	5.61 ± 2.13	2.00	9.51	7.51	0.731
	Left	5.71 ± 1.63	3.24	8.59	5.35	

Table 3: Gender-wise variations – Right side

Parameter	Male Mean ± SD	Female Mean ± SD	Male − Female	Minimum–Maximum Male	Minimum–Maximum Female	p-value
P1	18.87 ± 2.07	17.22 ± 2.46	+1.64	14.65–22.94	13.80–22.07	0.043
P2	22.62 ± 2.34	21.32 ± 2.17	+1.29	18.65–27.25	17.67–24.34	0.094
P3	17.12 ± 1.83	17.52 ± 1.57	−0.40	14.13–21.26	15.07–20.07	0.479
P4	4.94 ± 1.68	5.61 ± 2.13	−0.67	2.93–9.51	2.00–9.51	0.320

showed slightly greater right P3 and P4 measurements than males, although neither difference was statistically significant.

Table 4 summarizes the minimum, maximum and range of each anatomical measurement according to left side for both genders. The results demonstrate appreciable individual variation within both male and female groups. In males, the widest range was observed for left-sided P1, whereas the narrowest range was observed for left-sided P5. Among females, right-sided P5 demonstrated the widest range, while right-sided P3 showed the narrowest range. The variation in the observed ranges indicates that individual anatomical differences exist within both sexes, although the overall pattern remains broadly comparable between the right and left sides.

Males generally showed greater P1 and P2 values than females: P1: males 18.64 mm vs females 16.95 mm P2: males 23.08 mm vs females 22.04 mm. However, neither difference reached the conventional level of statistical significance. The difference for left P1 approached significance ($p = 0.056$).

For P3, the two sexes were almost identical, Difference = 0.12 mm, $p = 0.863$n Female P5 was higher than male P5 by approximately 0.91 mm, but this difference was also not statistically significant ($p = 0.079$).

Table 5 indicates that male measurements generally showed greater variability, particularly for left P1 and left P3. Female P3 measurements were comparatively less

Table 4: Gender-wise variation — Left side

Parameter	Male Mean ± SD	Female Mean ± SD	Male − Female	Minimum–Maximum Male	Minimum–Maximum Female	p-value
P1	18.64 ± 2.68	16.95 ± 2.45	+1.69	12.43–23.26	13.07–21.85	0.056
P2	23.08 ± 2.51	22.04 ± 2.35	+1.04	19.28–27.55	18.36–26.93	0.206
P3	16.58 ± 2.20	16.46 ± 1.95	+0.12	11.61–20.36	13.04–19.51	0.863
P4	4.80 ± 1.24	5.71 ± 1.63	−0.91	2.79–7.30	3.24–8.59	0.079

Table 5: Gender – wise - overall comparison of the dataset

Measurement	Bilateral pattern in males	Bilateral pattern in females	Sex difference
P1	R > L by 0.22 mm, NS	R > L by 0.27 mm, NS	Right: males > females, significant
P2	L > R by 0.46 mm, NS	L > R by 0.71 mm, NS	Males > females on both sides, NS
P3	R > L by 0.34 mm, NS	R > L by 1.06 mm, significant	No significant sex difference
P4	R > L by 0.14 mm, NS	L > R by 0.10 mm, NS	Females > males, NS

NS = not statistically significant

variable on the right side. The observed ranges demonstrated considerable individual variation. Among males, the widest range was observed for left P1, whereas the narrowest range was observed for left P5. Among females, the widest range was observed for right P5, while the narrowest range was observed for right P3. Overall, the findings indicate predominantly bilateral symmetry, with statistically significant bilateral asymmetry limited to P3 among females and a significant sex-related difference observed for right P1.

Discussion

The present study provides baseline morphometric data on the relationship of the stylomastoid foramen (SMF) to important surrounding bony landmarks in Sri Lankan adult skulls. The overall findings demonstrate predominantly bilateral symmetry, with statistically significant right–left variation limited to P3 in females. A significant sex-related difference was identified only for right-sided P1, with males showing a greater mean distance than females. The remaining measurements did not demonstrate statistically significant bilateral or sex-related differences. These findings indicate that, although the position of the SMF is relatively consistent within the studied Sri Lankan sample, measurable individual variation exists and should be considered when the SMF is used as a surgical landmark.

The P1 measurement, representing the distance from the centre of the SMF to the mastoid tip, is particularly relevant for surgical localization of the facial nerve. The facial nerve exits the temporal bone through the SMF and subsequently passes into the parotid region; consequently, the SMF and mastoid process

are important landmarks during mastoidectomy, facial nerve decompression, parotid surgery and other procedures involving the temporal bone and skull base (1, 2). In the present study, the mean P1 was 18.87 ± 2.07 mm in males and 17.22 ± 2.46 mm in females on the right side, and 18.64 ± 2.68 mm and 16.95 ± 2.45 mm, respectively, on the left. The right-sided male value was significantly greater than the female value (p=0.043), indicating limited sex-related variation in this anatomical relationship. However, the considerable overlap between male and female measurements indicates that P1 should not be regarded as a sex-specific surgical measurement.

The individual ranges provide an important additional perspective. Male left P1 showed the greatest variation, extending from 12.43 to 23.26 mm, with a range of 10.83 mm. Thus, the location of the SMF relative to the mastoid tip differed by more than 1 cm among individuals in this sample. This finding is clinically important because a population mean cannot adequately represent the anatomical position of the SMF in every patient. The use of a single conventional distance as an absolute surgical landmark may therefore result in inaccurate expectations of the position of the facial nerve in an individual Sri Lankan patient.

Comparison with other populations supports this interpretation. Tewari *et al.,* reported mean SMF-to-mastoid-tip distances of 16.0 ± 2.4 mm on the right and 15.7 ± 2.6 mm on the left in 58 Indian dry skulls (6). Murlimanju *et al.,* reported mean values of approximately 15.26 ± 1.4 mm and 14.32 ± 1.8 mm on the right and left, respectively, in another Indian sample (5). In comparison, the mean values in the present Sri Lankan males were higher, whereas the female values were closer to the reported Indian measurements. Conversely, a recent Serbian study reported male values of 18.56 ± 2.41 mm on the right and 18.13 ± 2.38 mm on the left, and female values of 17.40 ± 2.84 mm and 16.87 ± 2.68 mm, respectively, which are remarkably close to the Sri Lankan findings (9). These comparisons demonstrate that the relationship between the SMF and mastoid tip is broadly conserved but that its absolute dimensions may vary between populations.

P2, representing the distance from the SMF to the upper end of the anterior border of the mastoid process, demonstrated mean values ranging from 21.32 to 23.08 mm in the present study. Although no statistically significant bilateral or sex-related differences were detected, substantial individual variation was evident. The male right-sided range was 17.67–27.25 mm and the left-sided range was 19.28–27.55 mm, while female values ranged from 17.67–24.34 mm on the right and 18.36–26.93 mm on the left. These findings indicate that the anterior mastoid border provides a relatively consistent anatomical reference at the population level, but individual measurements can differ considerably.

The P2 findings also demonstrate an interesting difference from some previously reported populations. Tewari *et al.,* reported mean distances of approximately 14.2 mm on the right and 13.9 mm on the left between the SMF and the upper end of the anterior border of the mastoid process in Indian skulls (6). The larger mean values observed in the present Sri Lankan sample suggest that this relationship may differ quantitatively between populations. However, differences in the precise definition of the anterior mastoid reference point and measurement methodology should be considered before interpreting this as a true population difference. Nevertheless, the findings reinforce the value of locally derived

anatomical reference data for Sri Lankan patients.

P3 represents the distance between the SMF and jugular foramen and is particularly relevant to procedures involving the lateral skull base. In the present study, males demonstrated mean P3 values of 17.12 ± 1.83 mm on the right and 16.58 ± 2.20 mm on the left, while females demonstrated values of 17.52 ± 1.57 mm and 16.46 ± 1.95 mm, respectively. A statistically significant right–left difference was observed among females ($p=0.027$), with the right-sided measurement being approximately 1.06 mm greater than the left. No significant bilateral difference was identified in males. Thus, P3 was the only measurement demonstrating statistically significant bilateral asymmetry in the present sample.

The clinical importance of P3 relates to the close anatomical relationship of the SMF and jugular foramen at the skull base. The jugular foramen transmits cranial nerves IX, X and XI and the internal jugular vein; consequently, knowledge of the spatial relationships of the jugular foramen to neighbouring structures is important during skull-base procedures (1, 2). Tewari *et al.,* reported lower mean SMF-to-jugular-foramen distances of approximately 12.7 mm on the right and 12.6 mm on the left in an Indian dry-skull sample (6). The comparatively greater Sri Lankan values indicate that this anatomical relationship may demonstrate population-level variation. However, the significant difference observed only among females should be interpreted cautiously because of the relatively small female sample. Further studies involving larger Sri Lankan samples are required to determine whether this asymmetry represents a consistent population characteristic.

The P4 measurement, representing the distance from the SMF to the root of the styloid process, showed relatively short mean values, ranging from approximately 4.80 to 5.61 mm in the present sample. Despite the short distance, individual variation was considerable. In males, the left P5 ranged from 2.79 to 7.30 mm, representing a range of 4.51 mm, whereas the female right P5 showed the widest female range, from 2.00 to 9.51 mm, representing a range of 7.51 mm. Therefore, even though no statistically significant sex-related or bilateral differences were identified, the individual ranges demonstrate that the relationship cannot be regarded as completely fixed.

The styloid process is an easily recognizable bony landmark in the region of the SMF and may provide an additional reference during facial nerve localization (1, 2). Previous morphometric investigations have also emphasized the importance of the relationship between the SMF and styloid process for facial nerve block and other procedures involving the facial nerve (5, 10). The present findings suggest that the styloid process should preferably be used together with other surrounding landmarks rather than as a single fixed-distance reference.

The population-specific nature of these measurements is particularly important for Sri Lankan surgical practice. The present P1 values are broadly similar to those reported in Serbian skulls but are somewhat greater than those reported in several Indian studies (6, 5, 9). Differences have also been reported in Turkish populations (9, 10). Therefore, although the general anatomical relationship is conserved, international morphometric values should not necessarily be transferred directly to Sri Lankan patients as fixed surgical measurements. The present data provide a locally derived reference range that may

improve anatomical awareness during procedures involving the temporal bone and facial nerve.

The findings may also be relevant to facial nerve block procedures. The SMF provides an anatomical reference for approaches to the facial nerve, and accurate localization is important for effective blockade while minimizing injury to adjacent structures (5, 10). The observed Sri Lankan variation suggests that using more than one palpable or radiological landmark may improve localization. Similarly, the measurements may assist in the interpretation of high-resolution temporal bone CT, although patient-specific imaging remains essential for detailed surgical planning.

The absence of significant bilateral differences for most parameters is also noteworthy. No significant right–left differences were observed in males, while females demonstrated significant asymmetry only for P3. This overall bilateral symmetry indicates that the SMF maintains a relatively consistent relationship with surrounding structures in the Sri Lankan skull. Nevertheless, the P3 finding demonstrates that the contralateral side should not automatically be considered an exact mirror image, particularly in patients with unilateral pathology or previous surgery.

The significant sex-related difference observed only for right P1 may reflect differences in cranial and temporal bone dimensions between males and females. However, because the remaining parameters did not demonstrate significant sex-related differences and the measurement ranges overlap considerably, the findings provide limited evidence for widespread sexual dimorphism of the SMF. Rather, the results suggest that sex contributes only modestly to variation in the anatomical relationships examined. This is consistent with the overall finding of relatively stable SMF positioning within the study population.

From an anatomical and forensic perspective, the present study adds population-specific data to the limited morphometric literature available for Sri Lankan skulls. Such data are valuable because anatomical measurements derived from one population may not necessarily be directly applicable to another. The differences observed between the Sri Lankan, Indian and Serbian data emphasize the importance of developing regional anatomical reference datasets (5, 6, 9, 10). However, these differences should be interpreted in the context of methodological variation and should not be regarded as evidence of population-specific genetic differences without further investigation.

An important overall observation from the present study is that the ranges may be more clinically informative than the means alone. The largest variation was observed for male left P1, with a range of 10.83 mm, while substantial ranges were also observed for P2, P3 and P4. This indicates that Sri Lankan individuals may show appreciable variation in the exact location of the SMF despite the general preservation of its anatomical relationships. Therefore, the present study provides not only mean reference values but also population-specific estimates of the expected range of anatomical variation.

This observation has direct implications for surgical planning in Sri Lankan patients. The SMF is an important landmark for identification of the facial nerve during mastoidectomy, facial nerve decompression, temporal bone surgery, parotidectomy and selected skull-base procedures (1, 2, 5, 6). In these procedures, the surgeon may use the

mastoid tip, anterior mastoid border and styloid process as complementary landmarks to estimate the location of the SMF. The present findings support a multi-landmark or triangulation approach, rather than reliance on a single predetermined distance. Such an approach may be particularly useful when normal anatomy is distorted by trauma, infection, congenital abnormalities, neoplasia, previous surgery or extensive bone removal.

In conclusion, the present study demonstrates that the SMF in Sri Lankan skulls has predominantly symmetrical relationships with surrounding bony landmarks, with significant bilateral asymmetry limited to P3 among females and significant sex-related variation limited to right P1. Although the Sri Lankan mean values generally overlap with those reported in other populations, important differences in absolute measurements and individual ranges are evident. The considerable range observed particularly for P1 demonstrates that the SMF should not be localized using a single fixed distance. Instead, the mastoid tip, anterior mastoid border, jugular foramen and styloid process should be considered collectively. These population-specific morphometric data may therefore provide useful supplementary anatomical information for surgical planning in Sri Lankan patients undergoing otologic, neurotologic, facial nerve, parotid and skull-base procedures, while patient-specific imaging should remain the principal method for detailed preoperative anatomical assessment.

Acknowledgments

The authors gratefully acknowledge the Department of Anatomy, Faculty of Medicine, University of Peradeniya, the Department of Anatomy, Faculty of Medicine, Wayamba University of Sri Lanka and the Department of Basic Principles, Faculty of Indigenous Medicine, Gampaha Wickramarachchi University of Indigenous Medicine for providing the skeletal specimens used in this study. The authors also express their sincere appreciation to Mr. Mufazir the technical staff of the Department of Anatomy, Faculty of Medicine, Wayamba University of Sri Lanka, for their valuable technical assistance and support throughout the study.

References

1. Standring S, ed. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 42nd ed. Elsevier; 2021.
2. Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy. 9th ed. Wolters Kluwer; 2023.
3. Cvetko E. Surgical anatomy of the extracranial facial nerve. Surg Radiol Anat 2015.
4. Janfaza P, Nadol JB, Galla R, Fabian RL, Montgomery WW, editors. Surgical anatomy of the head and neck. Cambridge: Harvard University Press; 2011.
5. Murlimanju BV, Prabhu LV, Pai MM, Kumar G, Dhananjaya KV, Prashanth V. Morphometry of stylomastoid foramen and its clinical application in facial nerve block. Saudi J Anaesth 2014;8(4):486-489. https://doi:10.4103/1658-354X.140865
6. Tewari S, Gupta C, Palimar V. A morphometric study of stylomastoid foramen with its clinical applications. J Neuro Surg Part B: Skull Base. 2022;83(01):033-6.
7. Rhoton Jr AL. The posterior cranial fossa: microsurgical anatomy and surgical approaches. Neurosurg

2000;1;47(suppl_3):S5-6. https://www.ovid.com/00006123-200009001-00005

8. Vaishali B, Mohanraj KG. Morphological and morphometric analysis of stylomastoid foramen in dry human skulls and its clinical implications. J Pharma Res Inter 2021;33(60B):1659–1664. https://doi.org/10.9734/jpri/2021/v33i60B34791
9. Devic M, Pupovac N, Zelenovic T, Pisaric M, Zbucnovic D, Tucakovic D, Sivcev I. Morphometric Analysis of Stylomastoid Foramen and its Clinical Significance. Inter J Morpho 2024 1;42(4):1144. https://doi.org/10.4067/S0717-95022024000401144
10. Kutoglu T, Çetkin M, Turan Ö, Bayko S, Yarkan IS. Morphometric and topographic features of stylomastoid foramen and its clinical significance in facial nerve block. J Neurol Surg B Skull Base. 2021;82(Suppl 3):e271-e277. https://doi:10.1055/s-0040-1701530