Int. J. Morphol.,
40(1):181-187, 2022.

Morphometric Studies of Supraorbital Foramen, Infraorbital Foramen and Mental Foramen in a Thai Population Related with Nerve Blocks

Estudios Morfométricos del Foramen Supraorbitario, Foramen Infraorbitario y Foramen Mental en una Población Tailandesa Relacionados con Bloqueos Nerviosos

Siriwat Thunyacharoen[1]; Phruksachat Singsuwan[2] & Pasuk Mahakkanukrauh[2,3]

THUNYACHAROEN, S.; SINGSUWAN, P. & MAHAKKANUKRAUH, P. Morphometric studies of supraorbital foramen, infraorbital foramen and mental foramen in a thai population related with nerve blocks. *Int J. Morphol., 40(1)*:181-187, 2022.

SUMMARY: The aim of this study was to study the anatomical landmarks and variations of supraorbital, infraorbital, and mental foramina. One hundred and sixty Thai dry skulls were randomly selected from the Forensic Osteology Research Center. The distances of the parameters were measured by using Vernier caliper. The supraorbital foramen could be found in a notch form 13.8 %, single supraorbital foramen accounted for 82.5 %, and supraorbital foramen with an accessory foramen represented 3.8 %. Single infraorbital foramen was found 90.0 %, and infraorbital foramen with an accessory foramen represented 10.0 %. Single mental foramen was observed 96.6 %, and the frequency of mental foramen with an accessory foramen was determined 3.4%. The majority of infraorbital foramina (48.0 %) was detected above the second premolar area. 19.0 % of the infraorbital foramina was seen in the region between the first premolar and the second premolar, and 22.8 % of the infraorbital foramina was located between the second premolar and the first molar. The infraorbital foramen is anatomically positioned above the first molar (10.2 %). The majority of mental foramina (53.5 %) can be identified below second premolar area. The region between the first premolar and the second premolar is the site for the mental foramen 26.0 % of the total variations. The region between the second premolar and the first molar is the site for the mental foramen 16.9 % of the total variations. The mental foramen is approximately situated below the first molar (3.6 %). The present study of anatomical variations of various foramina demonstrates a useful application in cosmetic and ophthalmic plastic surgery. The findings could improve the efficacy of the surgeons and accuracy for the indicated localization of these foramina during maxillofacial operations and local anesthetic procedures.

KEY WORDS: Anatomical variation; Infraorbital foramen; Mental foramen; Supraorbital foramen.

INTRODUCTION

Supraorbital foramen (SOF) is located above the supraorbital margin. It is an important foramen in the upper part of the anterior skull. The supraorbital nerve is the crucial cutaneous nerve that passes through this foramen and innervates the forehead region, which includes the upper eyelid, eyebrow area, and frontal skin (Haladaj *et al*., 2019). Moreover, a supraorbital vessel also transmits through this foramen. The importance of this foramen applies to anesthetic procedures as well as cosmetic facial surgery, and pertains to maxillofacial surgery for more accurate approach (Ashwini *et al*., 2012). The supraorbital notch (SON) can be identified at the supraorbital margin. Injuries and microtrauma can occur at this anatomical landmark during surgical procedures if the surgeon does not know the precise location of this foramen (Satwik & Kumar, 2019).

The infraorbital foramen (IOF) is located inferiorly to the infraorbital rim, lateral to nasal bone, and medial to the zygomatic bone. The IOF allows passage for the infraorbital nerve (second division of the cranial nerve V or trigeminal nerve) and infraorbital artery as well as vein. The infraorbital nerve has several branches that innervate the midface of mucocutaneous, such as the lateral portion of the nasal area, the lower eyelid, and the upper lip. The anatomical variation of the infraorbital foramen is noteworthy in cosmetic surgery and local anesthetic procedures. The competent nerve

[1] Faculty of Medicine, Chiang Mai University, Chiang Mai, 50200, Thailand.
[2] Excellence in Osteology Research and Training Center (ORTC), Chiang Mai University, Chiang Mai, 50200, Thailand.
[3] Department of Anatomy, Faculty of Medicine, Chiang Mai University, Chiang Mai, 50200, Thailand.

Received: 2021-10-01 Accepted: 2021-11-03

blockage of the infraorbital nerve is clinically important for blocking the lower eyelid, the upper lip, incisors, canines, premolars, and roots of the first molar on the maxilla bone in dental procedures (Nguyen *et al*., 2016). Blocking of the infraorbital nerve is useful for the management of the pharmacologically unresponsive trigeminal neuralgia (Wilkinson, 1999). Locating the precise position of this foramen can assist the direction of the anesthesia injection and can raise the awareness of the structure of this foramen.

The mental foramen (MF) is a small aperture in the anterolateral mandible and is situated below the gap between the premolar teeth. It is centrally located between the superior and the inferior rims of the mandible. The mental foramen allows the passage for the vessels and a terminal branch of the inferior alveolar nerve, which is called the mental nerve (Moogala *et al*., 2014). The mental nerve provides the sensory innervations to the soft tissues of the lower face, buccal gingivae, and a muscle called the depressor anguli oris (also known as the triangularis muscle). The accessory mental foramen is an addition to the mental foramen, situated primarily posterosuperior (Udhaya *et al*., 2013). The understanding of the precise anatomical structure of the mental foramen and accessory mental foramen is essential for clinical anatomy and dentistry to correctly inject anesthesia during the surgical procedures and teeth extractions. The mental nerve block is common in cosmetic surgery during chin reconstructive surgery.

Comparably, the anatomical location of the supraorbital foramen (or notch) is on the equal sagittal plane as the infraorbital foramen and mental foramen (Lee *et al*., 2006). The supraorbital, infraorbital, and mental foramina are located on the anterior surface of the skull bilaterally. The supraorbital, infraorbital, and mental foramina are essential landmarks of the anterior skull for the administration of local anesthesia to the neurovascular architecture during surgical operations in the maxillofacial zone. Comprehension of the accurate anatomical localization of these foramina is crucial for precisely predicting the nerve block and facilitating the minimization of neurovascular damages.

However, current knowledge about the precise locations of these foramina and their anatomical variations related to sex and side is limited. Clear understanding of the clinical anatomy and landmarks is fundamental to avoid neurovascular injuries during the procedures involving these foramina. The finding of this study can be applicable in nerve block procedures. Therefore, we conducted the cross-sectional study to investigate whether the anatomical structures of these foramina are different between sexes and the sides (left and right). The undefined positions of these foramina can result in insufficient nerve block, leading to procedural sedation failures in patients.

MATERIAL AND METHOD

Samples. Eighty male and eighty female adult skull samples were selected (ranged from 20 to 80 years of age) from the skeletal collection of the Forensic Osteology Research Center, Faculty of Medicine, Chiang Mai University. Impaired skulls or bones with pathological conditions such as skull fracture, congenital anomalies, osteoporosis were excluded from this study. The variations of supraorbital, infraorbital, and mental foramina were documented in this research.

Morphological-Osteometry. To ascertain the anatomical locations of these foramina, diversified parameters were measured on the specific landmarks of the anterior skull by digital vernier calipers of 0.02 mm accuracy on both sides of the supraorbital, infraorbital and mental foramen as in Figure 1. The descriptions of all measurements are given as follows:

1. SOF-G: The distance between supraorbital foramen (SOF) and the midpoint of the glabella (G).
2. SOF-IOF: The distance between the supraorbital foramen (SOF) and the infraorbital foramen (IOF).
3. IOF-IOB: The distance between the infraorbital foramen (IOF) and the inferior orbital margin (IOB).
4. IOF-MF: The distance between the infraorbital foramen (IOF) and the mental foramen (MF).
5. MF-MB: The perpendicular distance between the mental foramen (MF) and the mandibular margin (MB)

The intra-observation was assessed by the three-time repetition of similar measurement parameters by one observer from 10 samples. This process provided more internal reliability to the measurement process.

Statistics Analysis. The various parameters of foramina illustrated the anatomical positions of these foramina were calculated to determine the mean ± standard deviation (mm. unit) and the frequencies of foramina were described in percentage (%). Also, the parameters were compared between both sides of supraorbital, infraorbital, and mental foramen among the total, male, and female samples by utilizing independent sample T-tests to investigate the statistically significant differences.

All of the foramen parameters were analyzed by using the SPSS version 26 (SPSS Inc., Chicago, IL, USA) and data were compiled in Microsoft Excel 2016 (Microsoft Corp., Redmond, WA, USA). The descriptive analysis was used to estimate mean and standard deviation. Independent sample t-test was carried out as a test of significance, and a p-value less than 0.05 was accepted as a level of statistical significance for this study.

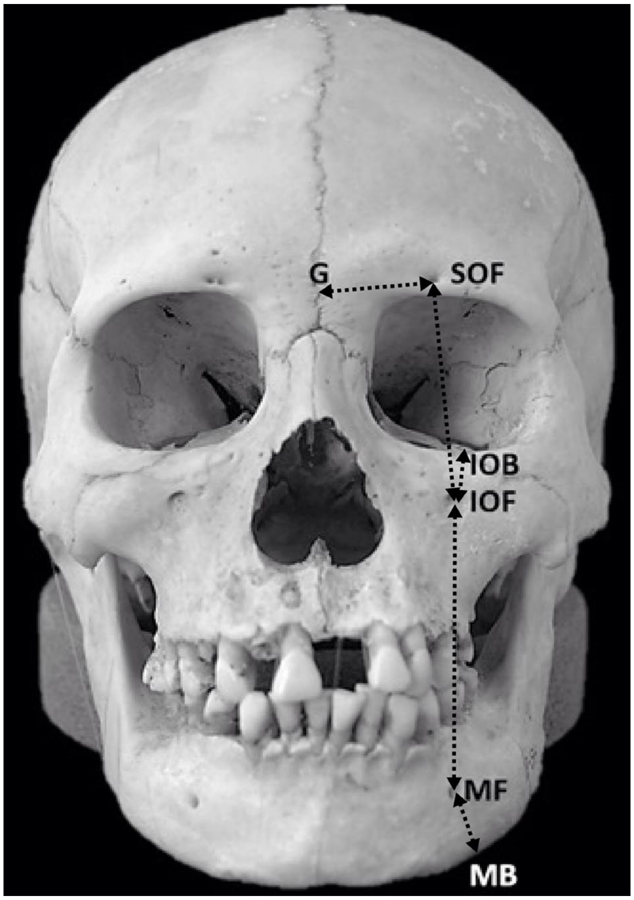

Fig. 1. Parameters of supraorbital, infraorbital and mental foramina; G: midpoint of glabella, SOF: supraorbital foramen, IOF: infraorbital foramen, IOB: inferior orbital margin, MF: mental foramen, MB: mandibular margin.

RESULTS

Morphometric measurements related to the supraorbital foramen, infraorbital foramen, and mental foramen. The multitudinous parameters between the different sexes were calculated and shown in Table I. The comparison between the different sides showed one statistically significant difference in the distance between each side of IOF-IOB in females ($p<0.05$). The statistically non-significant parameters ($p>0.05$) include SOF-G in males and females, SOF-IOF in males and females, IOF-IOB in males, IOF-MF in males and females, and MF-MB in males and females. In addition, the comparison between the different sexes and sides in various parameters showed statistically significant differences in both sides of SOF-G, SOF-IOF, IOF-IOB in the right, IOF-MF in the left and right, MF-MB in the left and right ($p<0.05$). However, IOF-IOB on the left of males and females found no statistical difference ($p>0.05$).

Among males, SOF-G average distances were estimated 26.16 ± 3.33 mm for the left side and 26.31 ± 3.40 mm for the right side, SOF-IOF average distances were 45.12 ± 3.07 mm for the left side and 44.57±3.82 mm for the right side, IOF-IOB average distances were 8.60±2.09 mm and 8.49 ± 2.02 mm for the left and right sides, respectively. IOF-MF average distances were 67.61 ± 5.05 mm and 67.56 ± 5.24 mm for the left and right sides, respectively, MF-MB average distances were calculated as 14.15 ± 1.79 mm and 14.54 ± 1.81 mm for the left and right sides, respectively. In females, SOF-G average distances were estimated 24.23 ± 2.89 mm for the left side and 25.37 ± 3.14 mm for the right side, SOF-IOF average distances were 43.59 ± 3.04 mm for the left side and 43.52 ± 2.89 mm for the right side, IOF-IOB average distances were 8.12 ± 1.81 mm and 7.75 ± 1.84 mm for the left and right sides, respectively. IOF-MF average distances were 64.33 ± 4.58 mm and 64.32 ± 4.48 mm for the left and right side, respectively. MF-MB average distances were calculated 13.67 ± 1.30 mm and 13.76 ± 1.21 mm for the left and right sides, respectively.

Numeration of supraorbital foramen, infraorbital foramen and mental foramen. The measurements of the anterior skull for investigation of the foramina illustrated the differences in percentage of foramen frequencies in Figures 2 and 3, and Table II. In males, the supraorbital foramen can be found in a notch form (12.5 %), single supraorbital foramen (80.0 %), and supraorbital foramen with an accessory foramen (7.5 %). However, in females, the supraorbital notch can be identified 15.0 %, and majority (85.0 %) had single supraorbital foramen. Single infraorbital foramen accounted for 91.9 % and 88.1 % in males and in females, respectively. Infraorbital foramen with accessory

Table I. Morphometric measurements related to the supraorbital foramen, infraorbital foramen, and mental foramen

	SOF-G			SOF-IOF			IOF-IOB			IOF-MF			MF-MB	
	L	R	p-value	L	R	p-value	L	R	p-value	L	R	p-value	L	R
Male	26.16±3.33	26.31±3.40	0.3967	45.12±3.07	44.57±3.82	0.3594	8.60±2.09	8.49±2.02	0.0834	67.61±5.05	67.56±5.24	0.4461	14.15±1.79	14.54±1.81
Female	24.23±2.89	25.37±3.14	0.1733	43.59±3.04	43.52±2.89	0.4765	8.12±1.81	7.75±1.84	0.0142	64.33±4.58	64.32±4.48	0.0963	13.67±1.30	13.76±1.21
P-value	0.0002	0.0457		0.0019	0.0359		0.0614	0.0082		0.00001	0.00002		0.0280	0.0008

foramen can be detected 8.1 % and 11.9 %, in males and in females, respectively. Single mental foramen was observed 94.4 % and 98.8 %, in males and in females, respectively. The frequencies of mental foramen with accessory foramen were 5.6 % and 1.2 %, in males and in females, respectively.

Frequencies of the location of an infraorbital foramen with upper teeth and mental foramen with lower teeth. To locate the infraorbital foramen and mental foramen, our findings can assist with identifying the anatomical location of the foramen using the position of tooth (Table III). The majority of infraorbital foramen can be identified at the second premolar area 46.0 % in males and 50.0 % in females. The location of the infraorbital foramen between the first and second premolar is observed 20.0 % in males and 18.0 % in females. The region between the second premolar and the first molar is the anatomical position of the infraorbital foramen that is found 21.0 % in males and 24.5 % in females. Above the first molar is the location of the infraorbital foramen 13.0 % in males and 7.5 % in females.

Additionally, mental foramen can be commonly found 54.0 % in males and 53.0 % in females below the second premolar region. The area between the first and the second premolars is the location of the mental foramen 25.0 % in males and 27.0 % in females. The area between the second premolar and the first molar is the location of the mental foramen 15.0 % in males and 18.8 % in females. Finally, below the first molar is the location of mental foramen 6.0 % in males and 1.2 % in females.

Intra-observational error measurement. To evaluate their reliability, the intra-observer error was analyzed by the technical error measurement (TEM), relative technical error of measurement (rTEM), and the coefficient of reliability (R) for estimating the exactness of measurement (Perini *et al*., 2005; Goto & Mascie-Taylor, 2007). The relative TEM of all parameters indicated acceptable (relative TEM ≤ 1.5 %) (Langley *et al*., 2018) and coefficient of reliability (R) of all parameters presented high with 0.998 - 0.999 (Table IV).

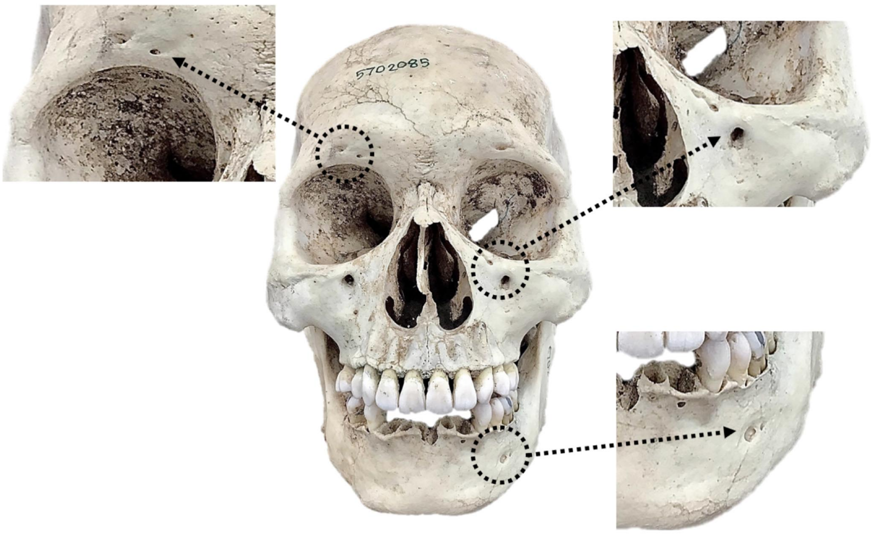

Fig. 2.The anatomical variation of supraorbital foramen, infraorbital foramen and mental foramen with accessory foramen.

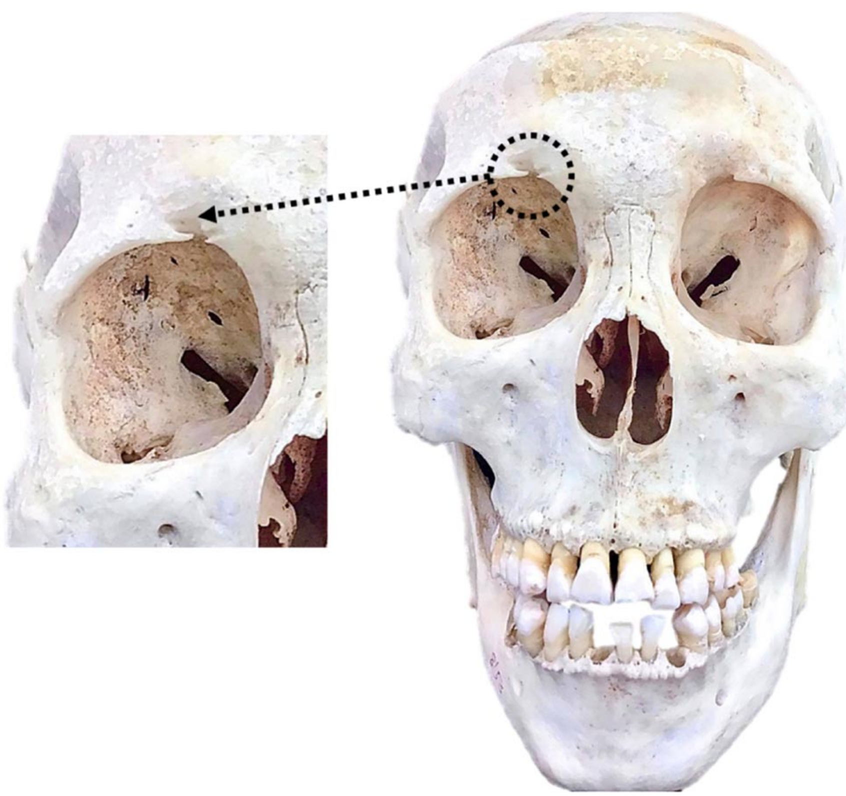

Fig. 3. The anatomical variation of supraorbital foramen: supraorbital notch.

Table II. Prevalence of supraorbital foramen, infraorbital foramen and mental foramen.

	SOF			IOF		MF	
	Supraorbital notch	Single supraorbital foramen	supraorbital foramen with accessory foramen	Single infraorbital foramen	infraorbital foramen with accessory foramen	Single mental foramen	mental foramen with accessory foramen
Male	12.5 %	80.0 %	7.5 %	91.9 %	8.1 %	94.4 %	5.6 %
Femal	15.0 %	85.0 %	0.0 %	88.1 %	11.9 %	98.8 %	1.2 %
Total	13.8 %	82.5 %	3.8 %	90.0 %	10.0 %	96.6 %	3.4 %

Table III. Frequencies of the locations of infraorbital foramen within upper teeth region and mental foramen within lower teeth region.

	Location	Males	Females	Total
Infraorbital foramen	Between the first and second premolar	20.0 %	18.0 %	19.0 %
	Above the second premolar	46.0 %	50.0 %	48.0 %
	Between the second premolar and the first molar	21.0 %	24.5 %	22.8 %
	Above the first molar	13.0 %	7.5 %	10.2 %
Mental foramen	Between the first and second premolar	25.0 %	27.0 %	26.0 %
	Below the second premolar	54.0 %	53.0 %	53.5 %
	Between the second premolar and the first molar	15.0 %	18.8 %	16.9 %
	Below the first molar	6.0 %	1.2 %	3.6 %

Table IV. Intra-observational error measurement.

Parameter	TEM* (mm)	Relative TEM (%TEM)**	R***
SOF-G	0.14	0.53	0.998
SOF-IOF	0.08	0.18	0.999
IOF-IOB	0.04	0.39	0.998
IOF-MF	0.11	0.17	0.999
MF-MB	0.04	0.28	0.999

* TEM = $\sqrt{\frac{\sum D^2}{2N}}$; when D = difference in values between two investigators' measurements, N = total number of selected cases.
** Relative TEM (%TEM) = $\frac{TEM}{\bar{X}}$ x 100 ; when $\bar{X}$ = variable average value.
***R= $1-(\frac{TEM}{S.D.})^2$;when S.D. = standard deviation of all measurement.

DISCUSSION

This study was conducted on 160 intact human skulls in Thailand, and it will contribute to the research of the morphometric analysis of anatomical variations of the supraorbital, infraorbital and mental foramen. The Thai population varies in foramen parameters compared to other international studies, and values was expressed in mean and standard deviation (mm. units).

The clinical impact of the findings regarding supraorbital foramen, infraorbital foramen, and mental foramen in nerve blocking yields advantages to plastic surgery, maxillofacial procedure, and dental operations. The supraorbital nerve block is a procedure to provide regional anesthesia to the ophthalmic nerve (V1) of the trigeminal cranial nerve for pain reduction. Regional anesthesia is applied under the infraorbital margin leading to an infraorbital nerve block, but the precise location of the infraorbital foramen is unclear. The infraorbital nerve block occurs during the maxillofacial surgery. The mental nerve block is also an essential procedure in dental operations, and plastic surgeons administer anesthesia to the ipsilateral lower mucocutaneous tissue blocking the sensation of the lower teeth of patients (Moskovitz & Sabatino, 2013). Nerve block failures due to the inaccurate location of the foramen can create soft tissue damage and increase patient discomfort. Particularly, the inadequate anesthetic agent is introduced into the foramen, but there are multiple foramina. The pain pathway also has no inhibition. Thus, knowing the precise location of each foramen can immensely aid the anesthesiologists.

The previous study in Thai samples was conducted on 70 male and 40 female skulls, in which they found no significant differences in foramina between different sexes and sides. They reported the average distance between supraorbital foramen and the midline as 2.44 ± 0.03 cm for the right side and 2.51 ± 0.04 cm for the left side. The average distance between infraorbital foramen and the inferior orbital margin was estimated at 0.78 ± 0.02 cm for the right side and 0.80 ± 0.02 cm for the left side. The average distance between mental foramen and the inferior margin of the mandible was 1.45 ± 0.02 cm for the right side and 1.44 ± 0.01 cm for the left side (Agthong *et al*., 2005).

Consistent with the other study in Thai population performed in 106 Thai adult skulls, they also stated that the distance between supraorbital foramen and mid-nasal bone was 25.14 ± 4.29 mm (range 17.35-39.45 mm) and documented the distance between infraorbital foramen and the infraorbital margin 9.23 ± 2.03 mm (range 3.21-14.58 mm). Understanding the distance between the infraorbital margin and foramen may be useful in identifying the risky zone during the surgical procedure of the anterior maxillary wall (Apinhasmit *et al*., 2006a).

In addition, South Indian 83 adult human skulls were studied bilaterally; they investigated the supraorbital foramen and supraorbital notch. They claimed that supraorbital notch was more commonly observed than the supraorbital foramen, and the distances between supraorbital notch or supraorbital foramen and the midline of nasal were 22.24 mm for the right side and 22.20 mm for the left side (Ashwini *et al*.). The study of 59 (32 males and 27 females) adult human skulls in Egypt meticulously described the structure of supraorbital foramen. They found that bilateral supraorbital notch accounted for 30.5 %, bilateral SOF 18.6 %, one-sided notch and a foramen on the other side were seen 11.9 % of the total samples, 22.0 % had bilaterally supraorbital ridge, and 8.5 % showed a ridge on one side and a notch on the other side (Sheikh *et al*., 2013).

In the present study, the investigation of the anterior skulls for the anatomical variations of the foramina and their frequencies are described in Table II. Among males, supraorbital foramen can be seen as notch 12.5 %, single supraorbital foramen 80.0 %, and supraorbital foramen with an accessory foramen 7.5 %. However, in females, the supraorbital notch can be found 15.0 %, and majority of the samples (85 %) exhibited single supraorbital foramen. Single infraorbital foramen was observed 91.9 % and 88.1 %, in males and females, respectively. Infraorbital foramen with accessory foramen was detected 8.1 % and 11.9 %, in males and females, respectively. The study in Sri Lanka samples reported that infraorbital foramen occurred on both sides in all skulls investigated. A single infraorbital foramen was identified in 92.6 % of the samples, and accessory foramina were observed 7.4 %. One-sided mental foramen can be identified 94.9 % and 98.8 %, in males and females, respectively. One-sided supraorbital foramen with accessory foramen was seen 5.1 % and 1.2 %, in males and females, respectively (Nanayakkara *et al*., 2016).

Regarding the infraorbital foramen and mental foramen, our findings for estimating the tooth position and locating the foramen are presented in Table III. The study in South Indian population investigated 90 adult dry mandibles and suggested that the mental foramen to be located at the base of the second premolar (Udhaya *et al*.). Moreover, they stated that the average distance between the inferior margin of MF and the base of the mandible is 12.65 ± 1.59 mm. The frequency of the accessory mental foramen was more observed on the left side (3.3 %) compared to the right side (2.2 %). The intact 69 adult mandibles (45 male, 24 female) of Thai dry skulls were similarly evaluated (Apinhasmit *et al*., 2006b). The most frequent locations of the MF were seen bilaterally, and average distances between MF and the lower boundary of the mandible were estimated 14.88 ± 1.77 mm in both sexes, 15.40 ± 1.73 mm in males, and 13.89 ± 1.40 mm in females.

Furthermore, the anatomical variations of the accessory infraorbital foramen are linked with the infraorbital foramen and infraorbital nerve (Polo *et al*., 2019). Neurovascular content passes through this foramen and has significant clinical implications, particularly the failure of local anesthesia procedure at the maxillofacial area. The accessory mental foramina are essential structures that should be evaluated cautiously preoperatively because neurovascular may be damaged after dental surgery and when the location of accessory mandibular foramen is known (Fuakami *et al*., 2011). The presence of accessory infraorbital nerve requires attention and necessitates more anesthesia for complete nerve blocking.

CONCLUSION

The anatomy of SOF, IOF, MF could be assessed by two methods in this study: measuring and tooth positioning. In both sexes of the Thai samples, SOF-G distances were 25.20 ± 3.26 mm and 25.84 ± 3.30 mm for the left and the right sides, respectively. SOF-IOF distances were 44.36 ± 3.14 mm and 44.04 ± 3.42 mm for the left and the right sides, respectively, IOF-IOB distances were 8.36 ± 1.96 mm and 8.11 ± 1.96 mm for the left and right sides, respectively, IOF-MF distances were 65.97 ± 5.07 mm and 65.94 ± 5.13 mm for the left and the right sides, respectively, MF-MB distances were 13.91 ± 1.58 mm and 14.15 ± 1.58 mm for the left and the right sides, respectively.

To locate the infraorbital foramen and mental foramen, our data provide tools by estimating the position of tooth to pinpoint the foramen position. Infraorbital foramen can be found 46.0 % in males and 50.0 % in females above the second premolar area. Mental foramen can be identified 54.0 % in males and 53.0 % in females below the second premolar area.

ACKNOWLEDGEMENTS. The authors are very thankful for the support from the Forensic Osteology Research Center, Faculty of Medicine, Chiang Mai University, and the authors would like to thank those who donated their bodies for medical research as well as partial support from Chiang Mai University. This work was also supported by the Faculty of Medicine, Chiang Mai University with Grant no. 015/2564. The approval was obtained from the Research Ethics Committee of Chiang Mai University (CODE: ANA-2563-07394). Special thanks to Patara Rattanachet for linguistic review.

THUNYACHAROEN, S.; SINGSUWAN, P. & MAHAKKANUKRAUH, P. Estudios morfométricos del foramen supraorbitario, foramen infraorbitario y foramen mentoniano en una población tailandesa relacionados con bloqueos nerviosos. *Int J. Morphol., 40(1)*:181-187, 2022.

RESUMEN: El objetivo de este estudio fue estudiar los puntos de referencia anatómicos y las variaciones de los forámenes supraorbitario, infraorbitario y mental. Ciento sesenta cráneos secos tailandeses fueron seleccionados al azar del Centro de Investigación de Osteología Forense. Las distancias de los parámetros se midieron utilizando un calibre Vernier. El foramen supraorbitario se pudo encontrar en forma de muesca el 13,8 %, el foramen supraorbitario único representó el 82,5 % y el foramen supraorbitario con un foramen accesorio representó el 3,8 %. El foramen infraorbitario único se encontró en un 90,0 % y el foramen infraorbitario con un foramen accesorio representó el 10,0 %. Se observó foramen mental único 96,6 % y se determinó la frecuencia de foramen mental con foramen accesorio 3,4 %. La mayoría de los forámenes infraorbitarios (48,0 %) se detectaron por encima del área del segundo premolar. El 19,0 % de los forámenes infraorbitarios se observó en la región entre el primer premolar y el segundo premolar, y el 22,8 % de los forámenes infraorbitarios se ubicó entre el segundo premolar y el primer molar. El foramen infraorbitario se ubica anatómicamente por encima del primer molar (10,2 %). La mayoría de los forámenes mentales (53,5 %) se pudieron identificar inferior al área del segundo premolar. La región entre el primer premolar y el segundo premolar es el sitio del foramen mental 26,0 % de las variaciones totales. La región entre el segundo premolar y el primer molar es el sitio del foramen mental 16,9 % del total de variaciones. El foramen mental se sitúa aproximadamente por debajo del primer molar (3,6 %). El presente estudio de variaciones anatómicas de estos forámenes demuestra una aplicación útil en la cirugía plástica y oftálmica. Los hallazgos podrían mejorar la eficacia de los cirujanos y la precisión para la localización de estos forámenes durante las operaciones maxilofaciales y los procedimientos anestésicos locales.

PALABRAS CLAVE: Variación anatómica; Foramen infraorbitario; Foramen mental; Foramen supraorbitario.

REFERENCES

Agthong, S.; Huanmanop, T. & Chentanez, V. Anatomical variations of the supraorbital, infraorbital, and mental foramina related to gender and side. *J. Oral. Maxillofac. Surg., 63(6)*:800-4, 2005.

Apinhasmit, W.; Chompoopong, S.; Methathrathip, D.; Sansuk, R. & Phetphunphiphat, W. Supraorbital notch/foramen, infraorbital foramen and mental foramen in Thais: anthropometric measurements and surgical relevance. *J. Med. Assoc. Thai., 89(5)*:675-82, 2006a.

Apinhasmit, W.; Methathrathip, D.; Chompoopong, S. & Sangvichien, S. Mental foramen in Thais: an anatomical variation related to gender and side. *Surg. Radiol. Anat., 28(5)*:529-33, 2006b.

Ashwini, L. S.; Mohandas Rao, K .G.; Saran, S. & Somayaji, S. N. Morphological and morphometric analysis of supraorbital foramen and supraorbital notch: A study on dry human skulls. *Oman Med. J., 27(2)*:129-33, 2012.

Fuakami, K.; Shiozaki, K.; Mishima, A.; Shimoda, S.; Hamada, Y. & Kobayashi, K. Detection of buccal perimandibular neurovascularisation associated with accessory foramina using limited cone-beam computed tomography and gross anatomy. *Surg. Radiol. Anat., 33(2)*:141-6, 2011.

Goto, R. & Mascie-Taylor, C. G. Precision of measurement as a component of human variation. *J. Physiol. Anthropol., 26(2)*:253-6, 2007.

Ha?adaj, R.; Polguj, M. & Topol, M. Anatomical variations of the supraorbital and supratrochlear nerves: Their intraorbital course and relation to the supraorbital margin. *Med. Sci. Monit., 25*:5201-10, 2019.

Langley, N. R.; Jantz, L. M.; McNulty, S.; Maijanen, H.; Ousley, S. D. & Jantz, R. L. Data for validation of osteometric methods in forensic anthropology. *Data Brief, 19*:21-8, 2018.

Lee, U. Y.; Nam, S. H.; Han, S. H.; Choi, K. N. & Kim, T. J. Morphological characteristics of the infraorbital foramen and infraorbital canal using three-dimensional models. *Surg. Radiol. Anat., 28(2)*:115-20, 2006.

Moogala, S.; Sanivarapu, S.; Boyapati, R.; Devulapalli, N. S.; Chakrapani, S. & Kolaparthy, L. Anthropometrics of mental foramen in dry dentate and edentulous mandibles in Coastal Andhra population of Andhra Pradesh State. *J. Indian Soc. Periodontol., 18(4)*:497-502, 2014.

Moskovitz, J. B. & Sabatino, F. Regional nerve blocks of the face. *Emerg. Med. Clin. North Am., 31(2)*:517-27, 2013.

Nanayakkara, D.; Peiris, R.; Mannapperuma, N. & Vadysinghe, A. Morphometric analysis of the infraorbital foramen: The clinical relevance. *Anat. Res. Int., 2016*:7917343, 2016.

Nguyen, D. C.; Farber, S. J.; Um, G. T.; Skolnick, G. B.; Woo, A. S. & Patel, K. B. Anatomical study of the intraosseous pathway of the infraorbital nerve. *J. Craniofac. Surg., 27(4)*:1094-7, 2016.

Perini, T. A.; de Oliveira, G. L.; Ornellas, J. D. & de Oliveira, F. P. Technical error of measurement in anthropometry. *Rev. Bras. Med. Esporte, 11(1)*:86-90, 2005.

Polo, C. L.; Abdelkarim, A. Z.; von Arx, T. & Lozanoff, S. The morphology of the infraorbital nerve and foramen in the presence of an accessory infraorbital foramen. *J. Craniofac. Surg., 30(1)*:244-53, 2019.

Satwik, A. & Kumar, S. Anatomical variations of supraorbital, infraorbital and mental foramen based on gender and side- A review. *J. Pharm. Sci. Res., 6(1)*:60-2, 2019.

Sheikh, E. E.; Nasr, W. F. & Ibrahim, A. A. S. Anatomical variations of supraorbital notch and foramen: a study on human adult Egyptian skulls. *Eur. J. Plast. Surg., 37*:135-40, 2013.

Udhaya, K.; Saraladevi, K. V. & Sridhar, J. The morphometric analysis of the mental foramen in adult dry human mandibles: a study on the South Indian population. *J. Clin. Diagn. Res., 7(8)*:1547-51, 2013.

Wilkinson, H. A. Trigeminal nerve peripheral branch phenol/glycerol injections for tic douloureux. *J. Neurosurg., 90(5)*:828-32, 1999.

Corresponding author:
Prof. Pasuk Mahakkanukrauh, MD
Excellence in Osteology Research and Training Center (ORTC)
Chiang Mai University
Chiang Mai 50200
THAILAND

E-mail: pasuk034@gmail.com