Surgical Anatomy of Fissures and Foramina in the Orbits of Thai Adults

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Background: *The anatomy of orbital foramina appears to vary depending on the population studied. Moreover, different data between sides and genders have been reported.*
Objective: *The present study was done to provide the morphometric data of the orbital foramina related to side and gender in Thai subjects.*
Material and Method: *One hundred orbits from 50 adult dried skulls were used. Gender of each skull was identified and the distances from the constant landmarks to the foramina in the medial, superior, inferior, and lateral walls were measured.*
Results: *In the medial wall, the mean distances from the anterior lacrimal crest to the optic canal (OC), anterior, and posterior ethmoidal foramina were 42.2, 23.5, and 36.0 mm for both sides and genders, respectively. The average distances from the supraorbital notch/foramen in the roof to the superior orbital fissure (SOF), OC, and lacrimal foramen were 44.7, 40.0, and 33.6 mm, respectively. In the inferior wall, the distances from the infraorbital rim to the OC, inferior orbital fissure (IOF), and the posterior edge of roof of the infraorbital canal were 46.2, 21.7, and 12.3 mm, respectively. The distances from the frontozygomatic suture to the OC, SOF, IOF, and LF were 46.9, 34.5, 24.0, and 27.2 mm, respectively. When compared to those of the previous reports, several considerable differences that may be of clinical importance were observed. Moreover, some distances were significantly different between sides or genders.*
Conclusion: *The present results suggest that race, side, and gender should be concerned during the orbital surgery and the data are good references for Thai subjects.*

Keywords: *Orbit, Anatomy, Foramina, Fissure, Thai*

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Several diseases including trauma, inflammation, infections, and tumors can involve the orbital cavity. In particular situations, surgeries in the orbit, for example, orbital decompression, enucleation, exenteration, optic nerve decompression and vascular ligation, have an essential role. However, to avoid injuries to the important structures in the orbit, mainly neurovascular bundles passing through various foramina and fissures, precise knowledge of the anatomy of these openings is indispensable.

Anatomical variations of the important apertures in the orbit have been reported. Kirchner et al(1) studied the anatomy of the anterior and posterior ethmoidal foramina along with the measurement of the distances between these foramina. They also determined the distances from these openings to the constant landmarks, the maxillo-nasal-lacrimal junction, and the optic canal. The more complete study was done by Rontal et al(2). They analyzed medial, lateral, superior, and inferior walls of 24 Indian skulls. In each wall, the distances among the foramina and from these foramina to the anatomical landmark were measured. They did not find any significant differences between sides or genders. McQueen et al(3) examined 54 orbits from 6 black and 48 white American cadavers and found that the distances of the majority of parameters were relatively longer when compared to those of Kirchner et al(1) and Rontal et al(2). In addition, the difference

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between genders was observed in one parameter. In 1999, Hwang and Baik have conducted a similar study in 41 adult Korean skulls (82 orbits)[4]. Some parameters were comparable to those of Rontal et al[2] but most were shorter than those of McQueen et al,[3] and found the significant differences between sides and genders in several measurements. Recently, Karakas et al[5] studied the morphometric data of 62 orbits from 31 male adult Caucasian skulls and found similar results to those of Rontal et al[2].

The existing data suggest that the locations of various foramina in the orbit are likely varied depending on the populations studied. Therefore, as there are no such data in Thai population, there may be with some variations in accordance with a previous report of different variations of the supraorbital, infraorbital, and mental foramina among Thai and other populations[6]. Moreover, the differences in the parameters between sides and genders have not been clarified. Thus, the present study was done to provide the morphometric data of the orbital foramina in Thai subjects. The differences between sides and genders were also determined to clarify the issue.

Material and Method

Specimens

Twenty-five male and 25 female human dried skulls (100 orbits) from the collection of the Department of Anatomy, Faculty of Medicine, Chulalongkorn University, Thailand were used in the present study. The skulls with damages in the area of measurement were excluded. Gender was identified using standard criteria in Forensic medicine[7], the same as in the authors' previous report[6]. Briefly, robust supraorbital ridge and occipital protuberance with a long and broad mastoid process suggest male cranium.

Measurements

An electronic caliper was used to measure the distances bilaterally. Two measurements were made for each distance to get average value.

Medial wall

All measurements in the medial orbital wall are illustrated in Fig. 1. The distances from the anterior lacrimal crest (ALC) to the posterior lacrimal crest (PLC), the anterior & posterior ethmoidal foramina (AEF, PEF) and to the medial border of the optic canal (OC) were measured. Furthermore, the distances among the AEF, PEF and OC were also determined. In case of multiple PEF, the most posterior foramen was used for the measurements. This was to provide the longest distance that this foramen could still be present posterior to other foramina or the landmark. Moreover, the distance

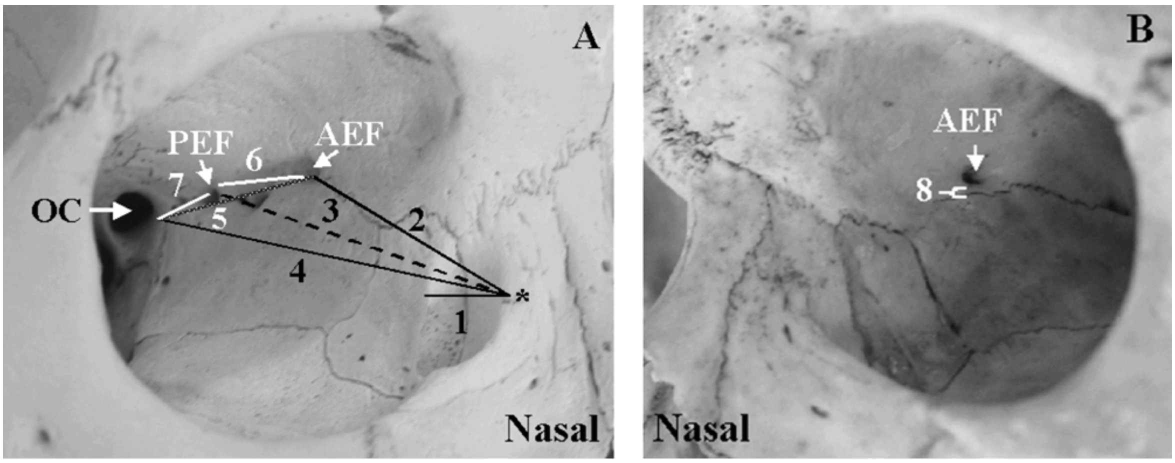

Fig. 1 Measurements in the medial wall, A: right orbit, B: left orbit, * = the midpoint of the anterior lacrimal crest, OC = the optic canal, PEF = the most posterior ethmoidal foramen, AEF = the anterior ethmoidal foramen, 1 = the anterior lacrimal crest to the posterior lacrimal crest, 2 = the anterior lacrimal crest to the anterior ethmoidal foramen, 3 = the anterior lacrimal crest to the posterior ethmoidal foramen, 4 = the anterior lacrimal crest to the medial border of the optic canal, 5 = the anterior ethmoidal foramen to the medial border of the optic canal, 6 = the anterior ethmoidal foramen to the posterior ethmoidal foramen, 7 = the posterior ethmoidal foramen to the medial border of the optic canal, 8 = the distance from the anterior ethmoidal foramen above the frontoethmoid suture

between the AEF and the frontoethmoidal suture was measured if this foramen was located superior to this suture (Fig. 1B).

Superior wall or roof

The distances from the supraorbital notch or foramen (SN/F) to the closest margin of the superior orbital fissure (SOF), the superior border of the OC, and to the lacrimal foramen (LF) (if present) were determined. If the double LF were found, the shorter distance was reported. The reason was to provide the safe distance. The measurements in the superior orbital wall are shown in Fig. 2.

Inferior wall or floor

As shown in Fig. 3, the orbital rim above the infraorbital foramen (IF) was used as a landmark to which the following structures were referred: the closest margin of the inferior orbital fissure (IOF), the inferior border of the OC, and the posterior margin of the roof of the infraorbital canal (PM).

Lateral wall

The distances from the closest margin of the SOF and IOF, the lateral border of the OC, and the LF (if present) to the frontozygomatic suture (FZ) were measured and illustrated in Fig. 4.

Statistical analysis

Statistical analysis was done using SPSS for Windows version 13. The average mean and standard deviation were calculated for every measurement. Student's t-test was used to test the differences between genders and sides for each measurement. Statistically significant differences were reported when p-values were less than 0.05.

Results

The results, categorized according to side and gender, are shown in Table 1-4. The representative data of the whole specimens, independent of side and gender, is shown in Table 5.

Measurements in the medial wall

The data is shown in details in Table 1. The average distances from the ALC to the PLC were 6.5 $\pm$ 1.1 and 6.8 $\pm$ 0.8 mm on the left and right, respectively. From the ALC to the AEF, the mean distances were 23.1 $\pm$ 2.6 mm (left) and 23.9 $\pm$ 2.7 mm (right). The average distances from the ALC to the PEF were 35.6 $\pm$ 2.4 and 36.4 $\pm$ 2.6 mm (left and right, respectively). In these

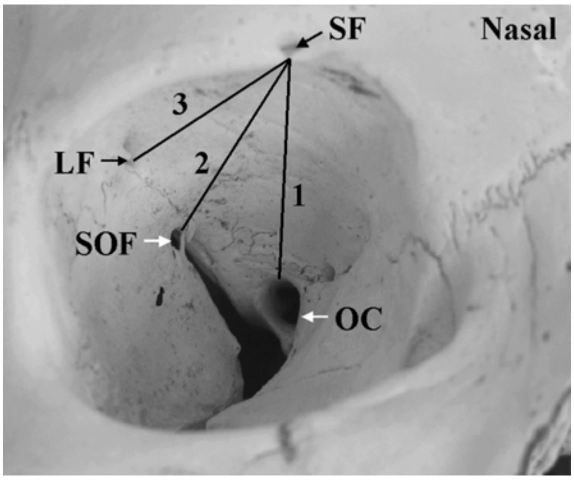

Fig. 2 Measurements in the superior wall (of right orbit), SF = the supraorbital foramen, LF = the lacrimal foramen, SOF = the superior orbital fissure, OC = the optic canal, 1 = the supraorbital notch or foramen to the superior border of the optic canal, 2 = the supraorbital notch or foramen to the closest margin of the superior orbital fissure, 3 = the supraorbital notch or foramen to the lacrimal foramen

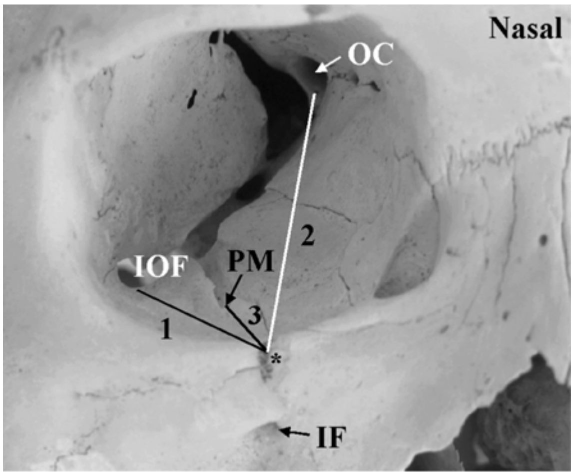

Fig. 3 Measurements in the inferior wall (of right orbit), IF = the infraorbital foramen, IOF = the inferior orbital fissure, PM = the posterior margin of the roof of the infraorbital canal, OC = the optic canal, * = the orbital rim above the infraorbital foramen, 1 = the orbital rim above the infraorbital foramen to the closest margin of the inferior orbital fissure, 2 = the orbital rim above the infraorbital foramen to the inferior border of the optic canal, 3 = the orbital rim above the infraorbital foramen to the posterior margin of the roof of the infraorbital canal

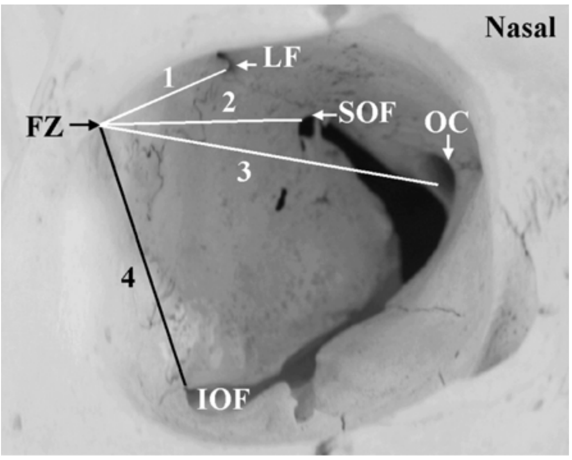

Fig. 4 Measurements in the lateral wall (of right orbit), FZ = the frontozygomatic suture, LF = the lacrimal foramen, SOF = the superior orbital fissure, OC = the optic canal, IOF = the inferior orbital fissure, 1 = the frontozygomatic suture to the lacrimal foramen, 2 = the frontozygomatic suture to the closest margin of the superior orbital fissure, 3 = the frontozygomatic suture to the lateral border of the optic canal, 4 = the frontozygomatic suture to the closest margin of the inferior orbital fissure

three measurements, the distances between two sides were significantly different. The average distances of other measurements in the medial wall were similar between two sides (Table 1). When comparing between genders, only the average distance between the ALC and PLC on the right was significantly different (7.1 $\pm$ 0.8 mm male vs. 6.5 $\pm$ 0.8 mm female, $p < 0.05$). It is worth noting that the AEF was found at the frontoethmoidal suture in the majority of orbits (85%). In the rest of orbits (15%), this foramen was located superior to the suture with the average distance of 2.0 $\pm$ 0.7 mm. Moreover, multiple PEF were observed in 62 orbits.

Measurements in the superior wall or roof

The average distance of each measurement is shown in Table 2. The average distances from the SN/F to the SOF were 39.8 $\pm$ 2.3 and 40.2 $\pm$ 2.4 mm on the left and right, respectively. The mean distances from the SN/F to the superior border of the OC were 44.8 $\pm$ 2.4 and 44.5 $\pm$ 2.2 mm (left and right, respectively). The LF could be observed in 37 orbits (37%, 20 on the left and 17 on the right). Double LF was found in five orbits (5%). The average distances from the SN/F to the LF on the left and right were 32.7 $\pm$ 3.5 and 34.7 $\pm$ 3.3 mm, respectively. Only the distances to the LF were significantly different between two sides ($p < 0.05$). Regarding gender differences, the distances to the SOF and to the superior border of the OC on the left side of female orbits were significantly shorter than those on the corresponding side of male orbits (Table 2).

Measurements in the inferior wall or floor

The relevant data are presented in Table 3. The average distances from the orbital rim above the IF to the IOF were 21.9 $\pm$ 2.1 mm on the left and 21.5 $\pm$ 1.8 mm on the right. The mean distances to the inferior border of the OC were 45.9 $\pm$ 2.8 mm (left) and 46.5 $\pm$ 2.8 mm (right). The distances to the PM in average were 12.4 $\pm$ 3.4 and 12.3 $\pm$ 4.1 mm on the left and right, respectively. There were no statistically significant

Table 1. The distances measured in the medial wall of the orbit

Measurement	Total (n = 100)		Male (n = 50)		Female (n = 50)	
	Left (n = 50)	Right (n = 50)	Left (n = 25)	Right (n = 25)	Left (n = 25)	Right (n = 25)
1. ALC-PLC	6.5 $\pm$ 1.1	6.8 $\pm$ 0.8^a	6.8 $\pm$ 1.3	7.1 $\pm$ 0.8	6.3 $\pm$ 0.9	6.5 $\pm$ 0.8^c
2. ALC-AEF	23.1 $\pm$ 2.6	23.9 $\pm$ 2.7^b	23.6 $\pm$ 2.7	24.3 $\pm$ 3.0	22.6 $\pm$ 2.4	23.4 $\pm$ 2.3
3. ALC-PEF	35.6 $\pm$ 2.4	36.4 $\pm$ 2.6^b	35.5 $\pm$ 2.6	36.1 $\pm$ 2.9	35.6 $\pm$ 2.2	36.5 $\pm$ 2.2
4. ALC-OC	42.1 $\pm$ 2.1	42.3 $\pm$ 2.6	41.8 $\pm$ 2.5	42.3 $\pm$ 3.1	42.4 $\pm$ 1.5	42.2 $\pm$ 2.1
5. AEF-OC	19.6 $\pm$ 2.0	19.3 $\pm$ 1.9	19.2 $\pm$ 2.0	19.3 $\pm$ 1.8	20.0 $\pm$ 1.9	19.2 $\pm$ 2.2
6. AEF-PEF	13.2 $\pm$ 2.0	13.2 $\pm$ 2.0	12.7 $\pm$ 2.3	12.7 $\pm$ 2.1	13.7 $\pm$ 1.6	13.7 $\pm$ 1.7
7. PEF-OC	6.3 $\pm$1.7	6.3 $\pm$ 1.6	6.5 $\pm$ 1.3	6.5 $\pm$ 1.5	6.0 $\pm$ 2.0	6.0 $\pm$ 1.6

Data are means $\pm$ SD

^{a} $p < 0.05$ vs. left, ^{b} $p < 0.01$ vs. left, ^{c} $p < 0.05$ vs. right in male

ALC = the anterior lacrimal crest, PLC = the posterior lacrimal crest, AEF = the anterior ethmoidal foramen, PEF = the most posterior ethmoidal foramen, OC = the optic canal (medial border)

Table 2. The distances measured in the superior wall or roof of the orbit

Measurement	Total (n = 100)		Male (n = 50)		Female (n = 50)	
	Left (n = 50)	Right (n = 50)	Left (n = 25)	Right (n = 25)	Left (n = 25)	Right (n = 25)
1. SN/F-SOF	39.8 ± 2.3	40.2 ± 2.4	40.1 ± 2.7	40.9 ± 2.4	39.6 ± 1.9	39.5 ± 2.3[b]
2. SN/F-OC	44.8 ± 2.4	44.5 ± 2.2	45.4 ± 2.8	45.2 ± 2.3	44.3 ± 1.9	43.8 ± 2.0[b]
	Left (n = 20)	Right (n = 17)	Left (n = 7)	Right (n = 10)	Left (n = 13)	Right (n = 7)
3. SN/F – LF*	32.7 ± 3.5	34.7 ± 3.3[a]	32.2 ± 2.3	35.3 ± 3.5	32.9 ± 4.0	33.8 ± 3.0

Data are means ± SD
* If double foramina were present, the shorter distance was used
[a] $p < 0.05$ vs. left, [b] $p < 0.05$ vs. right in male
SN/F = the supraorbital notch (or foramen), SOF = the closest margin of the superior orbital fissure, OC = the optic canal (superior border), LF = the lacrimal foramen

Table 3. The distances measured in the inferior wall or floor of the orbit

Measurement	Total (n = 100)		Male (n = 50)		Female (n = 50)	
	Left (n = 50)	Right (n = 50)	Left (n = 25)	Right (n = 25)	Left (n = 25)	Right (n = 25)
1. IF-IOF	21.9 ± 2.1	21.5 ± 1.8	22.2 ± 0.4	21.9 ± 1.7	21.6 ± 2.1	21.1 ± 1.9
2. IF-OC	45.9 ± 2.8	46.5 ± 2.8	46.5 ± 3.0	46.9 ± 2.8	45.3 ± 2.4	46.1 ± 2.8
3. IF-PM	12.4 ± 3.4	12.3 ± 4.1	12.3 ± 3.4	11.3 ± 3.6	12.5 ± 3.5	13.2 ± 4.4

Data are means ± SD
IF = the orbital rim above the infraorbital foramen, IOF = the closest margin of the inferior orbital fissure, OC = the optic canal (inferior border), PM = the posterior margin of the roof covering the infraorbital canal

Table 4. The distances measured in the lateral wall of the orbit

Measurement	Total (n = 100)		Male (n = 50)		Female (n = 50)	
	Left (n = 50)	Right (n = 50)	Left (n = 25)	Right (n = 25)	Left (n = 25)	Right (n = 25)
1. FZ-SOF	34.3 ± 2.5	34.7 ± 2.6	34.6 ± 2.7	35.0 ± 2.6	34.1 ± 2.4	34.4 ± 2.7
2. FZ-IOF	23.2 ± 2.3	24.7 ± 2.1[a]	23.9 ± 2.4	24.6 ± 2.1	22.5 ± 2.0[c]	24.8 ± 2.1
3. FZ-OC	47.2 ± 2.2	46.6 ± 2.5[b]	47.8 ± 2.7	46.8 ± 2.7	46.6 ± 1.5	46.4 ± 2.3
	Left (n = 20)	Right (n = 17)	Left (n = 7)	Right (n = 10)	Left (n = 13)	Right (n = 7)
4. FZ-LF *	26.3 ± 3.6	28.2 ± 3.6	25.2 ± 2.3	28.9 ± 4.3	26.9 ± 4.1	27.1 ± 2.2

Data are means ± SD
* If double foramina were present, the shorter distance was used
[a] $p < 0.001$ vs. left side, [b] $p < 0.05$ vs. left side, [c] $p < 0.05$ vs. left in male
FZ = the frontozygomatic suture, SOF = the closest margin of the superior orbital fissure, IOF = the closest margin of the inferior orbital fissure, OC = the optic canal (lateral border), LF = the lacrimal foramen

Table 5. Comparison of important distances in four walls of the orbit among the studies

Wall of orbit	From	To	Rontal et al[2] (48 orbits)	McQueen et al[3] (54 orbits)	Hwang et al[4] (82 orbits)	Karakas et al[5] (62 orbits)	This study* (100 orbits)
			mean (mm)	mean ± SD (mm)	mean ± SD (mm)	mean ± SD (mm)	mean ± SD (mm)
Medial	ALC	OC	42	43.29 ± 4.19	40.5 ± 3.0	41.7 ± 3.1	42.2 ± 2.3
		AEF	24	21.96 ± 3.13	21.0 ± 3.3	23.9 ± 3.3	23.5 ± 2.6
		PEF	36	33.36 ± 2.94	31.7 ± 3.0	35.6 ± 2.3	36.0 ± 2.5
Roof	SN/F	OC	45	48.65 ± 3.21	44.9 ± 2.0	45.3 ± 3.2	44.7 ± 2.3
		SOF	40	44.34 ± 3.97	40.0 ± 2.5		40.0 ± 2.4
		LF	32	38.99 ± 4.55			33.6 ± 3.5
Floor	IF	OC	48	49.73 ± 2.71	45.5 ± 2.5		46.2 ± 2.8
		IOF	24	37.43 ± 4.13	21.6 ±1.8		21.7 ± 2.0
		PM	14	17.08 ± 3.64			12.3 ± 3.7
Lateral	FZ	OC	43	47.10 ± 2.88	47.4 ± 3.0	44.9 ± 2.5	46.9 ± 2.4
		SOF	35	36.59 ± 4.30	34.3 ± 2.7		34.5 ± 2.6
		IOF	25	40.92 ± 3.62	24.8 ± 2.3		24.0 ± 2.3
		LF	25	31.41 ± 5.78			27.2 ± 3.7

* Data were derived from both genders and both sides in combination

ALC = the anterior lacrimal crest, OC = the optic canal, AEF = the anterior ethmoidal foramen, PEF = the posterior ethmoidal foramen, SN/F = the supraorbital notch or foramen, SOF = the superior orbital fissure, LF = the lacrimal foramen, IF = the orbital rim above the infraorbital foramen (= infraorbital foramen in Rontal et al), IOF = the inferior orbital fissure, PM = the posterior margin of the covering of the infraorbital canal, FZ = the frontozygomatic suture

differences in these measurements between sides or genders.

Measurements in the lateral wall

The measurement data are shown in Table 4. The average distances from the FZ to the SOF were 34.3 ± 2.5 and 34.7 ± 2.6 mm on the left and right, respectively. The mean distances to the IOF were 23.2 ± 2.3 mm (left) and 24.7 ± 2.1 mm (right). The distances to the lateral border of the OC in average were 47.2 ± 2.2 and 46.6 ± 2.5 mm (left and right, respectively). The average distances to the LF were 26.3 ± 3.6 mm (left) and 28.2 ± 3.6 mm (right). Among these measurements, the distances from the FZ to the IOF and to the lateral border of the OC were significantly different between sides (Table 4). Regarding gender, the mean distance to the IOF in the left female orbit was significantly shorter than that in the left male orbit ($p < 0.05$).

Discussion

Since the anatomy of orbital fissures and foramina seems to be dependent to the population selected as suggested by the previous reports[2-5], the present study was conducted to provide the morphometric data of these openings in the orbits of Thai adults. The authors' previous study in the same population of specimens has shown the different variations of several skull foramina between sides and genders[6]. Furthermore, the significant differences in the distances to the orbital foramina between sides and genders in Korean adults were previously reported[4]. Therefore, comparisons in the measurement parameters between sides and genders were also done to clarify whether the variations were dependent on these two factors in a Thai population.

The AEF and PEF, through which anterior and posterior ethmoidal vessels pass, are present in the medial wall. The anatomy of these foramina is important when performing several procedures, for example, ethmoidal vessel ligation for epistaxis, exploration of the medial wall fractures and orbital decompression. Anterior lacrimal crest was used as a constant landmark on this wall in this and other studies[2-5] since it can be easily located by palpation. In agreement with the previous reports[1,3], the AEF in this study was located within the frontoethmoidal suture line in the majority of the orbits (85%). In 15% of the orbits in the present study, the mean distance from the AEF above the frontoethmoid suture was 2 mm. McQueen and coworkers reported the same distance of 1.3 and 3.6 mm in 2 orbits (4%). As for the PEF, multiple foramina were observed in 62 orbits (62%) in the present study. Smaller figures were previously reported: 25%[2], 30%[8] and 28%[5]. This higher incidence of multiple posterior ethmoidal foramina is clinically important, as all ethmoidal vessels must be identified to effectively control epistaxis. All the discrepancies among the studies may be explained by the different populations used.

The data of the present study suggests that the optic nerve within the OC and ethmoidal vessels passing through the PEF and AEF are likely present at approximately 42.2, 36.0, and 23.5 mm from the palpable ALC, respectively. The mean distances from the ALC to the ethmoidal foramina and OC in the present study were similar to some studies[2,5], but different to the others[3,4] (Table 5). These findings cannot be explained by the different populations as the authors' was more closely related to that of Hwang et al. (Korean)[4] than that of Karakas et al (Caucasian)[5].

Another important parameter is the distance from the PEF, especially the most posterior foramen, to the OC. The authors found that this distance was 6.3 mm in average. This figure was smaller compared to the majority of other reports: 7[2], 9.15[3], 6.8 mm[5]. Therefore, the optic nerve can be located posterior to the posterior ethmoidal vessels in the range of 4.6-8.0 mm in our subjects may be shorter than other populations. This should be kept in mind when performing medial wall surgery in Thai patients in order to avoid optic nerve injury.

There were significant differences between sides in three parameters: the distances from the ALC to the PLC, AEF, and PEF (Table 1). Moreover, the distance from the ALC to the PLC was also significantly different between genders on the right. Similar to the present study, Hwang et al[4] reported the significant difference between sides in the distance from the ALC to the AEF. McQueen et al[3] observed the significant difference between genders in the distance from the PEF to the OC. These findings suggest possible asymmetric anatomy of some foramina in the medial wall of orbit.

The superior wall of orbit is involved in several procedures, such as frontal sinus obliteration, orbital decompression, exploration for fractures and orbital exenteration. The SN/F is constantly found close to the superior orbital rim and thererfore, was used as the reference point for the measurements in the superior wall. The LF may also be found on this wall of orbit lateral to the SOF. The LF was found in 37% of the orbits in the present study compared to 44% in McQueen and co-workers' study[3].

From the present study, the LF, SOF, and OC are likely located at approximately 33.6, 40.0, and 44.7 mm from the SN/F regardless of gender or side. These values were similar to those previously reported[2,4,5] except McQueen et al,[3] (Table 5). This discordance may be partly due to the inclusion of both Caucasian and Negroid skulls in their study and the data of Negroid skulls were not shown separately.

Regarding the comparison between sides, the distance from the SN/F to the LF was significantly different. In addition, the distances to the SOF and the OC on the right were significantly shorter in females than in males. Hwang et al[4] reported a significant difference in the distance to the SOF between genders, which was similar to the present study. These findings may indicate that locations of important structures in the orbital roof can be slightly closer to the SN/F in females than in males and should be kept in mind aware.

In the inferior wall, orbital floor exploration and maxillectomy are important related procedures. The inferior orbital rim above the infraorbital foramen was used as a landmark for the measurements. Variable length of the roof plate covering the anterior part of the infraorbital groove to form the infraorbital canal, which contains the infraorbital vessels and nerve, has been reported. The authors observed the mean distance of 12.3 mm, which was shorter than those of Rontal et al[2] and McQueen et al[3] (14 and 17.1 mm, respectively) (Table 5). The average distances from the orbital rim to the inferior border of the OC and to the IOF in the present study were also shorter than those of two previous studies. However, these two parameters were comparable to those of Korean skulls[4]. These findings suggest that the probably shorter distances to the neurovascular bundle during surgical approach in the inferior orbital wall in the Asian including Thai subjects should be kept in mind aware.

Intraorbital operations related to the lateral wall of orbit are, for example, exploration of orbital fractures, lateral orbitotomy, and excision of the lacrimal gland. The frontozygomatic suture line can be detected once the periosteum is elevated and therefore, was used as a constant landmark for this wall. The presented measurements suggest that the IOF, SOF, and OC can be estimated to locate at 24.0, 34.5, and 46.9 mm from the FZ, respectively. The distances in the present study were similar to those of Hwang et al study[4] but were relatively different from those of other reports[1,3,5] (Table 5).

Comparing between sides, the distances from the FZ to the IOF and to the OC were significantly different. In addition, the distance to the IOF was also significantly different between genders on the left. These differences were not found in the previous studies and suggest asymmetry and gender difference in the anatomy of the lateral wall foramina.

In conclusion, the distances from the landmarks to various foramina in the four orbital walls of Thai skulls were obtained. Although these were comparable to several previous studies, some considerable differences that may be of clinical importance were demonstrated. Moreover, the significant differences between sides and genders in several measurements were also observed in the present study. As a result, variations in the anatomy of orbital foramina and fissures related to race, side and gender should be kept in mind when performing the orbital surgery.

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ศัลยกายวิภาคของรูเปิดในเบ้าตาของคนไทย

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ลักษณะทางกายวิภาคของรูเปิดต่าง ๆ ในเบ้าตามีแนวโน้มที่จะแตกต่างกันตามเชื้อชาติของกะโหลกศีรษะที่ใช้ศึกษา นอกจากนี้ยังมีรายงานถึงความแตกต่างของกายวิภาคของรูเปิดเหล่านี้ระหว่างข้างและเพศด้วย การศึกษานี้จึงมีจุดประสงค์เพื่อหาข้อมูลทางกายวิภาคของรูเปิดในเบ้าตาที่สัมพันธ์กับเพศ และข้างในคนไทย โดย ศึกษาใน 100 เบ้าตาจาก 50 กะโหลกศีรษะแห้งของผู้ใหญ่ในประเทศไทย โดยในแต่ละกะโหลก จะทำการระบุ เพศ และวัดค่าระยะทางจากรูเปิดต่าง ๆ ไปยังตำแหน่งอ้างอิงของผนังเบ้าตาทั้งด้านใน ด้านบน ด้านล่าง และด้านข้าง พบว่าที่ผนังด้านในระยะทางเฉลี่ยจาก anterior lacrimal crest ไปยัง optic canal, anterior และposterior ethmoidal foramina โดยไม่แบ่งเพศและข้างเท่ากับ 42.2, 23.5 และ 36.0 มิลลิเมตร ตามลำดับ สำหรับด้านบนของเบ้าตา ระยะทางจากรูเปิด supraorbital ไปยัง superior orbital fissure, optic canal และรูเปิด lacrimal โดยเฉลี่ยเท่ากับ 44.7, 44.0 และ 33.6 มิลลิเมตรตามลำดับ ในกรณีของพื้นหรือด้านล่างของเบ้าตา ระยะทางจาก ขอบล่างเบ้าตาเหนือรูเปิด infraorbital ไปยัง optic canal, inferior orbital fissure และขอบหลังของหลังคาของ infraorbital canal โดยเฉลี่ยคือ 46.2, 21.7 และ 12.3 มิลลิเมตร ตามลำดับ สำหรับผนังด้านข้างของเบ้าตา ระยะทางจาก frontozygomatic suture ไปยัง optic canal, superior และ inferior orbital fissure รวมทั้งรูเปิด lacrimal เท่ากับ 46.9, 34.5, 24.0 และ 27.2 มิลลิเมตร ตามลำดับ เมื่อเปรียบเทียบกับการศึกษาก่อนหน้านี้ มีบางค่าที่แตกต่างไปอย่างชัดเจน และอาจมีความสำคัญทางคลินิกด้วย นอกจากนี้ยังพบว่าบางระยะทางมีความแตกต่างอย่างมีนัยสำคัญ ระหว่างข้างหรือเพศด้วย ผลการศึกษานี้บ่งชี้ว่าเชื้อชาติ เพศ และข้าง เป็นปัจจัยสำคัญเกี่ยวข้องกับลักษณะทางกายวิภาคของรูเปิดในเบ้าตา จำเป็นต้องคำนึงถึงในการผ่าตัดบริเวณดังกล่าว และยังเป็นประโยชน์ในการนำไปใช้สำหรับคนไทยในด้านอื่นอีกด้วย