

Original Article

Ethmoidal foramina: the rule 24-12-6: is it true for Indian orbits?

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Abstract : Aim : The literature states that the distances between the medial margin of the orbit to the anterior ethmoid foramen, from it to the posterior ethmoid foramen and from it to the optic canal are 24mm, 12mm & 6 mm. This study is to verify if this is true in the Indians as there is no data available in the literature. To the best of our knowledge it is the first study from India, which focused on the relationship of ethmoid foramina. Methods: 70 orbits of 35 Indian skulls were studied, using depth gauge, sliding calipers, dividers and metal scale by a single observer. Results: The average distance between the medial margin of the orbit and the anterior ethmoid foramen is 21.30mm and 20.37mm for right and left orbits respectively (range varying from 18 to 26mm in the right and from 14 to 26 in the left orbit). The average distance between the anterior and posterior ethmoid foramina is 12.45 and 12.47mm (range 6mm to 18mm). The average distance between the posterior ethmoid foramen and the optic canal is 6.32 and 7.37mm (range 2 mm to 18mm). 10 of 35 skulls (28.6%) had 3 foramina instead of 2 (accessory foramen), involving right orbit in 5, left in 4 and both the orbits of a skull. Conclusions: The rule 24-12-6 does not apply to Indian orbits. The anterior Ethmoid foramen is about 3mm nearer to the orbital margin. There is a great variation in the distances of ethmoid foramina. Nearly a third of the skulls have accessory ethmoid foramen.

Key Words : Rule of 24-12-6, Anterior Ethmoid foramen, Posterior Ethmoid foramen, Optic canal, Accessory foramen,

Introduction

The relationship between the ethmoid foramina and the optic nerve is interesting as the conventional literature^{1,2}. States that the distances between the medial margin of the orbit to the anterior ethmoid foramen (AEF), from it to the posterior ethmoid foramen (PEF) and from it to the optic canal (OC) are 24mm, 12mm & 6 mm respectively while differences in this anatomical relationship of the bony orbit depending on the race were described^{1,3,4,5,6}. Some studies^{7,8} showed the presence of accessory foramina. Accessory foramina upto 6 in number, in an orbit was also cited⁸. These studies were made on dry skulls or from imaging⁹. There is only one article in the literature available regarding anthropometric studies of bony orbit among Indians¹⁰. Hence, a study was conducted to examine the distances between the ethmoidal foramina, presence of any accessory foramina, and verify if the 24-12-6 rule is true in the Indian skulls, since a knowledge of it will be of use not only for orbital surgical approaches but also for other approaches¹¹.

Materials and Methods

Seventy orbits of thirty-five Indian skulls available at the department of Anatomy, of Maharajah's Institute of

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Medical Sciences, were studied. The most anterior and the most prominent posterior ethmoidal foramina were identified as the anterior and posterior ethmoidal foramina (Fig.1) and all others as the accessory foramina. The distances from medial orbital margin to AEF, from it to PEF and PEF to OC were measured'. When accessory foramen was noted, its distance to PEF and OC are measured. Vernier calipers, sliding-calipers, surgical calipers, depth gauge, compass and scale were used to record these measurements, which were taken by a single observer to prevent inter-observer variation.

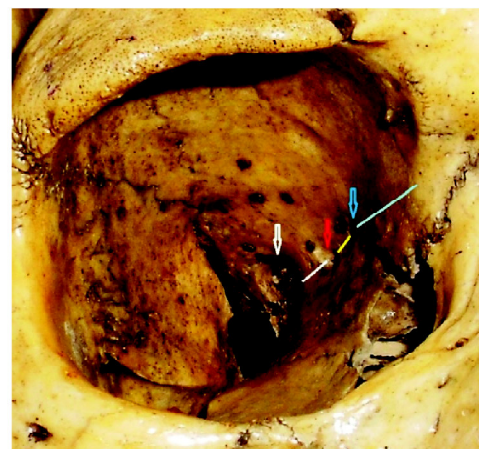


Fig 1: Foramina and distances between them: Blue arrow points towards anterior ethmoidal foramen ;red arrow points towards posterior ethmoidal foramen; white arrow points towards optic foramen; blue line shows distance between medial orbital margin to anterior ethmoidal foramen; yellow line shows distance between anterior to posterior ethmoidal foramina; white line shows distance between posterior ethmoidal foramen to optic foramen

Results

The measurements between the orbital margins, AEF, PEF, OC, Accessory foramen are tabulated (Table 1) from which meaningful conclusions could be drawn. We can see lot of variations in the measurements among the orbits. We can also observe gross asymmetry between the right and left orbits.

TABLE 1: Distances between orbital margin, EF, PEF and Accessory Foramina and the Optic Canal

RIGHT ORBIT				LEFT ORBIT			
AEF to Medial orbital margin	AEF to PEF	PEF to Optic foramen	PEF to Accessory foramen	AEF to Medial orbital margin	AEF to PEF	PEF to Optic foramen	PEF to Accessory foramen
24	10	5		23	10	7	
20	8	7		18	6	5	5
22	11	4		20	15	6	
21	8	9	9	20	18	5	3
18	16	4		20	12	3	
26	14	10		22	11	2	
20	9	12		28	15	16	
19	13	6		23	9	8	
21	16	8		23	15	10	
26	12	8		17	16	8	
24	11	3	5	17	8	10	12
23	12	6		19	10	18	
24	8	6		20	12	9	
21	10	10		20	11	6	
20	9	3	7	20	16	9	
22	13	9		21	9	10	
22	17	4		22	12	8	
20	16	4		20	18	7	
18	10	6	4	21	15	7	
18	15	5		21	11	5	
18	14	6		21	12	4	
20	2	6	6	22	12	7	
28	12	6		22	12	4	
19	14	4		25	15	6	
20	16	3		20	15	2	
19	16	5		18	15	9	
20	19	6		21	7	5	
23	12	5		20	16	4	
23	11	5	8	23	13	3	
18	14	6		23	10	3	10

The average distance between the medial margin of the orbit and the anterior ethmoid foramen is 21.30mm and 20.37mm for right and left orbits respectively (Table 1). The range was varying from 18mm as the shortest and 26mm as the longest distance (Fig.2) in the right orbit and from 14mm as the shortest (Fig.3) and 26mm as the longest distance in the left orbit (Table 2).



Fig 2: Blue line shows longest distance between medial orbital margin and anterior ethmoidal foramen (26mm)

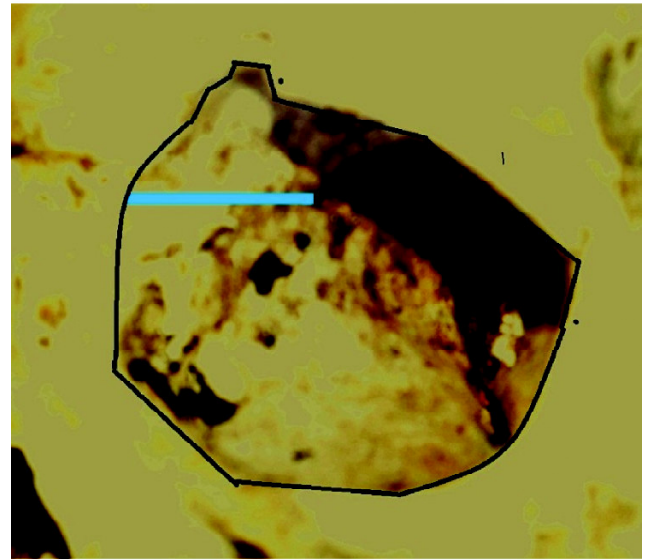


Fig 3: Blue line shows shortest distance between medial orbital margin and anterior ethmoidal foramen(14mm)

The average distance between the anterior and posterior ethmoidal foramina is 12.45 mm and 12.47mm for the right and left orbits respectively (Table 1). The shortest distance between the two foramina was found to be 2mm (Fig.4) and the longest distance 18mm (Fig.5) in both the right and left orbits (Table 2)

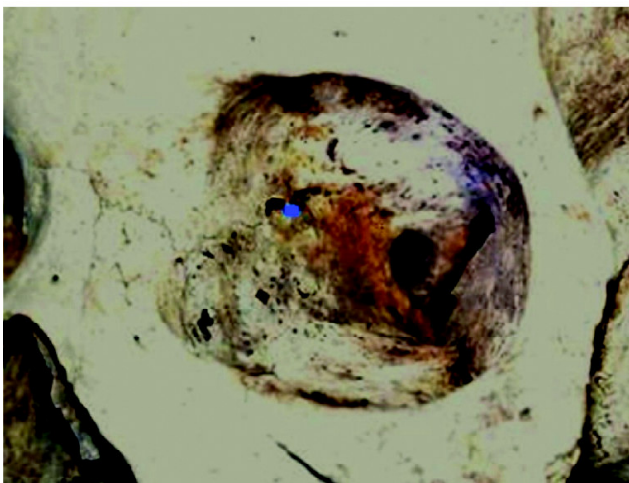


Fig.5 : Blue line shows shortest ethmoidal anterior to posterior foramina (2 mm)

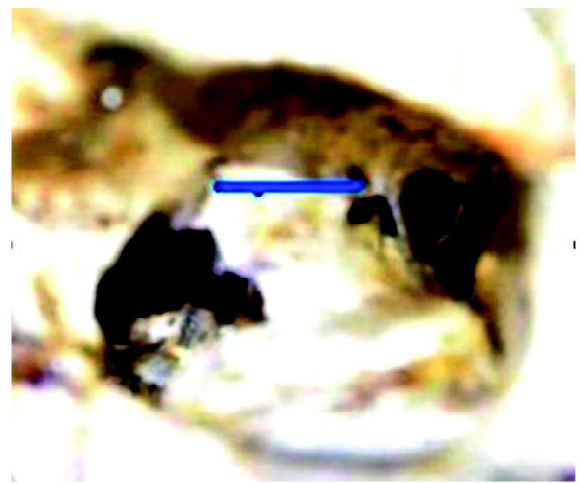


Fig.5 : Blue line shows longest ethmoidal anterior to posterior foramina (18 mm)

The average distance between the posterior ethmoidal foramen and the optic canal is 6.32in the right orbit and 7.37mm in the left orbit (Table 1) with distances varying from as short as 2mm and as long as 18mm in both right and left orbits. (Table 2) There are 10 orbits which showed accessory foramen (3 instead of 2). (Fig.6a and 6b). The accessory foramen was present in 5 right orbits, 4 left orbits and 1 was present bilaterally (Table 3).

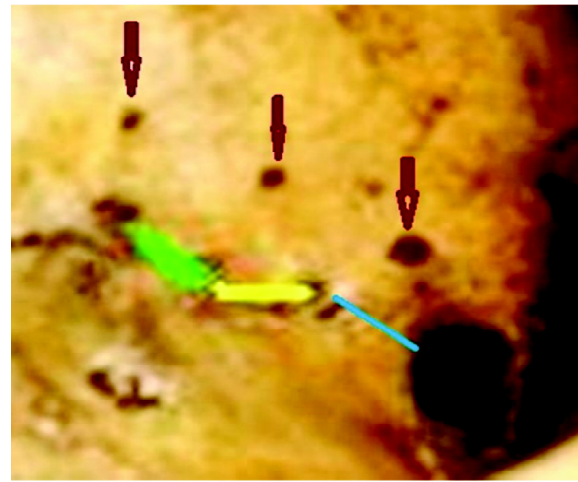
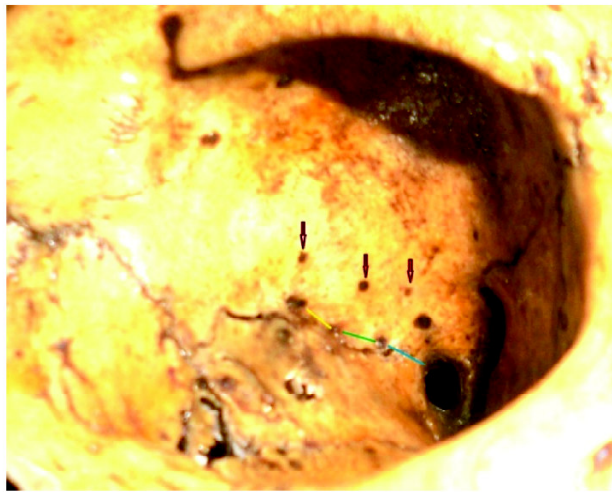


Fig.6 a: 1-anterior ethmoidal foramen ; 2-posterior ethmoidal foramen; 3-accessory foramen; 4-optic foramen; yellow line represents distance between anterior to accessory foramen; green line represents distance between accessory foramen to posterior ethmoidal foramen; blue line represents distance between posterior ethmoidal foramen to optic foramen; 6b-foramina in detail

Table 2: Longest and shortest distances between the foramina

	RIGHT ORBIT			LEFT ORBIT		
	AEF to medial orbital margin	AEF to PEF	PEF to optic foramen	AEF to medial orbital margin	AEF to PEF	PEF to optic foramen
Longest	26	18	18	26	18	18
Shortest	18	2	2	14	2	2

Table 3: presence of accessory foramina in the right and left orbits

RIGHT ORBITS	LEFT ORBITS	BILATERAL
5	4	1

Maria Piagkou studied 249 dry orbits and assessed that the distances between anterior lacrimal crest (ALC) to AEF, AEF-PEF, and PEF to optic canal (OC) in Greek population was "23-10-4 mm". A variation in the number of ethmoidal foramina was found, ranging from 1 to 6. A significant gender difference was observed for ALC-AEF in males (20.67-26.39) versus females (18.79- 26.23).^[8](Tables 4 and 5)

Abed SF studied 47 orbits and analyzed that the average distances from the anterior lacrimal crest to AEF, PEF and OC were 25.61 mm, 36.09 mm, and 43.77 mm. The average distance between the AEF to first PEF, last PEF, and optic canal were 13.88mm, 16.60 mm and 21.65 mm respectively. The average distances from the first and last PEF to the optic canal were 11.63mm and 7.25 mm

respectively. They found that the distance between the PEF to the OC is more than double the distance quoted in the surgical literature⁴. (Table 4)

Takahashi studied 54 orbits and found from them that the mean distances from anterior lacrimal crest to anterior and posterior ethmoidal foramina and the optic canal were 19.6 mm, 33.5mm, and 41.9 mm respectively⁷. In another study among 84 orbits, he found accessory ethmoidal foramina in 32 orbits, one accessory foramen was identified in 30 orbits, and 2 foramina in 2 orbits³ (Tables 4 and 5).

In a study which was conducted by Ashwini Mutalik, the distance between the AEF to PEF ranged from 3-18mm and the distance between PEF to optic canal ranged between 2-18 mm¹⁰.

In a study conducted by Huanmanop in Thai subjects, the mean distances from the anterior lacrimal crest to the optic canal, anterior, and posterior ethmoidal foramina were 42.2, 23.5, and 36 mm for both sides and genders, respectively⁵.

In a study by Pereira and Lopes, 38.67% of accessory ethmoidal foramina were present on right side and 48.38% were on the left side⁶. Accessory foramina were less in number in males than in females.

Table 4: Distances between foramina in various races

Studies	Distance between medial orbital margin to AEF	Distance between AEF to PEF	Distance between PEF to Optic foramen
Present study	20.83	12.46	6.84
Greeks ⁸	23	10	4
Caucasians ⁴	25.6	13.88	11.6
Chinese ⁷	19.6	13.9	8.4

The relationship of anterior and posterior Ethmoid foramina to the orbital rim and the Optic canal has shown significant difference among different races. Knowledge of these changes is of importance in this era of frequent migration of doctors and patients.

Table 5: Presence of accessory foramina among various races

Studies	Number of orbits with accessory foramina	Number of orbits with Single accessory foramen	Extra foramina	Orbits with Bilaterally present accessory foramina	Number of orbits studied
Present study	10	9		2	70
Greeks ⁸	22	15	5 EF in 2 orbits 6 EF in 1 orbit		249
Chinese ³	32	30	2 EF in 2 orbits		84

Conclusion

This is the first study on the rule of 24-12-6 among Indians' orbits. Rather than the 24-12-6 rule, 21-12-7 rule applies to the Indian skulls. Therefore, it is important for the orbital and ENT surgeons to know about this variation. This knowledge is helpful during surgeries involving the medial orbital walls, both for the orbital surgeon and the ENT colleague. The presence of accessory ethmoid foramen in nearly 30% of Indian skulls is to be known and remembered by these surgeons.

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- Financial Support : Declared None
Conflict of Interest : Declared None