

Landmark of Ethmoid Arteries in Adult Thai Cadavers: Application for Sinus Surgery

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Background: Ethmoid arteries, branches of the ophthalmic artery, are crucial structures supplying ethmoid mucosa. Its locations are important during ethmoid sinus surgery. There has been no study in Thais before.

Objective: To determine the number and locations of ethmoid arteries in relation to important surrounding structures.

Material and Method: A prospective, descriptive study in 42 Thai cadaveric adult half-heads was conducted at departments of Otorhinolaryngology and Anatomy, Faculty of Medicine, Khon Kaen University, Thailand. Meticulous dissections were performed to identify number of ethmoid arteries branching from ophthalmic artery and site of entrance of the arteries into ethmoid sinus. Relationships of these arteries with anterior ethmoid crest, optic foramen, bulla lamella and middle third of basal lamella of middle turbinate were studied.

Outcomes: Types of ethmoid arteries, distances between ethmoid arteries and their relations to important surrounding structures: anterior lacrimal crest, optic foramen, superior aspects of bulla lamella, middle third of basal lamella of middle turbinate and the superior aspect of anterior wall of sphenoid sinus.

Results: All specimens had anterior and posterior ethmoid arteries. The prevalence of tertiary ethmoid artery was 36% (95% CI 22-52%). The mean distance between the anterior ethmoid artery and anterior lacrimal crest, anterior ethmoid artery and posterior ethmoid artery and the distance between posterior ethmoid artery and optic foramen were 24.3, 13.5 and 6.4 millimeters respectively. Most of the entry of anterior ethmoid artery into the ethmoid sinus was in the posterior half of the distance between the bulla lamella and middle third of basal lamella of middle turbinate, 85.7%.

Conclusion: This is the first study of location of ethmoid arteries in Thai adult cadavers. The information of the present study may be useful for sinus surgeon.

Keywords: Ethmoid artery, Anterior ethmoid artery, Posterior ethmoid artery, Tertiary artery, Sinus surgery

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Ethmoid arteries, branches from the ophthalmic artery, are one of the major arteries supplying nasal mucosa and ethmoid sinuses. Their locations are very important so that surgeons have to be aware during the ethmoid sinus surgery either by external or intranasal approaches because injuring them may lead to massive bleeding which will obscure the operative field and the operation may be terminated. Moreover if they are severed, they may retract into the orbit and continue to profusely bleed. This phenomenon may result in retrobulbar hemorrhage causing decrease in visual acuity even blindness. Currently identifying the locations of ethmoid arteries

during sinus surgery in Asian, Mongoloid race, are usually referenced from the western-populations studies^(1,6), Caucasian race. However the craniofacial cephalometry of Mongoloid and Caucasian were proved to be different⁽⁵⁾, which means that Asian people should have their own referent locations of ethmoid arteries.

The objectives of the present study were to determine the number of ethmoid arteries branching from the ophthalmic artery, the distances between ethmoid arteries and their relations to important surrounding structures: anterior lacrimal crest, optic foramen, superior aspects of bulla lamella, middle third of basal lamella of middle turbinate and the superior aspect of anterior wall of sphenoid sinus.

Material and Method

A descriptive study was prospectively conducted at the Department of Anatomy and the

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Department of Otorhinolaryngology, Faculty of Medicine, Khon Kaen University, Thailand. The sample specimens were from embalmed cadavers donated for Khon Kaen University students' anatomical study. Only skulls which had intact orbit and paranasal sinuses were included. Forty-two half heads from forty two skulls were used for study. Orbit and retrobulbar tissues were removed, periorbital septa was elevated to identify the ethmoid arteries branching from ophthalmic artery. Ethmoid sinuses were dissected from medial aspect preserving bulla lamella, basal lamella of middle turbinate and anterior wall of sphenoid sinuses. The distances between surgical landmarks were measured by a measuring gauge including; the distances between each ethmoid artery at its entry into the ethmoid sinuses; distances between ethmoid arteries and the nearest point of important nearby structures including anterior lacrimal crest, anterior rim of optic foramen, bulla lamella, middle third of basal lamella of middle turbinate and anterior wall of sphenoid sinus.

The data were analyzed using descriptive statistics. Point estimates and 95% confidence interval (95% CI) were reported. If the continuous data, distances, were shown to be normally distributed by using "Skewness and kurtosis test for normality", the mean and 95% CI were analyzed. If not, median with 25 percentile and 75 percentile were analyzed.

The present study was approved by the ethics committee of Khon Kaen University.

Results

The ages at death were between 17 and 92 years (mean 60, median 61). Twenty-nine specimens were male and 20 specimens were from right side.

All specimens had anterior and posterior

ethmoid arteries entering anterior and frontoethmoid foramina respectively. Tertiary arteries were present in 15 specimens (36%, 95% CI 22-52%). Anterior ethmoid artery was the largest branch, while tertiary ethmoid artery was the smallest one.

Results of the relationships between the ethmoid arteries and the nearby structures were summarized in Table 1. The present study demonstrated that anterior ethmoid artery was always behind the bulla lamella. After entering the anterior frontoethmoidal foramen, it traversed the roof of ethmoid sinus medially and anteriorly. In contrast, after entering the posterior ethmoid sinus, the posterior ethmoid artery traversed medially and posteriorly with few traversed medially and anteriorly.

There were 21 specimens (50%, 95% CI 34-66%) whose entries of anterior ethmoid arteries were close to the middle third of basal lamella of middle turbinate. The artery in one specimen stayed behind and traversed close to the basal lamella.

When the distance between the upper aspect of bulla lamella and middle one-third of the basal lamella was half divided, it demonstrated that the entries of anterior ethmoid arteries in 6 specimens (14.3%, 95% CI 5.4-28.5%) were in the anterior half and the rest (85.7%, 95% CI 71.5-94.6%) were in the posterior half. When separate the distance into 3 equal parts, 2 specimens (4.8%, 95% CI 0.6-16.2%) were in the anterior 1/3, 13 specimens (31%, 95% CI 17.7-47.1%) were in middle 1/3 and the rest (27 specimens) (64.3%, 95% CI 48-78.5%) were in the posterior one third.

Discussion

The present study demonstrated that every cadaver had anterior and posterior ethmoid arteries.

Table 1. Distances between entries of ethmoid arteries and other important nearby structures. Mean, SD and 95% CI were shown if the data proved to be normally distributed. If not, median with 25 & 75 percentile were shown. (AEA = anterior ethmoid foramen, PEA = posterior ethmoid artery, TEA = tertiary ethmoid artery, MinD = minimum distance, MaxD = maximum distance, SD = standard deviation)

Variable	MinD (mm)	MaxD (mm)	Mean (SD)	95% CI	Median	25 & 75 percentile
AEA-Anterior lacrimal crest	20	30	24.3 (1.9)	23.7-24.9	-	-
AEA-PEA	10	20	13.5 (2.2)	12.9-14.2	-	-
AEA-Basal lamella	0	10	-	-	5	0, 4
AEA-Bulla lamella	0	13	-	-	8	6,10
PEA-optic foramen	1	12	6.4 (1.2)	5.7-7.1	-	-
PEA-basal lamella	3	22	12.8 (3.4)	10.8-14.8	-	-
PEA-anterior sphenoid wall	0	18	-	-	4.25	0, 7
AEA-TEA	1	12	7.3 (3.5)	5.3-9.3	-	-

There were small tertiary ethmoid arteries in 36% (95% CI 22-52%). The mean distances between the entry of anterior ethmoid artery and anterior lacrimal crest, entry of anterior ethmoid artery and entry of posterior ethmoid artery were 24.3 and 13.5 millimeters respectively. The mean distance between posterior frontoethmoid foramen and anterior rim of optic foramen was 6.4 millimeters. These distances were close to the studies from western countries with the means of 24, 11 and 7 millimeters respectively⁽¹⁾.

Tertiary ethmoid artery is the ethmoid artery which usually is neglected by the otolaryngologists. Lang et al⁽²⁾ reported the prevalence of tertiary ethmoid to be 33% which is close to the result in the present study. During the external ethmoidectomy, the sinus surgeon usually identifies the first ethmoid artery to be anterior ethmoid artery and the second one to be posterior ethmoid artery. From the present study and Lang's study, the prevalence of tertiary ethmoid artery was rather high. It implies that the second ethmoid artery which stays deeper than the ethmoid artery may not always be a posterior ethmoid artery, but tertiary ethmoid artery. From our study, the distance between the entry of tertiary ethmoid artery and entry of anterior ethmoid artery was between 1-12 millimeters with the mean (95% CI) of 7.3 (5.3-9.3) millimeters. There was only one specimen with 12 millimeters distance. The distance between the entry of anterior ethmoid artery and posterior ethmoid artery was between 10 and 20 millimeters with the mean (95% CI) of 13.5 (12.9-14.2) millimeters. These findings should imply that the artery situated behind the anterior ethmoid artery less than 10 millimeters should be tertiary ethmoid artery, not posterior ethmoid artery.

The present study also demonstrated that posterior ethmoid artery was 1-12 millimeters, mean (95% CI) to be 6.4 (5.7-7.1) millimeters, anterior to the anterior edge of optic foramen. There was one specimen whose posterior ethmoid artery was only 1 millimeter from optic nerve. Lang⁽³⁾ reported in the present study that posterior ethmoid artery was at least 2 millimeters far from optic nerve. During performing external ethmoidectomy, caution should be taken in the area behind the posterior ethmoid artery, because it will increase risk of optic nerve injury.

The technique for identification of the anterior ethmoid artery was described by Stammberger⁽⁴⁾ using bulla lamella as a useful landmark. He mentioned that anterior ethmoid artery was usually 1 to 2 millimeters posterior to bulla lamella which endoscopic sinus surgeon should be taken care not to injure the artery⁽⁴⁾.

On the contrary, the present study showed that the entry of anterior ethmoid artery was quite far from bulla lamella, half of specimens were close to the middle 1/3 of basal lamella middle turbinate. After entry the ethmoid sinus, it then traverse medially and anteriorly. Therefore anterior ethmoid artery could be identified at the roof of ethmoid sinus anywhere between bulla lamella and basal lamella. However there was one specimen whose anterior ethmoid artery was traversed just behind the basal lamella. Lisboa et al performed a non-systematic review of location of anterior ethmoid artery and found that the anterior ethmoid artery was placed in ethmoid bulla 1.61%, mostly between bulla lamella and middle one-third of basal lamella of middle turbinate 74.20%, at basal lamella 16.13% and after the basal lamella in 8.06%⁽⁷⁾.

Conclusion

The present study demonstrated the prevalence of tertiary ethmoid artery to be 36% (95% CI 22-52%). The mean distance between the anterior ethmoid artery and anterior lacrimal crest, anterior ethmoid artery and posterior ethmoid artery and the distance between posterior ethmoid artery and optic foramen were 24.3, 13.5 and 6.4 millimeters respectively. Most of the entry of anterior ethmoid artery into the ethmoid sinus was in the posterior half of the distance between the bulla lamella and middle third of basal lamella of middle turbinate, 85.7%.

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Potential conflicts of interest

None.

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ตำแหน่งของเส้นเลือดแดงเอทมอยด์ในศพคนไทยผู้ใหญ่: การนำไปใช้สำหรับ การผ่าตัดไซนัส

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ภูมิหลัง: เส้นเลือดแดงเอทมอยด์เป็นแขนงของเส้นเลือดแดง ophthalmic เลี้ยงเยื่อบุไซนัสเอทมอยด์ตำแหน่งของเส้นเลือดนี้มีความสำคัญระหว่างการผ่าตัดไซนัสเอทมอยด์ ไม่เคยมีการศึกษาถึงเส้นเลือดแดงเอทมอยด์ในคนไทยมาก่อน

วัตถุประสงค์: เพื่อศึกษาจำนวน ตำแหน่งของเส้นเลือดแดงเอทมอยด์ และความสัมพันธ์กับอวัยวะที่สำคัญข้างเคียง
วัสดุและวิธีการ: การศึกษาเชิงพรรณนาแบบไปข้างหน้าในกะโหลกศีรษะครึ่งซีกผู้ใหญ่จำนวน 42 ข้าง โดยการชำแหละหาจำนวนเส้นเลือดแดงเอทมอยด์ที่ออกจากเส้นเลือดแดง ophthalmic และศึกษาตำแหน่ง ที่เส้นเลือดแดงเอทมอยด์วิ่งเข้าไปในไซนัสเอทมอยด์โดยดูความสัมพันธ์กับ anterior ethmoid crest, optic foramen, bulla lamella และ basal lamella ส่วนกลางของ middle turbinate

ผลการศึกษา: ทุกตัวอย่างที่ใช้ในการศึกษามีทั้งเส้นเลือดแดงเอทมอยด์ด้านหน้า (anterior ethmoid artery) และเส้นเลือดแดงเอทมอยด์ด้านหลัง (posterior ethmoid artery) พบเส้นเลือดแดงเอทมอยด์เส้นที่ 3 (tertiary ethmoid artery) ร้อยละ 36 (95% CI 22-52%) ระยะทางเฉลี่ยระหว่างเส้นเลือดแดงด้านหน้าและ anterior lacrimal crest ระหว่างเส้นเลือดแดงด้านหน้า และเส้นเลือดแดงด้านหลัง และระหว่างเส้นเลือดแดง ด้านหลังและ optic foramen มีค่าเท่ากับ 24.3, 13.5 และ 6.4 มิลลิเมตรตามลำดับ ทางเข้าของเส้นเลือดแดงด้านหน้า สูไซนัสเอทมอยด์ส่วนมากอยู่ในช่วงครึ่งหลังของระยะทางระหว่าง bulla lamella กับ basal lamella ส่วนกลางของ middle turbinate โดยพบร้อยละ 85.7 (95% CI 71.5-94.6)

สรุป: ตำแหน่งของเส้นเลือดแดงเอทมอยด์ในการศึกษานี้ เป็นการศึกษาแรกในศพคนไทย ซึ่งจะมีประโยชน์สำหรับแพทย์ผู้ทำการผ่าตัดไซนัส