



Characteristics of Posterior Ethmoidal Artery and Its Relationship with Anterior Ethmoidal Artery and Skull Base on CT Scan

BT Taramasında Posterior Etmoidal Arterin Özellikleri ve Anterior Etmoidal Arter ve Kafa Tabanı ile İlişkisi

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ABSTRACT

Objective: Investigation of the anterior and posterior ethmoidal arteries on computed tomography (CT) scans of the sinuses before and during surgery is important, especially for inexperienced surgeons. The aim of this study was to examine the anatomical characteristics of the posterior ethmoid artery in Vietnamese and the distance from the posterior ethmoid artery to the anterior ethmoid artery and the skull base on CT scan.

Methods: A cross-sectional study was conducted involving patients aged ≥ 18 years who underwent CT scan imaging at the Ear, Nose and Throat Hospital of Ho Chi Minh City from February 2023 to July 2023.

Results: There were 100 patients in this study, of whom 51% (51/100) were female and 49% (49/100) were male. Patient ages ranged from 20 to 84 years. Their average age was 40.92 ± 14.65 years. The distance on CT scan between the posterior and anterior ethmoidal arteries was 13.98 ± 1.95 mm (9.3 to 18.6 mm). This distance in males was significantly higher than female ($p=0.001$). However, there is no difference in this distance between the left and right side ($p=0.67$). The distance between the posterior ethmoid artery and skull base ranged from 0 to 5.4 mm. The average distance between the posterior ethmoidal artery and skull base on CT scan was 0.95 ± 0.94 mm. The diameter of the posterior ethmoid artery was $0.57-0.91$ mm. The average diameter of the posterior ethmoidal artery on CT scan was 0.76 ± 0.09 mm.

Conclusion: The characteristics of the posterior ethmoid artery should be considered when examining the CT scan. Distance from the posterior ethmoid This study provides useful information on the characteristics of the posterior ethmoid artery on CT scans, which can be applied in endoscopic sinus surgery and skull base surgery.

Keywords: Posterior ethmoid artery, anterior ethmoid artery, skull base on CT scan

ÖZ

Amaç: Ameliyat öncesinde ve sırasında sinüslerin bilgisayarlı tomografi (BT) taramalarında anterior ve posterior etmoidal arterlerin incelenmesi, özellikle deneyimsiz cerrahlar için önemlidir. Bu çalışmanın amacı Vietnamlılarda posterior etmoid arterin anatomik özelliklerini ve BT taramasında posterior etmoid arterin anterior etmoid artere ve kafa tabanına olan mesafesini incelemektir.

Yöntemler: Şubat 2023 ile Temmuz 2023 tarihleri arasında Ho Chi Minh City Kulak, Burun ve Boğaz Hastanesi'nde BT taraması yapılan ≥ 18 yaşındaki hastaları içeren kesitsel bir çalışma yürütülmüştür.

Bulgular: Bu çalışmada %51'i (51/100) kadın ve %49'u (49/100) erkek olmak üzere 100 hasta yer aldı. Hastaların yaşları 20 ile 84 arasında değişmekteydi. Ortalama yaş $40,92 \pm 14,65$ yıl idi. BT taramasında posterior ve anterior etmoidal arterler arasındaki mesafe $13,98 \pm 1,95$ mm (9,3 ile 18,6 mm) idi. Erkeklerde bu mesafe kadınlara göre anlamlı derecede yüksekti ($p=0,001$). Ancak sağ ve sol taraf arasında bu mesafe açısından fark yoktu ($p=0,67$). Posterior etmoid arter ile kafa tabanı arasındaki mesafe 0 ile 5,4 mm arasında değişmekteydi. BT taramasında posterior etmoidal arter ile kafa tabanı arasındaki ortalama mesafe $0,95 \pm 0,94$ mm idi. Posterior etmoid arterin çapı $0,57-0,91$ mm idi. BT taramasında posterior etmoidal arterin ortalama çapı $0,76 \pm 0,09$ mm idi.

Sonuçlar: BT taraması incelenirken posterior etmoid arterin özellikleri göz önünde bulundurulmalıdır. Bu çalışma, BT taramalarında posterior etmoid arterin özellikleri hakkında endoskopik sinüs cerrahisi ve kafa tabanı cerrahisinde uygulanabilecek yararlı bilgiler sağlamaktadır.

Anahtar kelimeler: Posterior etmoid arter, anterior etmoid arter, BT taramasında kafa tabanı

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Received: 26 March 2024

Accepted: 27 April 2024

Online First: 29 May 2024

Cite as: Tran Phan TC, Dang KV. Characteristics of Posterior Ethmoidal Artery and Its Relationship with Anterior Ethmoidal Artery and Skull Base on CT Scan. Medeni Med J 2024;39:85-90



INTRODUCTION

The anterior ethmoidal arteries (AEA) and posterior ethmoidal arteries (PEA) are branches of the ophthalmic artery, originating from the internal carotid artery. The ethmoidal artery is one of the main blood supplies to the ethmoidal cells and nasal septum¹. The AEA is an important anatomical landmark to which surgeons should pay special attention to avoid damage during endoscopic sinus surgery². According to many authors, the AEA is more susceptible to injury than the PEA during endoscopic sinus surgery^{3,4}. Consequently, prior research has primarily concentrated on the front ethmoidal artery, whereas there is a scarcity of publications regarding the PEA⁵.

Since skull base surgery has become increasingly popular and developed, surgeons have begun to pay more attention to the PEA. Cauterization of the ethmoidal arteries to limit bleeding is necessary and almost mandatory during surgery on anterior skull base masses, such as olfactory tumors⁶. Hence, it is crucial to perform a comprehensive examination of the anterior and PEAs on computed tomography (CT) scans before and during surgery, particularly for new surgeons. This study aimed to analyze the anatomical features of the Vietnamese PEA, the length from the PEAs to the AEAs, and the skull base, as observed using CT scans.

MATERIALS and METHODS

Subjects

A cross-sectional investigation was conducted on patients aged ≥ 18 years who underwent CT imaging at the Ear, Nose and Throat Hospital of Ho Chi Minh City from February 2023 to July 2023. We excluded patients who had injuries to the ethmoidal sinuses or skull base causing deformation of the skull, congenital craniofacial abnormalities, ethmoidal sinusitis, which obscured anatomical structures and landmarks that needed to be investigated, and patients with unidentified AEA on CT scan. The necessary sample size for this investigation was 186 CT scans, which was similar to the sample sizes used in previous studies that specifically examined the ethmoidal arteries. This study was approved by the Department of Otorhinolaryngology of Pham Ngoc Thach University of Medicine and the Medical Ethics Council of Pham Ngoc Thach University of Medicine and Ho Chi Minh City Ear, Nose and Throat Hospital (29/GCN-BVTMH, no. 226/QĐ-TĐHYPNT, date: 19.01.2023). This study obtained fully informed consent from all patients.

CT Scan

The CT scanner used was the Somatom Emotion 32-slice version, which was manufactured by Siemens

Healthineers AG in Forchheim, Germany. The images obtained were thin-sliced (0.625 mm). The gap between each slice was 0.6 mm. The data were processed using a three-dimensional Digital Imaging and Communications in Medicine (DICOM) viewer, namely the OsiriX Lite version 12.0 developed by Pixmeo SARL in Geneva, Switzerland. The examinations were conducted using three-dimensional photographs as the basis.

The AEA was recognized as the initial transverse canal observed on coronal slices when viewed from the front to the back. The PEA was observed as the initial transverse channel on coronal slices when viewed from the posterior to anterior direction. The location of the anterior and PEAs was then confirmed on the sagittal plane. The length from the posterior to AEAs was determined as the distance from the PEA to the AEA on sagittal CT. The length across the PEA and the skull floor was measured by determining the length of the vertical section from the skull base to the PEA on the sagittal CT scan. The PEA's diameter was determined as the length of the longest horizontal line crossing the PEA (anteroposterior diameter) on the sagittal CT scan.

Statistical Analysis

We used the Kolmogorov-Smirnov and Shapiro-Wilk tests to verify the normal distribution of the data. Data were normally distributed when $p > 0.05$. We used Student's t-test to compare two independent samples. CT scans of the study participants' noses and sinuses were performed in accordance with the treatment protocol of Ho Chi Minh City Ear, Nose and Throat Hospital. Statistical analysis of all data was performed using the SPSS Statistics software version 20.0.0 for Windows (SPSS, Chicago, IL, USA) and MedCalc version 22.009 software (MedCalc Software Ltd, Ostend, Belgium). A two-tailed p-value < 0.05 was considered statistically significant.

RESULTS

Characteristics of Patients in the Study

There were 100 patients in this study, of whom 51% (51/100) were female and 49% (49/100) were male. The patients' ages ranged from 20 to 84 years. Their average age was 40.92 ± 14.65 years.

Rate of Identification of Posterior Ethmoidal Artery on CT Scan

There were 200 sinus CT scans, of which the PEA was present in 187 CT scans (93.5%). On CT, the presence of the PEA was unidentified in 13 cases, which accounted for 6.5% of the total. CT successfully identified the PEA

in women at a rate of 96.08% (98 of 102 cases). In men, the prevalence of the PEA on CT scan is 90.82% (89 of 98 cases). The prevalence of the PEA in males and females on CT scan was not statistically different ($p=0.136$).

The rate of presence of the right PEA on CT scan is 93% (93/100 CT scans). The rate of presence of the left PEA on CT scan was 94% (94/100 CT scans). There was no statistically significant difference in the prevalence of left and right PEAs on CT scan ($p=0.776$).

Distance Between the Posterior and Anterior Ethmoidal Arteries on CT Scan

The average distance between the posterior and AEA was 13.98 ± 1.95 mm, with the longest distance was 18.6 mm (Figure 1) and the shortest distance was 9.3 mm (Figure 2).

Difference in Sex

In female patients, the distance between the posterior and AEA was 9.3-18.5 mm. The average distance between the posterior and AEA on CT in women was 13.54 ± 1.84

mm. In male patients, the distance between the posterior and AEA was 9.4-18.6 mm. The average length from the posterior to the AEA on CT in men was 14.47 ± 1.96 mm. There was a significant difference in this length between the sexes ($p=0.001$) (Table 1) (Figure 3).

Difference in Sides

The distance between the right PEA and the right AEA was 9.4-18.6 mm. The average distance between the right PEA and the right AEA on CT scan was 13.92 ± 1.98 mm. The distance between the left PEA and the left AEA was 9.3-18.5 mm. The average distance between the left PEA and the left AEA on CT scan was 14.04 ± 1.93 mm. There was no significant difference in the average distance from the PEA to the AEA on CT between the left and right sinuses ($p=0.678$) (Table 2).

Distance Between the Posterior Ethmoidal Artery and Skull Base on CT

The distance between the PEA and skull base ranged from 0 to 5.4 mm (Figure 4). The average distance between the PEA and skull base on CT scan was 0.95 ± 0.94 mm.

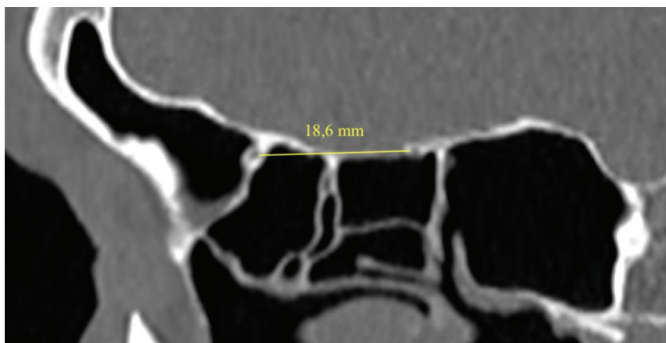


Figure 1. Distance between the posterior ethmoidal artery and anterior ethmoidal artery on CT scan of patient Vo Hoang V. Source: Dang Vuong Kiet, 2023.

CT: Computed tomography

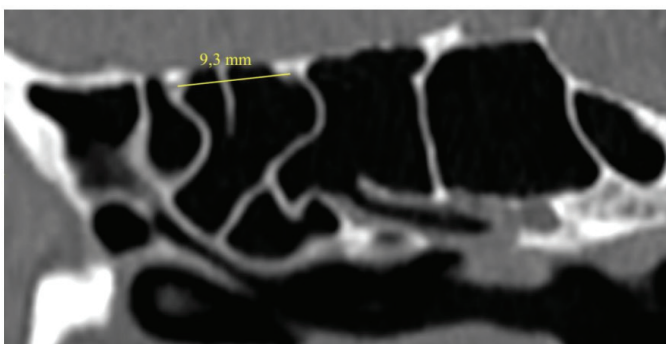


Figure 2. Distance between the posterior ethmoidal artery and anterior ethmoidal artery on CT scan of patient Tran Thi Ngoc H. Source: Dang Vuong Kiet, 2023

CT: Computed tomography

Table 1. Difference in distance PEA-AEA between sexes.

	Distance between PEA and AEA	p*
Male	14.47 ± 1.96 mm	0.001
Female	13.54 ± 1.84 mm	

*Independent sample test

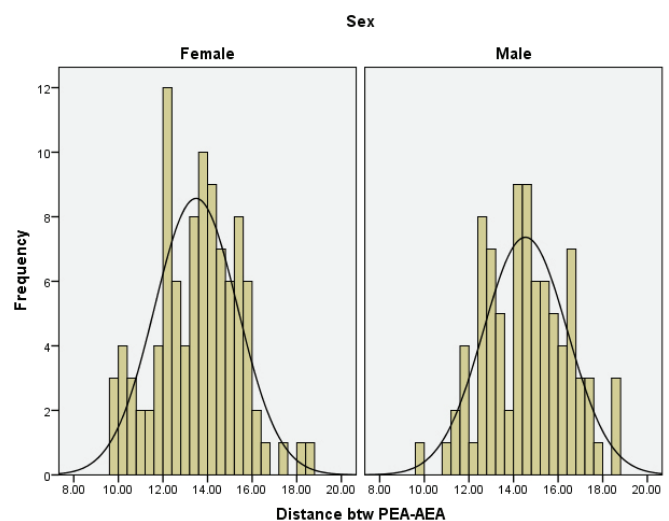


Figure 3. Difference in distance between PEA and AEA between males and females.

Posterior Ethmoidal Artery Diameter on a CT Scan

The diameter of the PEA ranged from 0.57 mm (Figure 5) to 0.91 mm (Figure 6). The average diameter of the PEA on CT scan was 0.76 ± 0.09 mm.

DISCUSSION

Characteristics of Patients in the Study

First, we found that there was no significant difference in the gender ratio (1.04) in our study compared with

Table 2. Difference in distance PEA-AEA between the left and right sides.

	Distance between PEA and AEA	p*
Left	14.04 ± 1.93 mm	0.678
Right	13.92 ± 1.98 mm	

*Independent sample test

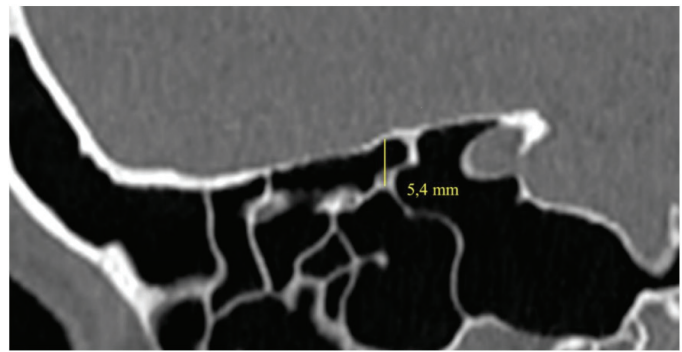


Figure 4. Distance between the posterior ethmoidal artery and skull floor on CT scan of patient Ho Thi T. Source: Dang Vuong Kiet, 2023.
CT: Computed tomography

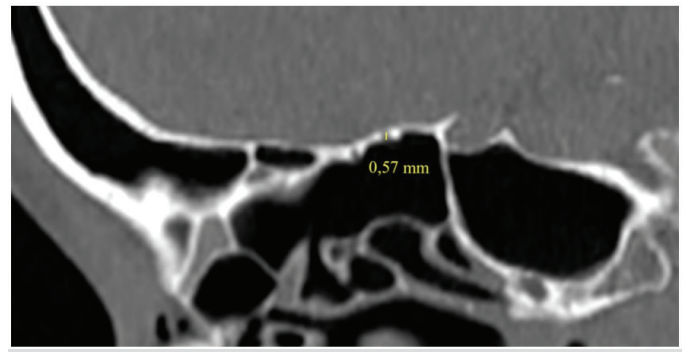


Figure 5. Posterior ethmoidal artery diameter on a CT scan of patient Pham Thi V. Source: Dang Vuong Kiet, 2023.
CT: Computed tomography

previous studies^{5,7}. However, there was a significant difference in the gender ratio in this study compared with other studies^{8,9}. We observed a significant difference in the average age in this study compared with previous studies^{5,7,8}.

Rate of Identification of the Posterior Ethmoidal Artery on CT Scan

We found no significant difference in the rate of presence of the PEA in our study compared with previous studies^{7,8,10}. We found a significant difference in the rate of the PEA in our study compared with that in prior studies^{5,9}. The reason for this difference may be different research methods, especially the slice thickness of the CT scan and ethnicity.

The identification of the PEA on CT scan varied among the studies from 86% to 100% (Table 3).

The differences might be due to the thickness of the CT scan and ethnicity. As in Yamamoto et al.'s⁵ study, this rate was 100% as the study was conducted in Japan using a CT scan with a thickness of 0.5 mm. In Kho et al.'s⁹ study and our study, the thickness of CT scan was 0.75 mm and 0.625 mm, respectively.

In addition, according to Cankal et al.⁷, the thinner the slice of the CT scan, the higher the rate of identification of the PEA on the CT scan (Table 4).

Distance Between the Ethmoidal Arteries on a CT Scan

The average distance between the posterior and AEA in males is 14.47 ± 1.96 mm, and the average distance between the posterior and AEA in females is 13.54 ± 1.84 mm. In our study, there was a statistically significant difference in the average distance between the posterior and AEA between males and

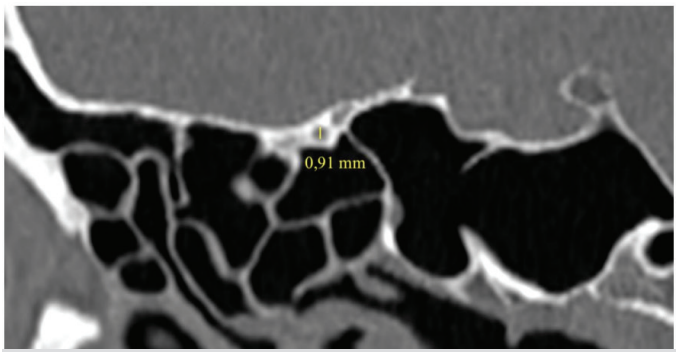


Figure 6. Posterior ethmoidal artery diameter on a CT scan of patient Pham Van T. Source: Dang Vuong Kiet, 2023.
CT: Computed tomography

females ($p=0.001$). However, there was no significant difference in distance between the ethmoidal arteries between genders in Kho et al.'s⁹ study. The studies of Cankal et al.⁷ and Vatanasapt et al.⁸ did not analyze the difference between genders.

In this investigation, we observed that the mean distance between the posterior and AEs did not show any significant variations compared with prior studies^{7,8}. However, we found that there was a significant difference in the average distance between the posterior and AEs in this study compared with that in another study⁹. The reason for this difference is probably because there are different significant factors between the two studies (the slice thickness of the CT scan, the rate of presence of the PEA on CT scan, the gender ratio of the study population, and the method of research).

Distance Between Posterior Ethmoidal Artery and Skull Base on CT Scan

In our study, we observed that the mean distance between the PEA and the skull base on CT scan was not significantly different from that in previous studies. However, we did find a significant difference in the average distance between the PEA and the skull base on CT scan when comparing our study with that of study⁵. The reason for this difference is probably because there were significant differences in factors between the two studies (the slice thickness of the CT scan, the prevalence of the PEA on CT scan, the average age of the

participants, and the study population). The prevalence of the suspended PEA on CT was 10.16% (19/187 on the sinus side). Accurately identifying the location of the PEA in relation to the skull base on a CT scan prior to surgery, particularly in its mesentery state (Figure 7), is very significant because the PEA in the mesentery is vulnerable to injury during endoscopic sinus surgery. Finally, damage to the ethmoidal artery can result in many severe problems, such as hemorrhage, orbital hematoma, and loss of vision.

Posterior Ethmoidal Artery Diameter on CT

We found that the average diameter of the PEA in our study was similar to that in previous studies. There was a significant difference in the average diameter of the PEA

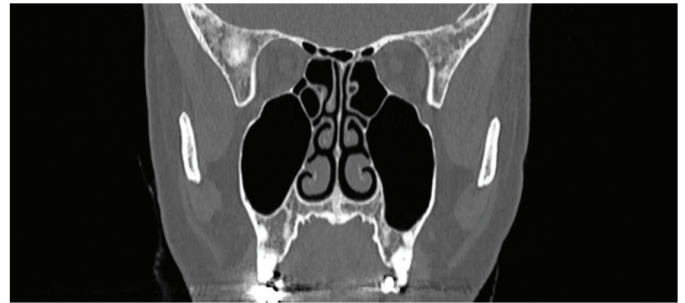


Figure 7. The bilateral posterior ethmoidal arteries are in a hanging form on the CT scan of patient Ho Thi T. Source: Dang Vuong Kiet, 2023.

CT: Computed tomography

Table 3. Identification of the posterior ethmoidal artery on CT scan varied among the research.

Studies	Research's method	Rate of identification	n
Cankal et al. ⁷ (2004)	CT scan	92%	300
Yamamoto et al. ⁵ (2018)	CT scan	100%	200
Kho et al. ⁹ (2019)	CT scan	86%	108
Our study	CT scan	93.5%	200

CT: Computed tomography

Table 4. Thickness of CT scan slides used in the study.

Studies	Thickness of the CT scan slides	Rate of identification
Cankal et al. ⁷ (2004)	3 mm	56%
	2 mm	72%
	1 mm	92%
Kho et al. ⁹ (2019)	0.75 mm	86%
Yamamoto et al. ⁵ (2018)	0.5 mm	100%
Our study	0.625 mm	93.5%

CT: Computed tomography

in our study compared with previous findings¹⁰. The main reason for this difference is probably due to different research methods and study populations.

There are some limitations to this study. We employed a research methodology to analyze the attributes of the PEA using CT imaging. We did not analyze the attributes of the PEA in cadavers. The study sample size was relatively small. Furthermore, the thickness of the CT scan slice is not optimal (CT scan slice thickness in recent studies was 0.5 mm) to examine the PEA (which is a relatively small anatomical structure) in the most comprehensive way. The sample in our study is not comprehensive enough and is limited to the research group of patients who came for medical examination and had a CT scan of their nose and sinuses at Ho Chi Minh City Ear, Nose and Throat Hospital.

CONCLUSION

We observed that the average distance between the PEA and the anterior ethmoidal on CT scan is 13.98 ± 1.95 mm. The average distance between the PEA and the skull base on CT scan is 0.95 ± 0.94 mm. The average diameter of the PEA on CT scan is 0.76 ± 0.09 mm.

The characteristics of the PEA should be considered when examining CT scans. This study provides useful information on the characteristics of the PEA on CT scan, which can be applied in endoscopic sinus surgery and skull base surgery.

Ethics

Ethics Committee Approval: This study was approved by the Department of Otorhinolaryngology of Pham Ngoc Thach University of Medicine and the Medical Ethics Council of Pham Ngoc Thach University of Medicine and Ho Chi Minh City Ear, Nose and Throat Hospital (29/GCN-BVTMH, no. 226/QĐ-TĐHYPNT, date: 19.01.2023).

Informed Consent: This study obtained fully informed consent from all patients.

Author Contributions

Surgical and Medical Practices: T.C.T.P., K.V.D., Concept: T.C.T.P., K.V.D., Design: T.C.T.P., K.V.D., Data

Collection and/or Processing: T.C.T.P., K.V.D., Analysis and/or Interpretation: T.C.T.P., K.V.D., Literature Search: T.C.T.P., K.V.D., Writing: T.C.T.P., K.V.D.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Araujo Filho BC, Weber R, Pinheiro Neto CD, Lessa MM, Voegels RL, Butugan O. Endoscopic anatomy of the anterior ethmoidal artery: a cadaveric dissection study. *Braz J Otorhinolaryngol.* 2006;72:303-8.
2. Lee WC, Ming Ku PK, van Hasselt CA. New guidelines for endoscopic localization of the anterior ethmoidal artery: a cadaveric study. *Laryngoscope.* 2000;110:1173-8.
3. Joshi AA, Shah KD, Bradoo RA. Radiological correlation between the anterior ethmoidal artery and the supraorbital ethmoid cell. *Indian J Otolaryngol Head Neck Surg.* 2010;62:299-303.
4. Sah BP, Chettri ST, Gupta M, Shah SP, Poudel D, Manandhar S. Radiological correlation between the anterior ethmoidal artery and the supraorbital ethmoid cell in relation to skull base. *A Ad Med Sc.* 2018;2:11-5.
5. Yamamoto H, Nomura K, Hidaka H, Katori Y, Yoshida N. Anatomy of the posterior and middle ethmoidal arteries via computed tomography. *SAGE Open Med.* 2018;6:2050312118772473.
6. Manjila S, Cox EM, Smith GA, et al. Extracranial ligation of ethmoidal arteries before resection of giant olfactory groove or planum sphenoidale meningiomas: 3 illustrative cases with a review of the literature on surgical techniques. *Neurosurg Focus.* 2013;35:E13.
7. Cankal F, Apaydin N, Acar HI, et al. Evaluation of the anterior and posterior ethmoidal canal by computed tomography. *Clin Radiol.* 2004;59:1034-40.
8. Vatanasapt P, Thanaviratnanich S, Chaisiwamongkol K. Landmark of ethmoid arteries in adult Thai cadavers: application for sinus surgery. *J Med Assoc Thai.* 2012;95 Suppl 11:S153-6.
9. Kho JPY, Tang IP, Tan KS, Koa AJ, Prepageran N, Rajagopalan R. Radiological Study of the Ethmoidal Arteries in the Nasal Cavity and Its Pertinence to the Endoscopic Surgeon. *Indian J Otolaryngol Head Neck Surg.* 2019;71:1994-9.
10. Erdogmus S, Govsa F. The anatomic landmarks of ethmoidal arteries for the surgical approaches. *J Craniofac Surg.* 2006;17:280-5.