

## Chapter

# Posterior Ethmoidal Artery: Surgical Anatomy and Variations

*Smail Kharoubi*

## Abstract

The posterior ethmoidal artery is a collateral of the ophthalmic artery and participates in the vascularization of the nasal cavities. It is an important landmark in endonasal surgery with complex orbital contents relationships. We recognize many anatomical and functional varieties. This chapter proposes to present a classic descriptive anatomical study but also a modern radiological and endoscopic study of the posterior ethmoidal artery. It also proposes to present a description of some pathologies associated with this artery, particularly posterior epistaxis and other vascular disorders. The surgical procedure to access to posterior ethmoidal artery, external or endoscopic approach of the posterior ethmoidal artery will be described.

**Keywords:** posterior ethmoidal artery, epistaxis, ligation posterior ethmoidal artery, skull base surgery, complication endonasal surgery

## 1. Introduction

Posterior ethmoidal artery is a branch of the ophthalmic artery and participates in the vascularization of the upper part of the nasal cavities, dura mater, ethmoid and sphenoidal sinuses. It often leads into a bony canal and is 14 mm from the anterior ethmoidal artery and 7 mm from the optic foramen.

The posterior ethmoidal artery is involved in several nasosinus and base of skull pathology or abnormalities. It may be responsible for persistent epistaxis requiring specific treatment or producing aneurysm lesion with its compressive and hemorrhagic complications.

Imaging (CT-scan of the facial mass, arteriography) facilitate its study as well as its bone canal and its orbital sphenoidal reports.

Ligation of the posterior ethmoidal artery allows effective hemostasis during intractable epistaxis or as a preventive procedure in surgery of skull base meningiomas.

## 2. Embryology

The arterial blood supply to the orbit depends on that of the cerebral arteries. Since the work of Padgett [1], we admit that the six aortic arches, connecting the ventral and dorsal ipsilateral aortas, appear very early.

The internal carotid arises from the 3rd arch and gives rise to the two primary ophthalmic arteries, ventral and dorsal.

Ophthalmic artery will give anterior ethmoidal artery, posterior ethmoidal artery and sometimes middle ethmoidal artery.

### 3. Anatomy

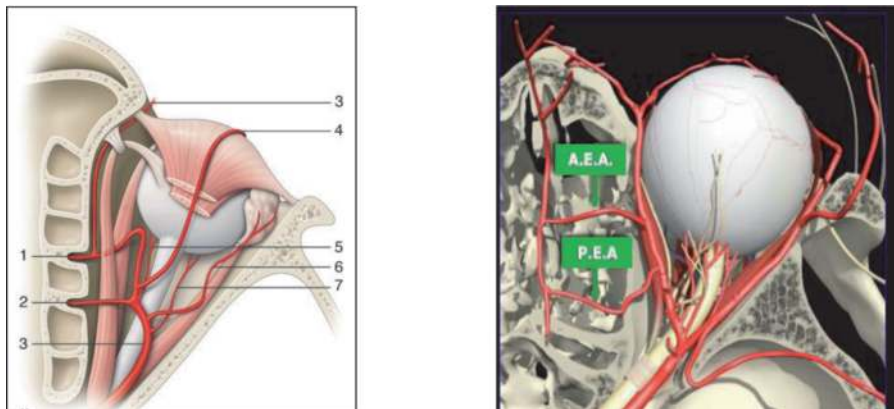
#### 3.1 Origin

The posterior ethmoidal artery is a small collateral branch of the ophthalmic artery that leaves the orbit (posterior third of the orbit) through the posterior orbital canal and is found at the junction of the roof of the sphenoid and posterior ethmoid sinuses (**Figures 1 and 2**).

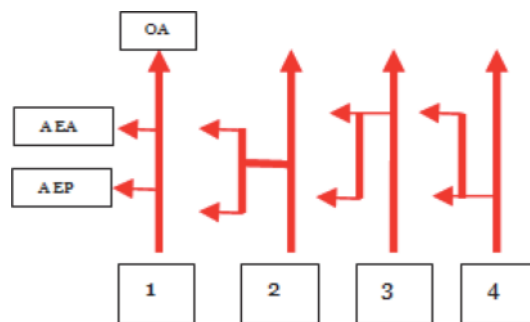
Anatomical variations at the origin occur more frequently in the posterior ethmoidal artery (86%). Many anatomical variations frequently occur at the origin of the PEA. The posterior ethmoidal artery can also originate from the third part of the ophthalmic artery (5%), or from the second part of the ophthalmic artery (5%). It may have its origin in the AEA and also in the middle meningeal.

#### 3.2 Course

From the posterior orbital canal the artery goes up and back.



**Figure 1.** Intra orbital ophthalmic artery: 1. anterior ethmoidal artery (AEA); 2. posterior ethmoidal artery (PEA) 3. ophthalmic artery; 4. supra orbital artery; 5. medial long ciliary artery; 6.lacrimal artery; 7. lateral long ciliary artery. (Iconography - Ducasse. A Ref. [2]).



**Figure 2.** Anatomic variability of origin of ethmoidal arteries. OA: ophthalmic artery AEA: anterior ethmoidal artery AEP: posterior ethmoidal artery. 1: independent origin of ethmoidal arteries. 2: common origin (single trunk) of anterior and posterior artery. 3: posterior ethmoidal artery origin from anterior ethmoidal artery. 4: anterior ethmoidal artery origin from posterior ethmoidal artery.

It runs between the rectus superior and the superior oblique muscle and then emerges from the myofascial cone of the orbit to finally pass perpendicular to the medial wall and enter the posterior ethmoidal canal.

Posterior ethmoidal artery into its canal presents a more horizontal orientation than that of the anterior ethmoidal artery with an entry angle into the skull base of between 0° and 18°.

The posterior ethmoidal artery is smaller than the anterior ethmoidal artery, usually less than 1 mm, which makes its identification difficult in CT studies. Its size is usually inversely proportional to that of the anterior ethmoidal artery.

The intra orbital part has a  $0.66 \pm 0.21$  mm diameter and  $0.63 \pm 0.19$  on the left.

The intracranial part has a  $0.45 \pm 0.12$  mm (range, 0.32 to 0.57 mm) diameter. Tomkinson et al. they could identify the PEA in only 14/40 nasal fossae [3].

Posterior ethmoidal artery runs very close to the optic nerve: the distance between the two structures is variable and can range from 4 to 16 mm (Table 1) (Figure 3).

### 3.3 Termination

It ends in the posterior part of the lateral wall of the nasal cavity.

In medial wall of nasal cavity (septum) posterior ethmoidal artery contribute to kisselbach area with superior labial, anterior ethmoidal and naso palatine artery (Figure 4).

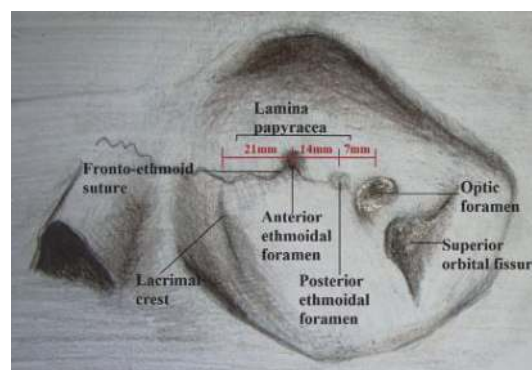
### 3.4 Branche

- anterior tract olfactif artery.
- accessory posterior olfactory artery (Figure 5).

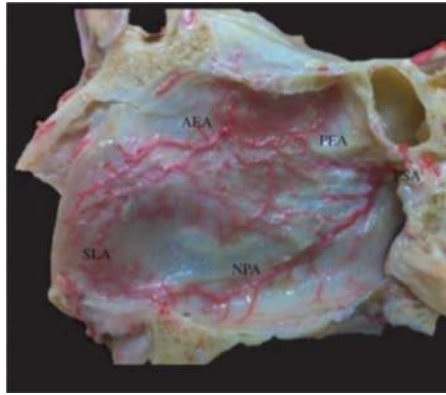
Author	Distance	Measurement
Cankal et al., 2004 [4]	From nasion to PEF	46.3 mm (range 38–55 mm)
	From optic foramen to PEF	6.7 mm (range 4–16 mm)
Caliot et al., 1995 [5]	From AEF to PEF	10–15 mm
	From optic foramen to PEF	5 mm

PEA: posterior ethmoidal artery. PEF: posterior ethmoidal foramen. AEF: anterior ethmoidal foramen.

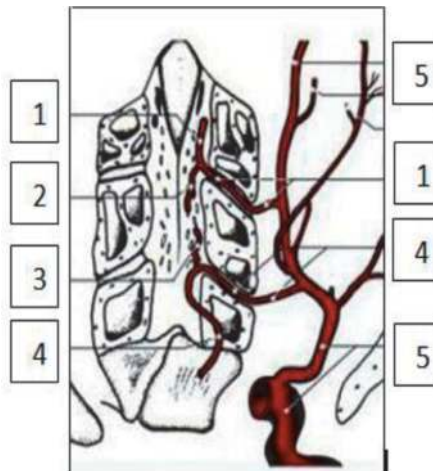
**Table 1.**  
 Anatomical landmarks in the literature for identifying the PEA.



**Figure 3.**  
 The medial wall of the orbit. The fronto ethmoidal suture guides the sub periorbital dissection to the anterior and posterior ethmoidal foramen. The main bony landmarks are highlighted. (Iconography - Cecchini. G Ref. [6]).



**Figure 4.**  
Nasal septum vascularisation. NPA nasopalatine artery, SLA superior labial artery, AEA anterior ethmoidal artery, PEA posterior ethmoidal artery, PSA posterior septal artery. (Iconography-Gras-Cabrerizo. JR Ref. [7]).



**Figure 5.**  
Branch of posterior ethmoidal artery. 1: anterior ethmoidal artery. 2: anterior tract olfactif artery. 3: accessory olfactif artery. 4: posterior ethmoidal artery. 5: orbital artery. (Iconography - Ducasse. A Ref. [2]).

### 3.5 Anastomoses

We can find some anastomoses of posterior ethmoidal artery with septal artery, lateral nasal artery and anterior ethmoidal artery (**Table 2**).

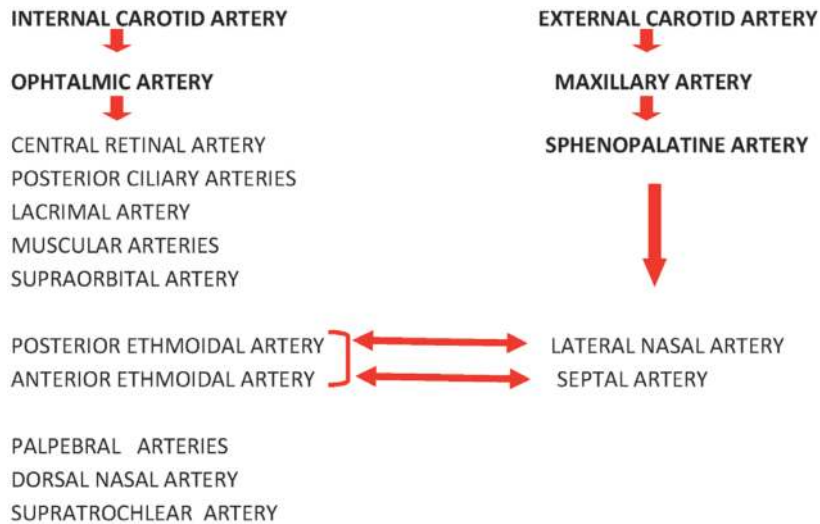
### 3.6 Supply

It irrigates the sphenoid sinus and the dura mater which covers the riddled blade of the ethmoid.

The posterior ethmoidal arteries run anteriorly and inferiorly divided through the crista galli suture to supply the anterior ethmoidal territory.

There is often a meningeal branch to the dura mater while it is still contained within the cranium. This artery supplies:

- the posterior ethmoidal.
- dura mater of the anterior canal fossa.



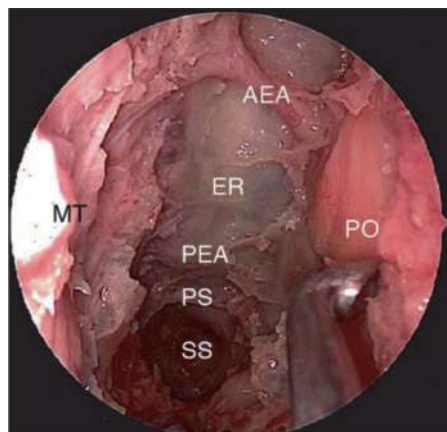
**Table 2.**  
 Diagramm anastomoses posterior ethmoidal artery.

- the upper part of the nasal mucosa of the nasal septum and it anastomoses with the sphenopalatine artery.

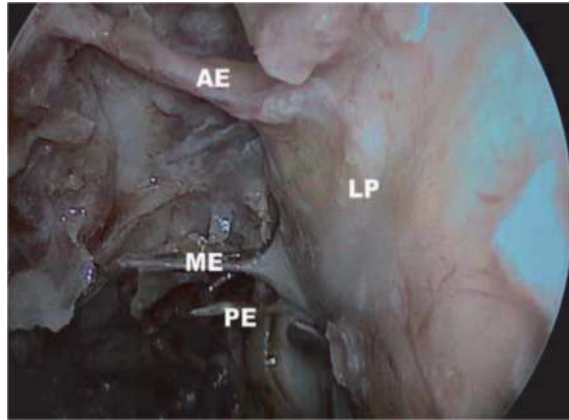
#### 4. Endoscopic anatomy

The identification of the posterior ethmoidal artery during endonasal surgery is an important step and allows an adapted hemostasis. The first step being a regulated ethmoidectomy which begins with the identification of the anterior ethmoidal artery (sometimes in a bony canal) then the posterior ethmoidal artery further back.

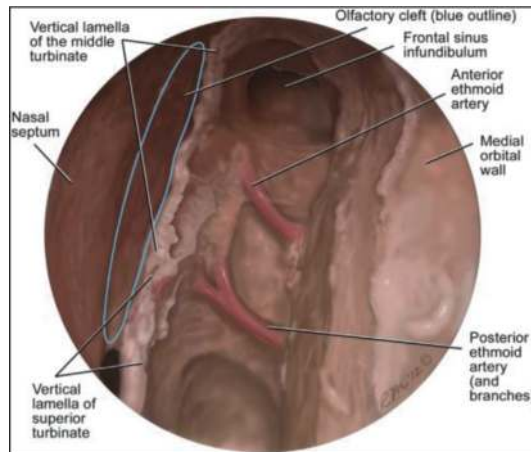
The posterior ethmoidal artery is the landmark access to the sphenoidal sinus (Figures 6–8).



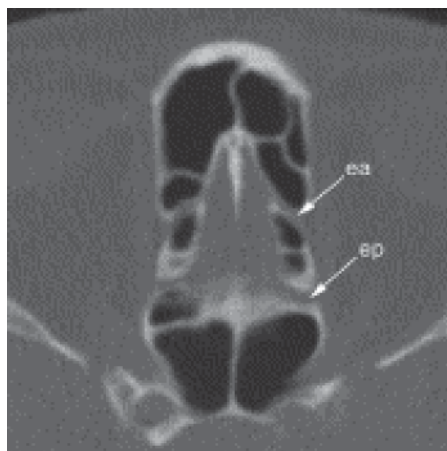
**Figure 6.**  
 Endoscopic view of the left anterior skull base. (AEA anterior ethmoidal artery, ER ethmoid roof, PEA posterior ethmoidal artery, PS, planum sphenoidale, SS sphenoid sinus, PO periorbita, MT middle turbinate).  
 (Iconography - McClurg. SW Ref. [8]).



**Figure 7.** Endoscopic view of the left nasal cavity. (AE anterior ethmoidal artery, ME middle ethmoidal artery, PE posterior ethmoidal artery, LP lamina papyracea bone PS, planum sphenoidale, SS sphenoid sinus, PO periorbita, MT middle turbinate). (Iconography - Kürşat Gökcan. M Ref. [9]).



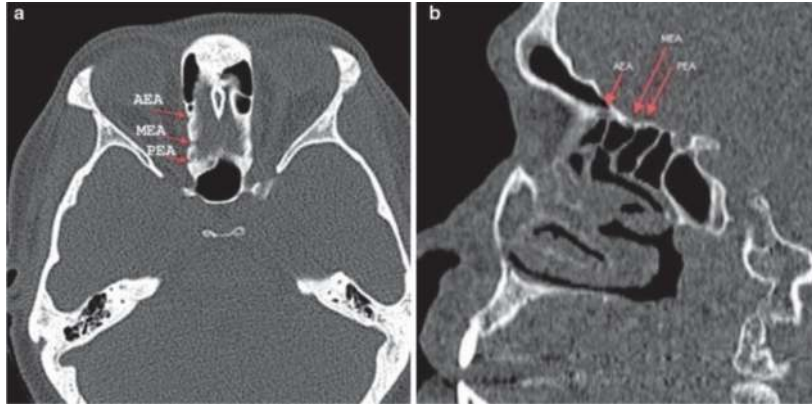
**Figure 8.** The bony canal of anterior and posterior ethmoidal artery is seen through the ethmoid roof traveling from the orbit to the cribriform plate. (Iconography - Casiano Roy. R Ref. [10]).



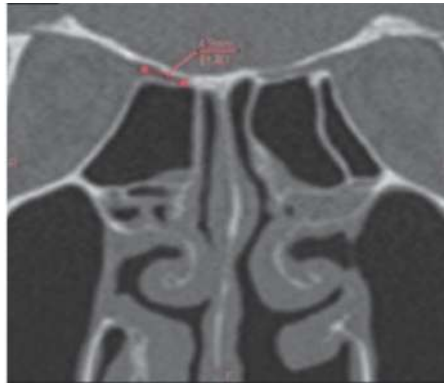
**Figure 9.** Computed tomography axial view anterior and posterior ethmoidal arteries in canals ea: anterior ethmoidal artery, ep: posterior ethmoidal artery.

## 5. Radiology

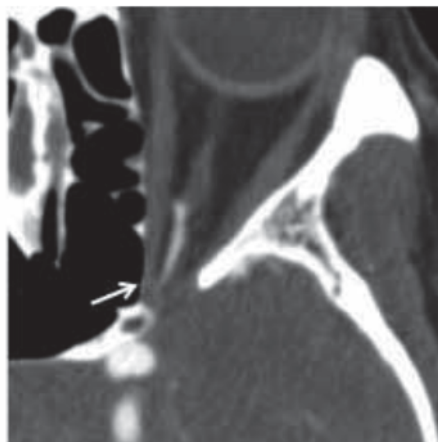
The ethmoidal arteries more easily identifiable on the axial view. CT-scan (with contrast) is a best exam from identifying ethmoidal arteries (anterior, middle and posterior arteries).



**Figure 10.** CT scan axial (a) and sagittal (b) view: ethmoidal arteries (anterior, medial and posterior ethmoidal arteries). (Iconography - Kho. JPY Ref. [11]).



**Figure 11.** Length of the PEA (4,9mm) exposed in the ethmoid cells on coronal CT scan. (Iconography - Yamamoto. H Ref. [12]).



**Figure 12.** Axial view of computed tomography scan with contrast enhancement revealed the PEA passing through the medial wall of the orbit and into the posterior ethmoidal sinus. (Iconography - Casiano Roy. R Ref. [10]).



**Figure 13.**  
*Arteriography: Ethmoidal vascularization by branches from the left ophthalmic artery. Black arrow: ophthalmic artery. White arrow: anterior ethmoidal artery. Black arrowhead: posterior ethmoidal artery. (Iconography - Giuseppe Greco. M Ref. [13]).*

The posterior ethmoidal artery usually crosses within the ethmoidal roof, in front of the most superior aspect of the anterior wall of the sphenoid sinus. In 25–50%, the corticated sulcus of this artery is identifiable on the coronal CT examination (**Figures 9–13**).

## 6. Pathology

### 6.1 Aneurysm of the posterior ethmoidal artery

#### 6.1.1 Moyamoya

The Moyamoya disease is a cerebrovascular condition that predisposes patients to stroke in association with progressive stenosis of the intracranial internal carotid arteries and their proximal branches. Furthermore in moyamoya patients, intracranial aneurysms are known to occur at the level of the polygon of Willis (often in the vertebra-basilar circulation), more rarely on the basal ganglia arteries or on anterior or posterior choroidal arteries.

One exceptionally case of posterior ethmoidal artery aneurysm by moyamoya was reported (**Figure 14**) [14].

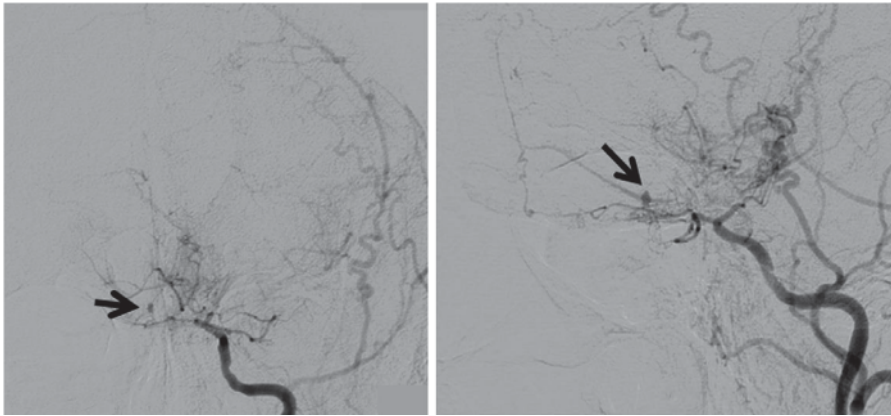
#### 6.1.2 Post traumatic aneurysm

Head trauma or skull base fracture can to induce aneurysmal lesion with some arteries like posterior ethmoidal artery.

### 6.2 Arteriovenous malformation and posterior ethmoidal artery

In some cases arteriovenous malformation can to be fed by a posterior ethmoidal artery. Computer tomography and arteriography facilitated the diagnosis and recognize their support artery [15].





**Figure 14.** Front view and Oblique view. Aneurysm of the right posterior ethmoidal artery fed by the left ophthalmic artery (black arrow). (Iconography - Mélot. A Ref. [14]).

### 6.3 Epistaxis

Clinical specificity: posterior and superior issue bleeding in nasal cavity.

- When bleeding seems to come from the roof of the nasal cavity, it is important to identify the ethmoid arteries always bearing in mind the possible existence of anomalous courses.
- Posterior bleeding (10% of epistaxis) usually originates from the sphenopalatine artery or from its branches or, more rarely, from the anterior or posterior ethmoid arteries, branches of the ophthalmic artery [8, 16].

Failure of ligation of the sphenopalatine artery in profuse and recurrent posterior epistaxis will be indicate ligation of the anterior and posterior ethmoidal arteries.

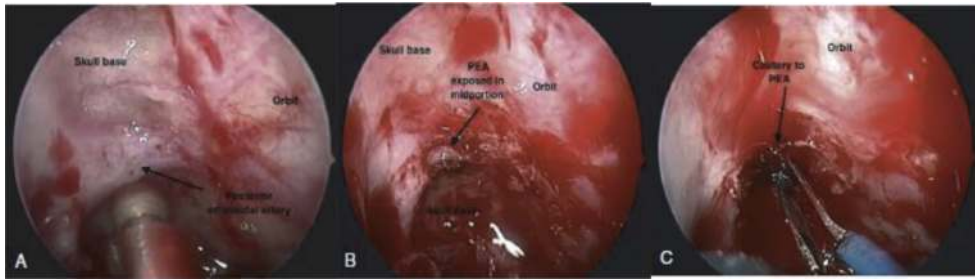
## 7. Surgery of posterior ethmoidal artery

Elective ligation of anterior and posterior ethmoidal arteries is indicates for extended endonasal procedures when control of these vascular structures is an essential component of the procedure, such as in endoscopic craniofacial resections.

Rarely, intractable or traumatic epistaxis requires ligation of these arteries, but this is probably best managed externally with endoscopic assistance.

### 7.1 Extra cranial open bilateral anterior ANS posterior ethmoidal artery ligation

- Lynch incision.
- exposure down to the periosteum of the medial orbital walls.
- the frontoethmoidal suture is followed bluntly for about 22 mm posterior to the lacrimal crest and the posterior ethmoidal artery is encountered about 15 mm posterior to the anterior ethmoidal artery.



**Figure 15.** Posterior ethmoidal artery: endoscopic approach. A: posterior ethmoidal artery in osseous canal. B: posterior ethmoidal artery (PEA) exposed in midportion. C: cauterisation of posterior ethmoidal artery. (Iconography - Naidoo. Y Ref. [17]).

## 7.2 Extra cranial transcaruncular approach

- incision lateral to the caruncle.
- identifying the lacrimal fossa.
- following the avascular facial plans posteromedially to the frontoethmoidal suture.
- the periosteum is incised bilaterally to allow a posterior sub periosteal dissection trajectory to the anterior ethmoidal arteries.

## 7.3 Endoscopic transnasal approach

The endoscopic approach of the ethmoidal arteries requires a good learning of endoscopic ethmoidectomy. The identification of the ethmoidal roof does not present any specificity like with conventional ethmoidectomy.

If you will to recognize the posterior ethmoidal artery, you must expose the posterior spheno ethmoidal region. The 0° optic is generally used: the region of the posterior ethmoidal artery being almost in the axis of the nasal cavity, it is quite easy to use a bipolar endonasal coagulant forceps (Dessi tool) for coagulation if the artery is easy viewable (whithout to embedding in the ethmoidal roof). identification of anterior ethmoidal artery is possible by following the ethmoidal roof to the fronto ethmoidal recess. In the majority of cases (83%), the artery is visible by this way (**Figure 15**) [18].

## 7.4 Endovascular approach

Because of the abundant anastomoses among anterior ethmoidal artery, posterior ethmoidal artery, collateral branches from Middle meningeal artery and Internal carotid artery, endovascular embolization puts the ophthalmic artery and vision at risk, so it is not recommandable to doing or choose embolisation of ethmoidal arteries.

## 8. Conclusion

The posterior ethmoidal artery branch of the ophthalmic artery is an anatomical, endoscopic and radiological entity very important to know in diagnosis, pathology and surgery of nasal and para nasal diseases.

The complete analysis of this anatomical structure will help and facilitate medical and surgical practice.

### **Conflict of interest**

No conflict of interest.

### **Author details**

Smail Kharoubi  
Department of ENT, Chu Annaba, Faculty of Medicine, University of Badji  
Mokhtar, Annaba, Algeria

\*Address all correspondence to: [smail.kharoubi17@gmail.com](mailto:smail.kharoubi17@gmail.com)

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