Transorbital endoscopic identification of supernumerary ethmoid arteries

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ABSTRACT

Background: *Anterior and posterior ethmoid arteries supply the paranasal sinuses, septum, and lateral nasal wall. Precise identification of these arteries is important during anterior skull base procedures, endoscopic sinus surgery, and ligation of ethmoid arteries for epistaxis refractory to standard treatment. There is controversy in the literature regarding the prevalence of supernumerary ethmoid arteries.*

Objective: *This study examined the prevalence of supernumerary ethmoid arteries by using direct visualization after transorbital endoscopic dissection.*

Methods: *Nineteen cadaveric specimens were evaluated by using a superior lid crease (blepharoplasty) incision and an endoscopic approach to the medial orbital wall. Ethmoid arteries were identified as they pierced the lamina papyracea coplanar with the skull base and optic nerve. The distances from the anterior lacrimal crest to the ethmoid arteries and optic nerve were measured with a surgical ruler under endoscopic guidance.*

Results: *Thirty-eight cadaveric orbits were measured. Overall, there were three or more ethmoid arteries (including anterior and posterior arteries) in 58% of orbits, with 8% of the total sample that contained four or more ethmoid arteries. The average number of ethmoid arteries was 2.7. Bilateral supernumerary ethmoid arteries were noted in 42% of the specimens. The distance between the anterior lacrimal crest and the anterior ethmoid, posterior ethmoid, and optic nerve averaged 20, 35, and 41 mm, respectively. The average distance to the supernumerary or middle ethmoid artery was 29 mm.*

Conclusion: *This study found supernumerary ethmoid arteries in 58% of cadaveric specimens, a prevalence much higher than previously reported. Recognition of these additional vessels may improve safety during endoscopic sinus surgery and skull base surgery, and may permit more effective ligation for refractory epistaxis originating from the ethmoid system.*

The anterior and posterior ethmoid arteries supply the paranasal sinuses, septum, and lateral nasal wall. Precise identification of these arteries is important during anterior skull base procedures, medial orbital wall surgery, endoscopic sinus surgery, and the treatment of epistaxis refractory to standard treatment. With respect to refractory epistaxis, ligation of the internal maxillary artery without consideration of the ethmoid system may fail to stop bleeding in 20% of cases.[1] In these cases, ligation of the ethmoid arteries may be required. Previous reports outlined external and endoscopic approaches to ligation of the ethmoid

arteries and the need to address the middle ethmoid or supernumerary ethmoid artery if present.[2,3] Despite realization of supernumerary ethmoid arthery importance, controversy exists in the literature regarding the prevalence of these "supernumerary ethmoid arteries," "accessory ethmoid arteries," or "middle ethmoid arteries."

According to previous studies, the supernumerary ethmoid artery is present in 15–40.9% of the population.[4–9] To evaluate the presence of the supernumerary ethmoid artery, two of these studies examined foramina in dry skulls[4,9] and another used endonasal endoscopic dissection of the anterior skull base in latex injected cadavers.[8] These methods do not directly visualize the ethmoid arteries in the orbits and may underestimate the prevalence of supernumerary ethmoid arteries. Our current study used a transorbital endoscopic approach to visualize the ethmoid arteries and optic nerve within the orbit. The plane of visualization was between the periorbita and lamina papyracea, where the vessels could be readily visualized in a location unobscured by overlying mucosa and bone.

METHODS

Thirty-eight orbits from 19 cadaveric specimens were dissected. There were 7 male and 12 female cadavers,
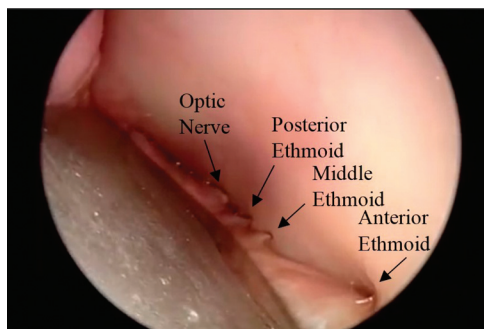
Figure 1. Endoscopic view of the cadaveric right medial orbital wall with a 0° HOPKINS rigid telescope at the level of the skull base, demonstrating three total ethmoid arteries.
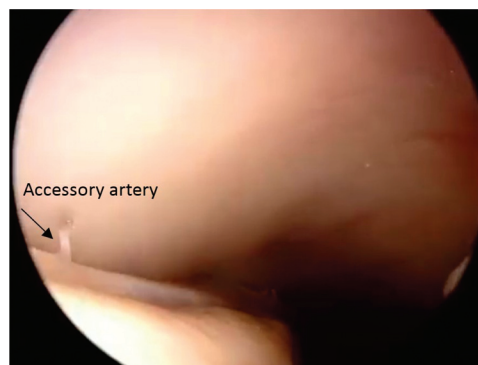

Figure 2. Endoscopic view of the cadaveric left medial orbital wall with a 0° HOPKINS rigid telescope to demonstrate assessory vessels, which are not coplanar. The dissection is between periorbita and orbit at a level superior to the plane of the skull base.

with an average age of 84 years. Seventeen of the cadavers were fresh, and two were embalmed and injected with latex. Before dissection, the specimens were visually inspected to ensure no previous trauma of the face or orbits was present, which could have obscured or distorted native anatomy. A classic blepharoplasty incision in the superior lid crease was used to approach the junction of the orbital roof and the medial orbital wall and identify the ethmoid arteries. This approach was used to provide maximum exposure during the dissection. In a clinical setting, the senior author (K.S.M.) uses a precaruncular rather than blepharoplasty approach to access the medial orbit to visualize and ligate the ethmoid arteries.[7] This work was performed at the WWAMI Institute for Simulation in Healthcare at the University of Washington Medical Center, Seattle, Washington.

Dissection Technique

A temporary tarsorrhaphy suture was placed at the lateral limbus with a 6–0 nylon. A standard blepharoplasty incision was made through the skin and orbicularis oculi muscle. The musculocutaneous flap was elevated superiorly, and dissection continued to the subperiosteal plane at the orbital rim, where the orbit was entered. A subperiosteal plane was developed medially and posteriorly.[10] A 0° HOPKINS rigid telescope was used for visualization and illumination (Karl-Storz Endoscopy, Culver, CA). Dissection continued in the subperiosteal plane to the junction of the skull base and medial orbital wall where the ethmoid vessels are located. Exposure from the anterior lacrimal crest posteriorly to the optic foramen was obtained, noting the location and number of vessels that were encountered (Fig. 1). Latex injected cadavers were used to verify association of artery within periorbita. A standard surgical ruler was used to measure the distance from the anterior lacrimal crest to the anterior and posterior ethmoid arteries, any middle ethmoid arteries, and the optic nerve.

RESULTS

The superior lid crease approach to the medial orbit was completed in all specimens, with identification of at least two ethmoid arteries for each specimen. Several specimens had submillimeter accessory vessels that were not coplanar with the ethmoid arteries and optic nerve (Fig. 2). These accessory vessels were not included in the artery count. Overall, 42% of orbits had only two total ethmoid arteries. More than two ethmoid arteries were noted in 58% of the orbits, and 8% of all specimens contained more than three ethmoid arteries. Eight specimens (42%) had bilateral supernumerary ethmoid arteries. The distance between the anterior lacrimal crest and the anterior ethmoid, posterior ethmoid, and optic nerve averaged 20, 35, and 41 mm, respectively. The average distance to the supernumerary ethmoid artery was 29 mm (Table 1). The average number of ethmoid arteries was 2.7.

DISCUSSION

A thorough understanding of the number and distribution of ethmoid arteries is critical for management of epistaxis refractory to anterior and/or posterior packing because these bleeds may fail ligation of the internal maxillary artery ~20% of the time.[1] Involvement of the ethmoid arterial systems in refractory epistaxis should also be considered after nasal injury, anterior skull base trauma, or recent endoscopic sinus surgery.[11] Previous studies evaluated the presence of supernumerary ethmoid arteries. Wang *et al.*[8] used a transnasal, endoscopic approach in latex-injected cadavers to visualize the ethmoid arteries along the anterior skull base. The investigators noted supernumerary ethmoid arteries in 31.8% of their specimens, with bilateral supernumerary ethmoid arteries in 14%.[8] Additional cadaveric studies published by Abed *et al.*[4] and Takahashi *et al.*[7] used orbital exenteration and noted more than two foramina in 33.3% and 36% of

Table 1 Measured distances from anterior lacrimal crest for medial orbital wall landmarks

	Anterior Ethmoid	Middle Ethmoid	Posterior Ethmoid	Optic Nerve
Distance from anterior lacrimal crest, average ± standard deviation, mm	20 ± 2.8	29 ± 4.2	35 ± 3.2	41 ± 2.8

specimens, respectively, which were presumed to contain supernumerary ethmoid arteries. Further studies evaluated the number of ethmoid arteries by using dry skulls and noted accessory foramina in 15–40.9% of specimens.[5,6] Of these studies, only two noted the presence of four or more ethmoid arties.[4,7]

Our current study demonstrated the highest prevalence of middle ethmoid arteries to date. Visualization the neurovascular bundle within the periorbita as it traverses the medial orbital wall improves the identification of small-caliber vessels. By retracting the periorbita away from the skull base and lamina, the vessels are distended and become immediately visible against the adjacent structures. In addition, latex injection confirmed the presence of an artery within the neurovascular bundle. Despite the improved visualization obtained by using transorbital dissection, our study may continue to underestimate the incidence of supernumerary ethmoid arteries, given the exclusion of vessels, which were submillimeter and not coplanar with the optic nerve and identified ethmoid arteries. Only two of our cadaveric specimens were latex injected to confirm the presence of arteries, therefore, we could have overestimated the presence of supernumerary ethmoid arteries in the nonlatex injected cadaveric heads.

CONCLUSION

This study investigated the prevalence and location of supernumerary ethmoid arteries by using an endoscopic transorbital approach in cadavers. Overall, there were more than two ethmoid arteries (including anterior and posterior arteries) in 58% of specimens and more than three ethmoid arteries in 8% of the total specimens. The average number of ethmoid arteries was 2.7. The locations relative to the anterior lacrimal crest of anterior ethmoid, posterior ethmoid, and optic nerve were 20, 35, and 41 mm, respectively. The average distance to the supernumerary ethmoid artery was 29 mm. The results of this study suggest that a majority of patients have more than two ethmoid arteries. These findings are important for the endoscopic treatment of refractory epistaxis, endoscopic sinus surgery, anterior skull base procedures, as well as other procedures in which localization of these structures is critical.

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