Endoscopic Identification of the Pharyngeal (Palatovaginal) Canal: An Overlooked Area

Islam R. Herzallah¹ Sameh Amin² Mona A. El-Hariri³ Roy R. Casiano⁴

¹Department of Otolaryngology, Faculty of Medicine, Zagazig University, Zagazig, Egypt

²Department of Otolaryngology-ENT, Faculty of Medicine, El Fayoum University, Cairo, Egypt

³Lecturer of Radiodiagnosis, Faculty of Medicine, Zagazig University, Zagazig, Egypt

⁴Rhinology and Endoscopic Fellowship Program, Department of Otolaryngology, University of Miami, Miller School of Medicine, Miami, Florida, United States

Address for correspondence and reprint requests Islam R. Herzallah, M.D., Department of Otolaryngology, Faculty of Medicine, Zagazig University, Zagazig, Egypt 44519 (e-mail: iherzallah@gmail.com).

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Abstract

Keywords

- pharyngeal canal
- palatovaginal canal
- pharyngeal artery
- pterygopalatine fossa
- sphenopalatine foramen
- vidian canal
- epistaxis
- endoscopic sinus surgery

Objective The pharyngeal or palatovaginal canal (PC) is a small tunnel that lies between the sphenoid process of the palatine bone and the vaginal process of the sphenoid bone. Currently, little endoscopic information is available about this region.

Design and Setting Endoscopic endonasal cadaveric study.

Subjects and Methods Twenty sides in 10 adult cadaver heads were studied endoscopically. The sphenopalatine foramen (SPF) and the adjacent pterygopalatine fossa were exposed. Dissection medial to the vidian canal demonstrated a tunnel that runs posteromedially in the sphenoid floor. Endoscopic data were documented. Additionally, canal measurements were obtained on 20 sides from coronal CT scans of paranasal sinuses.

Results The PC was identifiable in 85% of the sides, although thickness of its bony wall was variable. The endoscopic relationship of the canal and its artery with other landmarks is described. Radiologically, the diameter of the PC averaged 1.7 mm, and the mean distance from the PC to the vidian canal was 3.78 mm.

Conclusion The current study provides a novel endoscopic identification of an overlooked canal. The pharyngeal artery can be a source of bleeding during extended endoscopic procedures. The PC itself could be a place for finger-like projections of anatomically related neoplasms.

Introduction

With the current advance in endoscopic sinus and skull base surgery, several studies are being performed to elucidate various anatomical details from the unique endoscopic perspective. Studies of the sphenopalatine artery (SPA) and its various branching patterns have been described.^{1–4} Understanding this complex anatomical area has improved our ability to control epistaxis through endoscopic means.^{5–8}

Furthermore, injections of the pterygopalatine fossa with adrenalin has been shown to provide improved hemostasis during endoscopic sinus surgery.⁹

The pharyngeal artery (PA), also termed the *pterygovaginal* or *palatovaginal artery*, is a variably sized branch that has been described in the standard anatomical literature. This artery arises from the distal portion of the internal maxillary artery within the pterygopalatine fossa and runs through a bony canal

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that carries the same name.¹⁰ As one of the numerous communications of the pterygopalatine fossa, the pharyngeal canal (PC) extends from the posterior wall of the fossa, running backward as a bony tunnel in the roof of the nasopharynx. This tunnel is said to be formed by the application of the sphenoid process of the palatine bone to the vaginal process of sphenoid bone. The PC also transmits a pharyngeal nerve arising from the pterygopalatine ganglion to supply the mucosa of nasopharynx behind the auditory tube.^{10,11}

Despite the existence of various endoscopic anatomical studies describing both the pterygopalatine fossa and the SPA,^{12–14} this bony tunnel has remained overlooked endoscopically. On the other hand, the PC and its artery have been well demonstrated in a recent computed tomography/magnetic resonance imaging (CT/MRI) study of this region.¹⁵ Additionally, angiographic identification of the PA as the source of posttraumatic posterior epistaxis has been reported.¹⁶ In fact, the PA can be of considerable size, equal to that of the SPA.¹⁷

In the current work, we present a study of the PC and the related anatomy in a series of endoscopic endonasal cadaveric dissections. Furthermore, we discuss the potential importance of this anatomical region from the surgical endoscopic point of view.

Materials and Methods

Twenty sides in 10 adult cadaver heads were dissected endoscopically in a position simulating that in the operating room to achieve as much real surgical information as possible. The sphenopalatine foramina and the related upper portions of the pterygopalatine fossae were explored using 0-degree and 30-degree nasal endoscopes (Karl Storz and Co., Tuttlingen, Germany). The endoscope was connected to a light source through a fiber optic cable and to a video camera coupled to a 21-inch monitor. High-quality digital pictures were produced utilizing a video camera connected to a Digital Recording System (JVC DV-Cam, Victor Company of Japan, Limited, Yokohama, Japan). Digital pictures were reproduced by coupling the DV-Cam to a computer video capture system.

Institutional Review Board approval was not necessary, as the study involved de-identified cadaveric specimens and thus is not considered human subject research.

The approach was started by performing a vertical incision in the posterior part of the middle meatus just behind the posterior fontanelle (►Fig. 1a). A mucosal flap was elevated to expose the thick orbital process of the vertical plate of the palatine bone and its ethmoid crest (►Fig. 1b). The basal lamella of the middle turbinate was carefully identified and detached from the ethmoid crest. Posterosuperior to the basal lamella, the sphenopalatine foramen (SPF) and the SPA branches were then identified in the most posterior portion of the superior meatus (►Fig. 1b, c).

The SPF was then opened by removing or drilling the thick orbital process that forms the anterior boundary of the foramen (►Fig. 2). From here, further dissection aimed at identifying the PC based on its standard anatomical description. As part of the endoscopic exposure required for additional cadaveric studies, partial middle turbinectomy, wide middle meatal antrostomy, anterior and posterior ethmoidectomies, as well as wide sphenoidotomy were also performed.

Additionally, CT imaging was performed using a helical scanner (HiSpeed, GE Medical Systems, Little Chalfont, Buckinghamshire, United Kingdom) on 10 adult patients (20 sides) who underwent CT scanning for other reasons at Zagazig University, Faculty of Medicine, Radio Diagnosis Department. CT scanning included unenhanced imaging of the paranasal sinuses in the coronal plane with acquisition of contiguous sections of 2-mm thickness starting from the posterior wall of the maxillary sinus to the cavernous sinus. For detection of the PC, the pterygopalatine fossa was identified first, then its course was followed posteriorly to identify both the vidian and the more medial pharyngeal canals. The diameter of the PC, as well as its distance from the vidian canal (measured from the center to the center), were obtained.

Results

Using the aforementioned approach, the SPA was exposed and retracted laterally. The periosteum at the posteromedial

Figure 1 Endoscopic exposure of the sphenopalatine foramen and the sphenopalatine artery (SPA) (left side): (a) An incision is performed just behind the posterior fontanelle (PF), in front of the tail of the middle turbinate (MT). NS, nasal septum; PC, posterior choana. (b) Exposure of the vertical plate of the palatine bone (VPP) and its orbital process (OP) that forms the anterior boundary of the sphenopalatine foramen. The basal lamella (BL) is detached from the ethmoid crest (EC), which is used as a landmark to identify the SPA; the latter being posterolateral to the crest. (c) Endoscopic exposure of the septal (s) and the posterolateral nasal (n) branches of the SPA.

Figure 2 Endoscopic exposure of the pharyngeal canal (PC) (left side): The orbital process of the palatine bone and the adjoining part of the posterior maxillary wall have been removed. The sphenopalatine foramen is thus opened and the sphenopalatine artery (SPA) is retracted laterally. C, clivus; FLS, floor of the sphenoid sinus; pcICA, paraclival ICA; SF, sellar floor. (a) The thin sphenoid process (SP) of the vertical plate of the palatine bone (VPP) is easily fractured using a Cottle elevator. This process forms the inferomedial wall of the PC that transmits the pharyngeal artery and nerve. (b) The thick SP is drilled to expose the pharyngeal artery (as shown in ►Fig. 3a).

angle of the pterygopalatine fossa was elevated and the anterior opening of the PC was identified at the most medial end of the pterygoid base. By elevating the nasopharyngeal mucosa, the sphenoid process of the palatine bone, which forms the inferomedial wall of the PC, was also identified. In fact, the thickness of this process was found to vary considerably. In 13 sides (65%), the inferomedial bony wall was thin and easily fractured with the Cottle elevator. Comparatively, this wall was thick and required drilling to expose the contents of the canal in four sides (20%). By either way, the PC was opened to identify the PA and nerve enclosed within a common periosteal sheath continuous with that of the pterygopalatine fossa. In two sides (10%), the inferomedial wall was hard to identify and the canal was in the form of a groove on the inferior surface of the sphenoid floor. Lastly, in one side (5%), no canal was identifiable in the described anatomical location.

Immediately lateral to the PC, the vidian canal was also exposed and identified (►Fig. 3). From here, the periosteum was further dissected off the anterior surface of the pterygoid base in a superolateral direction to expose the foramen rotundum (►Fig. 4a). In addition, the superior portion of the posterior maxillary wall was removed and the periosteum of the pterygopalatine fossa was opened to provide a more panoramic view as shown in ►Fig. 4.

Thus, three foramina were identified in the upper portion of the pterygoid base that forms the posterior wall of the pterygopalatine fossa. From medial to lateral, these are the PC, the vidian canal just lateral to this tunnel, and the foramen rotundum more superiorly and laterally. The PC coursed posteromedially in the roof of the nasopharynx. The PA was found to arise from the proximal portion of the SPA (or the distal portion of internal maxillary artery) within the pterygopalatine fossa. The PA joined the nerve fibers from the pterygopalatine ganglion into the PC (►Fig. 4).

From its anterior end at the pterygopalatine fossa, the closely related vidian canal coursed posteriorly lateral to PC and pointed to the anterolateral aspect supralacerum (second) genu of the internal carotid artery. Finally, the foramen rotundum transmitted the maxillary nerve from the cavernous sinus into the upper portions of the pterygopalatine and infratemporal fossae before continuing as the infraorbital nerve (►Fig. 4).

Radiologically (►Fig. 5), PC was identified on 16 out of 20 sides (80%). The diameter of the PC ranged from 1.4 to 2.2 mm, with an average of 1.7 mm. The mean distance from the PC to the vidian canal was 3.78 mm, with a range of 2.9 to 4.8 mm. (►Table 1.)

Discussion

The PC has a relatively standard anatomical description that has remained, however, overlooked even in the most detailed endoscopic studies of this area.^{12–14} In fact, during our own extended endoscopic procedures that involve drilling of the sphenoid floor, bleeding from the PA in this bony tunnel has been identified and was often confused with the septal branch of the SPA that actually courses submucosally anterior to this vessel.

In their endoscopic study of the pterygopalatine fossa, Cavallo and his colleagues¹⁴ did not refer to this anatomical structure. In a similar study, Alfieri et al¹² labeled one of the branches of the terminal internal maxillary artery as the pharyngeal (palatovaginal) artery. The image was, however, hard to interpret as the PC itself was not exposed. The labeled branch was shown to disappear behind the tail of the middle turbinate and could have been actually one of the terminal branches of a short SPA. In fact, the SPA is known to divide into its terminal septal and lateral nasal branches within the pterygopalatine fossa, lateral to the SPF, in the majority of cases.^{2,3}

Figure 3 Endoscopic exposure of the pharyngeal artery (PA) (left side): C, clivus; pcICA, paraclival ICA; PPF, pterygopalatine fossa; SF, sellar floor. (a) The thick sphenoid process of the vertical plate of the palatine bone (VPP) has been drilled to expose the pharyngeal artery (PA) running posterosuperiorly in the floor of the sphenoid sinus. (b) The PA is divided and the contents of the PPF are retracted (r) laterally to expose the vidian canal (VC) just medial to the pharyngeal canal. (c) The pharyngeal groove (PG) is shown after removal of the contents of the pharyngeal canal. The groove lies in the vaginal process of the sphenoid floor. BPP, base of pterygoid process.

Similarly, the PC had no mention in a recent well-demonstrated report on the osseous anatomy of the pterygopalatine fossa correlated to the CT images of this complex region.¹⁸ A few years later, the PC and its artery were studied radiologically,¹⁵ even before endoscopic identification. In their focused study, Rumboldt et al¹⁵ found that the easiest way to detect the pharyngeal canal on coronal CT images was to identify the pterygopalatine fossa and then follow its course posteriorly. In this direction, according to the authors' description, the shape of the pterygopalatine fossa changes from triangular to ovoid and oblique; its superior and lateral aspect continues posteriorly as the vidian canal, and the medial portion becomes the PC. Nevertheless, it should be remembered

that such anatomical details are more difficult to identify radiologically than with the close, magnified, multi-angled view of the endoscope.

In their case report, Borden et al¹⁶ angiographically identified the PA as the source of posttraumatic posterior epistaxis. Indeed, the PA is known to vary considerably in size,¹⁷ and a large pharyngeal canal on CT may indicate a prominent artery that can be a source of posterior epistaxis.¹⁵ It was not until recently that the PC was studied endoscopically, demonstrating that the vaginal process of the sphenoid bone does not contribute to the formation of the canal.¹⁹

In the current study, besides the endoscopic identification of this region, we have shown that the inferomedial wall of

Figure 4 Endoscopic exposure of the posterior wall of the pterygopalatine fossa and related regions: (a) Three openings are identified in the posterior wall of the pterygopalatine fossa. Form medial to lateral, these are (1) the pharyngeal canal (PC) running from the posteromedial angle of the pterygopalatine fossa into the floor of the sphenoid sinus, (2) the vidian canal (VC) running posteriorly in the lateral part of the sphenoid floor and pointing at the anterolateral aspect (FR) of the supralacerum (second) genu of the ICA, and (3) the foramen rotundum more superiorly and laterally transmitting the maxillary nerve (V2) from its cavernous portion in the lateral wall of the sphenoid sinus (V2s) to its pterygopalatine portion (V2p). The posteromedial end of the superior orbital fissure (SOF) lies above the FR. ICA, internal carotid artery; OT, optic tract; PPG, pterygopalatine ganglion; pwMS, posterior wall of the maxillary sinus; SP, sphenoid process of the palatine bone; SPA: sphenopalatine artery. (b) The SPA and the PPG have been retracted (r) inferolaterally to additionally expose the base of the pterygoid process (BPP) that forms the posterior wall of the pterygopalatine fossa. IMA, internal maxillary artery in the infratemporal fossa.

Figure 5 Coronal computed tomography (CT) scan at the level of the posterior wall of pterygopalatine fossa (PPF): three openings are identified in the posterior wall of the PPT. From medial to lateral, these are (1) the pharyngeal canal (PC) running into the floor of the sphenoid sinus, (2) the vidian canal (VC) running posteriorly in the lateral part of the sphenoid floor, and (3) the foramen rotundum (FR) more superiorly and laterally.

the PC varied from a thick one, to a thin, easily fractured, bony shell. In the latter case, fracture of the medial bony wall following traumatic accidents could account for the posterior epistaxis. Furthermore, in our own extended endoscopic procedures that involve drilling of the sphenoid floor, we identified the PA as a source of intraoperative bleeding. Although this source, like the SPA itself, is easily controllable in the intraoperative scenario, this should not substitute for good anatomical knowledge of this region.

As shown in the current report, the PC is also closely related to, and should not be confused with, the vidian canal—the latter being a good landmark to the supralacerum genu of the ICA. Finally, the PC, like the vidian canal and the foramen rotundum, could be a potential place for the finger-like projections of juvenile nasopharyngeal angiofibromas²⁰ or other lesions in this anatomical area. Thus, appropriate orientation to this region could be of potential importance when considering better endoscopic control of such lesions.

The mean distance from the PC to the vidian canal in this study was 3.78 mm. Since CT slices were relatively thick (2 mm), cuts may have passed the proximal portion of the canal and thus measured the distance between the middle portions of the PC and vidian canal. This could explain why our average was between the proximal and distal distances reported recently (1.95 and 4.14 mm, respectively).¹⁹

Table 1 Diameter of the PC and the Distance Between PC and Vidian Canal as Measured on Coronal CT

Side #	Diameter of PC	Distance Between PC and Vidian Canals (From Center to Center)
1	2.0 mm	4.8 mm
2	1.8 mm	4.0 mm
3	1.6 mm	3.4 mm
4	1.7 mm	3.8 mm
5	1.5 mm	3.4 mm
6	1.4 mm	3.3 mm
7	N/A	N/A
8	N/A	N/A
9	2.2 mm	4.1 mm
10	1.9 mm	3.7 mm
11	N/A	N/A
12	N/A	N/A
13	1.6 cm	3.8 mm
14	1.5 mm	3.8 mm
15	1.6 mm	4.0 mm
16	1.7 mm	2.9 mm
17	1.4 mm	3.9 mm
18	1.9 mm	4.2 mm
19	1.7 mm	4.0 mm
20	1.8 mm	3.5 mm
Mean	1.706 mm	3.78 mm

CT, computed tomography; PC, pharyngeal canal.

In general, the vascular compartment is known to lie anterior to the nervous structures in the pterygopalatine fossa. Therefore, access to the vidian canal is limited without first transecting the PA. Although we have studied the endoscopic anatomy of the PC and PA in detail, we did not report different relationships that PA might take with the pterygopalatine ganglion.

Conclusion

The current study updates our knowledge of the endoscopic endonasal anatomy to include a relatively overlooked area. The endoscopic identification of the pharyngeal canal and artery could be of potential importance in the management of resistant posterior epistaxis, especially in posttraumatic cases, or during extended endoscopic procedures. Furthermore, identification of this bony tunnel might be of value in the precise management of closely related lesions or neoplasms.

References

- 1 Bolger WE, Borgie RC, Melder P. The role of the crista ethmoidalis in endoscopic sphenopalatine artery ligation. *Am J Rhinol* 1999;13:81–86
- 2 Lee HY, Kim HU, Kim SS, et al. Surgical anatomy of the sphenopalatine artery in lateral nasal wall. *Laryngoscope* 2002;112:1813–1818
- 3 Babin E, Moreau S, de Rugy MG, Delmas P, Valdazo A, Bequignon A. Anatomic variations of the arteries of the nasal fossa. *Otolaryngol Head Neck Surg* 2003;128:236–239
- 4 Schwartzbauer HR, Shete M, Tami TA. Endoscopic anatomy of the sphenopalatine and posterior nasal arteries: implications for the endoscopic management of epistaxis. *Am J Rhinol* 2003;17:63–66
- 5 Snyderman CH, Goldman SA, Carrau RL, Ferguson BJ, Grandis JR. Endoscopic sphenopalatine artery ligation is an effective method of treatment for posterior epistaxis. *Am J Rhinol* 1999;13:137–140
- 6 Wormald PJ, Wee DT, van Hasselt CA. Endoscopic ligation of the sphenopalatine artery for refractory posterior epistaxis. *Am J Rhinol* 2000;14:261–264
- 7 O'Flynn PE, Shadaba A. Management of posterior epistaxis by endoscopic clipping of the sphenopalatine artery. *Clin Otolaryngol Allied Sci* 2000;25:374–377
- 8 Voegels RL, Thomé DC, Iturralde PP, Butugan O. Endoscopic ligation of the sphenopalatine artery for severe posterior epistaxis. *Otolaryngol Head Neck Surg* 2001;124:464–467
- 9 Wormald PJ, Athanasiadis T, Rees G, Robinson S. An evaluation of effect of pterygopalatine fossa injection with local anesthetic and adrenalin in the control of nasal bleeding during endoscopic sinus surgery. *Am J Rhinol* 2005;19:288–292
- 10 Williams PL, Warwick R, Dyson M, Bannister LH, Eds. *Gray's Anatomy of the Human Body*. 36th ed. New York: Churchill Livingstone; 1980:300–304
- 11 Wentges RT. Surgical anatomy of the pterygopalatine fossa. *J Laryngol Otol* 1975;89:35–45
- 12 Alfieri A, Jho HD, Schettino R, Tschabitscher M. Endoscopic endonasal approach to the pterygopalatine fossa: anatomic study. *Neurosurgery* 2003;52:374–378, discussion 378–380
- 13 Mellema JW, Tami TA. An endoscopic study of the greater palatine nerve. *Am J Rhinol* 2004;18:99–103
- 14 Cavallo LM, Messina A, Gardner P, et al. Extended endoscopic endonasal approach to the pterygopalatine fossa: anatomical study and clinical considerations. *Neurosurg Focus* 2005;19:E5
- 15 Rumboldt Z, Castillo M, Smith JK. The palatovaginal canal: can it be identified on routine CT and MR imaging? *AJR Am J Roentgenol* 2002;179:267–272
- 16 Borden NM, Dungan D, Dean BL, Flom RA. Posttraumatic epistaxis from injury to the pterygovaginal artery. *AJNR Am J Neuroradiol* 1996;17:1148–1150
- 17 Pearson BW, MacKenzie RG, Goodman WS. The anatomical basis of transantral ligation of the maxillary artery in severe epistaxis. *Laryngoscope* 1969;79:969–984
- 18 Daniels DL, Mark LP, Ulmer JL, et al. Osseous anatomy of the pterygopalatine fossa. *AJNR Am J Neuroradiol* 1998;19:1423–1432
- 19 Pinheiro-Neto CD, Fernandez-Miranda JC, Rivera-Serrano CM, et al. Endoscopic anatomy of the palatovaginal canal (palatosphe-noidal canal): a landmark for dissection of the vidian nerve during endonasal transpterygoid approaches. *Laryngoscope* 2012;122:6–12
- 20 Onerci TM, Yücel OT, Öğretmenoğlu O. Endoscopic surgery in treatment of juvenile nasopharyngeal angiofibroma. *Int J Pediatr Otorhinolaryngol* 2003;67:1219–1225