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VIDIAN CANAL- A LANDMARK FOR IDENTIFICATION OF THE INTERNAL CAROTID ARTERY DURING SKULL BASE SURGERY

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ABSTRACT

The relationship of the vidian canal to the anterior genu of the internal carotid artery (ICA) is one of the most important anatomical relationships that must be understood to achieve endoscopic control of the petrous internal carotid artery. This study, was performed in the dissection laboratory of the department of otorhinolaryngology and head and neck surgery in Sri Devaraj Urs Medical College from 2016 to 2018. Ten fresh cadaveric specimens (20 sides) provided by the department of anatomy were a part of this study. The carotid artery was superior and medial to the vidian canal in all cadavers on both sides. The vidian canal and nerve were constant landmarks to help identify the anterior genu and lacerum segment of the ICA, as the nerve runs on the anterolateral aspect of the ICA. Therefore drilling inferior and medial to the vidian nerve provided the safest access to the anterior genu of the ICA.

KEYWORDS

Anterior skull base, skull base dissection, vidian canal, internal carotid artery

INTRODUCTION

Over the past decade, endoscopic skull base surgery has emerged as an integral component to the treatment of benign and malignant skull base pathology.[1–5] A comprehensive study of skull base anatomy is essential to understand the various anatomical relationships that serve as fundamental landmarks for the endoscopic skull base surgeon.

The relationship of the vidian canal to the anterior genu of the internal carotid artery (ICA) is one of the most important anatomical relationships that must be understood to achieve endoscopic control of the petrous internal carotid artery.[1]

The vidian canal runs from the pterygopalatine fossa to the foramen lacerum and houses the vidian nerve and in 30% of cases the vidian artery. [1,2]

Multiple important neurovascular structures pass through the pterygopalatine fossa as indicated by an extensive network of foramina and fissures. Bony foramina such as the inferior orbital fissure, foramen rotundum, greater and lesser palatine foramina pterygomaxillary fissure and the sphenopalatine foramen represent important landmarks that may be used by the endoscopic surgeon to navigate the skull base.

Hence a complete understanding of the relationship and distance of one foramen to the other is essential.

Expanded endoscopic approaches (EEA) can be classified by the approach into the median craniocaudal skull base (access to structures in the median sagittal plane), and approaches to the paramedian skull base (access to structures in the coronal plane).[3,4]

In the coronal plane, the most critical and defining structure is the internal carotid artery (ICA), which in turn, can be divided in segments that have their own distinct landmarks.[1,4] According to Bhoutillier et al classification the ICA is divided into cervical (c1), petrous(c2), lacerum(c3), cavernous(c4), clinoid(c5), ophthalmic(c6) and communicating(c7).[23] Other important anatomic landmarks in the coronal plane are the pterygoid plates, the vidian canal and the foramen rotundum with the maxillary nerve

SEGMENTS OF THE INTERNAL CAROTID ARTERY- BHOUTILLIER ET AL.[5]

SEGMENT	EXTENT
Cervical (C1)	Carotid artery bifurcation to Carotid canal
Petrous (C2)	Carotid canal to Posterior edge of the foramen lacerum
Lacerum (C3)	Posterior edge of the Foramen lacerum to Superior border of the petrolingual ligament
Cavernous (C4)	Superior border of the petrolingual ligament to Proximal dural ring
Clinoid (C5)	Proximal dural ring to Distal dural ring
Ophthalmic (C6)	Distal dural ring to Posterior communicating artery
Communicating (C7)	Posterior communicating artery to ICA bifurcation

MATERIALS AND METHODS

This study, approved by our ethical institutional research committee, was performed in the dissection laboratory of the department of otorhinolaryngology and head and neck surgery in Sri Devaraj Urs Medical College, Kolar from 2016 to 2018. Ten fresh cadaveric specimens (20 sides) provided by the department of anatomy were a part of this study, The surgical dissection was performed using paranasal sinus and skull base/neurosurgical endoscopic instruments (Karl Storz, Tuttlingen, Germany), and a high- speed drill with diamond and cutting burrs (Karl Storz) or a gouge and mallet. All dissections were performed via a pure endonasal endoscopic approach by the same surgeon using a 0°, 30°, and 70° rod-lens endoscope coupled to a high-definition camera and monitor (Karl Storz Endoscopy).

Technique of Dissection

Unilateral wide maxillary antrostomy, anterior and posterior ethmoidectomies, and sphenoidotomy were the initial steps of the dissection. After isolating the sphenopalatine and posterior septal arteries, we completed a medial maxillectomy (inferior turbinectomy and removal of the lateral nasal wall down to the level of the nasal floor). Next, we removed the posterior maxillary sinus wall and the orbital process of the palatine bone. After removing the periosteum of the posterior maxillary sinus wall and fat from the pterygopalatine fossa, we identified the third and most distal segment of the maxillary artery and its major terminal branches: descending palatine artery, sphenopalatine artery, posterior septal artery, vidian artery, pharyngeal artery, and superior alveolar artery. This was best accomplished via retrograde dissection of the sphenopalatine artery.

After displacing the vascular compartment of the pterygopalatine fossa laterally, we exposed the neural structures of the pterygopalatine fossa including the pterygopalatine ganglion, vidian nerve, greater palatine nerve, lesser palatine nerve, infraorbital nerve, and maxillary nerve (V2) at the foramen rotundum and its anastomotic branch to the pterygopalatine ganglion. A posterior septectomy and bilateral sphenoidectomies were done, removing the intra-sinus septa and part of the floor of the sphenoid sinuses

We then proceeded with the trans-pterygoid approach, drilling the base of the pterygoid process around the vidian canal in an anterior to posterior direction to expose the anterior genu and lacerum segment of the ICA. At this point we could access the medial aspect of the infratemporal fossa and identify the foramen rotundum, the infraorbital artery and infraorbital nerve entering the infraorbital canal, the inferior orbital fissure, the medial insertion of the upper and inferior heads of the lateral pterygoid muscle inserting on the lateral pterygoid plate, the deep aspect of the temporalis muscle (sphenomandibular muscle), and the temporal branches of the maxillary artery. Removal of the bone around the foramen ovale facilitated the visualization of the horizontal petrous segment of the ICA just posterior to the foramen.

On completion of the transpterygoid approach we had exposed V2, V3, the Gasserian ganglion, the dura mater of the middle cranial fossa, the cavernous sinus, and the ICA extending from the paraclival segment to the horizontal aspect of the petrous segment.

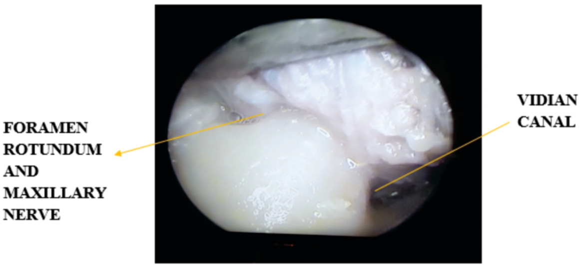

Fig1: foramen rotundum, transmitting the maxillary nerve is seen superior and lateral to the vidian canal

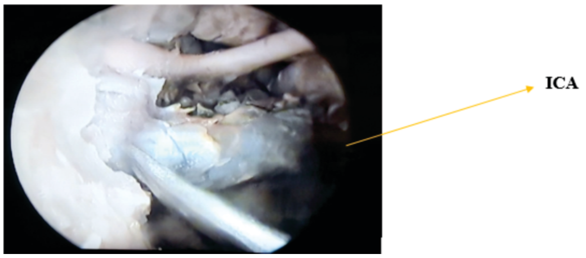

Fig 2: the internal carotid artery is seen superior and medial to the vidian canal

RESULTS

The carotid artery can be classified as being superior- medial, superior-lateral, inferior-medial, or inferior-lateral to the vidian canal. The carotid artery was superior- medial to the vidian canal in all cadavers on the right and left sides.

The pterygoid canal and nerve (i.e. vidian canal and nerve) were constant landmarks to help identify the ICA anterior genu and lacerum segment, as the nerve runs on the anterolateral aspect of the ICA. We found that drilling inferior and medial to the vidian nerve provided the safest access to the anterior genu of the ICA. After completing the transpterygoid approach, we also exposed the foramen rotundum and V2 (following the infraorbital nerve posteriorly) at a level that was superior and lateral to the vidian nerve. Drilling and removing the bone inferior to V2 exposed the foramen ovale and V3. In turn, following V2 and V3 proximally exposed the Gasserian ganglion (Meckel's cave) and the floor of the middle cranial fossa. The foramen ovale and the short segment of V3 proximal to the foramen are always anterior and superior to the petrous ICA. Therefore, they are reliable landmarks that help to control the petrous ICA (horizontal segment). From the endoscopic standpoint, V3 partially blocks the view of the proximal petrous segment of the ICA.

DISCUSSION

Multiple clinical situations may require exposure and control of the ICA, including the management of advanced sinonasal or nasopharyngeal malignancies, paragangliomas, and other skull base lesions originating in the middle or posterior cranial fossa, such as meningiomas, schwannomas, chordomas, and chondrosarcomas.[6] In addition, primary lesions from the pterygopalatine fossa and infratemporal fossa can extend around the ICA. Traditionally, surgical approaches to this region include a lateral corridor via an infratemporal approach (Fisch B and C), subtemporal-preauricular with orbitozygomatic osteotomies or Fisch D, and/or an anterior approach, such as the degloving technique or the Lefort I osteotomy. These approaches, although providing adequate exposure, may require retraction or resection of the glenoid fossa, mandibular condyle, facial nerve manipulation, and/or a craniotomy.[6-9]

Regardless of the approach, exposure of the ICA is a surgical challenge. This is more evident when dissecting the petrous, lacerum, and distal parapharyngeal segments. Thus, a detailed knowledge of the ICA is mandatory.[8,9,10] The anatomy of the ICA from the perspective of the open skull base approaches is well established. However, despite recent advances in EEAs, the understanding of the endoscopic anatomy of the ICA remains insufficient.

Various anatomical classifications of the ICA exist in the literature. Bouthillier et al.[5] proposed a classification that seems most useful from our standpoint, as it is based on structures that are exposed during an EEA

During an endoscopic transpterygoid approach, which is a common step in the exposure of the suprapetrous and infrapetrous areas, one should recognize critical anatomical landmarks to the different segments of the ICA.

The vidian canal and nerve are reliable landmarks to determine the height (vertical axis position) of the anterior genu and lacerum segment of the ICA as it emerges from the petrous bone. In fact, the vidian canal connects the pterygopalatine fossa to the foramen lacerum. It is important to note that the canal has a slight posterolateral orientation, with the posterior opening located inferolateral to the anterior end of the carotid petrous canal and anterior genu of the ICA. Its anterior opening is at the upper medial surface of the pterygoid process of the sphenoid bone and can only be identified after exposing the medial pterygopalatine fossa. The union of the greater superficial and deep petrosal nerves forms the vidian nerve. It travels through the vidian canal to end in the pterygopalatine ganglion, which is positioned in front of the anterior opening of the canal.[11,12] When present; a vidian artery runs in the vidian canal along with the vidian nerve. In the pterygopalatine fossa, the artery will be anterior to the nerve and ganglion. Therefore, it needs to be mobilized to better expose the neural structures. Thus, the vidian nerve should be used as a landmark to determine the vertical position of the petrous ICA and lacerum foramen and not to injure the most medial aspect of the ICA as it turns into the paraclival ICA.

We strongly advocate a stepwise approach identifying the lacerum and petrous segments of the ICA. V3 (posterior trunk) is a useful endoscopic anatomic landmark to the parapharyngeal segment, as it is located anterior and lateral and with a relative parallel orientation.

In this anatomical study, an EEA provided adequate exposure of ICA, It should be noted, however, that this surgical exposure is complex and requires ample experience and training before it is applied clinically, where injury to the vessel may produce catastrophic complications. In addition, we strongly advocate the use of an image-guided system (preferably using computed tomography angiography) and intraoperative acoustic Doppler sonography to further aid the identification of the ICA. Institutional intensive care support and the availability of an interventional angiographer are also important safeguards.[7,8]

CONCLUSION

The consistent location of the anterior genu of the ICA superior and medial to the vidian canal can reliably serve as a guide to safely identify the artery. A stepwise approach is critical to the endonasal endoscopic exposure and control of the ICA. The vidian nerve is an important landmark to the lacerum segment of the ICA in the transpterygoid approach. V3 and its foramen (foramen ovale) are other useful landmarks to identify and control these segments of the ICA. The endoscopic approach is a feasible surgical option that complements other traditional external approaches. A deep understanding of the anatomy from an endonasal perspective is imperative as tumor growth, trauma, or prior surgery may change the anatomy of the area.

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