The Endoscopic Endonasal Approach to the Meckel's Cave Tumors: Surgical Technique and Indications

Emmanuel Jouanneau[1,2], Emile Simon[1,4], Timothée Jacquesson[1,4], Marc Sindou[1], Stéphane Tringali[3], Mahmoud Messerer[1], Moncef Berhouma[1]

Key words
- Biopsy
- Cavernous sinus
- Endonasal endoscopic extended approaches
- Endoscopy
- Meckel's cave
- Tumor

Abbreviations and Acronyms
CT: Computed tomography
ICA: Internal carotid artery
ITF: Infra temporal fossa
MRI: Magnetic resonance imaging

From the [1]Department of Neurosurgery A, Pierre Wertheimer Hospital, Hospices Civils de Lyon, Lyon 1 University; [2]INSERM, U1028, CNRS UMR5292, Lyon Neuroscience Research Center, Neuro-Oncology an Neuro-Inflammation Team; [3]ENT Department, Lyon SUD Hospital Center, Hospices Civils de Lyon, Lyon 1 University; and [4]Department of Anatomy, Lyon 1 University, Lyon, France

To whom correspondence should be addressed: Emmanuel Jouanneau, M.D., Ph.D. [E-mail: emmanuel.jouanneau@chu-lyon.fr]

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Many benign and malignant tumors as well as other inflammatory or vascular diseases may be located in the areas of Meckel's cave or the cavernous sinus. Except for typical features such as for meningiomas, imaging may not by itself be sufficient to choose the best therapeutic option. Thus, even though modern therapy (chemotherapy, radiotherapy, or radiosurgery) dramatically reduces the field of surgery in this challenging location, there is still some place for surgical biopsy or tumor removal in selected cases. Until recently, the microscopic subtemporal extradural approach with or without orbitozygomatic removal was classically used to approach Meckel's cave but with a non-negligible morbidity. Percutaneous biopsy using the Hartel technique has been developed for biopsy of such tumors but may fail in the case of firm tumors, and additionally it is not appropriate for anterior parasellar tumors. With the development of endoscopy, the endonasal route now represents an interesting alternative approach to Meckel's cave as well as the cavernous sinus. Through our experience, we describe the modus operandi and discuss what should be the appropriate indication of the use of the endonasal endoscopic approach for Meckel's cave disease in the armamentarium of the skull base surgeon.

INTRODUCTION

Many benign as well as malignant tumors can involve Meckel's cave (11). Inflammatory processes also may mimic the appearance of tumors in this region (1, 11, 21). Modern radiotherapy or radiosurgery dramatically reduces the need for surgical intervention in this challenging location; however, except in the case of specific imaging features or of a well-known oncologic context, histologic sampling or tumor removal may still be required as the first step of management. Until recently, the classical routes to Meckel's cave or cavernous sinus were the microscopic subtemporal extradural approach (with or without orbitozygomatic removal) or the anterior transpetrosal approach (9, 10, 14, 16, 23). These routes have a non-negligible morbidity because of vessels and cranial nerves inhabiting a narrow corridor between the branches of the Vth nerve, the internal carotid artery, and the petrous apex with the geniculate ganglion, the semicircular canals, and the cochlea in proximity. Percutaneous biopsy has been developed using the Hartel technique but may fail in case of firm tumors and is in addition not appropriate for more anteriorly located parasellar tumors (5, 11, 21, 22, 24).

The endonasal route provides access to the Meckel's cave and solves the previously mentioned issues. Rarely used for skull base surgery because of the microscope's limited axial vision, it is now routinely performed because of the remarkable evolution of endoscopic techniques. Endoscopic endonasal skull base surgery is now becoming the gold-standard approach to the sellar, retrosellar, and clival regions and has provided an innovative and less-invasive route to the parasellar area. Through our experience, we describe the modus operandi and discuss what should be the appropriate indications of this endonasal endoscopic approach for Meckel's cave disease within the armamentarium of the skull base surgeon.

RATIONALE FOR AN ENDONASAL ENDOSCOPIC APPROACH TO MECKEL'S CAVE

To approach skull base tumors, neurosurgeons have to tailor a route that avoids crossing any nerves and vessels. For extradural parasellar tumors, such as chondrosarcomas, which grow medially to laterally and displace critical structures laterally, or for parasellar tumors, which extend anteriorly toward the sphenoid recess, the endonasal anteromedial corridor appears to be the more appropriate and less-risky route than the cranial route. To predict the origin of the tumors and plan the optimal route, the position of the C3 and C4 segments of the internal carotid is a useful anatomic landmark. Indeed, for a Meckel's cave tumor such as a neurinoma, the internal carotid artery (ICA) usually is displaced medially. The infratemporal fossa (ITF) is therefore the best entry point to reach the tumor. For a tumor originating

from the petrous bone or skull base synchondrosis such as a chondrosarcoma, the ICA is pushed up superiorly, anteriorly, and laterally, and working medially to the carotid through the sella turcica may be more appropriate. For large tumors, the infratemporal and the sella turcica windows need to be used simultaneously, with the surgeon working on both sides of the carotid artery (Figure 1).

These deep lateral approaches to Meckel's cave require extensive exposure and a high degree of visualization of critical neurovascular structures. By bringing the light closer to the surgical target, endoscopy solves the problem of the visual deficiencies of the microscope and offers many possibilities to develop innovative extended approaches to the skull base. However, endoscopic surgery clearly requires specific training and expertise. Experience in pituitary surgery of more than 100 standard interventions has been for the authors and others the portal to extended approaches. Dedicated and collaborative teams of experts are of course of paramount importance.

ENDOSCOPIC ENDONASAL SURGERY FOR MECKEL'S CAVE TUMORS: STEP BY STEP

Relevant Anatomy

Only a certain number of important points concerning the main anatomic landmarks will be mentioned in this article with regard to the 3 basic operative steps, described as nasal, sphenoid, and infratemporal. For more detailed description, readers are invited to refer to classical references (8, 13, 17, 19, 20).

Once entering the nostril, 3 landmarks appear immediately: on the midline, the nasal septum and inferolaterally, the inferior turbinate and superiorly adjacent the middle turbinate. Proceeding posteriorly below the middle turbinate with the endoscope leads to the choanae. Moving up the endoscopic tube 1 cm up leads to the sphenoid ostium, the entry point to the sinus. This route may be more complicated when the turbinates are hypertrophied or in case of septal deviation. All these details need to be assessed either on the 3D computed tomography (CT) scan or the magnetic resonance imaging (MRI) to plan which side to choose for the approach and how to plan the nasoseptal flap.

The sphenoid sinus anatomy and especially its degree of pneumatization need particularly to be studied. Most sinuses are well-pneumatized (the sellar type) with 1 or 2 septa but many variations exist, whereas some patients have no sinus at all (the conchal type) (20). This variation may complicate both sellar and parasellar endonasal approaches. Before the surgeon moves forward to the infratemporal step, all the following landmarks must be identified: the sella turcica on the midline, on either side from inferior to superior, the C3 paraclival segment of the internal carotid (ICA), the cavernous sinus with the C4 segment of the ICA, and superiorly the paraclinoid C5 segment of ICA just beneath the optic nerve with its medial and lateral opticocarotid recesses. More laterally, from inferior to superior are the foramen lacerum with the C2 segment of the ICA, the ITF and right above it, the superior orbital fissure (2, 3, 8, 13, 17). Superior and lateral are the V1 and V2 branches of the trigeminal nerve, the former within the superior orbital fissure. Inferior and medial are the C2 and C3 segments of the ICA, all define 2 superior (between the SOF, C3 ICA, and V2) and inferior quadrangular spaces (the inferior among the V2, the C2-C3 ICA, and the Vidien nerve corresponding to the ITF and Meckel's cave) (Figures 2 and 3) (8). These virtual spaces become an adequate entry point to Meckel's cave and the petrous apex when enlarged by lesions. To access the Meckel's cave, the amount of bone drilling necessary varies according to the surgical plan and to the degree of pneumatization of the sphenoid sinus. For a simple biopsy, the aperture of the ITF superior and lateral to respectively the C2 and C3 segments of ICA may be adequate. For tumor removal, however, controlling all the ICA segments is of paramount importance to facilitate emergency clipping if a vascular injury occurs.

For well-pneumatized sinuses (the sellar type), a simple midline sphenoidotomy extended to the lateral sphenoid recess provides good exposure of the superior and inferior quadrangular spaces described by Cavallo et al. (8). In such a case, the anatomic markers are easily identified. For less-pneumatized sphenoid sinuses (presellar or conchal types), no landmarks are readily visible, and a large and

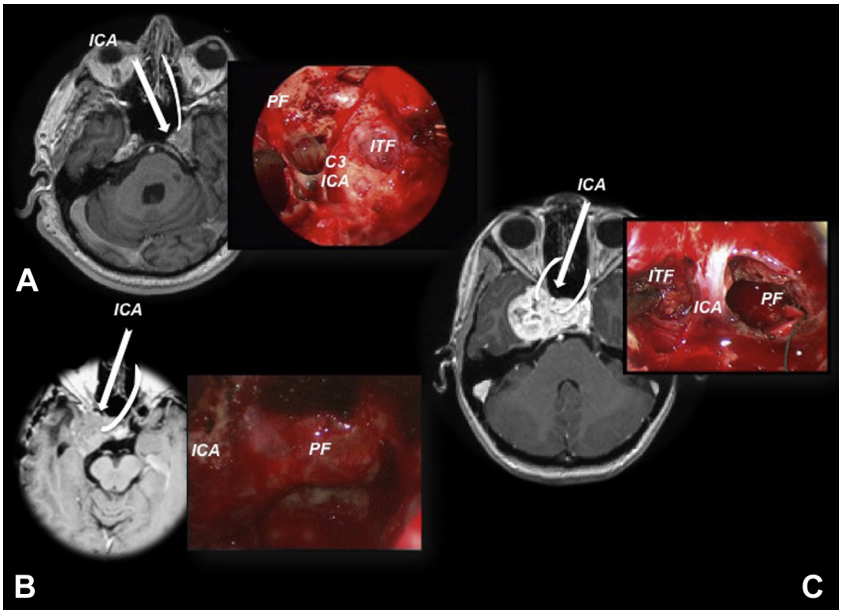

Figure 1. Several examples of parasellar tumors approaches from below (preoperative and operative magnetic resonance imaging views). (**A**) Metastasis of a Meckel's cave adenocarcinoma (unknown origin): The transnasal route allows a productive biopsy of the tumor passing through the infratemporal window, laterally to the C3 internal carotid artery (ICA) after a failure of a transjugal percutaneous biopsy. This was a firm tumor explaining the failure of the percutaneous biopsy. (**B**) Chondrosarcoma extended to the cavernous sinus that has been removed using an endonasal route. Note the ICA pushing away laterally and anteriorly that allow using the pituitary fossa (PF) window. ITF, infratemporal fossa. (**C**) Large neurinoma of the cavernous sinus subtotally removed using the endonasal route. Note the ICA midline and anterior to the tumor and a bilateral approach through the PF and the ITF has been made in this case to obtain great access to the tumor.