# Endoscopic Extradural Subtemporal Approach to Lateral and Central Skull Base: A Cadaveric Study

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**Key words**
- Cavernous sinus
- Endoscopy
- Infratemporal fossa
- Middle cranial fossa
- Posterior cranial fossa
- Tympanic cavity

**Abbreviations and Acronyms**
**AICA**: Anterior inferior cerebellar artery
**GSPN**: Greater superficial petrosal nerve
**IAM**: Internal acoustic meatus
**MMA**: Middle meningeal artery
**SPS**: Superior petrosal sinus

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**OBJECTIVE:** **Endoscopy has provided a less invasive approach to skull base surgery, mainly through endonasal routes, but has been limited in its applications due to potential complications. The aims of this study were to evaluate the feasibility of the purely endoscopic extradural transcranial approach to lateral and central skull base through a subtemporal keyhole and to better understand potential distortions of the related anatomy via endoscopy.**

**METHODS:** **Ten fresh cadaver heads were studied with 4-mm 0° and 30° endoscopes to develop the surgical approach and to identify surgical landmarks.**

**RESULTS:** **The endoscopic extradural subtemporal approach was divided into 3 sections after exposure of the extradural space in the middle cranial fossa: 1) exposure of the lateral wall of the cavernous sinus and the preauricular infratemporal fossa; 2) anterior petrosectomy and posterior cranial fossa exploration; and 3) unroofing of the tympanic cavity and exposure of the facial nerve. This keyhole endoscopic technique clearly visualized anatomical landmarks of the lateral and central skull base via an extradural subtemporal route.**

**CONCLUSIONS:** **The endoscopic extradural subtemporal approach was feasible. This approach could display a wide range of lateral and central skull base structures with minimal invasiveness. The use of extradural space would be key to performing safe and effective endoscopic skull base surgery.**

## INTRODUCTION

A variety of neoplasms arise from extradural components in the middle cranial fossa, located at the lateral part of the skull base. Surgical approaches have been developed through anatomical studies, and modern skull base surgical techniques have contributed to improvement in tumor removal and patient outcome (1-3, 16, 31, 32, 35, 37). The extradural subtemporal approach is considered suitable for removing extradural neoplasms in the middle cranial fossa, and the Kawase approach, a variation of the extradural subtemporal approach, is also used for pathology in the anterolateral area of the posterior cranial fossa (11-13). One of the disadvantages of an extradural subtemporal approach has been a limited operative view because the temporal lobe restrains exposure of structures in the middle cranial fossa and the central skull base. Therefore, a conventional craniotomy has been mandatory to obtain wide-angle views in microscopic surgeries.

In the past decade, endoscopy has become widely accepted as a neurosurgical strategy, and it is becoming more important in treating conditions involving the skull base (4, 5, 7, 9, 10, 38). Endoscopy offers distinct advantages over microscopy. Endoscopy provides bright and excellent visualization with high magnification and allows one to look behind anatomic structures that cannot be seen via a straight microscopic view. Endoscopy also has the theoretical advantage that less invasive surgery can be performed, potentially reducing operative morbidity and facilitating early patient recovery. Thus far, a few studies have reported endoscopic assistance in traditional extradural subtemporal approaches; however, a purely endoscopic extradural approach through a subtemporal keyhole has not been investigated sufficiently (17, 24, 26, 27, 29, 33, 34). This approach may have the potential to overcome the disadvantages of the traditional extradural subtemporal approach. The aims of our study were to evaluate the feasibility of an endoscopic extradural subtemporal approach to the lateral and central skull base and to describe the related anatomy as visualized in the endoscopic view.

## METHODS

All anatomical dissections were performed in the Laboratory of Microsurgical and Endoscopic Anatomy at the Medical University of Vienna. The protocol of this study was approved by the local institutional research committee. An endoscopic subtemporal extradural approach was studied in 10 fresh cadaver heads. The specimens were injected with red silicone through the arterial system. Cadaveric heads were positioned to simulate the surgical position in the operating room.

A 4-mm-diameter endoscope, 18 cm in length, was used with 0° and 30° rod-lenses (Karl Storz GmbH and Co., TUMOR

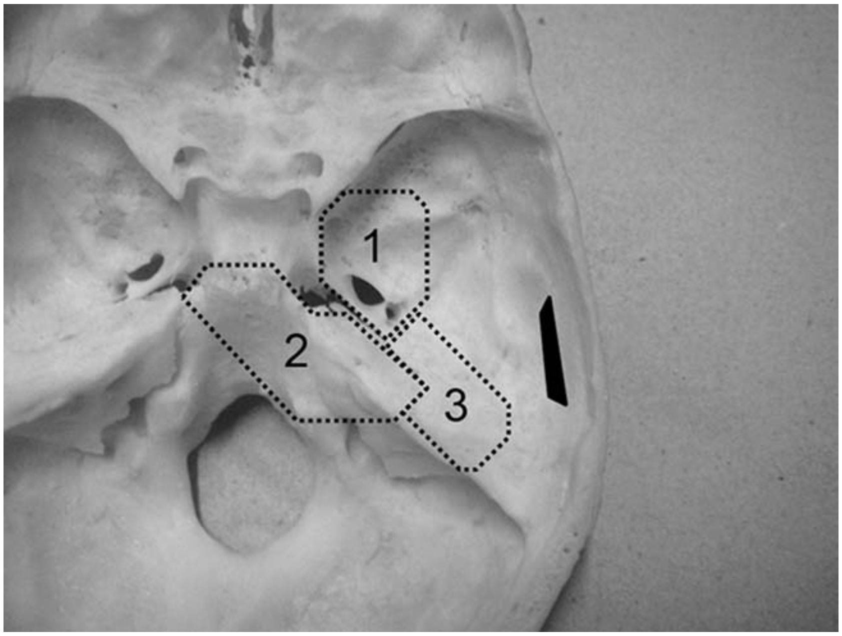


**Figure 1.** Outline of the endoscopic extradural subtemporal approach. The surgical sections are illustrated on the endocranial surface of the dry skull. *1*, Exposure of the lateral wall of the cavernous sinus and the preauricular infratemporal fossa. *2*, Anterior petrosectomy and posterior cranial fossa exploration. *3*, Exposure of the tympanic cavity and facial nerve. *Solid black area* indicates subtemporal keyhole.

Tuttlingen, Germany). The endoscope was connected to a light source through a fiberoptic cable and to a camera fitted with 3-chip, high-definition sensors. The video camera was connected to a monitor for optimal display of the high-definition images. All procedures were performed under endoscopy alone, and single-shaft instruments for endoscopic endonasal surgery were used for dissection procedures. An endoscopic holder was used to fix the endoscope for bimanual procedures such as handling of venous sinuses, drilling, and intradural microdissection.

### Subtemporal Keyhole Craniotomy

A 4-cm vertical linear skin incision was made just anterior to the tragus from the point at the inferior margin of the zygomatic arch, preserving the superficial temporal artery. The temporal fascia and muscle were dissected, and the posterior zygomatic root and squamosal portion of the temporal bone were exposed. A keyhole craniotomy (2.0 cm in width, 2.5 cm in height) was performed just above the posterior zygomatic root.

## RESULTS

After a subtemporal keyhole craniotomy, the endoscopic extradural approach was divided into 3 sections: 1) exposure of the lateral wall of the cavernous sinus and the preauricular infratemporal fossa; 2) anterior petrosectomy and posterior cranial fossa exploration; and 3) unroofing of the tympanic cavity and exposure of the facial nerve (Figure 1).

The subtemporal keyhole craniotomy was performed as described in the Methods. After the craniotomy, an endoscope (4 mm, 0°) was introduced into the extradural space, and the dura was bluntly peeled from the floor of the middle cranial fossa using a dissector. The middle meningeal artery (MMA) with the foramen spinosum was observed anteromedial to the keyhole (Figure 2A) and was cut at its cranial entrance. The third division of the trigeminal nerve with the foramen ovale was visualized anteromedial to the foramen spinosum (Figure 2B). The dura mater was then further raised, and the greater superficial petrosal nerve (GSPN) was exposed and dissected from the dural adhesions by cutting the periosteal dura with a scalpel (Figure 2C). The dural elevation reached to the anterior petrous ridge, allowing the identification of anatomical landmarks: the trigeminal impression anteriorly, the petrous ridge medially, GSPN laterally, and the arcuate eminence posteriorly (Figure 2D). Thus, enough working space was secured in the extradural space in the middle cranial fossa to perform a bimanual technique with instruments, including both drill and suction, under fixation of endoscopy.

### Exposure of the Lateral Wall of the Cavernous Sinus and the Preauricular Infratemporal Fossa

The lateral wall of the cavernous sinus was separated into 2 layers, inner and outer, at the upper border of the third division of the trigeminal nerve. The outer layer was elevated and the inner layer of the lateral wall of the cavernous sinus was exposed. The first, second, and third divisions of the trigeminal nerve were evident, and the oculomotor and trochlear nerves were identified. The posterior bend of the carotid artery and the abducens nerve were displayed after opening the infratrochlear (Parkinson) triangle (Figure 3A). Then the floor of the middle cranial fossa around the third division of the trigeminal nerve was drilled off to expose the superior portion of the preauricular infratemporal fossa. During drilling, the sphenosquamous suture was used as a landmark to preserve the mandibular fossa (Figure 3B). The third division of the trigeminal nerve, which was divided on the upper head of the lateral pterygoid muscle, was visualized after opening of the pterygoid plexus (Figure 3C). The upper and lower heads of the lateral pterygoid muscle were removed, and the maxillary artery and lateral pterygoid plate were exposed (Figure 3D). With the 30° optic, angled instruments were able to reach up to 20 mm on average beneath from the foramen ovale in the infratemporal fossa, while preserving the mandibular joint and branches of the third division of the trigeminal nerve. The lateral recess of the sphenoid sinus was opened beneath the second division of the trigeminal nerve (anterolateral triangle), and the Vidian canal was visualized in the lateral recess of the sphenoid sinus (Figure 3E). The eustachian tube was observed medial to the third division of the trigeminal nerve