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The Role of Endoscopic Assistance in Ambient Cistern Surgery: Analysis of Four Surgical Approaches

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■ OBJECTIVE: **We used microscopy with endoscopic assistance to conduct an objective analysis of 4 surgical approaches commonly used in the surgery of the ambient cistern: infratentorial supracerebellar (SC), occipital interhemispheric (OI), subtemporal (ST), and transchoroideal (TC). In addition, we performed a parahippocampalis gyrus resection in the ST context.**

■ METHODS: **Each approach (SC, OI, ST, TC) was performed on 3 cadaveric heads (6 sides). After the microscopic anatomic dissection, the 30-degree endoscope was used to explore the exposure. The parahippocampalis gyrus was resected through an ST approach and the exposure was evaluated. The quantitative analysis was based on linear exposure of the vascular structures (linear exposure), such as the posterior choroidal artery (PChA), the P2 and P3 segments of the posterior cerebral artery (PCA) with their branches, the basal vein of Rosenthal, and the area of exposure of the ambient cistern region (area of exposure) limited by points on its superior, mesial, and anterior walls. In all cases, a *P* value of less than 0.05 was considered significant.**

■ RESULTS: **There was a significant difference ($P < 0.05$) in linear exposure of the PCA and medial PChA between microsurgery and endoscopic assistance using the ST approach. This approach also improved the medial, superior, and total exposure of the ambient cistern region.**

■ CONCLUSIONS: **This study demonstrates that endoscope assistance improved exposure of the ambient cistern region when using the ST approach. Endoscopic assistance provided similar surgical exposure compared with ST associated with parahippocampalis resection.**

INTRODUCTION

The increasing use of rigid endoscopes in endonasal and transcranial approaches has changed the way cerebral and skull base lesions are managed. Visualization of the anatomic structures has improved reducing exposure and brain retraction, thereby minimizing surgical morbidity. In the current minimally invasive trend in neurosurgery, endoscopic surgery is a growing field and widely accepted as a means of treating intracranial lesions.[1–9]

The ambient cistern region is a unique cerebral compartment and represents a challenge to the neurosurgeon because of its deep location surrounding vital structures, narrow boundaries, and complex tridimensional anatomy. Several surgical approaches with modifications and in combinations have been described to access the ambient cistern region and the posterior portion of the posterior cerebral artery (PCA). However, selecting the appropriate surgical route remains controversial. In addition, the use of endoscopic assistance has not been studied thus far.[10–18]

We used microscopy associated with endoscopic assistance to conduct an objective analysis of 4 surgical approaches commonly used in the surgery of the ambient cistern: infratentorial

Key words
- Ambient cistern
- Endoscopy
- Endoscopic assistance
- Anatomy
- Microsurgery
- Microneurosurgery

Abbreviations and Acronyms
BVR: Basal vein of Rosenthal
OI: Occipital interhemispheric
PCA: Posterior cerebral artery
PChA: Medial posterior choroidal artery
SC: Infratentorial supracerebellar
ST: Subtemporal
STh: Parahippocampal gyrus resection
TC: Transchoroideal

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supracerebellar (SC), occipital interhemispheric (OI), subtemporal (ST), and transchoroideal (TC). In addition, we performed a parahippocampalis gyrus resection (STh) in the ST context. This study sought to analyze and compare surgical exposure provided by these techniques using a computerized tracking system and discuss the role of endoscopic assistance when approaching the ambient cistern region.

METHODS

Three silicone-injected cadaveric heads (6 sides) without obvious intracranial disease were used in this study. Before dissection, the heads were rigidly fixated in a Mayfield headholder (Codman, Inc. Raynham, Massachusetts). The procedures were performed using standard microsurgical instruments under the surgical microscope (S88; Carl Zeiss, Germany). A high-speed drill (Midas Rex, L.P., Fort Worth, Texas) was used to drill the bone. Endoscope assistance was provided by a 30-degree-angle glass-rod lens endoscope (Minop System; Aesculap, Tuttlingen, Germany). The video units were composed of 3 chip video cameras and videotape records and monitors (Sony Corp., San Jose, California). Before dissection, the specimens were rigidly fixed in a Mayfield headholder in a position that recreated surgical positioning.

Surgical Approaches

The detailed surgical techniques for each approach have been well illustrated and were performed as previously described in the literature.[19–22]

Briefly, suboccipital and occipital craniotomies with preservation of the bone overlying the transverse sinus were performed. The SC approach followed by the OI approach was carried out providing a posterior route to the ambient cistern region.

On the same side of the cadaver head, a low-set temporal craniotomy provided access to the ST and TC approaches. The subtemporal approach involves placing the sagittal suture parallel to the floor with the vertex angled inferiorly to allow for maximal visualization along the tentorial surface to the ambient cistern. The arachnoid adhesions connecting the mesial temporal lobe to the tentorial edge were sharply dissected and removed to expose the underlying structures.

For the TC approach, we used the inferior temporal sulcus to access the temporal horn of the lateral ventricle and open the choroidal fissure between the hippocampal fimbria and the choroid plexus.

After microscopic anatomic dissection, the 30-degree endoscope was used to explore the exposure in each approach. The parahippocampal gyrus was resected through an ST approach in order to improve the exposition of the ambient cistern region.

Defining the Landmarks: Ambient Cistern Anatomy

The ambient cistern is a complex arachnoid compartment that is shaped like a “C” around the parahippocampal gyrus if viewed from a coronal perspective (Figure 1A). It extends from the posterior margin of the crural cistern to the lateral edge of the midbrain colliculi.[23] Some authors consider the crural cistern as part of the anterior ambient cistern because no definite border or separation can be observed between the 2 arachnoid compartments.[16] We consider the ambient cistern region area limited anteriorly by the posterior lateral surface of the cerebral peduncle; medially by the lateral surface of the midbrain; laterally by the tentorial edge, parahippocampal gyrus, fimbria of the fornix, and choroidal fissure; and superiorly by the pulvinar of the thalamus, lateral geniculate body, and optic tract (Figure 1B).[24] This region contains the anterior choroidal artery, the P2 and P3 segments of the PCA with their branches, the basal vein of Rosenthal (BVR), and, infrequently, a segment of the superior cerebellar artery. The anterior choroidal artery runs along the roof of the cistern and enters the choroidal fissure between the pial layers of the peduncle and the uncus, which fuse to form the tela choroidea.[25–27]

The P2 segment of the PCA can be subdivided into P2a and P2p, which are bordered by the posterior edge of the peduncle. The P2a begins at the junction of the posterior communicating artery and courses through the anterior ambient or crural cistern along the upper surface of the anterior perimesencephalic membrane. The P2p begins at the posterior border of the anterior ambient or crural cistern and ends at the lateral edge of the midbrain colliculi. The P2p often courses superiorly and laterally within the ambient cistern to lie on the superior surface of the parahippocampal gyrus. The P3 segment proceeds posteriorly from the posterior edge of the ambient cistern into the quadrigeminal cistern.[28]

The medial posterior choroidal artery (PChA) typically originates as a single trunk from the P1 or P2 and courses through the ambient cistern. It travels inferiorly and medially to the PCA through the crural and ambient cisterns, turns medially to enter the quadrigeminal cistern, and finally turns superiorly and anteriorly to enter the velum interpositum cistern. The lateral PChA arteries arise most commonly from the P2p as 1 or several branches, course laterally along the upper edge of the parahippocampal gyrus within the ambient cistern, and pass through the choroidal fissure to enter the posterior part of the temporal horn and atrium.[29–32]

The BVR passes around the upper midbrain and drains the walls of the ambient cistern. It finally exits the ambient cistern and enters the arachnoid envelope over the pineal region to join the great vein or internal cerebral vein.[33] Linear exposure of these 3 relevant vascular structures (PCA, medial PChA, and BVR) was evaluated.

Evaluation of Exposure

The quantitative analysis was based on linear exposure of the vascular structures (linear exposure) and the area of exposure of the ambient cistern region (area of exposure) provided by microsurgery and by endoscopic assistance. We used the Optotrak 3020 system (Northern Digital, Waterloo, Canada) with a 6-marker digitizing probe and accompanying software for data collection.[34–36] The Optotrak 3020 system is a frameless method of stereotactic location that allows anatomic points to be spatially located with a high level of precision.

The head was rigidly fixed in a 3-point headholder to ensure that it remained in the same Cartesian coordinate system as the Optotrak. A computer connected to the Optotrak 3020 system stored the data files in the form of the x, y, and z coordinates (in millimeters) of each vertex. The retractor was secured firmly to prevent measurement errors, and the points were located spatially.