Microsurgical Approaches to the Ambient Cistern Region: An Anatomic and Qualitative Study

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■ OBJECTIVE: **We used microscopy to conduct qualitative and quantitative analysis of 4 surgical approaches commonly used in the surgery of the ambient cistern: infratentorial supracerebellar (SC), occipital interhemispheric, subtemporal (ST), and transchoroidal (TC). In addition, we performed a parahippocampal gyrus resection in the ST context.**

■ METHODS: **Each approach was performed in 3 cadaveric heads (6 sides). After the microscopic anatomic dissection, the parahippocampal gyrus was resected through an ST approach. The qualitative analysis was based on anatomic observation and the quantitative analysis was based on the linear exposure of vascular structures and the area of exposure of the ambient cistern region.**

■ RESULTS: **The ST approach provided good exposure of the inferior portion of the cistern and of the proximal segments of the posterior cerebral artery. After the resection of the parahippocampal gyrus, the area of exposure improved in all components, especially the superior area. A TC approach provided the best exposure of the superior area compared with the other approaches. The posterolateral approaches (SC/occipital interhemispheric) to the ambient cistern region provided similar exposure of anatomic structures. There was a significant difference ($P < 0.05$) in linear exposure of the posterior cerebral artery when comparing the ST/TC and ST/SC approaches.**

■ CONCLUSIONS: **This study has demonstrated that surgical approaches expose dissimilarly the different regions of the ambient cistern and an approach should be selected based on the specific need of anatomic exposure.**

OBJECTIVE

The ambient cistern region is a unique cerebral compartment and presents 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 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 and requires precise understanding of the limitations of each approach as well as the anatomy of the region.[1-9]

We conducted a qualitative and quantitative analysis of 4 surgical approaches used in the surgery of the ambient cistern: infratentorial supracerebellar (SC), occipital interhemispheric (OI), subtemporal (ST), and transchoroidal (TC). In addition, we performed resection of the parahippocampal gyrus when carrying out the ST approach with parahippocampal gyrus resection (STh).

Key words
- Ambient cistern
- Anatomy
- Approach
- Microneurosurgery
- Microsurgery
- Surgical Approaches

Abbreviations and Acronyms
AChA: Anterior choroidal artery
BRV: Basal Rosenthal vein
OI: Occipital interhemispheric
PChA: Medial posterior choroidal artery
PCA: Posterior cerebral artery
SC: Infratentorial supracerebellar
ST: Subtemporal
STh: Subtemporal with parahippocampal gyrus resection
TC: Transchoroidal

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We have studied the role of endoscope assistance in other work using the same surgical approaches. The goals of the present study were to highlight the microanatomy of the ambient cistern region from different perspectives, objectively compare the approaches in terms of anatomic exposition using a computerized tracking system, and discuss the strategies for approaching lesions in this area.

METHODS

Three cadaveric heads (6 sides), without obvious intracranial disease, fixed in formalin and perfused with colored silicone, were included in this study. Before dissection, the specimens were rigidly fixed in a Mayfield head holder (Ohio Medical Instrument Co., Cincinnati, OH, USA) in a position that recreated surgical positioning. The procedures were performed using standard microsurgical and powered instruments and an operating microscope.

Surgical Approaches

The detailed surgical techniques for each approach have been well described and were performed as previously described in the literature.[10-13]

Suboccipital and occipital craniotomies were performed with preservation of the bone overlying the transverse sinus. The SC approach was followed by the OI approach, 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 ST 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. The parahippocampal gyrus was resected through an ST approach to improve the exposition of the ambient cistern region.

Ambient Cistern Anatomy

The ambient cistern is a complex arachnoid compartment that is shaped like a letter C around the parahippocampal gyrus if viewed from a coronal perspective. It extends from the posterior margin of the crural cistern to the lateral edge of the midbrain colliculi.[14] Some investigators[6] consider the crural cistern as part of the anterior ambient cistern because they did not observe a definite border or separation between the 2 arachnoid compartments. We defined the ambient cistern region[15] as the area that is 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.

The region contains the anterior choroidal artery (AChA), the P2 and P3 segments of the PCA with their branches, the basal Rosenthal vein (BRV), and, infrequently, a segment of the superior cerebellar artery.

The AChA 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.[16-18]

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.[19]

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 inferior and medial to the PCA through the crural and ambient cisterns and turns medially to enter the quadrigeminal cistern. The lateral PChAs 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.[20-23]

The BRV passes around the upper midbrain and drains the walls of the ambient cistern. It exits the ambient cistern and enters the arachnoid envelope over the pineal region to join the great vein or internal cerebral vein.[24]

Evaluation of Exposure

The qualitative analysis was performed based on anatomic observations of the surgical exposure and limitations of the different approaches during cadaveric dissections.

The quantitative analysis was based on the linear exposure of vascular structures and the area of exposure of the ambient cistern region. We used the Optotrak 3020 system (Northern Digital, Waterloo, Canada) with a 6-marker digitizing probe and accompanying software for data collection. The head was fixed rigidly in a 3-point head holder to ensure that it remained in the same Cartesian coordinate system as the Optotrak. A computer connected to the Optotrak system stored data files in the form of x, y, and z coordinates (in millimeters) of each vertex. The retractor was secured firmly to prevent measurement errors, whereas the points were located spatially. A data point was acquired by touching the tip of the digitizing probe to the anatomic points of interest while its position was recorded with cameras.

We evaluated the extent of exposure of the PCA, medial PChA, and BRV in each approach.

The area of surgical exposure was measured and calculated as in previous studies.[25-27] We divided the total area into 3 components: anterior, medial, and superior areas. In each component, 4 points were selected forming a quadrangle or 2 triangles with a common side. The area of exposure of the anterior, medial, and superior regions was measured by summing the areas formed by the 2 triangles. The areas of the triangles were calculated as half the magnitude of the vector cross-product of any 2 vectors forming 2 sides of a triangle.