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Quantitative Endoscopic Comparison of Contralateral Interhemispheric Transprecuneus and Supracerebellar Transtentorial Transcollateral Sulcus Approaches to the Atrium

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■ OBJECTIVE: **The contralateral interhemispheric transprecuneus approach (CITP) and the supracerebellar transtentorial transcollateral sulcus approach (STTC) are 2 novel approaches to access the atrium of the lateral ventricle. We quantitatively compared the 2 approaches.**

■ METHODS: **Both approaches were performed in 6 sides of fixed and color-injected cadaver heads. We predefined the 6 targets in the atrium for measurement and standardization of the approaches. Using a navigation system, we quantitatively measured the working distance, cortical transgression, angle of attack, area of exposure, and surgical freedom.**

■ RESULTS: **The distances from the craniotomy edge to the posterior pole of the choroid plexus of the CITP (mean ± standard deviation, 67 ± 5.3 mm) and STTC (mean, 57 ± 4.0 mm) differed significantly ($P < 0.01$). Cortical transgression with the CITP (mean, 27 ± 2.8 mm) was significantly greater than that with the STTC (mean, 21 ± 6.7 mm; $P = 0.03$). The CITP showed a significantly wider rostrocaudal angle of attack than that with the STTC ($P = 0.01$). The STTC showed a significantly wider mediolateral angle ($P < 0.01$). No significant difference was found for surgical freedom of any target except for point E, for which the CITP was larger. The exposure area did not differ significantly between the 2 approaches ($P = 0.07$).**

■ CONCLUSIONS: **Both approaches were feasible for accessing the atrium. The STTC provided a shorter working distance and wider mediolateral angle, CITP provided a wider rostrocaudal angle of attack and better exposure and maneuverability to the anterior and superior atrium. In contrast, the STTC was more favorable for the inferior and posterior regions.**

INTRODUCTION

The contralateral interhemispheric transprecuneus approach (CITP)[1-4] and supracerebellar transtentorial transcollateral sulcus approach (STTC)[5-8] to the atrium of the lateral ventricle are relatively novel approaches for this location (Figure 1). Previous studies showed the feasibility of both approaches to address lesions such as meningioma,[2,4,7,8] glioma,[8] and arteriovenous malformation.[1] Both approaches avoid the optic radiation, which runs through the lateral wall of the lateral ventricle. However, they both also have the disadvantages of a long working distance and a narrow working angle for which endoscopic assistance might be required. The different working views and maneuverability between the 2 approaches remain uncharacterized. In the present study, we quantitatively compared the anatomical details of the CITP and STTC performed in cadaveric specimens with the assistance of an endoscope to elucidate their advantages and disadvantages, including the working distance, working angle, surgical exposure, and maneuverability.

METHODS

Quantitative Assessment

Five formalin-fixed human cadaveric heads with vascular systems injected with colored silicone were examined. Magnetic resonance

Key words
- Atrium of lateral ventricle
- Endoscopic assistant surgery
- Transcollateral sulcus approach
- Transprecuneus approach

Abbreviations and Acronyms
CITP: Contralateral interhemispheric transprecuneus approach
MRI: Magnetic resonance imaging
STTC: Supracerebellar transtentorial transcollateral sulcus approach

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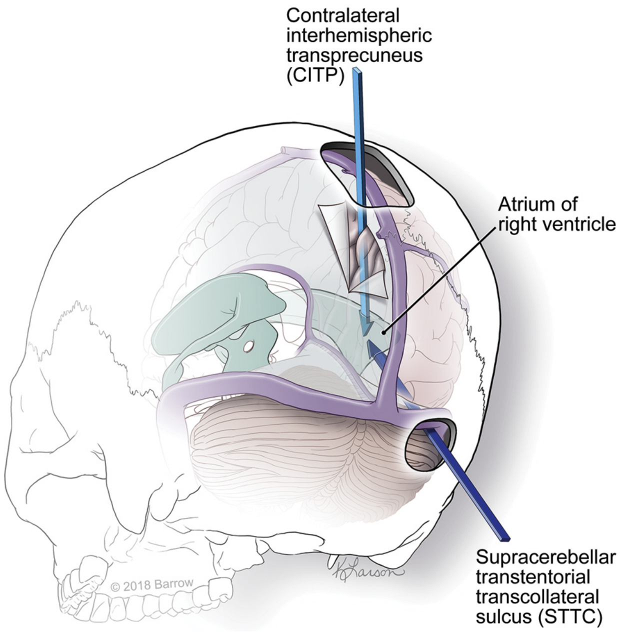


Figure 1. Schematic illustration of 2 approaches accessing the atrium of the right ventricle. (Used with permission from Barrow Neurological Institute, Phoenix, Arizona.)

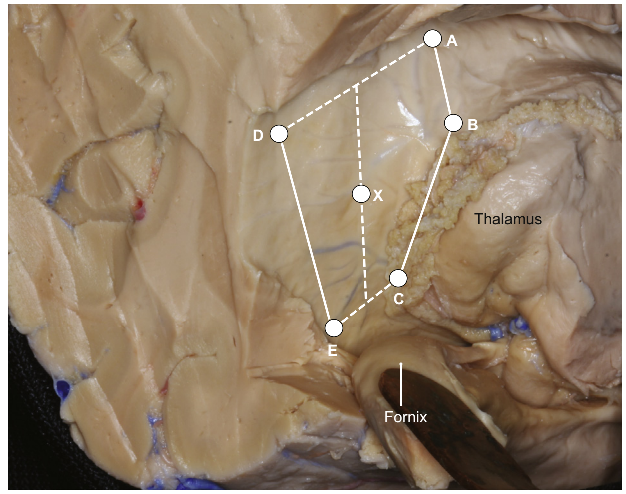


Figure 2. Posterior medial view of a cadaveric dissection of the lateral wall of the atrium of the left ventricle. The occipital lobe was sharply removed; the left fornix was sharply resected and retracted medially by the retractor. The approximate positions of the 6 points that define the area of exposure are as follows: *point A*, the anterior superior reachable point on the lateral wall of the atrium of the lateral ventricle; *point B*, the anterior reachable point along the choroid plexus; *point C*, the most posterior aspect of the pulvinar; *point D*, the posterior superior reachable point; *point E*, the posterior inferior reachable point; and *point X*, the midpoint of the connecting line of the midpoints of the lines *AD* and *CE*, approximately representing the center of the exposure. (Used with permission from Barrow Neurological Institute, Phoenix, Arizona.)

imaging (MRI) scans of the heads were obtained before dissection and were uploaded into the navigation system (Stealth-Station Image Guidance Workstation, Medtronic Surgical Navigation Technologies, Minneapolis, Minnesota, USA). Each head was rigidly fixed in a Mayfield head holder in the proper surgical position and registered into the neuronavigation system.

The distances of the most posterior aspect of the choroid plexus to the bone window plane and the length of the cortical transgression were measured. Distances among 6 points on the lateral wall were established to estimate and compare the area of exposure and surgical freedom. The angles of attack in the rostrocaudal and mediolateral directions were measured and compared. The image-guided surgical system was used to record the coordinates and measurements of the working distance, working angle, and surgical exposure according to previously established methods.[9-11] The results are reported as the mean ± standard deviation. The submillimeter measurements reported by the navigation system were rounded to the closest whole millimeter for practicality and to reflect typical surgical practice.

Area of Exposure

The coordinates of the 6 points on the lateral wall of the atrium under endoscopic view were recorded using a stereotactic navigation probe (Figure 2). The 6 points were as follows: point A, the most anterior superior reachable point along the junction of the roof and lateral wall of the lateral ventricle; point B, the most anterior reachable point on the choroid plexus; point C, the most posterior point of the choroid plexus; point D, the most posterior superior reachable point along the junction of the lateral wall and roof of the lateral ventricle; point E, the most posterior inferior reachable point along the junction of the collateral trigone and lateral wall; and point X, the midpoint of the connection of the midpoints of lines *AD* and *CE*, representing the center of the area of exposure. The areas of exposure were not identical in the 2 approaches. The area was calculated by the summing the areas of the triangles *ABC*, *ACD*, and *CDE*.

Surgical Freedom

Surgical freedom was defined as the maximum allowable working area (mm^2) at the proximal end of the 190-mm probe, with the distal end on the target. This area was determined by calculating the quadrilateral area formed when the distal end of the probe was first placed at the anatomical target and then for each target, moving as medial—rostral, medial—caudal, lateral—rostral, and lateral—caudal as possible. The movement of the probe shaft could be limited by the corner of the rectangular bone window, cortical window, or brain surface. The area was calculated by treating the quadrilateral area as 2 juxtaposed triangles. Using Statistica (TIBCO Software Inc., Palo Alto, California, USA), we created a color diagram of the surgical freedom across the area of exposure.[9]

Angle of Attack

The angle of attack was defined as the maximum allowable angle of approach in the axial (mediolateral) and sagittal (rostrocaudal) planes. These measurements were determined by moving the proximal end of the probe in each direction, with the distal end placed at each target. The angle-of-attack measurements were also rounded to the closest whole degree for surgical practicality.

Statistical Analysis

Calculation of the surgical freedom, angle of attack, distance, and area of exposure was performed using Microsoft Excel 2013 (Microsoft Corp., Redmond, Washington, USA). The statistical comparisons were performed using PASW Statistics, version 18.0.0 (IBM Corp., Armonk, New York, USA). The paired t test was used to compare the attributes between the approaches; $P < 0.05$ was considered to indicate statistical significance. Heron's formula was used to calculate the sizes of the triangles, and the equations of the inverse trigonometric functions were used to calculate the angles.

RESULTS

Working Distance and Cortical Transgression

The differences in the distances from the craniotomy edge to the posterior pole of the choroid plexus for the CITP (67 ± 5.3 mm) and the STTC (57 ± 4.0 mm) were statistically significant ($P < 0.01$). The cortical transgression length of the CITP (27 ± 2.8 mm) was significantly greater than that of the STTC (20 ± 6.7 mm; $P = 0.03$).

Area of Exposure

The area of exposure of the STTC (297 ± 91.0 mm^2) and CITP (215 ± 56.8 mm^2) did not differ significantly ($P = 0.07$). We subjectively observed that the CITP offered exposure to the more anterior and superior part of the atrium, including the superior surface of the thalamus and the anterior part of the choroid plexus. The STTC offered exposure to the posterior and inferior region, including the lower part of the choroid plexus, pulvinar, and entrance to the temporal horn.

Surgical Freedom

The surgical freedom is demonstrated in Figure 3. Surgical freedom did not differ at any target point between the 2 approaches, except for point E, for which the STTC afforded significantly greater surgical freedom (3384 ± 1054.6 mm^2) compared with the CITP (1296 ± 783.8 mm^2; $P = 0.03$; Figure 4A). Although no statistically significant difference was found (Table 1), we did find some variation in the mean surgical freedom along the lateral wall of the atrium (Figures 3 and 4).

Angle of Attack

In the mediolateral plane, the STTC offered a significantly wider angle of attack (30° ± 5.0°) than the CITP (12° ± 1.5°; $P < 0.01$; Figure 4B). The CITP had a wider rostrocaudal angle (22° ± 4.6°) than did the STTC (13° ± 2.6°; $P = 0.01$; Figure 4B).

Case Description

Both patients gave written informed consent for surgical treatment. Both cases were performed microscopically with endoscope assistance. Institutional review board approval was not sought because the patients were not participating in a clinical study.

Patient 1. A 69-year-old man had presented to the emergency room with altered mental status, a history of frontal headaches, and left homonymous hemianopia. MRI showed a heterogeneously enhancing right mesial precuneus lesion (Figure 5A–C). The patient underwent a left CITP, leading to gross total resection of the tumor (Figure 5D–I and Supplemental Video 1). Postoperatively, the patient noted an improvement in his visual field defect. The patient was neurologically

Video

Video available at www.sciencedirect.com

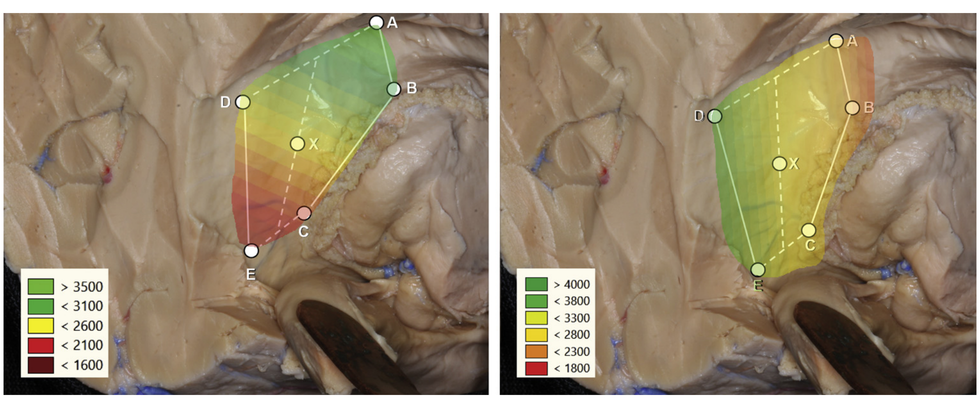


Figure 3. Comparison of the surgical freedom (mm^2) to the lateral wall of the atrium for (**Left**) contralateral interhemispheric transprecuneus and (**Right**) supracerebellar transtentorial transcollateral sulcus approaches. A gradient color map representing the mean area of surgical freedom (points *A*, *B*, *C*, *D*, *E*, and *X*, as defined in Figure 2) shown imposed on photographs of the cadaveric specimen. *Green* represents greater surgical freedom; *red* represents less surgical freedom. Values in the color gradient are in mm^2. (Used with permission from Barrow Neurological Institute, Phoenix, Arizona.)

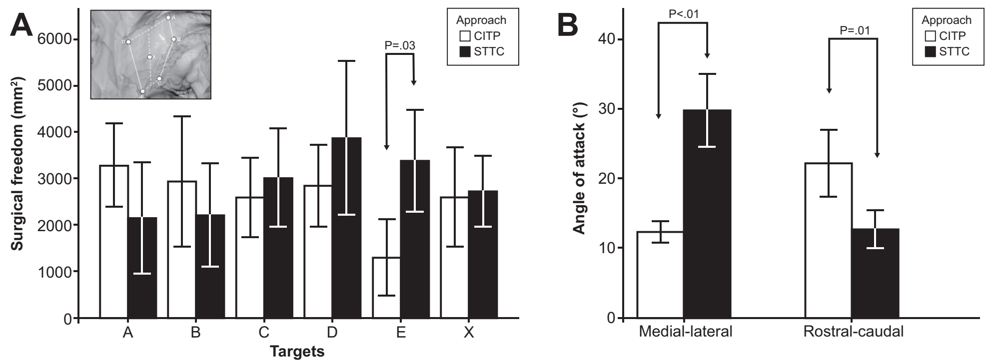


Figure 4. (**A**) Graphic illustration comparing the surgical freedom for contralateral interhemispheric transprecuneus approach (CITP) and supracerebellar transtentorial transcollateral sulcus approach (STTC). The STTC offers greater surgical freedom at point E, the posterior inferior reachable point. (**B**) Graphic illustration comparing the angle of attack for CITP and STTC. STTC offers a wider angle of attack in the medial-to-lateral direction, and CITP provides a greater angle of attack in a rostrocaudal direction. (Used with permission from Barrow Neurological Institute, Phoenix, Arizona.)

stable and was discharged on postoperative day 3. The histopathological diagnosis was metastatic non—small-cell lung carcinoma.

Patient 2. A 33-year-old woman had presented with an episode of complex partial seizure, imbalance, discoordination, and worsening of short-term memory. The preoperative MRI showed a right posterior temporal heterogeneous ring-enhancing lesion with a mass effect and surrounding edema (**Figure 6A—C**). The patient underwent a right STTC with gross total resection of a glioblastoma (**Figure 6D—I** and **Supplemental Video 2**). The patient recovered well and was discharged on postoperative day 3.

DISCUSSION

The surgical approach into the atrium of the lateral ventricle is challenging because of its deep location and the vicinity of eloquent structures, such as the pulvinar and fornix.[12] Anatomically, the atrium of the lateral ventricle is bordered anterosuperiorly by the body of the lateral ventricle and anteroinferiorly by the temporal horn of the lateral ventricle.[5,13] The roof of the atrium is formed by the body, splenium, and tapetum of the corpus callosum. The calcar avis is located inferiorly, and the bulb of the corpus callosum overlying the forceps major is located superiorly of its medial wall. The tapetum of the corpus callosum separates the fibers of optic radiation and the atrium; together, they form the lateral wall of the atrium. The floor of the atrium is formed by the collateral trigone, which is the intraventricular eminence of the collateral sulcus.[5,12,13] The optic radiation originates at the lateral geniculate body and travels in the roof and lateral wall of the temporal horn.[14,15] Three groups of fibers of Meyer's loop configure the temporal horn as it travels posteriorly. The roof and lateral wall of the atrium are covered by the optic radiation and the tapetum of the corpus callosum.[13]

The atrium of the lateral ventricle is a common location for neoplastic lesions such as choroid plexus papilloma, ependymoma, meningioma, astrocytoma, central neurocytoma, and others.[16-19] Vascular lesions such as arteriovenous malformations have also been found in the atrium of the lateral ventricles.[20] The location of the atrium makes transgressing cortical structures mandatory with most approaches.[17] Conventionally, transgression of the middle temporal gyrus or superior parietal lobule has been widely used to access the atrium of the lateral ventricle.[21] The middle temporal gyrus approach offers the shortest trajectory but is often associated with partial or complete homonymous hemianopia, resulting from damage to the optic radiations that pass along the lateral wall and roof of the atrium.[22,23] The superior parietal lobule approach is unlikely to damage the optic radiations but has been associated with a high risk of postoperative language dysfunction, with the potential for the development of Gerstmann syndrome of the dominant side or hemineglect syndrome of the nondominant side.[12,21]

Two novel minimally invasive approaches have been applied to avoid optic radiation damage when treating lesions in the atrium: the CITP[1-4] and STTC.[5-8] Using an endoscope, surgeons can obtain

Table 1. Comparison of Surgical Freedom to Each Target

	Surgical Freedom (mm^2)		
Target	CITP	STTC	*P* Value
A	3291 ± 854	2153 ± 1141	0.06
B	2935 ± 1339	2210 ± 1055	0.24
C	2595 ± 816	3019 ± 1014	0.32
D	2849 ± 838	3872 ± 1587	0.32
E	1296 ± 784	3384 ± 1055	0.03
X	2594 ± 1020	2726 ± 726	0.77

Data presented mean ± standard deviation.
CITP, contralateral interhemispheric transprecuneus approach; STTC, supracerebellar transtentorial transcollateral sulcus approach.

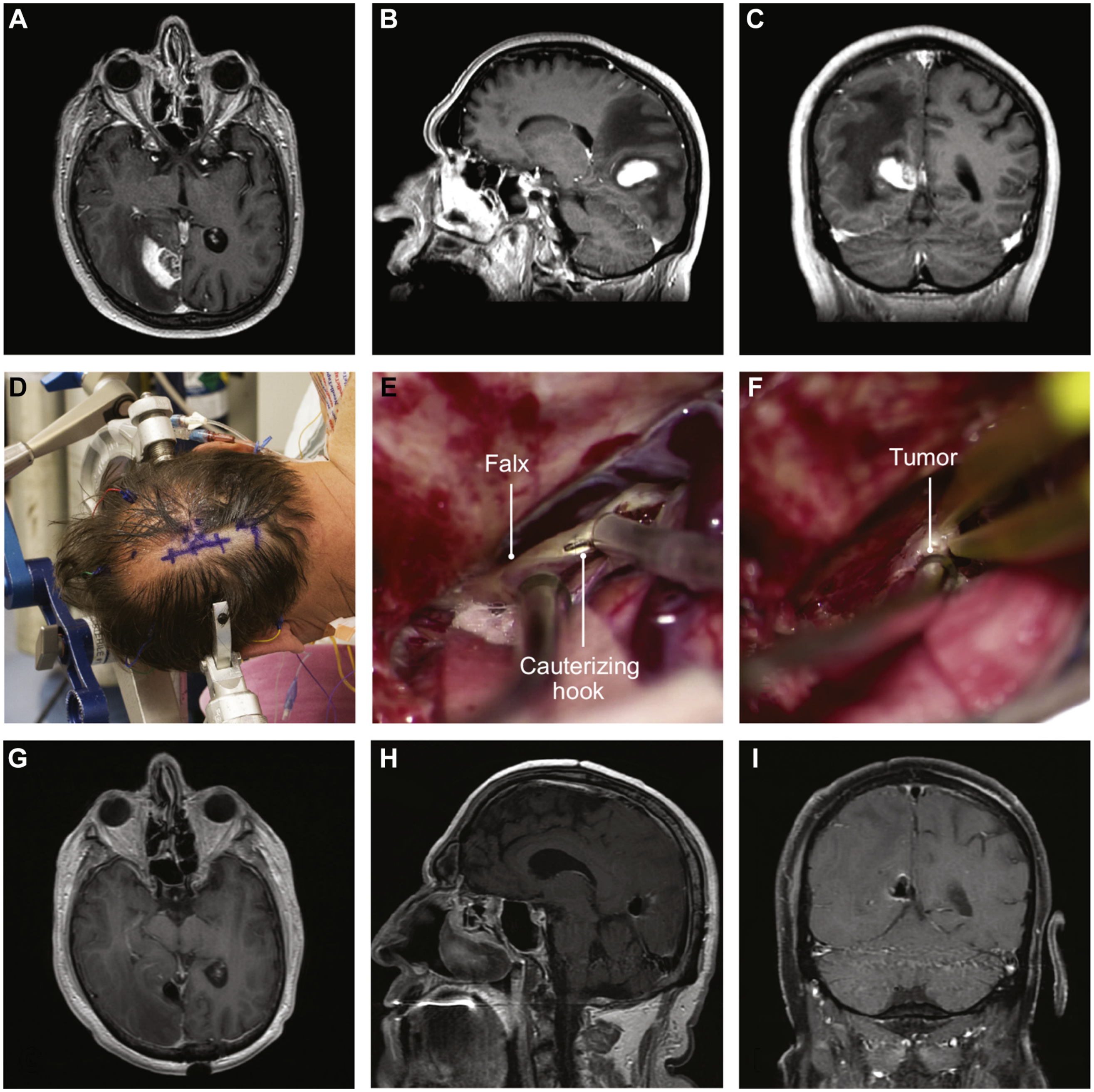


Figure 5. (**A**–**C**) Preoperative T1-weighted contrast-enhanced magnetic resonance images in axial, sagittal, and coronal views showing a contrast-enhancing heterogeneous lesion located in the proximity of the right mesial precuneus gyrus. (**D**) Photograph of patient in the three-quarter prone position and a linear midline skin incision marked. (**E**) Opening of the falx using a cauterizing hook. (**F**) The tumor was reached through a transprecuneus approach, and resection was performed using bipolar coagulation. (**G**–**I**) Postoperative T1-weighted contrast-enhanced magnetic resonance images in axial, sagittal, and coronal views confirming gross total resection of the lesion. (Used with permission from Barrow Neurological Institute, Phoenix, Arizona.)

close, high-quality images that allow for identification of residual tumor and blood clot, resulting in more extensive removal, which can reduce postoperative complications such as hydrocephalus and fever.[24]

Contralateral Interhemispheric Transprecuneus Approach

The CITP was first described by Wang et al.[3] in 2010. They had modified it from the ipsilateral transprecuneus approach.[25,26] The posterior interhemispheric transcallosal approach is a similar

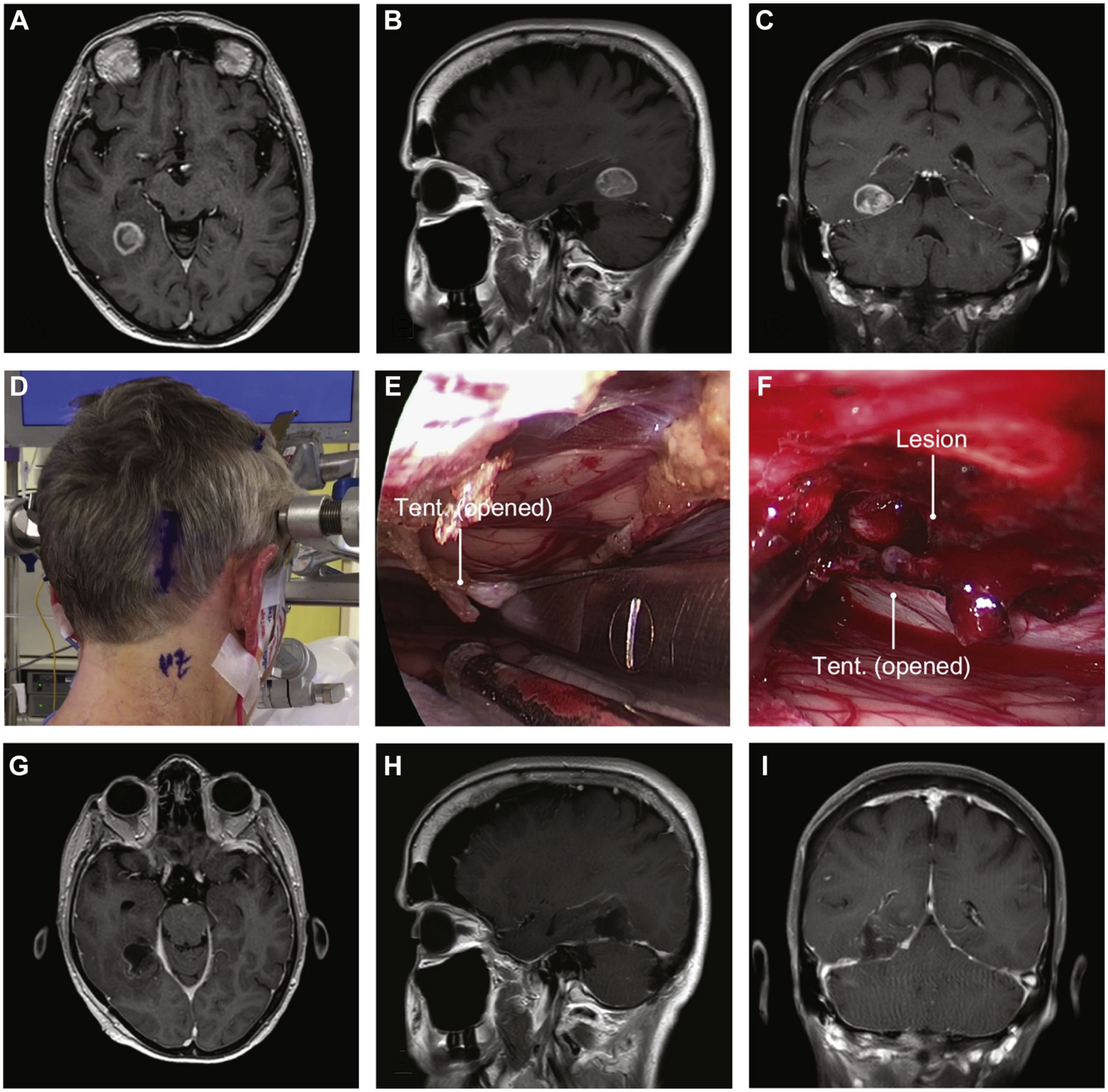
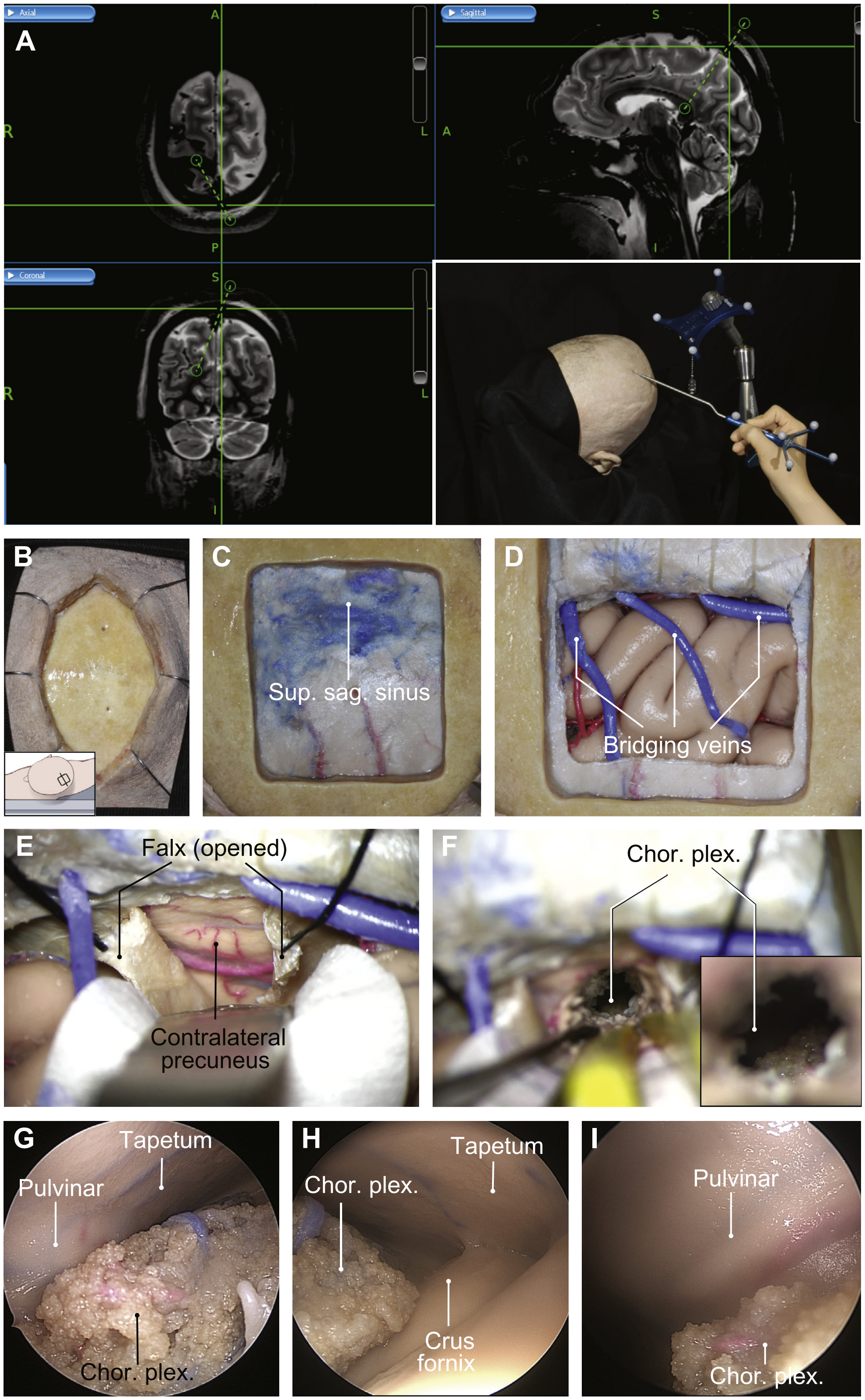


Figure 6. (**A**—**C**) Preoperative T1-weighted contrast-enhanced magnetic resonance images in axial, sagittal, and coronal views showing a right posterior temporal heterogeneous ring-enhancing lesion and surrounding edema. (**D**) Photograph of a patient placed in the seated position with a linear incision marked. (**E**) The tentorium was opened with microscissors. (**F**) The lesion was accessed through a transcollateral approach. (**G**—**I**) Postoperative T1-weighted contrast-enhanced magnetic resonance images in axial, sagittal, and coronal views confirming gross total resection of the lesion. Tent., tentorium. (Used with permission from Barrow Neurological Institute, Phoenix, Arizona.)

approach to access the atrium[27] and is more suitable for lesions that extend to the superior corpus callosum (**Supplemental Video 1**).[3] For the CITP, a three-quarter prone or Concord position with the head rotated such that the contralateral side is down will allows for gravity-assisted retraction of the hemisphere and creation of a greater surgical space (**Figure 7A**). A linear incision perpendicular to the sagittal sinus near the lambda suture is made, and a 3- × 4-cm craniotomy located just anterior to the parieto-occipital sulcus is performed with the assistance of neuronavigation. This zone is located at the posterior part of the condensed bridging vein plexus and has relatively fewer bridging veins (**Figure 7B—D**).[28] The falx can then be opened using various techniques such as a T-shaped


A
Axial
Sagittal
Coronal
B
C
Sup. sag. sinus
D
Bridging veins
E
Falx (opened)
Contralateral precuneus
F
Chor. plex.
G
Tapetum
Pulvinar
Chor. plex.
H
Chor. plex.
Tapetum
Crus fornix
I
Pulvinar
Chor. plex.

incision (Figure 7E),[1] a C-shaped incision along the superior sagittal sinus,[4] or an angled incision along the junction of the superior sagittal sinus and straight sinus.[3] However, cautious attention is required during the opening of the falx because of its complex relationships with the straight sinus, inferior sagittal sinus, and falcine venous plexus.[4] Entering the atrium using these general guidelines with image guidance is reliable. However, without navigation, the atrium can be reached and entered through a cortical window centered ~2.5 cm inferior to the most superior aspect of the precuneus and 1 cm anterior to the parieto-occipital sulcus, with an approximate trajectory angle of 15°, relative to the falx. The transverse parietal sulcus is a good landmark for the cortical opening site (Figure 7F). Various endoscopic perspectives of the atrium have been illustrated in Figure 7G–I and Supplemental Video 1.

Although the medial wall of the lateral ventricle has been shown to be entirely separate from the optic radiation,[29] ~21% patients will still develop a new visual field deficit after surgery.[1] Aggressive coagulation of the choroid plexus and ependymal passage vessels could be a potential explanation for this phenomenon. Temporary memory impairment has also been reported[30] because self-awareness and short-term memory are functions located in the precuneus gyrus area.[31,32] The CITP also requires some retraction on the contralateral side of the occipital lobe, which could potentially cause a transient visual deficit.[33] The advantage of the CITP is the "cross-court" working angle and dynamic retraction, which afford a more ample work zone.[1] In addition, for peritrigonal arteriovenous malformations, the CITP offers a relatively direct route and early control of arterial feeders and drainage.[34]

Supracerebellar Transtentorial Transcollateral Sulcus Approach

The STTC was first described in 2006 by Kawashima et al.[12] and demonstrated in a cadaver study by İzci et al.[5] No optic radiation fibers will be found in the floor of the atrium or between the atrium and collateral sulcus. The rationale to choose the collateral sulcus as a distinct entry site is that the collateral sulcus is the most consistent landmark on the basal surface of occipital and temporal lobes[6,35] (Figure 8A). The collateral sulcus is the deepest sulcus on the occipital basal surface and offers the closest corridor to the atrium.[36] In addition, the only white fibers that would be transgressed are the U fibers of the collateral sulcus. The optic radiation fibers, which are located on the lateral wall and roof of the ventricle, would be preserved.[5]

Patient positioning in the seated or the three-quarters prone positions has been used in clinical series.[7,8] Midline, paramedian, and retrosigmoid incisions and craniotomies have been performed in different studies (Supplemental Video 2).[5-8] We used a paramedian approach (Figure 8B–D) for dissection for the following reasons: 1) to avoid bridging vein sacrifice around the midline[37]; 2) to obtain direct access to the collateral sulcus; 3) to allow for a choice of patient position (i.e., sitting or three-quarters prone); and 4) to preserve the range of movement along the sagittal plane, which is wider as the cerebellum slopes downward laterally.[6]

After opening the tentorium in a T-shaped fashion, we immediately encountered the collateral sulcus. With the assistance of navigation, a transcollateral sulcus approach was performed, and the atrium of the lateral ventricle was entered (Figure 8E and F). Endoscopic views of the atrium are illustrated in Figure 8G–I and Supplemental Video 2.

Previous clinical studies have reported successful removal of different types of lesions in the atrium.[7,8] The STTC has the disadvantage of a deep and narrow corridor, which makes neuronavigation imperative. Additionally, a preoperative ophthalmologic assessment and preoperative analysis of the contour of the optic radiation using diffusion tensor imaging[8] and the tentorial slope using MRI are recommended.[7]

Endoscopic View and Accessibility Comparison

The endoscope provides advantages when addressing a deeply located lesion through a narrow trajectory, offering a close-up view and wider "around-the-corner" visualization, especially with the patient in the semi-sitting position such as in the STTC.[38-40] We used the endoscope for both the CITP and STTC. We compared the distance to the target and the length of the cortical transgression. The STTC resulted in a shorter working distance and a shorter transgression. We found that the trajectory was relatively straightforward with the STTC because the concavity of the collateral sulcus shortens the length of the passage through the cortex.

The areas of exposure were shown to be different for the 2 approaches. For CITP, we found a better view of the anterior part of the choroid plexus, superior surface of the thalamus, and body of the lateral ventricle. Nonetheless, the CITP was inadequate for exposure of the entrance to the temporal horn; however, the entrance to the occipital horn was exposed, and the entire occipital horn was accessible. In contrast, the STTC was better for exposure of the lower part of the choroid plexus, entrance to the temporal horn, pulvinar, and trigone area. The STTC also offered access to the calcar avis, medial wall of the atrium of the lateral ventricle, and tapetum of the corpus callosum. The posterior part of the body of the lateral ventricle was reachable; however, the STTC allowed for an exposure that was further posterior compared with that with the CITP. During our dissection, although the microscope revealed a view of the upper part of the atrium and

Figure 7. (**A**) Identification of the surgical trajectory for contralateral interhemispheric transprecuneus approach using neuronavigation. (**B**) A linear incision perpendicular to sagittal sinus was made near the lambdoid suture. (**C**) A 3- × 4-cm craniotomy was performed exposing the superior sagittal sinus. (**D**) The dura mater was reflected superiorly, and the underlying bridging veins were visualized. (**E** and **F**) After opening the falx, the contralateral precuneus gyri were visualized, and the atrium was accessed with the aid of a small cortical window. Endoscopic views of the (**G**) entrance to the body of the lateral ventricle and choroid plexus and ventricle (**H**) medial to the choroid plexus and (**I**) lateral to the choroid plexus showing the pulvinar. Chor. Plex., choroid plexus; Sup. Sag., superior sagittal. (**A–I**, **A Inset**, and **F Inset** used with permission from Barrow Neurological Institute, Phoenix, Arizona; **B Inset** used with permission from Thieme, New York, New York.)

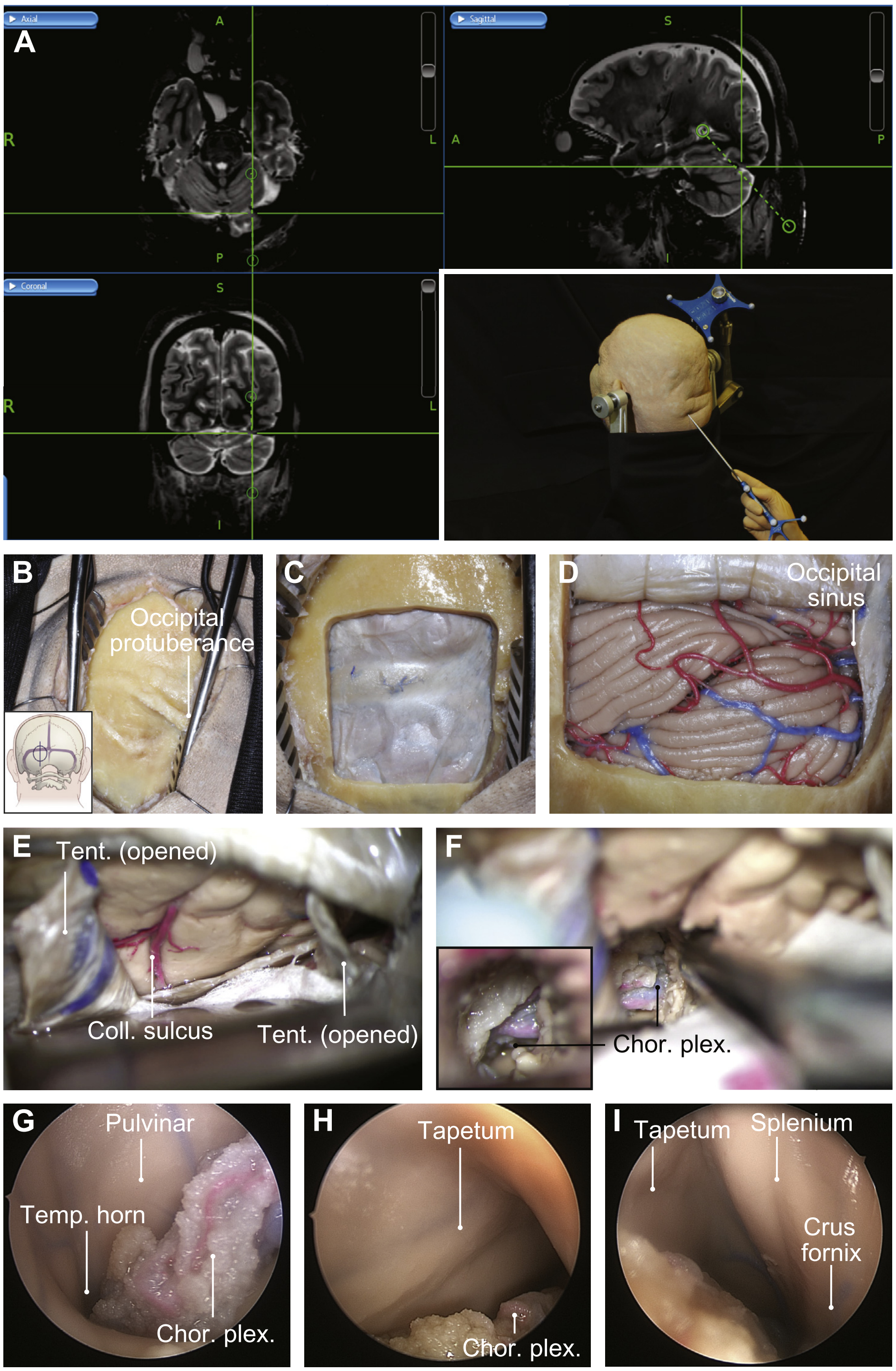


Figure 8. (**A**) Identification of the surgical trajectory for supracerebellar transtentorial transcollateral sulcus approach using neuronavigation. (**B**) Subcutaneous dissection and bony exposure using the occipital protuberance as a landmark to identify the underlying transverse sinus. (Inset) Miniature illustration highlights the craniotomy site. (**C**) A lateral 4- × 4-cm square-shaped craniotomy centered 1 cm anterior to the parieto-occipital sulcus. (**D**) Reflection of dura superiorly and exposure of the left cerebellar hemisphere along with partial exposure of the occipital sinus. (**E**,**F**) After opening the tentorium, the collateral sulcus was identified; with the assistance of neuronavigation, a transcollateral approach was performed. Endoscopic views of the (**G**) temporal horn of the left lateral ventricle, (**H**) entrance to the body of the lateral ventricle, and (**I**) medial to the choroid plexus. Chor. Plex., choroid plexus; Coll., collateral; Temp., temporal; Tent. Tentorium. (Used with permission from Barrow Neurological Institute, Phoenix, Arizona.)

body of the lateral ventricle with the CITP, it was difficult to expose the floor of the atrium. With the assistance of the endoscope, the trigone area can be easily exposed. With the STTC, dissection of the atrium region under microscope visualization was unsuitable because the trajectory was directed upward; thus, such an angle for visual guidance was only feasible with endoscopic assistance.

When accessing the pulvinar, we observed that the CITP had a larger angle of access in the rostrocaudal plane, and the STTC provided a larger mediolateral angle for access. The mediolateral angle of the CITP was limited by the falx and parietal lobe, and the rostrocaudal angle of the STTC was confined by the tentorium and superior surface of the cerebellum.

No statistically significant difference was found in the surgical freedom for any of the predefined targets, except for point E. Although the results showed a difference in the average surgical freedom, the standard deviation was large owing to the variable size of the ventricles. We found that the CITP provided better surgical freedom to the anterior part of the atrium (points A and B) and that the STTC provided better surgical freedom to the posterior part of the atrium (points D and E). For lesions in the pulvinar, although similar results in surgical freedom were found, we concluded that the STTC was more favorable than the CITP because the STTC offered a direct view to the pulvinar posteriorly. In contrast, the CITP offered access only to the medial surface of the pulvinar.

Study Limitations

The surgical freedom and area of exposure were assessed using the probe. The shaft of the probe could be restrained by the cortical window, bone window, or brain surface owing to the long working distance to the deep target. The cortical window and brain retraction are associated with the compliance of the brain tissue, which varies from cadaver to cadaver. Also, these are not comparable to those of live brain tissue. The ventricle size is another important factor that could affect the quantitative measurements. In our dissection, we noted the relatively small surgical freedom for small ventricles and relatively larger surgical freedom for larger ventricles, which could be a possible reason for the large *P* value due to inconsistency of the data. Although we used automated navigation, slight differences in the head position, location of the cortical opening, and entry angle could also have affected the results. Nonetheless, a cadaver study provides valuable insight into the feasibility of these 2 approaches.

CONCLUSIONS

Endoscopic CITP and STTC approaches are feasible for accessing lesions in the atrium of the lateral ventricle. The CITP has a deeper working distance and longer cortical transgression than the STTC. The CITP has a wider angle of attack in the rostrocaudal plane, and the STTC has a wider mediolateral working angle. The CITP is more favorable than the STTC for addressing the upper part of the lateral wall of the atrium because it offers greater maneuverability. The STTC is a more preferable approach for reaching the lower part of the atrium, including the pulvinar because it offers a shorter working distance and is able to control the choroid plexus from both sides. The endoscope is essential for these 2 approaches because it allows for a high-quality magnified view in a flexible direction, which cannot be offered by a microscope.

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