Supracerebellar transtentorial approach—resection of the tentorium instead of an opening—to provide broad exposure of the mediobasal temporal lobe: anatomical aspects and surgical applications

Clinical article

JEAN G. de OLIVEIRA, M.D., PH.D.,1,2 RICHARD GONZALO PARRAGA, M.D.,1 FERES CHADDA-NETO, M.D., PH.D.,1,3 GUILHERME CARVALHAL RIBAS, M.D., PH.D.,1,4,5 AND EVANDRO P. L. DE OLIVEIRA, M.D., PH.D.1,3

1Microneurosurgery Laboratory, Institute of Neurological Sciences, Hospital Beneficência Portuguesa de São Paulo; 2Division of Neurosurgery, School of Medicine, University Nove de Julho, São Paulo; “Clinical Anatomy Discipline, Department of Surgery—Laboratório de Investigação Médica—02, University of São Paulo Medical School; 3Hospital Israelita Albert Einstein, São Paulo; and 4Division of Neurosurgery, School of Medicine, State University of Campinas, Brazil

Object. The aim of this study was to describe the surgical anatomy of the mediobasal aspect of the temporal lobe and the supracerebellar transtentorial (SCTT) approach performed not with an opening, but with the resection of the tentorium, as an alternative route for the neurosurgical management of vascular and tumoral lesions arising from this region.

Methods. Cadaveric specimens were used to illustrate the surgical anatomy of the mediobasal region of the temporal lobe. Demographic aspects, characteristics of lesions, clinical presentation, surgical results, follow-up findings, and outcomes were retrospectively reviewed for patients referred to receive the SCTT approach with tentorial resection.

Results. Ten patients (83%) were female and 2 (17%) were male. Their ages ranged from 6 to 59 years (mean 34.5 ± 15.8 years). All lesions (3 posterior cerebral artery aneurysms, 3 arteriovenous malformations, 3 cavernous malformations, and 3 tumors) were completely excluded or resected. After a mean follow-up period of 143 months (range 10–240 months), the mean postoperative Glasgow Outcome Scale score was 4.9.

Conclusions. Knowledge of the surgical anatomy provides improvement for microsurgical approaches. The evolution from a small opening to a resection of the tentorium absolutely changed the exposure of the mediobasal aspect of the temporal lobe. The SCTT approach with tentorial resection is an excellent alternative route to the posterior part of mediobasal aspect of the temporal lobe, and it was enough to achieve the best neurosurgical management of tumoral and vascular lesions located in this area.


Key Words • anatomy • aneurysm • arteriovenous malformation • brain tumor surgery • cavernous malformation • supracerebellar transtentorial approach • diagnostic and operative techniques

Lesions arising from the mediobasal aspect of the temporal lobe are usually treated using a subtemporal, transtemporal, transsylvian, or interhemispheric parietooccipital approach.1,9 The retraction required in the subtemporal approach may cause temporal lobe injury by direct contusion or venous infarction as a consequence of injury to the vein of Labbé complex, which is undesirable especially to the dominant hemisphere.1 The transtemporal approach produces lesions of the temporal cortex, which should also be avoided in the dominant side, and may cause injury to optic radiations if the entrance into the temporal horn is extended posteriorly through its lateral wall.1,9 Whereas the transinsular variant of the transsylvian approach may cause optic radiations injury when the inferior insular sulcus is opened posteriorly, the transcisternal variant provides a deep and narrow window with limited access to the posterior part of the medial temporal region.1

In 1976, Voigt and Yaşargil10 showed that an opening of the tentorium via a supracerebellar infratentorial approach could expose the medial aspect of the temporal lobe, when they successfully resected a cavernous malfor-
mation located in the left parahippocampal gyrus. Since then, several authors have published their experience using the supracerebellar transtentorial approach for different kinds of lesions.\(^1\)\(^-\)\(^4\),\(^6\)\(^-\)\(^8\),\(^12\)\(^-\)\(^15\),\(^17\)\(^-\)\(^19\) We have been using this approach for more than 20 years, and after some cases we realized that if the tentorium was resected, instead of a small opening, it could provide a larger window to the mediobasal surface of the temporal lobe.

This study presents the surgical anatomy of the SCTT approach for the mediobasal aspect of the temporal lobe in cadavers, as well as a consecutive series of patients whose lesions were approached via an SCTT approach with a broad resection of the tentorium.

**Methods**

A retrospective analysis of the personal experience of the senior author (E.P.L.O.) using the SCTT with tentorial resection was performed. Medical records, radiographic studies, surgical videos, and clinical follow-up evaluations of the patients were retrospectively reviewed. The microsurgical laboratory of the Institute of Neurological Sciences, Hospital Beneficiência Portuguesa de São Paulo provided formalin-fixed specimens used for this study to illustrate the surgical anatomy aspects.

**Surgical Anatomy of the Mediobasal Temporal Region**

**Neural Structures.** The mediobasal aspect of the temporal lobe was previously divided into the following parts: anterior, middle, and posterior.\(^1\) The anterior part is limited posteriorly by the transverse imaginary line passing at the posterior limit of the uncus, whereas the middle and posterior parts are separated by the anterior splenial line (Fig. 1).\(^1\)\(^,\)\(^2\)\(^,\)\(^10\)\(^,\)\(^11\)

The anterior part may also be divided into anterosuperior, inferior, and medial surfaces. The anterosuperior surface has the semilunar and ambient gyri, which face the sylvian fissure and the carotid cistern. The inferior surface is composed of the parahippocampal gyrus, which is separated anterolaterally from the occipitotemporal gyrus by the rhinal sulcus. In 28% of cases, the rhinal sulcus runs posteriorly in the middle part of the mediobasal temporal region, called the collateral sulcus. The anterior part of the parahippocampal gyrus and the uncus are the components of the medial surface, which are facing the anterior two-thirds of the cerebral peduncle, with the crural cistern interposed between the peduncle and the uncus.

The middle part of the mediobasal aspect of the temporal lobe is composed of the inferior and medial surfaces. The inferior surface has the collateral sulcus that separates the medial aspect of the parahippocampal gyrus from the occipitotemporal gyrus lateral to the occipital temporal gyrus. The occipitotemporal sulcus separates the inferior temporal from the occipitotemporal gyrus. At the level of the anterior splenial line, where the parahippocampal gyrus ends, the lingual gyrus continues posteriorly and the isthmus of the cingulated gyrus runs posteriorly and superiorly. The occipitotemporal gyrus extends from the anterior temporal base to the occipital pole, whereas the collateral sulcus extends from the anterior to posterior part of the mediobasal temporal region. In 36% of the cases, the occipitotemporal sulcus courses close to the inferolateral margin of the temporal lobe, over the temporal base. The subiculum of the parahippocampal gyrus, the dentate gyrus, and the fimbria of the fornix are the medial surface’s components of the middle part. This surface faces the posterior one-third of the cerebral peduncle and the tegmentum of the midbrain, and is separated from them by the ambient cistern.

The posterior part of the mediobasal region of the temporal lobe includes part of the occipital and parasplenial area and has 3 surfaces: inferior, medial, and anterior. The inferior surface has the lingual gyrus, which is in continuation with the parahippocampal gyrus and is separated laterally from the occipitotemporal gyrus by the collateral sulcus. The medial surface includes the parasplenial region and contains the isthmus of the cingulated gyrus, the splenium of the corpus callosum, and the inferior part of the precuneus. The anterior surface is formed by the anterior end of the isthmus of the cingulated gyrus, the posterior end of the dentate gyrus, and the fascicular gyrus, which is continuous anteriorly with the dentate gyrus. The posterior aspect of the ambient cistern and the quadrigeminal cistern separates the anterior surface from the tectum of midbrain and the pulvinar of the thalamus.

**Arterial Supply.** The early branches of the M1 segment of the MCA are responsible for the arterial supply of the anterior surface of the anterior part. The most medial area of this surface may receive a branch from the ICA, and also receives a branch from the AChA, called the uncal artery. The hippocampal arteries, which are branches from the first cortical branch of the PCA, supply the inferior surface. Branches from the AChA and the hippocampal artery are responsible for the medial surface’s supply.\(^1\)\(^,\)\(^2\)\(^,\)\(^10\)\(^,\)\(^11\)

The inferior surface of the middle part of the mediobasal temporal region receives branches from the PCA: the anterior, middle, and posterior temporal arteries, which originate in the lateral surface of the PCA, pass through the ambient cistern, and cross the tentorial edge to reach the temporal base. These arteries pass under the parahippocampal gyrus, enter the collateral sulcus, run over the occipitotemporal gyrus, enter the occipitotemporal sulcus, and end over the surface of the inferior temporal gyrus. The medial surface of the middle part is supplied by the AChA, which enters through the choroidal fissure at its anteroinferior end, also called the inferior choroidal point. In addition, several PChAs enter the choroidal fissure posteriorly to the AChA.

The posterior part of the mediobasal temporal region is supplied by the terminal branches of the PCA, the parietooccipital and calcine arteries, which cross postero-laterally over the anteroinferior part of the isthmus of the cingulated gyrus. While the parietooccipital artery supplies the posterior half of the precuneus and the anterior half of the cuneus, the calcine artery sends branches to the posterior half of the cuneus and to the lingual gyrus.

**Venous Drainage.** The basal vein complex is the main

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\(^1\)\(^2\)\(^10\)\(^11\)
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The uncal vein is responsible for the drainage of the anterosuperior surface of the anterior part of the medio-basal temporal region, and drains into the deep middle cerebral vein or directly into the first segment of the basal vein. The medial surface is also drained by the uncal vein and by the anterior hippocampal vein, which extends posteriorly into the main trunk of the inferior ventricular vein or directly into the second segment of the basal vein.

The inferior surface of the middle part of the medio-basal temporal region is drained by the medial temporal vein, which runs directly into the basal vein. The medial surface of the middle part is drained by the anterior longitudinal hippocampal vein, which drains into the inferior ventricular vein, anterior hippocampal vein, or into the basal vein at the level of the inferior choroidal point.

The venous drainage of the inferior surface of the posterior part of the medio-basal temporal region is basically composed of the occipitotemporal vein, which drains into the third segment of the basal vein. The internal occipital vein drains the medial surface of the one occipital lobe, and usually joins the posterior pericallosal vein at the level of the splenium, before terminating into the internal cerebral vein or even into the vein of Galen. On the anterior surface of this posterior part, the venous drainage is composed of the posterior longitudinal hippocampal vein, which may drain into the third segment of the basal vein, the internal cerebral vein, the lateral atrial vein, or the medial atrial vein.

Preoperative Assessment

All patients underwent neuroradiological investigation, which included CT scanning, MR imaging, and DS angiography studies. In addition, a preoperative echocardiography study is performed to evaluate the occurrence of patency of the foramen ovale, which increases the risk of air embolism.

Surgical Technique

All procedures were performed after induction of general anesthesia. Because of the risk of air embolism during the surgical procedure, a central venous catheter was placed in all patients to allow air aspiration. In addition, a precordial Doppler sonography probe was placed over the heart for the precise diagnosis. Sequential compression stockings are used in the lower extremities to prevent deep venous thrombosis.

The patient is placed in the semisitting position with the head flexed toward the floor and then fixed using the Sugita 4-point head-holder system (Mizuho America, Inc.). The elevation and flexion of the head should be done carefully to expose the suboccipital region, keeping the tentorium parallel to the floor, but cannot be exaggerated in a manner that compromises the venous jugular outflow. The legs should be semiflexed to make the venous out-
flow easier. The hair is shaved along the posterior middle cervical line to approximately 5 cm above the external occipital protuberance.

A vertical skin incision is performed in the midline, extending from the inion to the spinous process of the second cervical vertebra (C-2), which provides a broad exposure of the posterior fossa. The skin and subcutaneous planes are dissected together and reflected laterally with fish hooks. The craniotomy should be wide enough to expose the transverse sinus and the confluence of sinuses to allow a retraction of the tentorium superiorly, and to expose the transverse sinus–sigmoid sinus junction. Bone wax is used to occlude venous sinuses that may be opened during the craniotomy. The dura mater is opened with a U-shaped incision. The tentorial surface of cerebellum is exposed and the dura is tacked up with sutures to increase the exposure. Draining of CSF provides a relaxation of cerebellum, which also improves the exposure. The semisitting position creates a natural space between the tentorium and the cerebellum with the aid of gravitational forces.

Whenever possible, bridging veins should be saved and, when sacrifice is necessary, the ones from the superior aspect of the cerebellum should be divided to permit exposure to the incisural region between the anterior vermis and inferior surface of the tentorium. The veins must be coagulated as near the surface of the cerebellum as possible. Although we rarely use it, a self-retaining retractor may be placed on the culmen or quadrangular lobe to increase medial and lateral exposure, respectively. Part of the posterior parahippocampal gyrus may extend medially above the posterior part of the free edge of the tentorium, depending on the width of the posterior incisura. At this point, the tentorium is resected following the border of the transverse and sigmoid sinuses, exposing the whole medio-basal aspect of the temporal lobe (Fig. 2). Figure 3 illustrates step by step the resection of tentorium. The dissection continues following the parahippocampal gyrus, through the ambient cistern, until the visualization of uncus, third cranial nerve, AChA, and inferior ventricular vein. This broad exposure provided by the SCTT approach with tentorial resection allows a microsurgical approach for vascular and tumor lesions.

Postoperative Management

All patients were extubated in the operating room to avoid prolonged mechanical ventilation and sedation. After that, the patients remained in the neurointensive care unit for at least 48 hours. A postoperative neuroradiological evaluation was performed with CT scans and MR imaging studies for all patients, and DS angiography for those whose lesion was of a vascular nature.

Results

The demographic aspects, characteristics of lesions, clinical presentation, surgical results, follow-up findings, and outcomes are summarized in Table 1. Among the patients included in this series, 10 (83%) were female and 2 (17%) were male. The age of the patients ranged from 6 to 59 years (mean 34.5 ± 15.8 years).

Regarding the lesions, 3 were PCA aneurysms, 3 were AVMs, 3 were cavernous malformations, and 3 were tumors. All aneurysms were clipped completely; this was confirmed by postoperative DS angiography. Patients harboring AVMs were postoperatively evaluated with MR imaging and DS angiography that confirmed complete resection for all of them. Postoperative MR imaging confirmed complete resection of all tumors approached via SCTT with tentorial resection. The anatomopathological results were consistent with ganglioglioma for the patients with tumors.

After a mean follow-up period of 143 months (range 10–240 months), the mean postoperative GOS score was 4.9. Eleven patients (91%) were clinically in good condition (GOS Score 5); only 1 patient (9%) presented a visual deficit (GOS Score 4) at postoperative evaluation. Figures 4–7 and Video 1 represent illustrative cases.

Video 1. Intraoperative video illustrating the SCTT approach with tentorial resection for a 6-year-old girl presenting with epilepsy caused by a tumor arising from the medio-basal temporal region, whose anatomopathological results were consistent with ganglioglioma (see Fig. 4). Click here
Tentorial resection for wide approach to mediobasal temporal lobe

**Fig. 3.** Intraoperative photographs showing a step-by-step tentorial resection technique.  A and B: Cutting the tentorium on the border of the transverse sinus.  C: Cutting the tentorium on the border of the superior petrosal sinus.  D: The trochlear nerve entering the free border of the tentorium.  E and F: The tentorium is completely resected, revealing the posterior aspect of the mesial temporal lobe (Mes. Temp. Lobe).

to view with Windows Media Player. Click here to view with Quicktime.

**Discussion**

A perfect knowledge of the complex anatomy of the mediobasal aspect of the temporal lobe is paramount for the best management of lesions arising on this area. Several lesions may be found on this area, including AVMs, tumors, cavernous malformations, or even aneurysms, as we have shown in this series.

The approaches commonly used to try to reach this region include routes through the lateral, basal, medial, and superior surfaces of the temporal lobe. The superior surface includes the transsylvian-transinsular approach; the lateral surface includes transcortical approaches through the sulci and gyri on the lateral surface and anterior lobectomy with amygdalohippocampectomy; the basal surface includes approaches through the occipitotemporal, collateral, or rhinal sulci or even through the fusiform and parahippocampal gyri; and the medial surface may be approached anteriorly via a transsylvian transcisternal approach, and posteriorly via the occipito-interhemispheric and SCTT approaches.

**TABLE 1: Characteristics in 12 patients with intracranial lesions**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Lesion</th>
<th>Clinical Presentation</th>
<th>FU (mos)</th>
<th>GOS Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>44, M</td>
<td>PCA aneurysm</td>
<td>sudden HA; SAH</td>
<td>240</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>41, M</td>
<td>PCA aneurysm</td>
<td>sudden HA; SAH</td>
<td>216</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>38, F</td>
<td>AVM</td>
<td>sudden HA; SAH</td>
<td>216</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>59, F</td>
<td>PCA aneurysm</td>
<td>sudden HA; SAH</td>
<td>216</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>14, F</td>
<td>cav mal</td>
<td>epilepsy</td>
<td>216</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>41, F</td>
<td>AVM</td>
<td>epilepsy</td>
<td>192</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>18, F</td>
<td>cav mal</td>
<td>epilepsy</td>
<td>192</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>55, F</td>
<td>cav mal</td>
<td>epilepsy</td>
<td>180</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>27, F</td>
<td>tumor</td>
<td>epilepsy; memory def</td>
<td>14</td>
<td>4 (visual def)</td>
</tr>
<tr>
<td>10</td>
<td>37, F</td>
<td>AVM</td>
<td>epilepsy</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>34, F</td>
<td>tumor</td>
<td>epilepsy</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>12†</td>
<td>6, F</td>
<td>tumor</td>
<td>epilepsy</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

* All lesions were completely removed or clipped. Abbreviations: cav mal = cavernous malformation; def = deficit; FU = follow-up; HA = headache; SAH = subarachnoid hemorrhage.
† See Video 1 for details of the operation.
The approaches to the mediobasal aspect of the temporal lobe are extremely useful for several kinds of lesions, but also have disadvantages that limit the indications for them. The transsylvian-transinsular approach provides a small working window for dealing with neoplastic or vascular lesions, and the entry point into the temporal horn through its roof can cause a Meyer loop injury. In addition, opening posteriorly along the inferior insular sulcus may cause damage to the optic radiations. The transsulcal or transgyral approaches may cause lesions of the lateral temporal cortex, which is worse when the lesion is located in the dominant hemisphere. Also, the optic radiations may be damaged if entrance into the temporal horn is extended posteriorly through its lateral wall. Besides, there is a significant distance between the lateral surface of the temporal lobe and temporal horn through this route. The transsulcal or transgyral approaches, on the mediobasal aspect of the temporal lobe, require cerebral retraction that may damage basal temporal cortex and the vein of Labbé. In addition, language dysfunction may occur due to cortical incision or retraction of the dominant fusiform gyrus.

The transsylvian transcisternal approach provides a deep and narrow window to the temporal horn through basal cisterns, and a limited access to the posterior part of the medial temporal region. Also, this approach requires posterior retraction of the temporal pole and apex of the uncus, increasing risk to structures in basal cisterns. The occipital hemispheric approach requires occipital lobe retraction and provides a difficult access to the middle segment of the mesial temporal region, and access to the whole anterior segment is rarely achieved. Also, a visual deficit may be found postoperatively. In addition, when using this approach, the neurosurgeon will experience a lack of proximal control of the PCA and AChA.

Voigt and Yaşargil were the first to perform an opening of the tentorium, via a supracerebellar infratentorial approach, to achieve a wider exposure on the mediobasal surface of the temporal lobe. After that pioneering work, several authors also published their experience performing a cut in the tentorium to approach lesions on the mediobasal surface. The SCTT approach has important advantages that include the preservation of lateral and basal cortices, preservation of the optic radiations, and avoidance of retraction of the temporal lobe. However, a single cut in the tentorium, although it improves the exposure, still provides a deep and narrow window requiring a greater working distance.

**Surgical Pitfalls**

The preoperative neuroradiological study is extremely important to the assessment of venous sinuses and veins of the tentorium. Therefore, the venous phase on MR angiography or DS angiography can be useful to recommend tentorial resection or avoidance of this technique, in cases of large venous sinuses running in the tentorium. When a venous sinus is found in the tentorium, even so we may perform a partial resection of the tentorium following the border of the sinus, as we did for the patient in Case 6 (Fig. 7E–H), whose left tentorium was crossed by a large sinus, which was preserved, and in whom a partial resection was enough to provide exposure of the mediobasal temporal AVM as well as its surgical removal. Although rare, sometimes the basal vein of
Rosenthal drains into the tentorium, which would contraindicate this approach.7,8

With regard to the trochlear nerve, the chance of injury during the tentorial resection is remote based on the detailed knowledge of its anatomy. The trochlear nerve arises in the posterior incisural space below the inferior colliculus, runs around the midbrain medial and inferior to the free border of the tentorium, and goes toward the
posterior part of the oculomotor trigone, where it pierces the free border, runs over the anterior petrocclinoidal fold, to finally enter the lateral wall of the cavernous sinus. When beginning to cut the tentorium, the surgeon should follow the border of the transverse and petrosal sinus, until the trochlear nerve is seen entering the free border, and then the tentorium should be cut before this point. Another important issue is to identify the posterior petrosal vein and veins arising from the petrosal surface of cerebellum, to avoid their injury during tentorial cutting.

A resection of the tentorium described in this work provides a broad window that reaches the mediobasal region of the temporal lobe, from the uncus to the back, especially the most posterior portion. The SCTT approach with tentorial resection increases the spectrum of lesions that can be microsurgically treated through this route, not only for small but also for mid-size lesions. We present a series of cases that include AVMs, aneurysms, cavernous malformations, and tumors, whose complete occlusion (aneurysms) or resection (AVMs, cavernous malformations, and tumors) was successfully achieved via an SCTT approach with a tentorial resection.

Conclusions

Knowledge of the surgical anatomy increases the neurosurgeon’s armamentarium and provides the only way to improve the microsurgical approaches to any region of the intracranial compartment. The evolution from a small opening to a resection of the tentorium absolutely
Tentorial resection for wide approach to mediobasal temporal lobe

changed the exposure of the mediobasal aspect of the temporal lobe, allowing a wider range of microneurosurgical treatment for lesions arising from this region. The SCTT approach with tentorial resection is an excellent alternative route to the posterior portion of the mediobasal aspect of the temporal lobe, and was enough to achieve the best neurosurgical treatment of the tumoral and vascular lesions located at this area.

Disclosure

During this work, Dr. Párraga was a fellow of Microneurosurgery Laboratory, Institute of Neurological Sciences, Hospital Beneficência Portuguesa de São Paulo, Brazil. The authors have no personal financial or institutional interest in any of the drugs, materials, or devices described in this article.

Author contributions to the study and manuscript preparation include the following. Conception and design: E de Oliveira, Párraga. Acquisition of data: E de Oliveira, J de Oliveira, Párraga, Neto. Analysis and interpretation of data: E de Oliveira, J de Oliveira, Ribas. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: E de Oliveira. Statistical analysis: J de Oliveira. Administrative/technical/material support: E de Oliveira. Study supervision: E de Oliveira, Ribas.

References


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Address correspondence to: Evandro P. L. de Oliveira, M.D., Ph.D., Praça Amadeu Amaral, 27, 5ª andar, 01327-010 São Paulo, SP, Brazil. email: icne@uol.com.br.

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