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Transsulcal approach to mesiotemporal lesions

Anatomy, technique, and report of three cases

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Surgical resection of mesiotemporal lesions, particularly those in the dominant hemisphere, is often challenging. Standard approaches require excessive brain retraction, removal of normal cortex, or manipulation of the middle cerebral artery branches. This report describes a transsulcal temporal approach to mesiotemporal lesions and its application in three patients. Gross-total resection of the lesion was accomplished in all cases. An anatomical cadaveric study was also performed to delineate the microsurgical anatomy of this approach. Precise knowledge of temporal intraventricular landmarks allows navigation to the lesion without the need for a navigational system. This approach is helpful for neurologically intact patients with mesiotemporal lesions.

Key Words * temporal lobe * seizure * brain tumor * cavernous angioma * surgical approach

In patients with temporal lobe epilepsy, surgical resection of a lesion in the temporal lobe, "lesionectomy," has been shown to provide successful seizure control for different pathologies;[1,2] however, gaining access to the mesiotemporal lobe lesions while preserving the surrounding normal structures is often challenging. Although several approaches to the amygdala and hippocampus have been described in the literature on surgery for epilepsy, they all require sacrifice of normal structures, manipulation of arteries, or excessive temporal lobe retraction. Here, the author describes a transsulcal approach for mesiotemporal lesions that requires no resection of normal structures and minimal retraction. Three cases in which this technique was used are presented.

OPERATIVE TECHNIQUE

The rationale for using this technique is that the superior and middle temporal sulci provide the most direct pathway to the mesiotemporal area. Precise identification of anatomical landmarks allows the surgeon to navigate to the amygdala, hippocampus, parahippocampal gyrus, or fusiform gyrus without the need for navigational devices. Because of the individual variability in the depth of the temporal sulci, preoperative T1-weighted magnetic resonance (MR) imaging of the brain is required to establish the details of the temporal anatomy in each patient (Fig. 1). To minimize resection of white matter, it is preferable to dissect the sulcus that ends closest to the temporal horn of the lateral ventricle, which in most patients is the sulcus between the superior and middle temporal gyri.

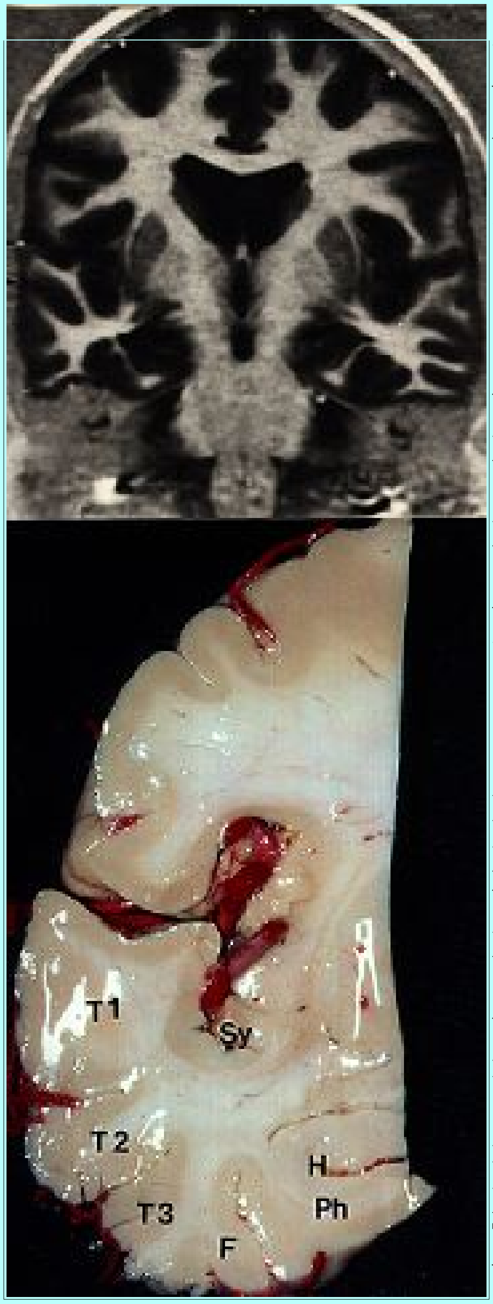

Fig. 1. Upper: Coronal magnetic resonance (MR) image of the brain (TR 2000 msec; TE 20 msec; TI 428; angle LR-25) showing the straight configuration of the superior temporal sulcus (small arrowhead) compared with the L-shaped serpiginous sylvian fissure (large arrowhead). In most patients, the bottom of the sylvian fissure and that of the superior temporal sulcus are equidistant from the temporal horn (range 10-15 mm). Occasionally, the bottom of the middle temporal sulcus is closer than that of the superior temporal sulcus. Careful review of the preoperative imaging studies allows the surgeon to tailor the surgical approach to each patient. Lower: Gross anatomical photograph showing a coronal section through the temporal lobe. Sy = sylvian fissure; T1 = superior temporal gyrus; T2 = middle temporal gyrus; T3 = inferior temporal gyrus; F = fusiform gyrus; Ph = parahippocampal gyrus; H = hippocampus.

Standard neurosurgical general anesthesia is used in all cases. The superior temporal gyrus is not manipulated, and awake craniotomy for language mapping on the dominant side is not necessary. The patient is positioned prone on the operating table with the head fixed by a three-point Mayfield holder. For lesions anterior to the cerebral peduncle, the head is turned 30º contralateral to the side of the operation and directed 20º vertex down. A "hockey stick" skin incision based on the zygomatic process is made behind the hair line and extended to the midpupillary line. For posterior lesions, the head is turned 45º contralateral to the side of the operation and a horseshoe skin incision is made around the pinna. A silver dollar-sized temporal craniotomy is performed with a craniotome (Midas Rex Institute Inc., Fort Worth, TX). The craniotomy need not expose the suprasylvian structures, because anatomical cortical landmarks can be used to confirm the infrasylvian location. The superior temporal gyrus is defined by the opercular branches of the middle cerebral artery, which originates in the sylvian fissure, courses along the dorsal lateral surface of the gyrus, and enters the superior temporal sulcus (Fig. 2). The arterial pattern allows the superior temporal gyrus to be identified easily despite the small bone window. The middle temporal gyrus is thick and usually twice the size of the superior temporal gyrus.

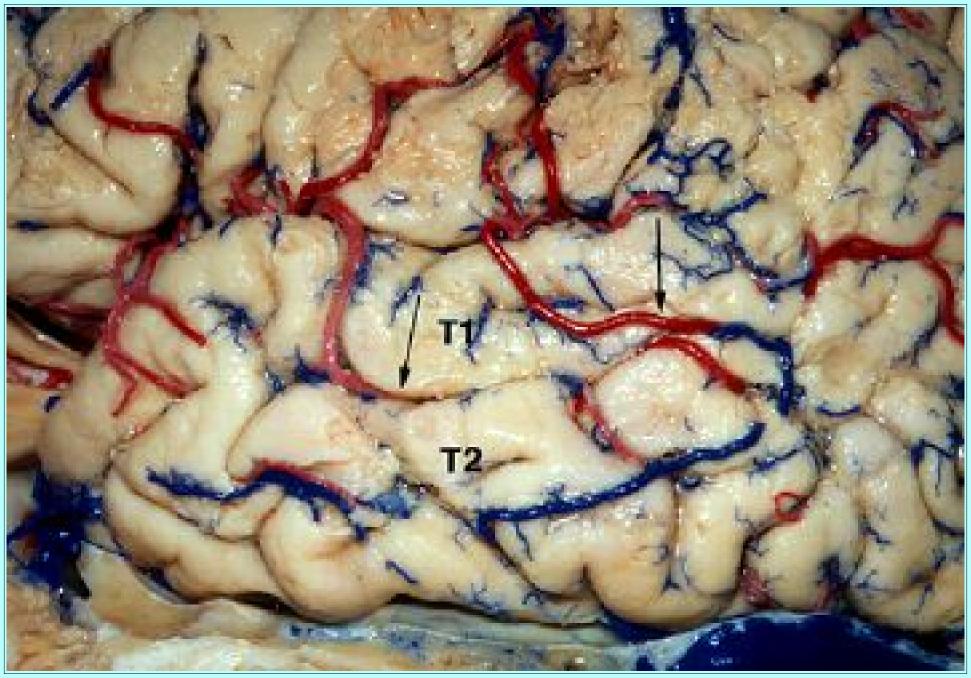

Fig. 2. Gross anatomical photograph showing a human brain. The superior temporal sulcus can be recognized, even through a small bone window not encompassing the sylvian fissure, based on two anatomical features. First, the superior temporal gyrus (T1) is small, often one-half the size of the medial temporal gyrus (T2). Second, the temporal branches of the middle cerebral artery exiting the sylvian fissure loop around the superior temporal gyrus and descend in the superior temporal sulcus (arrows).

After the dura is opened, the arachnoid over the chosen sulcus is microsurgically dissected. A self-retaining retractor blade can be used to apply minimal retraction on the middle temporal gyrus inferiorly. This facilitates dissection in the depth of the sulcus and reduces manipulation of the cortex. Retraction on the superior temporal gyrus is not necessary and should be avoided on the dominant side. When the bottom of the sulcus is encountered, the pia is cauterized and an ultrasonic aspirator is used at the 25% setting to perform a corticectomy and leukotomy necessary to enter the temporal horn. The microscope can be angled in the anteroposterior direction to provide a better view of the mesiotemporal structures, allowing their resection through a limited opening of the white matter. Anatomical landmarks are used to navigate to the lesion.

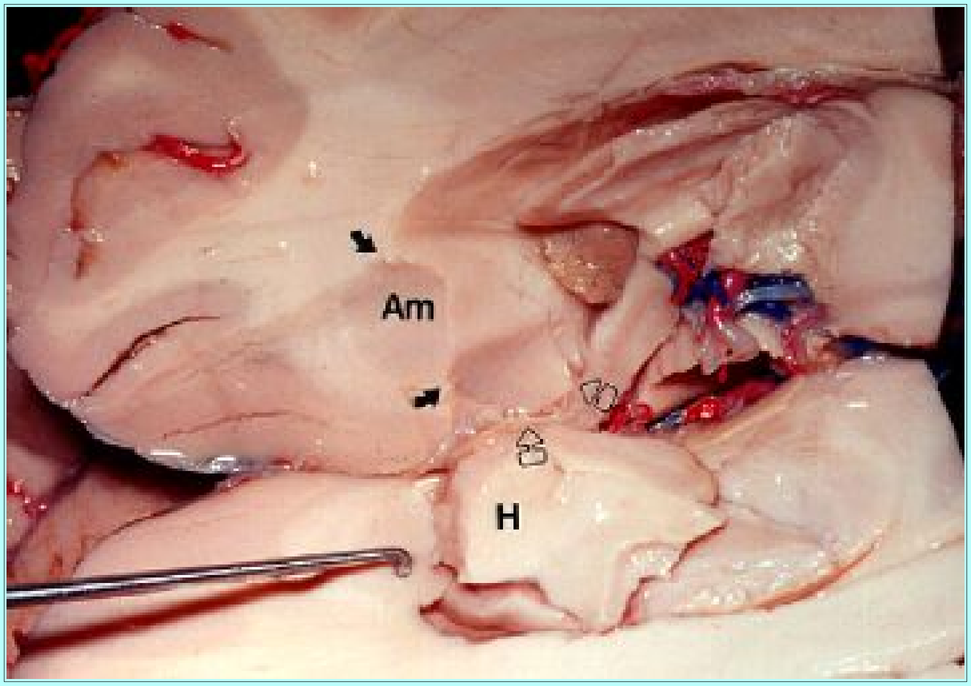

Fig. 3. Gross anatomical photograph showing an axial section through the middle temporal gyrus. The amygdala (Am) projects into the anterior aspect of the temporal horn; its lateral and medial extents into the ventricle are defined by the amygdaloid recesses (solid arrows). Note the darker appearance of the amygdala compared with the adjacent white matter. The inferior aspect of the amygdala is connected to the digitationae hippocampi of the hippocampal head (open arrows). During resection of a lesion in this location, especially on the dominant side, careful dissection from the digitationae will avoid postoperative memory deficits. H = hippocampus.

Lesions in the Amygdala

The amygdala projects into the anterior aspect of the temporal horn and its lateral and medial extent into the ventricle are defined by the amygdaloid recesses (Fig. 3). The inferior aspect of the amygdala is connected to the hippocampus through the digitationae hippocampi. Careful dissection of the amygdala from the latter structures will avoid postoperative memory deficits on the dominant side. The superior margin of the amygdala is not well defined because it blends with the white matter of the anterior commissure and globus pallidus. The amygdala has a grayish hue compared with the ventricular walls and the white matter of the uncinate fasciculus, but its color does not differ significantly from that of the globus pallidus. Therefore, care must be taken in resecting lesions in the superior portion of the amygdala.

Lesions in the Hippocampus

The hippocampus bulges into the temporal horn of the lateral ventricle and arches around the mesencephalon with a seahorse shape. It can be easily distinguished from the other intraventricular structures by its shiny white color. The choroidal point and the hippocampal sulcus are helpful anatomical landmarks for removal of hippocampal lesions. The anterior choroidal artery enters the temporal horn of the lateral ventricle at the choroidal point (Fig. 4 left), courses along the choroidal fissure, and ends in the choroid plexus. The choroidal point demarcates the most anterior part of the medial free edge of the hippocampus. Anterior to the choroidal point the hippocampus is connected to the amygdala through the digitationae hippocampi. The lateral aspect of the hippocampus is demarcated by an unnamed groove within the ventricle that separates it from the collateral eminence. Within the hippocampal formation, the hippocampal sulcus separates the hippocampus proper, also known as cornu ammonis, from the subiculum. One or two arteries are usually present in the hippocampal sulcus; these hippocampal arteries are the first cortical branches arising from the posterior cerebral artery (Fig. 4).

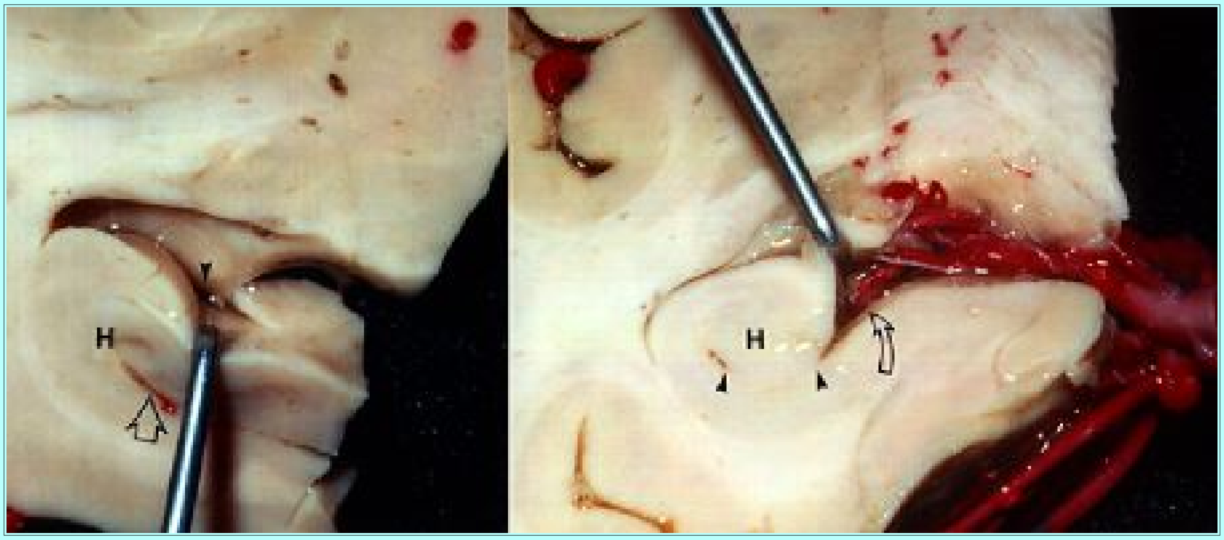

Fig. 4. Gross anatomical photograph showing coronal sections of the anterior (left) and the posterior hippocampus (right). Left: The hippocampus is retracted inferiorly to show the choroidal point (arrowhead). Anterior to the choroidal point, the hippocampus is connected to the amygdala by the digitationae hippocampi (see Fig. 5). The hippocampal sulcus (open arrow) separates the hippocampus proper (cornu ammonis) from the fascia dentata. Right: One or two arteries (arrowheads) are usually present within the hippocampal sulcus. These hippocampal arteries are the first cortical branches arising from the posterior cerebral artery. H = hippocampus.

Lesions in the Parahippocampal and Fusiform Gyri

The collateral eminence and fissure are helpful landmarks for resecting lesions in the parahippocampal and fusiform gyri. The white matter of the fusiform and parahippocampal gyri can be entered through the collateral eminence, an intraventricular white matter protuberance of the parahippocampal gyrus that parallels the hippocampus along its lateral intraventricular margin (Fig. 5). Dissection into the collateral eminence perpendicular to the floor of the middle fossa leads to the collateral fissure, which separates the parahippocampal gyrus from the fusiform gyrus. Lesions in the parahippocampal gyrus will be found medial to the lateral eminence and collateral fissure, and lesions in the fusiform gyrus will be found laterally.

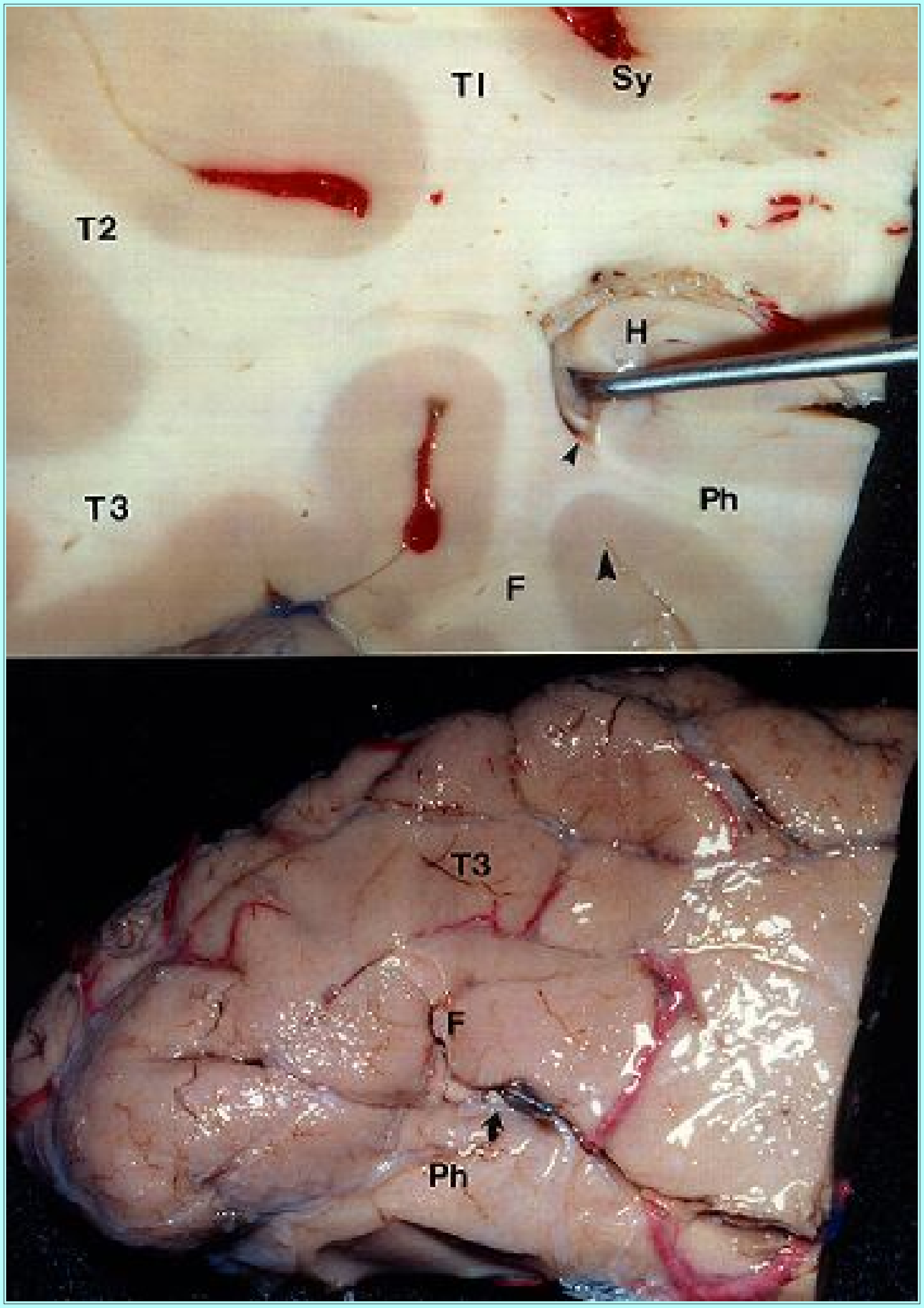

Fig. 5. Upper: Gross anatomical photograph showing a coronal section through the temporal lobe. The collateral eminence (small arrowhead) is an intraventricular protuberance of the parahippocampal white matter; its medial aspect is a groove demarcating the intraventricular portion of the hippocampal alveus. Dissection into the collateral eminence perpendicular to the floor of the middle fossa leads to the collateral fissure (large arrowhead), which separates the parahippocampal gyrus from the fusiform gyrus. Lower: Gross anatomical photograph of the mesiotemporal temporal lobe cortex (ventral view). The tip of the blunt dissecting hook (upper) is in the collateral fissure on the inferior aspect of the temporal lobe (arrow). T1 = superior temporal gyrus; T2 = middle temporal gyrus; T3 = inferior temporal gyrus; F = fusiform gyrus; Sy = sylvian fissure; Ph = parahippocampal gyrus; H = hippocampus.

CASE REPORTS

Case 1

This 60-year-old right-handed woman experienced her first grand mal seizure 10 years before presentation. Imaging studies showed a small lesion of the left parahippocampal gyrus. Her seizures were controlled by phenytoin for 9 years. Subsequently, she began to have medically refractory complex partial seizures without generalization that caused anxiety followed by inability to speak. The episodes lasted less than 60 seconds and occurred several times per week.

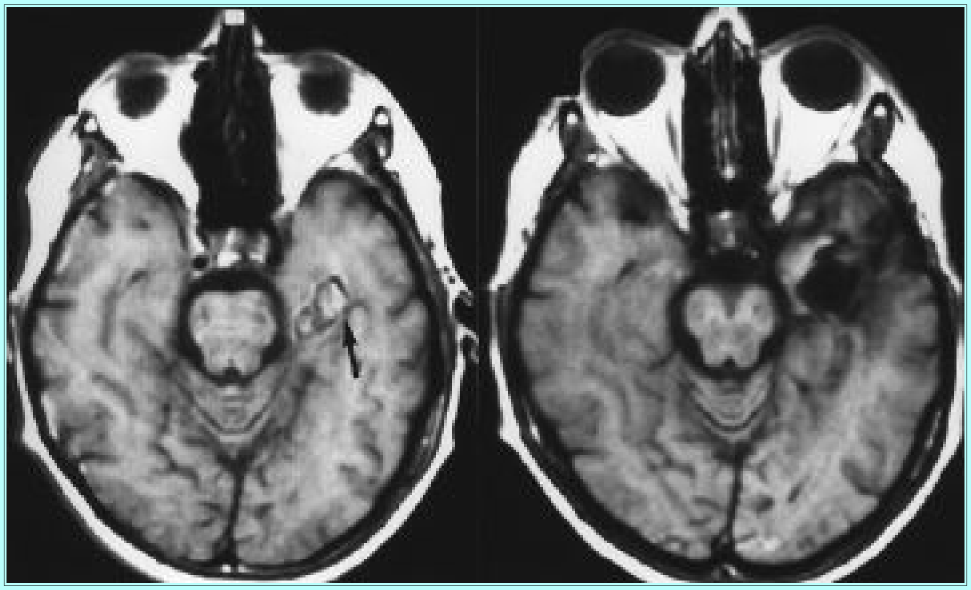

Fig. 6. Case 1. Left: Preoperative axial magnetic resonance (MR) image (TR 500 msec; TE 7 msec) showing two adjacent lesions (arrow) in the parahippocampal gyrus characterized by focal central heterogeneity and a circumferential ring of iron-storage forms. Right: Postoperative MR image showing complete removal of both lesions.

Magnetic resonance imaging showed two "kissing" lesions in the left parahippocampal gyrus (Fig. 6 left). The lesions were characterized by focal central heterogeneity, consistent with methemoglobin, and a circumferential ring of iron-storage forms without evidence of edema, most likely consistent with a cavernous angioma. A left temporal craniotomy was performed for transsulcal resection of the two lesions. Pathological analysis of the surgical specimens confirmed the diagnosis of cavernous angioma. Postoperative MR imaging documented complete removal of the lesions (Fig. 6 right). Eighteen months after the operation, the patient is maintained on a course of phenytoin and remains seizure free.

Case 2

This 50-year-old right-handed man had a history of bronchogenic adenocarcinoma (diagnosed from bronchal aspirate), which was treated with chemotherapy. He presented with a new-onset seizure disorder and dense paresis of the left upper extemity. Magnetic resonance imaging of the head demonstrated two heterogeneously enhancing lesions surrounded by significant edema: one in the left fusiform gyrus and one in the right frontal precentral gyrus. The frontal lesion was resected under stereotactic guidance through a craniotomy. The patient was then repositioned on the operating table and underwent a left temporal craniotomy for transsulcal resection of the lesion in the fusiform gyrus. Postoperative MR imaging demonstrated removal of both lesions. Pathological analysis of the surgical specimens confirmed the diagnosis of metastatic adenocarcinoma. The preoperative paresis improved with physical therapy. Postoperatively, the patient received 3000 cGy of whole-brain radiation therapy.

Three months after the operation, follow-up MR imaging showed no evidence of metastatic disease in the brain. At his 6-month follow-up examination, the patient was seizure free, but died at home shortly thereafter.

Case 3

This 53-year-old ambidextrous woman had history of small-cell lung carcinoma, which was diagnosed after excision of a metastatic breast nodule. After receiving three cycles of chemotherapy and experiencing a 2-year disease-free interval, she presented with memory loss. Magnetic resonance imaging of the brain showed two large lesions in the right temporal lobe: one in the parahippocampal gyrus (approximately 3 X 2 X 2 cm) posterior to the cerebral peduncle and one in the anterior parahippocampal gyrus (approximately 3 X 4 X 3 cm) causing significant uncal herniation. A right temporal craniotomy was performed for transsulcal resection of the two lesions. Postoperative MR imaging showed removal of both lesions. Pathological analysis of the surgical specimens confirmed the presence of metastatic carcinoma. Postoperatively, the patient received 3000 cGy of whole-brain radiation therapy. She died of intracranial hypertensive hemorrhage 3 months after the surgery.

DISCUSSION

Recent clinical data have shown that lesional surgery for the treatment of temporal lobe epilepsy provides good seizure control, particularly in patients with cavernous angiomas and a relatively short seizure history.[2] Surgical resection of mesiotemporal lesions, however, particularly those in the dominant hemisphere, is often challenging. Standard approaches require manipulation of the middle cerebral artery branches, significant brain retraction, or resection of normal structures. The transsylvian approach used by Yasargil, et al.,[10] for selective amygdalahippocampectomy requires meticulous dissection of the middle cerebral arteries in the sylvian fissure to minimize transient or permanent neurological ischemic deficits. Furthermore, this pathway is serpiginous, making the use of certain surgical instruments, such as the ultrasonic aspirator, more cumbersome.

The subtemporal approach requires excessive temporal lobe retraction that may lead to significant morbidity, especially in the presence of an exuberant vein of Labbé complex. To minimize retraction of the temporal lobe, Shimizu, et al.,[7] used the zygomatic approach for ablating the amygdala and hippocampus. Hori, et al.,[5] modified the subtemporal approach by having the surgeon standing to the patient's side, facing the vertex. Despite this modification, individual variations in the length of the collateral sulcus may require significant retraction. Smith and Spetzler[8] reported seven cases of posteromedial temporal lesions resected via a supratentorial-infraoccipital approach. However, an intraoperative navigational system is recommended with this technique because the exposure is through a narrow long approach.

Resection of the temporolateral cortex to gain access to the mesiotemporal structures has been described by Spencer, et al.[9] These authors used a partial anterolateral temporal resection, sparing the superior temporal gyrus, to resect the hippocampus. Heros[4] decribed resection of mesiotemporal vascular malformations through the inferior temporal gyrus and the fusiform gyrus.

The use of neurosurgical navigational systems is becoming more popular as the technology advances.[6] These systems are especially helpful when anatomical landmarks are scarce, as in the resection of deep-seated lesions.[3] On the other hand, a thorough knowledge of existing anatomical landmarks should be stressed especially when educating young neurosurgeons. With the transsulcal approach to mesiotemporal lesions, anatomical landmarks are used to guide dissection to the location of interest. If the anatomy of the mesiotemporal region is unfamiliar, cadaveric dissection should be considered to gain a clear understanding of the structures involved.

The surgical approach described herein is useful in neurologically intact patients with mesiotemporal lesions. The advantage of this approach is that resection of temporal neocortex is not necessary. This is particularly important when resecting lesions in the dominant hemisphere. Furthermore, with the transsulcal approach, retraction is unnecessary because access to the temporal horn of the lateral ventricle allows drainage of cerebrospinal fluid and significant brain relaxation. The pathway to the mesiotemporal structures through a transsulcal approach is relatively straight and short, facilitating microsurgical dissection.

Acknowledgments

The cadaver dissections were performed in Dr. C. Sen's laboratory. The author thanks Dr. C. Siang for photographic assistance and Stephen Ordway for editorial comments.

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Manuscript received Septeber 20, 1996.

Accepted in final form October 17, 1996.

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