An Applied Anatomic Guide to Anterior Temporal Lobectomy and Amygdalohippocampectomy: Laboratory Cranial and White Matter Dissections to Inform Surgical Practice

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BACKGROUND AND OBJECTIVES: Anterior temporal lobectomy and amygdalohippocampectomy is a challenging procedure because of the deep surgical trajectory and complex regional neurovascular anatomy. A thorough knowledge of the involved anatomic structures is crucial for a safe and effective procedure. Our objective is to explore the white matter pathways in or around the operative corridor and to illuminate the 3-dimensional relationships of the pertinent operative parenchymal and skull base anatomy, aiming to inform and simplify surgical practice.

METHODS: Four normal, adult, cadaveric, formalin-fixed cerebral hemispheres (2 left and 2 right) treated with the Klinger's technique and 2 formalin-fixed and colored-latex–injected cadaveric heads (4 sides) were used. Focused white matter and cadaveric dissections were used to study the relevant anatomy implicated during an anterior temporal lobectomy. Four illustrative cases were also included. Digital photographs from every dissection step were obtained.

RESULTS: Major white matter pathways that are inevitably traversed during the approach are the inferior longitudinal fasciculus, uncinate fasciculus, and inferior arm of the cingulum. Tracts that can be potentially injured, should the dissection plane tilt inadvertently superiorly or posteriorly, are the inferior fronto-occipital fasciculus, Meyer's loop, superior longitudinal fasciculus/arcuate fasciculus complex, and basal ganglia. Consistent cranial and parenchymal landmarks that can act as a roadmap during the procedure are recorded and paired with their intraoperative equivalent to provide a thorough, yet simple, stepwise guide for the surgeon.

CONCLUSION: White matter dissections, cadaveric cranial dissections, and intraoperative images are put together to provide a simplified stepwise surgical manual for anterior temporal lobectomy. Laboratory investigations that focus on the intricate 3-dimensional relationships of the pertinent operative anatomy from the surgeon's eye may enrich anatomic knowledge and push surgical boundaries, to minimize complication rates and ultimately improve patient outcomes.

KEY WORDS: Anterior temporal lobectomy, Epilepsy, Fiber tracts, Medial temporal lobe, Surgical anatomy, Temporal horn, White matter dissection

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ABBREVIATIONS: AF, arcuate fasciculus; **AH,** amygdalohippocampectomy; **ATL,** anterior temporal lobectomy; **IFOF,** inferior fronto-occipital fasciculus; **IFS,** inferior frontal sulcus; **ILF,** inferior longitudinal fasciculus; **ITS,** inferior temporal sulcus; **LGB,** lateral geniculate body; **MdLF,** medial longitudinal fasciculus; **ML,** Meyer's loop; **OTS,** occipitotemporal sulcus; **PCA,** posterior cerebral artery; **PHG,** parahippocampal gyrus; **SLF,** superior longitudinal fasciculus; **STG,** superior temporal gyrus; **STS,** superior temporal sulcus; **TS,** temporal stem; **UF,** uncinate fasciculus.

Medial temporal lobe epilepsy is a well-characterized focal epilepsy syndrome in which surgical treatment is indicated for drug-resistant cases.[1-8] The 2 main surgical approaches to the medial temporal lobe are the anterior temporal lobectomy (ATL) and amygdalohippocampectomy (AH)[9] and the selective amygdalohippocampectomy[10] through different corridors such as the transsylvian,[11] transcortical,[12] subtemporal,[13] and paramedian supracerebellar transtentorial.[14]

ATL and AH involves the resection of the anterolateral temporal lobe along with the hippocampus head-body and the amygdala, sparing the superior temporal gyrus. Complications of the procedure include language, cognitive, and visual field deficits.[15,16] These complications are associated with hemispheric dominance and manipulation of major fiber pathways that are encountered en route to the area of interest.[17] Accurate knowledge of the topographic anatomy and silhouette of the involved white matter is essential for a safe and effective procedure.

Our objective was to outline the microsurgical anatomy of the fiber tracts that reside in or around the actual operative corridor through focused white matter dissections. Cranial dissections to review the basic steps of the procedure were also performed. Consistent cranial and parenchymal landmarks that can act as a roadmap during the procedure were identified and were paired with their intraoperative equivalent with the aim to provide a manual of applied anatomy for surgical practice.

METHODS

White Matter Dissections

Four normal, adult, cadaveric, formalin-fixed cerebral hemispheres (2 left and 2 right) treated with the Klinger's technique were studied.[18,19] The arachnoid membrane and vessels were carefully removed and the specimens were frozen at temperatures between −10 C and −15 C for 2 weeks. They were then allowed to thaw under running water for several hours (freeze-thaw procedure). The fiber microdissection technique was used to reveal the major fiber tracts that travel in or around the actual operative corridor used during the anterior temporal lobectomy, and digital photographs were obtained from every dissection step.

Cadaveric dissections Two formalin-fixed (10% to 15% formalin) and colored-latex–injected cadaveric heads (4 sides) were used. The heads were positioned in a way that resembled the actual operative settings and the pretemporal corridor was used. The intradural procedure was divided into 2 distinct stages. The first stage comprised an "en block" anterolateral temporal neocortical resection sparing the superior temporal gyrus and avoiding entering prematurely the temporal horn. In the next stage, the temporal horn was entered and the

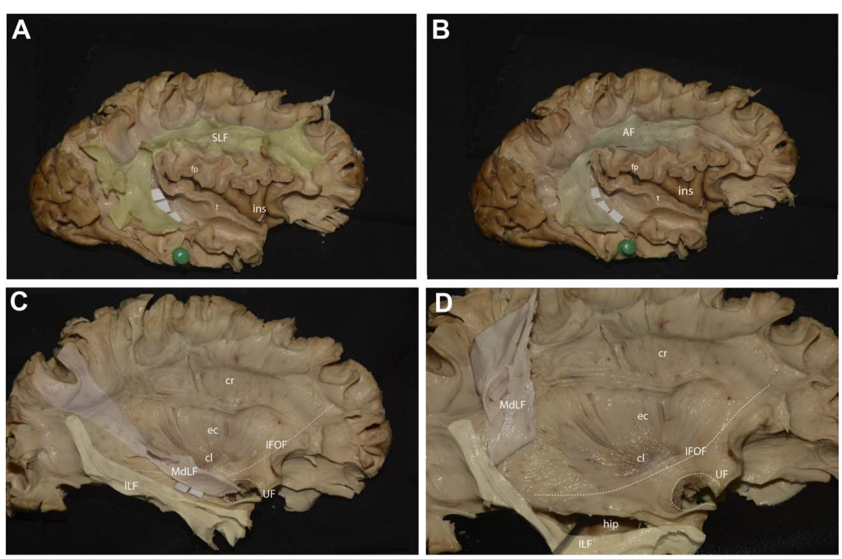

FIGURE 1. *Lateral to medial stepwise dissection of a right hemisphere.* **A**, *The cortex and U-fibers of the frontal, parietal, and temporal lobes have been removed. The green pin is placed approximately 5 cm from the temporal pole. SLF is revealed.* **B**, *SLF has been dissected and the arcuate fasciculus is revealed.* **C**, *SLF/AF complex has been dissected. The frontal and temporoparietal operculum have been removed as well as the insular cortex along with the extreme capsule. The MdLF is disclosed and marked with 2 white strips, running from the temporal pole to the parieto-occipital arcus within the white matter of the superior temporal gyrus. At this point of dissection, the lateral segment of the ILF is also revealed.* **D**, *The MdLF is elevated, and the IFOF and UF are disclosed and marked with white dots. Dissecting between the IFOF and ILF leads into the temporal horn as indicated by the periosteal elevator. The IFOF, as a part of the temporal stem, runs along the roof of the temporal horn and the ILF forms its lateral wall and floor. AF, arcuate fasciculus; cl, claustrum; cr, corona radiata; ec, external capsule; fp, frontoparietal operculum; hip, hippocampus; IFOF, inferior fronto-occipital fasciculus; ILF, inferior longitudinal fasciculus; MdLF, middle longitudinal fasciculus; SLF, superior longitudinal fasciculus; t, temporal opercula; UF, uncinate fasciculus.*

resection of the mesial temporal structures along with the amygdala was completed. Microsurgical instruments and the operating microscope (Carl Zeiss OPMI) were used and digital photographs were obtained to vividly illustrate every step (Nikon DSLR D7100, aperture priority mode, ISO sensitivity:100, using flash).

Illustrative Cases

Four patients (3 males and 1 female, age between 20 and 30 years) underwent a standard right-sided ATL to treat mesial temporal lobe epilepsy. Photographs from distinct intraoperative dissection stages were obtained aiming to pair laboratory findings with their intraoperative equivalent and to offer a consistent and comprehensive anatomic guide for surgical practice. All procedures were performed by the senior author (C.K.).

IRB/Ethics Committee Approval

IRB/ethics committee approval was not required, because the study was based on cadaveric dissections. Informed consent was obtained from all participants included in the study.

RESULTS

Evidence from white matter dissections Upon removing the gray matter and U-fibers of the lateral and basal cerebral surface, we focused our attention on the anterior 5 cm of the temporal lobe. The first group of fibers exposed were those of the superior longitudinal fasciculus (SLF)/arcuate fasciculus complex (AF). At the same dissection plane, the parietotemporal aslant tract became evident at approximately 5 cm from the temporal pole (Figure 1A and 1B). The dissection proceeded by removing the gray matter of the insula, the transverse temporal gyri, and the planum temporale. At this step, the middle longitudinal fasciculus (MdLF) was disclosed, travelling from the temporal pole to the parieto-occipital arcus, along the white matter of the superior temporal gyrus (STG) (Figure 1C). After removing the MdLF, deep to the superior temporal sulcus and at the level of the external capsule, the stem of the inferior fronto-occipital fasciculus (IFOF) was unveiled, blending with the fibers of the sagittal stratum posteriorly and the corona radiata anteriorly.

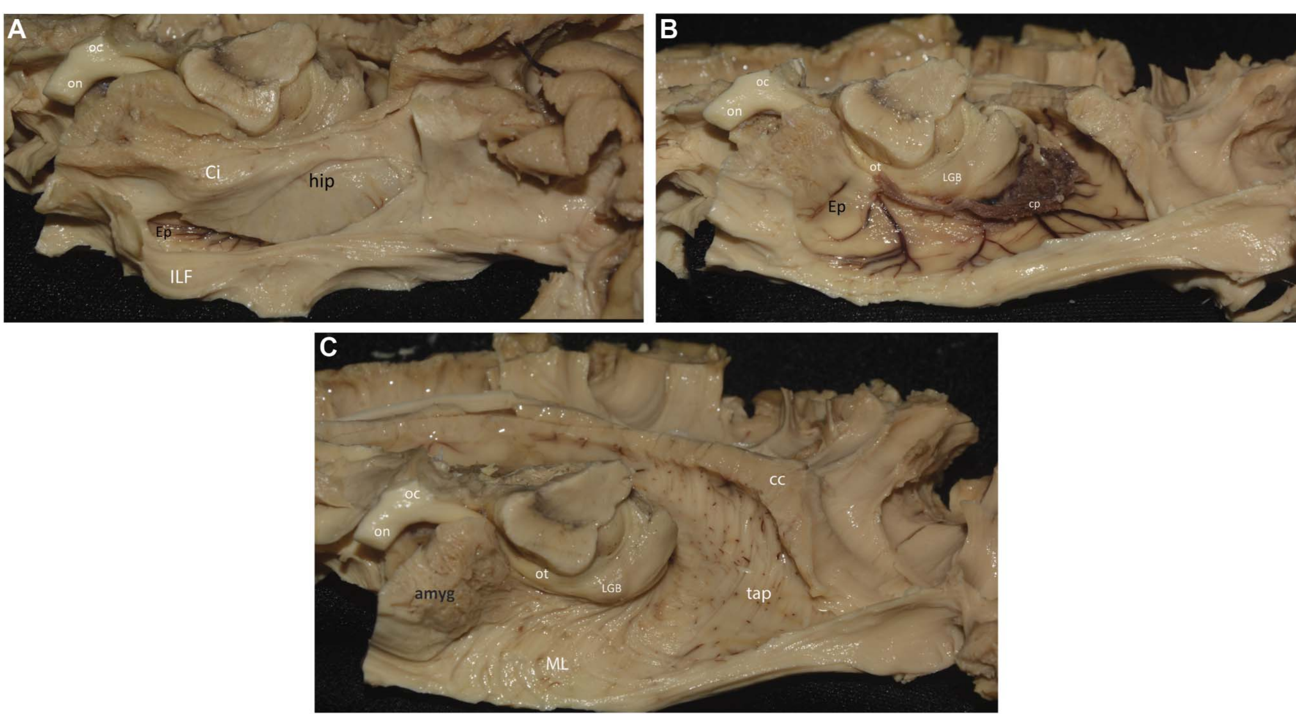

FIGURE 2. *Stepwise dissection of the basal surface of a right hemisphere.* **A**, *The gray matter and U-fibers of the parahippocampal gyrus have been dissected. The hippocampus sitting on the inferomedial wall of the temporal horn, the inferior bundle of the cingulum, and the ILF forming the inferolateral wall of the temporal horn are illustrated.* **B**, *The hippocampus, cingulum, and ILF have been removed. The ependymal layer of the temporal horn and the choroid plexus are disclosed. The optic tract is seen to terminate to the lateral geniculate body of the thalamus. Appreciate the correspondence of the LGB to the inferior choroidal point.* **C**, *The ependymal layer has been removed, corpus callosum has been sharply cut, and the fibers forming the so-called Meyer's loop are seen. These fibers originate from the LGB, make an anterior loop, and extend posteriorly to blend with the sagittal stratum. The amygdala nuclei are seen to reside at the anterosuperior part of the temporal horn. Tapetal fibers are seen to radiate from the splenium of the corpus callosum investing the lateral wall of the atrium and temporal horn. amyg, amygdala; cc, corpus callosum; Ci, cingulum (inferior bundle); cp, choroid plexus; Ep, ependyma; hip, hippocampus; ILF, inferior longitudinal fasciculus; LGB, lateral geniculate body; ML, Meyer's loop; oc, optic chiasm; on, optic nerve; ot, optic tract; tap, tapetum.*

Ventrally to the IFOF stem, at the level of the external capsule, the uncinate fasciculus (UF) was revealed, connecting in a hook-shape manner the posterior orbitofrontal cortex with the temporal pole and the uncus. Moving basally, the next crucial white matter pathway encountered was the inferior longitudinal fasciculus (ILF), comprising a dorsolateral part, which runs from the anterior temporal lobe to the occipital lobe, and a fusiform part, which resides in the homonymous gyrus. Dissecting between the stem of the IFOF superiorly and the ILF inferiorly leads to the temporal horn. At this point, one can appreciate how the IFOF courses along the roof of the temporal horn, as part of the temporal stem, and how the ILF runs along the lateral wall and the floor of the temporal horn (Figure 1D). Switching to the medial aspect of the hemisphere, the inferior arm of the cingulum is seen to line the medial side of the hippocampus (Figure 2A). The exposure of the hippocampus was enhanced by cutting along the collateral eminence and ILF up until the inferior choroidal point was identified. We resected the hippocampus proper together with the ILF to expose the roof of the temporal horn with the amygdala seen to reside on its anterior part (Figure 2B).We then meticulously dissected the ependymal layer of the roof of the temporal horn and encountered a group of fibers seen to stem from the lateral geniculate body and follow an anterior loop to travel posteriorly and blend with the sagittal stratum. These fibers form the anterior part of the optic radiation also known as the Meyer's loop (Figure 2C).

Hence, the white matter tracts that are inevitably traversed during ATL are the ILF, UF, and the inferior arm of the cingulum during fusiform gyrus and amygdala resection, respectively. At the posterior limit of the resection, the surgeon should be aware of the SLF/AF complex, particularly on the dominant side. The MdLF travels safely in the white matter of the STG, which is left intact during the procedure. Finally, while manipulating the temporal horn, the surgeon should be vigilant of the temporal stem running on its roof. The temporal stem is the white matter located between the inferior periinsular sulcus and the temporal horn, and consists of the extreme capsule, the external capsule-IFOF-UF, and Meyer's loop in superficial to deep direction.

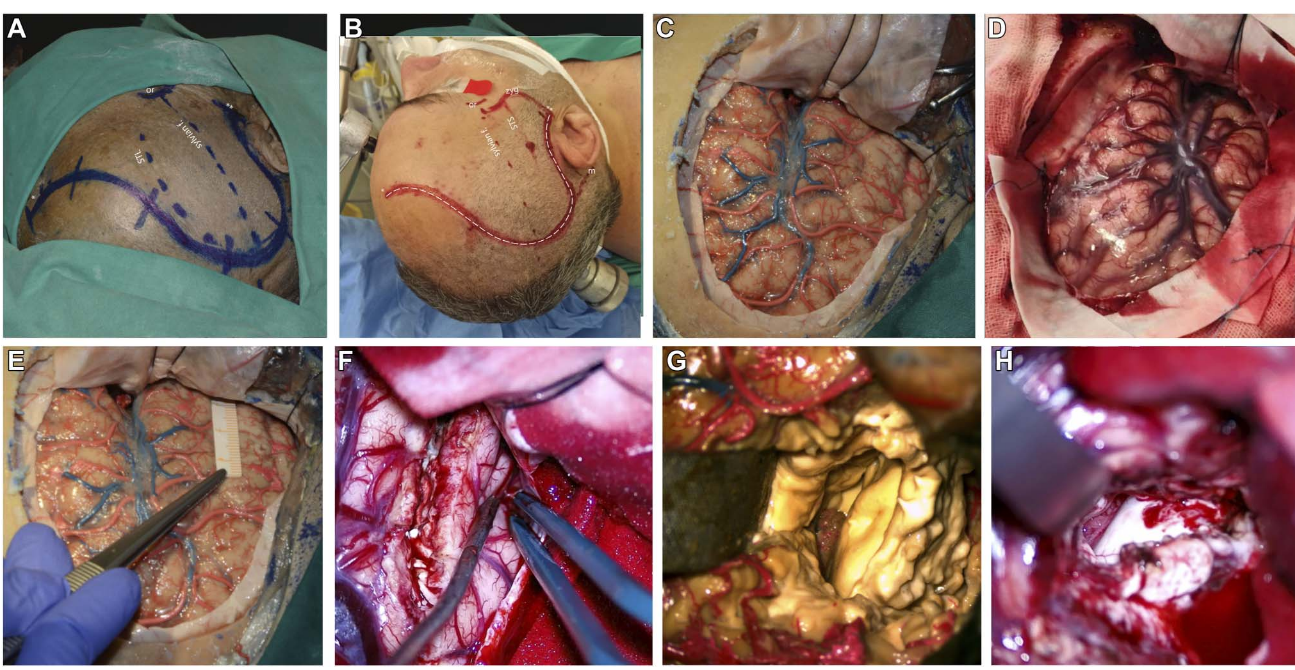

FIGURE 3. *ATL and AH stepwise dissection* **A**, **C**, **E**, *and* **G**, *on a cadaveric specimen and* **B**, **D**, **F**, *and* **H**, *on a patient. Right-sided approach. Cadaveric photographs are paired with their intraoperative equivalent.* **A** *and* **B**, *Positioning: the head is turned 45 on the contralateral side, tilted laterally, and markedly extended to place the long axis of the hippocampus along the operator's line of sight. A question mark incision starting anterior to the tragus, corresponding to the root of the zygoma (**), curving backward up until the mastoid process (m) and ending at the widow's peak (*), is drawn on the cadaveric specimen and marked with a white dotted line on the real patient. The or, the STL, and the Sylvian fissure are also marked on the cadaveric specimen. The or, the Sylvian fissure, the STS, and the zygoma (zyg)—representing the middle fossa floor—are marked on the real patient.* **C** *and* **D**, *A low temporal craniotomy up until the superior temporal line has been performed. The inferior frontal gyrus and superior, middle, and inferior temporal gyri are exposed.* **E** *and* **F**, *A surgical ruler is placed at the temporal tip and over the middle temporal gyrus to mark the posterior extension of the corticotomy. The resection starts from the superior temporal sulcus or just below it to avoid sulcal vessels and involves the middle and inferior temporal gyri and part of the fusiform gyrus.* **G** *and* **H**, *In the next step, we enter the temporal horn and identify the choroid plexus and the head of the hippocampus. or, orbital rim; STL, superior temporal line; STS, superior temporal sulcus.*

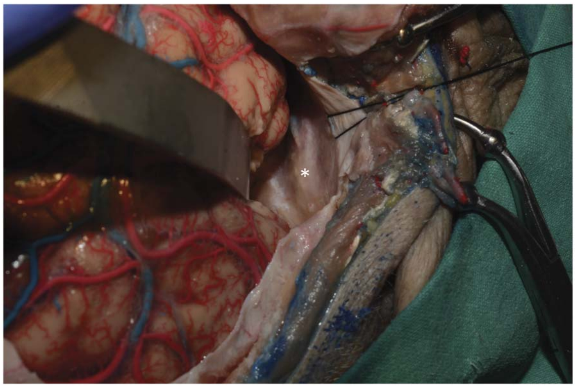

FIGURE 4. *The midsubtemporal ridge identified on a cadaveric specimen (*). The right temporal lobe is retracted with a brain spatula. The midsubtemporal ridge is a bony prominence on the middle fossa floor. It corresponds to the point between V1 and V2 divisions of the trigeminal nerve. It can be used to indicate the white matter dissection plane during the lateral neocortical resection. It can also be used as a landmark for the localization of the temporal horn on the anteroposterior axis.*

A Stepwise Guide for ATL and AH

Eight discrete and consecutive steps are highlighted to provide a simple but comprehensive guide for a safe and effective anterior temporal lobectomy. Consistent cranial and parenchymal landmarks to navigate the surgeon through the entire procedure are indicated.

Positioning

The patient is placed supine with the head above the heart and fixed in a Mayfield three-point fixation system. The head is turned 45 contralaterally, tilted laterally, and markedly extended to place the long axis of the hippocampus at the operator's line of sight (Figure 3A and 3B).

Skin Incision

A question mark incision is fashioned starting anterior to the tragus, extending posteriorly behind the ear at the mastoid vertex line and curving anteriorly above the superior temporal line up until the widow's peak (Figure 3A and 3B). A single myocutaneous flap is elevated.

Craniotomy

Two burr holes are drilled, one just above the root of the zygoma and the other at the Dandy keyhole point, just posterior to the frontozygomatic suture, and a craniotomy is turned up until the level of the superior temporal line. Having in mind that the root of the zygoma corresponds to the middle fossa floor and the superior temporal line to the inferior frontal sulcus, the outlined

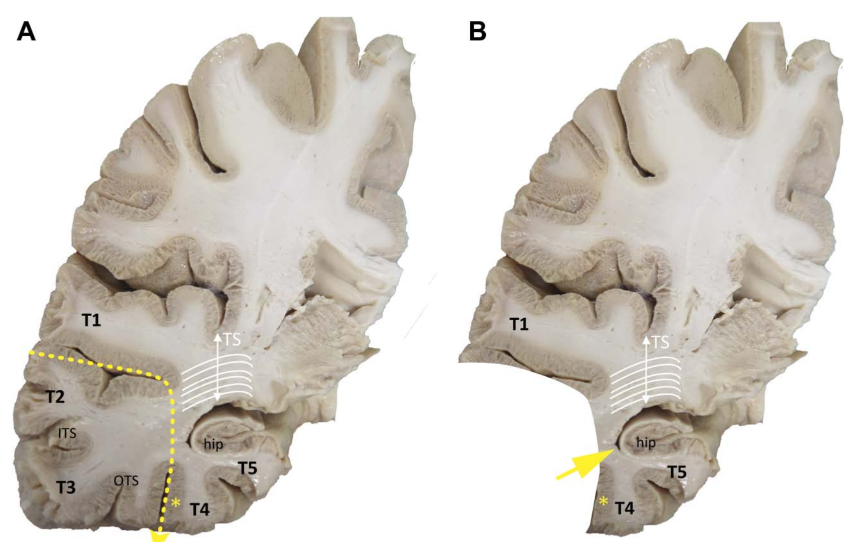

FIGURE 5. *Coronal cuts of a right hemisphere.* **A**, *The yellow dotted line indicates the direction of the white matter dissection during the lateral neocortex resection. The dissection starts from the superior temporal gyrus or immediately below it and aims toward the middle fossa floor. As soon as the gray matter of the basal temporal sulci is recognized (yellow star), the surgeon should direct the dissection toward to avoid entering the temporal horn prematurely.* **B**, *The lateral neocortex of the temporal lobe has been resected. The yellow arrow indicates the point of entrance into the temporal horn. hip, hippocampus; ITS, inferior temporal sulcus; OTS, occipitotemporal sulcus; STS, superior temporal sulcus; T1, superior temporal gyrus; T2, middle temporal gyrus; T3, inferior temporal gyrus; T4, fusiform gyrus; T5, parahippocampal gyrus; TS, temporal stem.*

craniotomy will expose the inferior frontal gyrus and the superior, middle, and part of the inferior temporal gyri (Figure 3C and 3D).

Dural Incision

The dura is incised in a U-shaped fashion and is reflected anteriorly with its base at the sphenoid wing (Figure 3C and 3D).

Anterolateral Temporal Lobectomy

Anterolateral temporal lobectomy involves the anterior 3.5 to 4 cm of the nondominant and the 3 to 3.5 cm of the dominant temporal lobe, always sparing the superior temporal gyrus. A Penfield dissector is placed at the temporal tip, over the middle temporal gyrus, to mark the posterior extension of the corticotomy (Figure 3E and 3F). A constant bony landmark on the middle fossa floor, the midsubtemporal ridge,[20] coincides also with the posterior limit of the resection (Figure 4). White matter dissection begins just below the superior temporal sulcus to avoid sulcal vessels. The dissection is carried for 2 to 3 cm deep down to the middle fossa floor and involves the middle temporal, inferior temporal, and part of the fusiform gyri. It is advised not to enter the temporal horn prematurely because intraventricular anatomy could be distorted from the ingress of blood. The gray matter of the occipitotemporal sulcus is a sound parenchymal landmark that navigates the surgeon and limits the medial dissection up to the fusiform gyrus.[21] Once this gray matter is identified, the dissection plane should be directed inferiorly toward it to avoid hitting the temporal horn (Figure 5).

Entering the Temporal Horn

Upon completing the lateral neocortical resection, the microscope is tilted medially. The temporal horn is located deep at the level of the middle temporal gyrus, approximately 3 cm posterior to the temporal tip. Novice surgeons can miss the temporal horn by searching for it too anteriorly or superiorly and therefore risking injury to the temporal stem, insula, or middle cerebral artery (MCA). To avoid disorientation, the importance of identifying and following the gray matter of the basal temporal sulci is again highlighted. Entry into the temporal horn is confirmed by the release of cerebrospinal fluid and identification of the choroid plexus (Figure 3G and 3H).

Hippocampal Resection

Once the temporal horn is entered, the superior temporal gyrus is retracted with a fixed brain spatula to elevate gently the roof of the temporal horn and allow better visualization and surgical manipulation of the mesial temporal structures. The inferior choroidal point that demarcates the hippocampal head from the body is identified, and the disconnection of the hippocampal body lateral to the choroid plexus can be initiated. The dissection proceeds aiming to resect "en block" the hippocampal head, the posterior uncus, the parahippocampal gyrus, and the remaining part of the fusiform gyrus. The dissection is initiated with the bipolar cautery and the suction device, but as the surgeon proceeds medially, an ultrasonic aspirator and/or a microdissector can be used to gently resect these structures from their pia cover, which should be kept intact to act as a

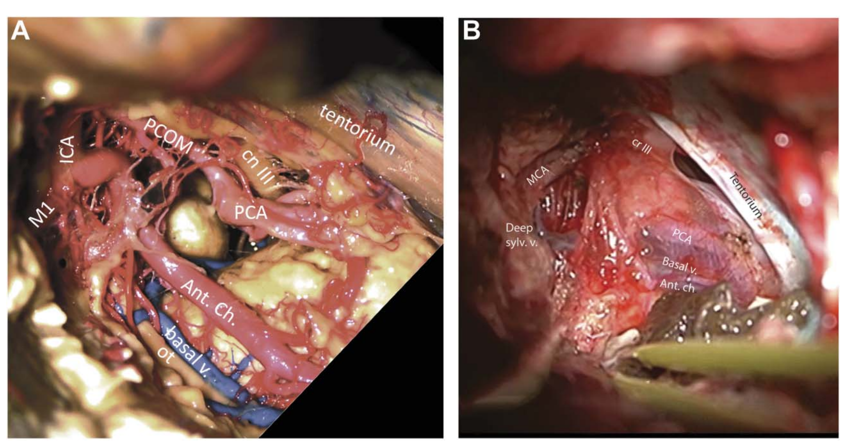

FIGURE 6. *Final view of a right anterior temporal lobectomy and amygdalohippocampectomy* **A**, *on a cadaveric specimen and* **B**, *on a patient. Upon completion of the amygdalohippocampectomy, one can appreciate the basal cistern contents through their arachnoid membrane. The tentorial edge lines the inferolateral margin of the resection area. The oculomotor nerve, the P2 segment of the posterior cerebral artery, the anterior choroidal artery, the basal vein, and the deep sylvian vein can be appreciated subpially in* **B**. **A**, *In the cadaveric specimen, the arachnoid membrane is removed to provide a more accurate view of the above-mentioned neurovascular structures. Ant. Ch., anterior choroidal artery; basal v., basal vein; cn III, cranial nerve III; Deep Sylv. v., deep Sylvian vein; M1, proximal segment of MCA; MCA, middle cerebral artery; ot, optic tract; PCA, posterior cerebral artery; PCOM, posterior communicating artery.*

protective veil for the contents of the basal cisterns. The tentorial edge, the oculomotor nerve, the P2 segment of the posterior cerebral artery, the anterior choroidal artery, the basal vein, and the optic tract can be appreciated subpially in a ventrodorsal direction (Figure 6).

Amygdala Resection

The amygdalar nuclei correspond to the anterior uncus. Interestingly, there is no landmark to differentiate the amygdala from the globus pallidus and basal ganglia, and therefore, their safe resection is risky (Figure 7). It has been proposed that the imaginary line connecting the MCA near the limen insulae to the anterior choroidal point can act as an effective dorsal intraoperative limit for the amygdala resection.[22] If the MCA has not been already identified, removing the white matter of the medial part of the STG should suffice to recognize the artery. Alternatively, the surgeon can identify the posterior communicating artery through the basal arachnoid and follow it all the way up to the internal carotid artery and MCA (Figure 6).

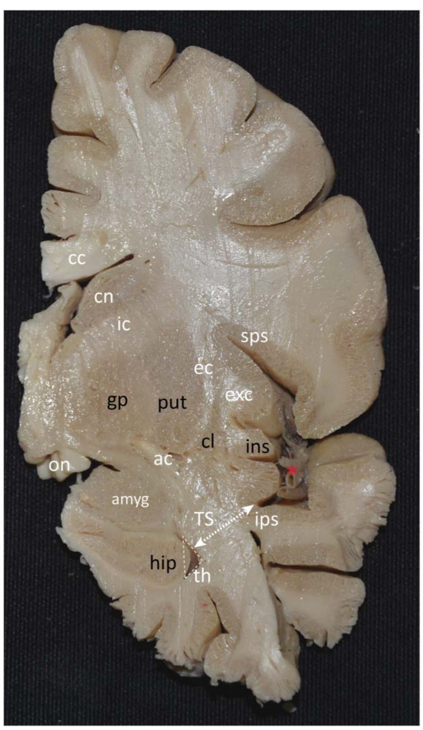

FIGURE 7. *Coronal cut of a left hemisphere. The proximity of the amygdala to the basal ganglia is vividly illustrated. *Middle cerebral artery M2 branches. ac, anterior commissure; amyg, amygdala; cc, corpus callosum; cl, claustrum; cn, caudate nucleus; ec, external capsule; exc, extreme capsule; gp, globus pallidus; hip, hippocampus; ic, internal capsule; ins, insula; ips, inferior periinsular sulcus; on, optic nerve; put, putamen; sps, superior peri-insular sulcus; th, temporal horn; TS, temporal stem.*

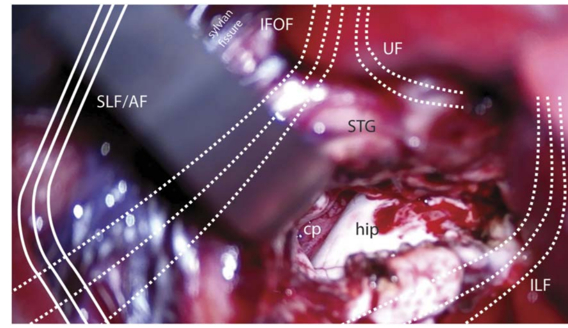

FIGURE 8. *Projection of the related white matter fiber tracts on an intraoperative image of a right anterior temporal lobectomy. AF, arcuate fasciculus; cp, choroid plexus; hip, hippocampus; IFOF, inferior fronto-occipital fasciculus; ILF, inferior longitudinal fasciculus; SLF, superior longitudinal fasciculus; STG, superior temporal gyrus; UF, uncinate fasciculus.*

DISCUSSION

The ATL corridor is mainly used for treating mesial temporal lobe epilepsy but also applies to lesions of the anterior temporal lobe and temporal horn. In epilepsy cases and purely intraventricular pathologies, white matter anatomy is almost intact. Since fiber tracts are not visible in real operative settings and brain parenchyma appears as an amorphous mass, it is crucial for the neurosurgeon to form an accurate mental image of the subcortical pathways that travel in or around the region of attack (Figure 8). Specific tracts are inevitably traversed during the procedure and others are at risk of disruption because of their proximity to the area of interest. The fiber bundle that is definitely severed during the early dissection of the fusiform gyrus is the ILF.[23] ILF is involved in word and object recognition, on the dominant side, and deficits such as dyslexia or visual para-aphasias can ensue. Similarly, injury to the ventral part of the uncinate fasciculus[24-26] and inferior arm of the cingulum results from resecting the anterior temporal lobe and the PHG, respectively. Upon entering the temporal horn, the surgeon must keep in mind that superiorly, at the roof of the horn, resides the temporal stem.[27] The most medial layer of the temporal stem is formed by the anterior bundle of the optic radiation, ie, the Meyer's loop, which, as it curves anteroinferiorly, can be disrupted during manipulation of the temporal horn (Figure 2C) and result in a homonymous upper quadrantanopia. Extending the neocortical resection posteriorly risks injury to the Meyer's loop as it travels at the lateral part of the ventricle and therefore the surgeon should be vigilant when extending the resection above 3.5 cm from the temporal pole.[28,29] Special attention should be paid to the IFOF, the major ventral language pathway,[30,31] which subserves verbal and nonverbal semantics. The IFOF is a component of the temporal stem and as such runs along the roof of the temporal horn[32] (Figure 1D). Fibers of the dorsal language pathways,[30,31] such as the SLF and

AF, are found at approximately 5 cm posterior to the temporal pole and therefore are not at risk of disruption (Figure 1A and 1B).

Aiming to simplify an arguably complicated surgical procedure, we have divided ATL into 3 distinct steps: (1) neocortical resection (2) hippocampectomy, and (3) amygdala resection. During the lateral neocortical resection, it is advisable not to enter the temporal horn prematurely so as to keep the intraventricular anatomy intact and bloodless. To this end, the surgeon can use the midsubtemporal ridge as a landmark for the medial extent of the dissection and identify the emergence of the basal temporal sulci gray matter as an indicator for the completion of the neocortical resection. The midsubtemporal ridge can also guide the accurate localization of the temporal horn in the anteroposterior axis. Upon entering the horn, the surgeon needs to identify the inferior choroidal point, which delineates the head from the body of the hippocampus. The resection of the hippocampus and the PHG requires meticulous microdissection skills to preserve the arachnoid of the basal cisterns as a protective veil. Finally, the MCA bifurcation-inferior choroidal point line will ensure a safe and effective amygdala resection and avoid inadvertent injury to the basal ganglia.

ATL and AH is by definition an anatomic procedure and is considered one of the most challenging in neurosurgery because of the deep surgical trajectory, the complex anatomy of the mesial temporal lobe,[33,34] the functionally important white matter tracts, and the proximity of the resection area to the basal ganglia and the basal cisterns. Apart from flawless microsurgical skills, this procedure requires a thorough and accurate 3-dimensional (3D) knowledge of the pertinent anatomy from the surgeon's point of view, which can be mastered from focused laboratory cranial and white matter dissections.

Anatomic papers for neurosurgeons should not present a "static anatomy", but ideally include many illustrations from different angles to ensure a comprehensive 3D understanding. This will partly compensate for those who do not have the opportunity to train in a microneurosurgical laboratory, but it definitely cannot replace the fascinating way in which anatomic knowledge is smoothly and permanently assimilated to the laboratory-trained minds.[35-38]

Strengths and Limitations

The Klingler's technique comprises the fixation of brains in formalin, followed by a freeze-thaw process. Recent research documented that this procedure maintains the structural integrity of nerve axons, and therefore, the evidence provided is of high sensitivity and accuracy.[39] Furthermore, the 3D architecture of subcortical pathways and their spatial relationships is preserved.

However, this method is expensive, time-consuming, and operator-dependent. The spatial resolution is lower compared with histology, optical coherence tomography, and polarized light imaging, and limitations are present when bundles with intermingling and perpendicular trajectories are studied, because the dissection of one can result in the destruction of the other.

CONCLUSION

ATL and AH is considered a challenging surgical procedure because of the complex regional anatomy and the deep surgical trajectory. The vital anatomic structures involved are specific white matter fiber tracts, i.e., the temporal stem, the ILF and the optic radiation, the neurovascular contents of the basal cisterns, and the basal ganglia.

In this study, white matter dissections, cadaveric cranial dissections, and intraoperative images are put together to enrich anatomic knowledge and provide a thorough yet simple, stepwise guide to navigate the surgeon for a safe and effective procedure.

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The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices used in this article.

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