Original Article

External cortical landmarks and measurements for the temporal horn: Anatomic study with application to surgery of the temporal lobe

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Abstract

Background: The location of the temporal horn is important to neurosurgeons during procedures such as amygdalohippocampectomy and intraventricular electrode placement for temporal lobe seizure monitoring. However, sometimes the temporal horn is difficult to localize, especially without neuronavigation. The authors aimed to better localize this structure using superficial anatomic landmarks.

Methods: Twenty-two brain halves were dissected from the midline, and the fornix identified and followed toward the left and right temporal horns. Once the temporal horn was isolated from a mesial approach, 6-cm long needles were placed into its anterior and posterior walls of the temporal horn and passed laterally from the axial plane to the cortical surface. Pin exit sites were marked externally and measurements taken between the outer temporal lobe cortex and the underlying temporal horn.

Results: No statistical differences were noted between left and right sides. The temporal horn was generally directed anteroinferiorly and best marked externally by the inferior temporal sulcus. The mean length of the temporal horn was 4.4 cm. Mean distance from anterior temporal tip to anterior wall of the temporal horn was 3.3 cm. The mean distance from the anterior temporal tip to the posterior wall of the temporal horn was 7 cm. The anterior wall of the temporal horn was a mean of 3 mm superior to the inferior temporal sulcus. The posterior wall was a mean of 1.2 cm superior to the inferior temporal sulcus.

Conclusions: These landmarks and measurements may help neurosurgeons better localize this part of the lateral ventricular system.

Key Words: Anatomy, lateral ventricles, landmarks, neurosurgery, temporal lobe

INTRODUCTION

Treatment of medically refractive epilepsy originating from the temporal lobe includes surgical removal of epileptic tissue. The most widely employed methods for carrying out this procedure include anterior temporal lobectomy, selective amygdalohippocampectomy through the sylvian fissure, selective amygdalohippocampectomy

through the middle temporal gyrus, and cortico amygdalohippocampectomy.[8] All procedures utilize entry through the superior or lateral wall of the temporal lobe to access various mesial temporal lobe structures.[8] Common to these procedures is entry into the temporal horn [Figure 1] of the lateral ventricle, which requires a detailed understanding of the surrounding anatomy in order to avoid potential morbidity.[5,8]

The general goal of temporal horn surgery should include (i) avoidance of visual pathways, (ii) white matter pathways involved in neurocognitive sequelae, (iii) extent of the incision within the temporal stem, (iv) extent of amygdalectomy, and (v) avoidance of vascular injury.[2] We performed an anatomic study with the hopes of improving the superficial landmarks used for locating the temporal horn during neurosurgical procedures in this area.

MATERIALS AND METHODS

Eleven formalin-fixed cadaveric brains (22 sides) were removed from the crania. The specimens were derived from six male and five female cadavers, aged 43–88 years (mean 71 years) at death. Brains were next hemisected in the midline and the fornix identified and followed toward the left and right temporal horns. Once the temporal horn was isolated from a mesial approach, 6-cm long straight needles were placed into its anterior and posterior walls of the temporal horn and passed laterally in the axial plane until they reached the cortical surface. The specimens were turned over and the pin exit sites marked externally with smaller pins. The pia and arachnoid mater had been previously removed to better visualize the cortical surface. Measurements between the outer temporal lobe cortex landmarks and the underlying temporal horn were then made with digital calipers (Mitutoyo, Japan). Statistical analysis between sides and gender were made using Statistica 12 (Tulsa, OK) with statistical significance set at $P < 0.05$.

RESULTS

No gross intracranial pathology (e.g. hydrocephalus) or evidence of previous surgery of the cranium was noted in any specimen. In general, the temporal horn was directed anteroinferiorly and marked externally by the inferior temporal sulcus. The length of the temporal horn ranged from 2.5 to 6.5 cm (mean 4.4 cm). The distance from the anterior temporal tip to the anterior wall of the temporal horn ranged from 2.3 to 3.5 cm (mean 3.3 cm). The distance from the anterior temporal tip to the posterior wall of the temporal horn ranged from 6.6 to 7.8 cm (mean 7 cm). In reference to the inferior temporal sulcus, the anterior wall of

the temporal horn ranged from 1 to 5 mm (mean 3 mm) above this structure [Figure 2]. The posterior wall ranged from 0.9 to 1.5 cm (mean 1.2 cm) above the inferior temporal sulcus [Figure 3]. No statistical
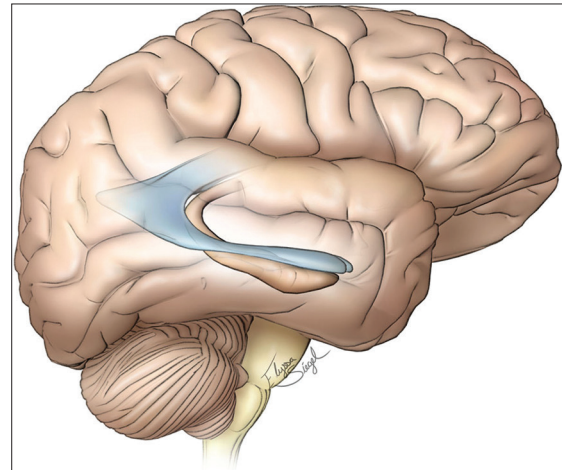

Figure 1: Schematic drawing of the typically noted position of the temporal horn. ©*The Neurosurgical Atlas* by Aaron A. Cohen-Gadol, MD, used with permission

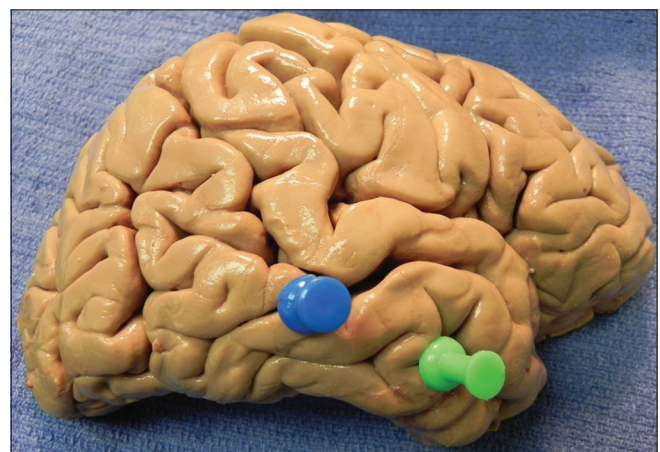Figure 2: Right-sided brain with pins in the anterior and posterior extent of the temporal horn

Figure 3: Left sided brain with pins marking the anterior and posterior extent of the temporal horn

difference for these measurements was noted between left and right sides.

DISCUSSION

The temporal horn of the lateral ventricle has been reported to be approximately 3.97–4.08 cm long.[6] We found that this distance had a wider range of 2.5–6.5 cm. Many have assumed that the temporal horn, which extends from the atrium into the medial part of the temporal lobe, is deep to the middle temporal gyrus and begins approximately 4 cm from the anterior pole of the temporal lobe.[1,7] However, we found that this range is wider and that the inferior temporal sulcus is a better landmark for this deeper lying cavity.

The uncal recess is located between the anteromedial surface of the head of the hippocampus and the posteromedial surface of the amygdala.[4] It is the continuation of the collateral eminence, and it turns medially, following the head of the hippocampus.[7] The most anterior point, or tip, of the temporal horn, is located laterally and a few millimeters anterior to the uncal recess and posterior to the lateral edge of the amygdala.[4] Wen *et al.*[7] stated, "The temporal amygdala therefore is the anterior wall of the temporal horn and constitutes the most anterior part of the roof of the temporal horn above the uncal recess and the head of the hippocampus, anterior to the inferior choroidal point, which is the beginning of the choroid plexus in the temporal horn."[7]

The choroidal fissure is one of the most valuable anatomic landmarks a neurosurgeon can rely on during temporal lobe surgery.[7] In the temporal horn, the choroidal fissure is located between the stria terminalis of the thalamus superomedially and the fimbria inferolaterally.[7] It ends immediately behind the uncus as the inferior choroidal point, which is inferior and anterior to the entrance point of the choroidal artery and exit of the inferior ventricular vein.[7] The posterior two-thirds of the medial wall of the temporal horn, posterior to the inferior choroidal point consists of the choroidal fissure.[7] The anterior one-third of the medial wall of the temporal horn is bordered by the head of the hippocampus.[7] The middle incisural space, which is located between the temporal lobe and midbrain, is so near the temporal horn that the horn is often utilized to gain access to the incisural space.[1,5] The crural and ambient cisterns are located medial to the temporal horn in the middle incisural space.[1]

The anatomy of the roof and lateral wall is important for superior and lateral surgical approaches to the temporal horn.[8] The roof of the anterior one-third of the temporal horn is mainly formed by the amygdala and the lateral wall is formed by the tapetum and part of the retrolentiform and sublentiform components of the internal capsule.[8] The roof of the middle one-third of the temporal horn is mainly tapetum with minor contributions from the tail of the caudate nucleus and the retrolentiform and sublentiform components of the internal capsule.[8]

From a neurosurgical standpoint, the optic radiations are considered the most important component of the roof of the temporal horn.[7] Therefore, there is no clear separation between the roof of the temporal horn and the thalamus; the roof of the temporal horn should be considered a lateral extension of the thalamus.[7] This relationship is important to note for superior approaches to the lateral horn during transsylvian or standard temporal lobectomy routes as there is a risk of damaging the thalamus if the roof of the temporal horn is removed too medially.[7]

The anterior group of optic radiation travels above the roof of the temporal horn and then courses ventrally to form the Meyer's loop.[3] Meyer's loop is located an average distance of 27 mm behind the pole of the temporal lobe and terminates up to 5 mm in front of the anterior wall of the inferior horn.[3] Damage to these fibers will result in a lateral superior homonymous quadrantanopia on the opposite side of the lesion.[3] The central group of the optic radiation runs laterally across the roof of the temporal horn. Its damage will result in a lateral homonymous hemianopia on the opposite side of the lesion.[3] The upper or posterior bundle travels directly behind the atrium of the lateral ventricle and ends at the upper lip of the calcarine fissure.[3] It carries fibers of the inferior nasal and temporal quadrants, and damage to these fibers will result in lateral inferior homonymous quadrantanopia on the opposite side of the lesion.[3]

Anteriorly, optic radiations are found along the roof of the temporal horn, but travel along its lateral surface more posteriorly.[4] Therefore, resections in the upper lobe directed anteriorly are less likely to cause visual field defects than those directed posteriorly.[4] Furthermore, resections, which extend into the horn, are more likely to cross the thin layer of tapetum, which separates the optic fibers from the temporal lobe.[4]

Other landmarks

The occipitotemporal and collateral sulci on the basal surface of the temporal lobe are two prominent sulci that can serve as landmarks for locating the temporal horn.[8] The occipitotemporal sulcus is located between the inferior temporal gyrus and the fusiform gyrus. The collateral sulcus is located medial to the fusiform gyrus and it bulges into the lateral part of the floor of the middle and posterior thirds of the temporal horn.[8] The rhinal sulcus can be considered an anterior continuation of the collateral sulcus and it separates the uncus from the temporal pole.[7] It bulges into the floor of the anterior third of the temporal horn.[8]

Wen *et al.* analyzed the occipitotemporal and rhinal sulci as landmarks to the temporal horn. These authors found that when approaching the mesial temporal structures from the superior or lateral surface of the temporal lobe, dissection is initially performed through the white matter toward the floor of the middle fossa until the gray matter overlying an anterior basal sulcus is encountered. Once identified, dissection was continued medially and superiorly from the top of the gray matter until the temporal horn was entered. These authors concluded that the gray matter overlying the occipitotemporal sulcus is a reliable landmark for the temporal horn, however, this sulcus was not always present. The gray matter overlying these sulci is a useful landmark for locating the anterior portion of temporal horn.[8]

When viewing the temporal lobe in the coronal plane, the superior and inferior temporal, occipitotemporal, and collateral sulci point radially toward the lateral end of the temporal horn.[8] The bottom of the collateral sulcus is located closest to the temporal horn.[8] We therefore recommend using the collateral sulcus as the most reliable landmark to follow during dissection along the middle fossa to reach the temporal horn without prematurely violating the hippocampus. In other words, during the lateral neocortical resection, the posterior corticotomy is extended medially until the arachnoid of the collateral sulcus (the second sulcus along the basal temporal lobe after the occipitotemporal sulcus) is encountered. Immediately lateral and superior to this sulcus is the more posterior aspect of the temporal horn.

The surface landmarks of the temporal horn discussed in our study can also be used to reach this portion of the ventricle for cerebrospinal fluid drainage if this cavity is trapped. It is important to note that different pathological processes in the region often distort the landmarks analyzed here and the effect of the pathology at hand in displacing the ventricle or expanding it should be accounted for in the final localization of the ventricle.

CONCLUSIONS

We performed this cadaveric study to better identify the relationships between the outer temporal cortex and the deeper lying temporal horn. Such landmarks and measurements may be useful to neurosurgeons in localizing this part of the lateral ventricular system in conjunction with or to verify imaged-guided technologies or when these devices are not used or are unavailable.

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