

# **TEMPORAL LOBE ANATOMY**

- Dr. J. Todd, an English psychiatrist., wrote in The Syndrome of Alice in Wonderland (1955) that, “There is wide appreciation of the fact that epileptic subjects, and their blood relatives, are prone to experience bizarre disturbances of the body image” .
- Lewis Carroll, who wrote Alice in Wonderland, is thought to have had epilepsy -- he may very likely have been describing his own symptoms as he penned the transformations of his characters.

# GROSS ANATOMY

- The temporal lobe lies inferior to the lateral sulcus (sylvian fissure).
- Limited posteriorly by an imaginary line joining the pre-occipital incisure to the parieto-occipital sulcus.
- The parieto-occipital sulcus runs along the medial aspect of the hemisphere and meets the superomedial margin of the hemisphere approx. 5 cm from the occipital pole.

# **EMBRYOLOGY**

The forebrain  
(prosencephalon) divides into  
telencephalon and  
diencephalon.

The telencephalon develops a  
diverticulum on each side and  
its cavity is called the lateral  
ventricle.

- The telencephalon forms the anterior end of the 3<sup>rd</sup> ventricle and the diverticulum on either side forms the cerebral hemisphere.
- Each hemisphere arises at the beginning of the 5<sup>th</sup> embryonic week.
- They grow in all directions rapidly.
- The inferior expansion forms the temporal lobes.
- The medial wall of the hemisphere remains thin and is formed by ependymal cells.
- This area is invaginated by vascular mesoderm, forming the choroid plexus.

# LATERAL ASPECT

- Lateral surface is divided into three parallel gyri by two sulci.
- Superior temporal gyrus                      Superior temporal sulcus  
Middle temporal gyrus                      Inferior temporal sulcus  
Inferior temporal gyrus

- The lateral temporal surface has three gyri:-
- Superior temporal gyrus -> Area 22.  
Middle temporal gyrus -> Area 21.  
Inferior temporal gyrus -> Area 20.
- These gyri terminate anteriorly at the temporal pole -> Area 38.
- The superior temporal gyrus lies between the sylvian fissure and the superior temporal sulcus.
- The angular gyrus, a parietal lobe structure, caps the upturned posterior end of the superior temporal sulcus.

- Along its superior margin, the sup. temp. gyrus is continuous with the gyri on the floor of the posterior ramus of the sylvian fissure.
- These gyri vary in no. and they extend anterolaterally around the insula as transverse temporal **gyri of Heschl**.
- Gyri of Heschl and adjoining area of sup. temp. gyrus form the primary auditory cortex (Area 42).

- The middle temporal gyrus lies between the superior and inferior temporal sulci.
- The temporal horn and the ambient and the crural cisterns are located deep to the middle temporal gyrus.
- The inferior temporal gyrus lies below the inferior temporal sulcus and continues around the inferior border of the hemisphere to form the lateral part of the basal surface.

- Planum temporale is a part of posterior aspect of sup. temp. gyrus.
- Takes part in language-related auditory processing.
- Gyrus of Heschl and planum temporale are more prominent on the left side.

- The temporal lobe is enormously expanded in humans.
- Commonly studied old world monkeys lack middle temp. gyrus.
- Poses problems in relating physiological and anatomical studies in non-human primates to human brain topography.

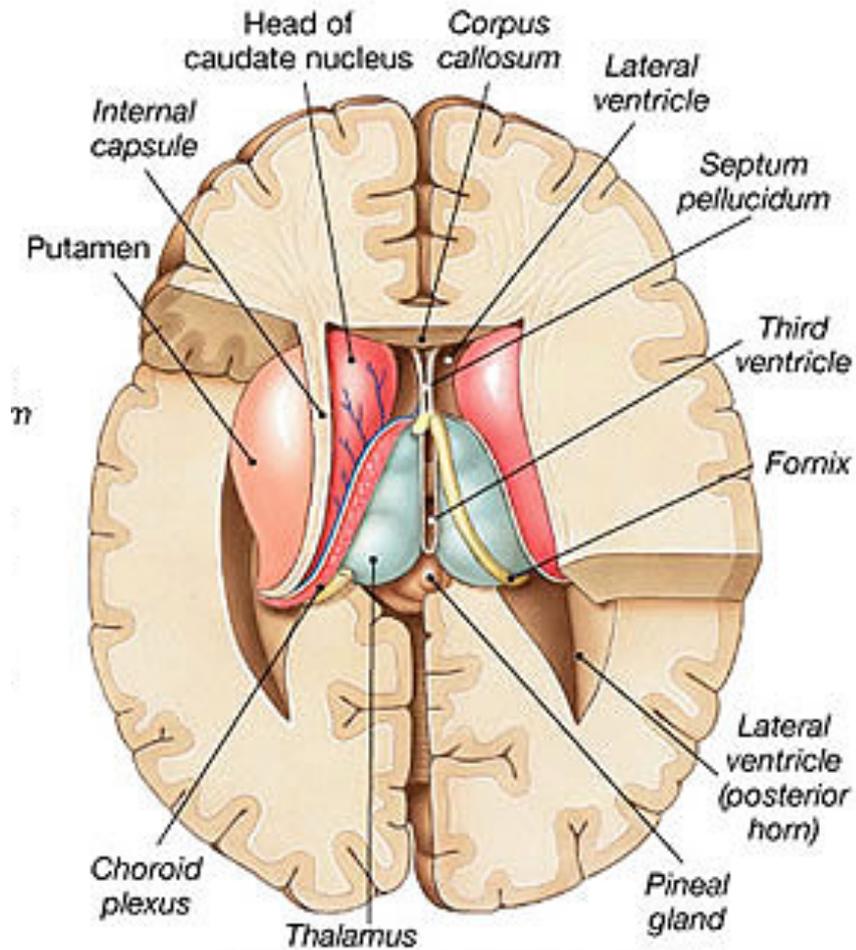
## MEDIAL ASPECT

- Most complex of the medial cortical areas.
- Formed predominantly by the rounded medial surfaces of the parahippocampal gyrus and uncus.
- Three longitudinal strips of neural tissue, one located above the other, which are interlocked with the hippocampal formation.

- The most inferior strip is formed by the rounded medial edge of the parahippocampal gyrus.
- The middle strip is formed by the dentate gyrus, a narrow serrated strip of gray matter located on the medial surface of the hippocampal formation.
- The superior strip is formed by the fimbria of the fornix, a white band formed by the fibers emanating from the hippocampal formation and directed posteriorly into the crus of the fornix.

- The parahippocampal and dentate gyri are separated by the hippocampal sulcus.
- The dentate gyrus and the fimbria are separated by the fimbriodentate sulcus.
- The amygdala and the hippocampal formation lie intimate to each other.

- The parahippocampal gyrus also extends around the lower border to form the medial part of the basal surface of the temporal lobe, where it is separated from the medially projecting uncus by the rhinal sulcus.
- **Uncus**, is the medially projecting anterior part of the parahippocampal gyrus.
- When viewed from above or below, it has an angular shape with anterior and posterior segments that meet at a medially directed apex.



**(d) Horizontal section, dissected**

- The anterior segment of the uncus faces anteromedially and the posterior segment faces posteromedially.
- The anterior segment has an undivided medial surface, but the posterior segment is divided into upper and lower parts by the uncal notch, a short sulcus.
- Medial face of the anterior segment faces the proximal part of the sylvian, the carotid cistern, and the ICA and proximal MCA.
- Posterior segment faces the cerebral peduncle and, with the peduncle, forms the lateral and medial walls of the crural cistern through which the posterior cerebral, anterior choroidal and medial posterior choroidal arteries pass.
- The apex between the anterior and posterior segment is located lateral to the oculomotor nerve.

- The amygdaloid nucleus forms almost all of the interior and comes to the medial surface of the upper part of the anterior segment.
- The upper part of the posterior segment is formed largely by the medial aspect of the head of the hippocampus.
- The inferior choroidal point is the lower end of the choroidal fissure along which the choroid plexus is attached.
- Located just behind the upper edge of the posterior uncal segment, immediately behind the head of the hippocampus.
- It is the site where the anterior choroidal artery passes through the choroidal fissure to enter the temporal horn.

- Dentate gyrus, is named for its characteristic tooth-like elevations.
- Extends posteriorly from the upper part of the posterior segment of uncus.
- Continuous posteriorly below and behind the splenium of the corpus callosum with the fasciolar gyrus, a smooth grayish band that blends above into the indusium griseum.

- Amygdaloid nucleus is named so because it resembles an almond.
- Situated entirely within uncus.
- Forms anterior wall of the temporal horn.
- It fuses with the tip of the tail of the caudate nucleus.
- The amygdala gives rise to the stria terminalis, which courses between the thalamus and caudate nucleus deep to the thalamostriate vein.

- Hippocampus is a curved elevation of gray matter; approximately 5 cm long.
- Runs along entire length of the medial part of floor of the temporal horn.
- Dentate gyrus runs along its medial edge.
- A curved collection of gray matter lies inferiorly (Ammon's horn).
- Sits above and is continuous below with the rounded medial surface of the parahippocampal gyrus.
- The hippocampus blends into and forms the upper part of the posterior uncal segment.

- The hippocampus, the parahippocampal gyrus and the dentate gyrus together form the hippocampal formation.
- The hippocampus is divided into three parts: head, body and tail.
- The head, directed anteriorly, has 3-4 digitations, resembling paw of sea-horse; hence called *pes hippocampus*.
- The body of the hippocampus extends along the medial part of the floor of the temporal horn, narrowing into the tail that disappears as a ventricular structure.

- The convex ventricular surface is covered with ependyma. Beneath this lies a thin layer of white matter – alveus.
- The alveus consists of nerve fibers which originated in the hippocampus.
- These fibers converge medially to form a bundle, viz. fimbria.
- The fimbria becomes continuous with the crus of fornix.

- The temporal horn extends into the medial part of the temporal lobe to just anterior to the hippocampal head and to just behind the amygdala.
- The temporal horn ends approximately 2.5 cm from the temporal pole.
- The **inferior choroidal point**, at the lower end of the choroidal fissure, is located just behind the head of the hippocampus and immediately lateral to the lateral geniculate body.

# BASAL ASPECT

- The basal surfaces of the temporal and occipital lobes are formed by the same gyri that continue from anterior to posterior across their uninterrupted border.
- From medial to lateral are the parahippocampal and occipitotemporal gyri and the lower surface of the inferior temporal gyrus.
- The parahippocampal gyrus extends backward from the temporal pole to the posterior margin of the corpus callosum.
- Continues posteriorly to blend into the isthmus of the cingulate gyrus and lingula.

- The **collateral sulcus**, one of the most constant cerebral sulci, begins near the occipital pole and extends anteriorly, parallel and lateral to the calcarine sulcus.
- Posteriorly, it separates the lingula and occipitotemporal gyrus, and anteriorly, it courses between the parahippocampal and the occipitotemporal gyri.
- The collateral sulcus is located below the temporal horn and indents deeply into the basal surface producing a prominence, the collateral eminence, in the floor of the temporal horn, viz. collateral eminence.
- The occipitotemporal sulcus courses parallel and lateral to the collateral sulcus and separates the occipitotemporal gyrus and basal surface of the inferior temporal gyrus.
- A short rhinal sulcus is often found anteriorly lateral to the uncus.

# BLOOD SUPPLY AND VENOUS DRAINAGE

- The lateral aspect is perfused mainly by the branches of the MCA –
  - Anterior temporal A.
  - Middle temporal A.
  - Temporo-occipital A.
- The inferior temporal gyrus is supplied by branches of the PCA.
- The choroid plexus of the temporal horn is supplied by the branches of the anterior choroidal A.

- The superficial middle cerebral V. drains most of the lateral aspect.
- It follows the Sylvian fissure to end at the cavernous sinus.
- A superior anastomotic vein of Trolard connects the sup middle cerebr V. to the superior sagittal sinus.
- An inferior anastomotic vein of Labbe runs over the temporal lobe and connects the sup middle cerebr V. to the transverse sinus.
- A few inferior cerebral veins drain the inferior aspect. They anastomose with basal veins and middle cerebr veins and drain into cavernous, transverse and superior petrosal sinuses.

- **Vein of Labbe:-**
- Inferior anastomotic vein.
- Largest anastomotic channel that crosses the temporal lobe between the sylvian fissure and the transverse sinus
- Usually arises from the middle portion of the sylvian fissure and is directed posteriorly and inferiorly toward the anterior part of the transverse sinus.
- May cross the temporal lobe as far back as the posterior limit of the lobe or as far forward as the anterior third of the lateral surface.
- There may be double veins of Labbé, in which case the posterior vein is usually larger

- Although the veins of Trolard and Labbé and the superficial sylvian vein may be of nearly equal size, it is more common for one or two of them to predominate and the other to be small or absent.
- Usually, there is asymmetry between the right and left hemispheres in the size of these channels.

# PAPEZ CIRCUIT

- Connects structures of the limbic system.
- Cingulate gyrus -> parahippocampal gyrus and amygdala -> hippocampus -> fornix -> mamillary body -> anterior nucleus of thalamus -> cingulate gyrus.
- Controls emotion, behaviour and drive. Also takes part in memory.

# CORTICAL STRUCTURE

- Predominantly 6-layered cortex.
- Gyrus of Heschl forms the primary auditory cortex (AI).
- Surrounding areas form aud. association areas (AII).
- Geniculocortical fibers from MGB terminate in layer IV of the cortex.
- Auditory cortex connects with the prefrontal cortex, anterior cingulate gyrus and to corresponding areas in the opp. hemisphere.
- Aud. Association areas connect with other sensory association areas around the sup. temporal sulcus.

- Injury to aud cortex produces cortical deafness, auditory agnosia, with contralateral predominance. Patient unaware of the deficit.
- Difficulty in localising source of sound.
- Noticeable deficit occurs only when there is b/l damage.
- Damage to temporoparietal junction causes auditory inattention.
- Damage to posterior superior temporal area on dominant side causes Wernicke's aphasia.

- Middle temporal cortex (area 21) is polysensory.
- Connects with auditory (sup temporal gyrus), visual and somatosensory association pathways.
- Also has connections with pulvinar areas of the thalamus.
- Lesion to middle temp gyrus (esp. dominant side) causes visuospatial difficulties, prosopagnosia and severe sensory dysphasia.

- Inferior temporal cortex (area 20) is a higher visual association area.
- Receives fibers from i/l occipitotemporal visual areas (V4).
- Sends efferent fibers to paralimbic areas on medial aspect of temporal lobe.
- Also connected to prefrontal cortex and frontal eye field.

- Cortex of the temporal pole receives fibers from widespread areas of temporal association cortex.
- Dorsal part receives auditory input and inferior part receives visual input.
- Sends efferent fibers to limbic and paralimbic areas and also to prefrontal cortex.
- Related to behavioural performance and recognition of high-level aspects of social stimuli.

- Superior, middle and inferior temporal gyri and parahippocampal gyrus are phylogenetically newer → neocortex → 6-layered cortex.
- Hippocampus and dentate gyri → part of older allocortex → 3-layered cortex.

- Damage to limbic system -> disturbs emotional behaviour, pattern of rage, anger and sexual behaviour.
- **Kluver-Bucy syndrome:-** Experimental damage to b/l amygdala in monkeys.
  - Visual agnosia or psychic blindness.
  - Loss of fear or rage reaction.
  - Hypersexuality.
  - Bulimia.

- **Hippocampus** is related to converting recent memory to long-term memory.
- Lesion in hippocampus causes affected person unable to store newly acquired long-term memory -> **Anterograde amnesia.**
- Memory of remote past events before the lesion developed is unaffected.
- **Visual memory** → Picture/scene recall → Rt parahippocampal cortex.
- **Verbal memory** → Word recall → Lt parahippocampal cortex.

- **Periamygdaloid area:-** Primary olfactory cortex.
  
- **Entorhinal area (area 28):-** Part of anterior portion of parahippocampal gyrus.  
Olfactory association area.  
Lesion causes olfactory hallucination.

Neoplasms or space occupy lesions of the temporal lobe present with:-

- Vague personality change to frank behavioural disturbances.
- Anxiety, depression;
- Fear and anger;
- Paranoia;
- Memory deficit;
- Learning and cognitive disabilities;
- Apathy.

## **Meyer's loop (Loop of Meyer and Archambault):-**

- Contains optic radiation fibers from LGB to calcarine cortex.
- Inferior retinal fibers, representing contralateral superior visual field.
- Arch anteriorly in the temporal lobe, sweeping forward and laterally above the temporal horn.
- Runs 5-7 cm from the temporal tip.
- Damage causes contralateral superior quadrantanopia.
- Light reflex preserved.

# TEMPORAL LOBE EPILEPSY

- Very common in humans.
- Commonest type of seizure - > Approx. 25% of all epilepsies
- Often resistant to pharmacotherapy.
- Most commonly associated with amygdalar and hippocampal sclerosis.
- Both are deep structures → 3-4 cm below the surface.
- Electrophysiological studies often miss.
- I/L temporal horn may dilate.

- Complex partial / psychomotor seizure.
- Described by Hughlings-Jackson (uncal fits).
- Lesion mostly in antero-medial parts of temp. lobe -> hippocampus, uncus, amygdala, parahippocampal gyrus.
  
- Formed visual hallucination – macropsia/micropsia.
- Olfactory hallucination.
- Auditory hallucination.
- Autonomic disturbances.
- *Déjà vu* or *jamais vu*.
- Anxiety, fear, rage, obsessive thoughts, speech or action.

# TEMPORAL LOBECTOMY

## INDICATIONS:-

- Where local regions of swelling and injury are identified.
- Where global swelling with volume expansion exceeds the capacity of the duraplasty or skin closure.
- When post-op findings show persistent intracranial hypertension after adequate bone decompression.

## LANDMARKS:-

- Dominant side -> Anterior 4 cm from temporal tip.
- Non-dominant side -> Anterior 5 cm from temporal tip.
- A layer of cortex bordering the sylvian fissure is preserved to prevent disruption of the vasculature
- In the dominant side, superior temporal gyrus is preserved to minimize disruption of speech function.

# Surgery in Temporal Lobe Epilepsy

- Extent of dissection depends on exact site of origin of seizure and probable neurologic and neuropsychological deficits that can result from such resection.
- Usual sites of origin -> Superior, Middle, Inferior temporal gyri, parahippocampal gyrus, hippocampus, amygdala and uncus.
- Ammon's horn sclerosis is found in 85% of resected specimens.

## When seizure focus lies in the lateral temporal lobe :-

- More extensive resection of lateral temporal lobe is done .
- For dominant side awake craniotomy is preferred to permit language mapping.
- Recording from amygdalohippocampal complex is also done simultaneously and resection done in presence of epileptiform activity.
- Solely resecting lesion in lateral temporal neocortex while sparing mesial structures is often ineffective.

## **When pre-op MRI reveals hippocampal sclerosis :-**

- Resection of lateral temporal neocortex -> upto 3 cm of anterior most part of middle and inferior temporal gyri.
- Relatively aggressive resection of the mesial temporal structures, tailored to intra-op electrophysiological recordings.
- Neocortical resection provides generous exposure for hippocampal resection.

# Anterolateral Temporal Lobectomy

- Structures to be preserved -
  - a. Superior Temporal gyrus on the dominant side.
  - b. Vein of Labbe (4-6 cm from temporal tip) .
  - c. Branches of MCA ( which leave the sylvian fissure and run over superior and middle temporal gyri within anterior 4 cm of temporal lobe, to supply posteriorly located language areas.
  - d. Veins draining from sylvian fissure to sphenoparietal sinus.
- Resection should be kept anterior to petrous ridge.
- Resection carried on till temporal horn is entered.

# Resection of Amygdala, Hippocampus and Parahippocampal gyrus

- Structures to be aware of:-
  - a. Internal capsule, lying medial to temporal horn
  - b. PCA
  - c. 3<sup>rd</sup> and 4<sup>th</sup> cranial nerves, lying in the incisura.
- Large amount of CSF drainage -> cortex falling away from dura -> stretching and avulsion of posterior inferior temporal vein (that drains into petrosal sinus) -> profuse haemorrhage. ----→ Prevented by frequent CSF replacement by irrigation of basal cistern with saline.
- Subpial resection is preferred.
- Resection extends approx. 1 cm posterior to the vein entering hippocampal fissure.

# Complications

- Transient dysphasia.
- Transient paresis of cranial nerves III and IV with subtle diplopia.
- Contralateral superior quadrantanopia – in 50% patients – incidence can be lowered if lateral temporal lobe resection is restricted to less than 4 cm.
- Acute psychosis – rare but well recognised complication.
- Anxiety (5% patients) – responds to psychotropic medications.
- Memory and attention deficits.

## Seizure control

- Patients with Ammon's horn sclerosis have the best outcome.
- About 68% turned seizure-free and another 24% had significant improvement in seizure frequency.
- Patients with atypical sclerosis have the poorest outcome.

***THANK YOU***