SAGITTAL ANATOMY OF THE SYLVIAN CISTERN

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INTRODUCTION:

The Sylvian cistern is well understood and described in the anatomical and surgical literature[2,7]. Computed tomography (CT) and magnetic resonance (MR) have advanced our knowledge of this area. Description of the sylvian cistern is generally done in the axial and coronal planes. The sagittal plane is underutilized but adds another dimension to anatomy not observed in the other planes. In particular, the triangular shaped insular cortex with its gyri and sulci, is well depicted in this plane. In this exhibit we present the normal sagittal MRI anatomy and various examples of pathology occurring in this area.

ANATOMY:

The Sylvian cistern is the subarachnoid space extending into the Sylvian fissure. It is bounded by the insular cortex (island of Reil)[4] and the opercular cortex (frontoorbital, frontoparietal and temporal). Within the Sylvian cistern lies the middle cerebral artery (MCA) and its branches. The opercula (lobes) cover and encase the insular cortex (Fig 1). The Sylvian fissure, insular cortex and operculum are anatomically intimately related to each other.

Sylvian fissure anatomy is variable and extends on the lateral surface of the brain from the anterior perforated substance to the supramarginal gyrus. It separates the frontal and parietal lobes from the temporal lobe and the insular cortex from its floor.[5] (Fig 1, 2,)

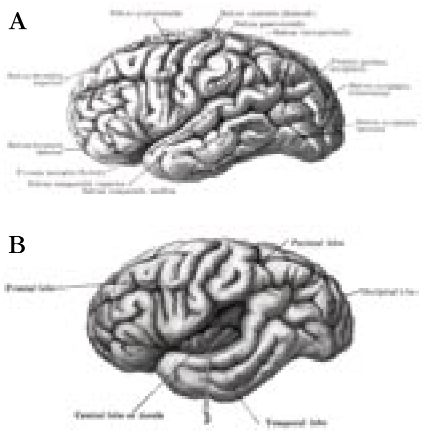


Fig 1. Normal Anatomy. A. Lateral surface of the brain showing the various fissures, sulci and gyri. B. Separation of the opercula reveal the insular cortex (central lobe) Printed from Applied Anatomy: Davis GG, Philadelphia: J.B.Lippincott Co, 1910,pp 32,33.

The Sylvian fissure is divided into anterior (stem) and posterior (insuloopercular) compartments[5,6] (Fig 3, 4) The limen insulae forms the junction point or knee between the anterior and posterior stem.[5] (Fig 2, 3, 4). This is the most lateral limit of the anterior perforated substance and is the starting point of the triangular shaped insular cortex. Anterior, superior and inferior periinsular sulci demarcate the limits of the insular cortex and the sulci demarcate the insular cortex from the adjacent opercula. (Fig 2, 3).

The frontoorbital, frontoparietal and temporal opercula enclose the insula. (Fig 1, 2). The operculum encloses areas which are vital to perception and motor aspects of speech, auditory function and secondary somatic sensory and motor functions.[1]

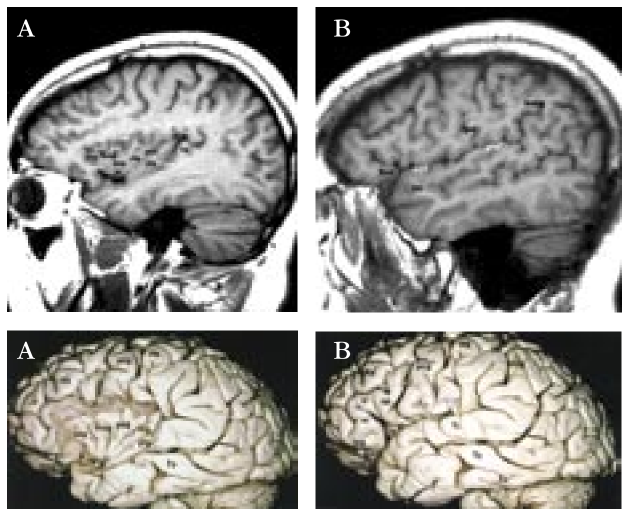


Fig 2. Normal Anatomy. A. Sagittal T1-weighted MR image and corresponding surgical anatomy specimen through the insular cortex defining the insular borders, gyri and sulci. B. Sagittal T1-weighted image and corresponding surgical anatomy specimen through the opercula. **alg** anterior long insular gyrus, **aps** anterior periinsular sulcus, **asf** anterior stem of sylvian fissure, **asg** anterior short insular gyrus, **cis** central insular sulcus, **foo** frontoorbital operculum, **fpo** frontoparietal operculum **hg** Heschl's gyrus, **ia** insular apex, **ips** inferior periinsular sulcus, **msg** middle short insular gyrus, **pcis** postcentral insular sulcus, **pis** precentral insular sulcus, **plg** posterior long insular gyrus, **pps** posterior periinsular sulcus, **psf** posterior stem of Sylvian fissure, **psg** posterior short insular gyrus, **sis** short insular sulcus, **smg** supramarginal gyrus, **sps** superior periinsular sulcus, **to** temporal operculum

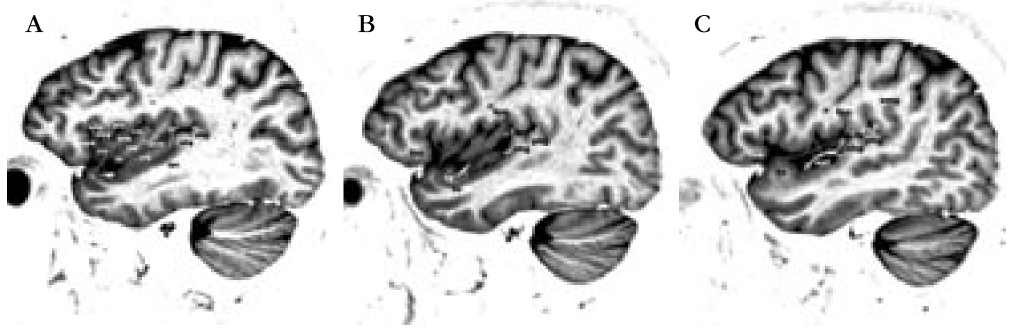


Fig 3. Normal Sagittal Anatomy. A. Sagittal T1-weighted STIR image through insular cortex. B. lateral to the insular cortex. C. through opercula. **ahg** anterior Heschl's gyrus, **alg** anterior long insular gyrus, **aps** anterior periinsular sulcus, **asf** anterior stem of Sylvian fissure, **asg** anterior short insular gyrus, **cis** central insular sulcus, **foo** frontoorbital operculum, **fpo** frontoparietal operculum, **ia** insular apex, **ips** inferior periinsular sulcus, **msg** middle short insular gyrus, **pcis** postcentral insular sulcus, **phg** posterior Heschl's gyrus, **pis** precentral insular sulcus, **plg** posterior long insular gyrus, **pps** posterior periinsular sulcus, **psf** posterior stem of sylvian fissure, **psg** posterior short insular gyrus, **sis** short insular sulcus, **smg** supramarginal gyrus, **sps** superior periinsular sulcus, **tg** triangular gyrus, **to** temporal operculum

The insula is classified as part of the paralimbic system and a variety of functions have been attributed to it including memory, drive, affect, gustation, and olfaction[1].

The central insular sulcus, the main and the deepest sulcus of the insula, courses obliquely across the insula, and extends uninterrupted from the limen insula to the superior periinsular sulcus. It divides the insula into two unequal zones: the larger anterior insula, and the smaller posterior insula . (Fig 2, 3)

The anterior insula is composed of the triangular and three principal short insular gyri (anterior, middle and posterior). The anterior, middle and posterior short insular gyri are separated by the short insular sulcus and the pre-central insular sulcus. The gyri of the anterior insula fuse to form the insular apex (Fig 2, 3), which is its most superficial area. The posterior insula is composed of anterior and posterior long insular gyri which are separated by the post-central insular sulcus. The cortical grey matter of the insular cortex is continuous with that of the different opercula (Fig 2, 3, 4, 5). The extreme capsule, consisting of the subcortical white matter of the insular cortex is continuous with the white matter of the opercula. (Fig 4, 5)

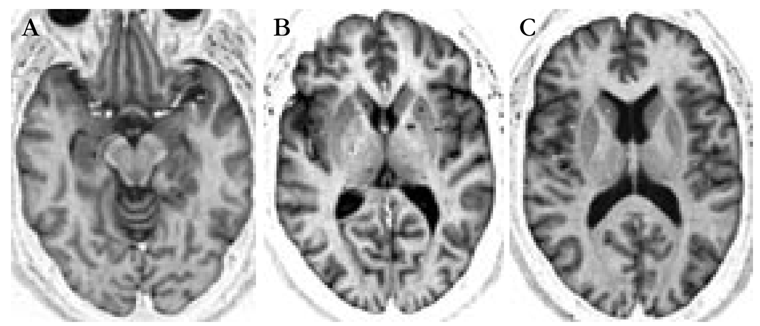


Fig 4. Normal Axial Anatomy. A. Axial T1-weighted STIR images at level of anterior atem of sylvian fissure. B. at level of inferior insular cortex. C. at level of superior insular cortex. **as** anterior perforated substance, **asf** anterior stem of Sylvian fissure, **c** caudate nucleus, **ec** external capsule, **gp** globus pallidus, **i** internal capsule, **ic** insular cortex, **li** limen insula, **mca** middle cerebral artery, **p** putamen, **psf** posterior stem of sylvian fissure, **t** thalamus

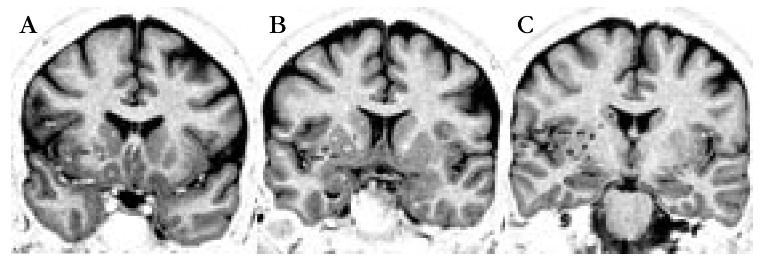


Fig 5. Normal Coronal Anatomy. A Coronal T1-weighted STIR image at the anterior stem of sylvian fissure. B. at level of anterior part of posterior stem of Sylvian fissure. C. at level of posterior part of posterior stem of Sylvian fissure. **asf** anterior stem of Sylvian fissure, **c** caudate nucleus, **cl** claustrum, **ec** external capsule, **exc** extreme capsule, **fpo** frontoparietal operculum, **gp** globus pallidus, **h** hippocampus, **i** internal capsule, **ic** insular cortex, **p** putamen, **psf** posterior stem of sylvian fissure, **to** temporal operculum, **si** substantia innominata

The horizontal or M1 segment of the MCA extends laterally in the depths of the sylvian fissure, from its origin at the ICA bifurcation to its bifurcation or trifurcation at the knee dividing into the anterior temporal artery, the superior trunk and the inferior trunk The insular or M2 segments (superior trunk, inferior trunk and its branches) begin at the limen insula (genu) extend to the periinsular sulci and loop over the insular cortex. The opercular or M3 segments extend from the periinsular sulci and ramify over the lateral hemispheric surface in the sylvian fissure.[3,6] (Fig 6)

Arteries supplying the insular cortex predominantly originate from the M2 segment of the MCA, with a few arising from the M3 segment. They also supply the extreme capsule and occasionally the claustrum and external capsule. Few branches from the M1 segment supply the limen insula.[6]

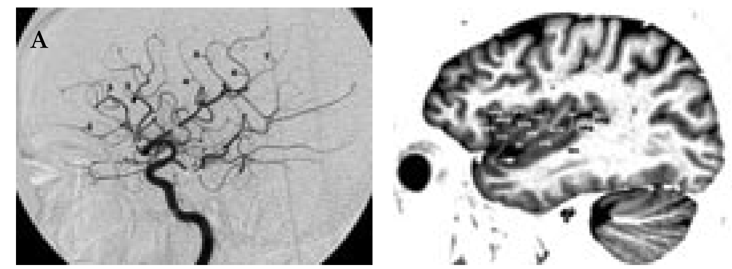


Fig 6A. Normal Arterial Anatomy. Lateral projection of right internal carotid angiogram and surgical anatomy specimen showing the arteries in the insula: **2** prefrontal artery, **3** precentral artery, **4** central artery, **5** anterior parietal artery, **6** posterior parietal artery. **7** angular artery, **it** inferior trunk, **pca** posterior communicating artery, **st** superior trunk.

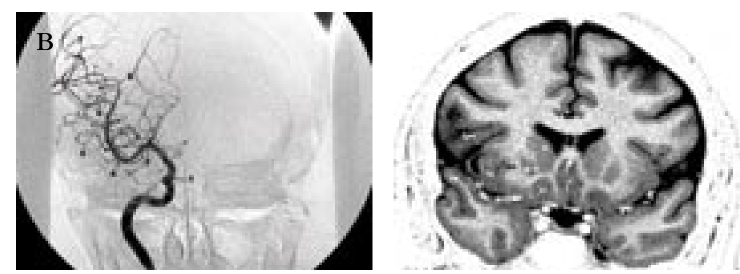
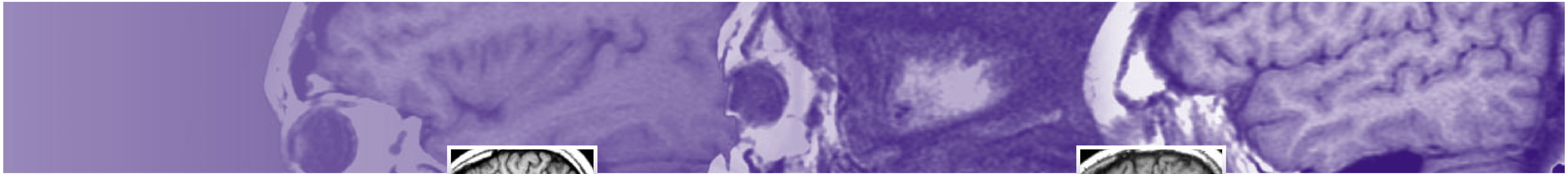
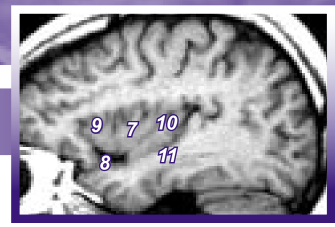


Fig 6B. frontal projection of right internal angiogram. **1** internal carotid artery, **2** horizontal (M1) MCA segment, **3** lateral lenticulostriate arteries, **4** MCA bifurcation, **5** anterior temporal artery, **6** M2 (Sylvian) segments of MCA hemispheric branches, **7** M3 (opercular) MCA branches, **8** Sylvian point.



INSULAR LESIONS:



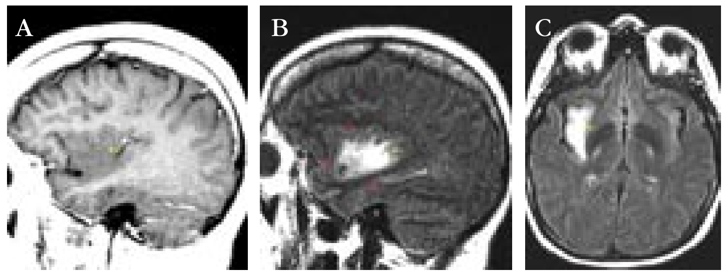


Fig 7. Insular Glioma. A. Sagittal postgadolinium T1-weighted MR image through the right insular cortex demonstrates an isointense nonenhancing mass (↗) occupying the insular cortex. B. Sagittal FLAIR image shows mass (↗) to have hyperintense signal. Note normal signal intensity of the surrounding opercular cortex (↗). C. Axial FLAIR weighted image shows hyperintense mass involving the right insular cortex. Note sharply marginated medial border of the mass (↗) abutting the adjacent extreme capsule.

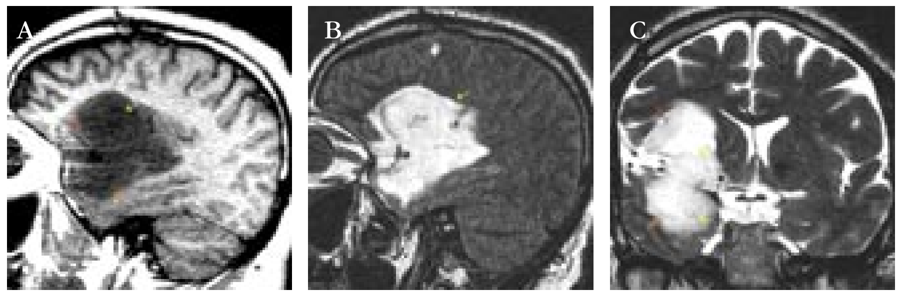


Fig 8. Recurrent Low grade astrocytoma. A. Sagittal noncontrast T1-weighted image through the right insular cortex demonstrates hypointense expansile mass (↗) occupying insular cortex. Note involvement of the adjacent superior frontoopercular cortex (↗) and temporoopercular cortex (↗). B. Sagittal FLAIR image shows entire mass to be uniformly hyperintense (↗) C. Coronal T2-weighted image demonstrates expansile mass (↗)along the right insular cortex with sharply defined medial extension. There is adjacent superior spread of the mass along the frontoopercular cortex (↗), inferiorly along the temporopercular cortex (↗) and medially along the substantia innominata (*). Note previous surgery with enlarged subarachnoid space of the right Sylvian fissure (↗)

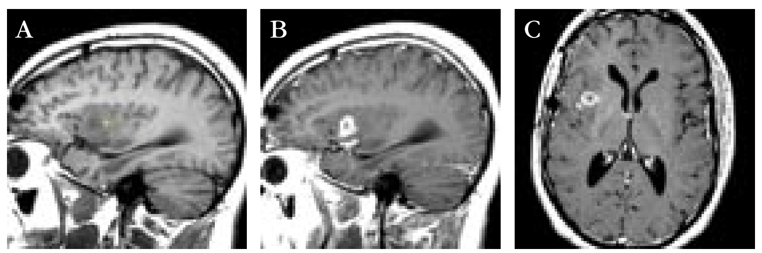


Fig 9. Recurrent pilocytic astrocytoma. A. Sagittal noncontrast T1-weighted image through the right insular cortex demonstrates isointense mass (↗) occupying the anterior insular cortex. B. Sagittal postgadolinium study demonstrates ring enhancement. C. Axial postgadoliunium T1-weighted image shows exact location of mass and note sharp linear border abutting the extreme capsule

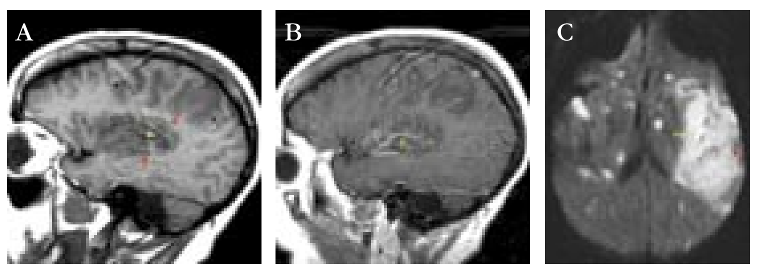


Fig 10. Left MCA infarct involving inferior trunk. A. Sagittal noncontrast T1-weighted image through the left insular cortex shows distinct regions of hypointensity involving the posterior insular cortex (↗) and the surrounding opercular cortex (↗). Note hypointensity of the cortex of the posterior frontal and parietal lobes (↗). B. Sagittal postgadolinium study shows slow flow (↗) through the inferior trunk branches of the middle cerebral arteries. C. Axial diffusion weighted image shows area of restricted diffusion involving the posterior insular cortex (↗) and adjacent opercular and superficial cortex (↗)

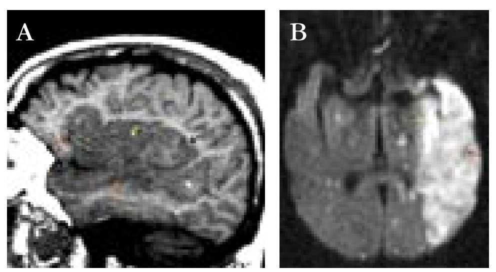
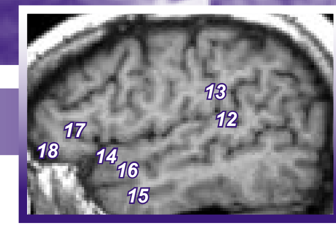


Fig 11. Left MCA infarct involving both trunks of MCA. A. Sagittal contrast T1-weighted image through the left insular cortex shows diffuse involvement of the insular cortex (↗). Note swelling of adjacent cortex of the frontoorbital opercular (↗), frontoparietal opercular (↗) and temporoopercular cortex (↗). B. Axial diffusion weighted image show restricted diffusion involving the entire insular cortex (↗) and adjacent opercular and superficial cortex. (↗)

OPERCULAR LESIONS:



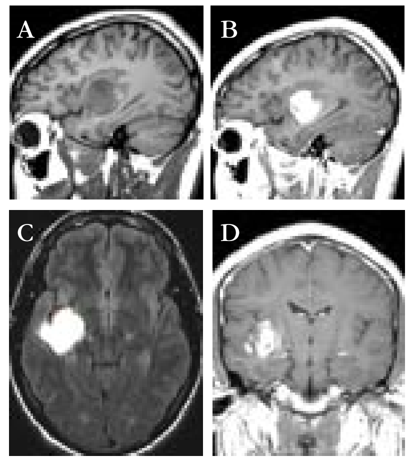


Fig 12. Recurrent pilocytic astrocytoma. A. Sagittal noncontrast T1-weighted image through the right insular cortex demonstrates isointense mass (↗) adjacent to the posterior insular cortex. B. Sagittal postgadolinium study shows homogeneous enhancement of mass. C. Axial FLAIR image shows mass (↗) in subinsular area sparing the posterior insular cortex(↗) D. Coronal postgadolinium study shows enhancing mass within the subinsular cortex with rounded medial border of the mass.

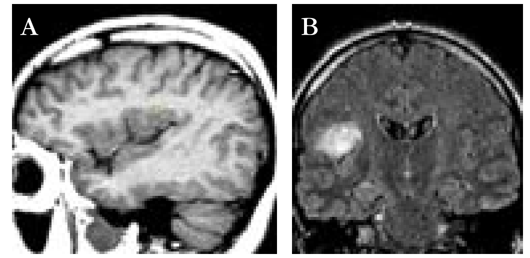


Fig 13. Low grade glioma. A. Sagittal noncontrast T1-weighted image shows focal mass (↗) in the right frontoparietal operculum. B. Coronal FLAIR image shows expansile hyperintense mass involving the opercular cortex

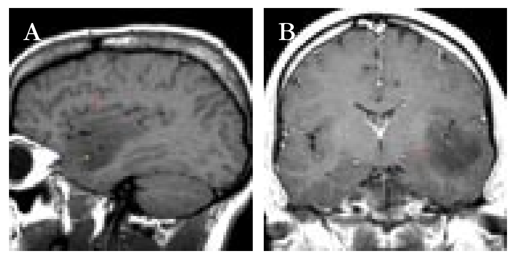


Fig 14. Glioma. A. Sagittal noncontrast T1-weighted image through the left insular cortex demonstrate focal mass (↗) involving the left anterior temporal operculum. Notice elevation of the entire insular cortex (↗). B. Coronal postgadolinium image shows mass primarily in left temporoopercular cortex. There is medial and superior extension to the adjacent insular cortex (↗) and elevation of the sylvian cistern

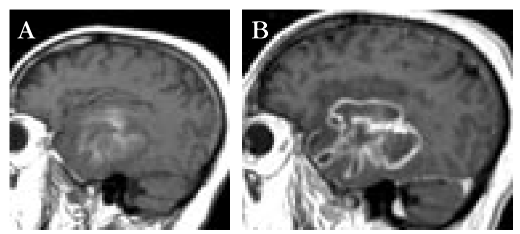


Fig 15. Glioblastoma. A. Sagittal noncontrast T1-weighted image through right insular cortex demonstrate large mass involving the right temporal lobe. Discrete zones of hyperintensity suggesting hemorrhage within the mass is seen. Note elevation of the right insular cortex. B. Sagittal postgadolinium image shows multilobulated area of rim enhancement of the mass.

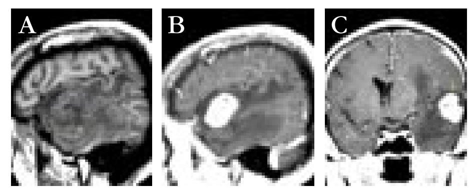


Fig 16. Cerebral metastases. A. Sagittal noncontrast T1-weighted image through left opercular cortex shows focal hypointensity involving the temporal lobe (↗). B. Sagittal postgadolinium T1-weighted image shows homogeneously enhancing mass involving the temporoopercular cortex with surrounding vasogenic edema. C. Coronal postgadolinium image shows enhancing mass in left temporoopercular cortex with elevation of Sylvian fissure (↗)

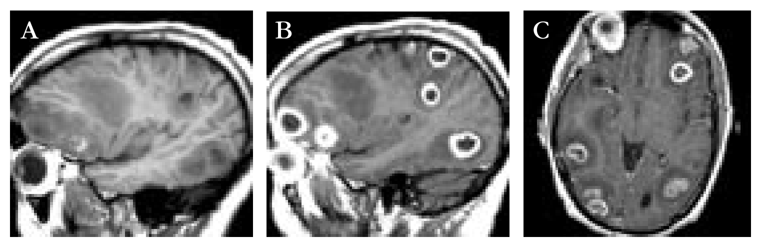


Fig 17. Cerebral abscess. A. Sagittal T1-weighted image through the left insular cortex demonstrate multiple areas of abnormalities around the insular cortex. B. Sagittal postgadolinium T1-weighted image shows multiple ring enhancing masses throughout the brain parenchyma. Note enhancing mass in the right frontoorbital operculum. (↗) C. Axial postgadolinium image shows the corresponding mass in the frontoorbital operculum (↗). Note multiple ring enhancing masses throughout the brain

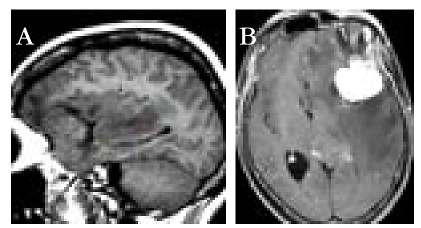


Fig 18. Left sphenoid wing meningioma. A. Sagittal noncontrast T1-weighted image through the left insular cortex shows an extradural isointense mass (↗) posterior to the sphenoid wing. Notice posterior displacement (↗) and superior elevation (↗) of the insular cortex. B. Axial postgadolinium image shows homogeneously enhancing extradural mass with posterior displacement of the Sylvian fissure. Notice marked hypointensity of the white matter suggesting vasogenic edema (↗)

CONCLUSIONS:

Sagittal imaging although included in routine protocols in MR studies of the brain, is underutilized in interpreting lesions around the Sylvian cistern. While axial and coronal images demonstrate the insula as a rim of cortex, the sagittal plane displays the triangular shape of the insula and depicts the various gyri and sulci which compose the anatomy of the insular cortex. The addition of other imaging sequences in the sagittal plane, such as FLAIR, T1-weighted STIR-FSE or contrast studies, can be used to better display lesions around the Sylvian cistern. Neurosurgeons using the Sylvian fissure as a surgical approach will find the sagittal plane as a good anatomical guide for preoperative planning.

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