*Med. J. Cairo Univ., Vol. 92, No. 3, Accepted 2/7/2024*
*DOI: 10.22608/MJCU. 779-785, September 2024*
*www.medicaljournalofcairouniversity.net*

# Combined Transcortical-Transsylvian Approach: A Way to Beat the Burdensome Large Insular Glioma

MOHAMED GABR, M.D.; MOHAMED F. ALSAWY, M.D. and AHMED H. ASHRY, M.D.

*The Department of Neurosurgery, Faculty of Medicine, Cairo University*

## Abstract

*Background:* Exploration of the benefits of the Combined transsylvian-transcortical approach to resect large insular gliomas which are challenging tumors due to their relations to eloquent areas and important vascular structures.

*Aim of Study:* Determine thae anatomical landmark for optimum resection of large and challenging insular gliomas.

*Patients and Methods:* We prospectively studied 75 patients with insular gliomas operated upon in the period from June 2017 till February 2019. All the patients had full neurological examination then they underwent preoperative MRI, MRA and MRV using 1.5 Tesla MRI-Systemto determine the location of the tumor and further classification of each lesion according to topographic zones of the insula which were postulated by Sanai andcolleagues.

*Results:* This prospective study was conducted upon 75 patients who have large insular gliomas. All patients were operated upon via a Combined transsylvian-transcortical approach either by awake surgery or ordinary surgery but with previously performed functional MRI.

Male patients were 45 (60%) while female patients were 30 patients (40%). The age of the patient ranged from 20 to 59 (mean 39.96 years).

In 60% of cases, tumors occupied more than 2 insular zones. Gross total resection was achieved in 48 cases (64%) while postoperative residual was only in 27 patients (36%). The pathology was astrocytoma grade 2 in 52 (70%), grade 3 in 10 (13%) and GBM in 13 (17%) patients.

*Conclusions:* Combined transsylvian-transcortical approach provides multiple surgical strategies for resection of insular gliomas by preparing the neurosurgeons with a dynamic surgical view that can be tailored according to different anatomical variabilities.

***Key Words:*** *Transcortical – Transsylvian – Insular – Glioma.*

***Correspondence to:*** Dr. Mohamed Gabr, The Department of Neurosurgery, Faculty of Medicine, Cairo University

## Introduction

**THE** insula has a very unique location within the brain. Being embedded within the Sylvian fissure, it happens to be situated between various eloquent areas that control many functions such as motor and speech **[1,2]**. Having a complex neural network, the insula itself may be responsible for multiple cognitive functions such as drive, affect, and memory **[3]**. Insular gliomas are tricky tumors as they hide within all the aforementioned important neural tissues. Moreover, the complex vascular structures within the Sylvian fissure act as another fence that makes neurosurgical approaches to this region more difficult and risky, not to mention the need to excise as much as possible of these tumors without postoperative morbidities with the aim atthe improvement of the overall survival rates **[2,4,5]**. In other words, the insular gliomas exist in a safe shelter that is difficult to be entered by a neurosurgeon. This shelter has walls that must not be damaged which are represented by the eloquent brain areas. This safe place also acquires wires represented by important vasculature which is not amenable to sacrifice. Transcortical (TC) and trans-Sylvian (TS) approaches are two ways to conquer this shelter. Each of them has its advantages and drawbacks **[5]**. In this study, we tried to merge both approaches to maximize the benefits via the accomplishment of maximum resection of insular gliomas together with avoidance of morbidities that might result.

***List of Abbreviations:***

TC : Transcortical.
TS : Transsylvian.
SF : Sylvian fissure
CT : Computed tomography.
MRI : Magnetic resonance image
MRV : Magnetic resonance venography.
MRA : Magnetic resonance arteriography.
fMRI : Functional magnetic resonance image.

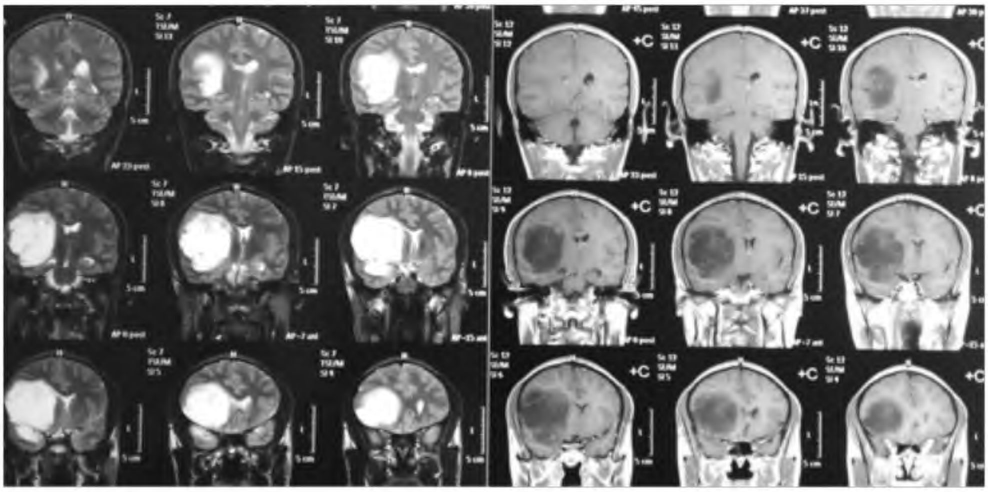
## Patients and Methods

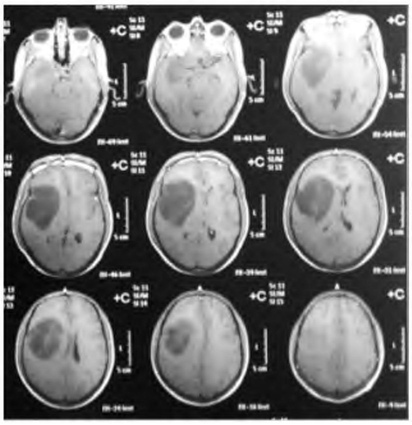
We prospectively studied 75 patients with insular gliomas operated upon in the period from June 2017 till February 2019. All the patients had full neurological examination then they underwent preoperative MRI, MRA and MRV using 1.5 Tesla MRI-System (Achieva, Philips Healthcare, Best, Netherlands) to determine the location of the tumor and further classification of each lesion according to topographic zones of the insula which were postulated by Sanai andcolleagues who divided the insula into 4 zones, zone 1 is the anteriorsuperior quadrant, Zone 2 is the posterior-superior quadrant, Zone 3 located at posterior-inferior quadrant and zone 4 is the anterior-inferior quadrant **[6]**. MRA and MRV also applied in the same study to delineate the vasculature map for each patient which in turn will help in the final employment of the surgical strategy as both lenticulostriate vessels and vessels distal to M2 form a very complex and variable network and should be studied briefly preoperatively **[7,8]**. All the patients then had a thorough psychological assessment to make sure that they are stable and can handle such experience of being operated while aware. The psychologically qualified patients then had a meeting with both the neurosurgery and the anesthesia consultants to walk the patients through each step of the surgery and to practice the language and motor orders that the patients will be asked to perform intraoperatively and also to inform them about what to expect. 52 Patients were psychologically fit and were operated upon with awake craniotomy. The other 23 patients who were operated on traditionally included 9 patients who were not psychologically eligible, three patients who didnot feel comfortable with the procedure after knowing the steps, and 21 patients with significant neurologic deficits at presentation to our institute. Those 11 patients had functional MRI (fMRI) to be able to detect the exact location of the motor and speech areas and also to delineate the eloquent white matter tracts for a better understanding of their relation to the tumors.

In this study, we depend on surgical experiences and other studies that determine the topographic and vascular anatomy in insular tumors **[1,6,7]**.

*Case presentation:*

42 years female patient complained of headache and generalized tonic-clonicseizure not controlled by antiepileptic. MRI brain with contrast showing insular glioma occupying the 4 zones. Size (5×7×4cm) Fig. (1).

(A)


(B)


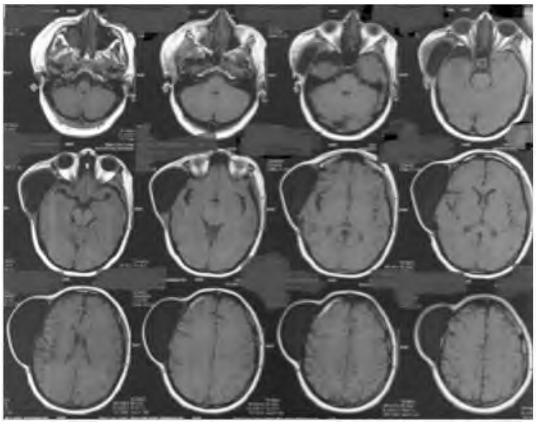

(C)

Fig. (1): Preoperative MRI brain (A,B,C) with contrast showing large insular glioma occupying the 4 zones and postoperative MRI (D) showing complete resection with a collection that managed conservative.

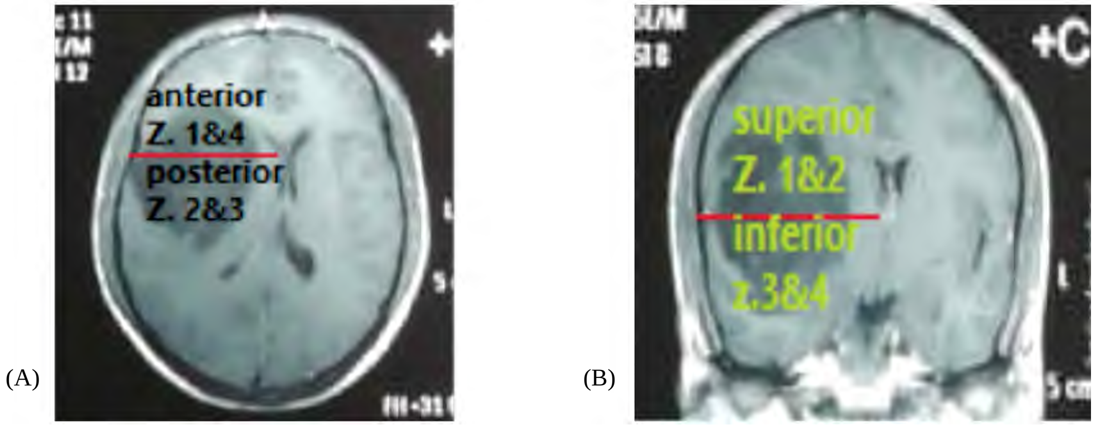



Fig. (2): Demonstrate zone classification in MRI and tumor location in relation to different zones. The line passing through the foramen of Monro and the line projected from the sylvian fissure divide the insula into 4 zones. Axial MRI (A) shows the anterior zones (1&4), and coronal MRI (B) showing posterior zones (2&3).

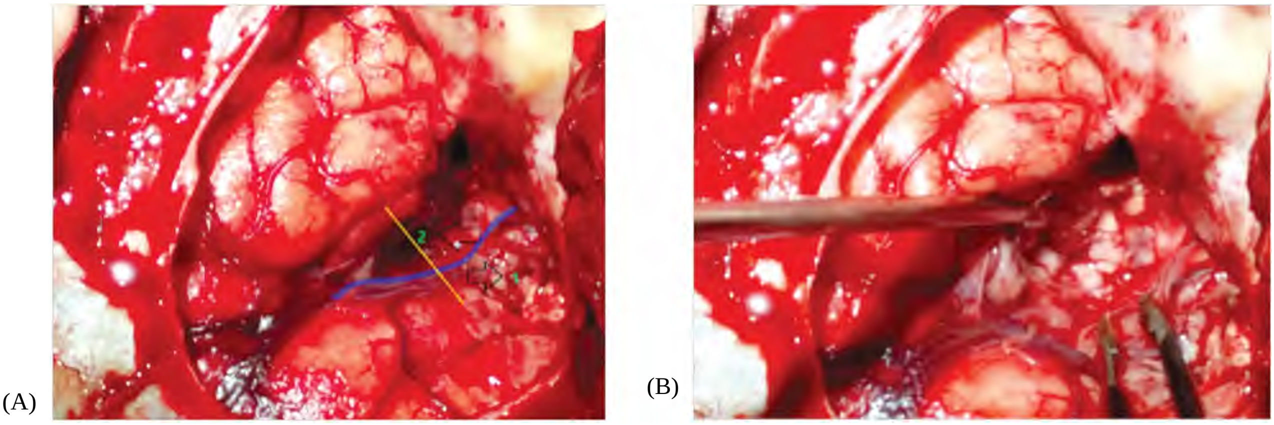



Fig. (3): (A) Illustrated intraoperative photo showing: The blue curved line represents the sylvian fissure and yellow line passing through the foramen of Monro. Hallow arrow (1) Transcortical resection of the tumour in zone 3, the hallow arrow (2) Showing transsylvian dissection and tumour inside the insula after the dissection. (B) Showing that transcortical resection of the tumour in a zone (3) Facilitates more transsylvian dissection that was easily opened like the window to identify tumor in the insula and more safe resection.

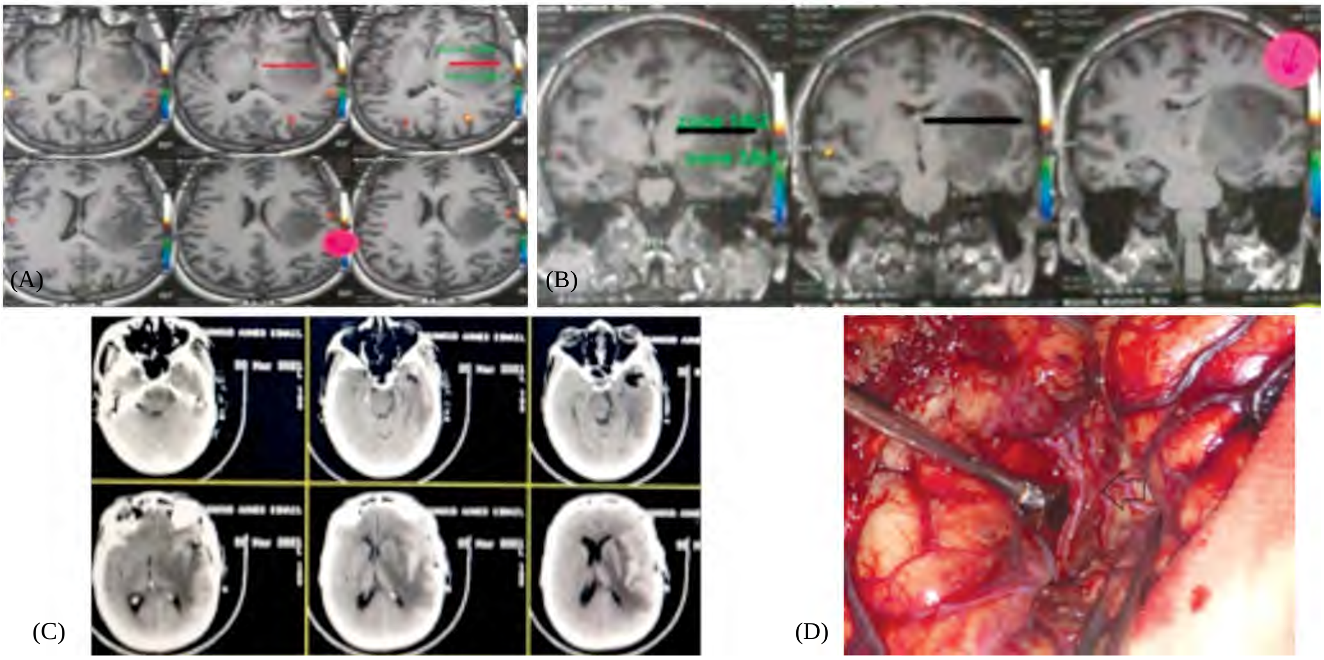



Fig. (4): Case 2 presentation, axial (a) and Coronal (b) Preoperative MRI showing zone classification in relation to tumor. Postoperative CT brain with good resection of tumor (c). (d) Showing intraoperative photo and hallow arrow refer to skeletonized MCA branches after successful sylvian fissure dissection.

The patient underwent surgery by awake craniotomy technique with (asleep-awake-asleep) pattern. The patient is placed in a supine position with a slight head tilt to the opposite side by 30 degrees and being fixed by the mayfield head holder. A fronto-temporal craniotomy is done in standard fashion taking into consideration to increase the posterior extension of the craniotomy for the posteriorly situated lesions especially those located at insular zones 2 and 3. Meanwhile, the anesthesia staff awakens the patient and after dural opening, the Sylvian fissure opening is attempted to identify MCA branches and to secure the Sylvian veins. If the tumors are very large and distort the Sylvian anatomy or invade the vessels, in this situation, the neurosurgeon will go with a 4- step plan to safely remove the lesion. Step one: TC approach through a non-eloquent area either through frontal or temporal opercula after vigorous and cautious testing of any possible function at the area of intended corticectomy. This testing can be performed via cortical mapping for language and motor function aided of course by the awakened patient. After safe corticectomy is done, step two will begin by debulking the tumor with standard neurosurgical techniques to alleviate the intra-tumoral pressure which in turn can decrease the displacement of the Sylvian fissure. Step three: The surgeon now has the opportunity to retry the Sylvian fissure opening to identify and secure the M2, M3 branches and lenticulostriate vessels then proceed to step four by shifting to TS approach and removing thetumor guided by dissected lenticulostriate without more retraction in Sylvian fissure whose opening was facilitated by the earlier debulking of the tumor.

While operating through TC approach, one can shift to TS approach if a motor or language deficit starts to appear and vice versa one can shift from TS to TC if the Sylvian fissure is still distorted and the tumor needs more debulking.

After finishing the tumor resection, hemostasis is carried out and the patient is put back to sleep while finishing the standard closure, then the patient is thoroughly assessed postoperatively for any resultant deficits and follow-up CT brain is performed in the day after surgery.

## Results

Male patients were 45 (60%) while female patients were 30 patients (40%).

Table (1): Demonstrate demographic, clinical, radiological, surgical, postoperative complications and pathology.

| | |
|---|---|
| Demographics: | |
| *Age:* | |
| • 20-39 years | 22 |
| • 40-59 years | 53 |
| *Sex:* | |
| • Male | 45 |
| • Female | 30 |
| *Clinical presentation:* | |
| • Headache | 60 |
| • Fits | 18 |
| • Weakness | 14 |
| • Vomiting | 3 |
| • Dysphasia | 2 |
| • Aphasia | 1 |
| *Radiological:* | |
| • Tumor occupies 2 or less zones | 30 |
| • Tumor occupies more than 2 zones | 45 |
| • Peri-tumoral edema | 60 |
| • Eloquent area involvement in fMRI | 47 |
| • M2 branches involvement in MRA | 16 |
| • Lenticulostriate involvement in MRA | 20 |
| *Surgery:* | |
| • Awake | 52 |
| • Standard with fMRA | 23 |
| *Intraoperative complications:* | |
| • Eloquent area encountered | 8 |
| • Vascular injury | 3 |
| • Postoperative deficits: | |
| • Worsening Weakness | 6 |
| • Denovo weakness | 8 |
| • Worsening Dysphasia | 5 |
| *Postoperative radiology:* | |
| • Residual | 3 |
| • Area of ischemia | 2 |
| *Pathology:* | |
| • Astrocytoma grade 2 | 52 |
| • Astrocytoma grade 3 | 10 |
| • GBM | 13 |

Headache was the most common presentation in our series. 60 patients (80%) presented with headaches, 3 of them had vomiting. And 18 patients presented with one or more attacks of convulsions. Significant neurologic deficits were the main presentation in 14 patients (10 patients with variable degrees of hemiplegia and lower facial palsy, 5 patients with motor dysphasia and one patient with aphasia). The presence of neurological compromise discourages us to operate those 14 patients via awake surgery and the tumors in those patients occupied more than 2 insular zones, along with other 38patients making a total number of 52 patients (about 70% of our series) with significantly large lesions with marked encroachment of the surrounding vascular and eloquent cortical structures as illustrated in Table (1). The combined approach provided us with multiple strategies and surgical corridors to allow us to remove those large lesions effectively and with very low postoperative morbidities. Gross total resection was achieved in 48 cases (64%) while postoperative residual was only in 27 patients (36%). We encountered the cortical areas in 8 patients and 9 vascular injuries happened (6 injurieswere in a lenticulostriate branch and 3 injury was in an M2 branch, all were stopped without cauterization), yet only 6 patients had temporary worsening of the already present weakness, 8 patients developed temporary hemiplegia and they recovered by the first follow-up visit and five patients developed motor dysphasia. The pathology was astrocytoma grade 2 in 52 (69%), grade 3 in 10 patients (13%), and GBM in 13 patients (17%).

## *Discussion*

The insula has delicate and complex anatomy with excessive and variable vascular relations which complicate the reach to its tumors by carrying significant risks of injury of an eloquent area and/or a vascular structure *[6]*.

Yasargil and colleagues,described stepwise dissection and excision of insular glioma *[9]*.

Sylvian fissure represents a gate to the insula. By opening the arachnoid bands in this fissure, the insula starts to appear behind. At first zone 1 and 4 appear then by the extensive opening of the fissure, zone 2 and 3 starts to emerge. Sometimes it becomes very hard to expose the whole insular zones as in cases with insular tumors that may occupy more than one zone especially if the tumor was in the posterior zones and associated with edema, thus one can be forced to sacrifice one of the Sylvian veins for the sake of more opening of the fissure, which carries the risk of compromising the venous drainage of the surrounding eloquent areas and may be followed by deficits. Moreover, such excessive opening of the fissure may necessitate significant retraction on the opercula which jeopardize the cortical areas to be damaged and put the venous structures at risk to be thrombosed *[1]*. Some studies reported various complications from the extensive opening of the Sylvian fissure. Schramm & Aliashkevich reported that complications may occur due to inadvertent subpial dissection and an injury of an insular artery *[2]*. Also, Hentschel and Lang reported speech deficits due to transient ischemia that might happen during Sylvian fissure dissection *[10]*. These vascular morbidities keep happening despite various strategies suggested in this issue like that proposed in another study by Lang and colleagues which incorporates dissection of the fissure in its horizontal segment first to identify and protect the M1 and lenticulostriate vessels *[11]*, but still, ischemic deficits do occur and might be permanent.

In their cadaveric study, Benet and colleaguesadvocated TC approach for tumors in Zone 2 and 3. The thing that gives a neurosurgeon a relative comfort with the direct attack of the tumors located in these zones without the need for the wide opening of the Sylvian fissure *[1]*. This assumption seems to be quite risky as it involves the possibility of damage of theopercular segment of the precentral gyrus, this area has control over the motor function of the contralateral side of the face *[12]*, nevertheless, many studies reported safety of such approach *[2,6,10]*. Even if damage did happen to the aforementioned area, there is evidence of recovery of the motor power of the face especially if the approach was in the non-dominant hemisphere *[6,13]*.

Patients usually present to our institute with large intracranial lesions due to poverty and their need for nonstop working which makes most of the population ignore a lot of manifestations like a headache in order not to lose their income for living. Which in turn increases the difficulty of the tumor excision. In our series, 60% of insular gliomas occupied more than 2 zones of the insula. This urged us to configure an efficient strategy by which we can attack those large insular lesions confidently aiming for maximum, yet safe excision. The study of Benet and colleaguespaved the way for us to come up with the idea of using combined TS and TC approaches for those tumors, but it was challenging to address those tumors in living neural tissue which is different from the cadaveric specimens described in their study *[1]*. Moreover, insular gliomas do exert mass effect by themselves or by the edema that results from pial invasion. This in turn distorts the surrounding anatomy making each and every case unique regarding the relation of the tumor to eloquent neural tissue, lenticulostraiate vessels, MCA, Sylvian fissure, and its veins. So, we advocate the careful and thorough study of preoperative MRI, MRA and MRV to delineate the topography of the affected insula and the surrounding structures. Also, we performed fMRI for the patients who were not eligible for awake surgery to determine the eloquent areas and tracts of motor and speech functions. It is mandatory to do so due to the high variability of eloquent areas representation among people especially in the setting of big tumors which would produce more disturbed anatomy *[14]*.

By using combined approaches, we accomplished complete tumor excision in 64% of cases. In 9 patients; we were unable to remove the tumors completely due to adherence to vascular structures. Neurological deficits happened in our series. 6 patients developed postoperative worsening of their weakness and 5 patients were dysphasic yet most of them were transient and only happened in the patients who were not operated by awake craniotomy. The vascular injury happened in 9 patients, in 6 of them a lenticulstriate branch was injured and in 3patient an M2 vessel was injured. 2 patients developed postoperative imaging of ischemia. We believe that it is a very small percentage of complications seeing that the large size of the tumors operated. By the combined approach, the surgeon has the flexibility to attack the tumors via various entries through TS and TC. For TS, one should not apply fixed retraction to open the Sylvian fissure. This can be achieved by the opening of superior and inferior peri-insular sulci briefly so that the frontal opercula become relaxed allowing better visualization of the tumors without compressing neither the eloquent areas nor the vascular structures as advocated by Safaeeand colleagues **[15]**. For TC, windows should be created above and/ or below the Sylvian fissure along with the non-functioning areas after careful mapping of the eloquent areas whether the patient was awake or by the aid of the fMRI **[6]**.

Combined TS and TC approaches may be also applied to small insular lesions that are buried deeply especially in zone 2 and 3 by giving the surgeon many tools to attack the lesion. Also, we advocate the use of a combined approach for recurrent and residual insular gliomas provided that a meticulous plan was plotted preoperatively as mentioned especially when the surgeon was surprised by disturbed anatomy.

*Conclusions:*

In our study we combine the TS and TC approaches to avoid unintended lenticulostriate injuries that may happen in transcortical route and to ensure maximal safe resection with more anatomical exposure of the insular gliomas which are usually surrounded by highly eloquent areas and complex vascular anatomy. In our study, we presented the merits of combined approaches to prepare the surgeon with a diversity of strategies to facilitate the complete excision of these tumors and to avoid the fixed view obtained by a single approach that may obligate the surgeon to stop the excision process before satisfaction.

*Ethical committee approval:* The study approved in 30-5-2024 under the REC number (N-153-2024).

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# الاستئصال عن طريق شق سيلفيان وعبر القشرة المخية للأورام الدبقية الكبيرة الصادرة من شق سيلفيان

الأورام الدبقية الكبيرة الموجودة بمنطقة الانسولا تمثل تحديا كبيرا فى استئصالها لوجودها بالقرب من مراكز هامة مثل مركز الكلام والحركة والتى تحيط بشق سلفيان.

المخاطر الجراحية كبيرة فى استئصال الورم لوجود الشريان الأوسطى بالدماغ بشق سلفيان وكذلك الشرايين المتفرعة والناشئة منه والتى أيضاً تحيط بالورم او يكون مسارها داخل الورم وبذلك تحمل خطورة كبيرة لاصابة هذه الشرايين اثناء استئصال الورم.

هذه المخاطر مجتمعة تحتاج الى خبرة جراحية كبيرة وعمل اشعات رنين مغناطيسى على المخ ورنين على شرايين المخ لتحديد أماكن هذه الشرايين وعلاقتها بالورم من اجل الحفاظ عليها اثناء الجراحة.

ومن ضمن الفحوصات عمل رنين وظيفي على المخ وذلك لتحديد مراكز الكلام والحركة الهامة وعلاقتها او مدى قربها من الورم .

فى بعض هذه الحالات قد تحتاج تكون الجراحة المتيقظة هى الحل الأمثل وخصوصاً بالفص الأيسر لضمان خروج المريض بدون مضاعفات.

تقسيم المناطق المحيطة بالأنسولا إلى اربع مناطق جراحية يسهل بشكل كبير وضع خطة مسبقة لاستئصال الورم من خلال هذه المناطق ومحاولة استئصالها بالكامل.

يمكن سهولة استئصال الورم الدبقى بسهولة من خلال شق سلفيان أو من خلال القشرة المخية من خلال الدخول المباشر للورم حسب مكانه.

كان هناك ٩ مرضى لم يتم استئصال الورم بالكامل وذلك لملاصقته للشرايين الهامة بينما تم استئصال الورم كاملا فى ٦٤ ٪ من المرضى.