The 8th Annual

International Neurosurgery Conference

How do I do it: advantages, limitations and pitfalls of intra-op **MRI**.

CLINICA ADVENTISTA BELGRANO

DR. ROBERTO R. HERRERA

BUENOS AIRES //
ARGENTINA //

BELGRANO ADVENTIST CLINIC

BELGRANO ADVENTIST CLINIC

- Dr. Roberto R. **Herrera**
- Dr. José Luis **Ledesma**
- Dr. Jorge **Lambre**
- Dr. Francisco **Sanz**
- Dr. Hugo **Pomata**
- Dr. Hector **Rojas**
- Dra. Andrea **Uez Pata**
- Dra. Blanca **Diez**
- Dra. Fabiana **Lubieniecki**
- Dra. Celia **Daraio**
- Dra. Margarita **Guiñazú**
- Dr. Jorge **Hryb**
- Dra. Mónica **Perassolo**

BELGRANO ADVENTIST CLINIC

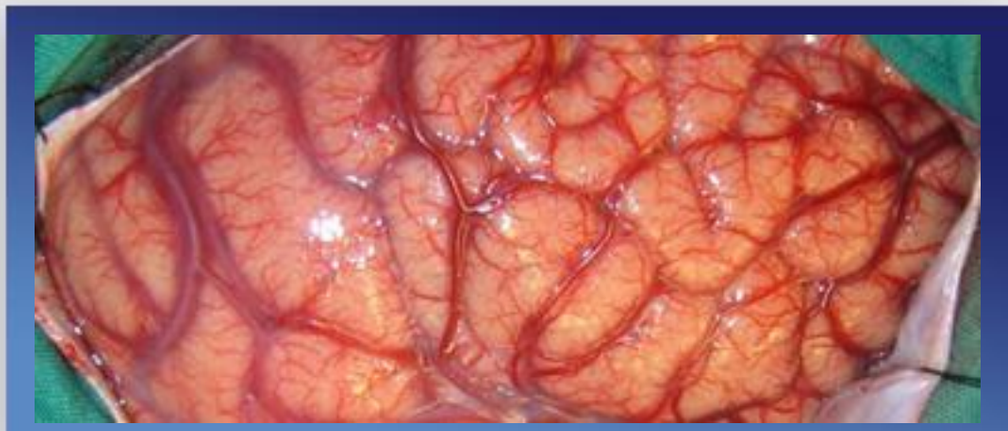
BELGRANO ADVENTIST CLINIC

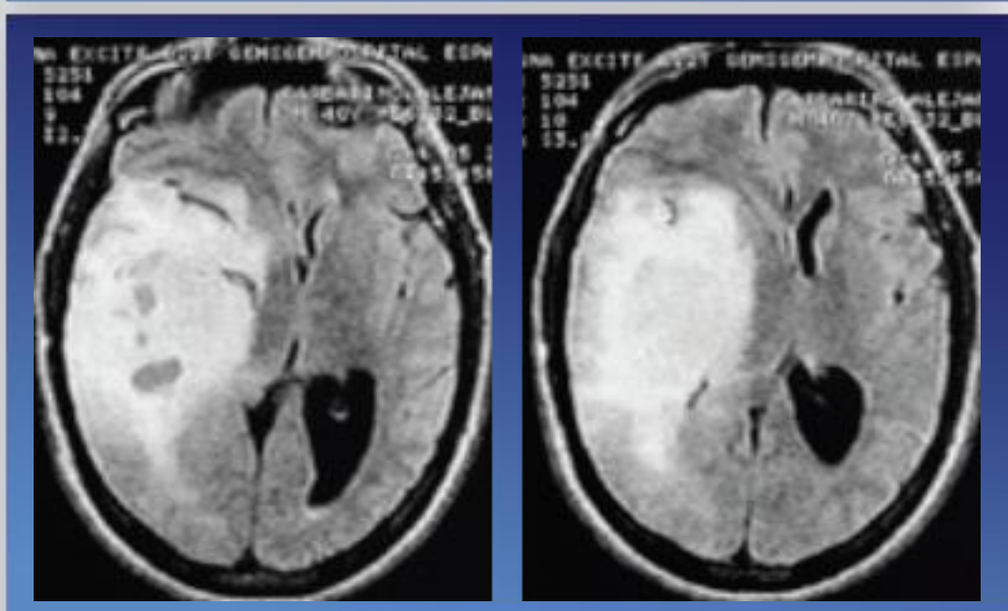
Contents

BRAIN TUMORS

It has always been worrying to a neurosurgeon to know exactly **where he is working in the brain.**

- Where the **pathology** is …
- Where a **tumor begins or ends**…
- Where **the most important functional areas** are…
- How much of the **tumors has been removed** and the most important, **how much has been left behind for not having seen it.**





BELGRANO ADVENTIST CLINIC

OPERATING ROOM

Philiphs Medical System.
Vertical field 0.23 T.

C-shapened “open” magnet.

BELGRANO ADVENTIST CLINIC

OPERATING ROOM

CLINICA ADVENTISTA BELGRANO

BELGRANO ADVENTIST CLINIC

OPERATING ROOM

CLINICA ADVENTISTA BELGRANO

BELGRANO ADVENTIST CLINIC

OPERATING ROOM

BELGRANO ADVENTIST CLINIC

- Titanium and Aluminum head rest.

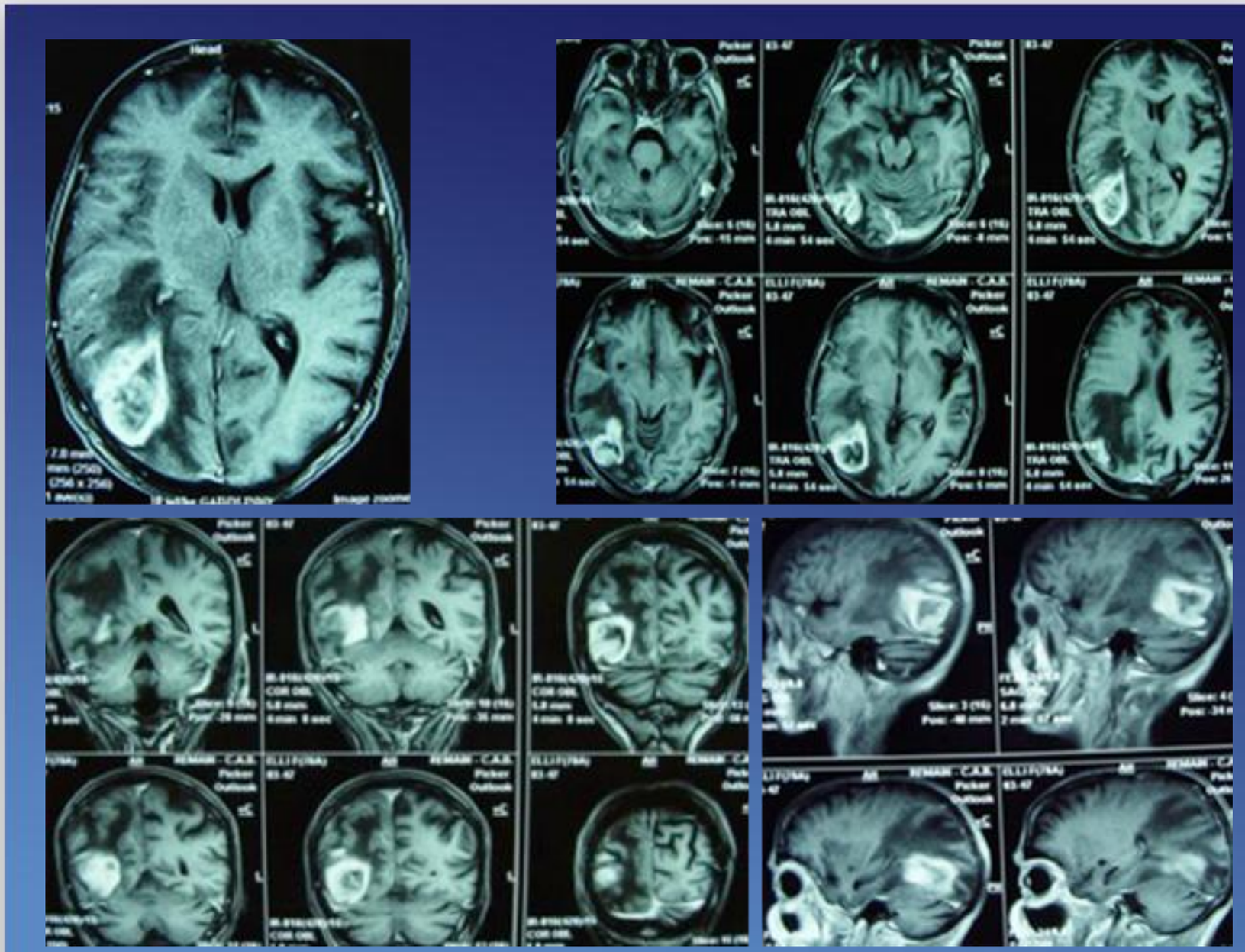
How do I do it?

Many brain tumors, particularly low-grade gliomas, have the look and feel of normal brain. Without **iMRI**, achieving gross total resection without being unduly aggressive with the normal tissue is virtually impossible. With **iMRI**, however, the neurosurgeon can evaluate the brain at any time during resection, and thus, he can both avoid eloquent structures damage and achieve a more complete resection.

HOW DO I DO IT?

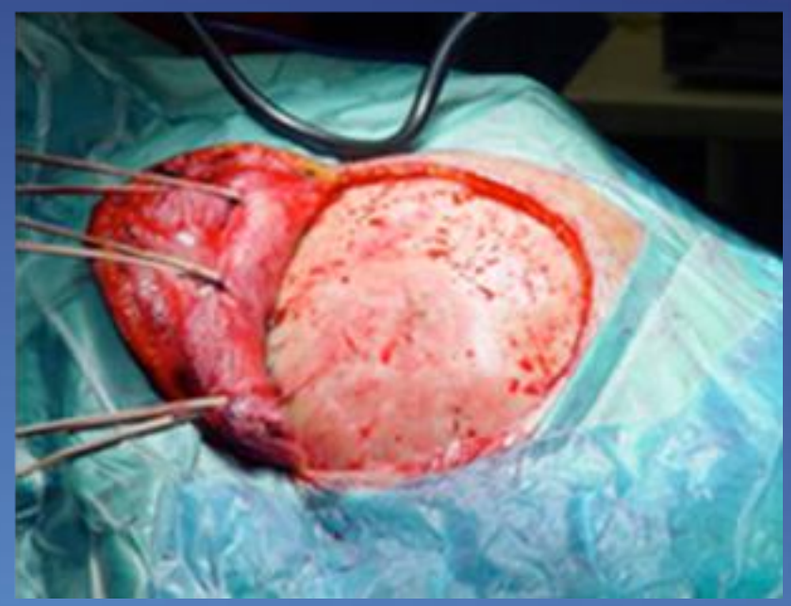
- Fem. 78 (r)

  Temporo-Occip.
  GBM.



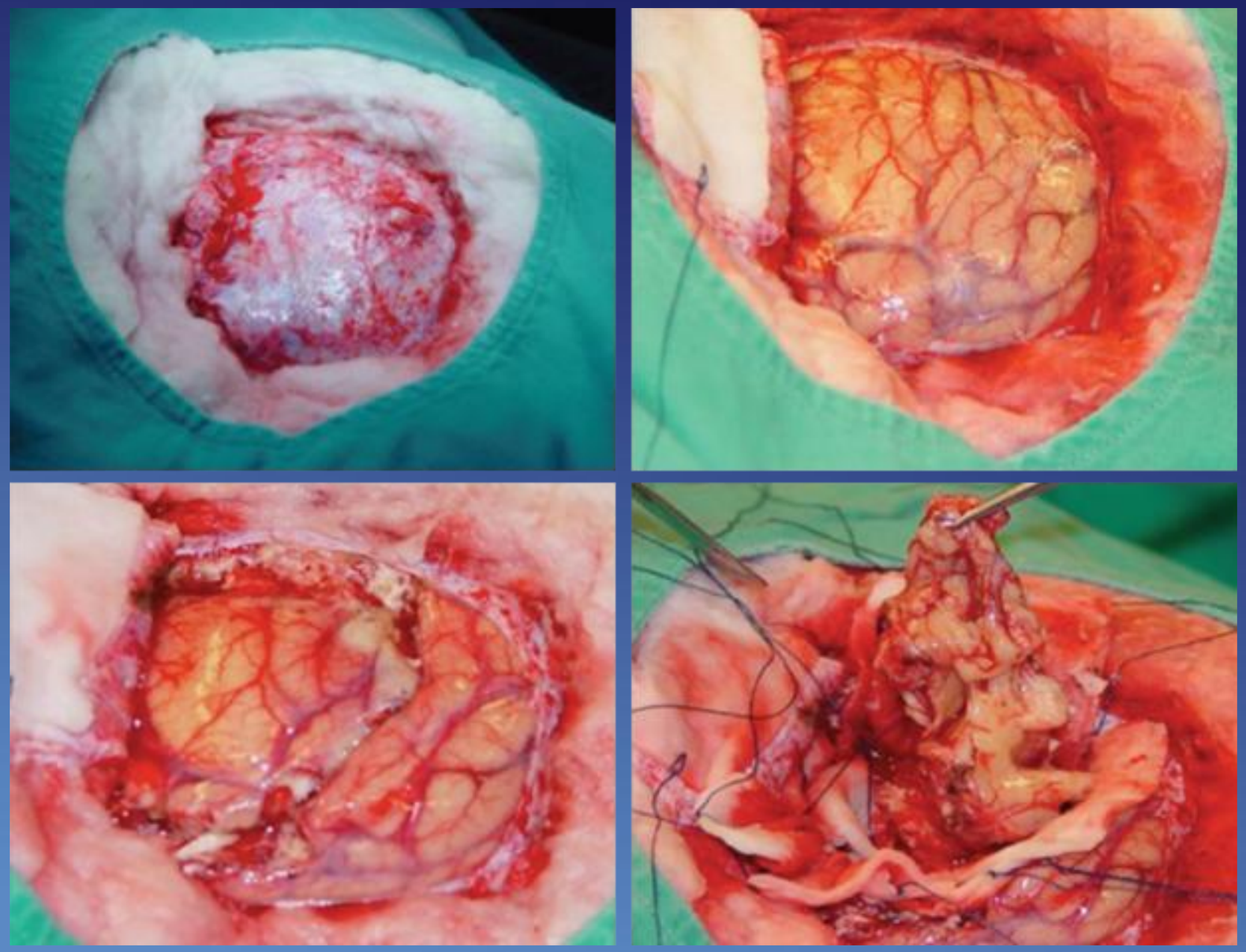
HOW DO I DO IT?

- This is the patient in surgical position.



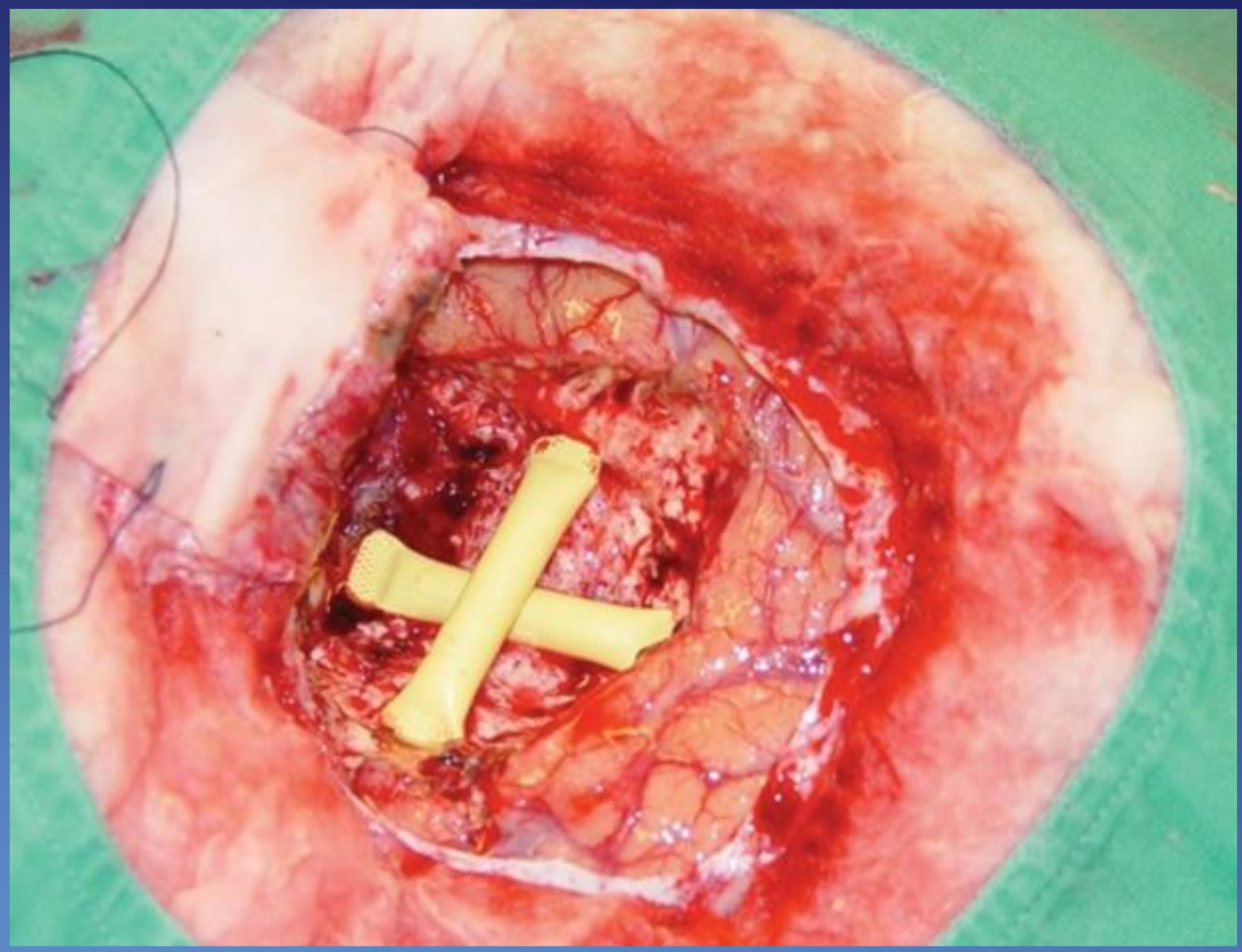
HOW DO I DO IT?

- We operate the tumor conventionally and make anatomical and morphological removing.



HOW DO I DO IT?

- Then, when de things seem to be the same but are not, we put some marks on the surgical bed and check it with a new Intraoperative **MRI**.



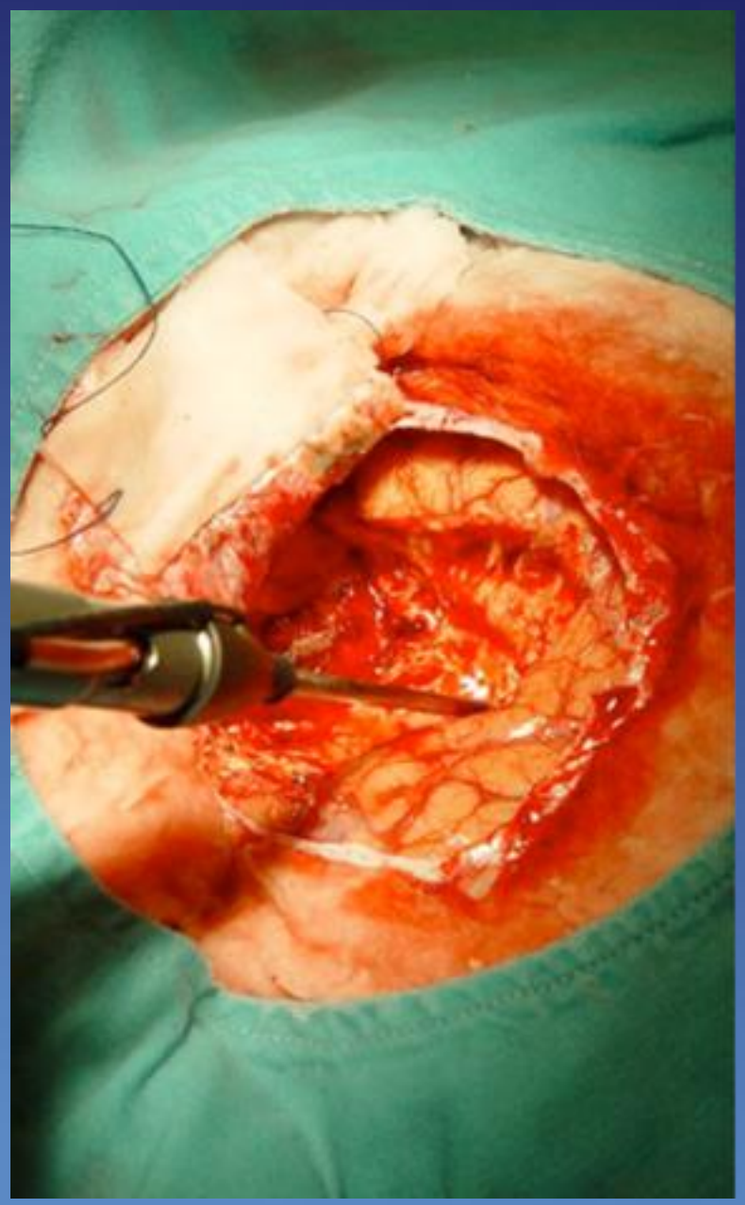
HOW DO I DO IT?

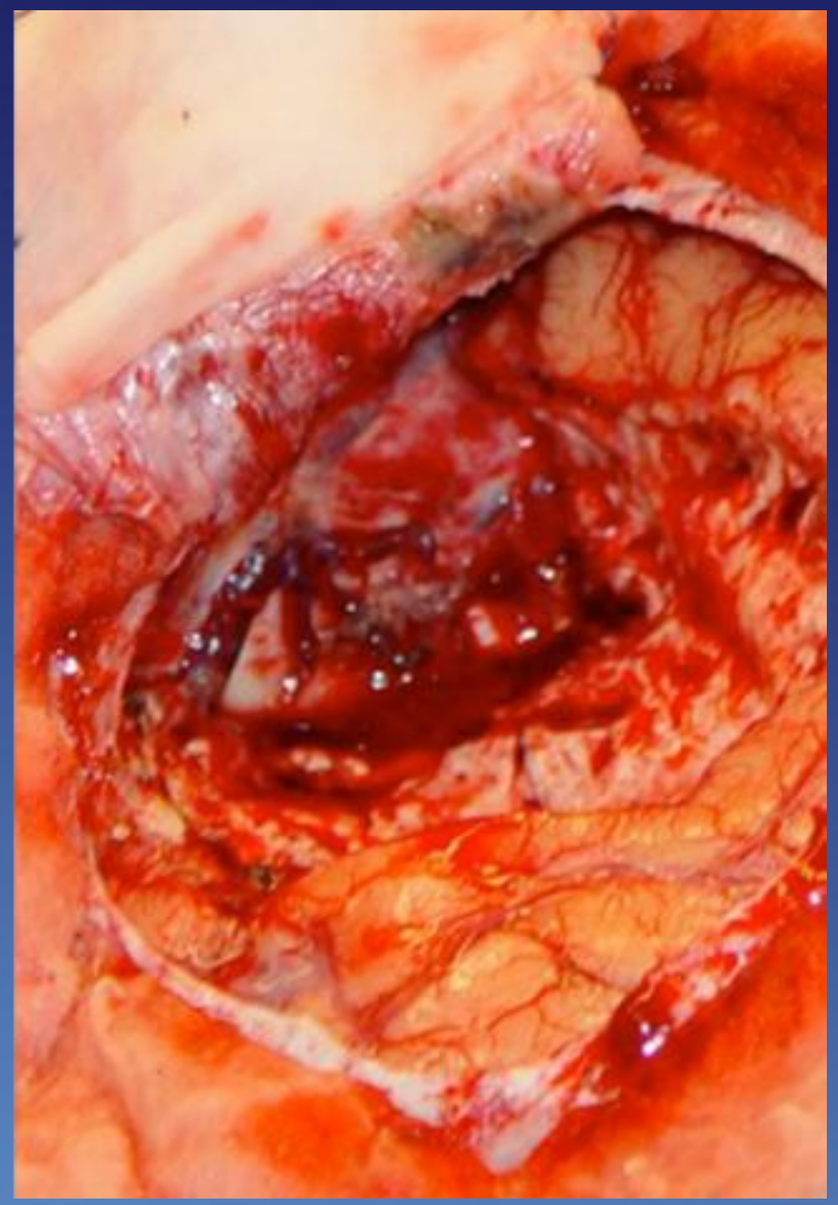
- Intraoperative **control**

We are checking the surgical steps with new images.

HOW DO I DO IT?

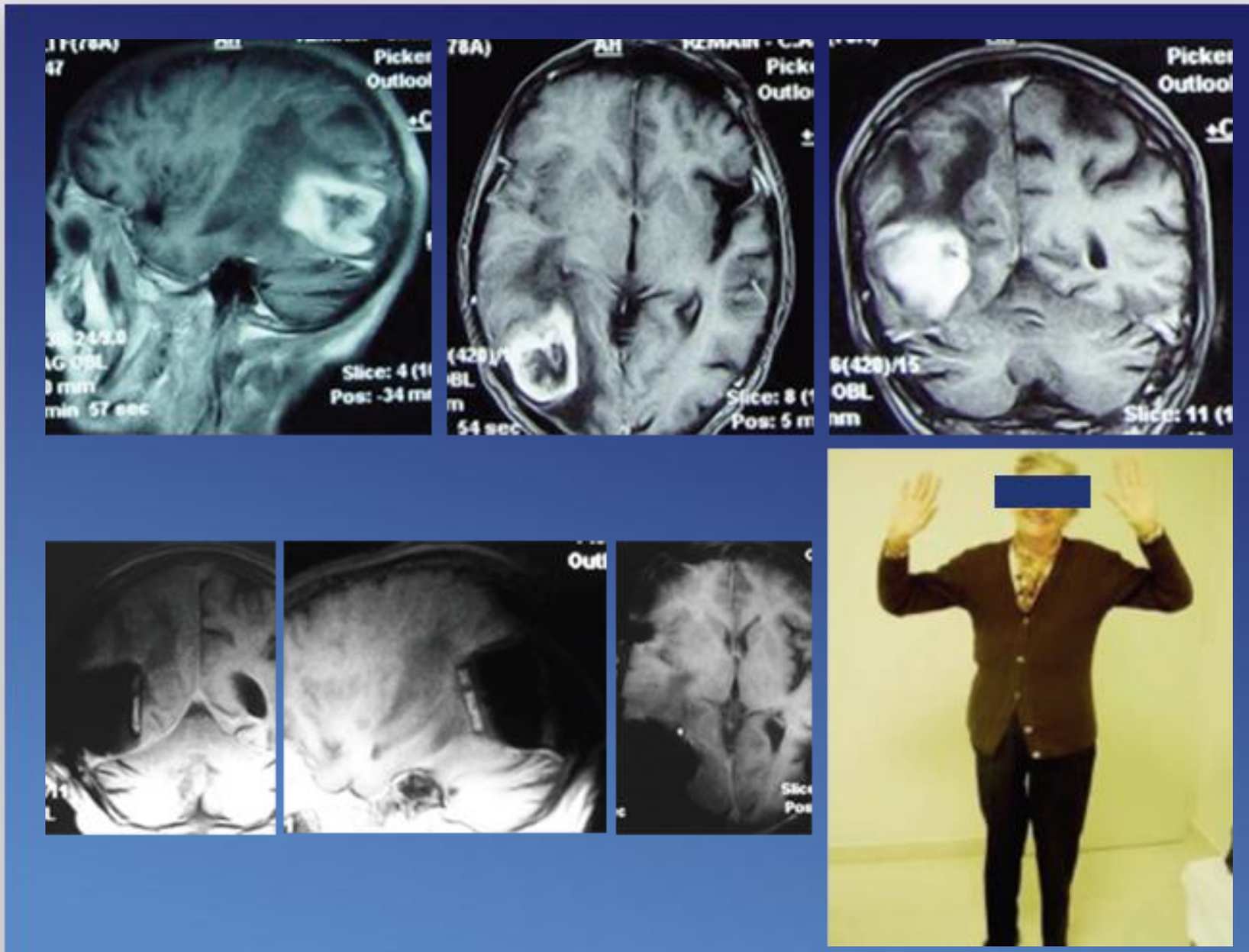
- Then we go on with the surgery.





HOW DO I DO IT?

- We can see the marks on the surgical bed with complete **removal of the tumor and the patient with very good outcomes.**



LOW GRADE GLIOMAS

CLINICA ADVENTISTA BELGRANO

DR. ROBERTO R. **HERRERA** AND COLLABORATORS

BUENOS AIRES //
ARGENTINA //

iMRI “ ADVANTAGE”

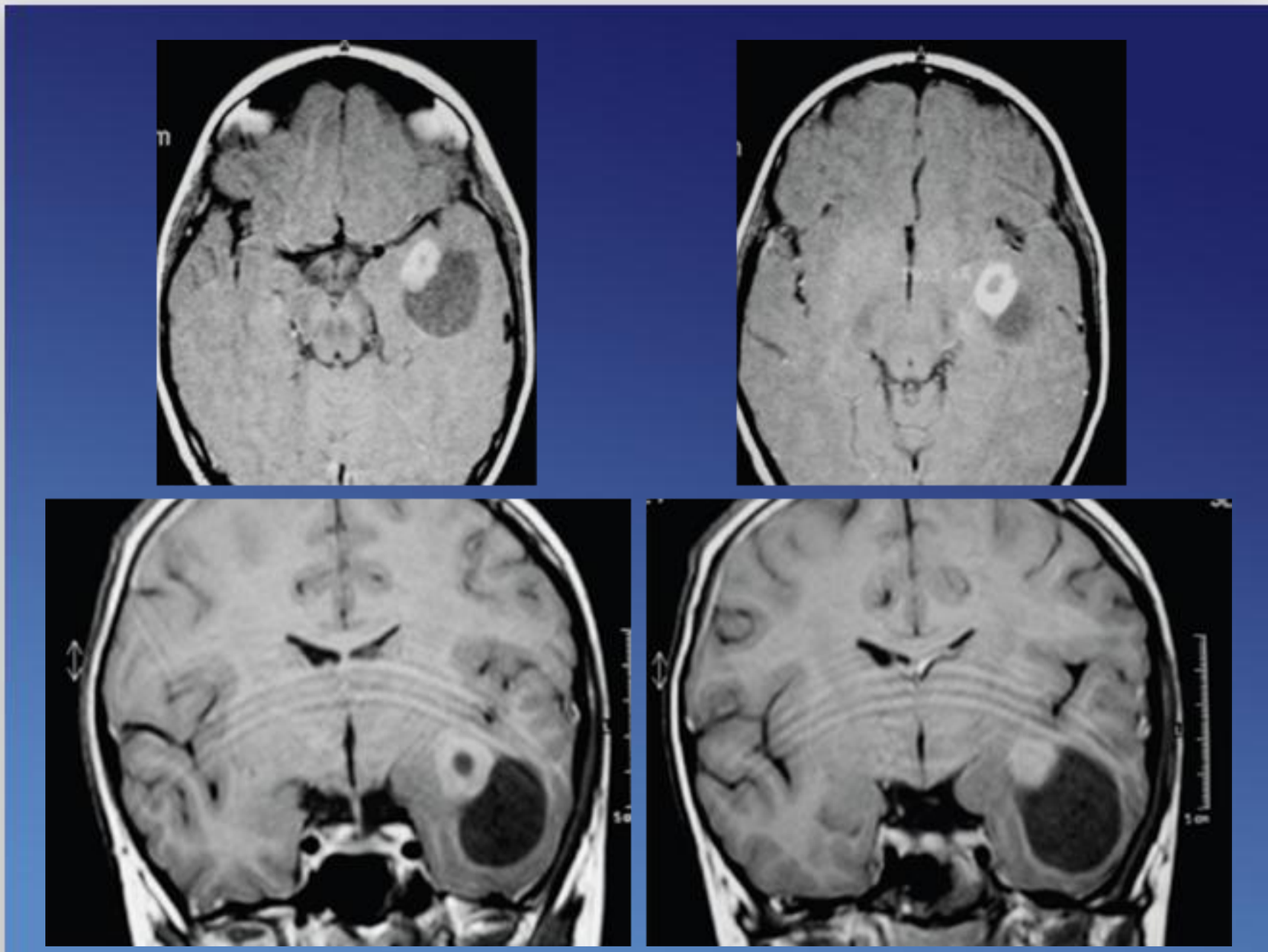
iMRI gives us the possibility to monitor tumor location, follow its extension to deeper areas and be sure to have reached its limits. It allows us to leave the operating room knowing we have removed the entire tumor, achieving the surgical target we set, preserving normal tissue and having not big surprises at first **MRI** postsurgical control.

LOW GRADE GLIOMAS

- Extraventricular
  Neurocitoma

9 year old boy.

July 2000

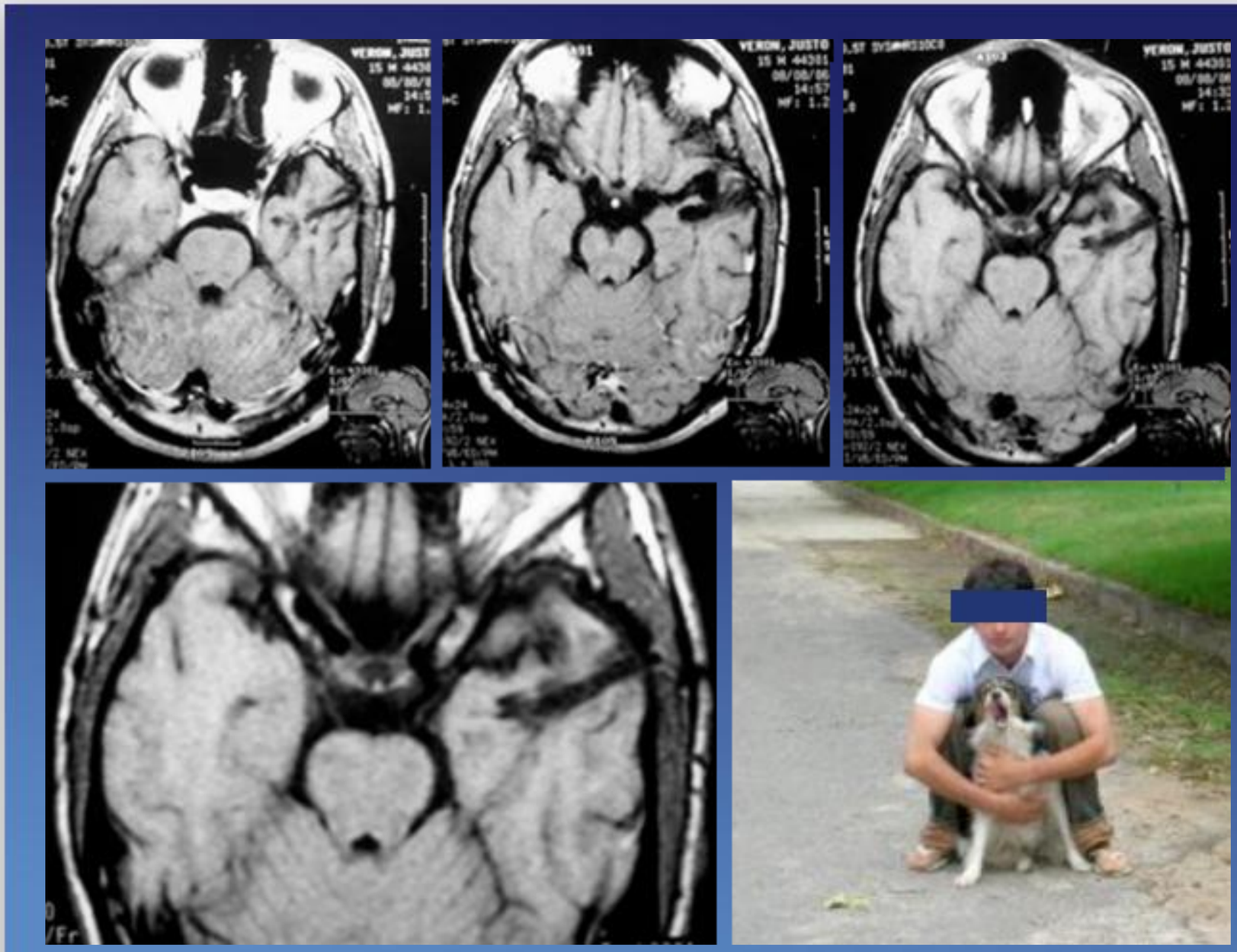


JULY 2000

LOW GRADE GLIOMAS

- 11 years

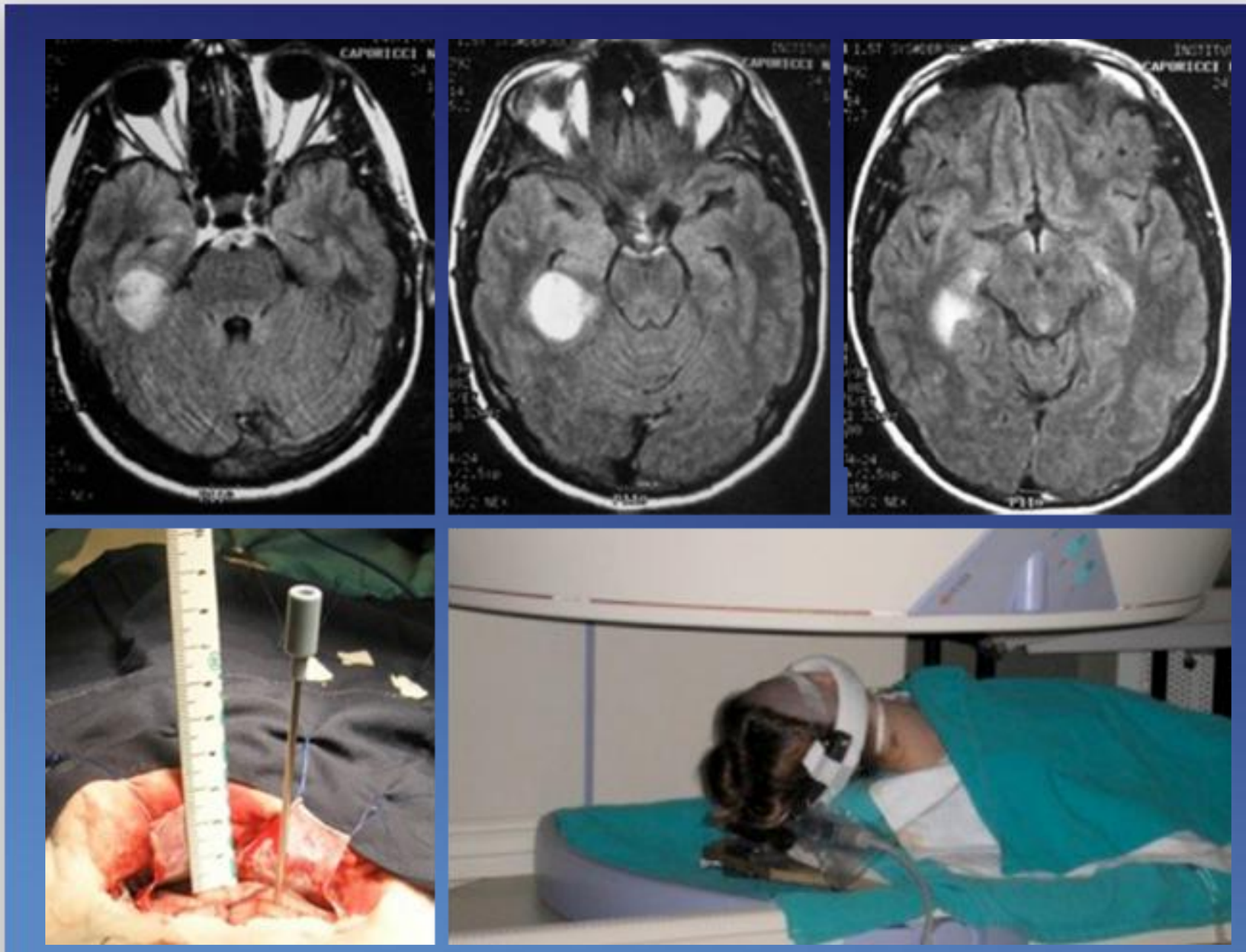
  Post-Operative.



LOW GRADE GLIOMAS

- Fem. 25

  2005

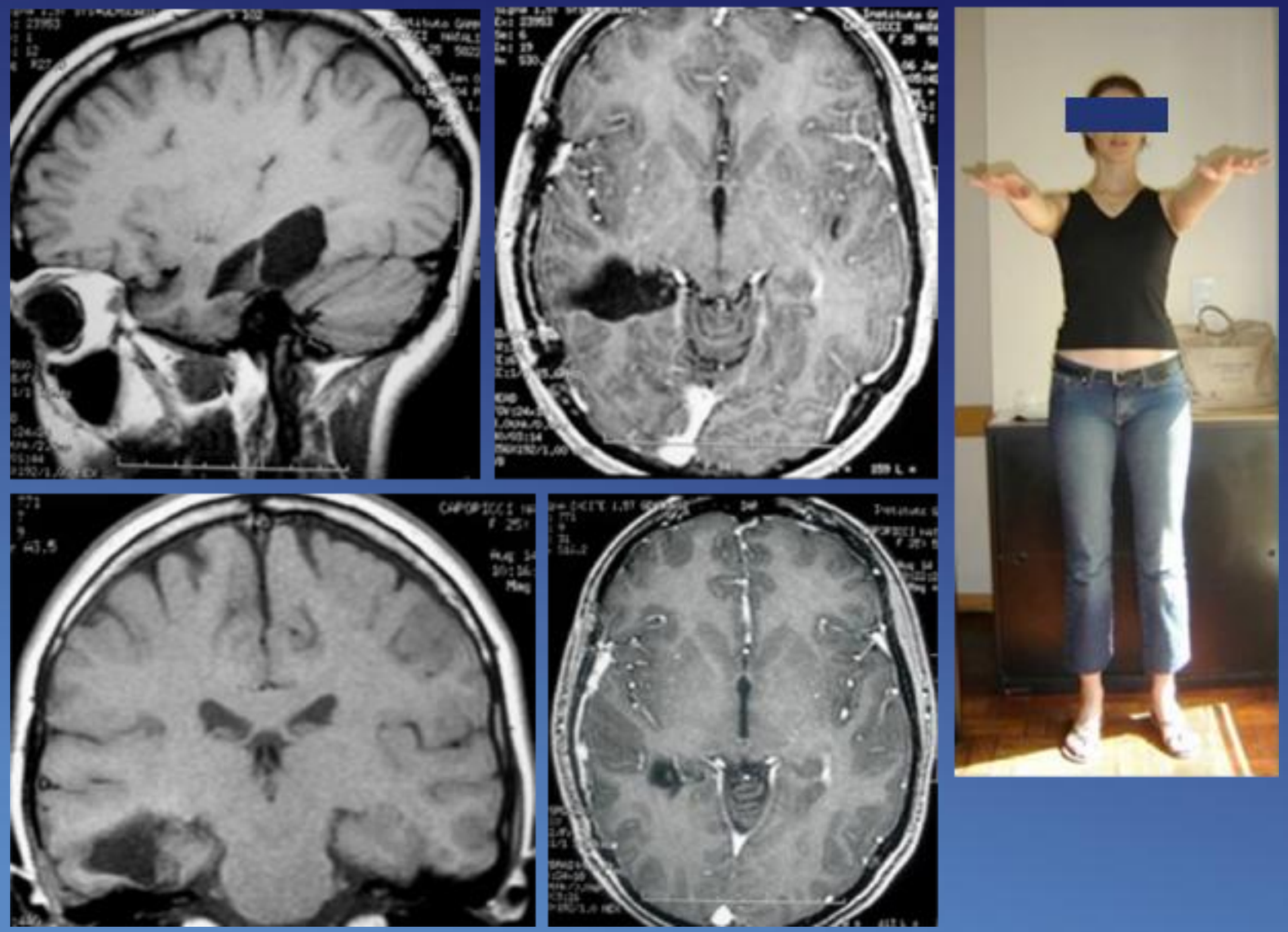


2005

LOW GRADE GLIOMAS

- Post-Operative

2010



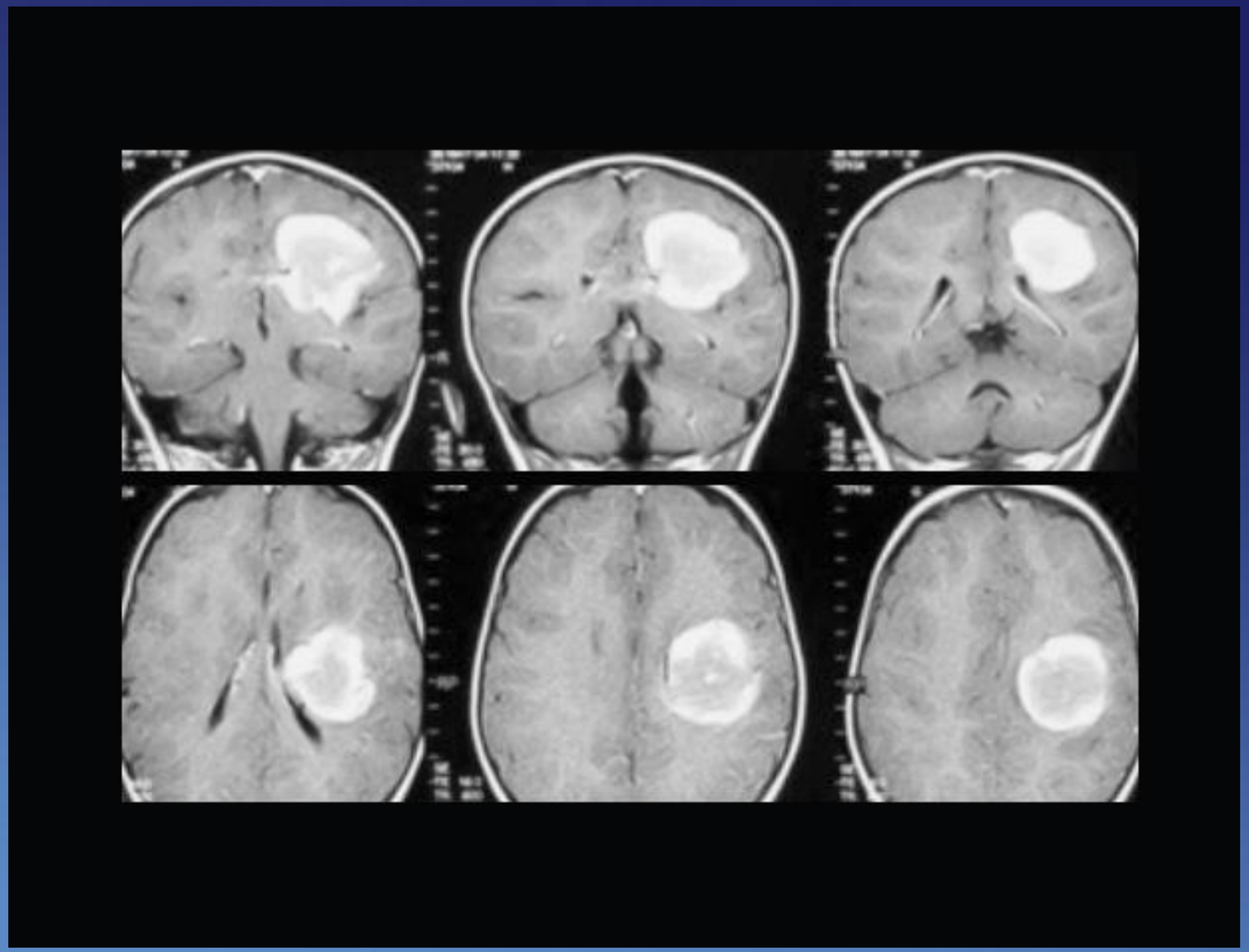
2010

LOW GRADE GLIOMAS

- Fem. 2 Years Old.
  OLIGODENDROGLIOMA.

  Operated in another Country.

August 2004

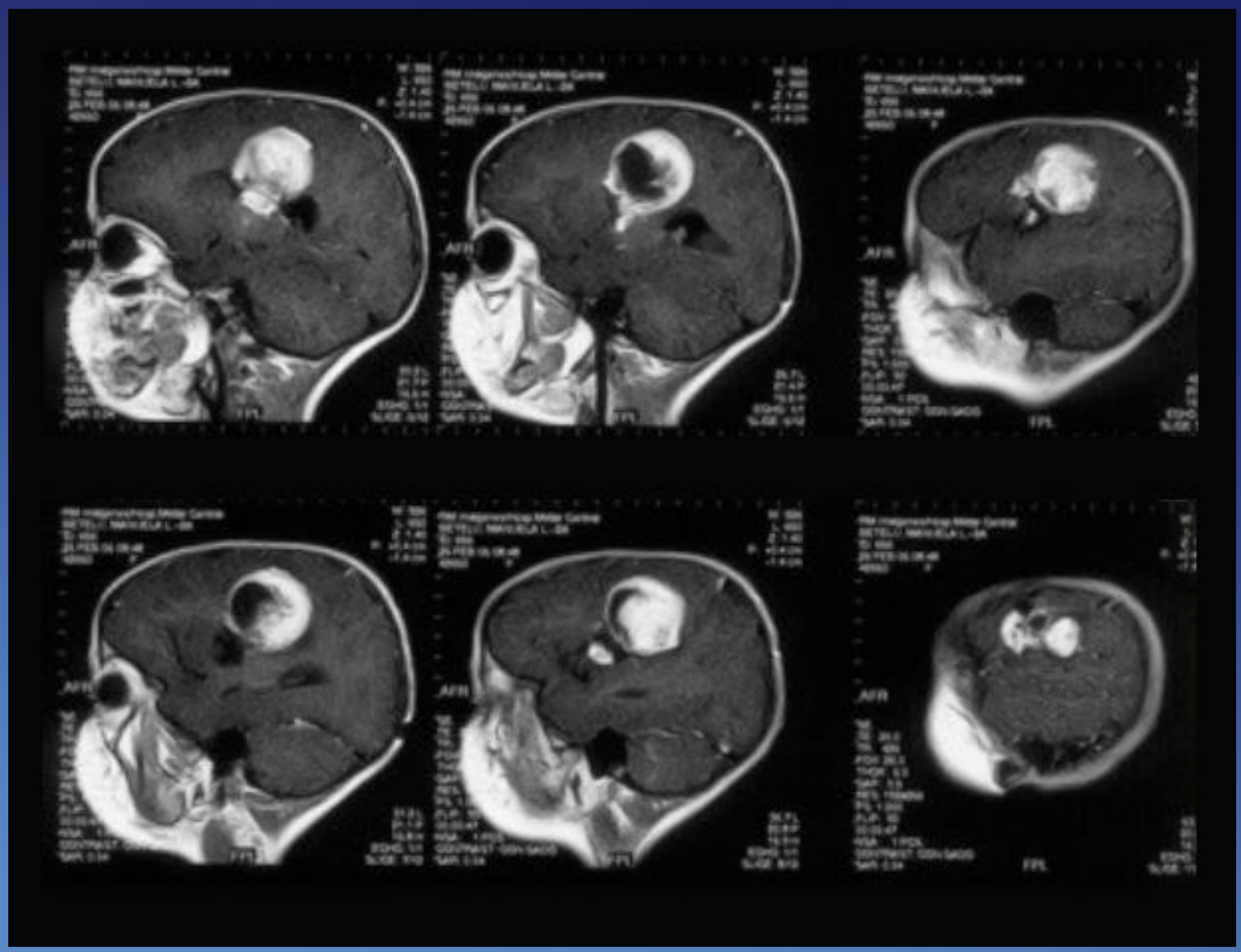


AUGUST 2004

LOW GRADE GLIOMAS

- **MRI** six months after the first operation.

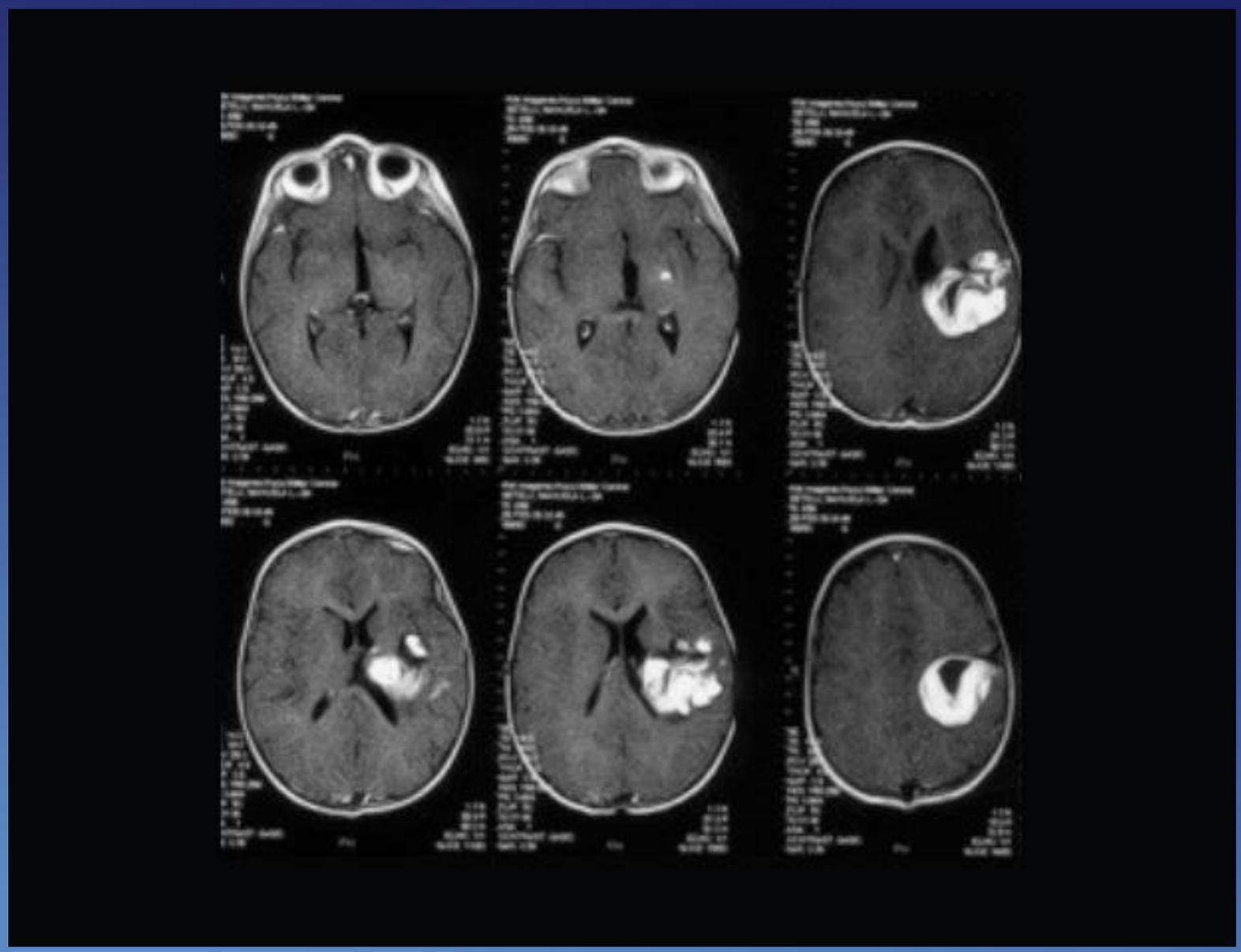
  Partial resection.



LOW GRADE GLIOMAS

- **MRI** six months after the first operation.

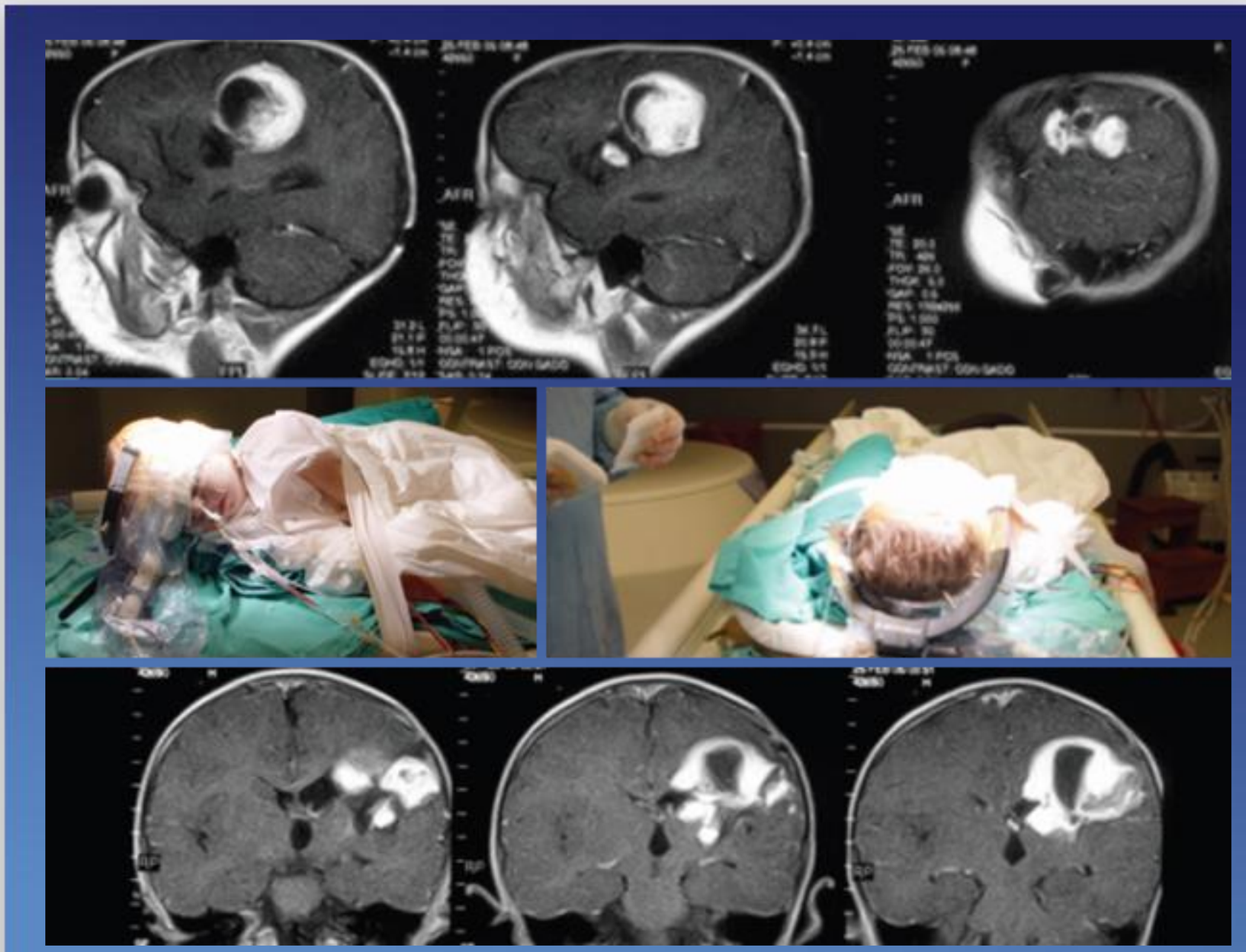
  Partial resection.



LOW GRADE GLIOMAS

- **iMRI** Surgery.

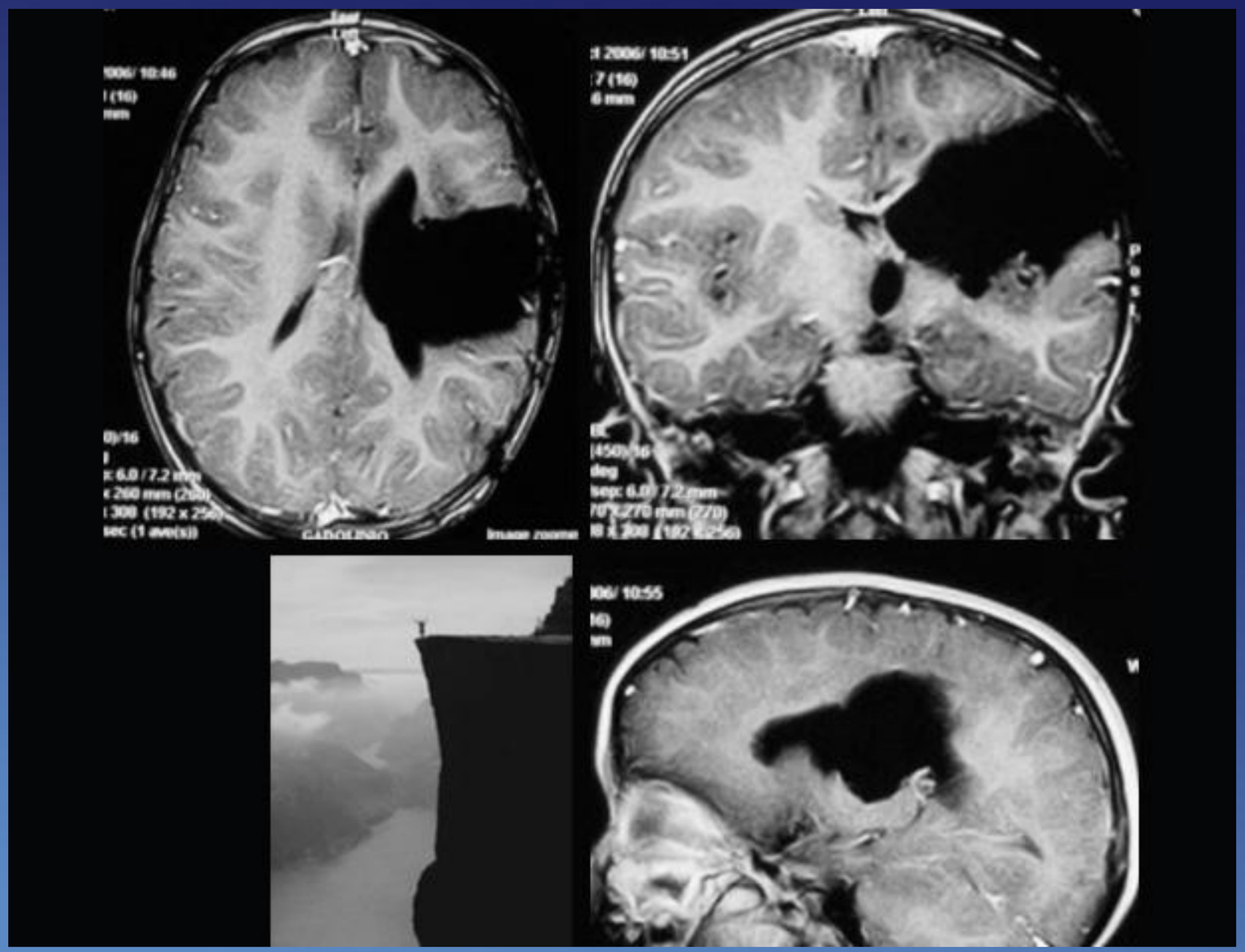
February 2005



FEBRUARY 2005

LOW GRADE GLIOMAS

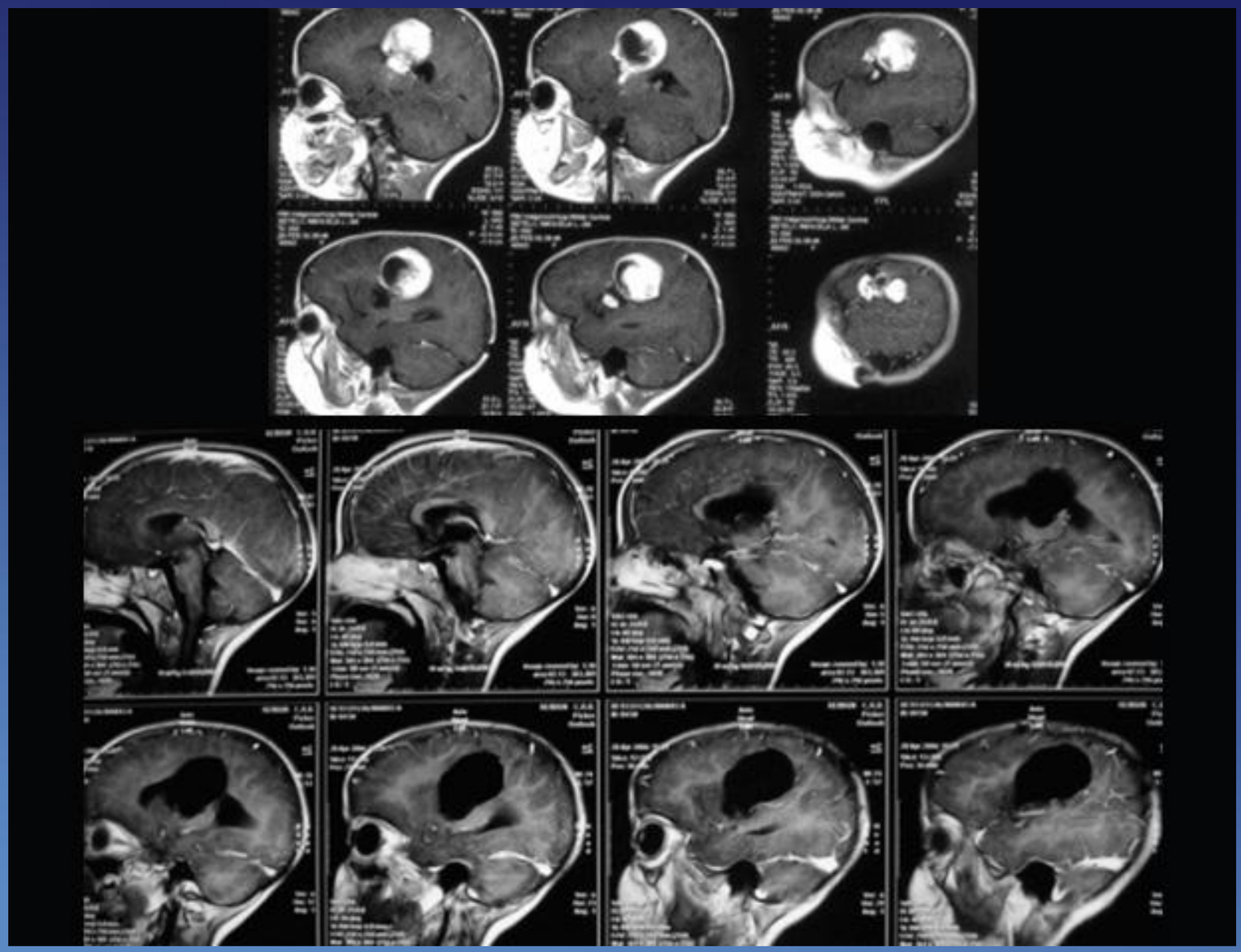
- Here is the post operative **MRI** control with complete removal of the tumor.



LOW GRADE GLIOMAS

- Here is the same in sagital plane.

  Pre-operative above and post operative below.



LOW GRADE GLIOMAS

- A: **10 days** post-operative.

  B: **1 month** post-operative.

  C: **1 month** post-operative.

LOW GRADE GLIOMAS

- Three years after surgery.

2008

2008

LOW GRADE GLIOMAS

- Six years after surgery.

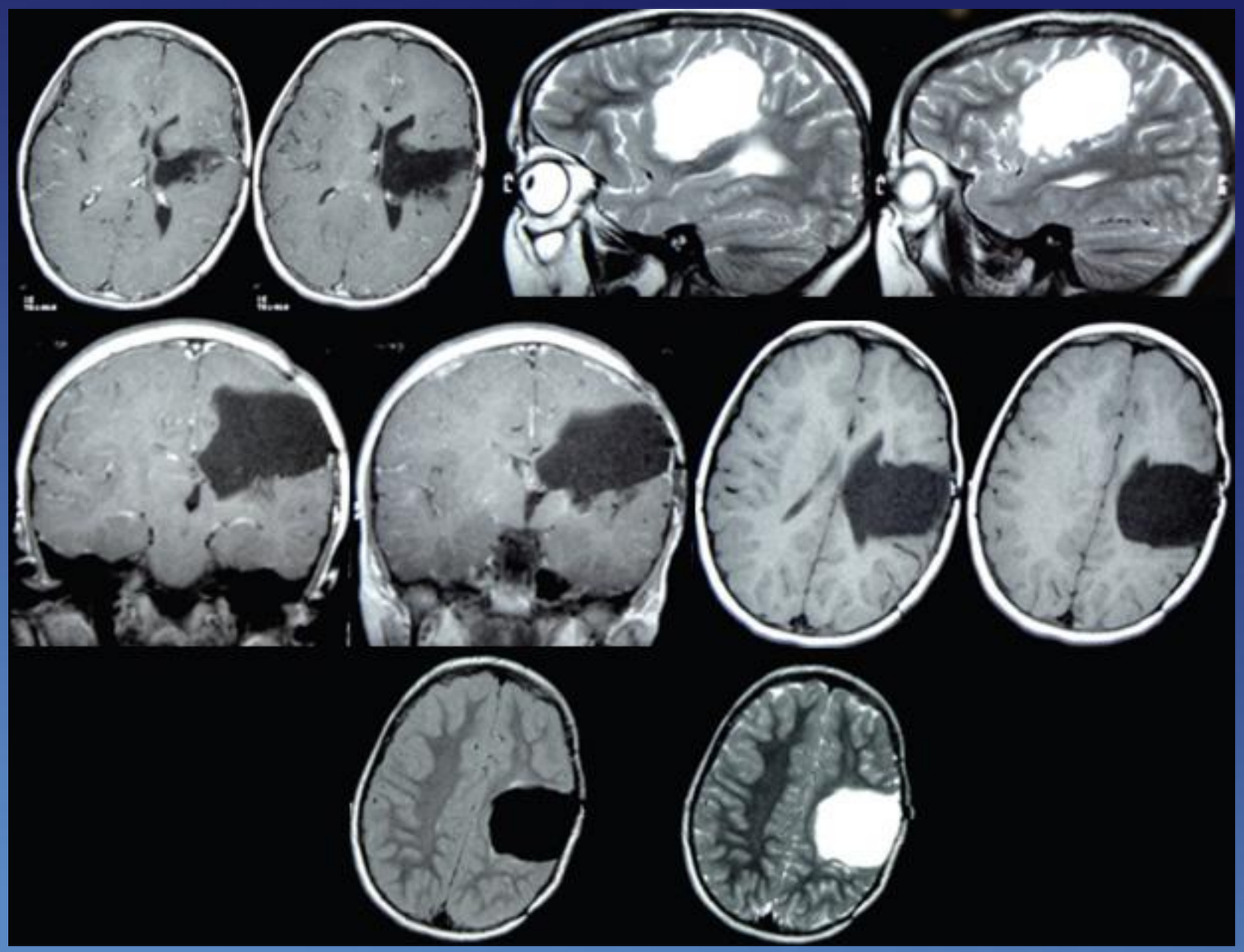
Summer 2011

SUMMER 2011

LOW GRADE GLIOMAS

- **MRI**. 7 Years.

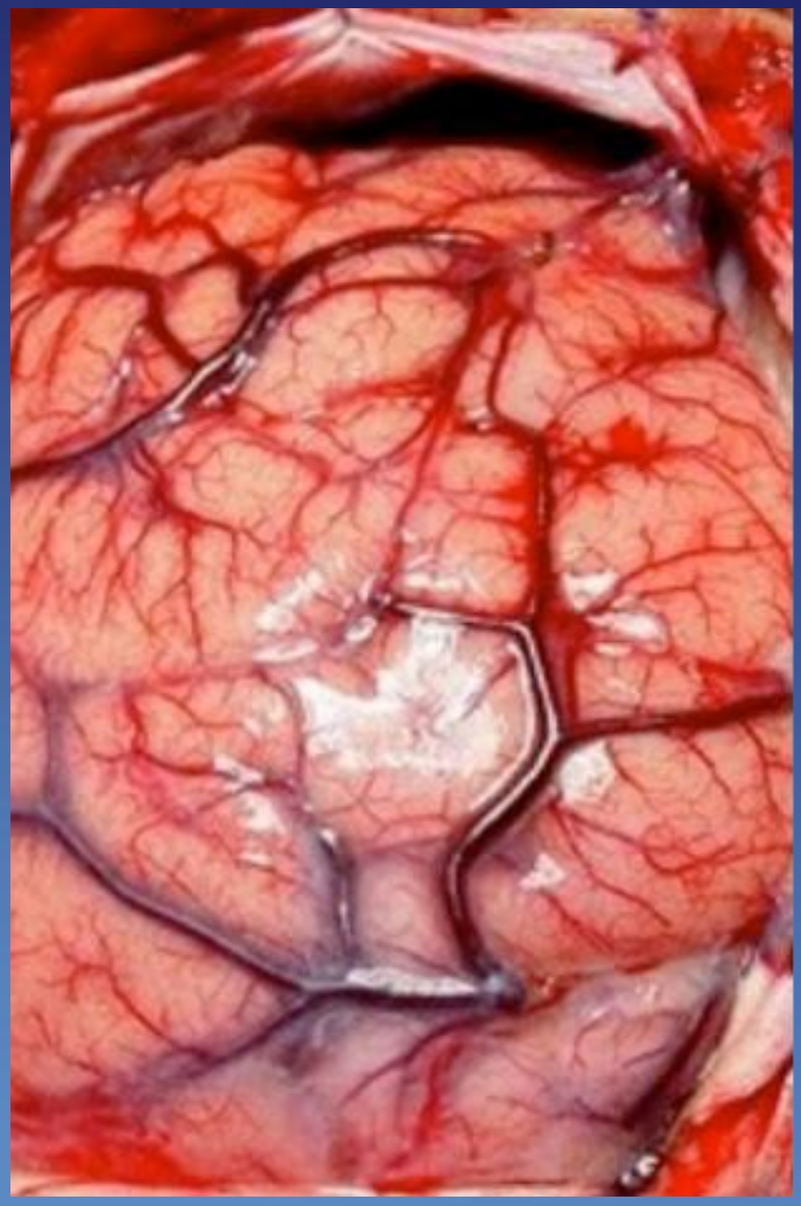
  Post -Operative.

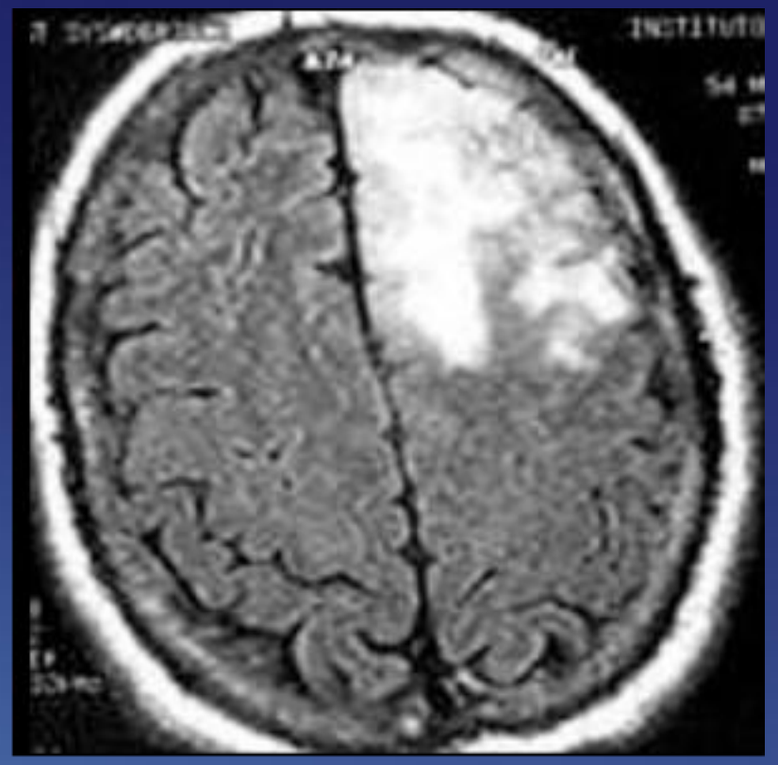


LOW GRADE GLIOMAS

- PH. M. 54
  Frontal left.

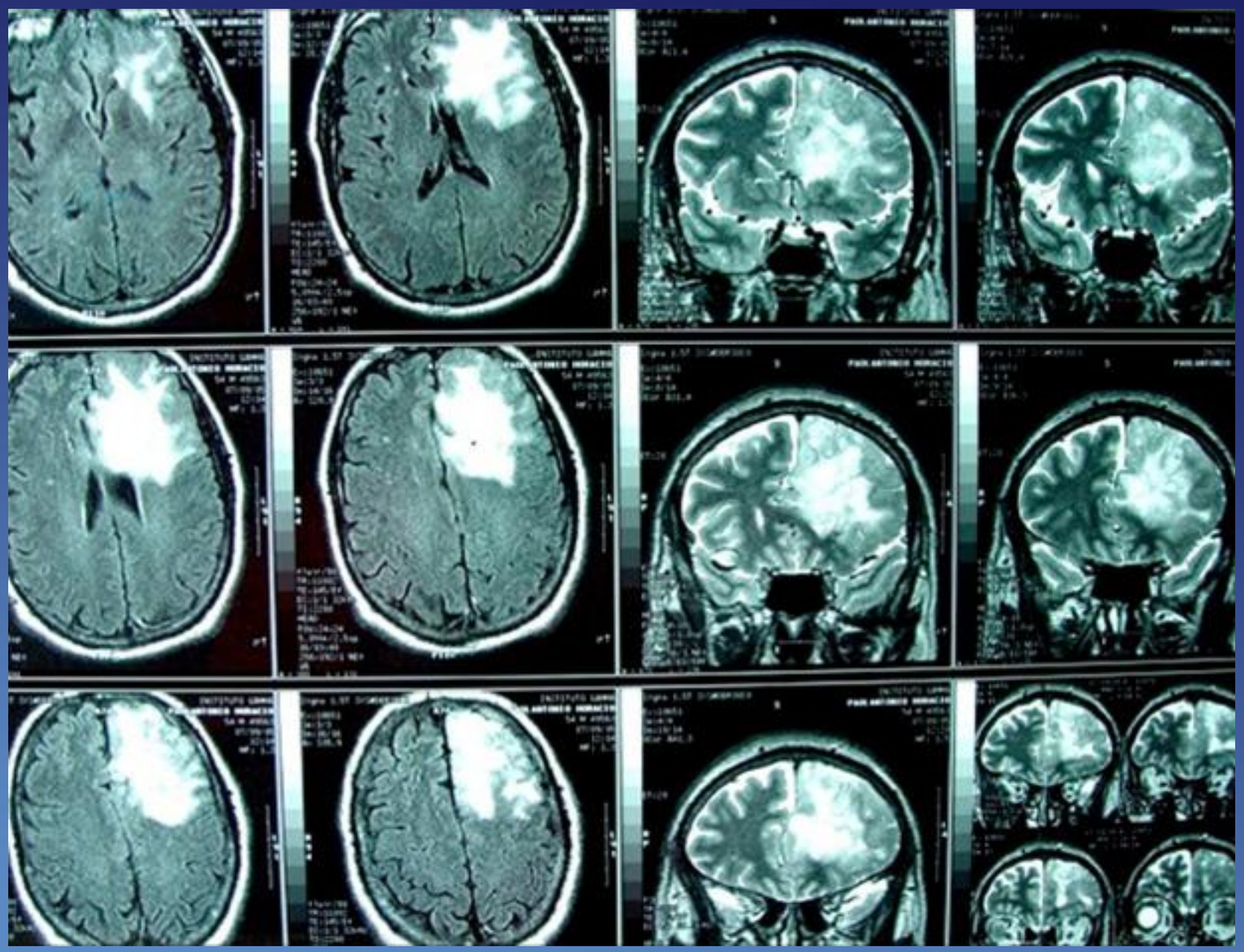
  Oligodendroglioma.





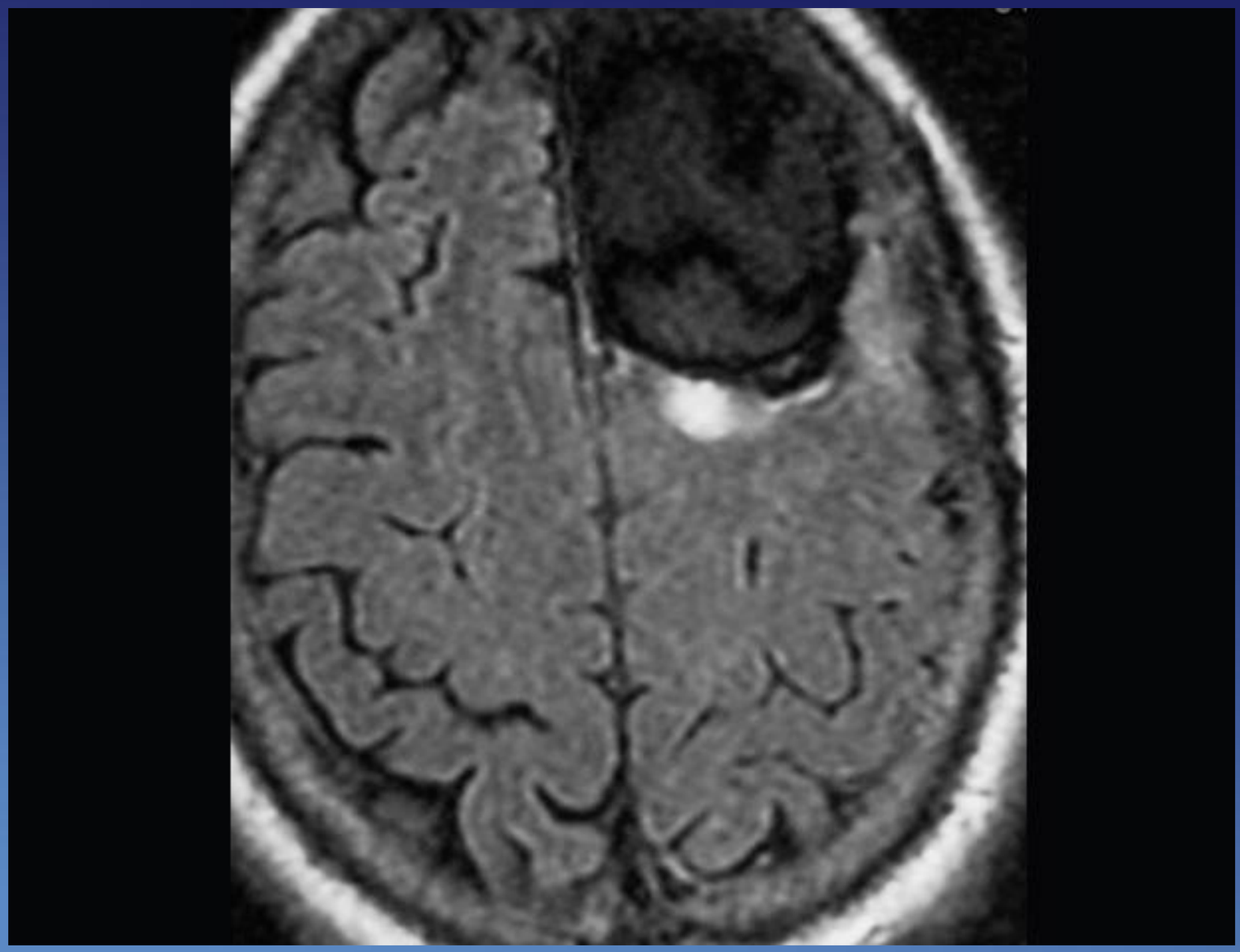
LOW GRADE GLIOMAS

- LGG



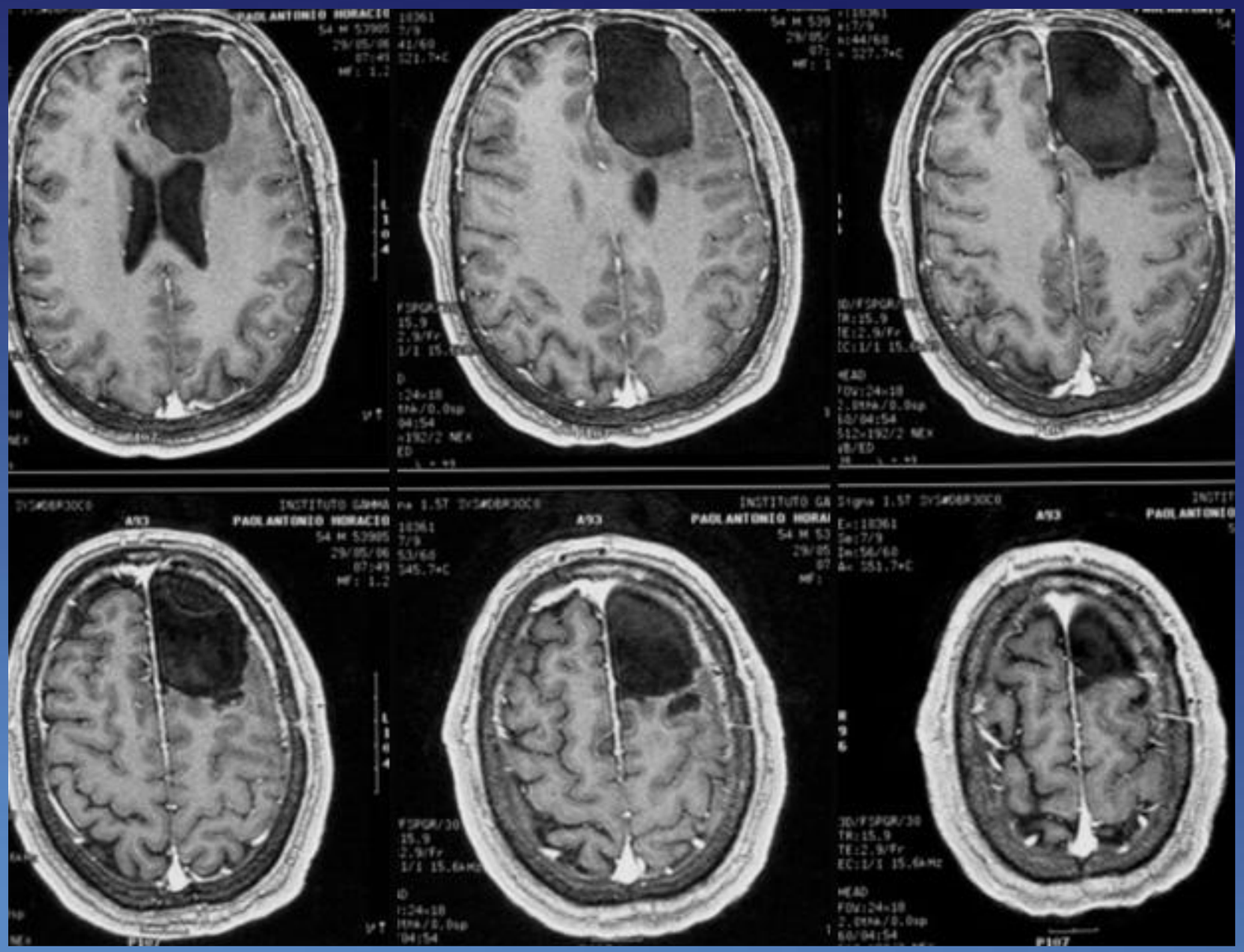
LOW GRADE GLIOMAS

- A residual tumor was found in **iMRI** so that resection had to be expanded.



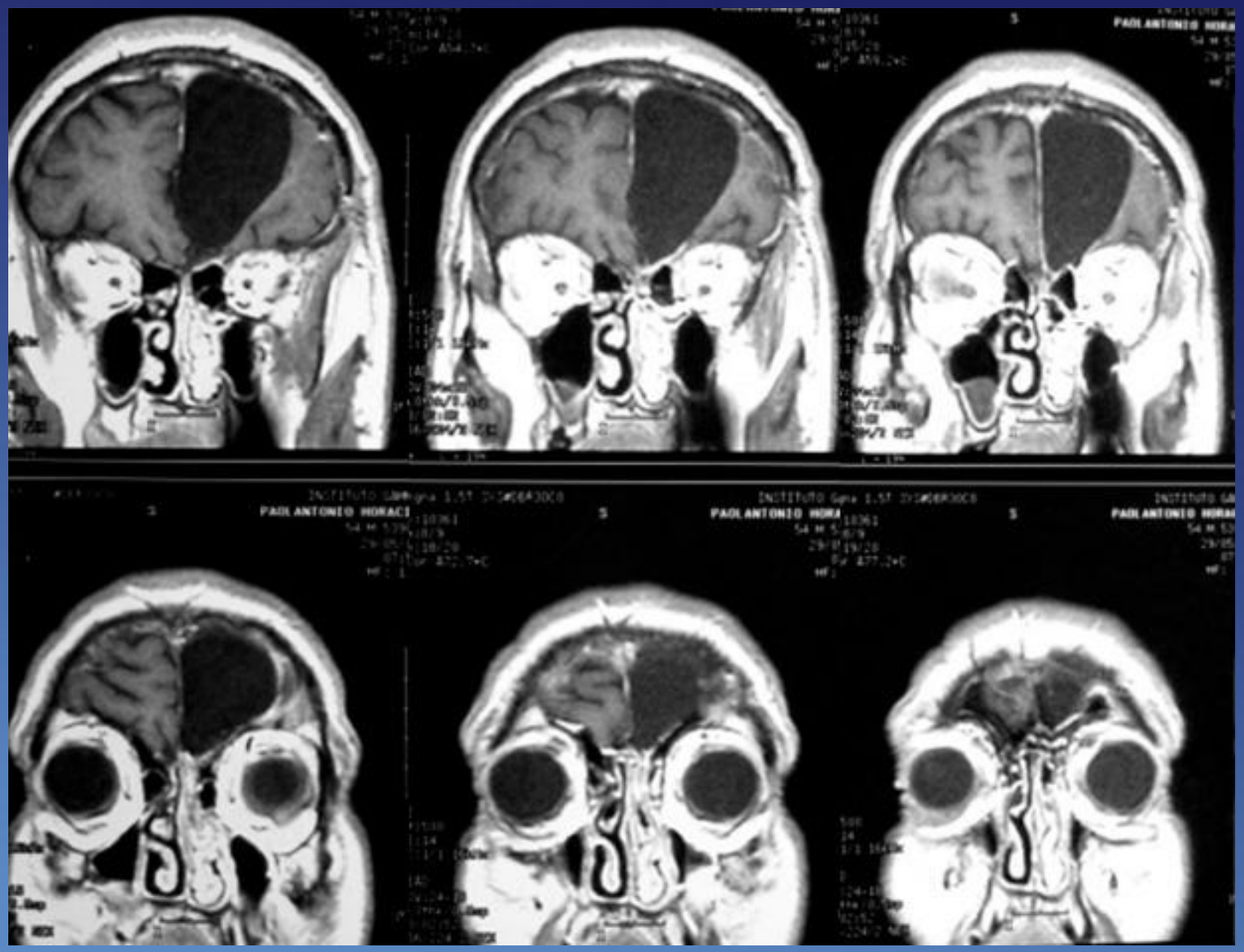
LOW GRADE GLIOMAS

- Complete removal.



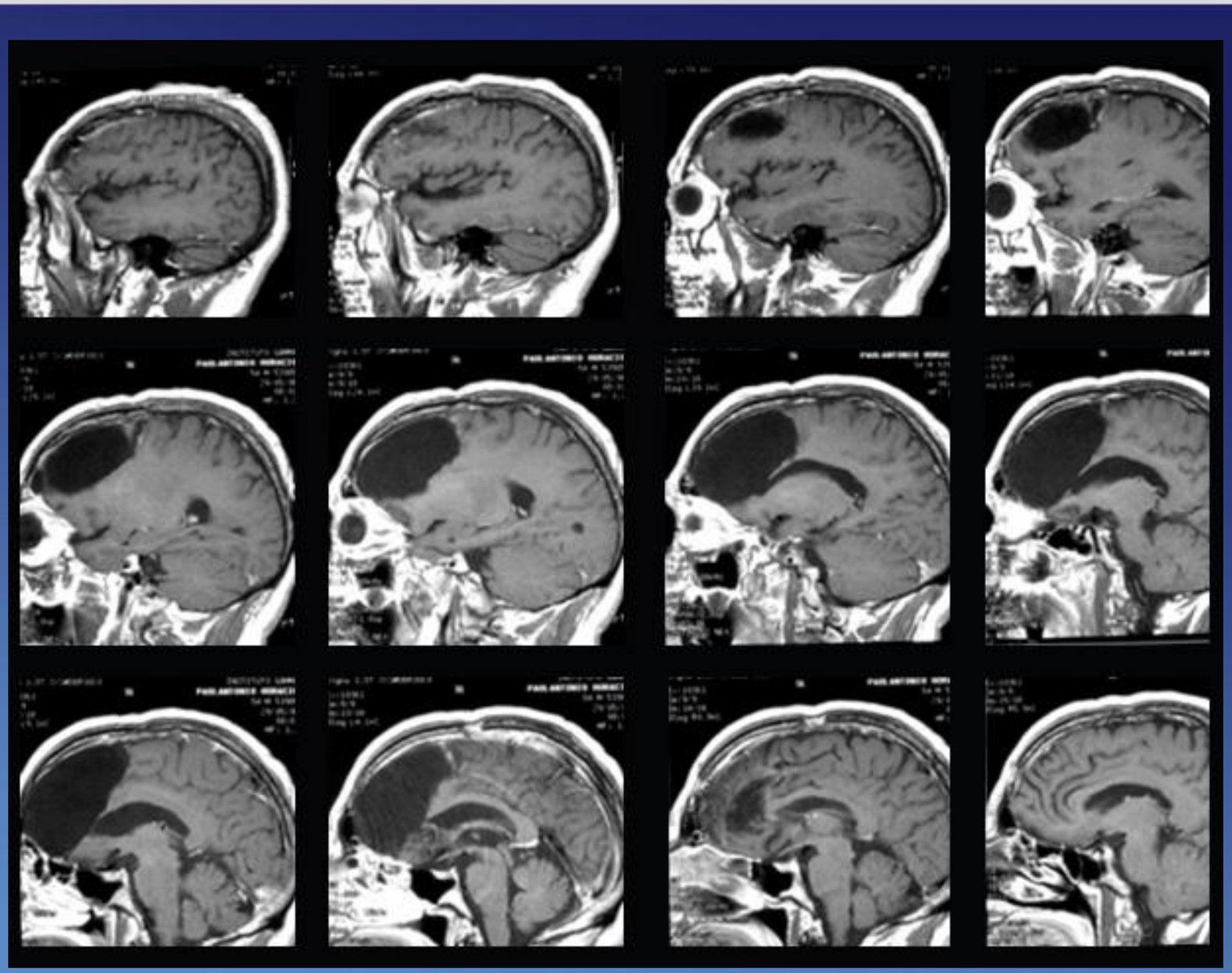
LOW GRADE GLIOMAS

- Complete removal.



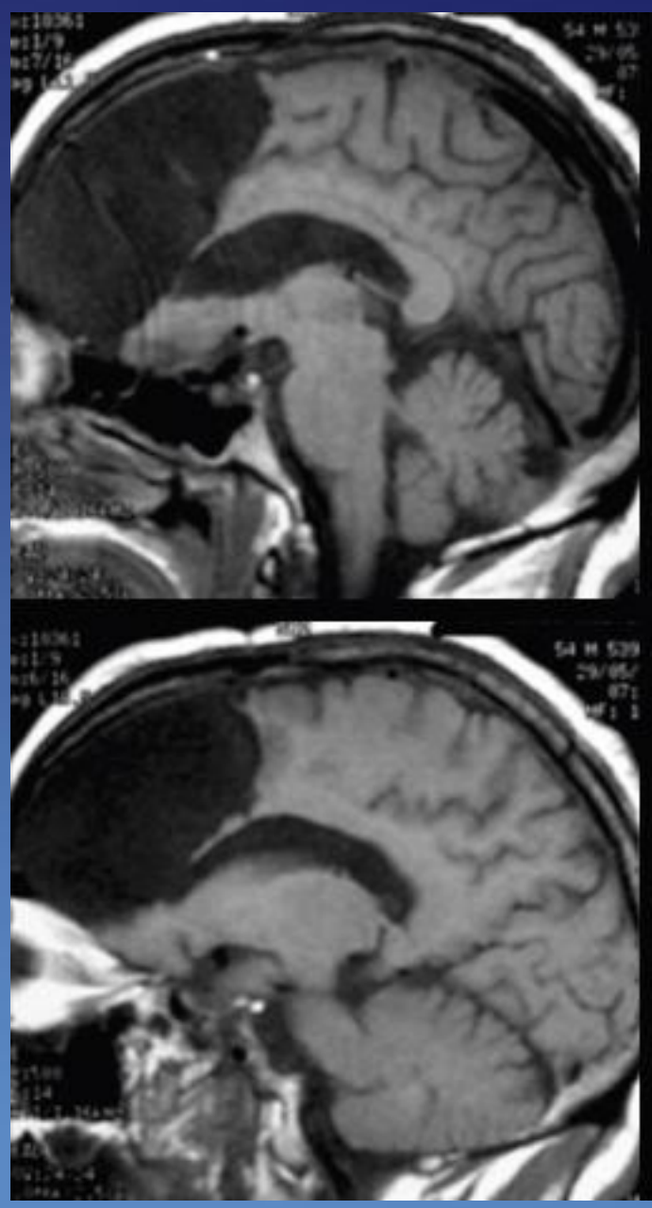
LOW GRADE GLIOMAS

- Post-Operative **MRI**.



LOW GRADE GLIOMAS

- Five Years Post-Operative.

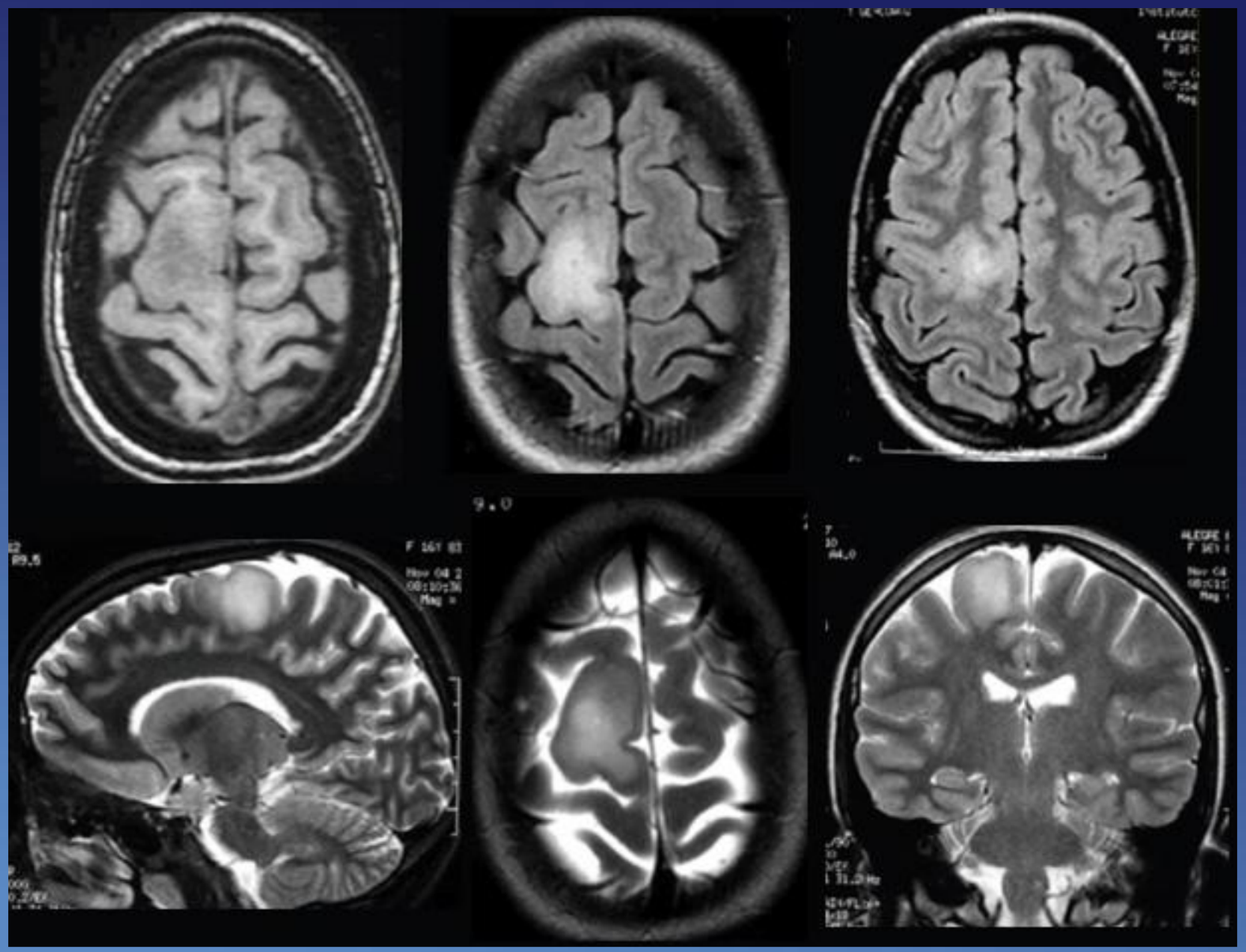


LOW GRADE GLIOMAS

- Fem. 17

  Pre motor area.

  Right LGG.

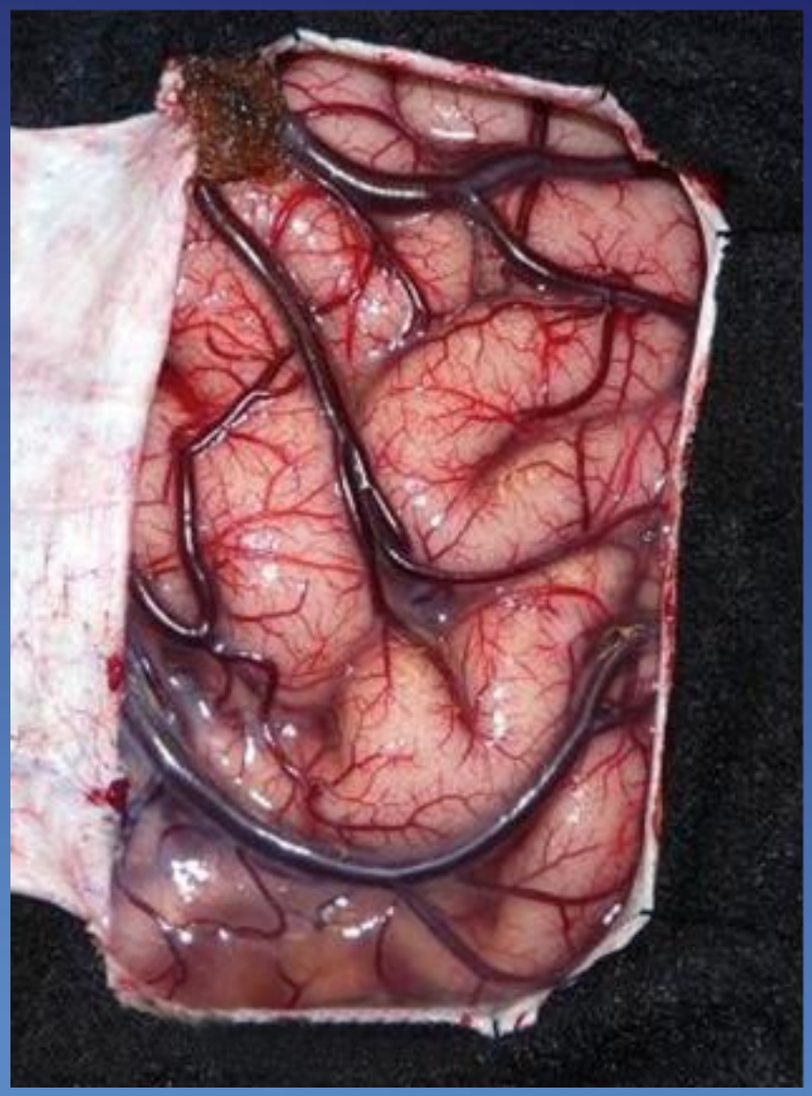


LOW GRADE GLIOMAS

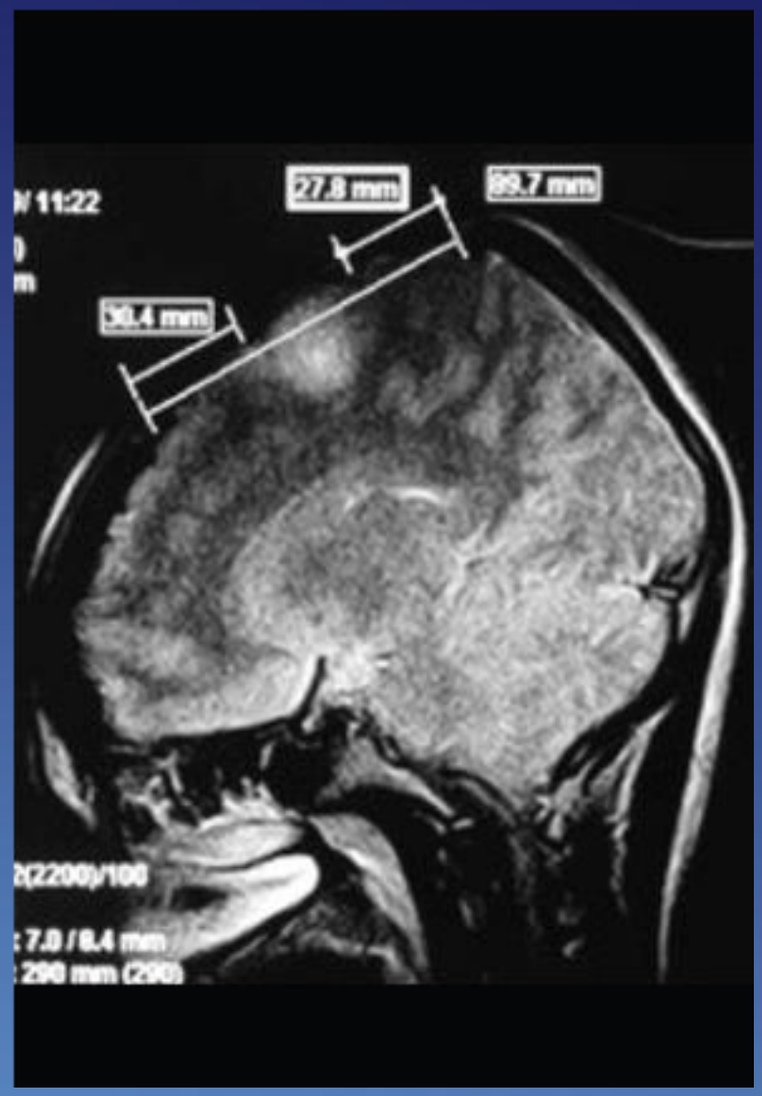
- A: The operating field. **Can I be completely sure where the tumor is?**

  B: Intraoperative **MRI**.

A

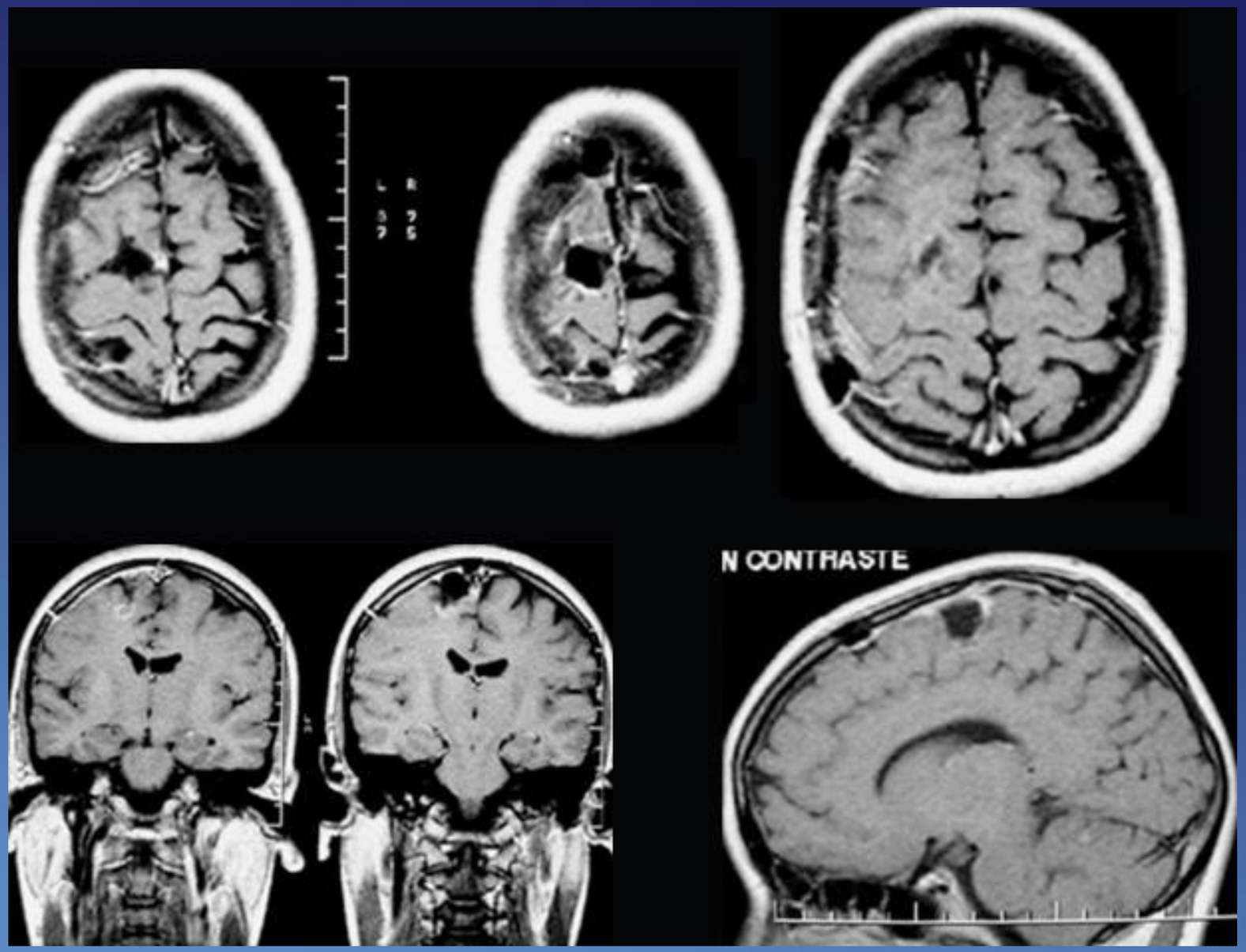


B



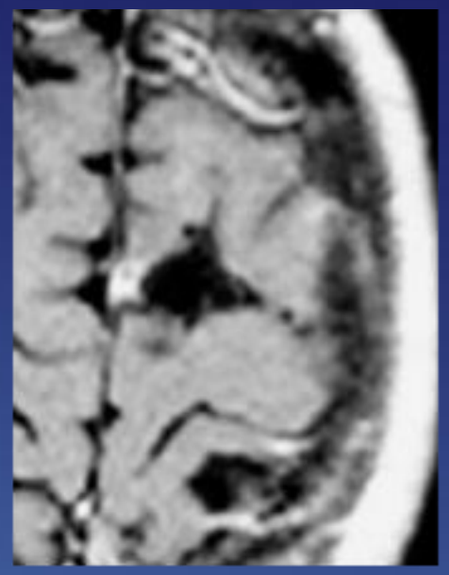
LOW GRADE GLIOMAS

- Post-Operative **MRI** control with complete removal of the tumor.



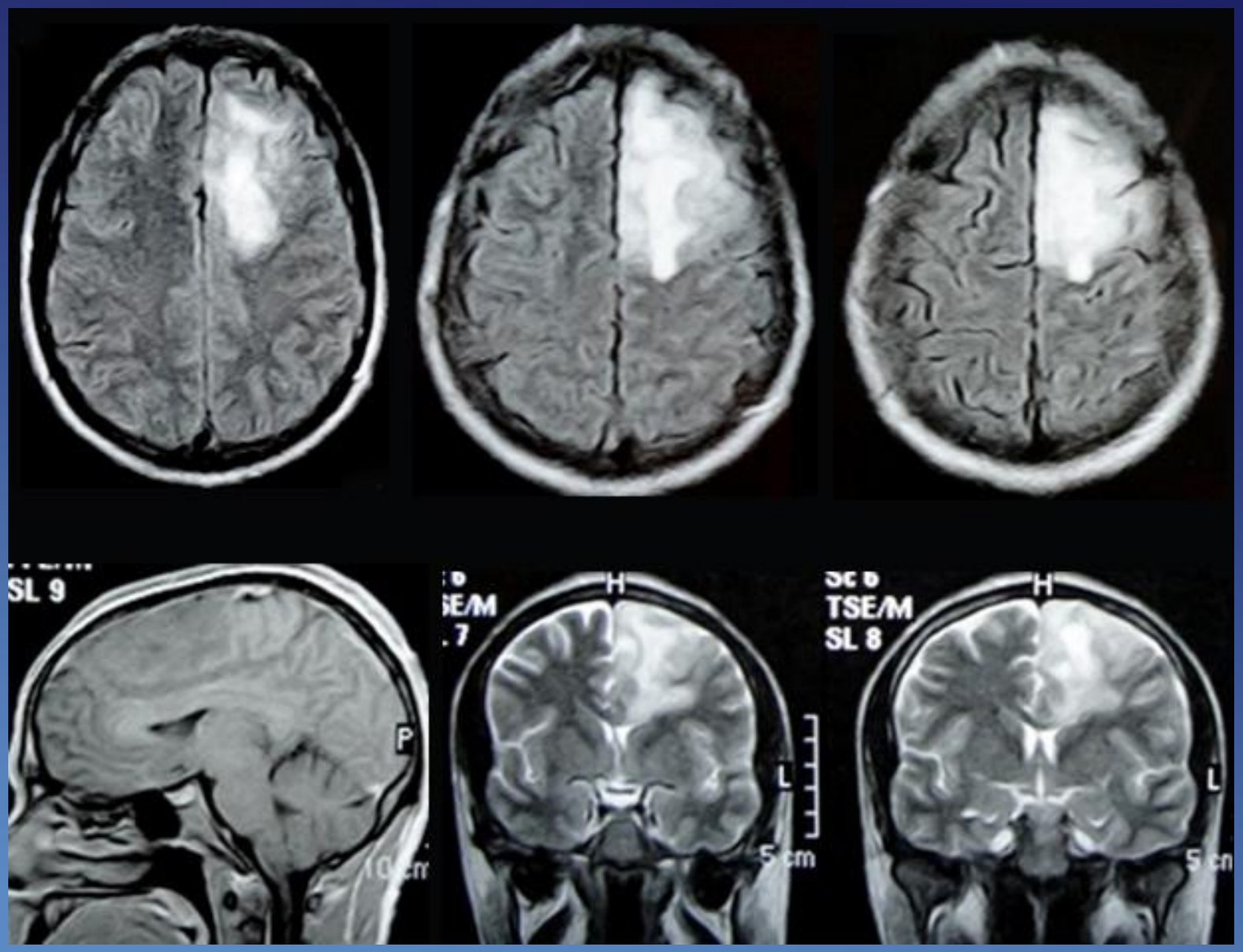
LOW GRADE GLIOMAS

- Post-Operative patient outcome.



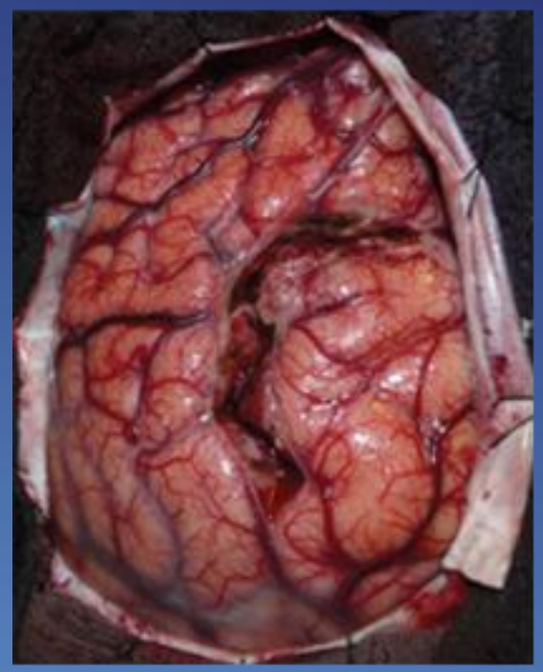
LOW GRADE GLIOMAS

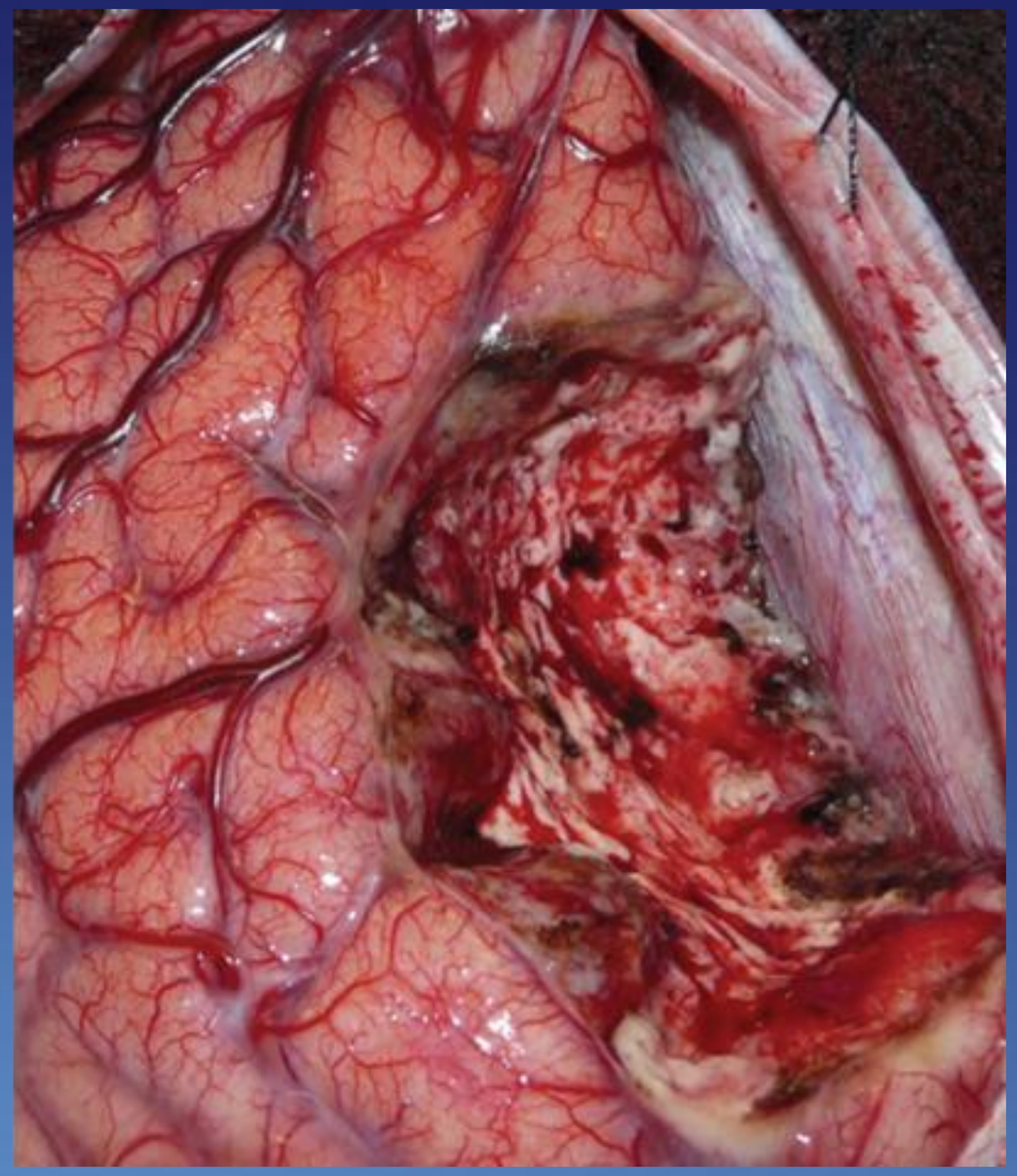
- LGG. M. 32.
  Pre Central Left.



LOW GRADE GLIOMAS

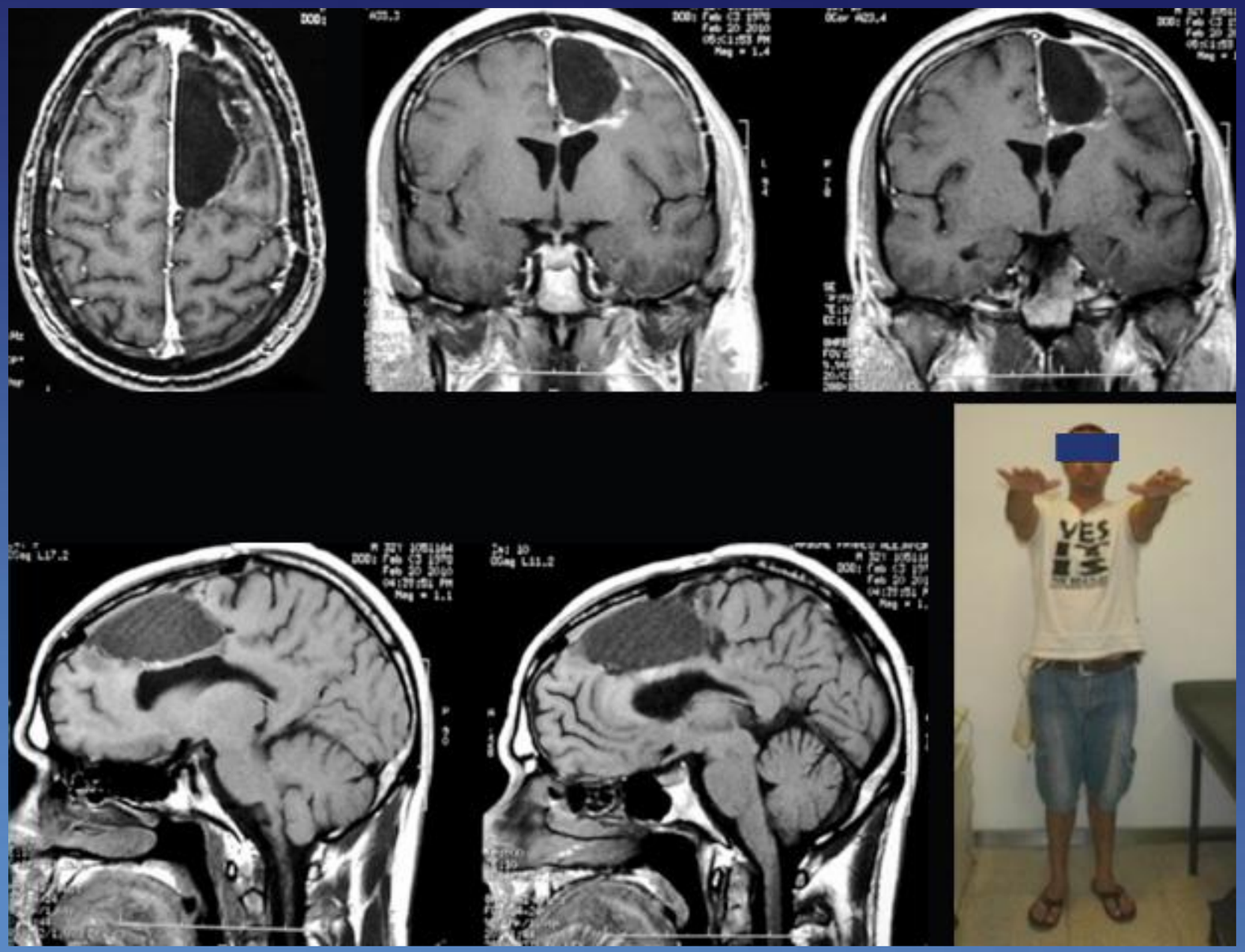
- Anatomical and Morphological resection.





LOW GRADE GLIOMAS

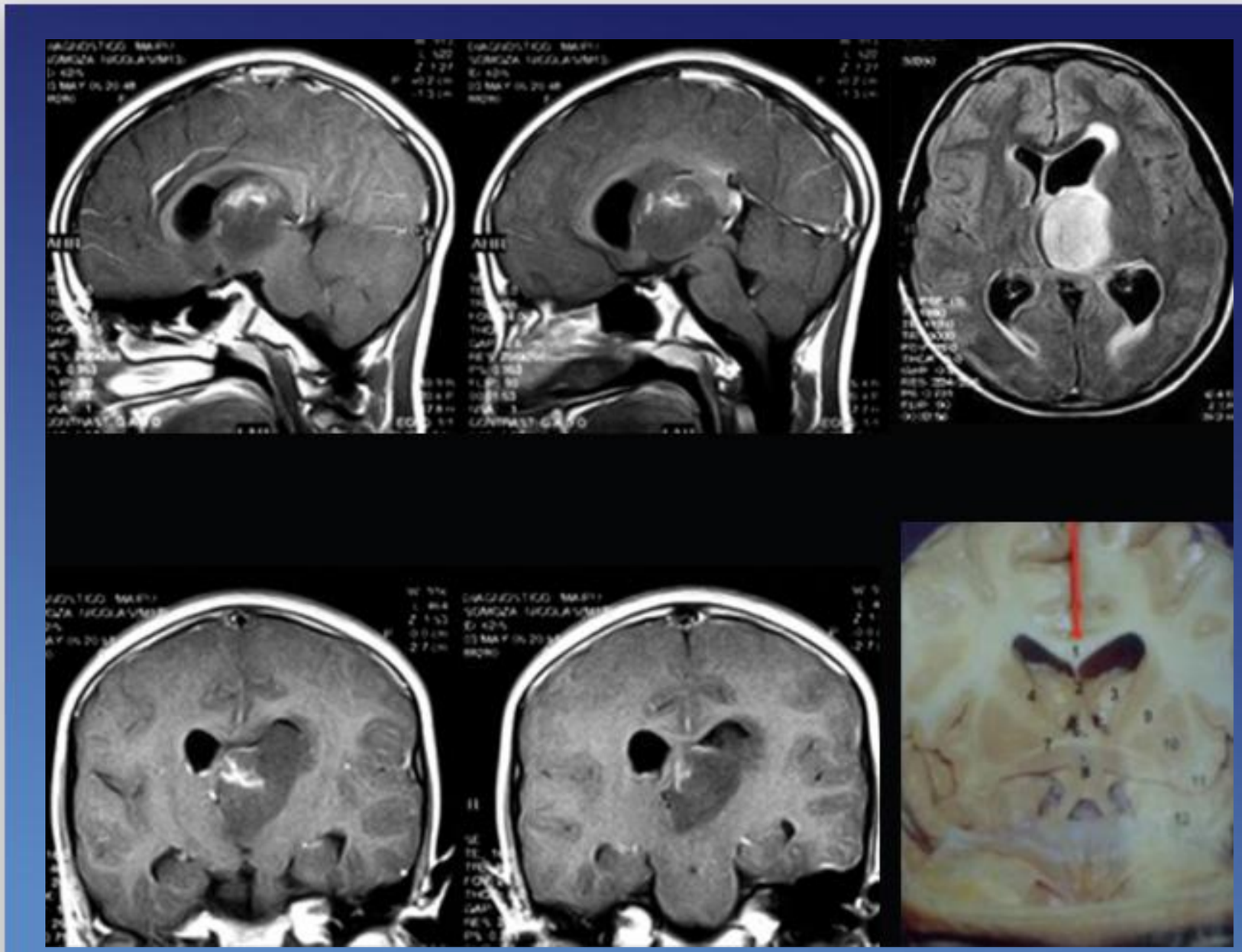
- Post-Operative **MRI** control with complete removal of the tumor and the patient in excellent outcome without neurological deficit.



LOW GRADE GLIOMAS

- M. 13

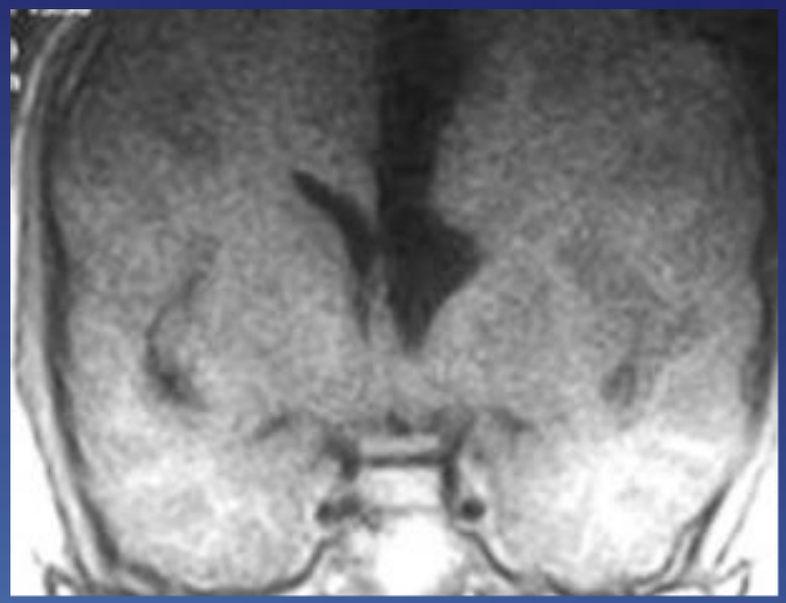
  Oligodendroglioma.

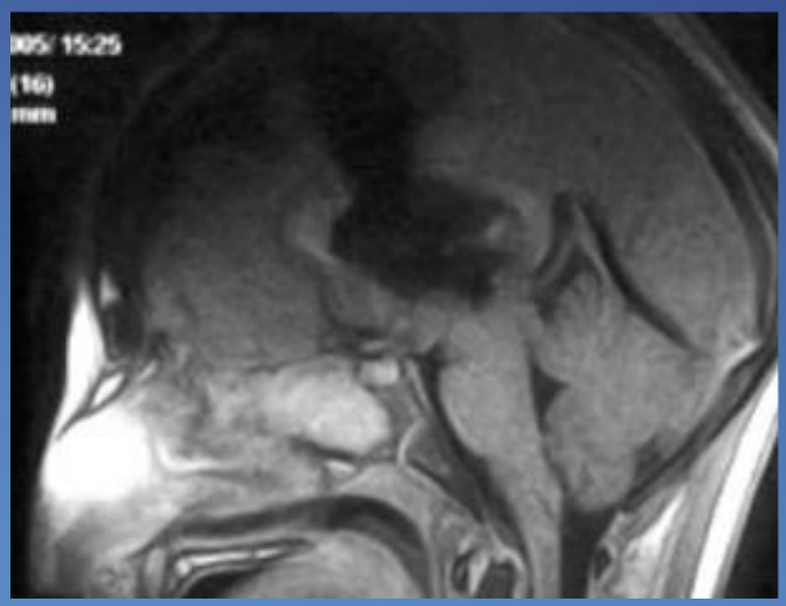


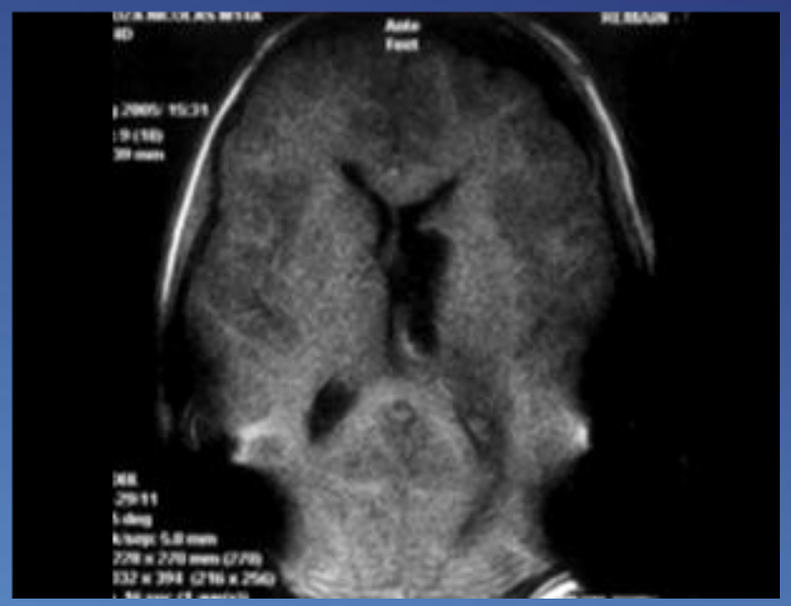
LOW GRADE GLIOMAS

LOW GRADE GLIOMAS

- Intraoperative **MRI** and Post-Operative patient outcome.







INSULAR TUMORS

CLINICA ADVENTISTA BELGRANO

21 CASES OPERATED

- **15** with iMRI.
- **1** with Neuronavigator.
- **5** Conventional neurosurgery.

- **17** L.G.G.
- **4** H.G.G.

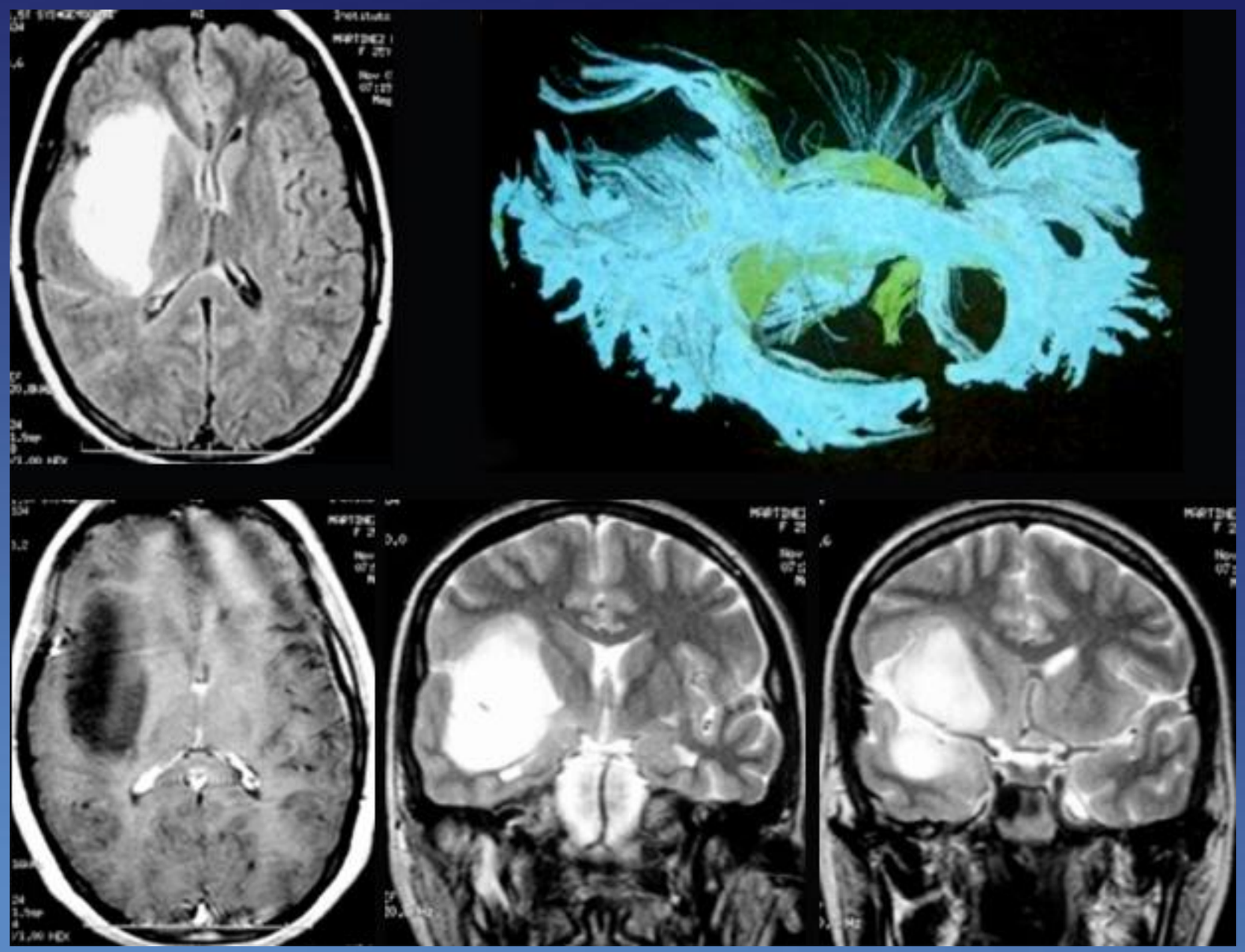
iMRI “ ADVANTAGES”

MRI offers several palpable advantages. Most important among these are improved medical outcomes, shorter hospitalization, and better and faster procedures with fewer complications.

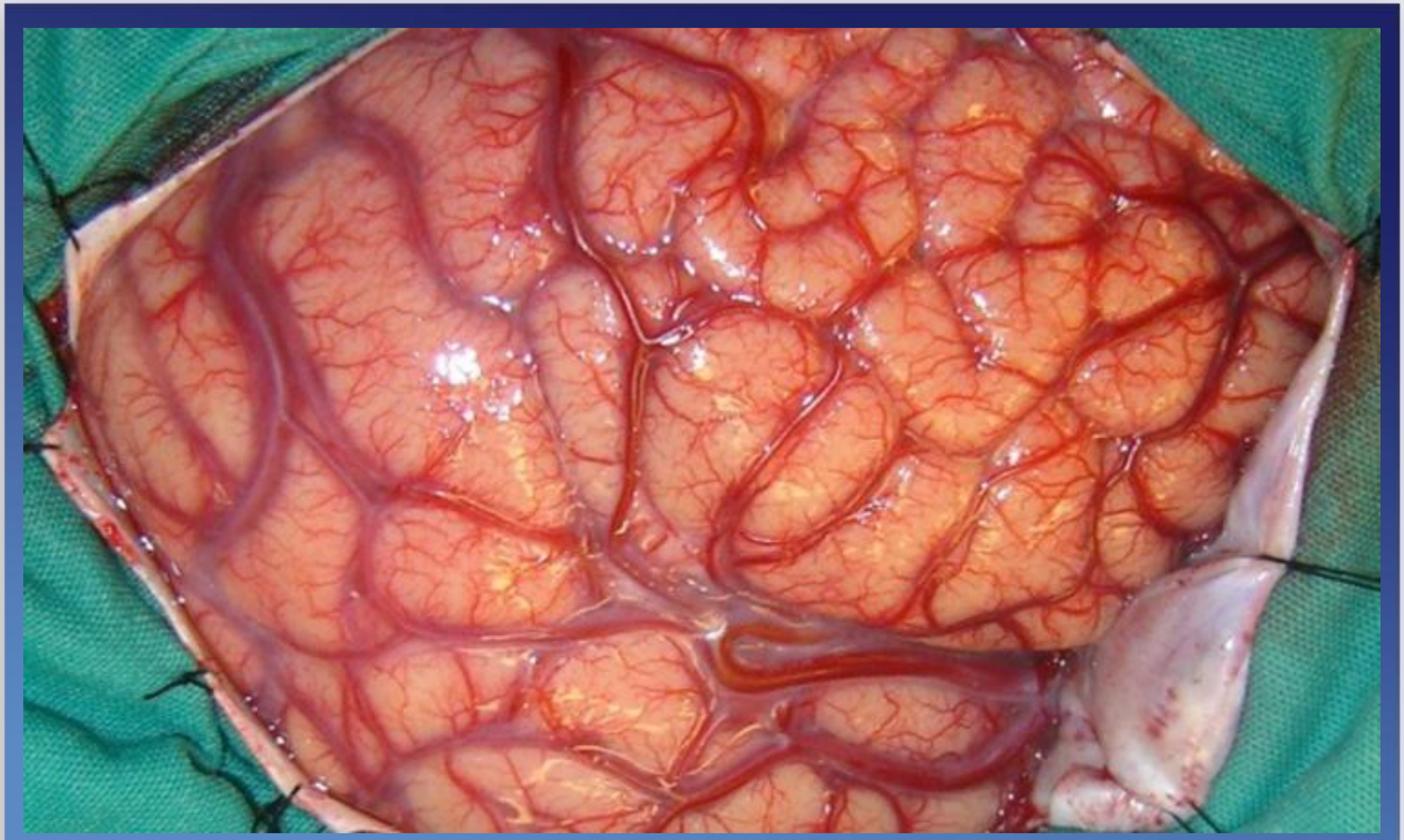
Specifically, in the context of the real-time representation of the patient's anatomy, we have improved the quality and utility of the information presented to the surgeon, which, in turn, contributes to more successful surgical outcomes.

INSULAR TUMORS

- This is a typical Insular Glioma. In Gliomas of Insular Region, the **iMRI** is very useful.

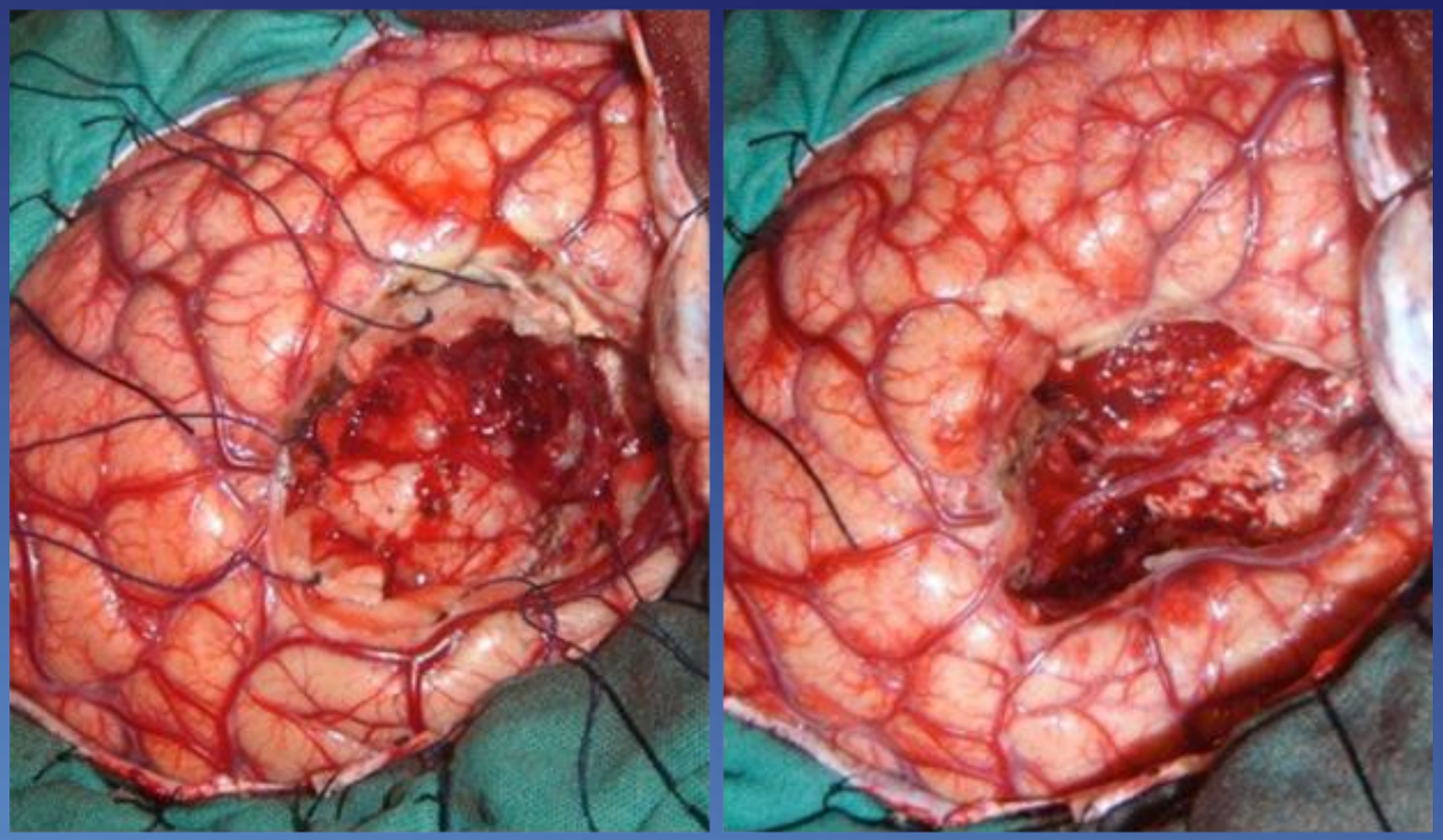


INSULAR TUMORS



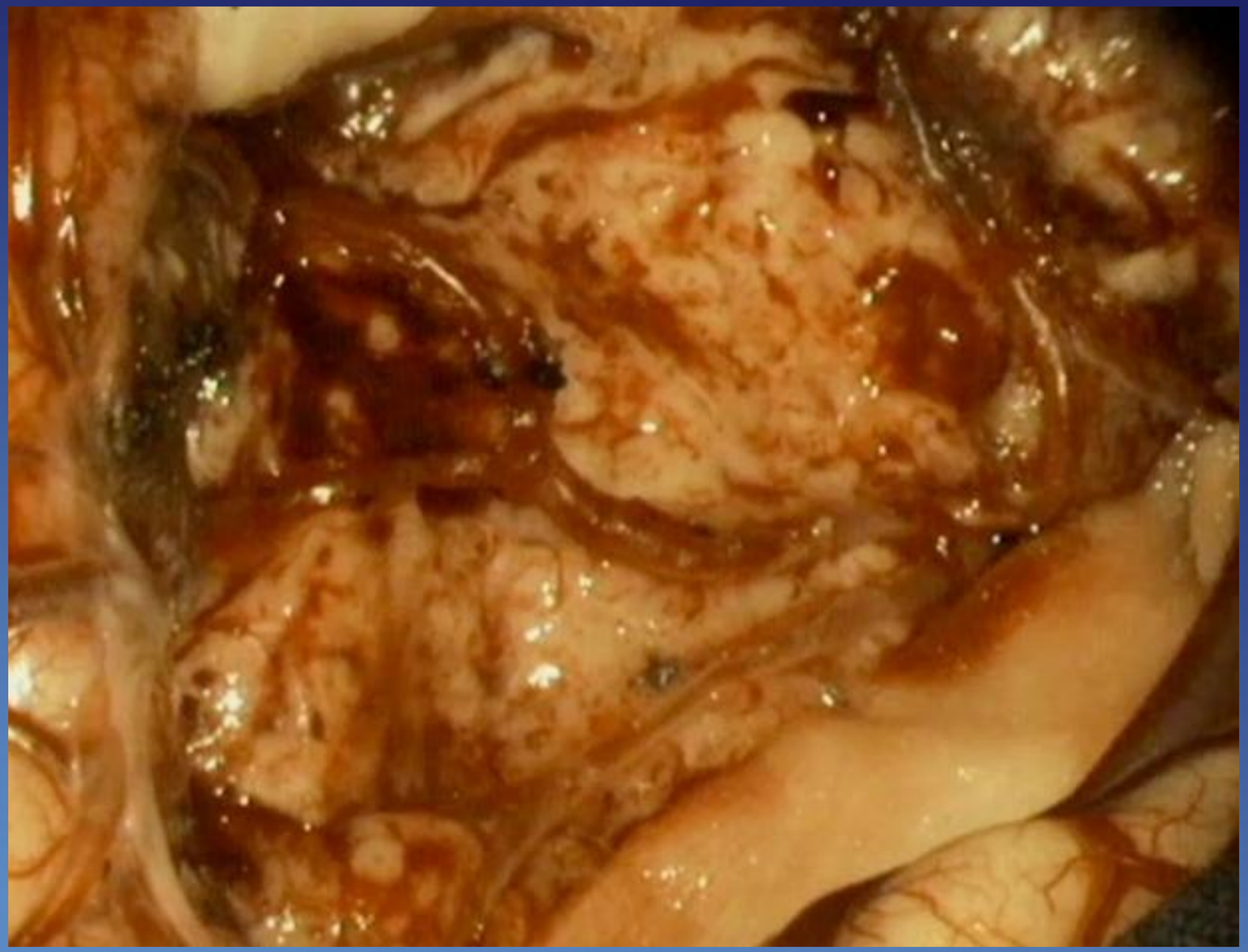
INSULAR TUMORS

- We can see the Silvian fisure opened showing the tumor on the left, and the tumor removed on the right.



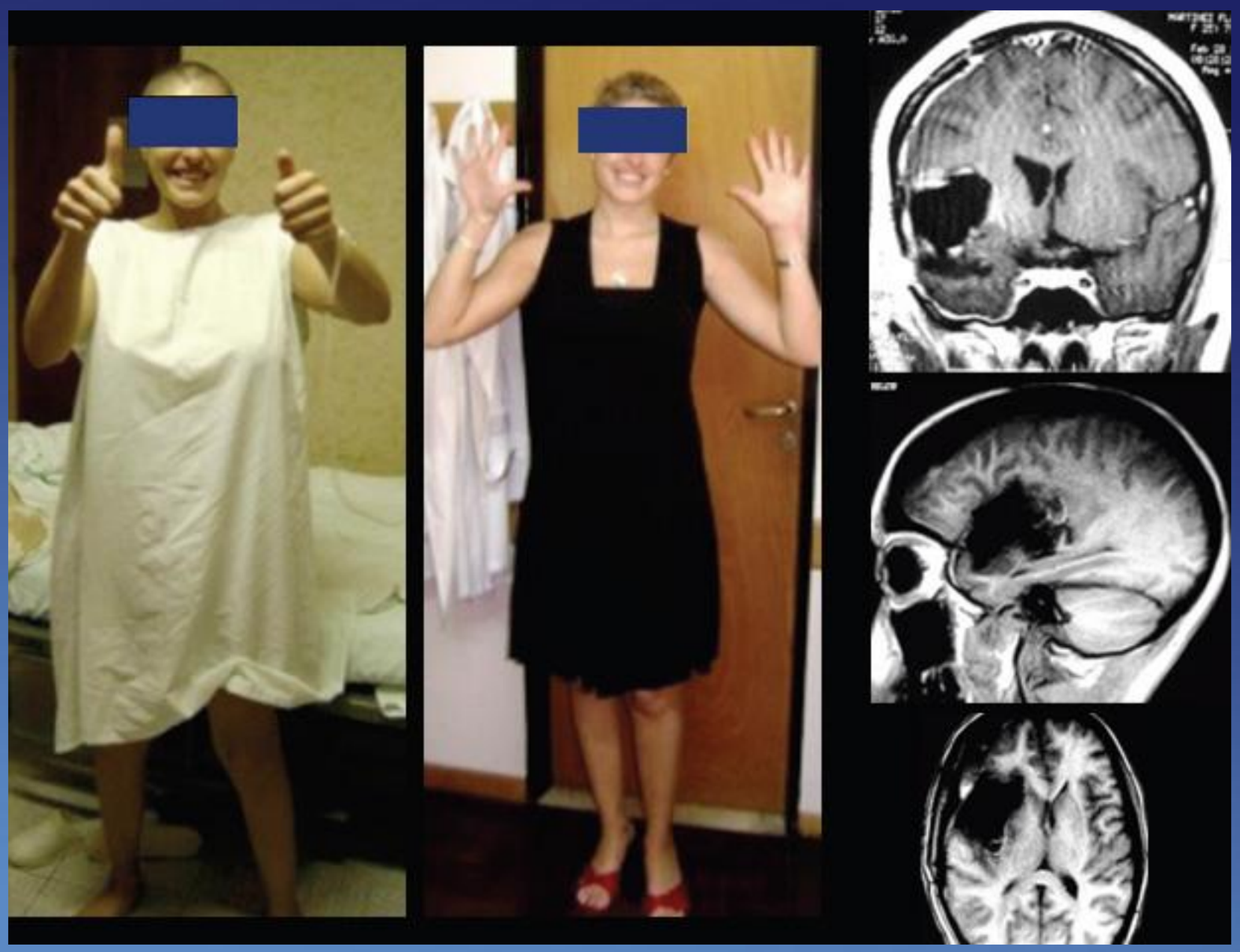
INSULAR TUMORS

- This is the middle cerebral artery preserved.



INSULAR TUMORS

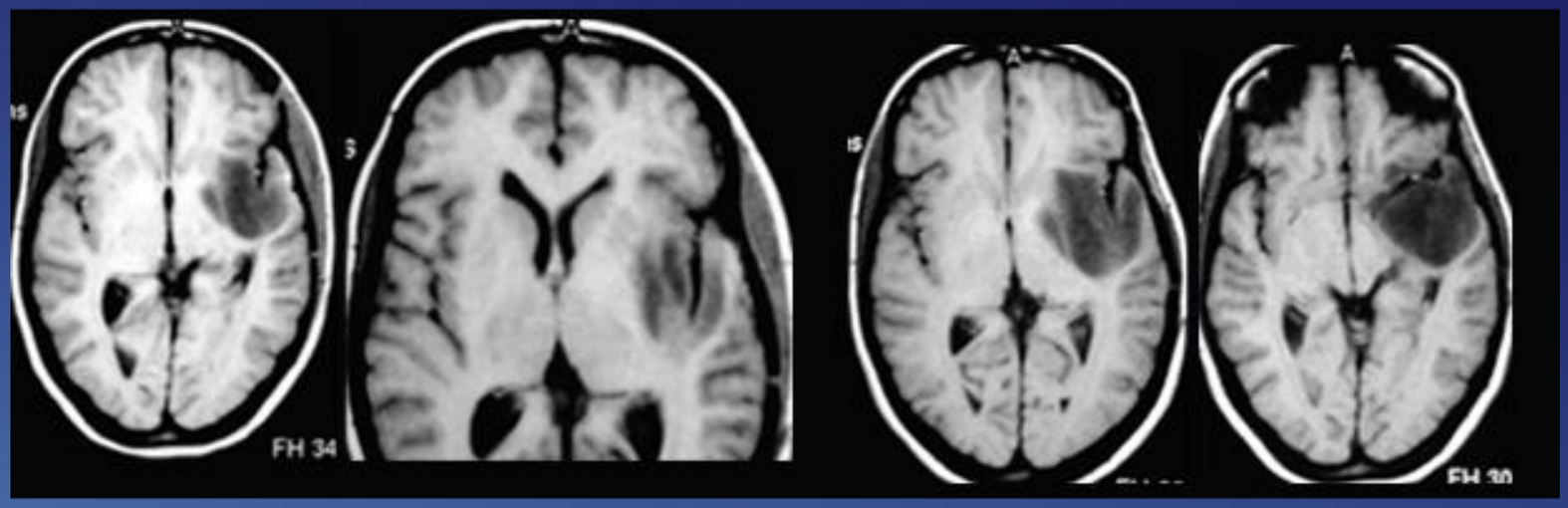
- Post-Operative. Control.



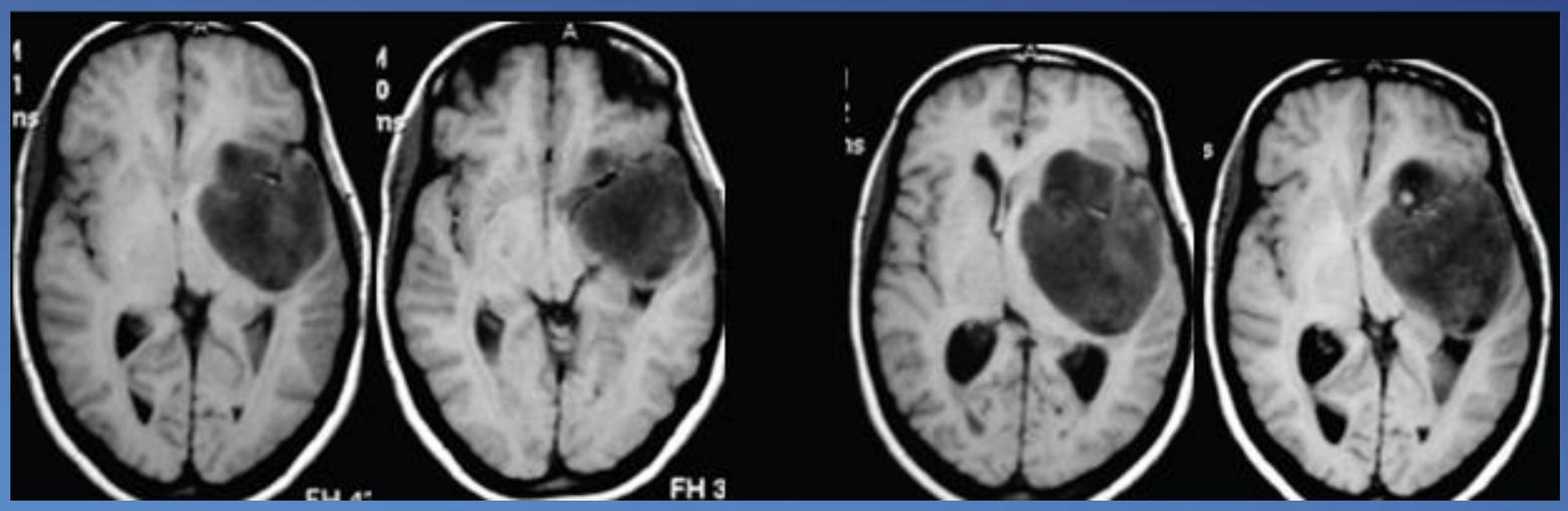
INSULAR TUMORS

- LGG. F. 28.
  Left Insular.

September 2005 **June 2006**



November 2006 **Abril 2007**

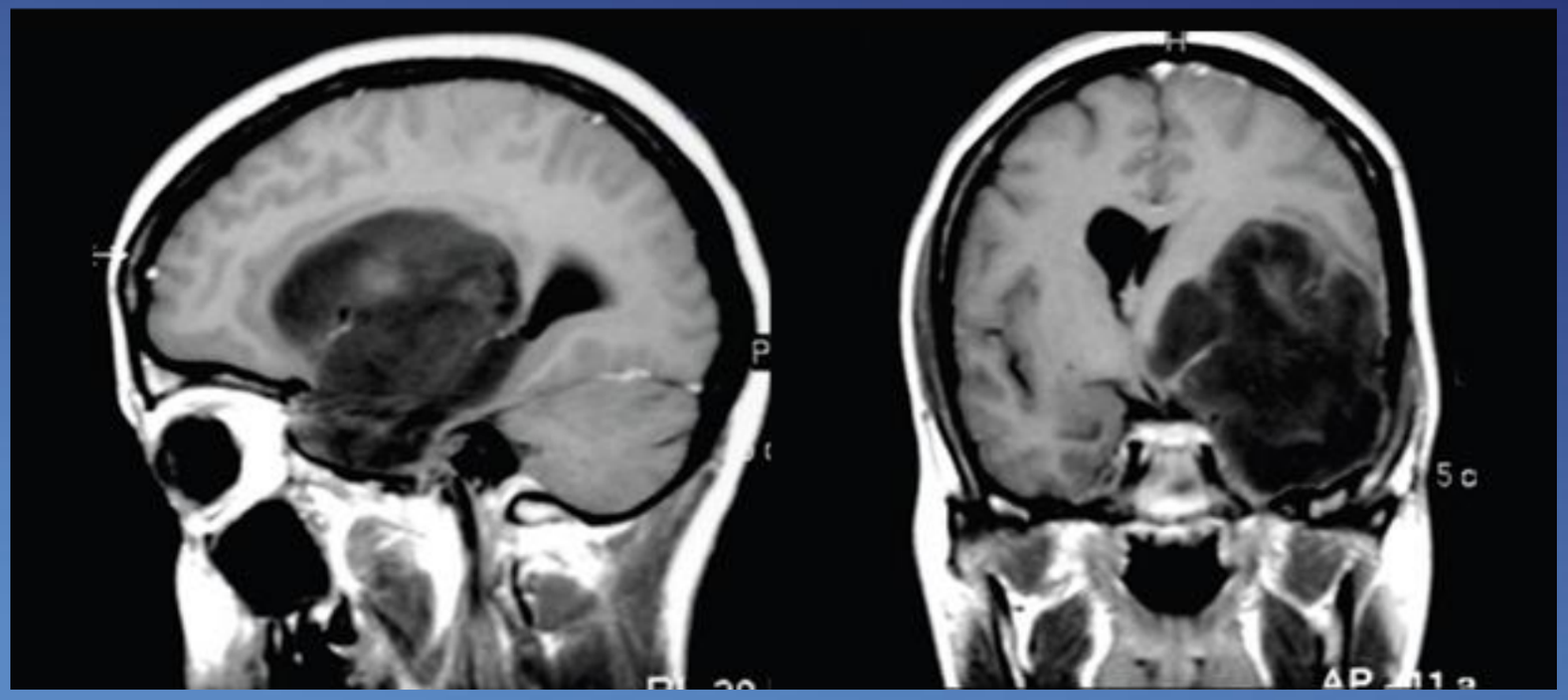


INSULAR TUMORS

- **LGG**, should not just be watched because they are growing while we are watching them.

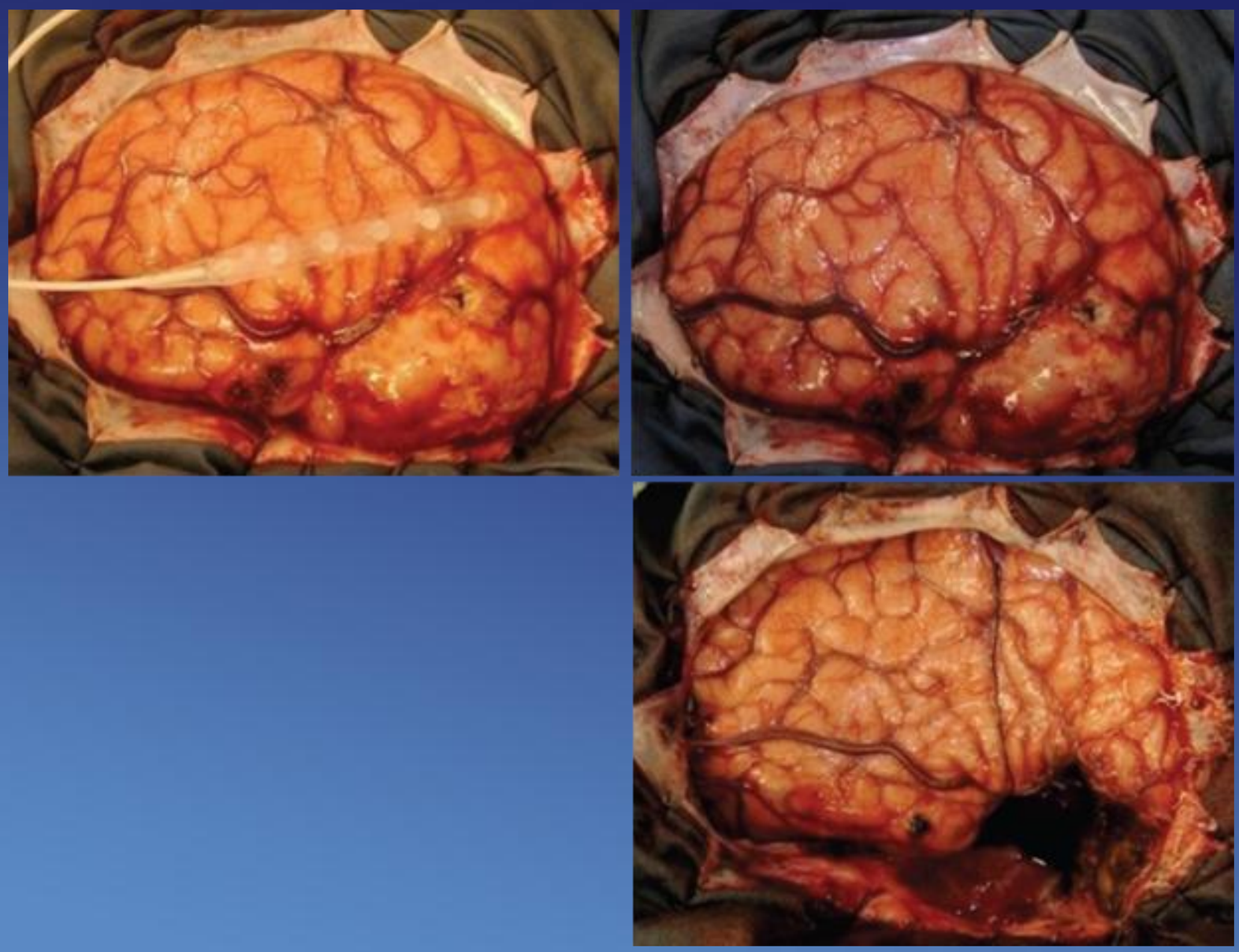
February 2005

November 2008



INSULAR TUMORS

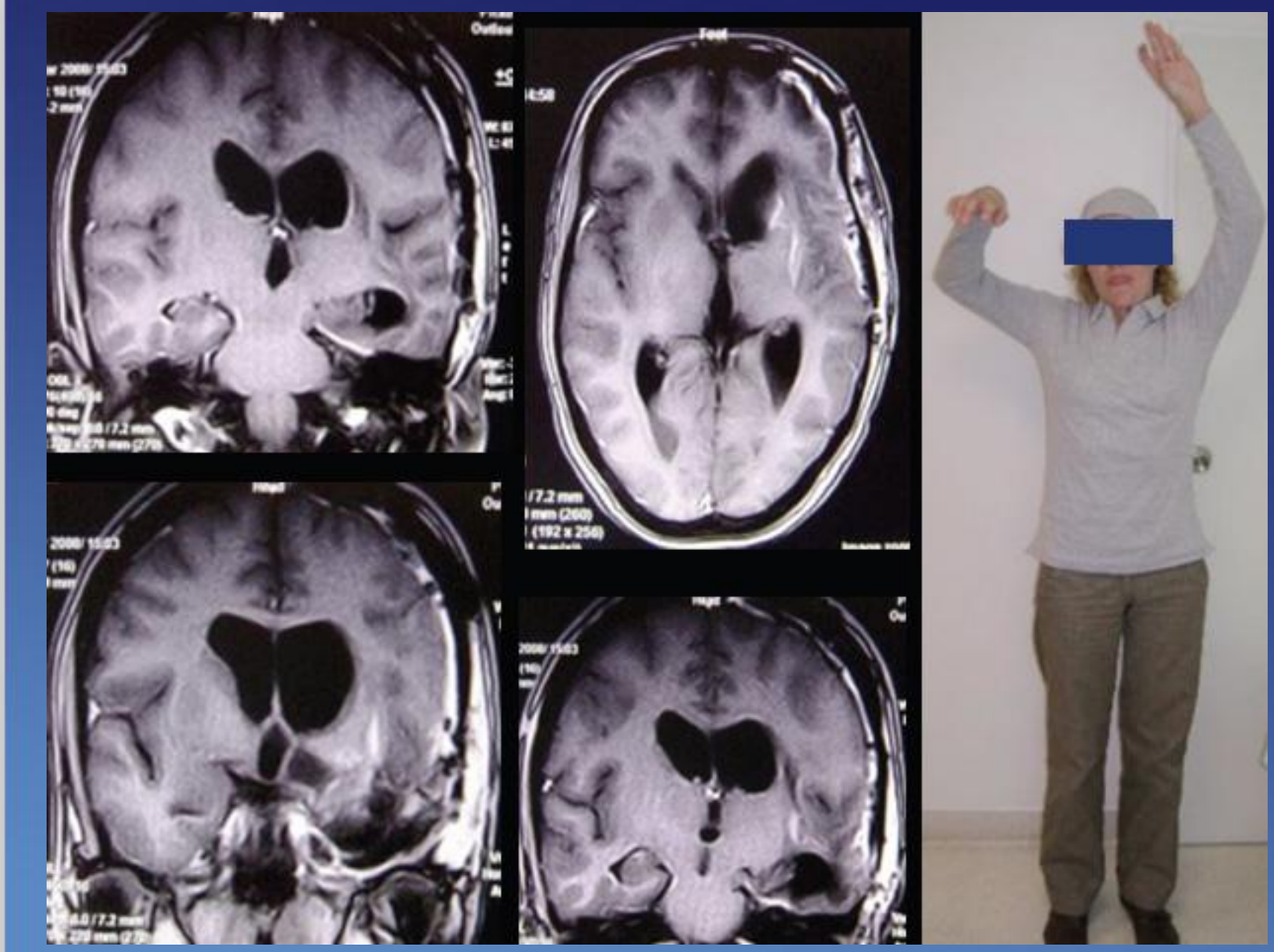
- February **2008**



FEBRUARY 2008

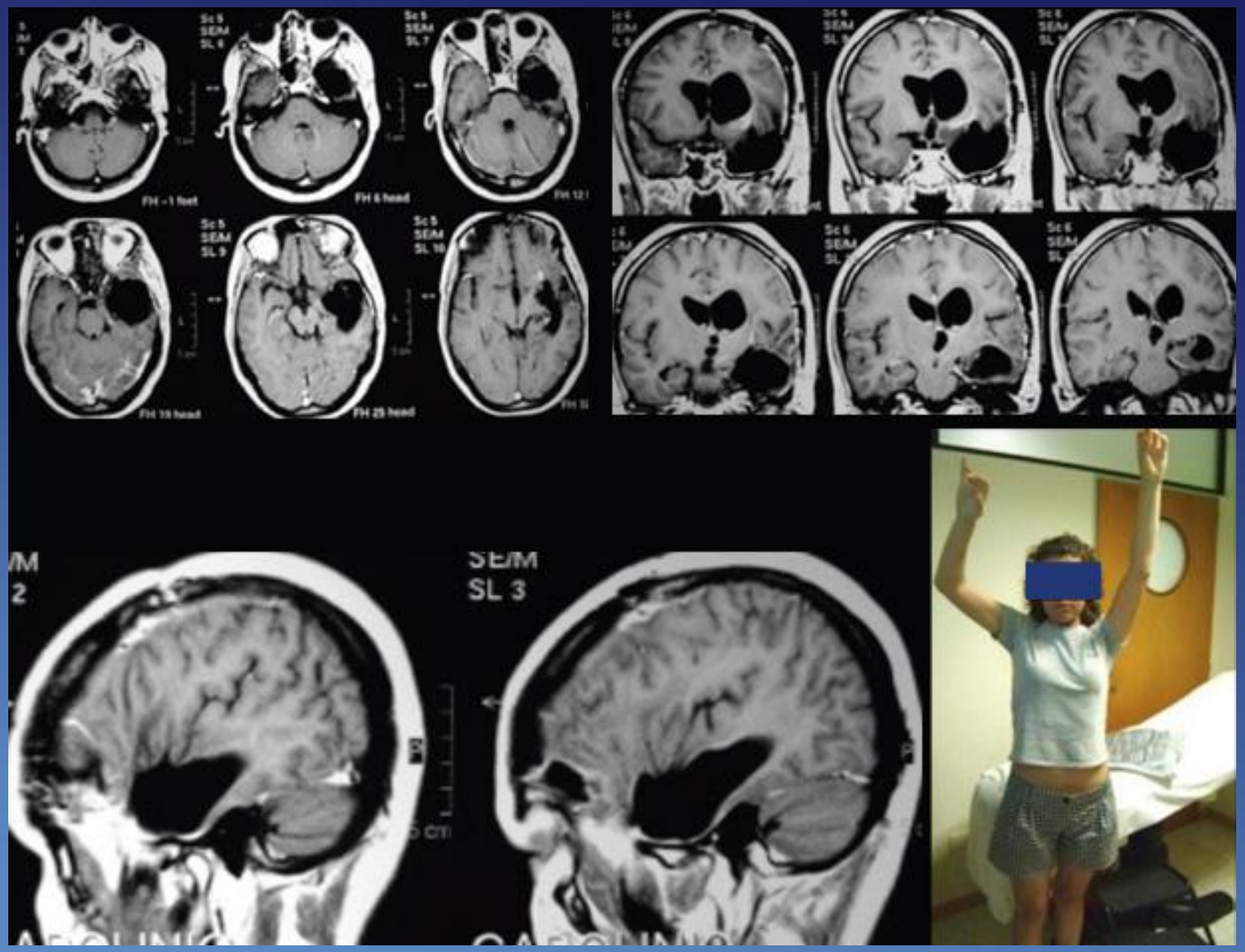
INSULAR TUMORS

- **1** month Post-Operative.



INSULAR TUMORS

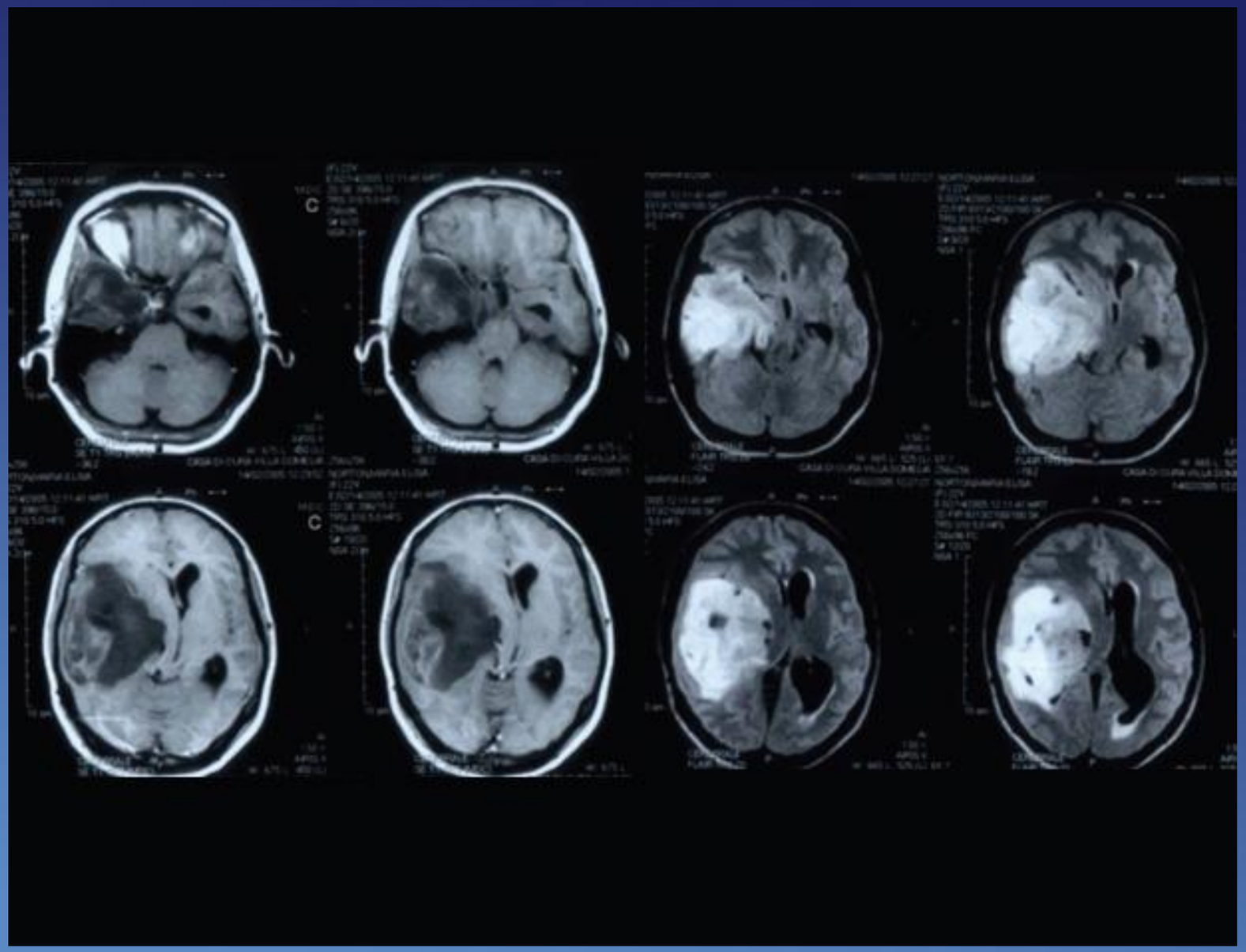
- **3** years Post-Opeartive.



INSULAR TUMORS

- Fem. 22 Years Old.

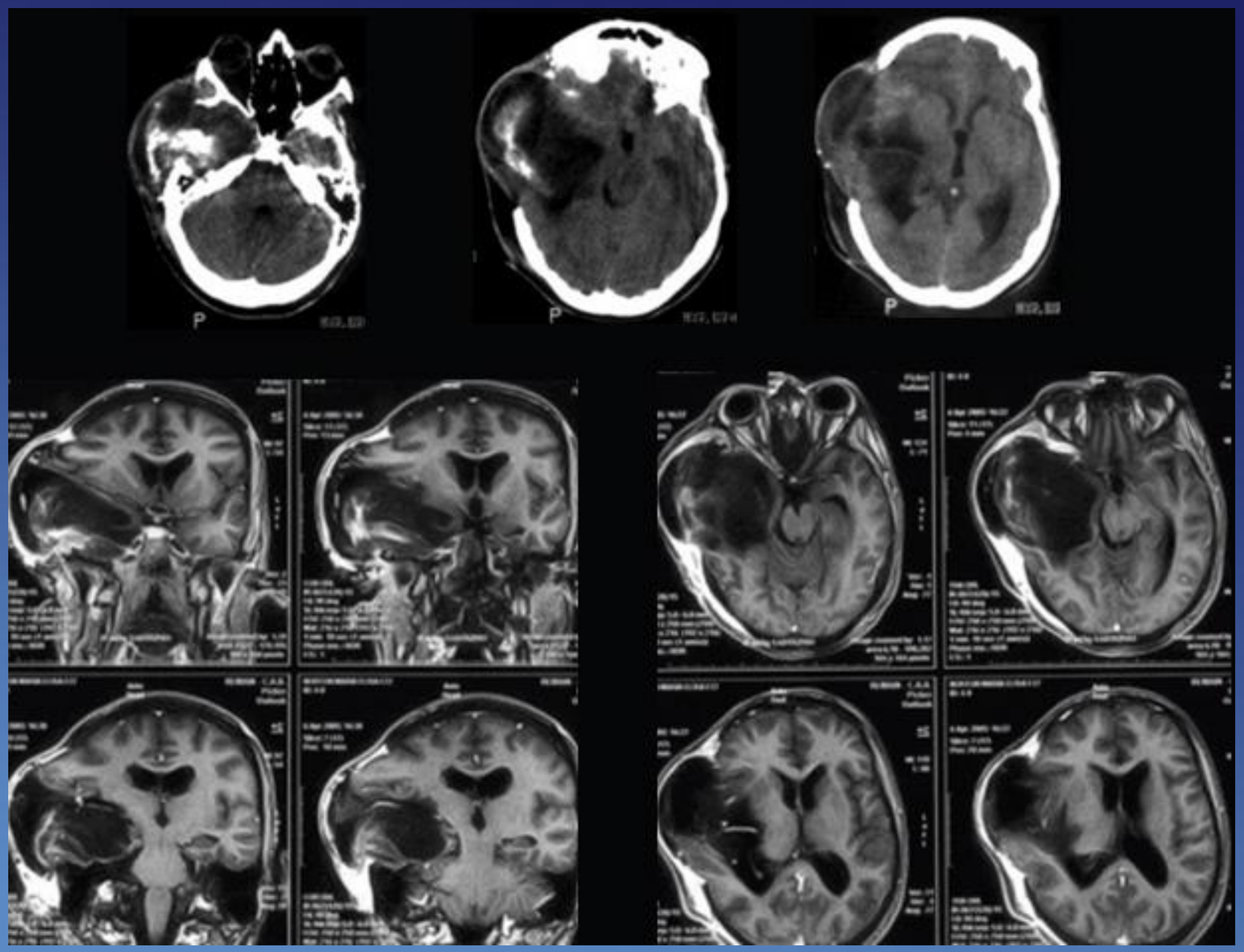
  Oligodendroglioma.



INSULAR TUMORS

- Decompressive Craniectomy in her city.

April 2005



APRIL 2005

INSULAR TUMORS

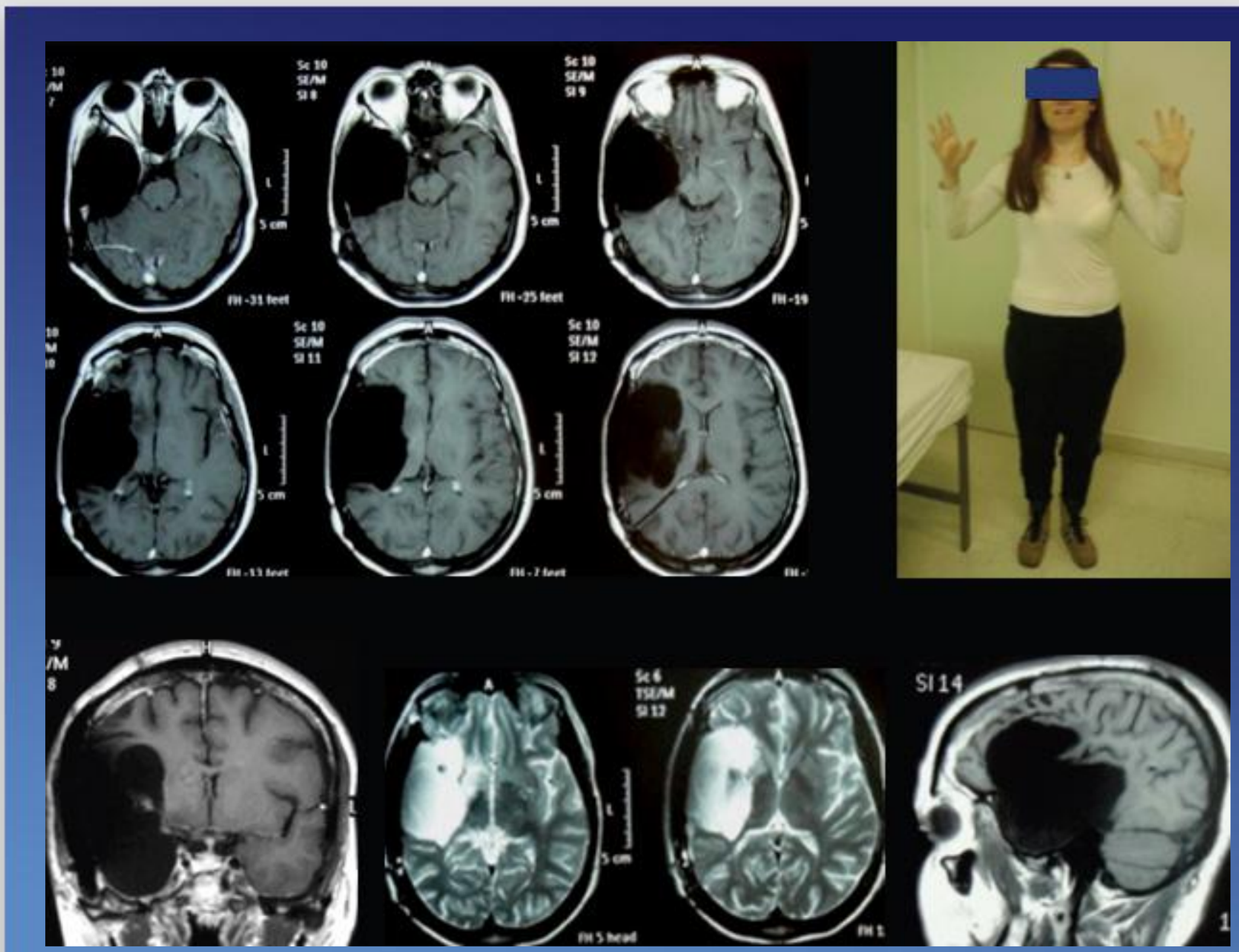
- Intraoperative **MRI** surgery.

May 2005

MAY 2005

INSULAR TUMORS

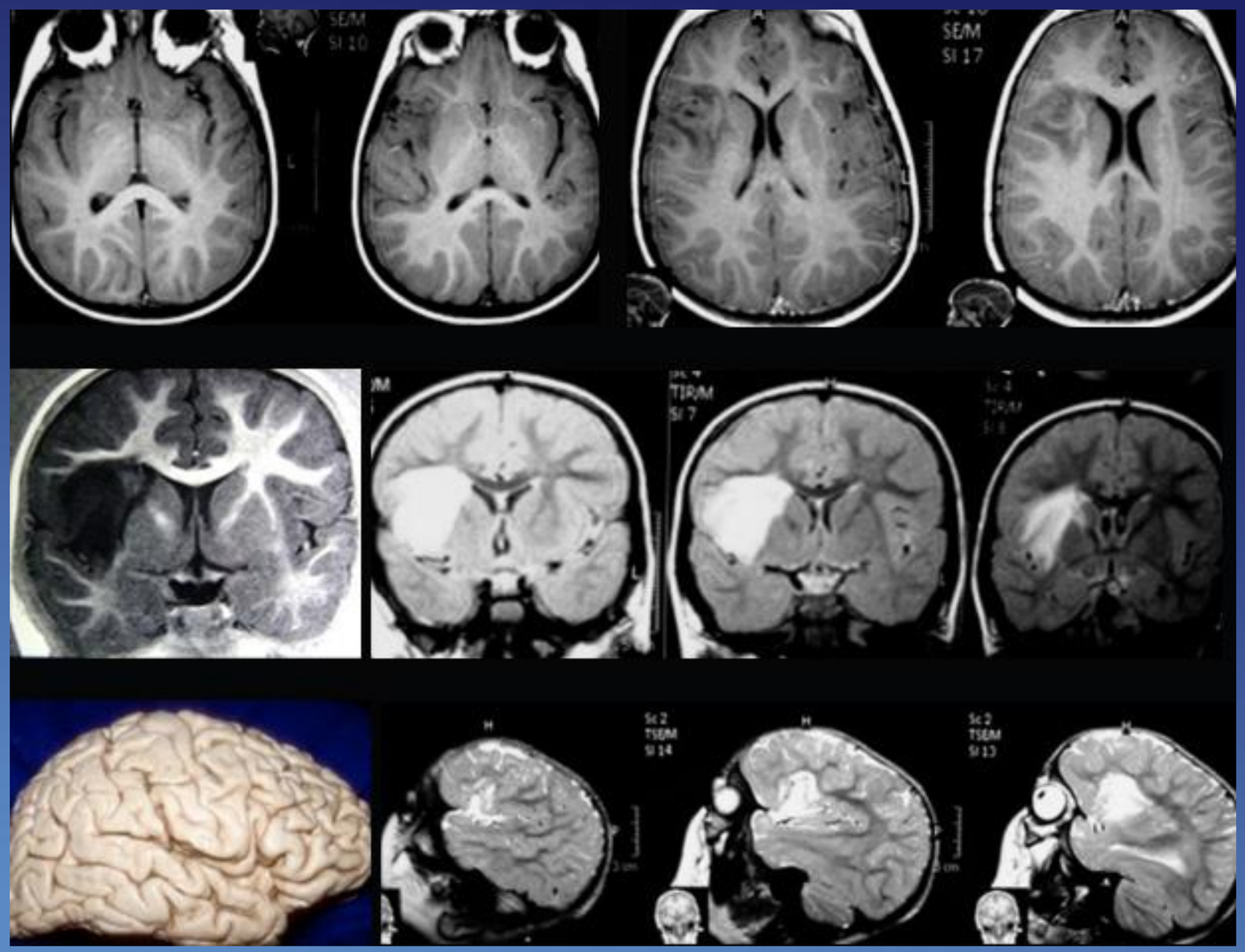
- **July 2010**



JULY 2010

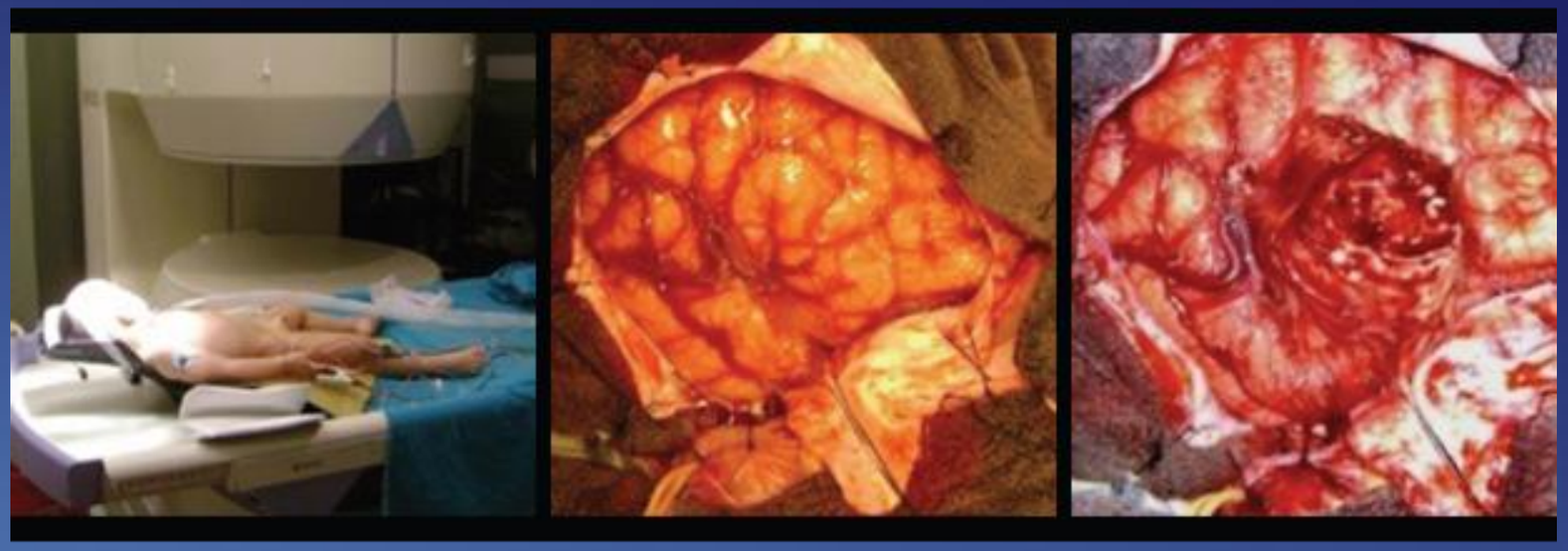
INSULAR TUMORS

- This is another typical Insular Glioma in a little boy.

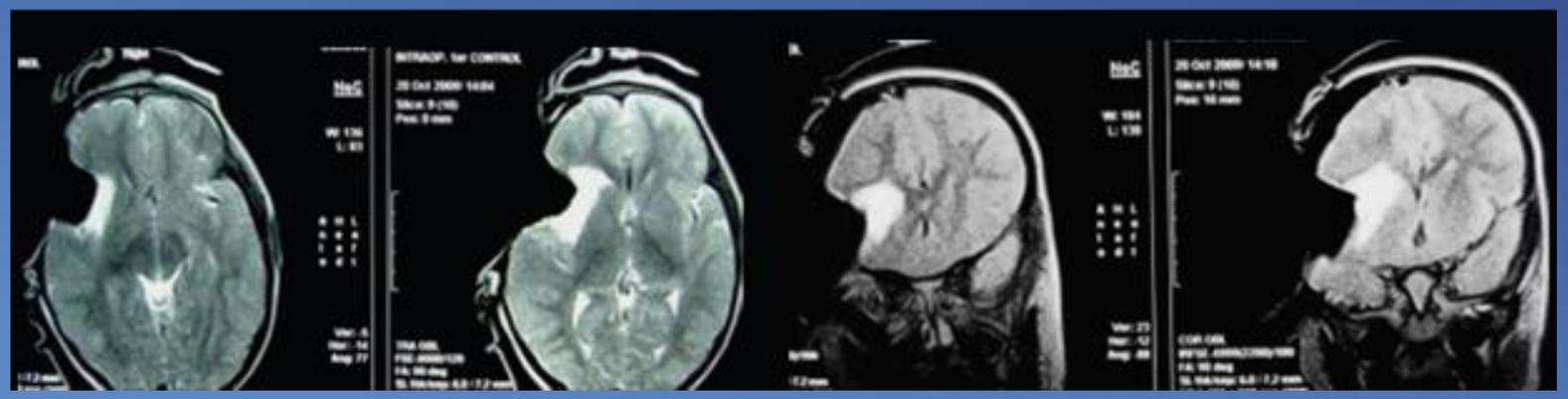


INSULAR TUMORS

- **3** years old boy. LGG



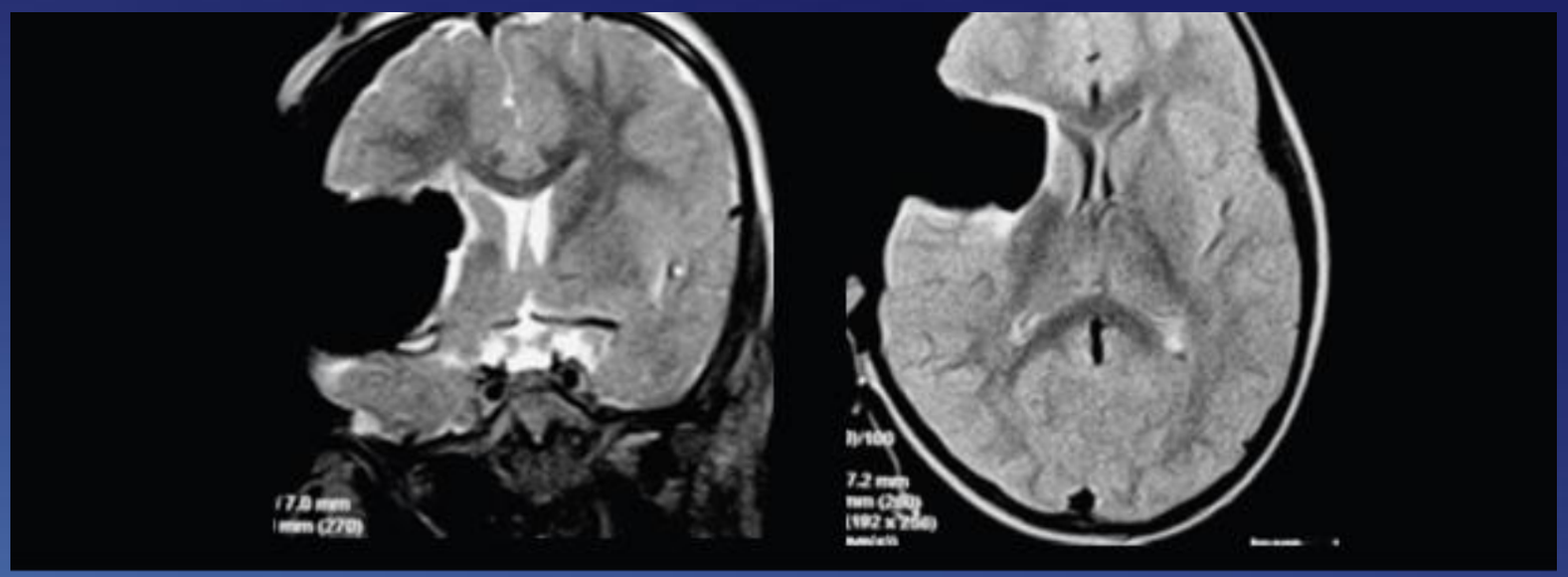
- Intraoperative **MRI**.



INSULAR TUMORS

- M. 3 **LGG.**

  Intraoperative imaging.
  Complete tumor removal.



HIGH GRADE GLIOMAS

CLINICA ADVENTISTA BELGRANO

DR. ROBERTO R. **HERRERA** AND COLLABORATORS

BUENOS AIRES //
ARGENTINA //

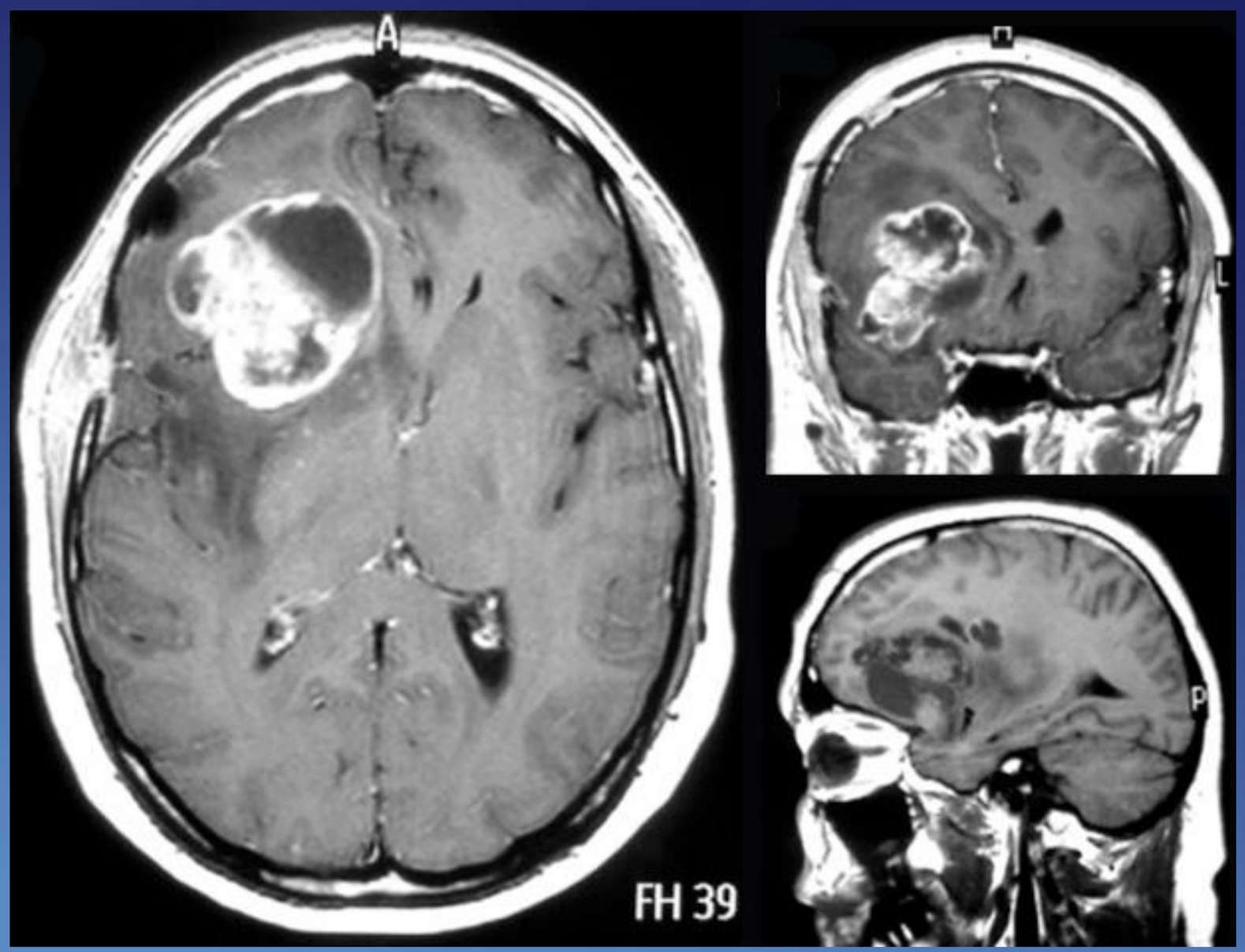
iMRI “ ADVANTAGE”

iMRI completes the possibility of neurosurgeons to see beyond even what can be seen through the microscope. This is an important issue, principally on brain glioma surgeries, where the physician wants to achieve GTR. Greater tumoral cytoreduction is always a favorable factor in quality and quantity of survival, even in trials evaluating chemotherapy and/or radiotherapy schedules.

Survival of patients is correlated to the extension of tumoral resection.

HIGH GRADE GLIOMAS

- M. 82 years old.
  G.B.M.

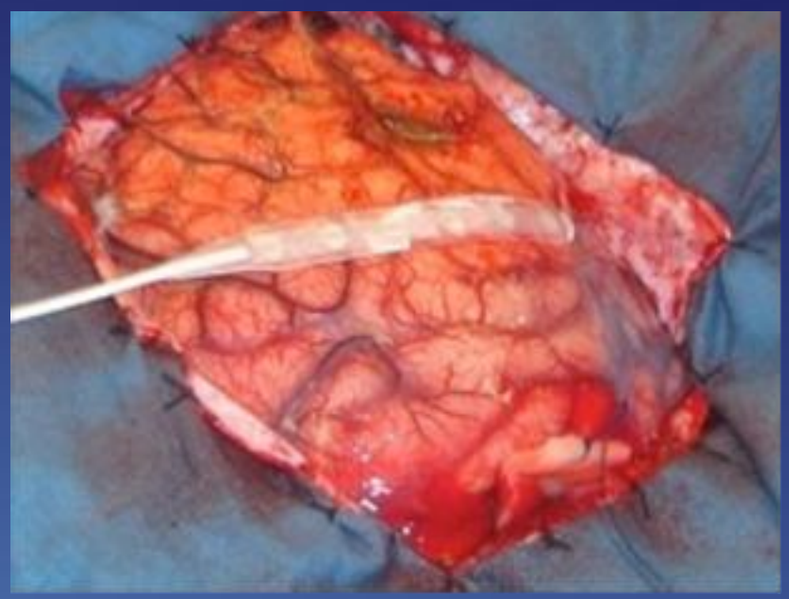


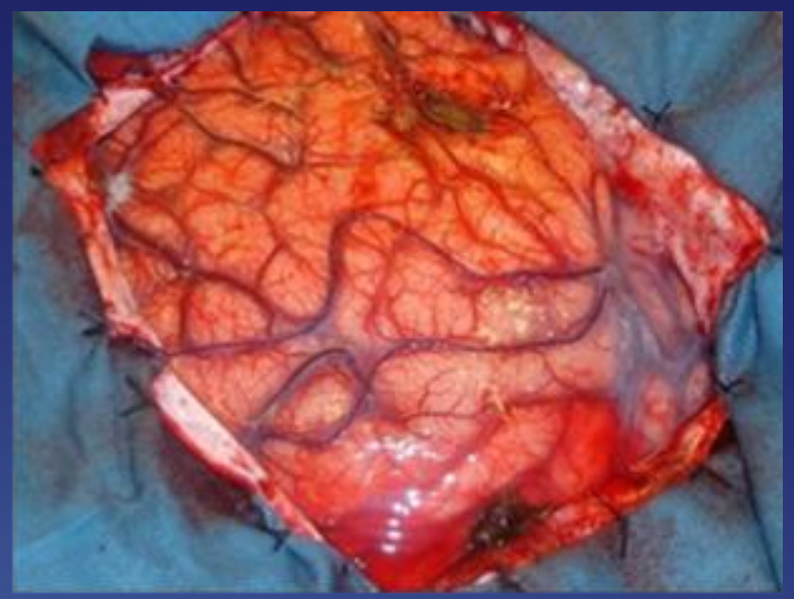
HIGH GRADE GLIOMAS

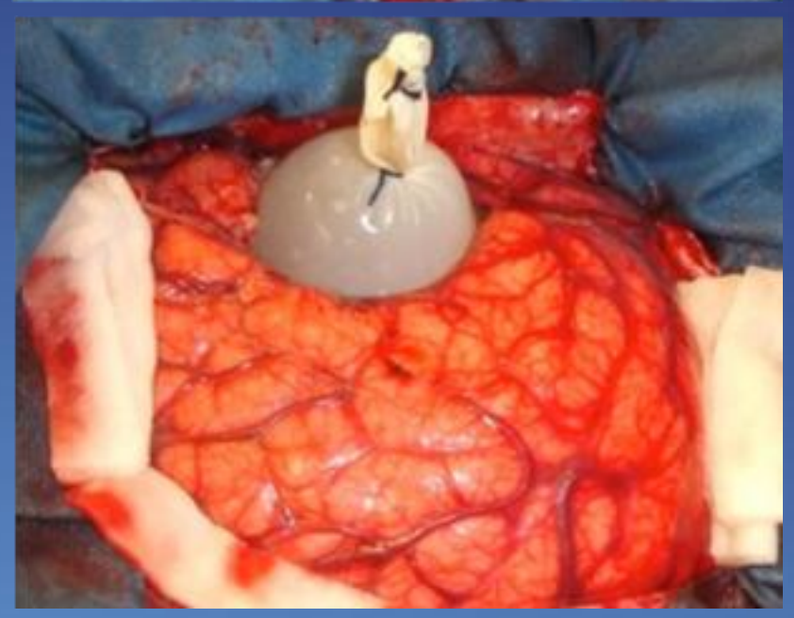
- Here we are doing Neurophysiological Monitoring.

  Locating the motor area and placing a finger glove with air before the **iMRI** control.

June 2008



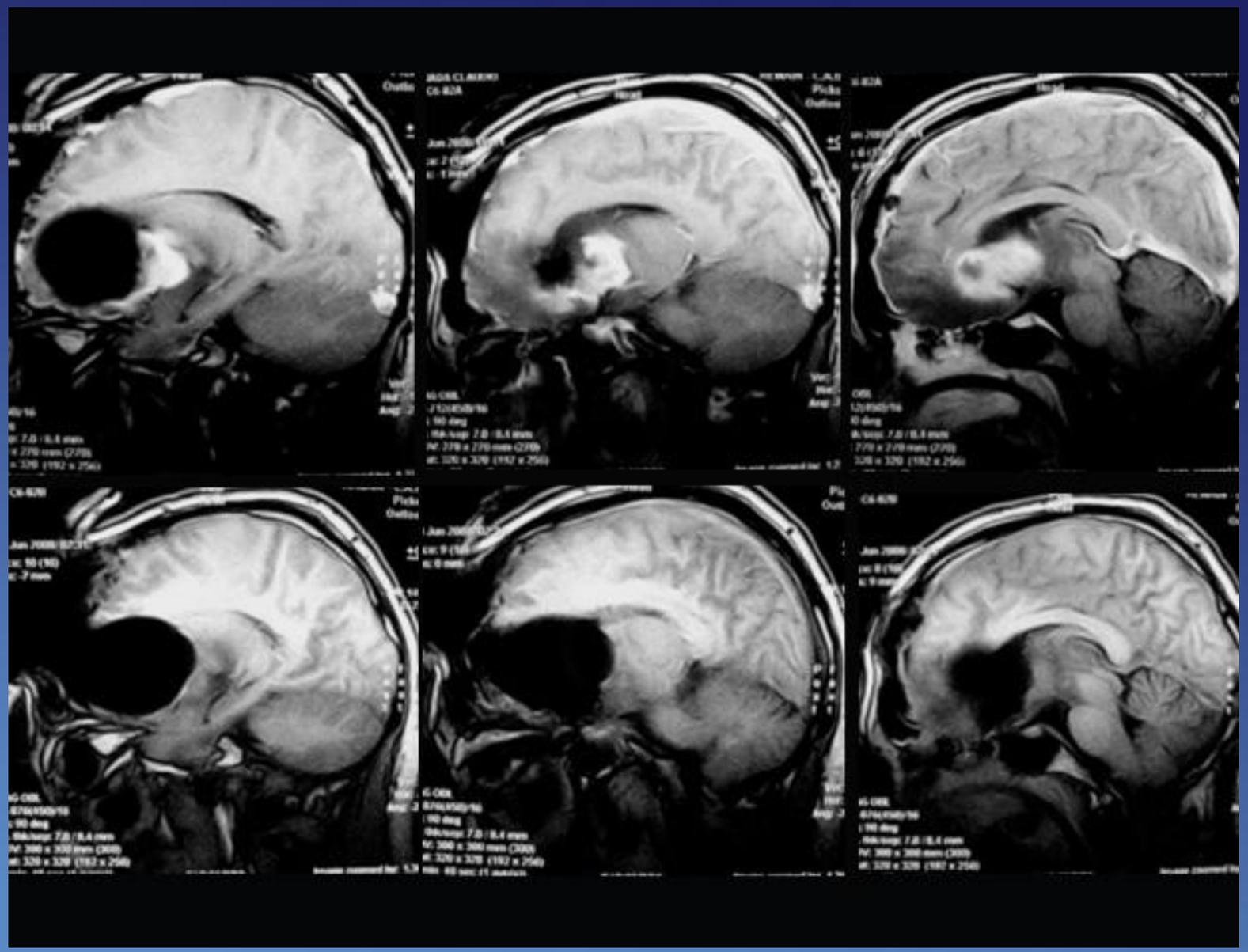




JUNE 2008

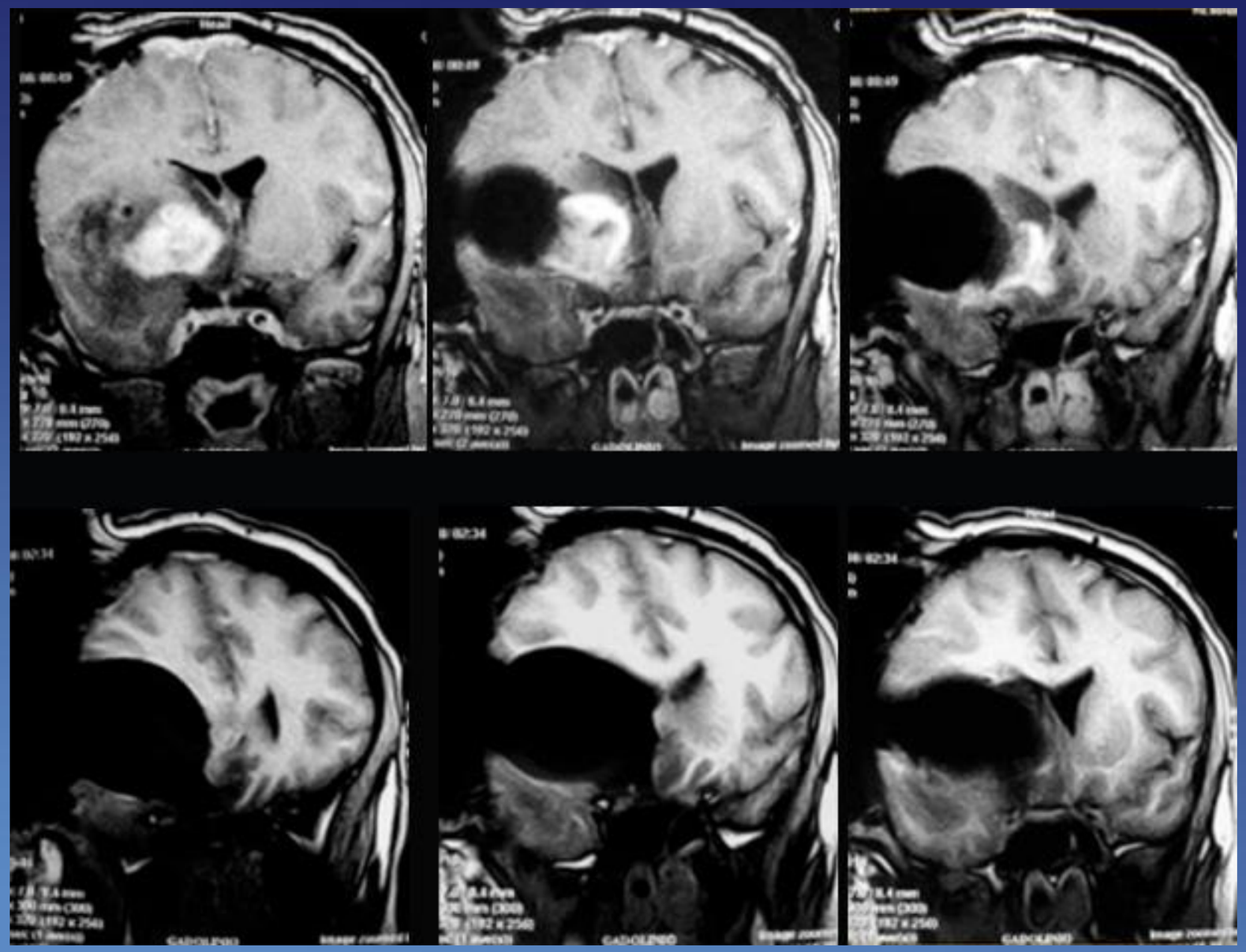
HIGH GRADE GLIOMAS

- Above we can see **iMRI** checking at the begining of the surgery and below, final **iMRI** control with **GTRs** of the tumor.



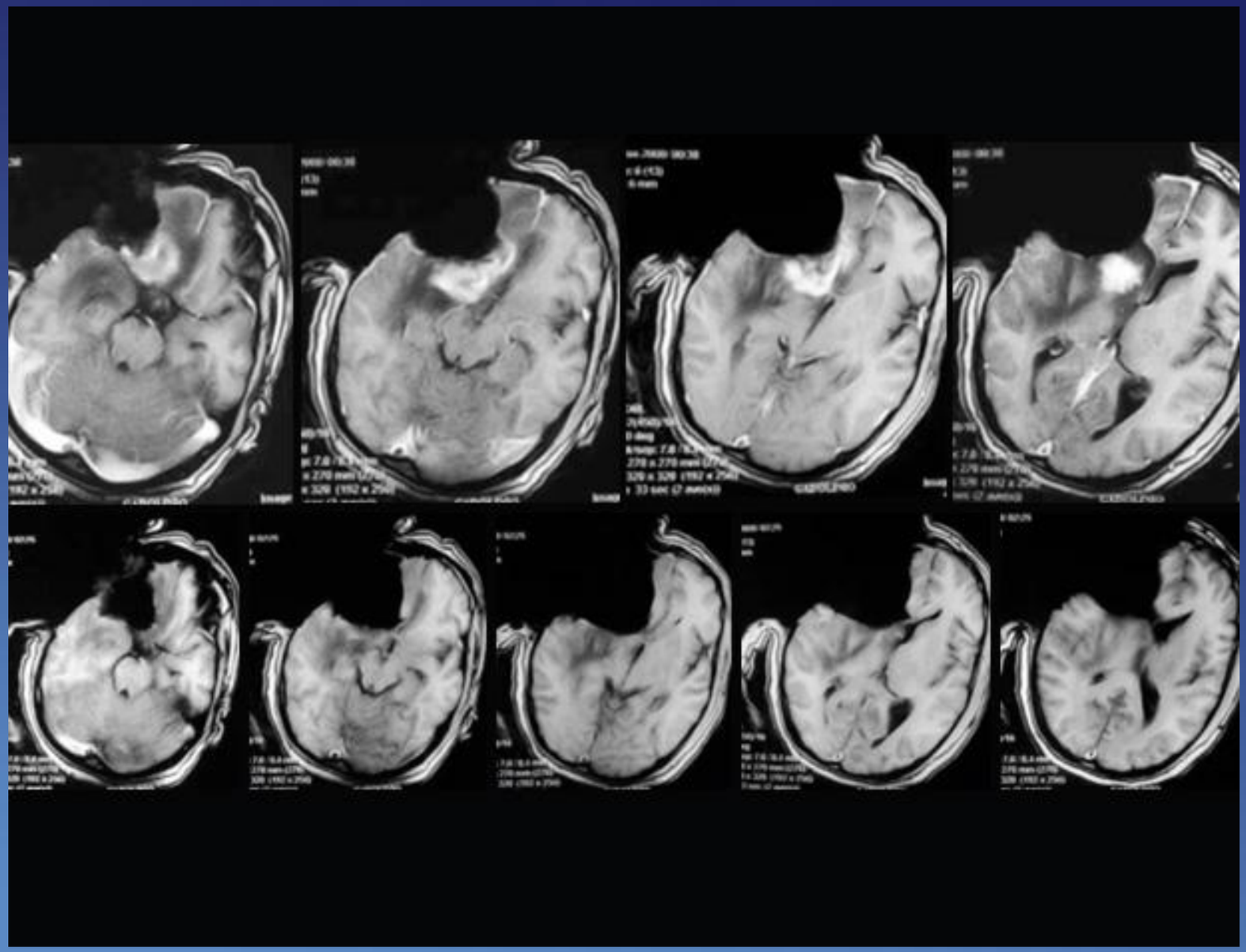
HIGH GRADE GLIOMAS

- The same in coronal series.



HIGH GRADE GLIOMAS

- The same in axial series with **GTRs**.



HIGH GRADE GLIOMAS

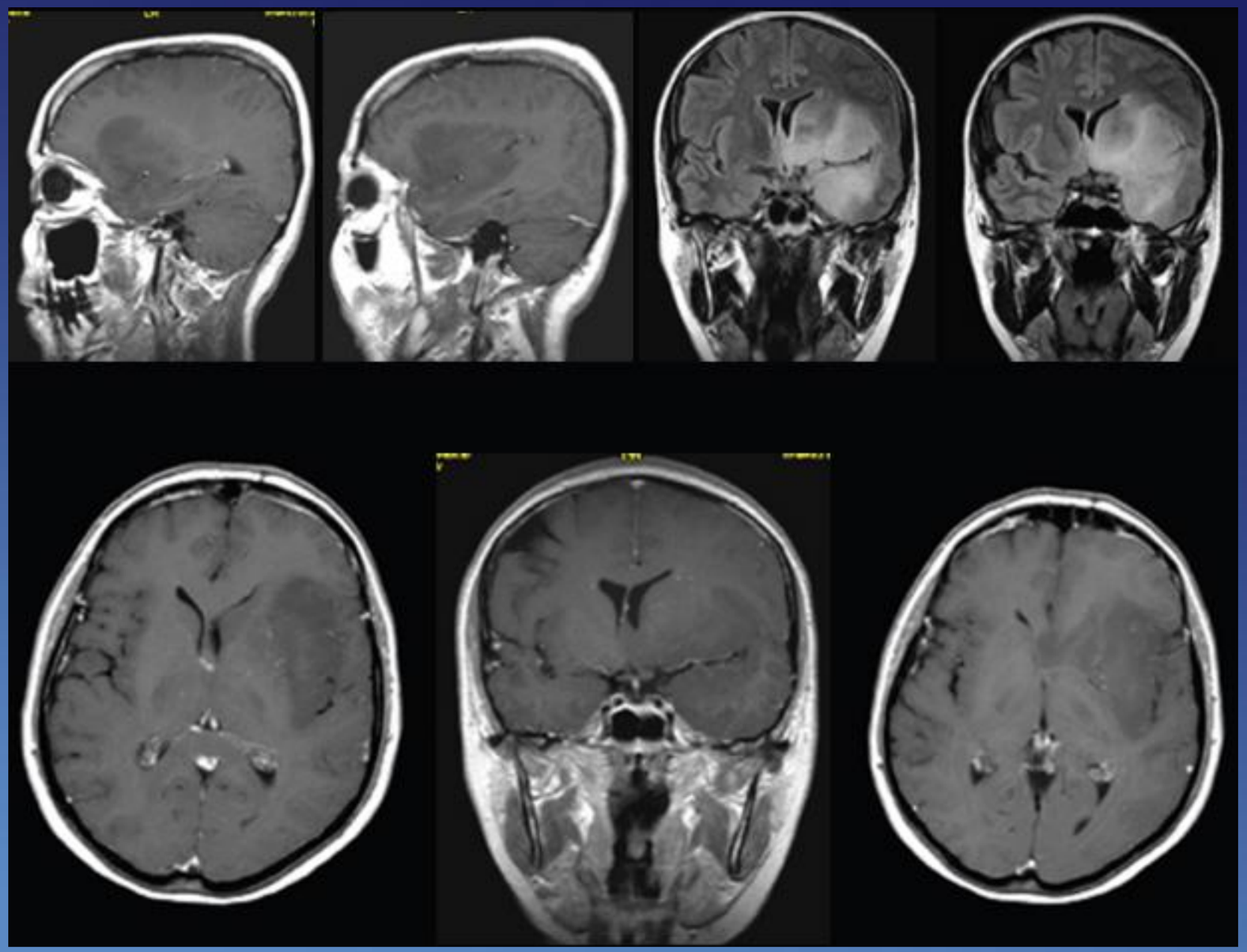
- M. 82 years old.
  G.B.M.

  21 months
  Post-Operative.

HIGH GRADE GLIOMAS

- **2007 ODG.**

  This is the case of a woman. She had this tumor in **2007**.
  It was an Oligodendroglioma.

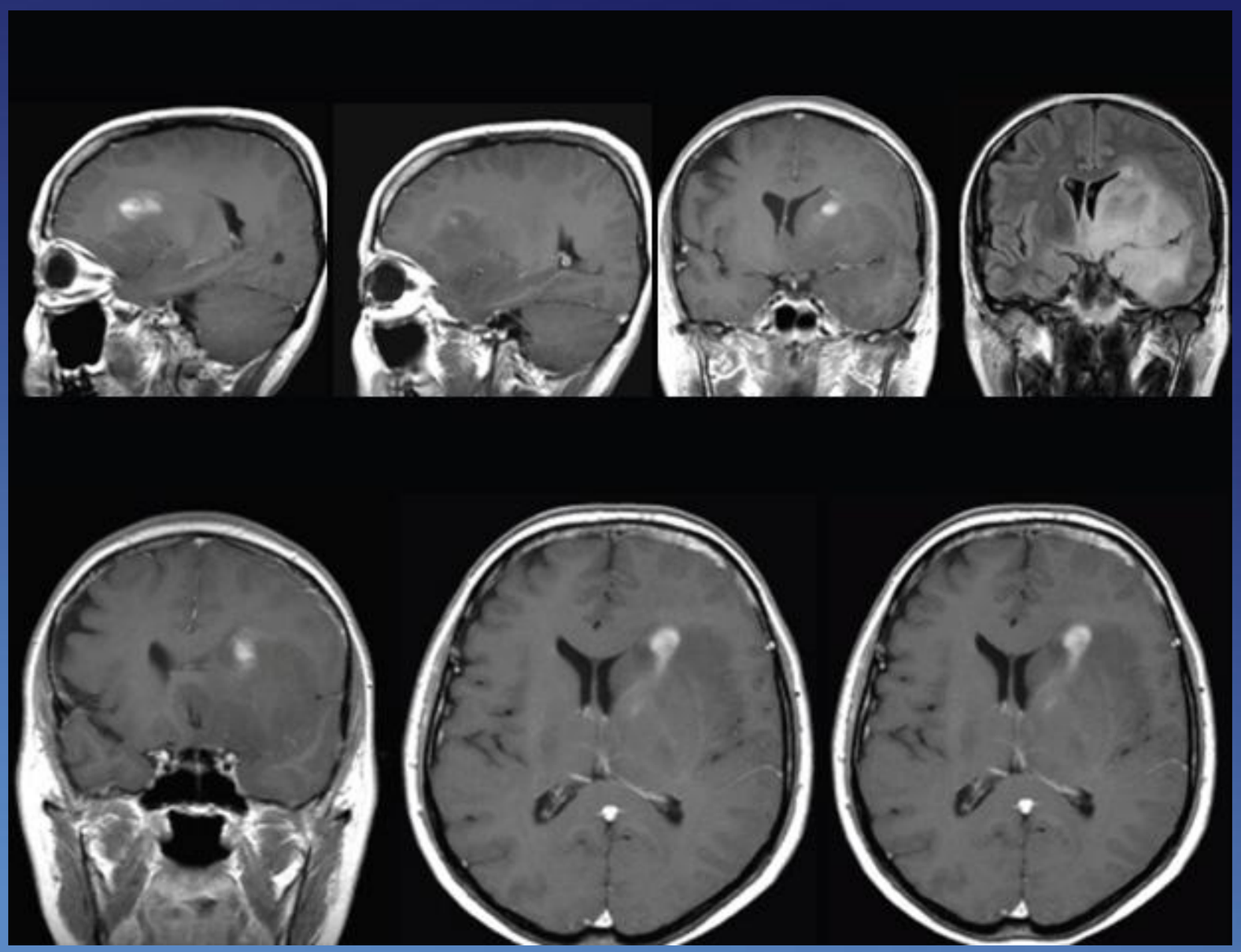


2007

HIGH GRADE GLIOMAS

- **2008 Anaplastic ODG.**

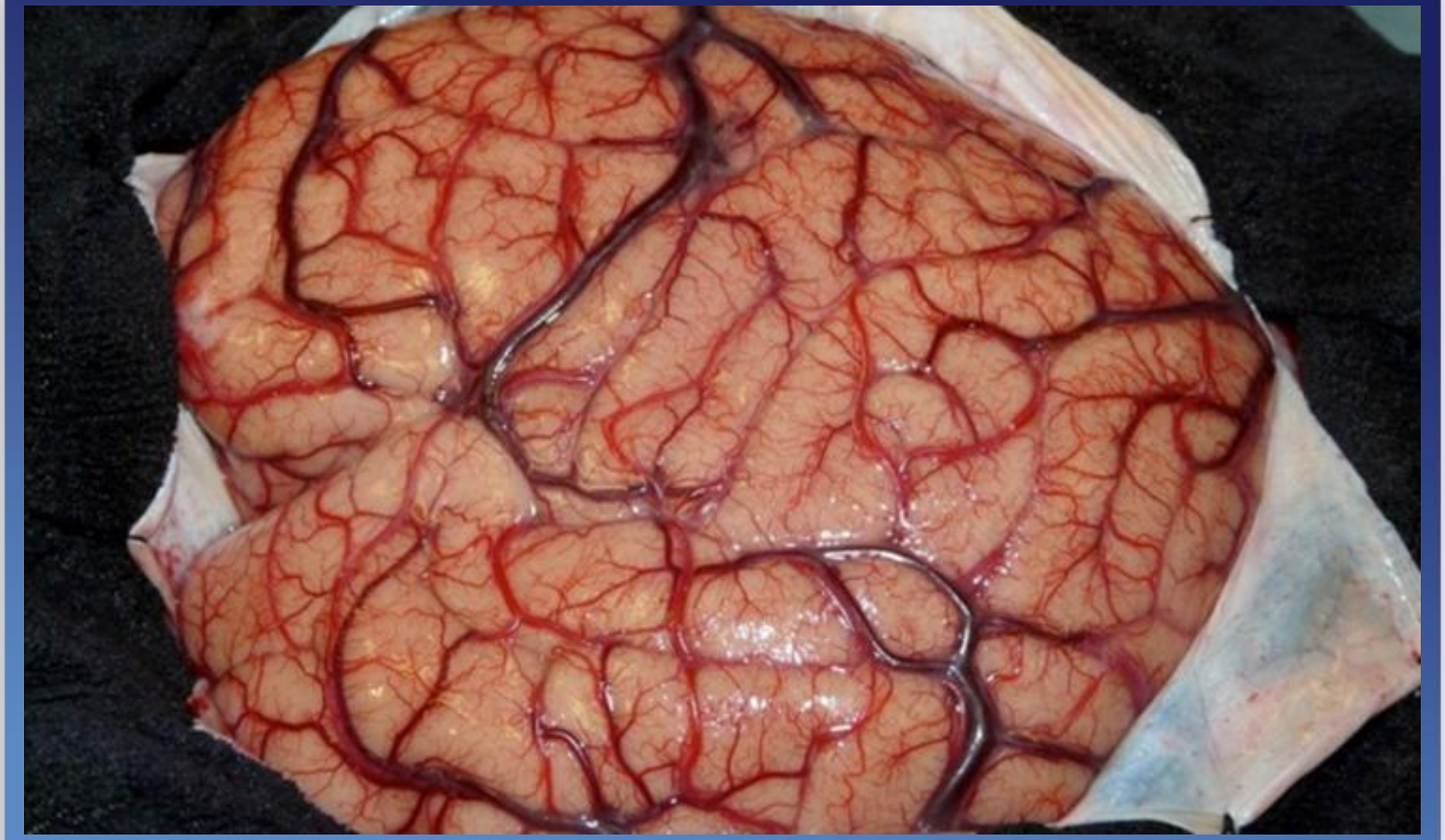
  One year later, the tumor enhanced with paramagnetic contrast and turned into a **HGG**.



2008

CLINICA ADVENTISTA BELGRANO

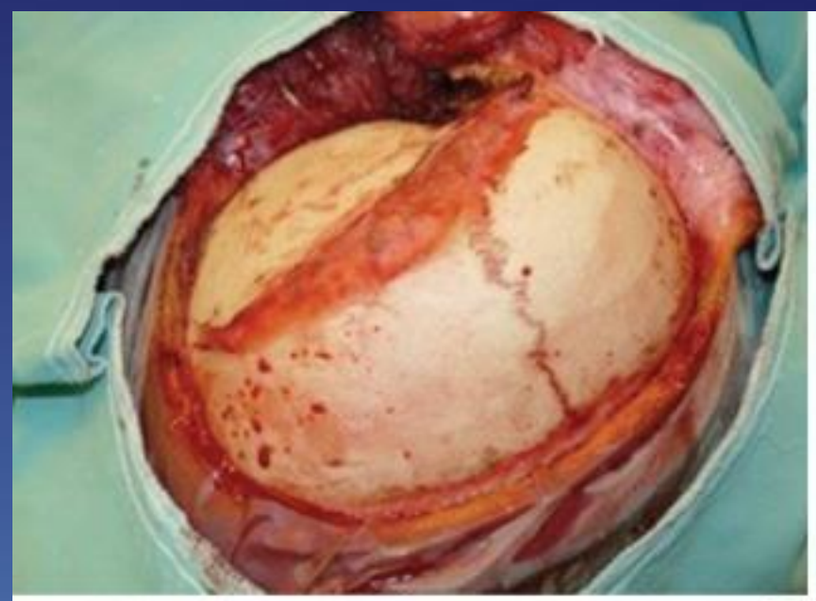
HIGH GRADE GLIOMAS



FEBRUARY 2008

HIGH GRADE GLIOMAS

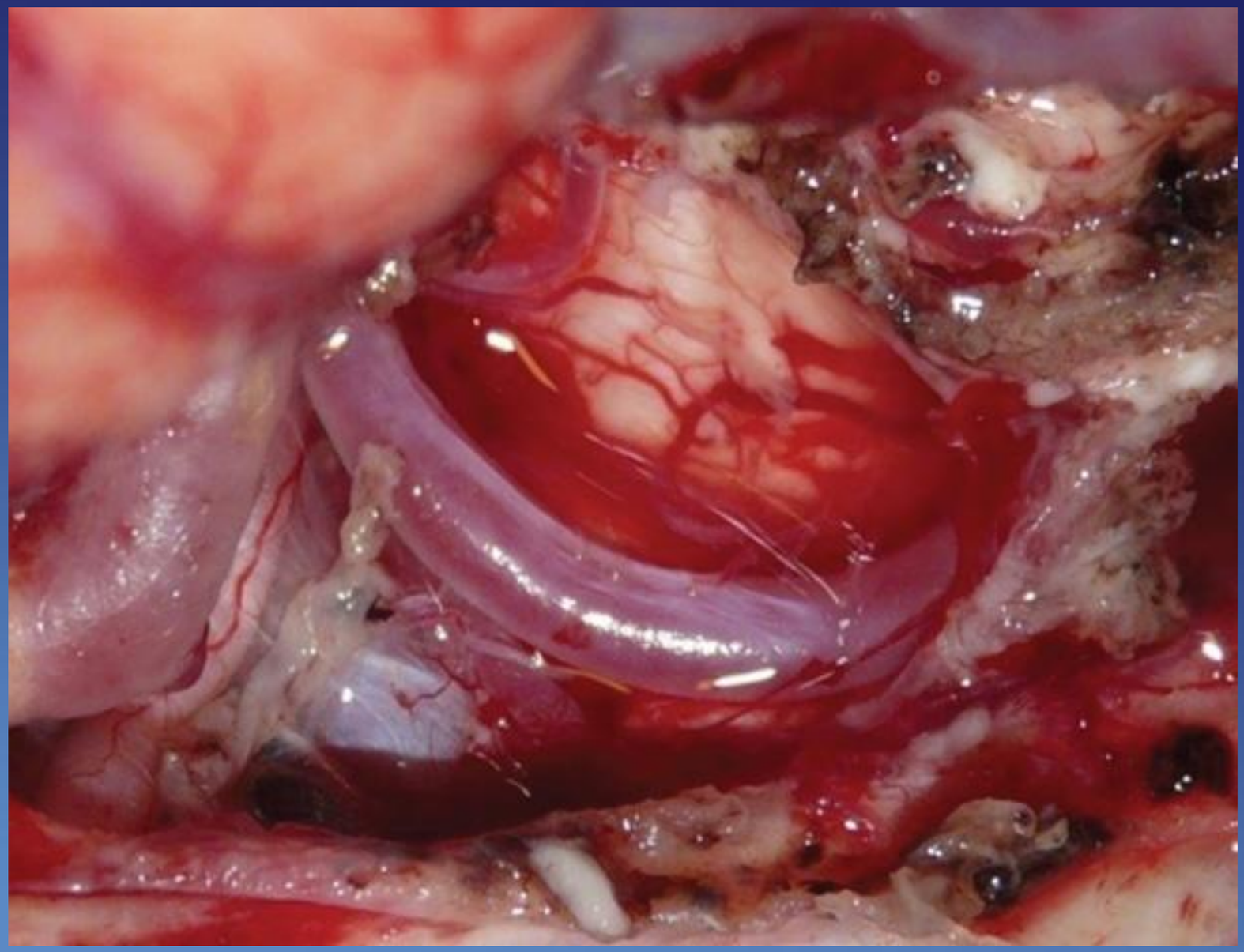
- We operated her awake and we localized the motor area with intraoperative Evoqued Potentials.



Intraoperative
Ev. Pot.

HIGH GRADE GLIOMAS

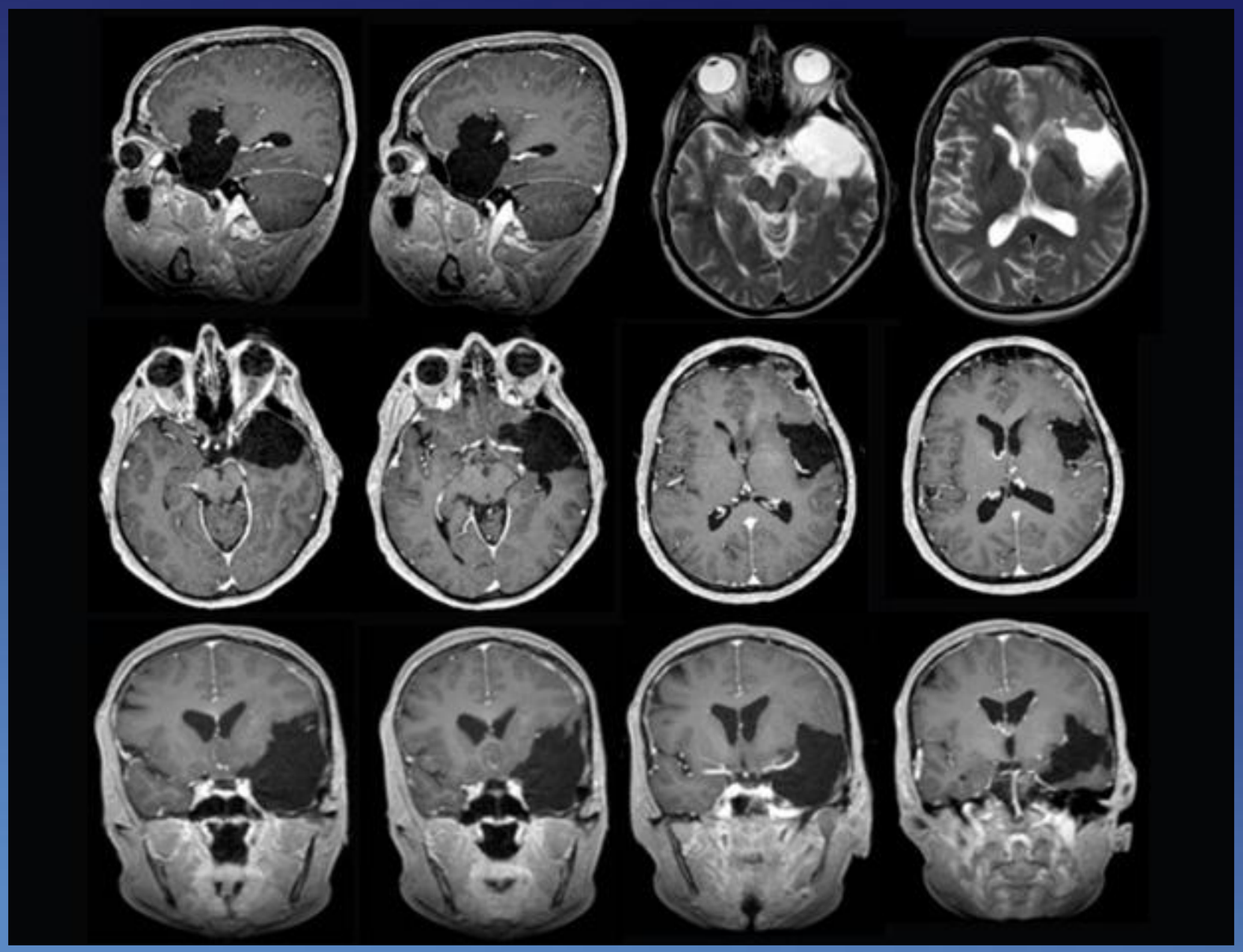
- This is the surgical bed after tumor resection with the brain stem completely free after fronto-basal and temporal lobe removal.



HIGH GRADE GLIOMAS

- The post operative **MRI** control 28 month after surgery.

June 2010

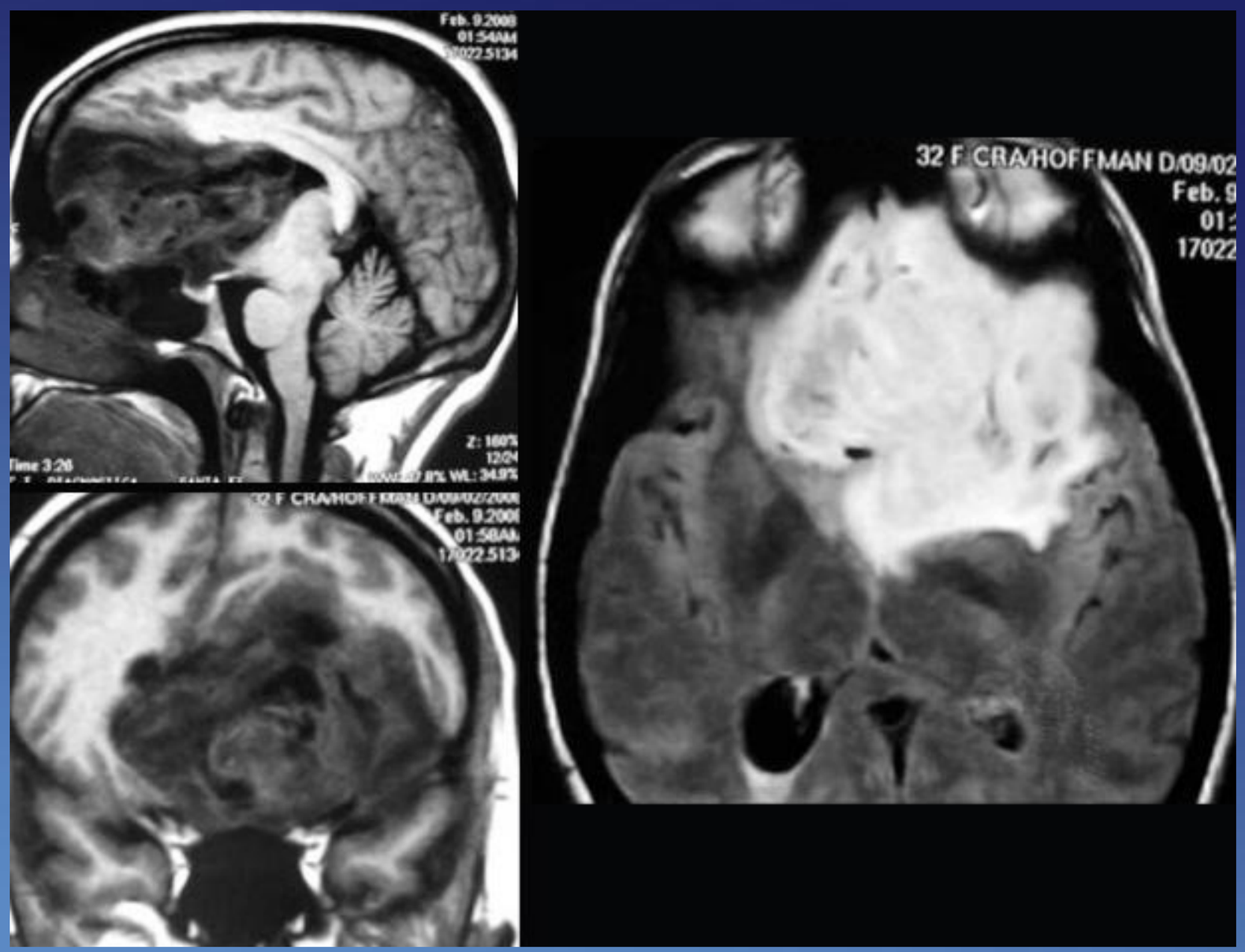


JUNE 2010

HIGH GRADE GLIOMAS

- Anaplastic Oligodendroastrocytoma.

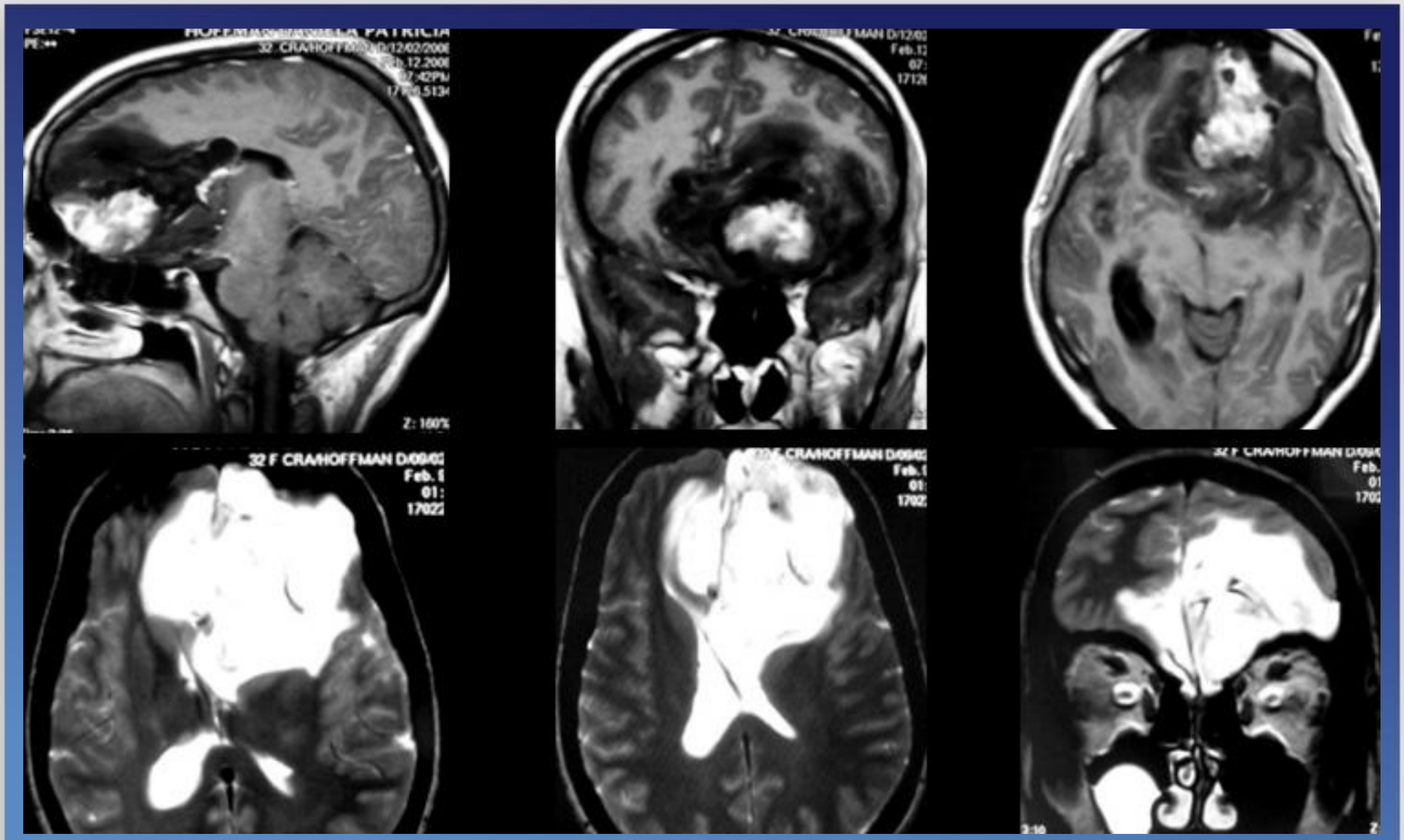
February 2008



FEBRUARY 2008

CLINICA ADVENTISTA BELGRANO

HIGH GRADE GLIOMAS



FEBRUARY 2008

CLINICA ADVENTISTA BELGRANO

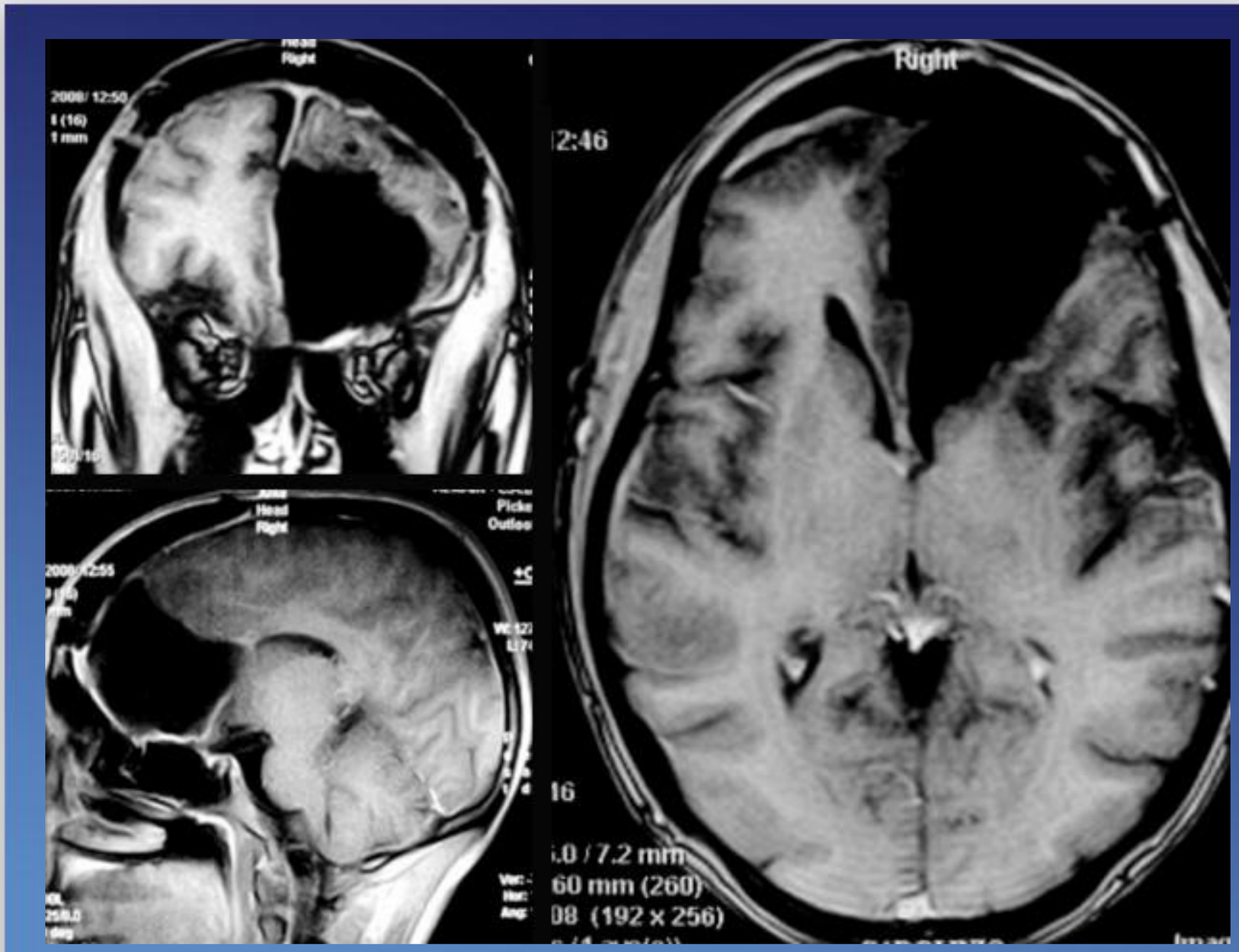
HIGH GRADE GLIOMAS

FEBRUARY 2008

HIGH GRADE GLIOMAS

- **October 2008**

  MRI Post-Operative.



OCTOBER 2008

HIGH GRADE GLIOMAS

- **October 2008**

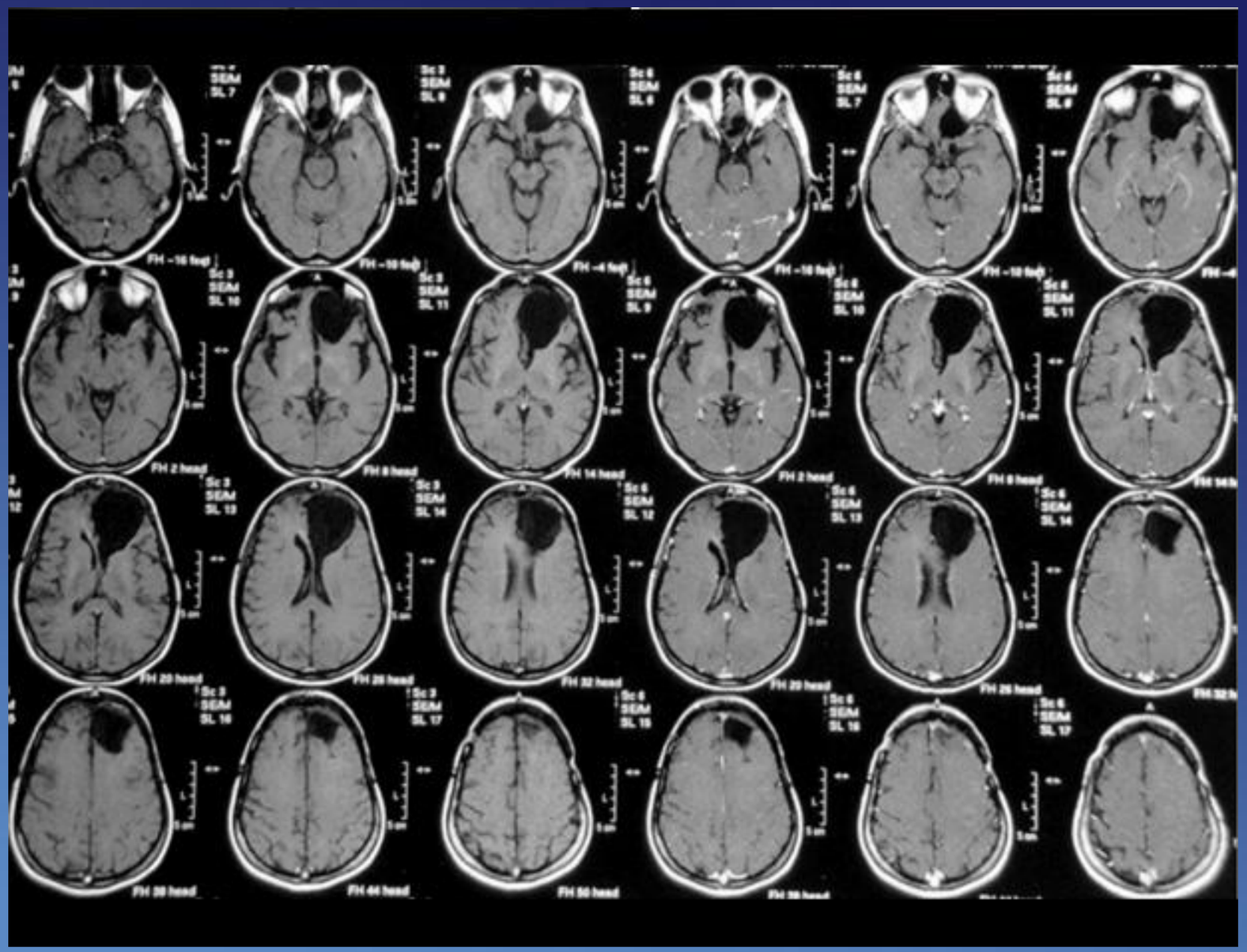
  Post-Operative.

OCTOBER 2008

HIGH GRADE GLIOMAS

- **June 2010**

  Complete tumor removal.

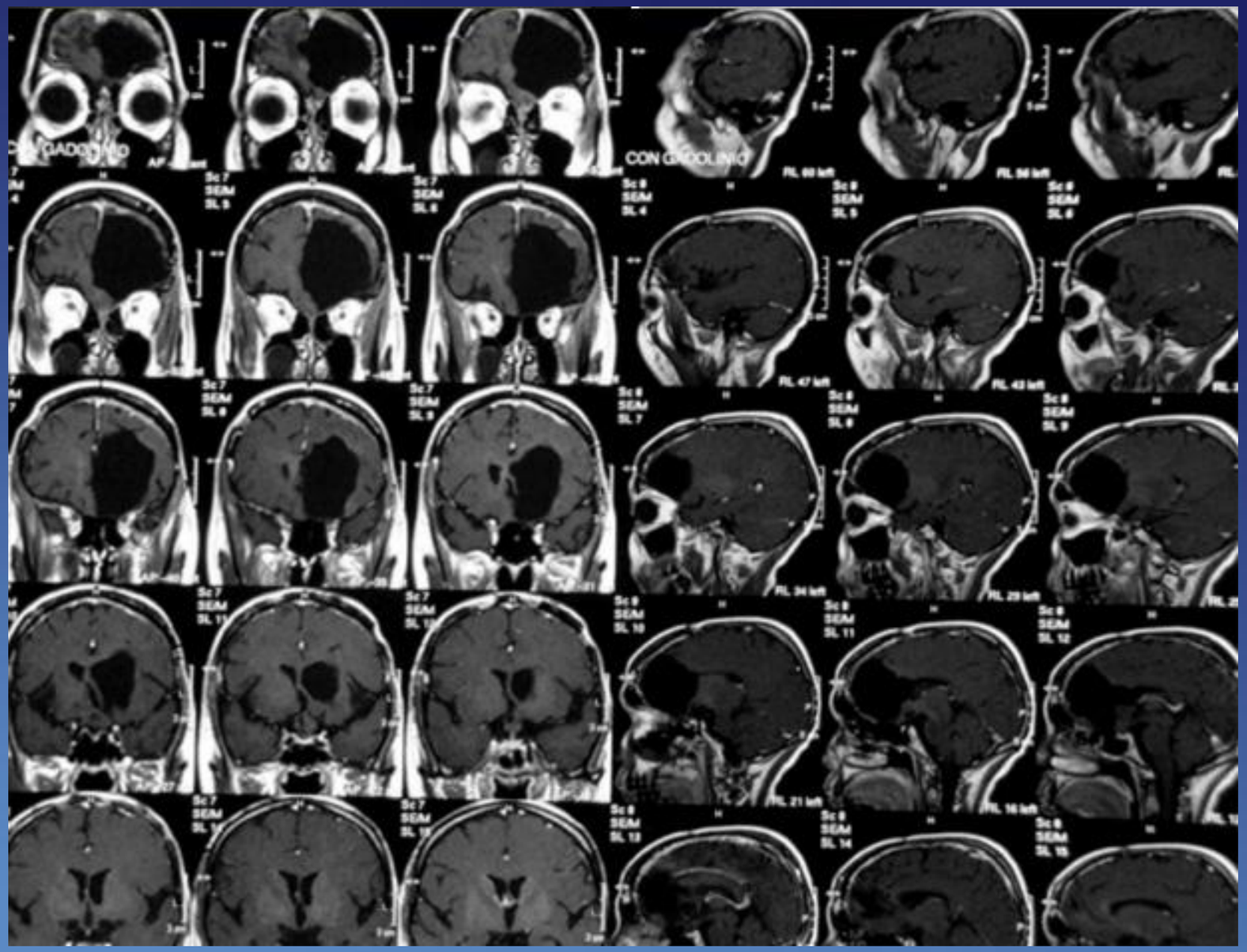


JUNE 2010

HIGH GRADE GLIOMAS

- **June 2010**

  Complete tumor removal.



JUNE 2010

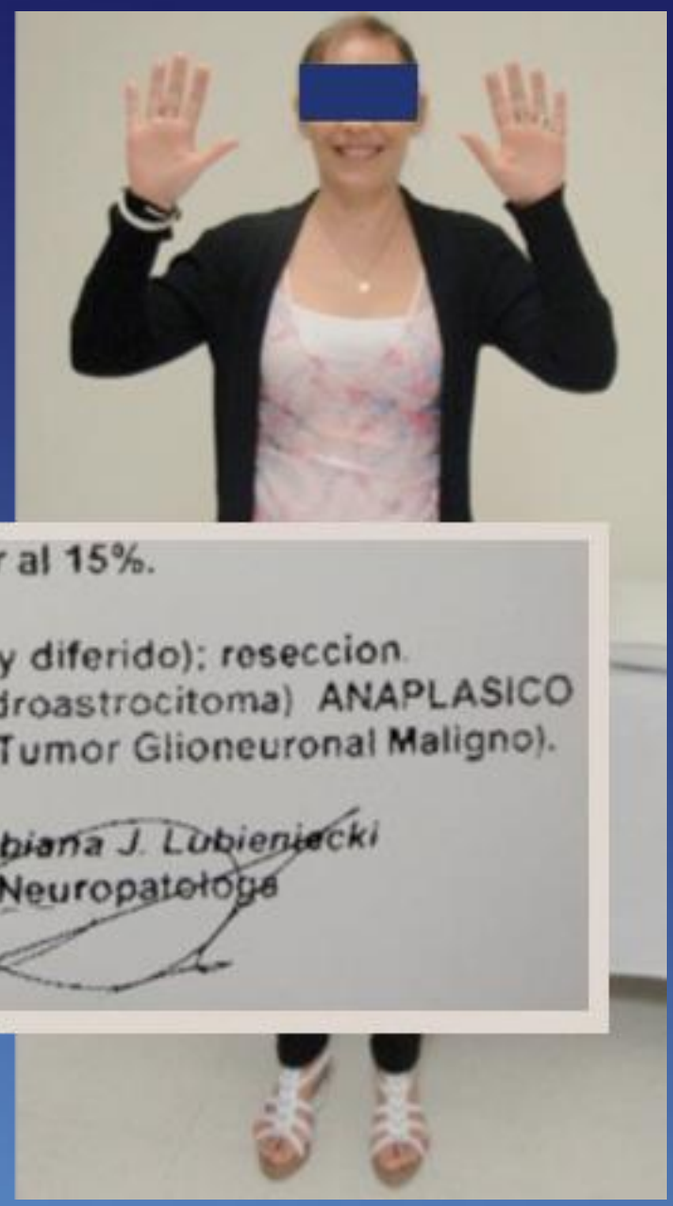
HIGH GRADE GLIOMAS

- FEM. 32.
  Mixed Glioma.

  Anaplastic Oligodendroastrocytoma.

  GTR Surgery
- **+ RTP**
- **+ TMZ**

  Three years after surgery.



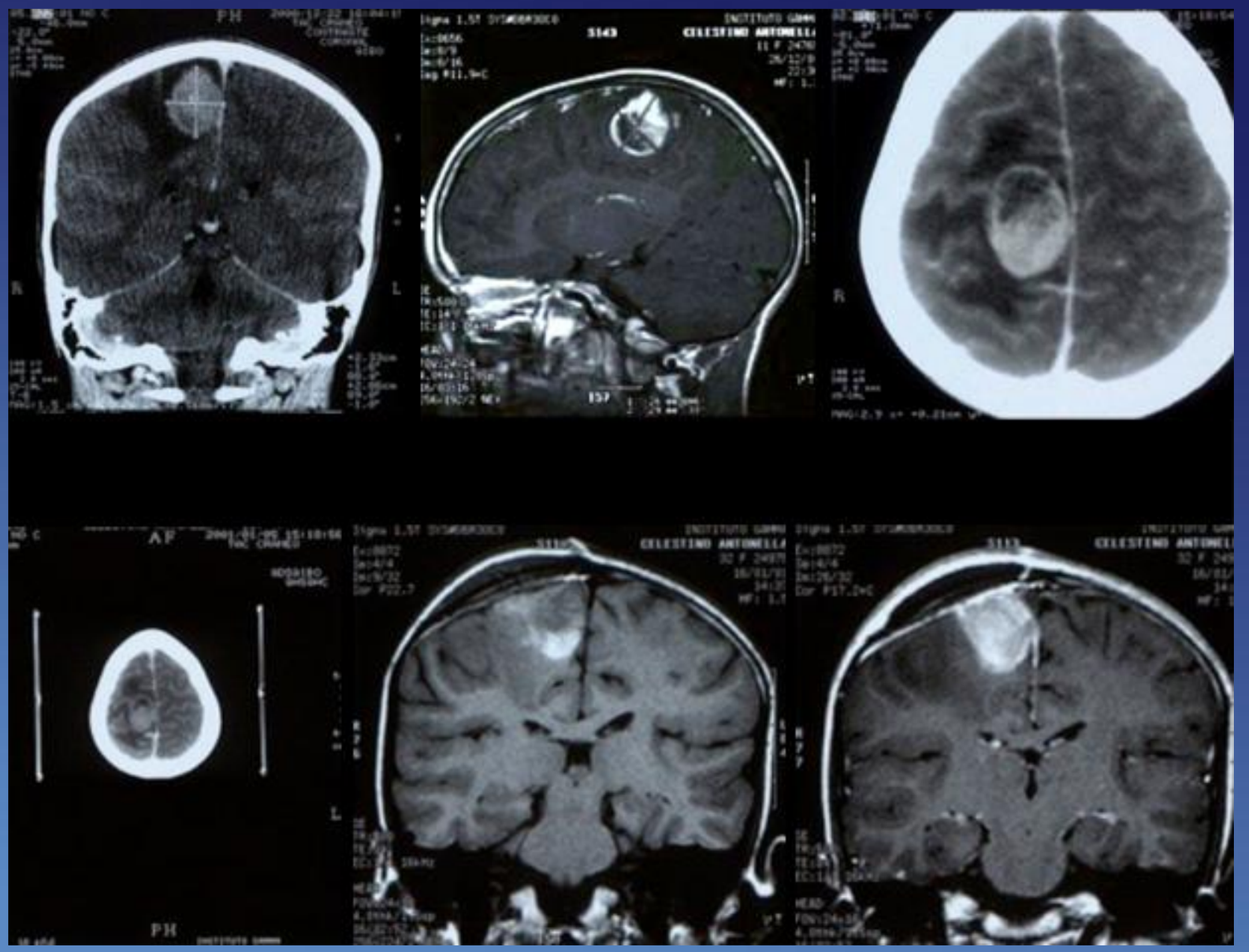
Ki67: alto porcentaje de proliferacion, mayor al 15%.

DIAGNOSTICO: Tumor frontal (congelacion y diferido): reseccion.
GLIOMA MIXTO (oligodendroastrocitoma) ANAPLASICO
que impresiona con componente neuronal (Tumor Glioneuronal Maligno).

Dra. Fabiana J. Lubieniecki
Neuropatologa

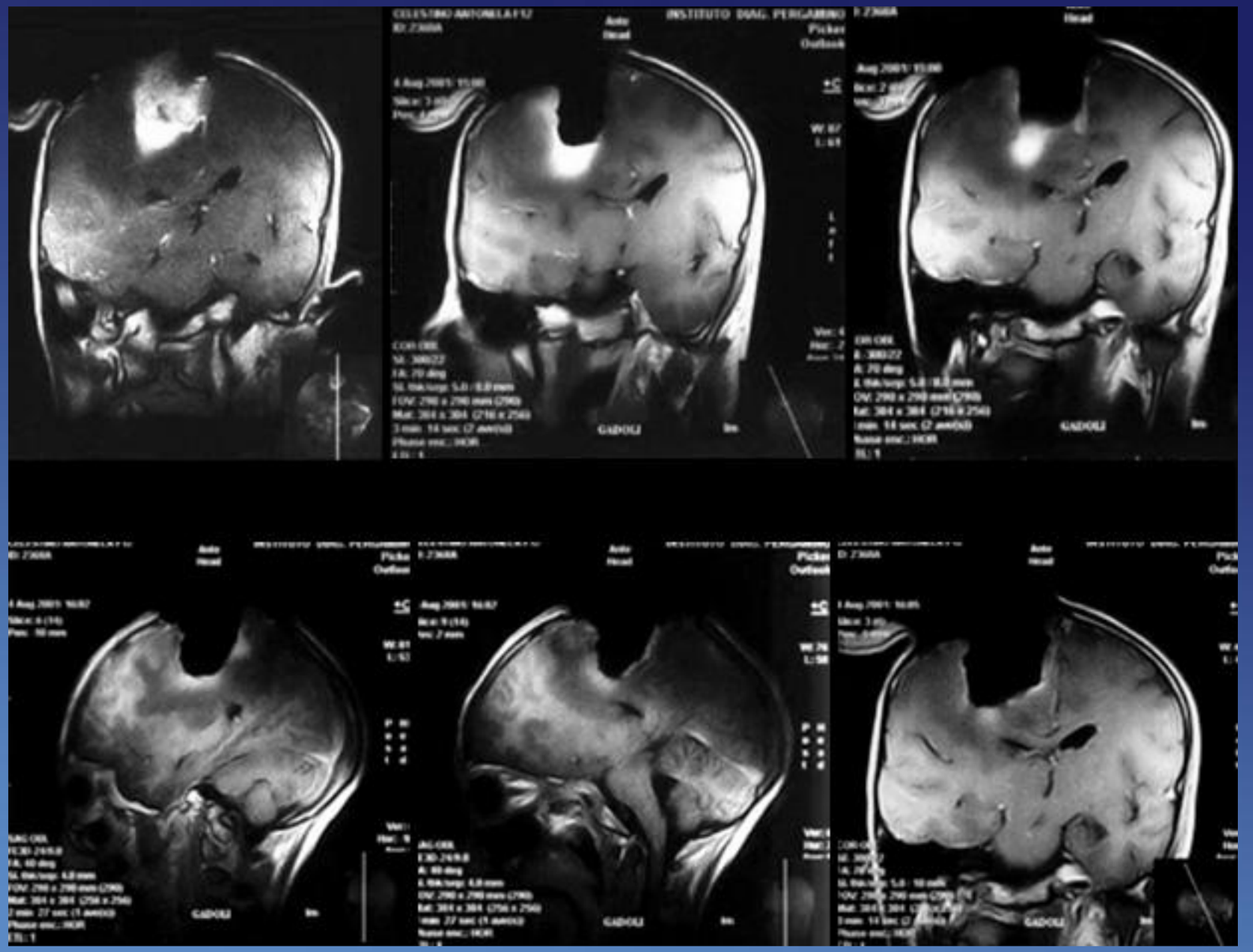
HIGH GRADE GLIOMAS

- A teenager girl with remaining tumor after having been operated with stereotactic guidance.



HIGH GRADE GLIOMAS

- Here an **iMRI** control with tumor remnant and below after complete tumor resection.



CLINICA ADVENTISTA BELGRANO

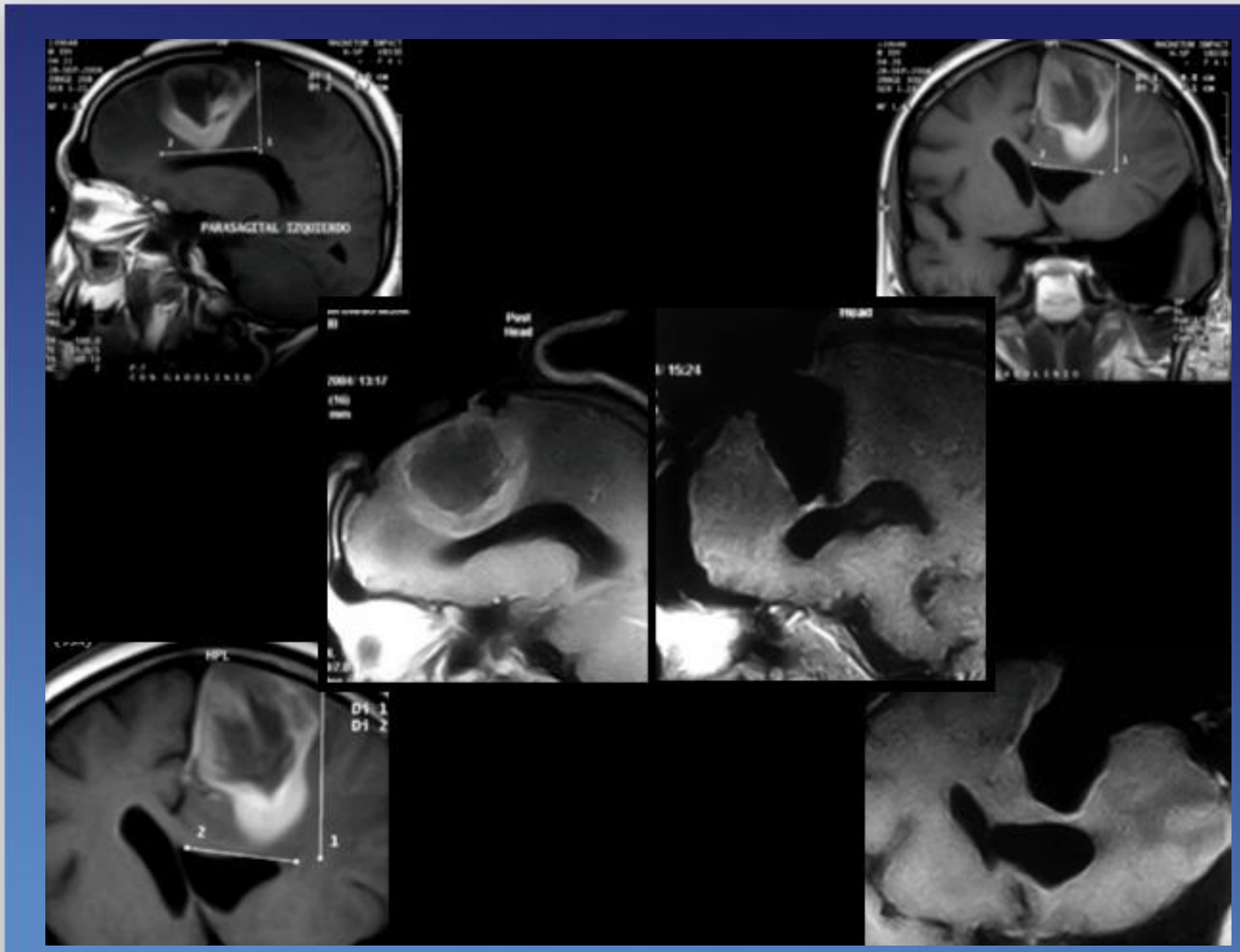
HIGH GRADE GLIOMAS

SURGICAL THEATRE

HIGH GRADE GLIOMAS

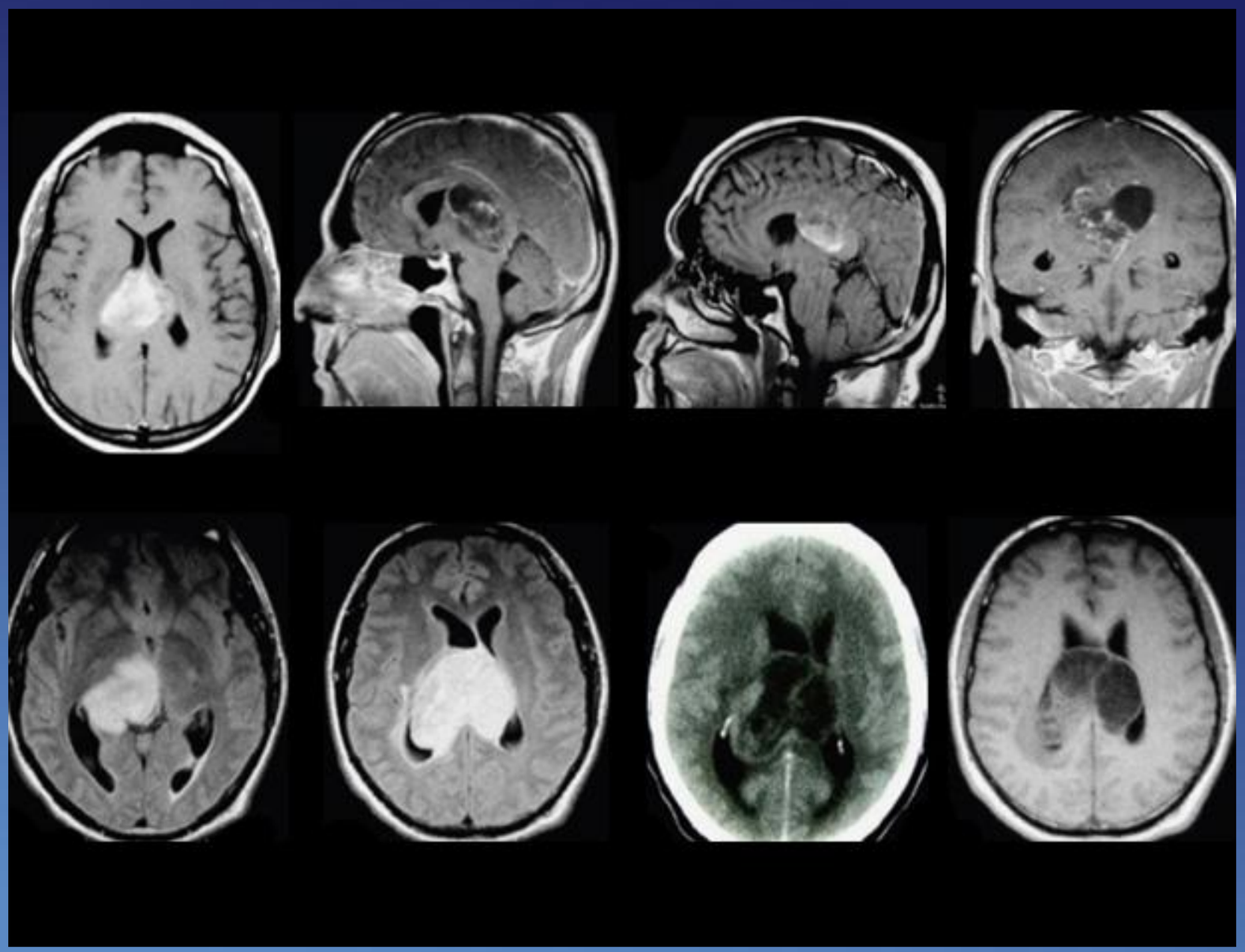
- M. 39. G.B.M.

  When we removed completely a brain glioma, in most of the cases, the surgical cavity has the same shape of the tumor removed.



HIGH GRADE GLIOMAS

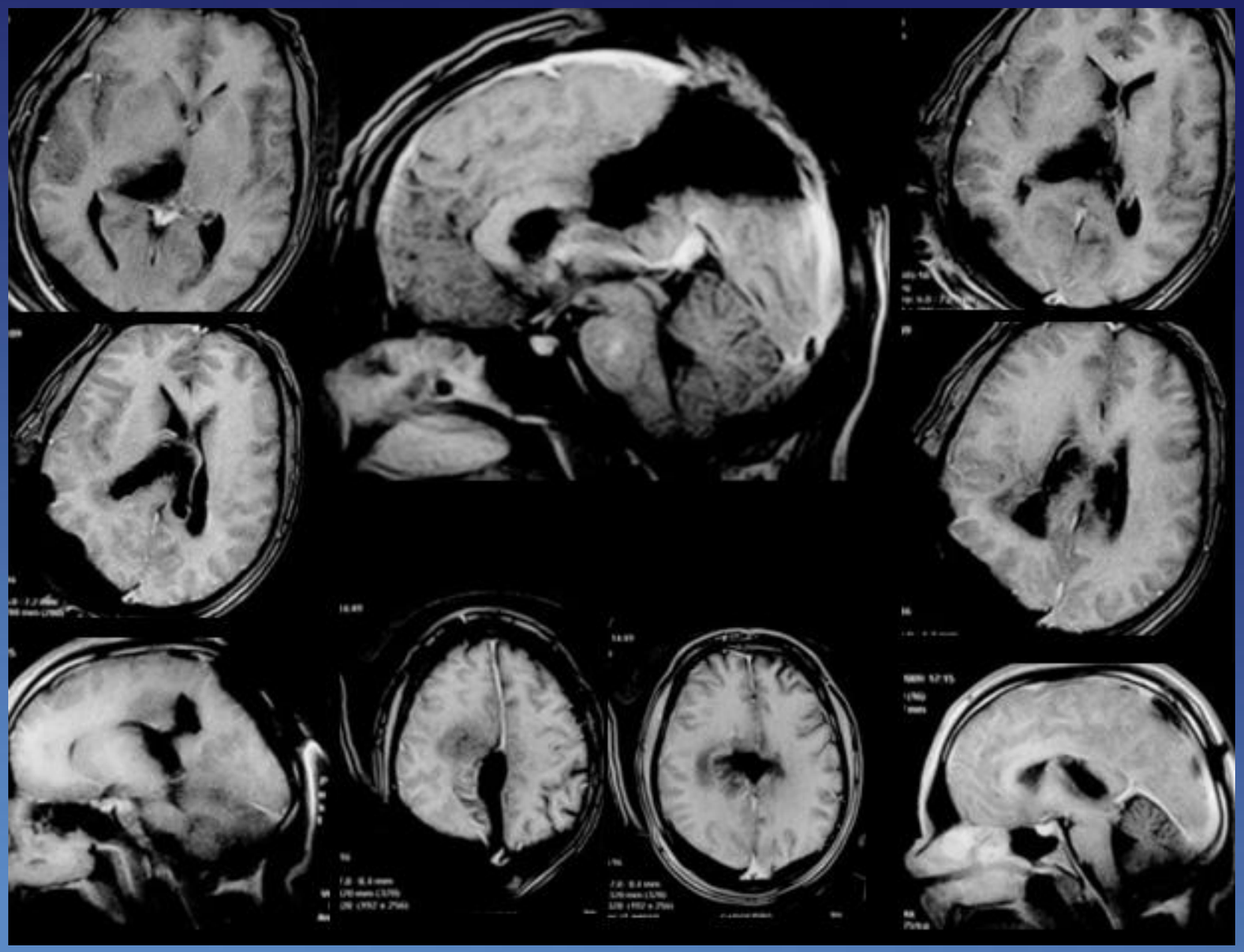
- Corpus Callosum **HGG**.



CORPUS CALLOSUM HGG

HIGH GRADE GLIOMAS

- We operated it through Inter hemispherical approach.



HIGH GRADE GLIOMAS

THIS IS THE PATIENT IN **POST-OPERATIVE**

INTRAOPERATIVE **iMRI** "ADVANTAGES"

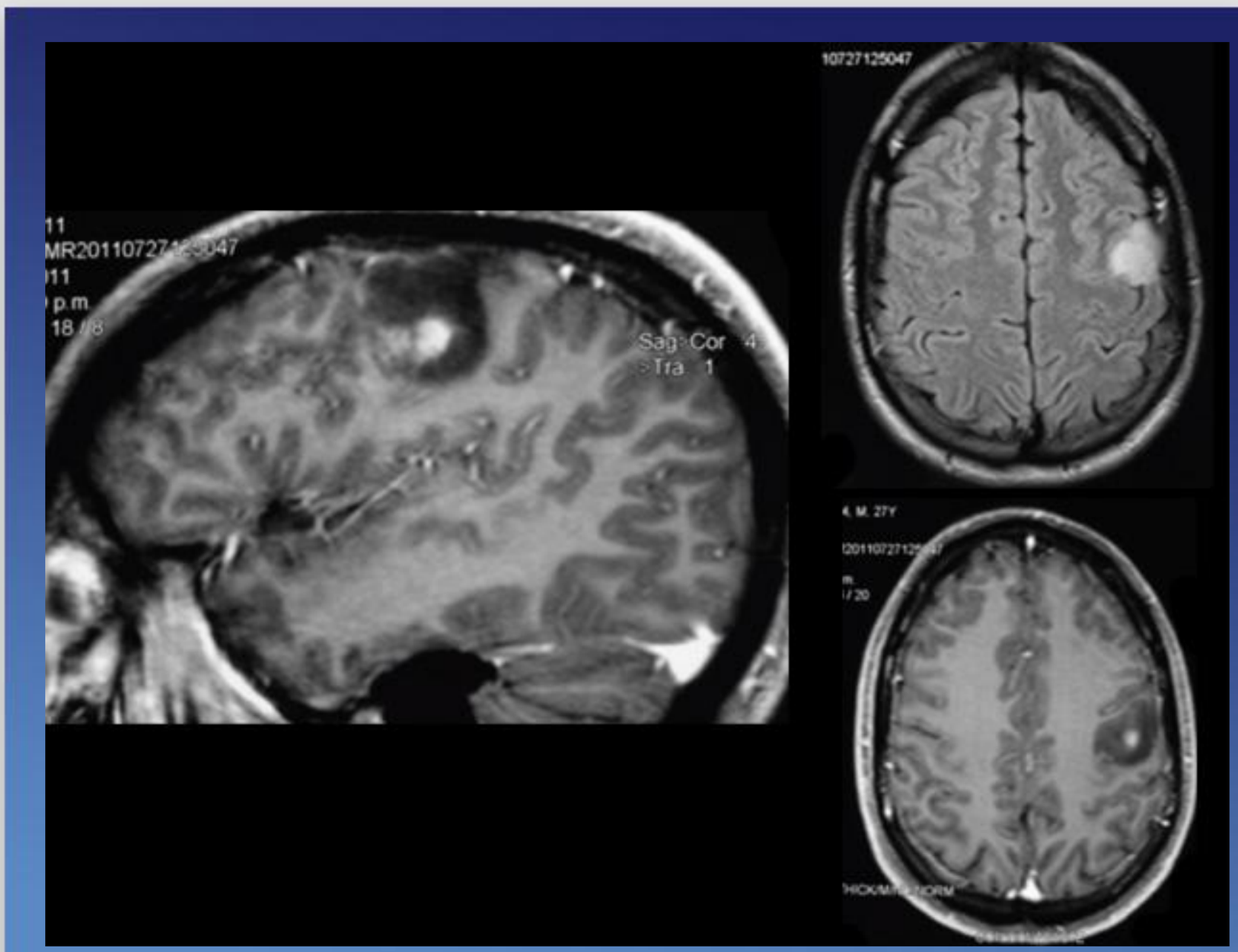
Neurophysiological Monitoring and Neuronavigation in "eloquent brain areas"

(One of the advantages of low field intraoperative systems, is that all kind of intraoperative neuromonitoring can be practiced very easily).

iMRI in
“ELOQUENT BRAIN AREAS”

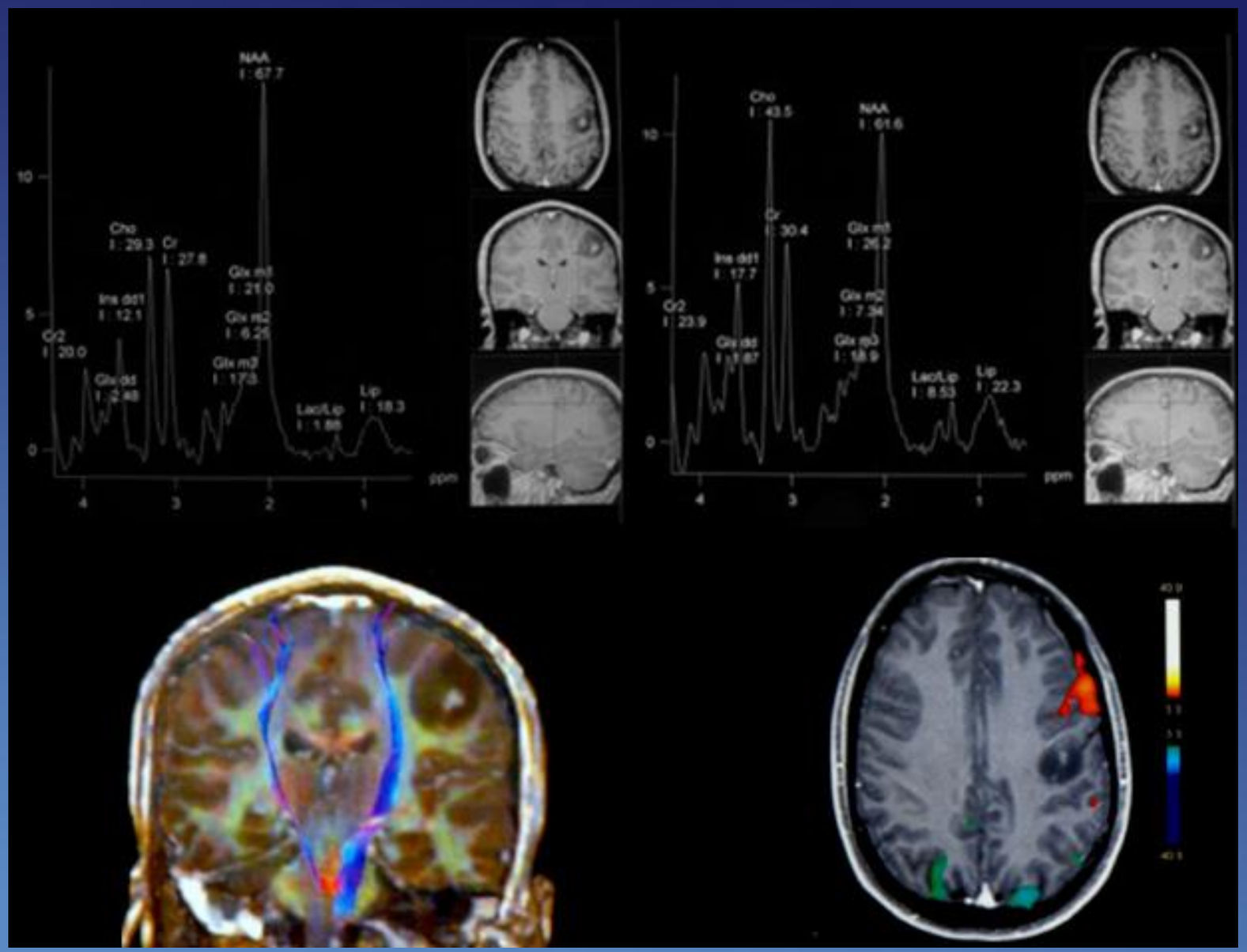
- M. 27.

  Glioma located in the left primary motor cortex.

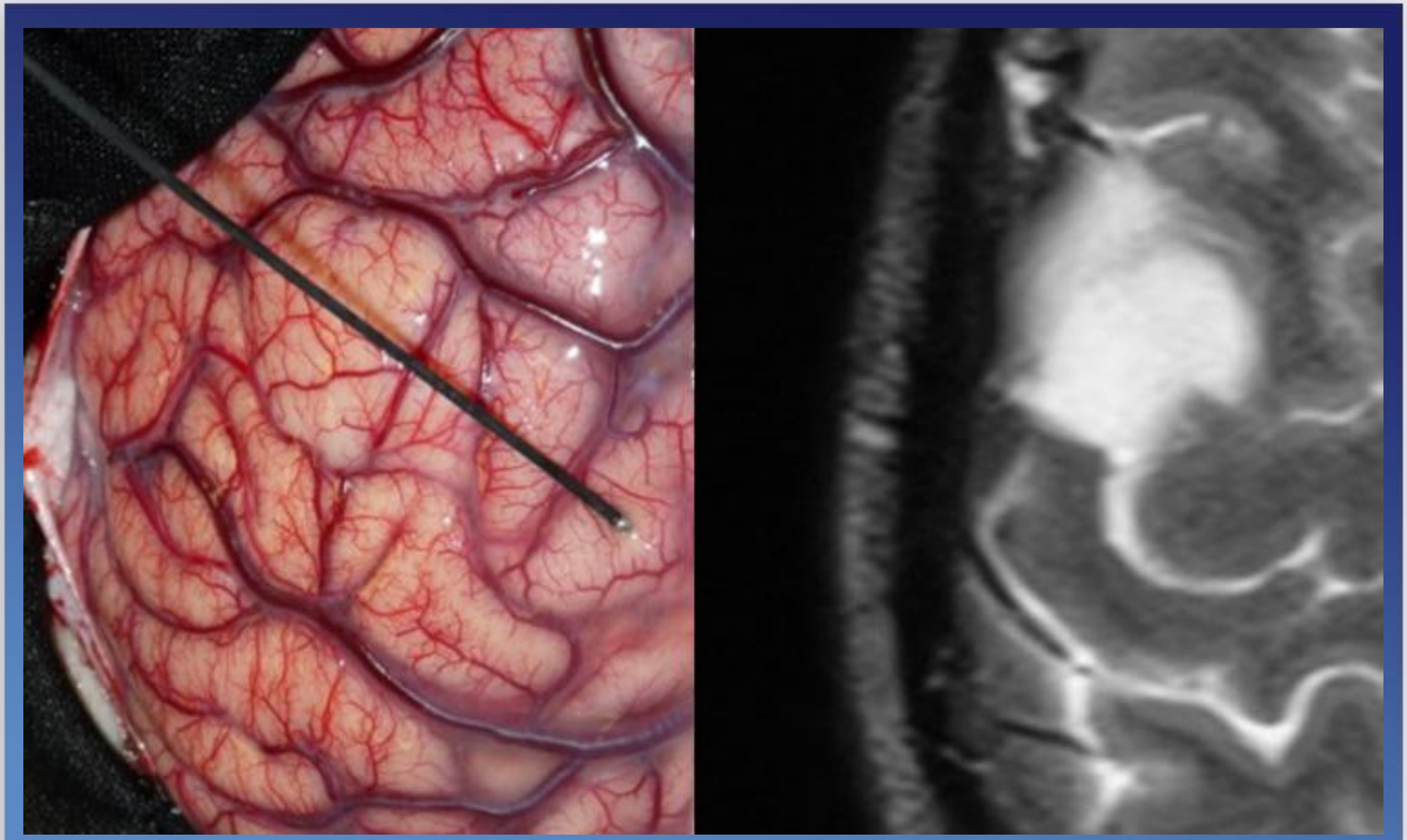


iMRI in
“ELOQUENT BRAIN AREAS”

- High field functional **MRI**, spectroscopy and tractography.



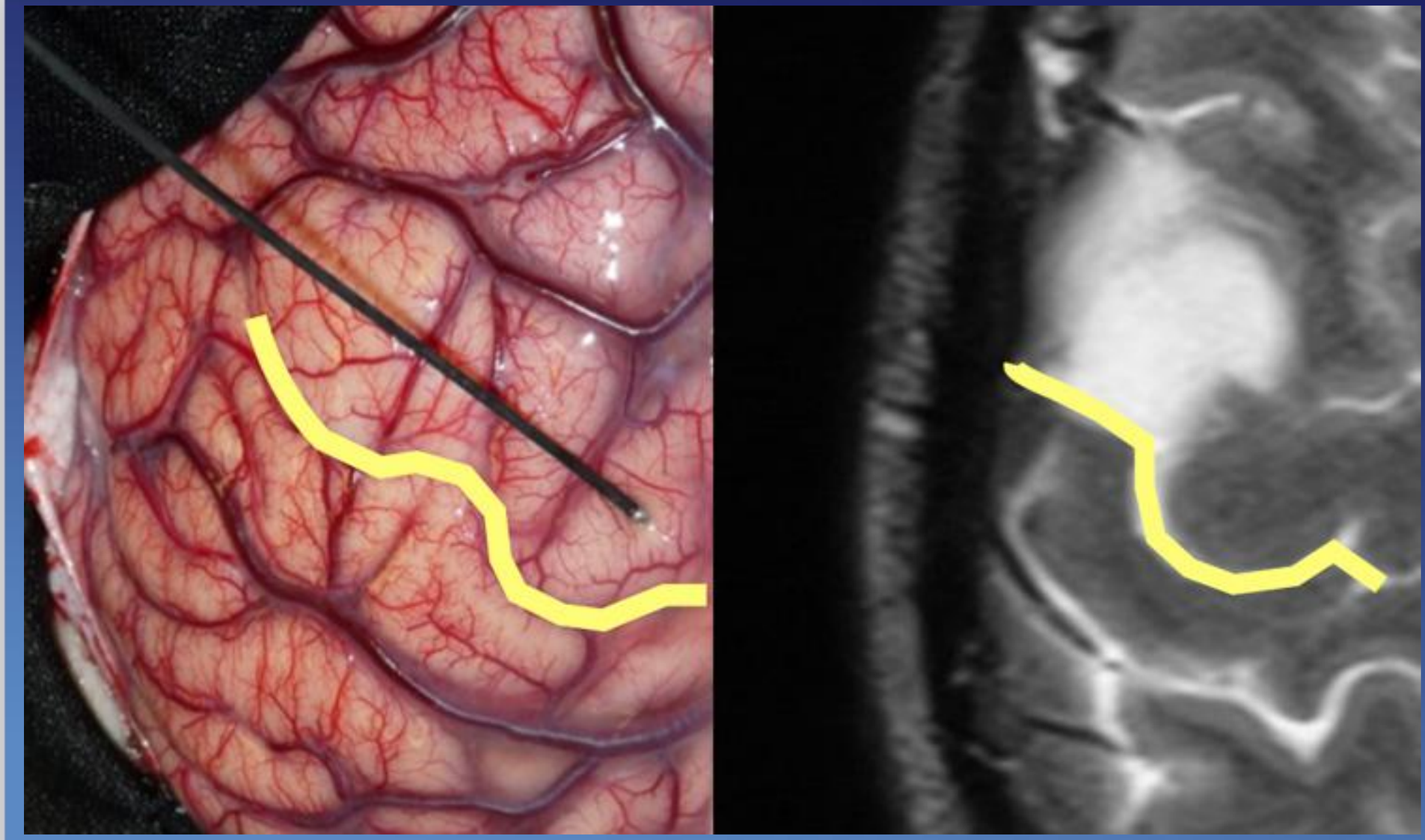
iMRI in
“ELOQUENT BRAIN AREAS”



DR. ROBERTO R. **HERRERA** AND COLLABORATORS

BUENOS AIRES //
ARGENTINA //

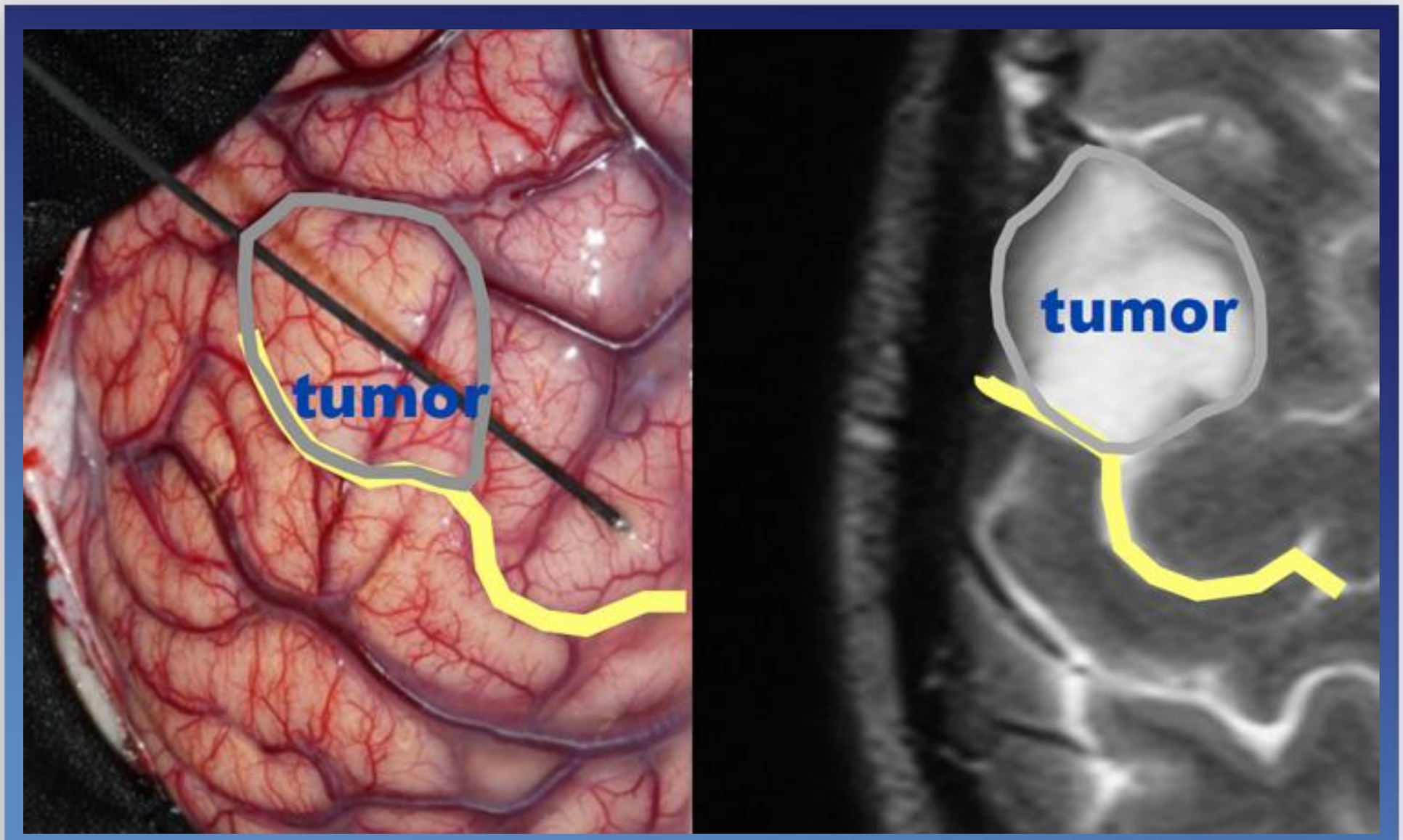
iMRI in
“ELOQUENT BRAIN AREAS”



DR. ROBERTO R. **HERRERA** AND COLLABORATORS

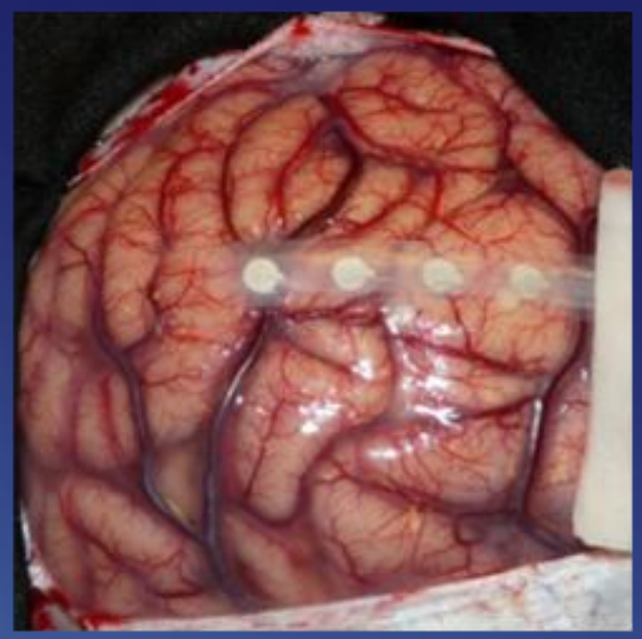
BUENOS AIRES //
ARGENTINA //

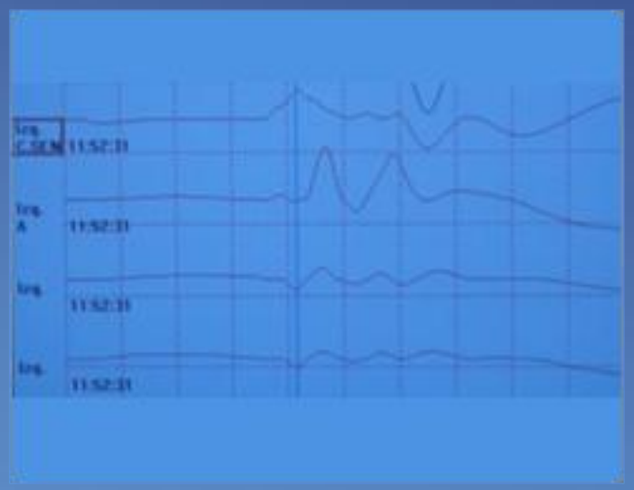
iMRI in
“ELOQUENT BRAIN AREAS”



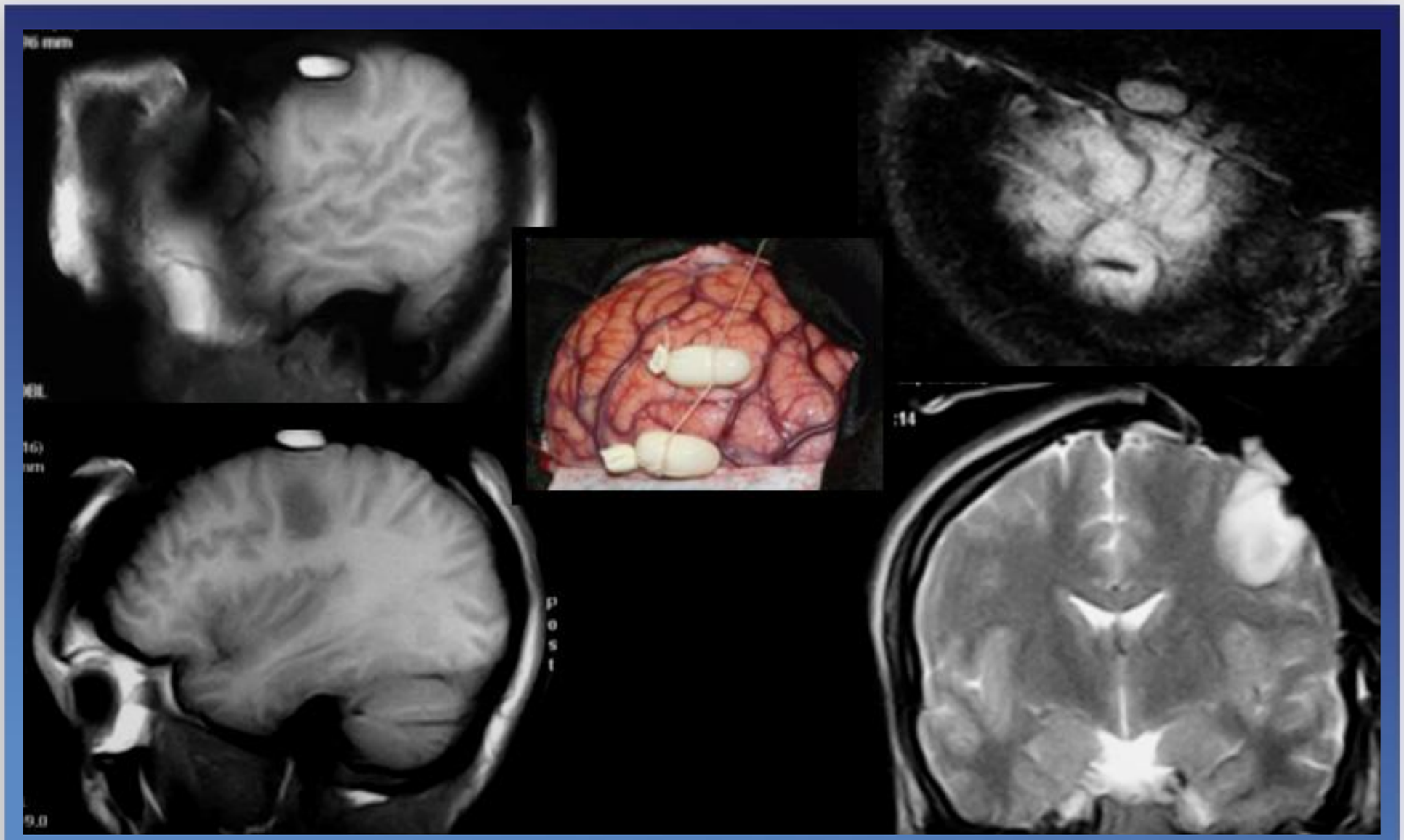
iMRI in
“ELOQUENT BRAIN AREAS”

- Intraoperative Electrophysiology. Cortical stimulation and somatosensory evoked potentials.



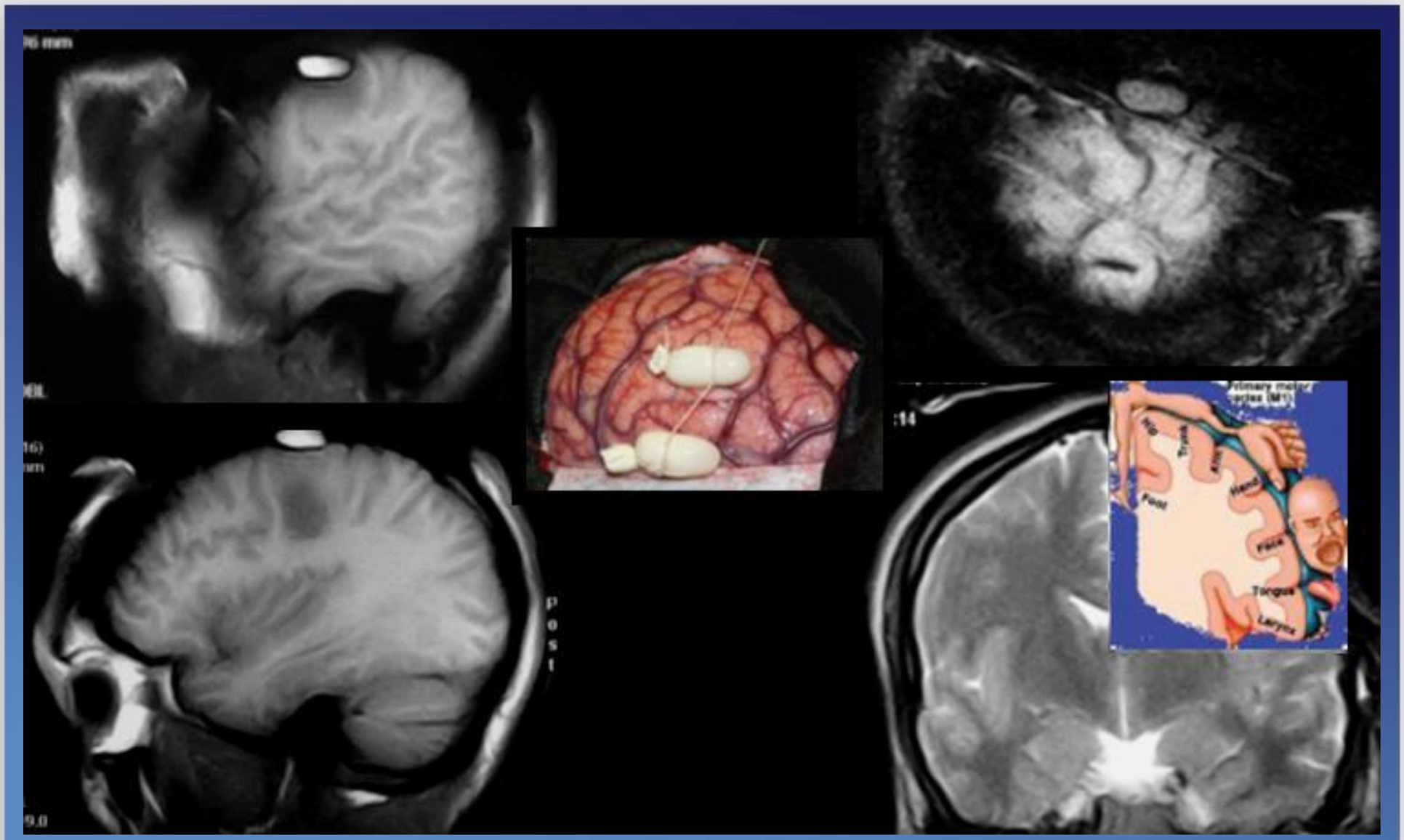


iMRI in
“ELOQUENT BRAIN AREAS”



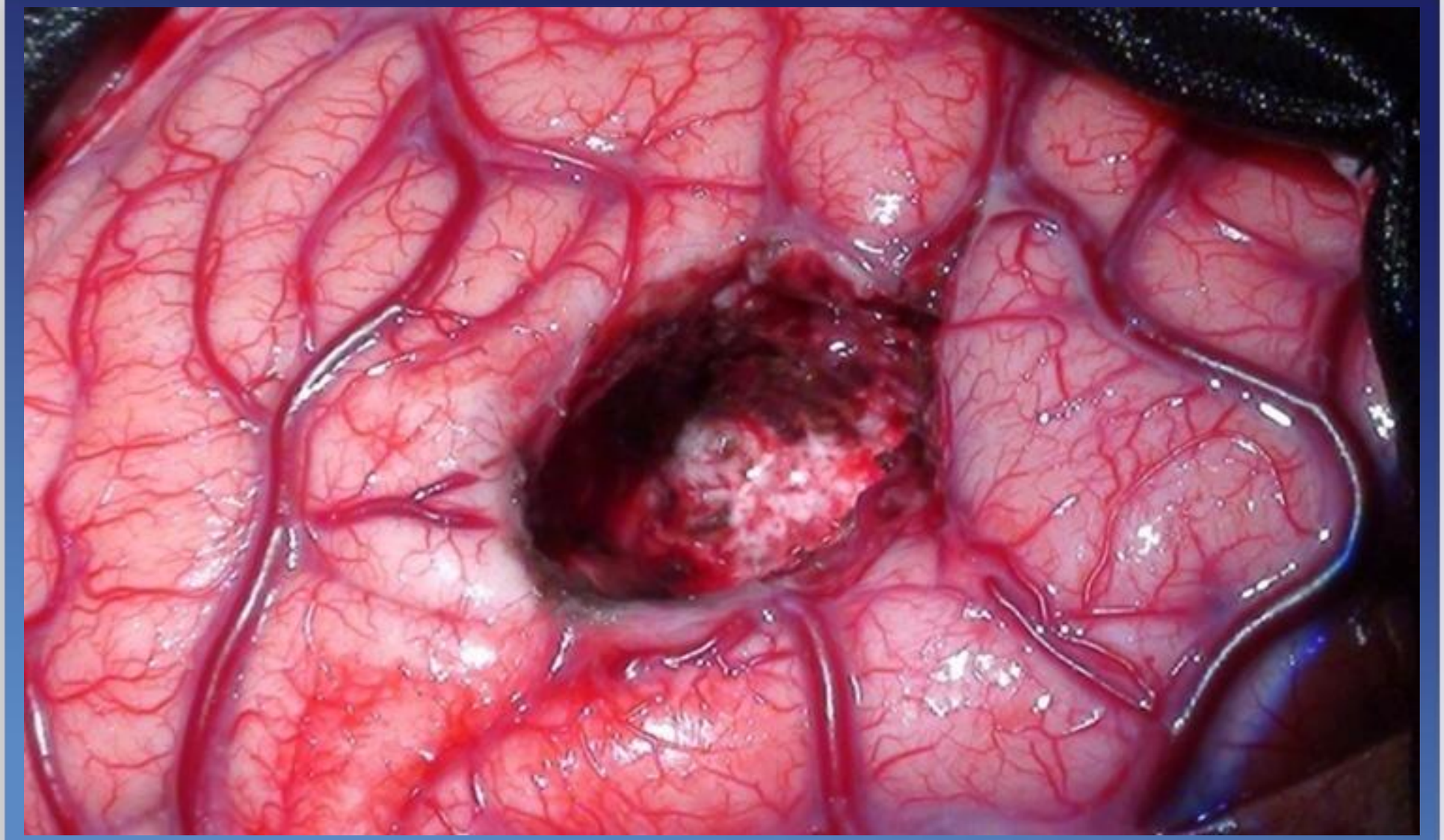
INTRAOPERATIVE MRI

iMRI in
“ELOQUENT BRAIN AREAS”



INTRAOPERATIVE MRI

iMRI in
“ELOQUENT BRAIN AREAS”



DR. ROBERTO R. **HERRERA** AND COLLABORATORS

BUENOS AIRES //
ARGENTINA //

iMRI in
“ELOQUENT BRAIN AREAS”

INTRAOPERATIVE MRI, POST. TUMOR RESECTION

iMRI in
“ELOQUENT BRAIN AREAS”

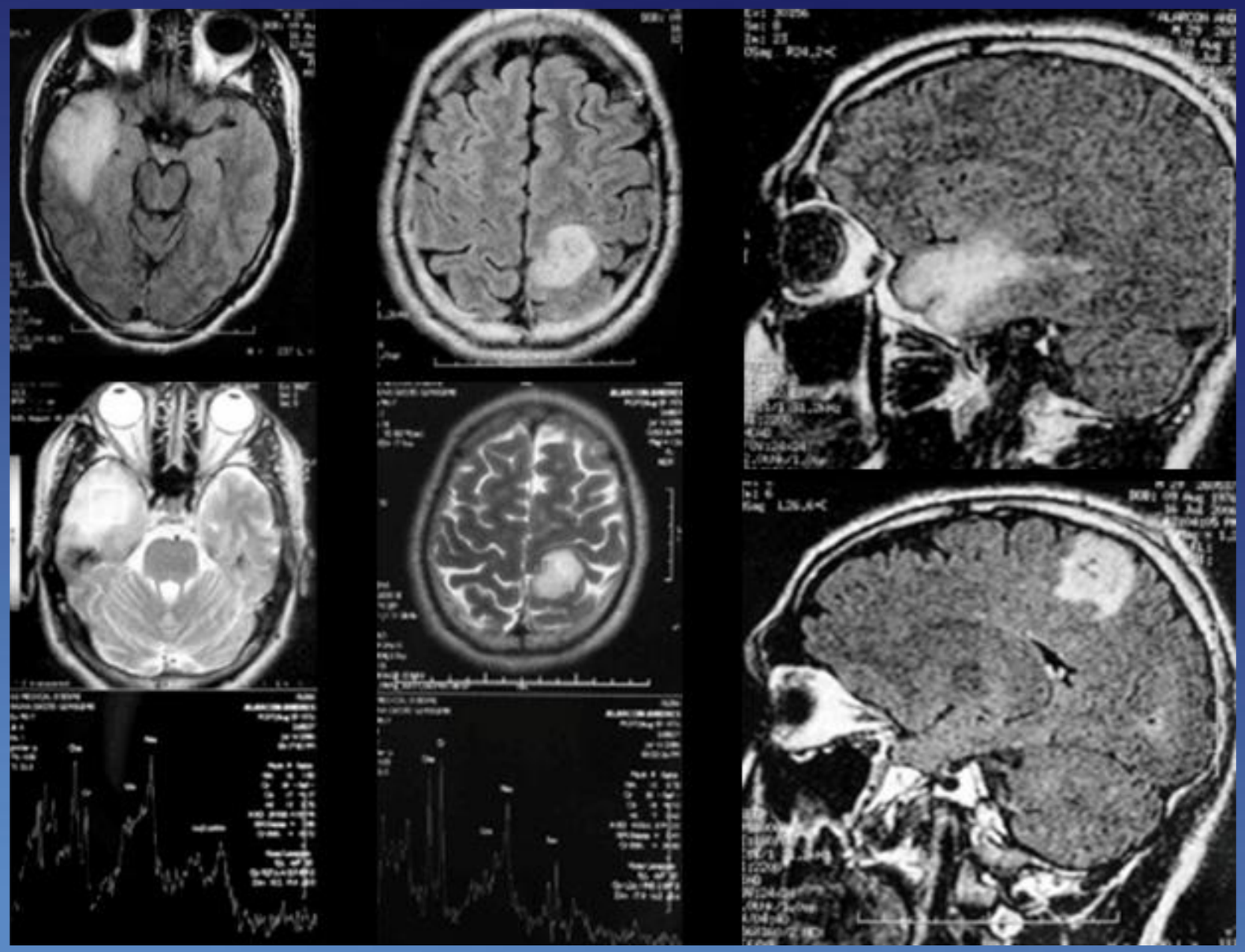
- The patient after surgery.
  No neurological deficit.

iMRI in
“ELOQUENT BRAIN AREAS”

- M. 30 Years Old.

  Multicentric Oligodendroglioma.

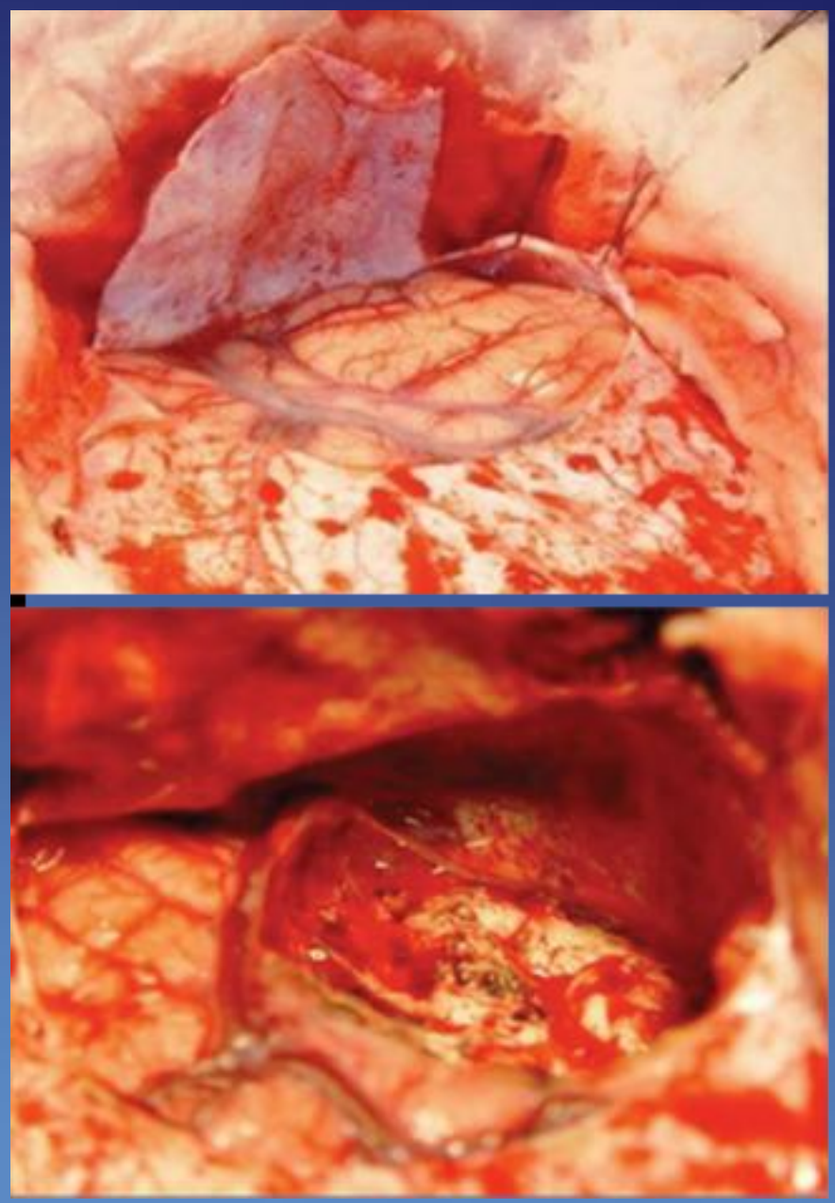
  This patient had two tumors. One in right temporal lobe and the other in left parietal lobe near motor area.



iMRI in
“ELOQUENT BRAIN AREAS”

- First we operated temporal
  tumor and resected it
  completely.

July 2006

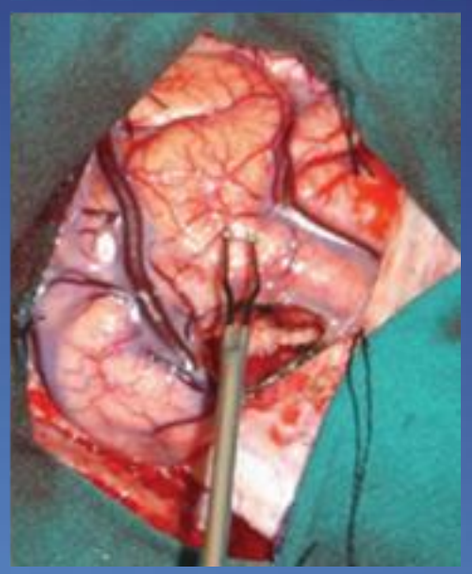


JULY 2006

iMRI in
“ELOQUENT BRAIN AREAS”

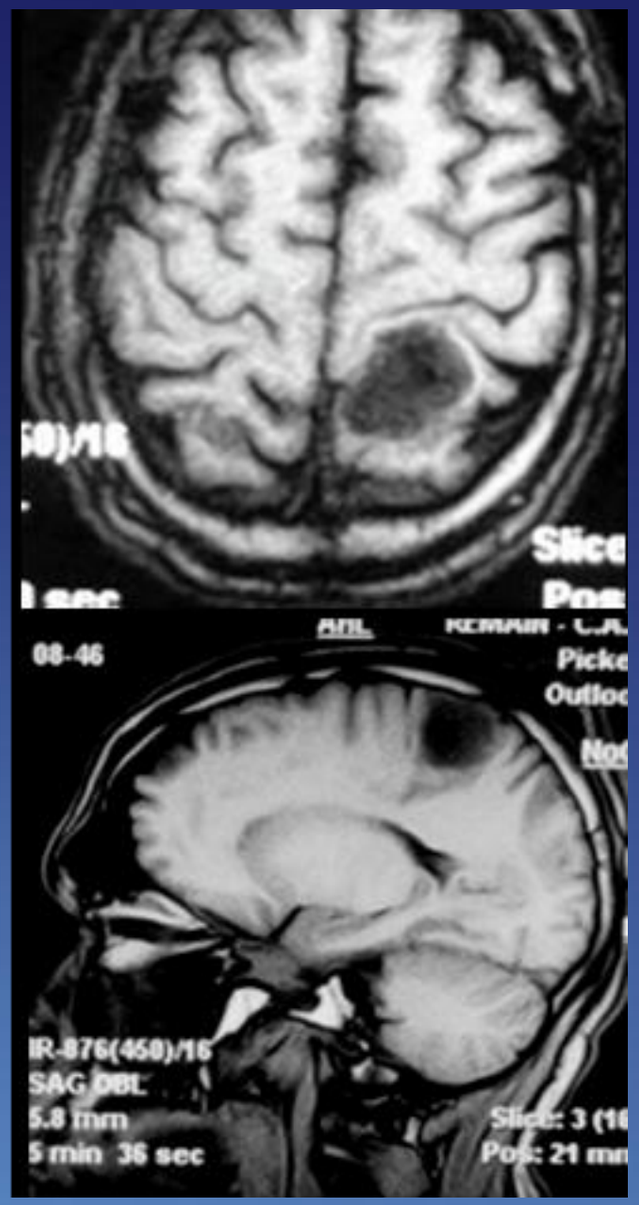
- **Cortical Electrical Stimulation.**

  Two month later, we operated
  his parietal tumor using intraoperative **MRI** and cortical stimulation.



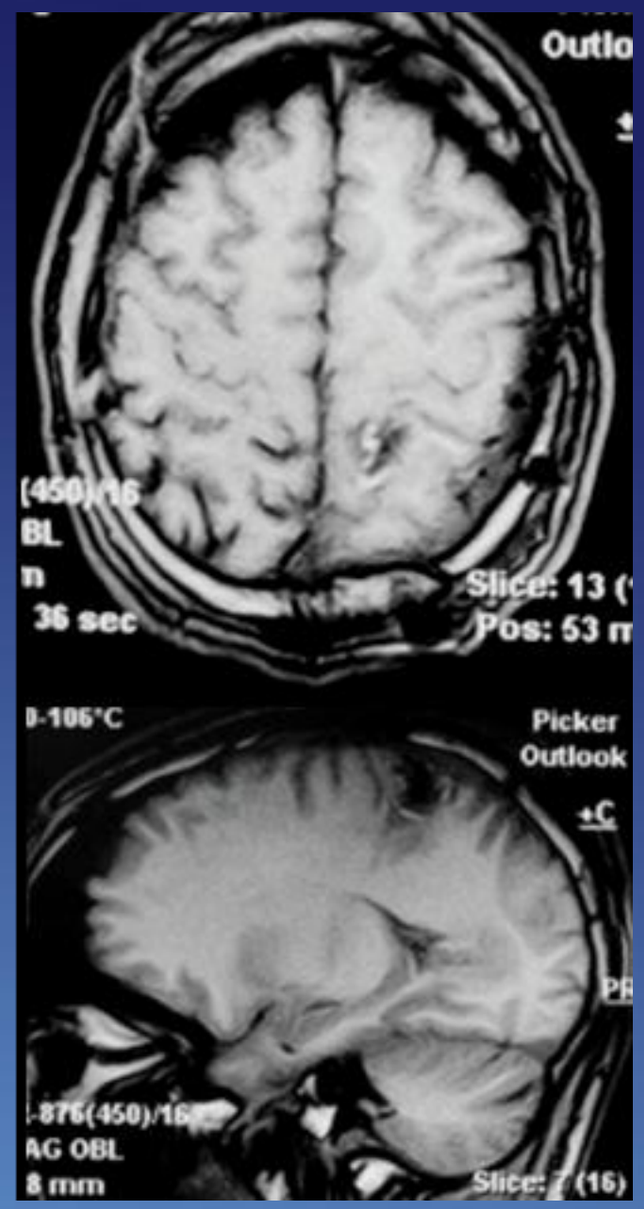
iMRI in
“ELOQUENT BRAIN AREAS”

- **PRE-OPERATIVE.**

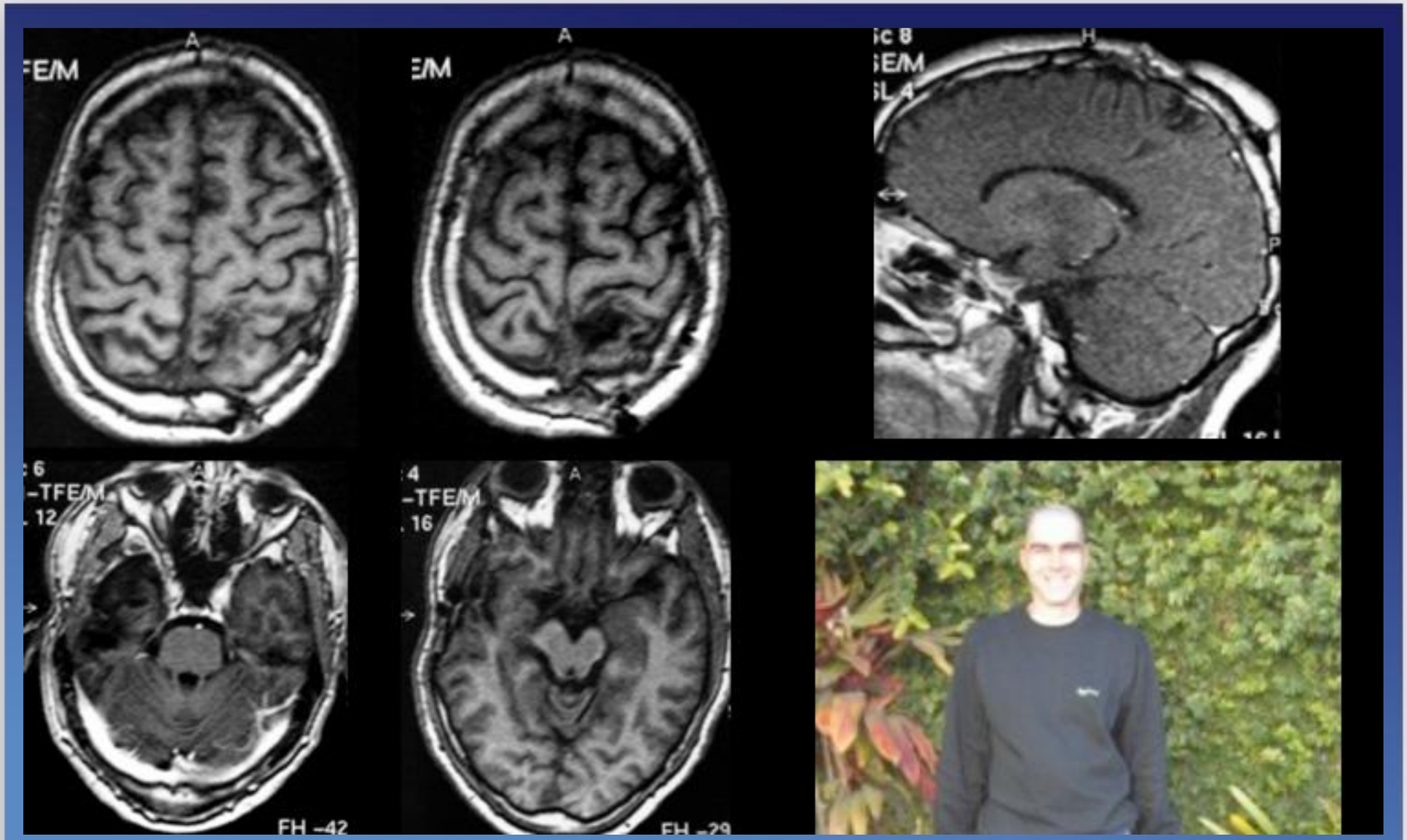


iMRI in
“ELOQUENT BRAIN AREAS”

- **POST-OPERATIVE.**



iMRI in
“ELOQUENT BRAIN AREAS”

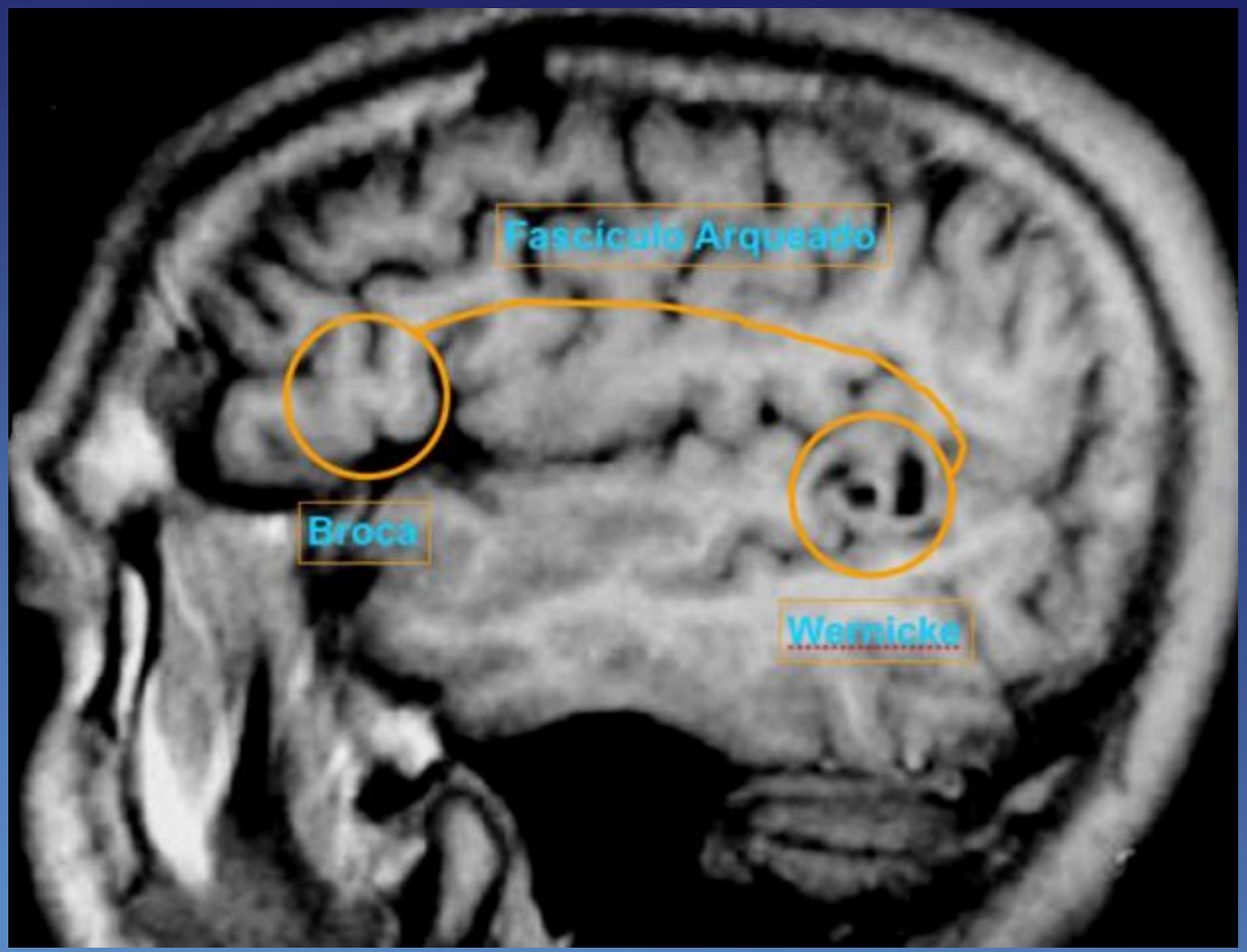


FIVE YEARS POST-OPERATIVE

iMRI in
“ELOQUENT BRAIN AREAS”

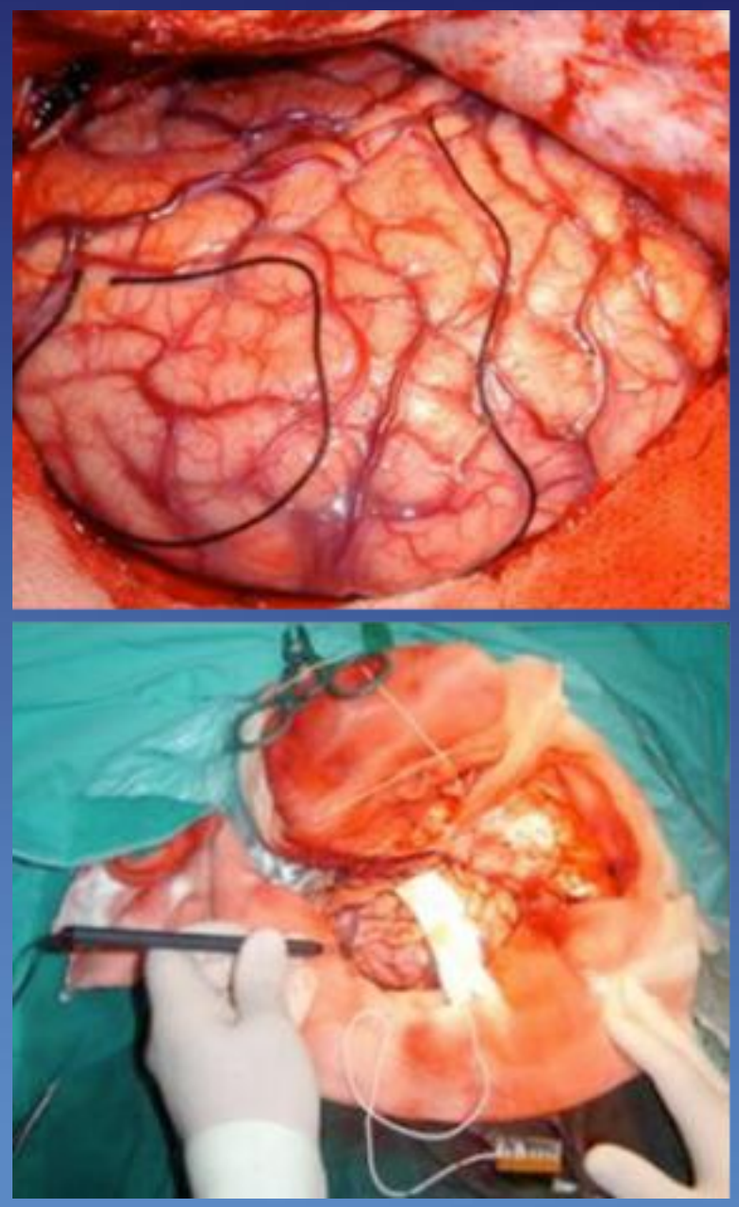
- M. 32.

  Wernicke area LGG.



iMRI in
“ELOQUENT BRAIN AREAS”

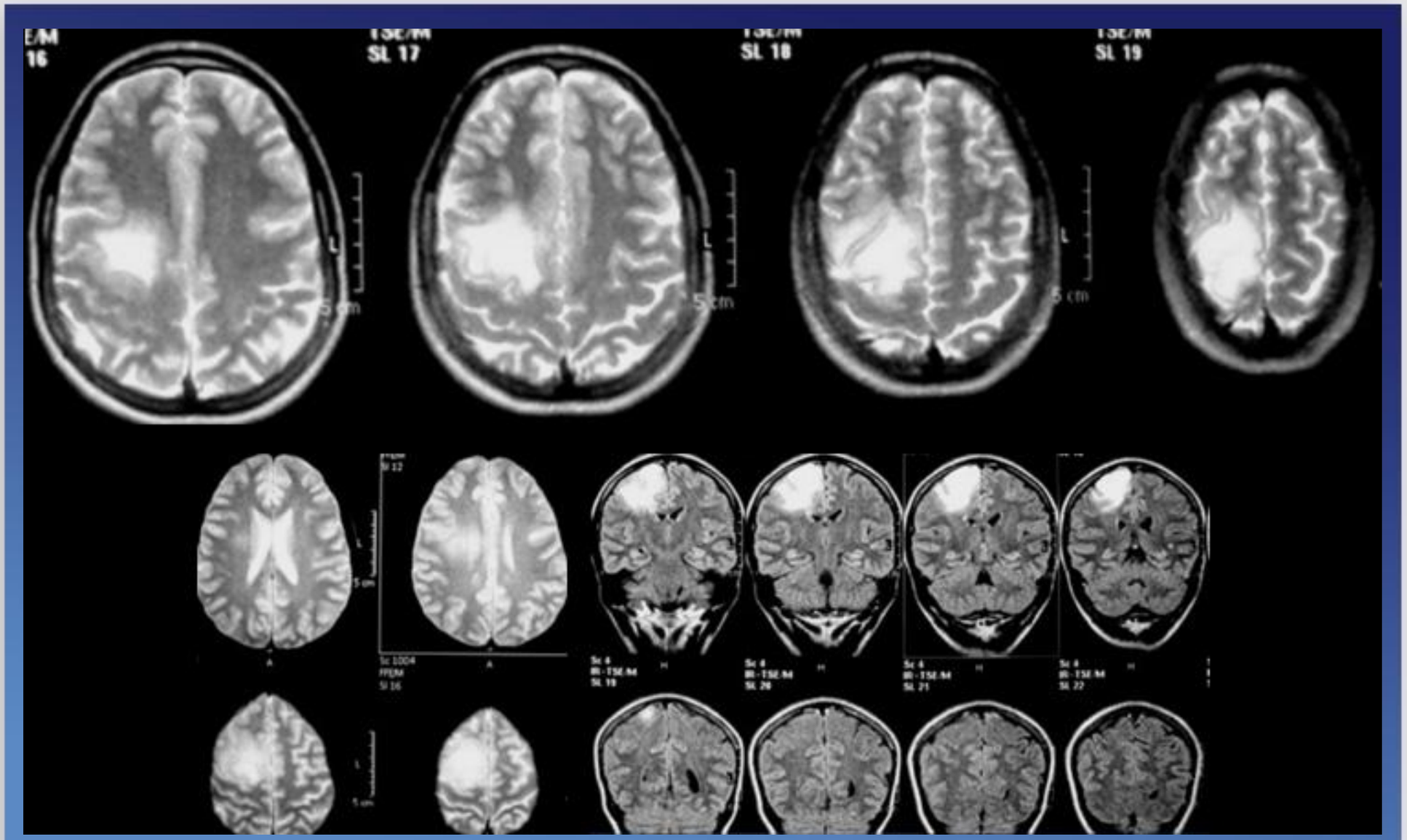
- We operated the patient awake and removed the tumor completely.



iMRI in
“ELOQUENT BRAIN AREAS”

SURGICAL AREA

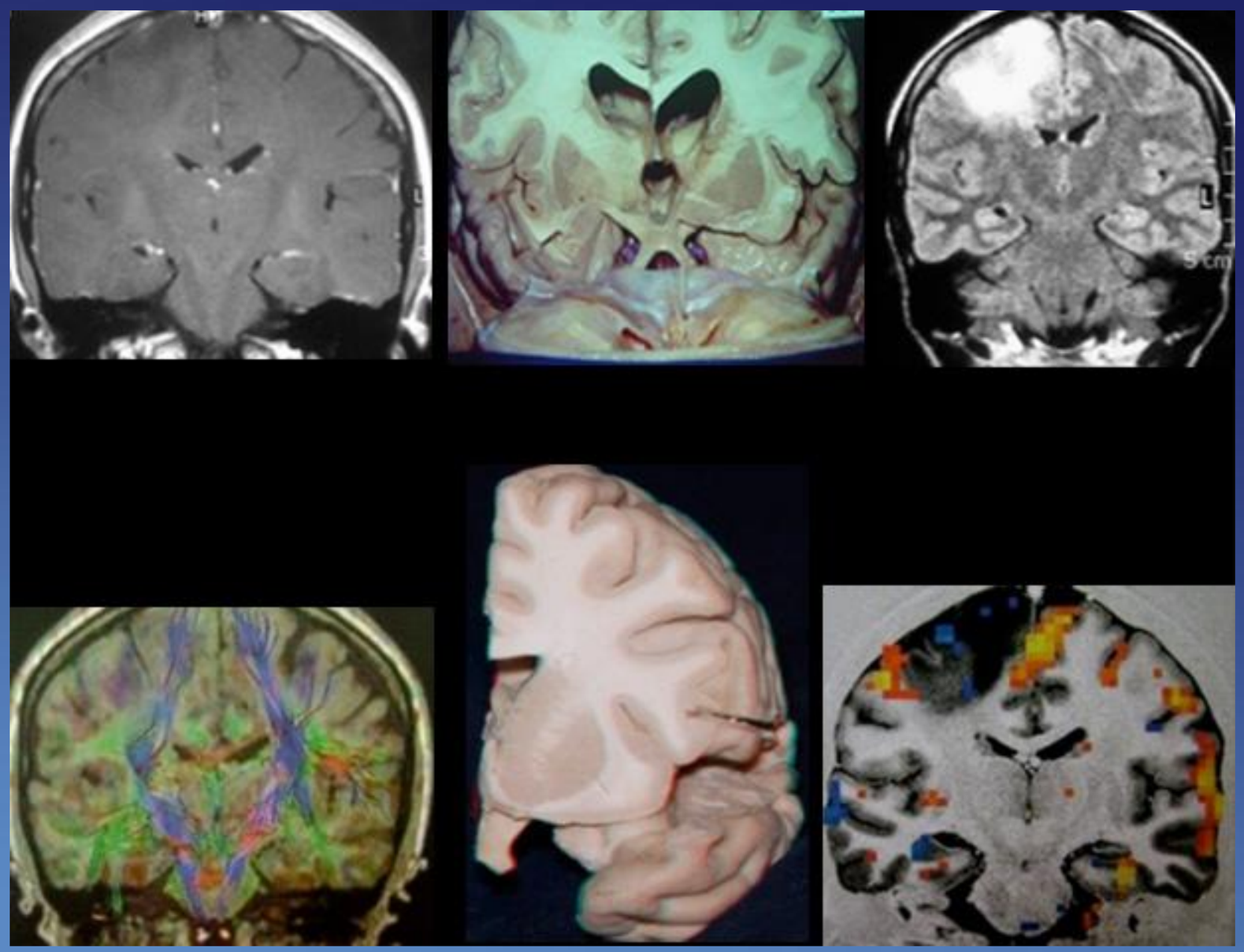
iMRI in
“ELOQUENT BRAIN AREAS”



A TEENAGERS GIRL WITH THIS RIGHT PRE CENTRAL LGG GLIOMA

iMRI in
“ELOQUENT BRAIN AREAS”

- She had a tumor which Pushed the cortico spinal tract.



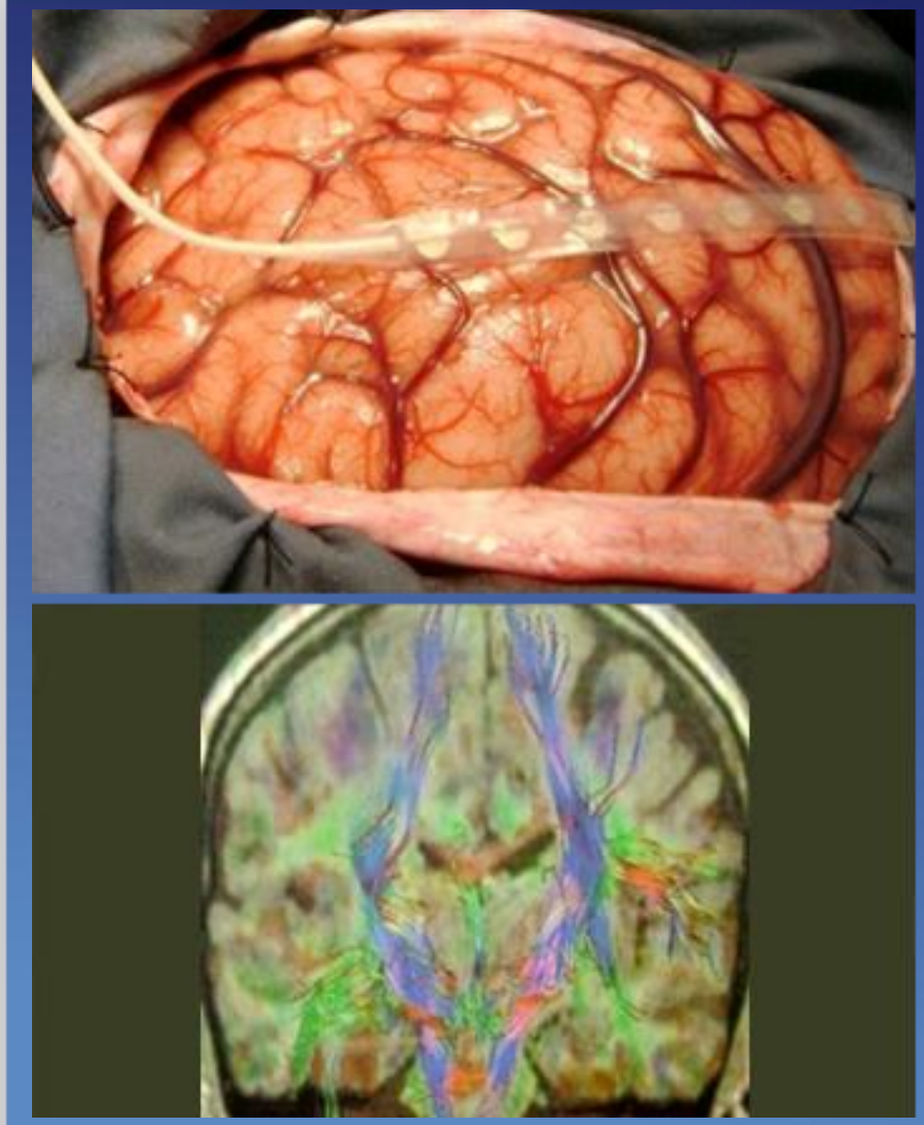
iMRI in
“ELOQUENT BRAIN AREAS”

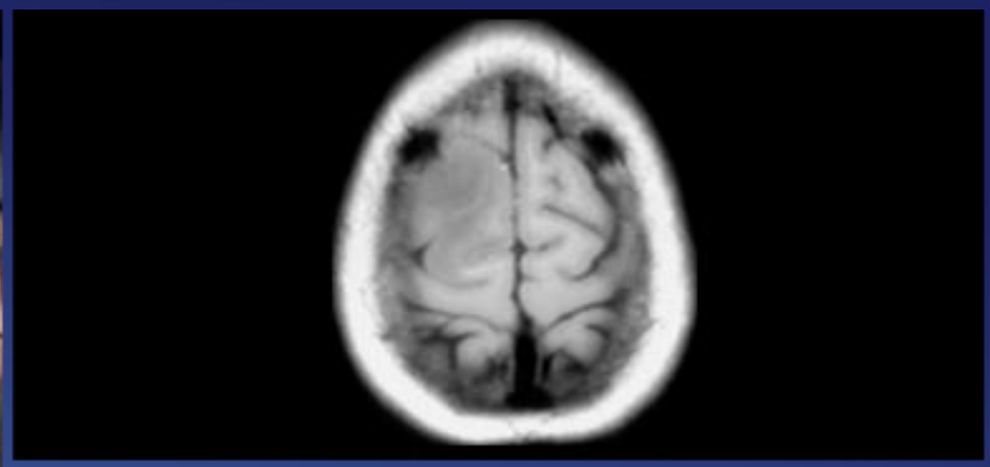
- We operated her with sub cortical electrical stimulation to preserve the cortico spinal tract.

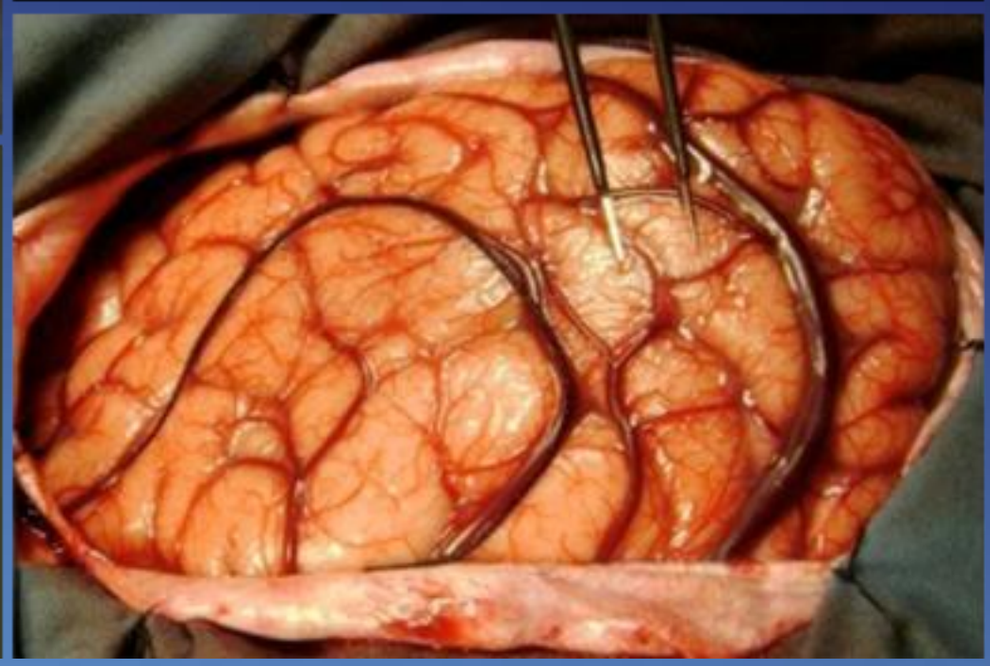
iMRI in
“ELOQUENT BRAIN AREAS”

- We operated her with sub cortical electrical stimulation to preserve the cortico spinal tract.

iMRI in
“ELOQUENT BRAIN AREAS”





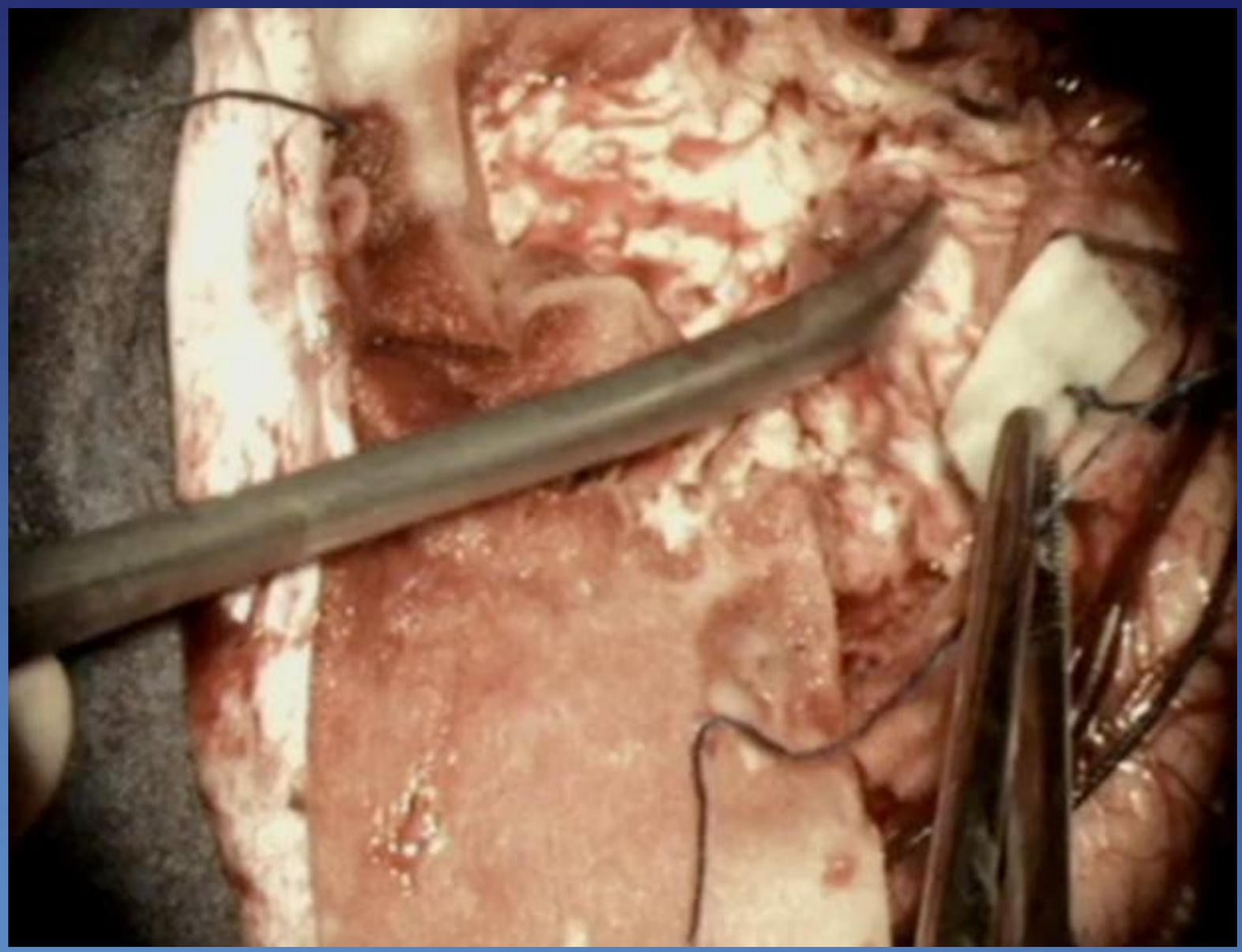


DR. ROBERTO R. **HERRERA** AND COLLABORATORS

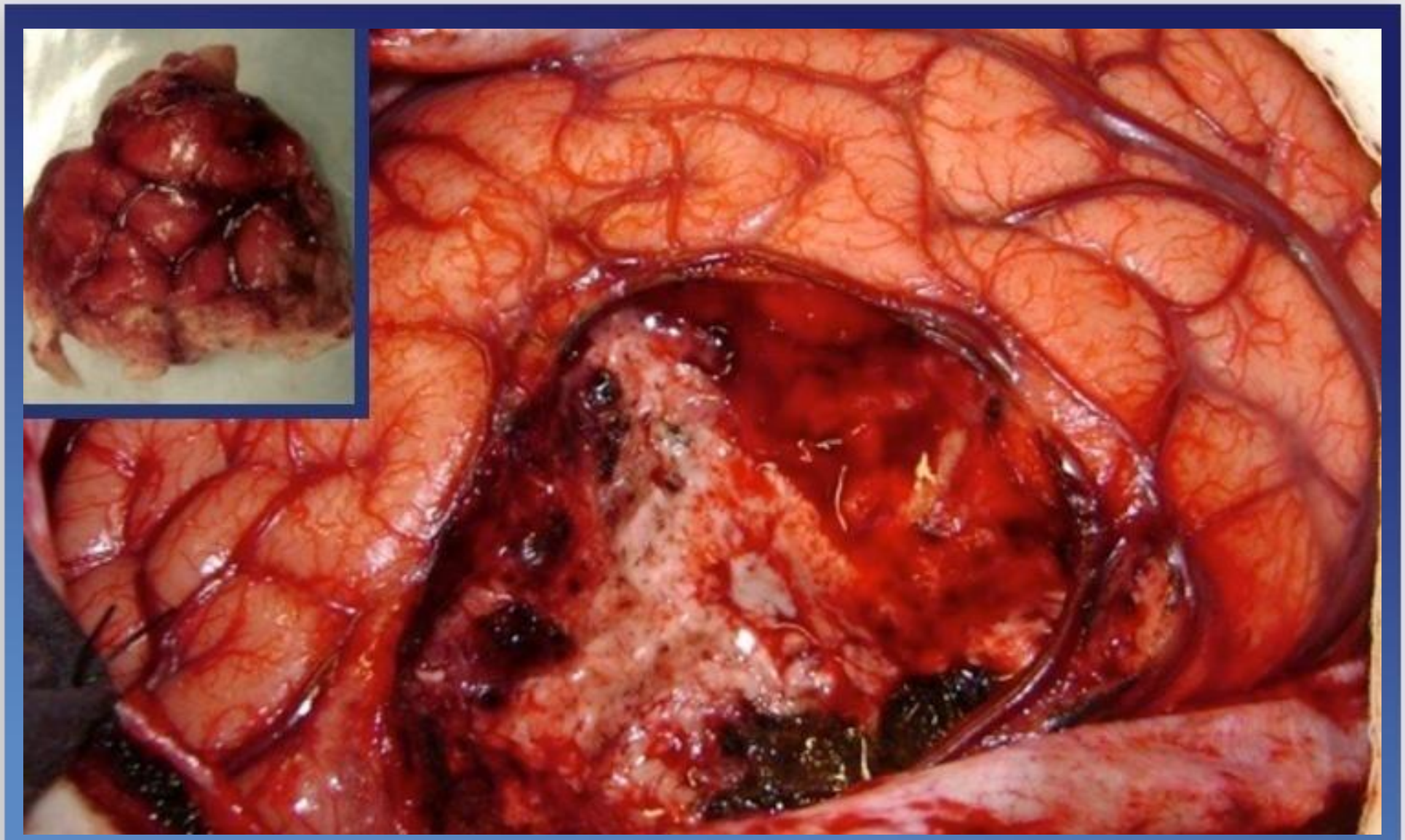
BUENOS AIRES //
ARGENTINA //

iMRI in
“ELOQUENT BRAIN AREAS”

- We can see Sub Cortical Electrical Stimulation to preserve the cortico spinal tract.



iMRI in
“ELOQUENT BRAIN AREAS”



SURGICAL BED

iMRI in
“ELOQUENT BRAIN AREAS”

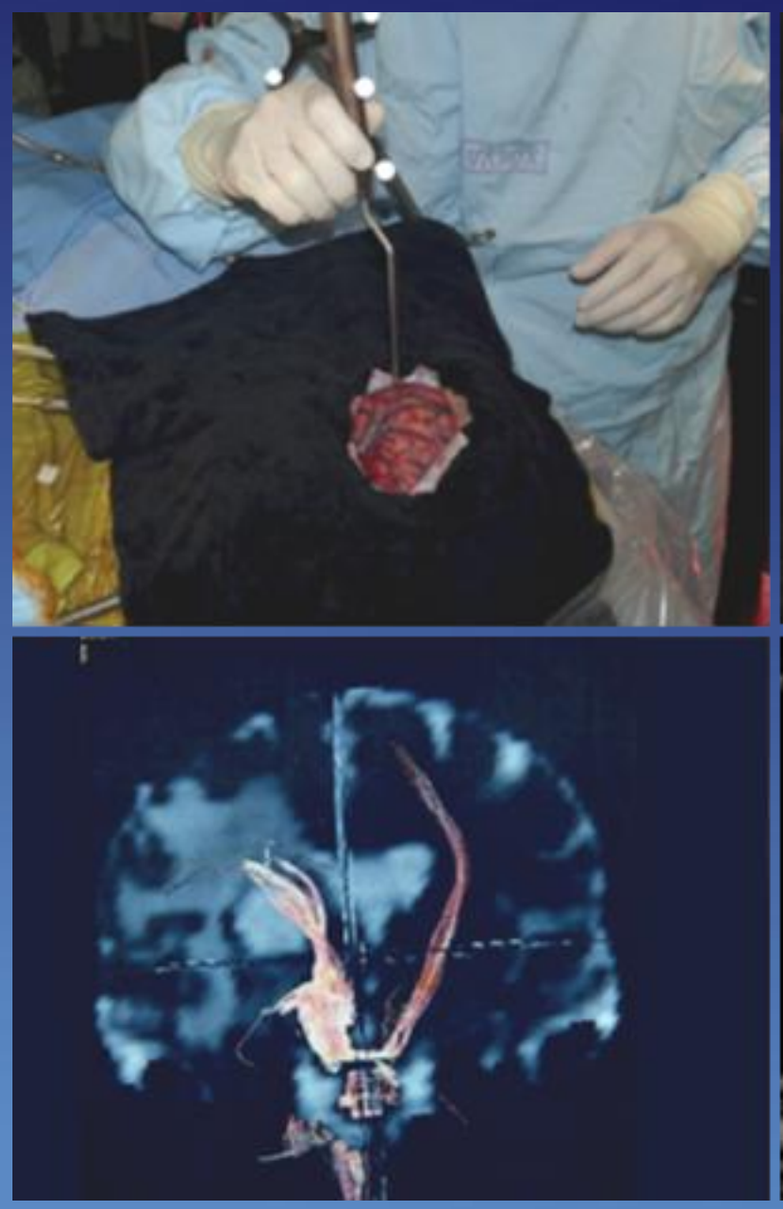
- And this is the patient right after the operation and completely recovered a few months later.

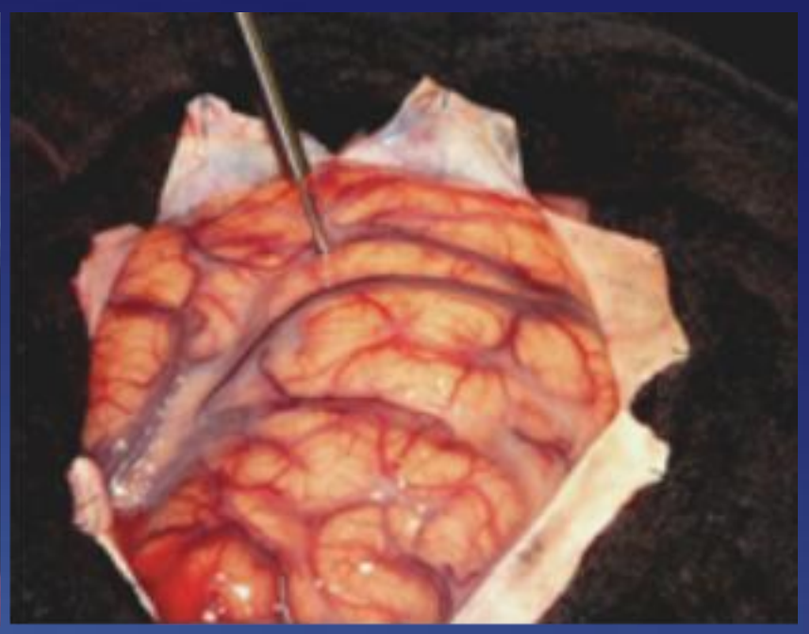
iMRI in
“ELOQUENT BRAIN AREAS”

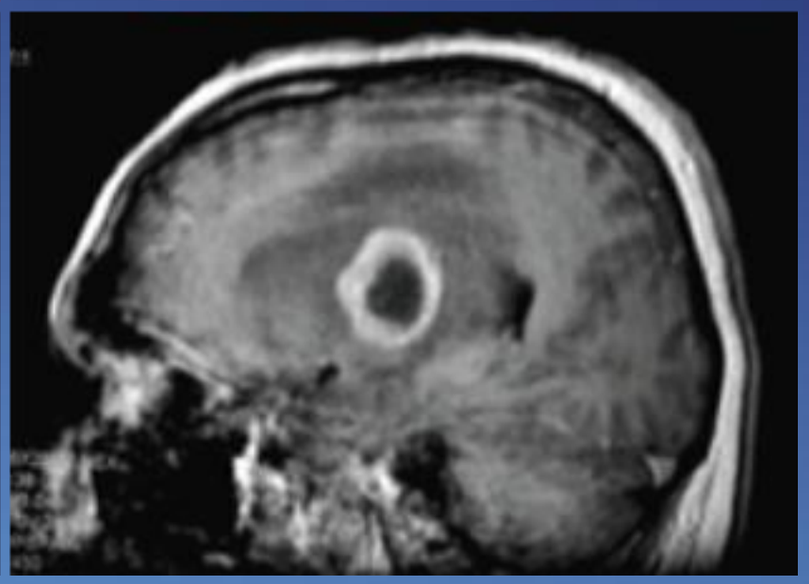
- Neuronavigation

We started working adding the neuronavegator to **iMRI** in the last two years.

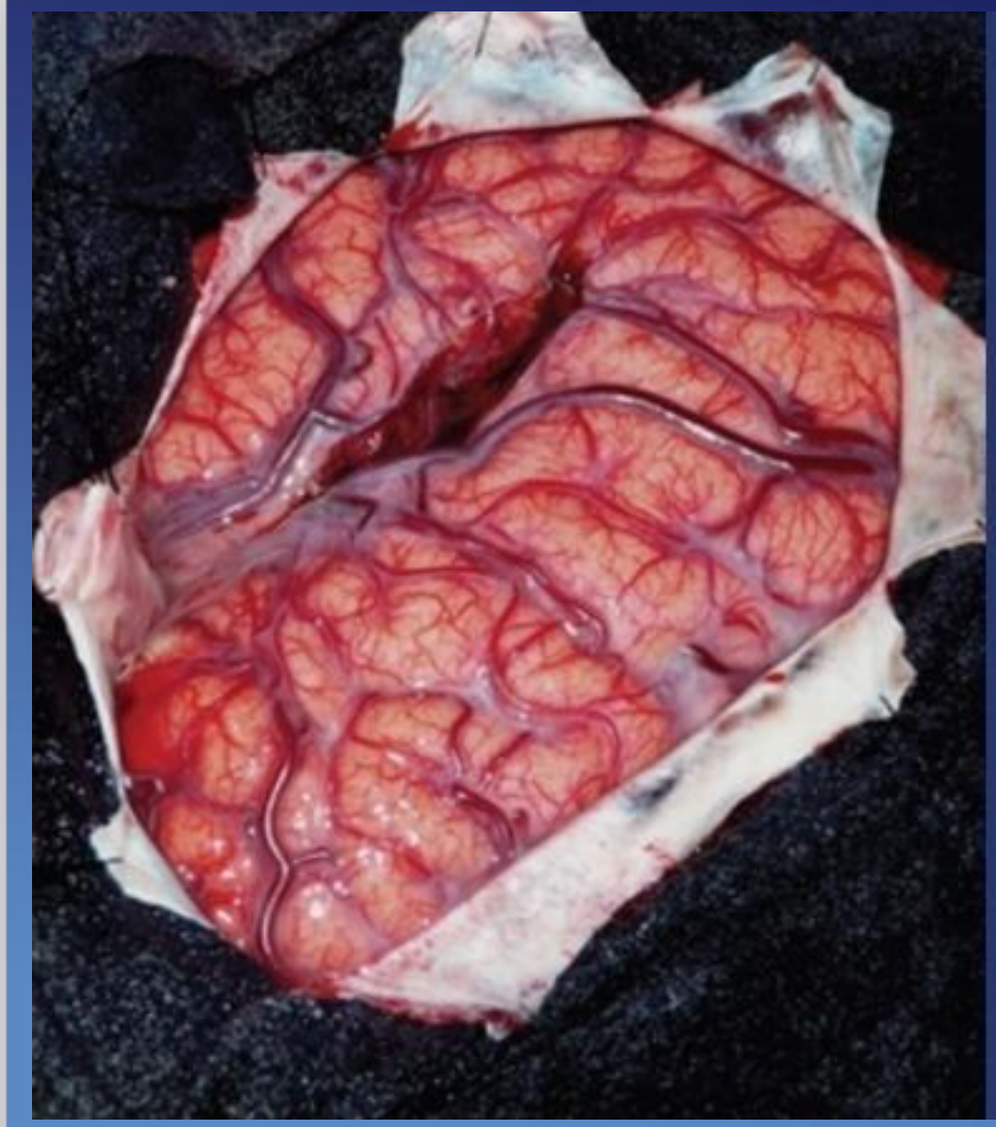
We use it mainly to guide the surgical approach and locate eloquent areas in the early stages of the operation.

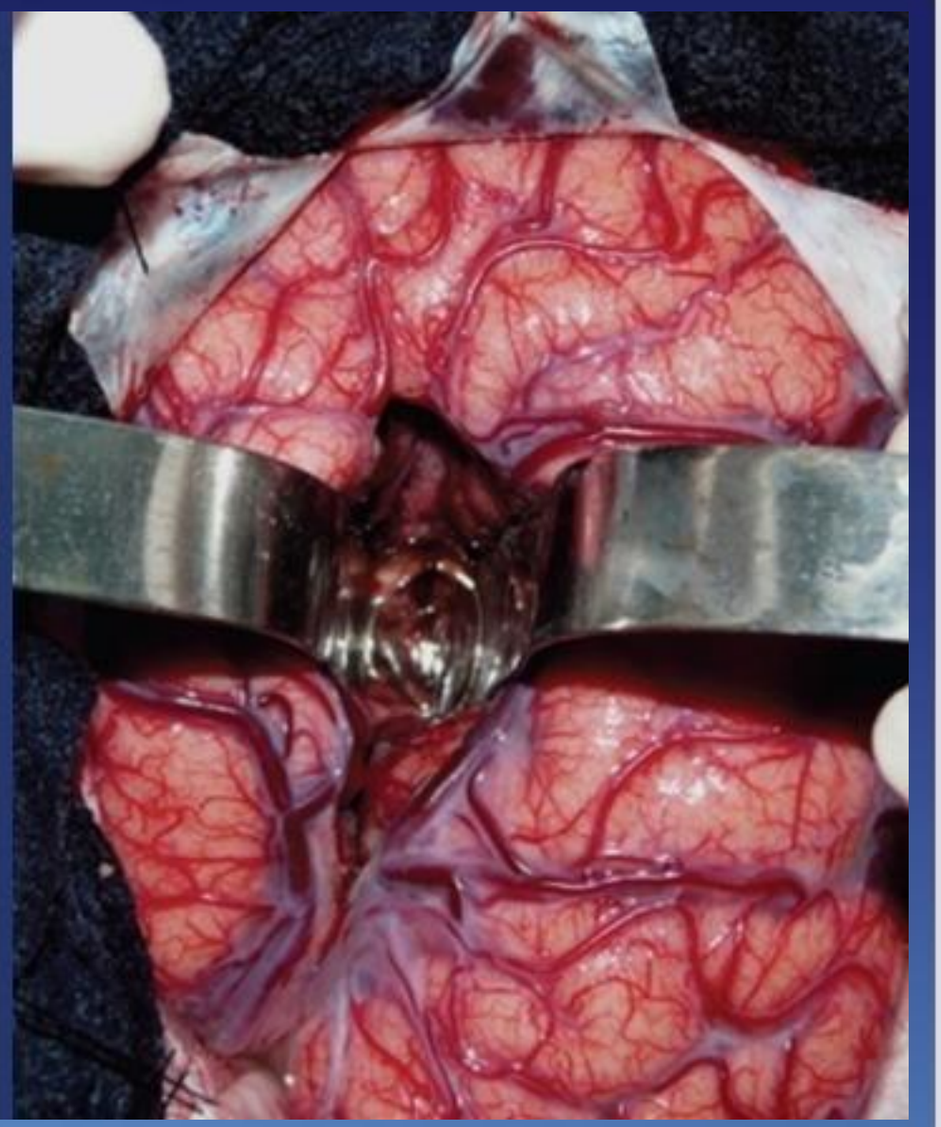






iMRI in
“ELOQUENT BRAIN AREAS”





DR. ROBERTO R. **HERRERA** AND COLLABORATORS

BUENOS AIRES //
ARGENTINA //

iMRI "LIMITATIONS AND PITFALLS"

(Arguing against the clinical benefits of Intraoperative MRI is very difficult).

COST

Certain economic and practical barriers also impede the large-scale use of intraoperative **MRI**. Clearly, performing **iMRI** for brain tumor resection increases costs, both for the equipment and site and for physician time. For high-grade malignant gliomas the additional cost may not be warranted, although perioperative morbidity rates would be expected to decrease with better intraoperative visualization.

"However, for low-grade gliomas, which are potentially curable with complete tumor removal, the use of IMRI, I believe that the cost is justified".

iMRI "LIMITATIONS AND PITFALLS"

Surgical Patient Position

With our system, we can not operate patients in sitting position.
Companies that manufacture magnetic resonance equipment that are used to operate, should in the future design operating tables that allow better patients positioning during surgery.

We modify the original operating table to operate in all surgical positions except in sitting position.

iMRI “LIMITATIONS AND PITFALLS”

Infections Incidence

The infections range is the same as in conventional neurosurgery.

Brain Shift

The brain shift during surgery is not a problem because the anatomical landmarks are taken from new **MR** imaging obtained while the surgery is performed.

Special instruments

The surgical microscope, microsurgical tools and conventional neurosurgery instruments, can be used throughout the operation because the magnet is turned on only for intraoperative controls. During the rest of the time, the magnetic field is off.

CONCLUTIONS

In all brain gliomas operations a **GROSS TOTAL RESECTION** should be attempted and intraoperative **MRI** is very useful for this.

This is why we believe that all Brain Gliomas should be operated with Intraoperative M.R.I.

CONCLUTIONS

We think the brain gliomas surgery, reached its Highest point with the **iMRI.**

We should work on how to detect gliomas earlier than we are doing now and so, we will be able to cure a lot of them.

THANK YOU!

PresentationPoint

dr.roberto.herrera@gmail.com