



# Impact(s) of IOMRI on the Academic Practice of Pediatric Neurosurgery

IHIWG / ASNR Meeting  
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# Disclosures

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- None



# Achieva 3.0- OR Juxtaposition





# MR guided DBS/Catheter placement



## DBS electrode insertion

- Titanium stylet is removed, leaving peel-away sheath
- DBS electrode is inserted through sheath lumen



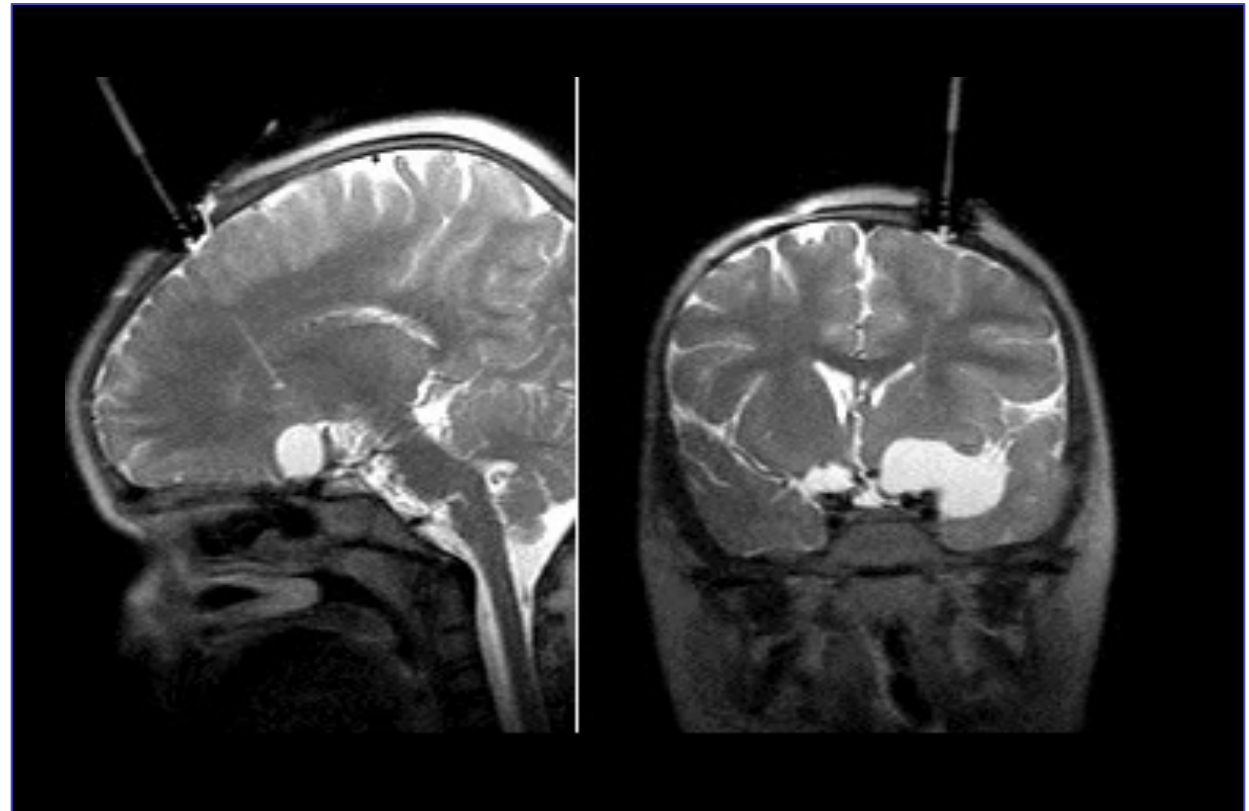


# Real-time interactive biopsy planning



## Cyst drainage / P32 administration

Real-time MR-guided biopsy (0.6 sec / image)



Courtesy: University of Minnesota, Minneapolis



# MCH Pediatric Brain Suite; October 2009









# Next generation Philips ioMRI Neurosurgery solution



- Built on experience from multiple sites
- Addressing the need for increased flexibility in system siting
  - Trolley based patient transfer system
- Addressing need for economic justification
  - Dual room, dual use
- Teaming up with strong partners to address specific demands of neurosurgery
  - *Maquet*: Fully functional OR table
  - *BrainLAB*: Navigation
  - *Noras MRI Products*: Integration of head fixation and RF coil





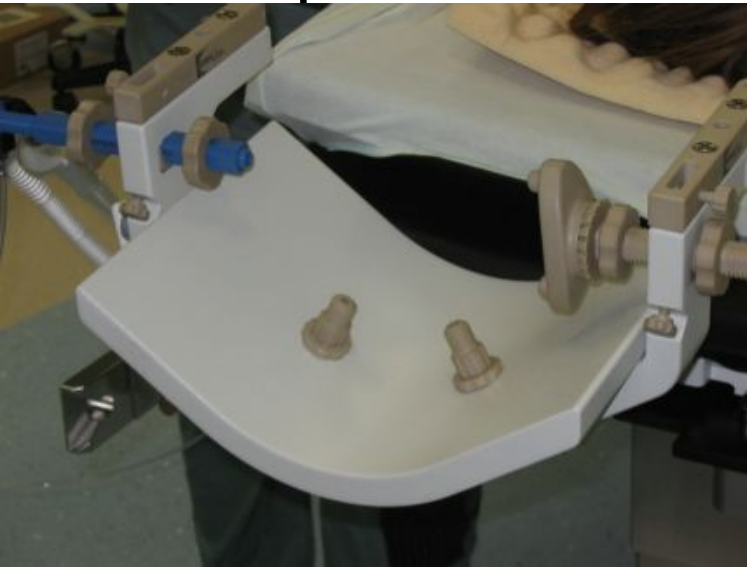


# 8 Channel coil/5 pin HH



# Technical Aspects

- Preparation for imaging

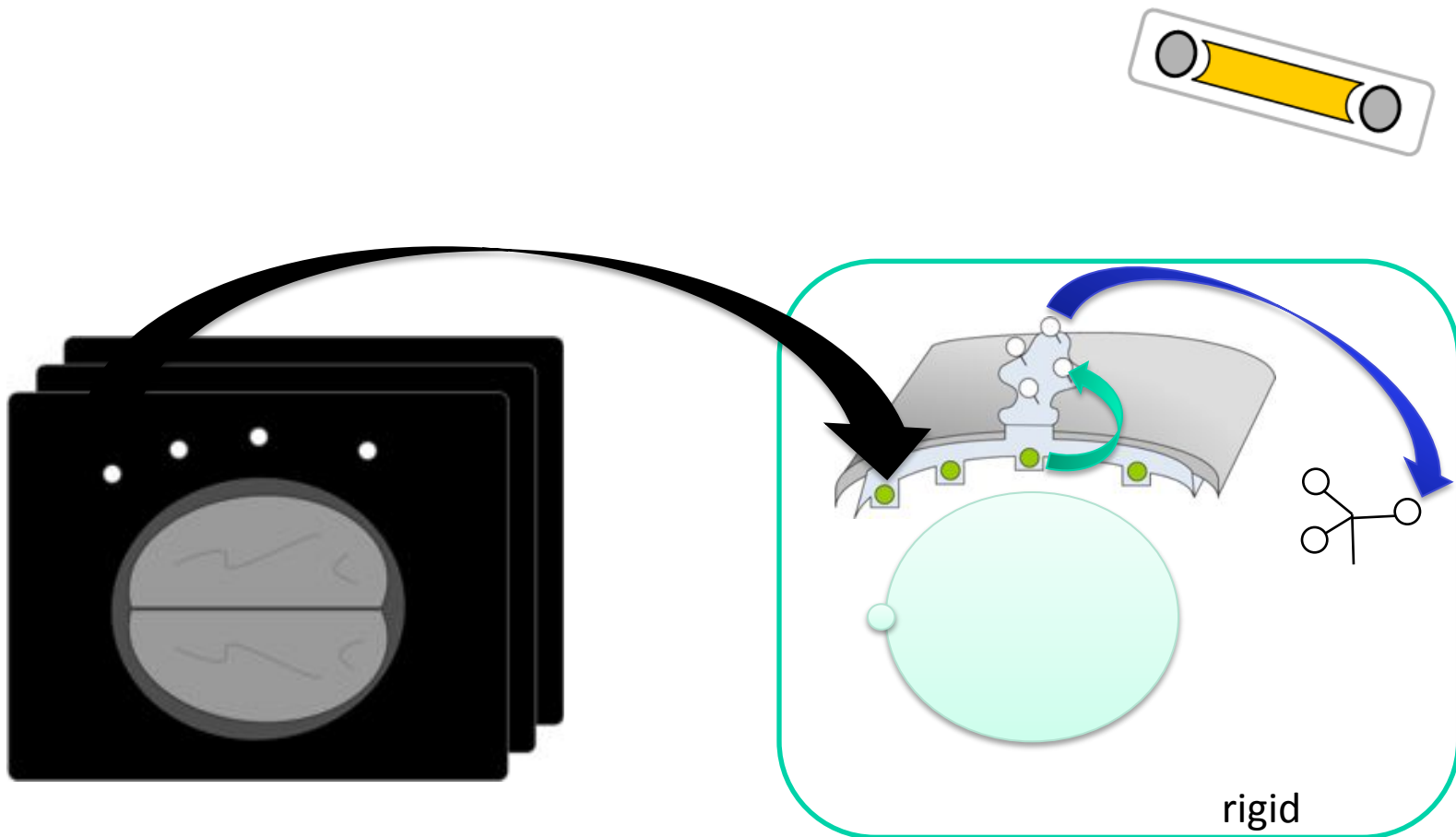


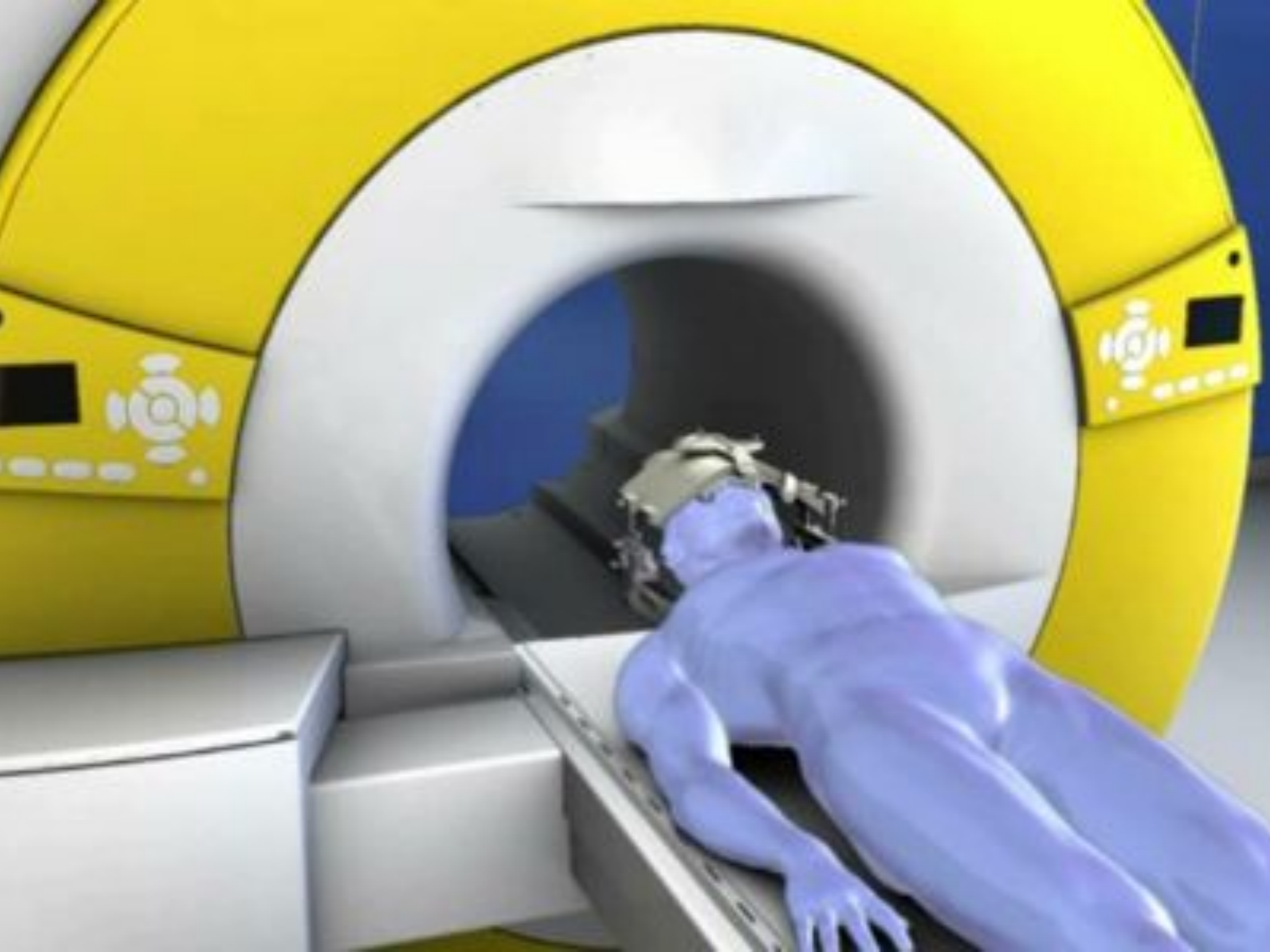


# AUTOMATIC IMAGE REGISTRATION (AIR)



## TECHNICAL BACKGROUND







# Brain Suite: Seven areas of impact

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1. Diagnostic imaging delays prior to 2009
2. Virtual surgery as a pedagogical tool
3. Preop – planning
  - a) Tumor surgery
  - b) Epilepsy surgery
4. Completeness of resections    -Tumors  
  -Epilepsy
5. Morbidity (Intra-operative/ Postoperative)
6. Understanding disease processes
7. Evaluation of technology





# Impact 1: Diagnostic Delay



Prior to 2009:

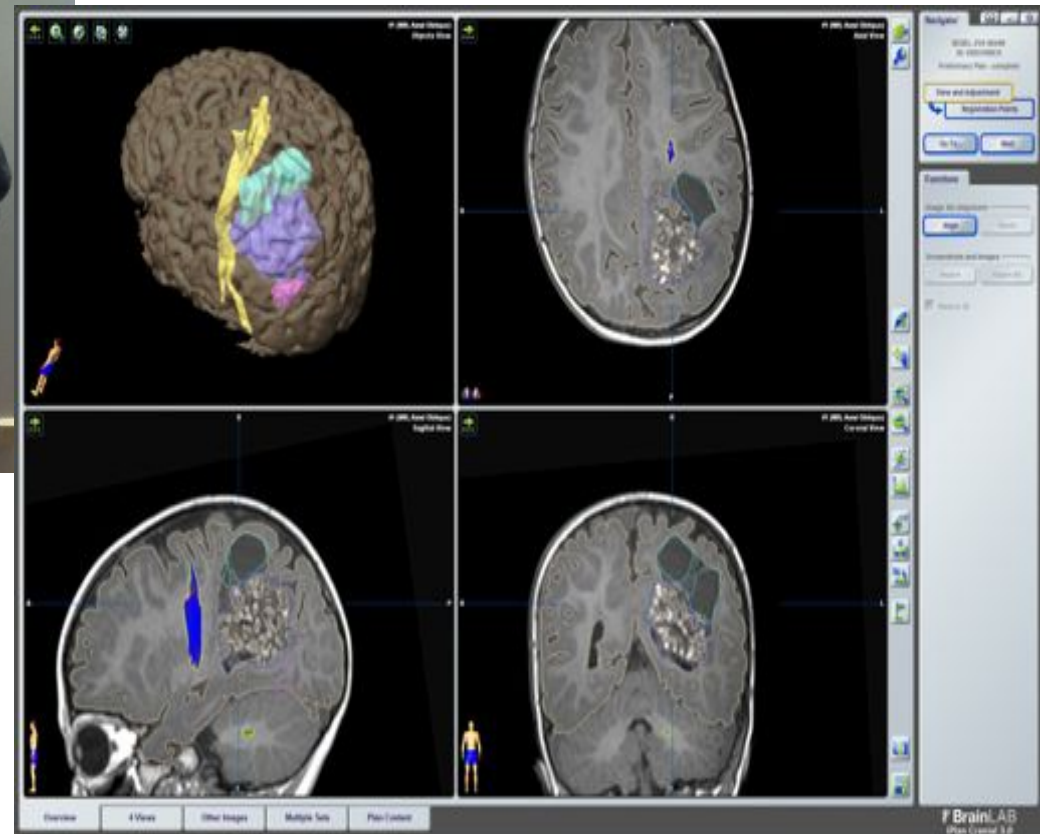
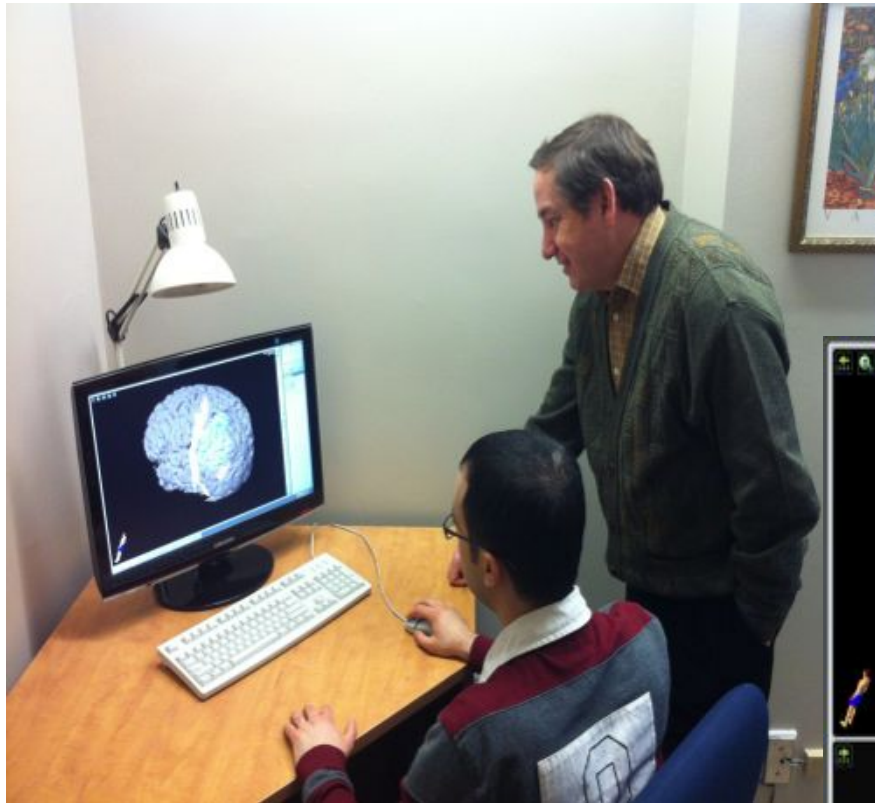
- DI latency: Up to 18 months and 800 cases waiting
- 6 D.I. cases done per day

After 2009:

- No waiting list except for cases requiring G.A. within 6 months
- 20-22 D.I. cases done per day

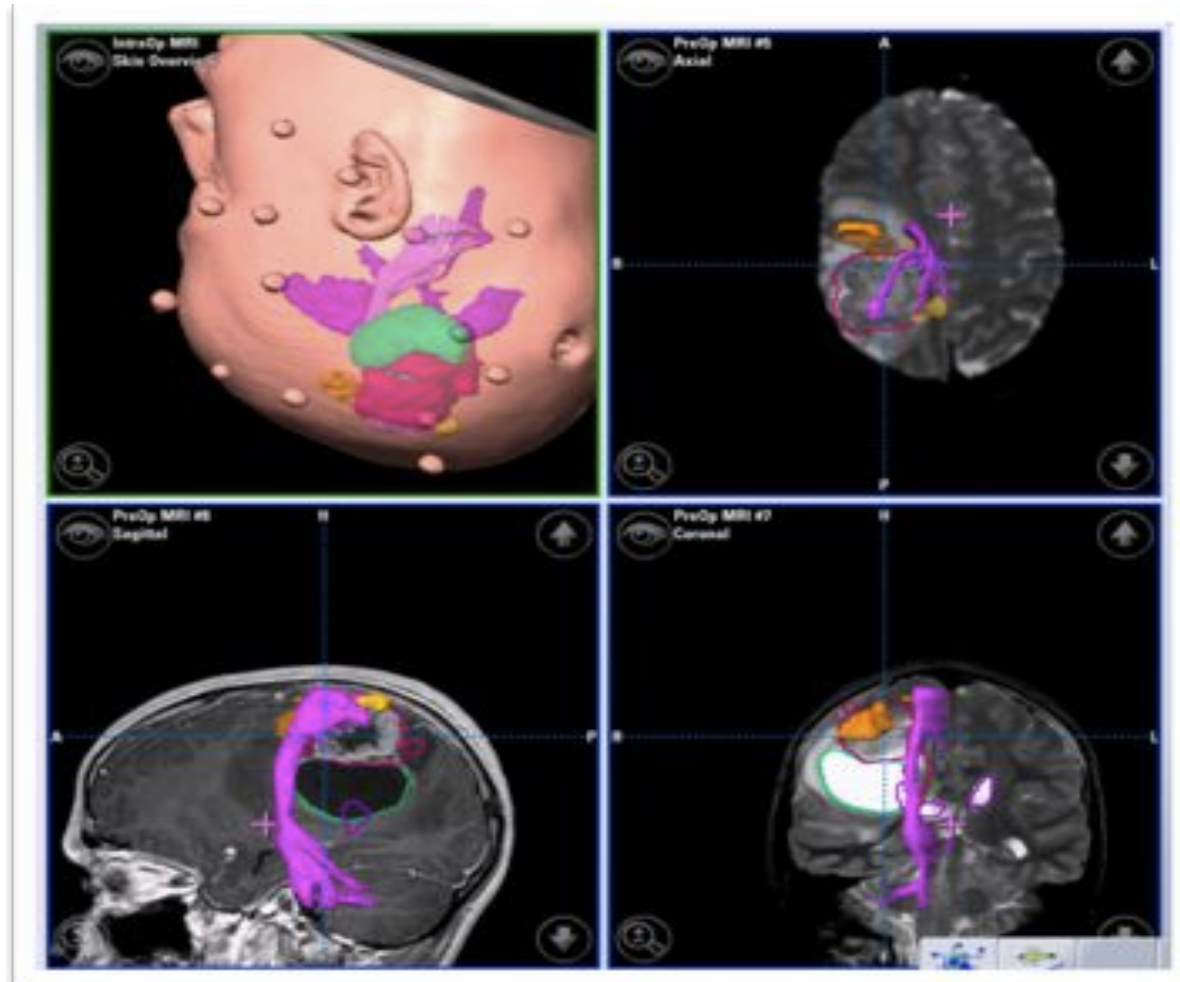


## Impact 2: Virtual Surgery as a Pedagogical Tool



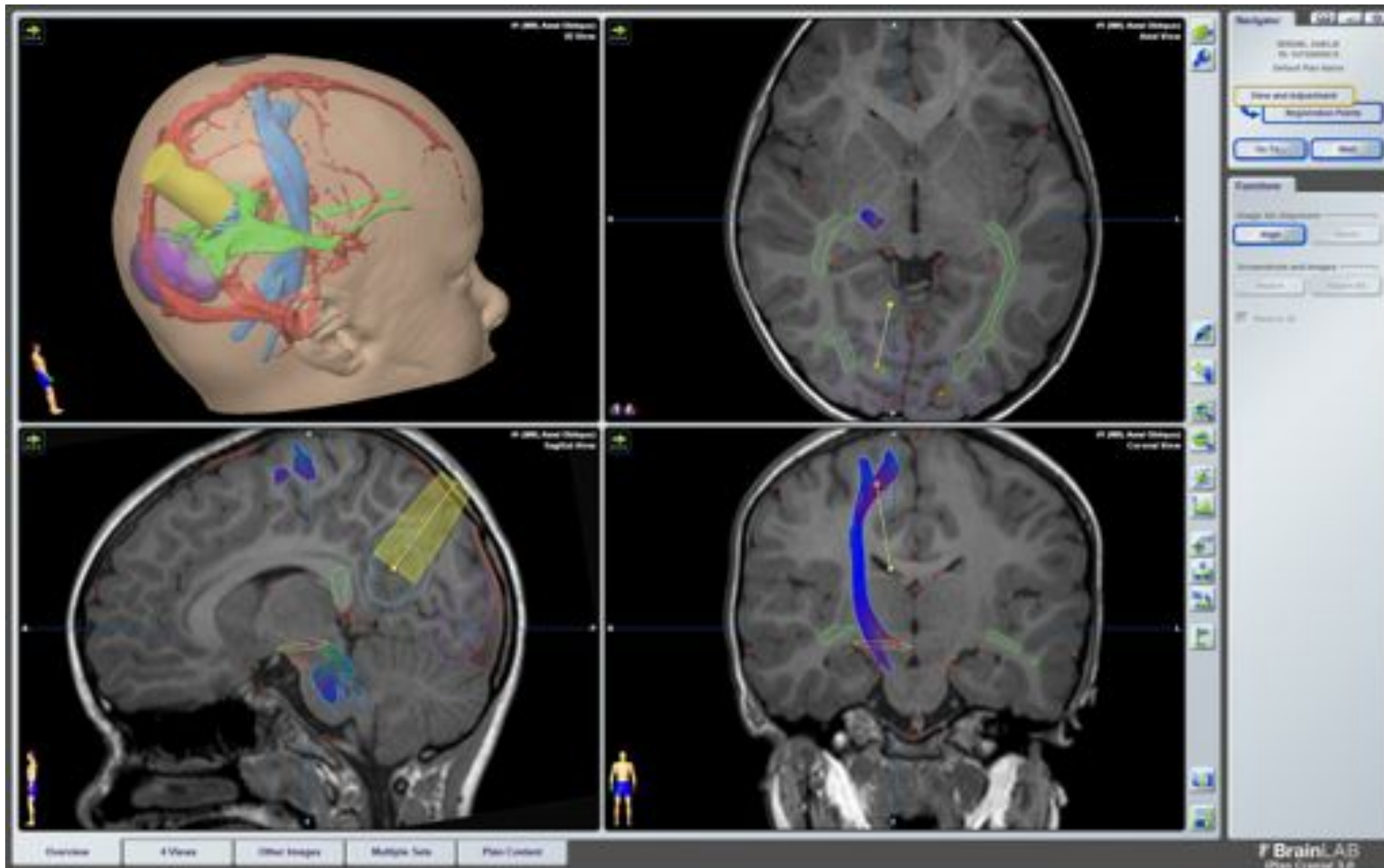


# Navigational Access to Complex Planning



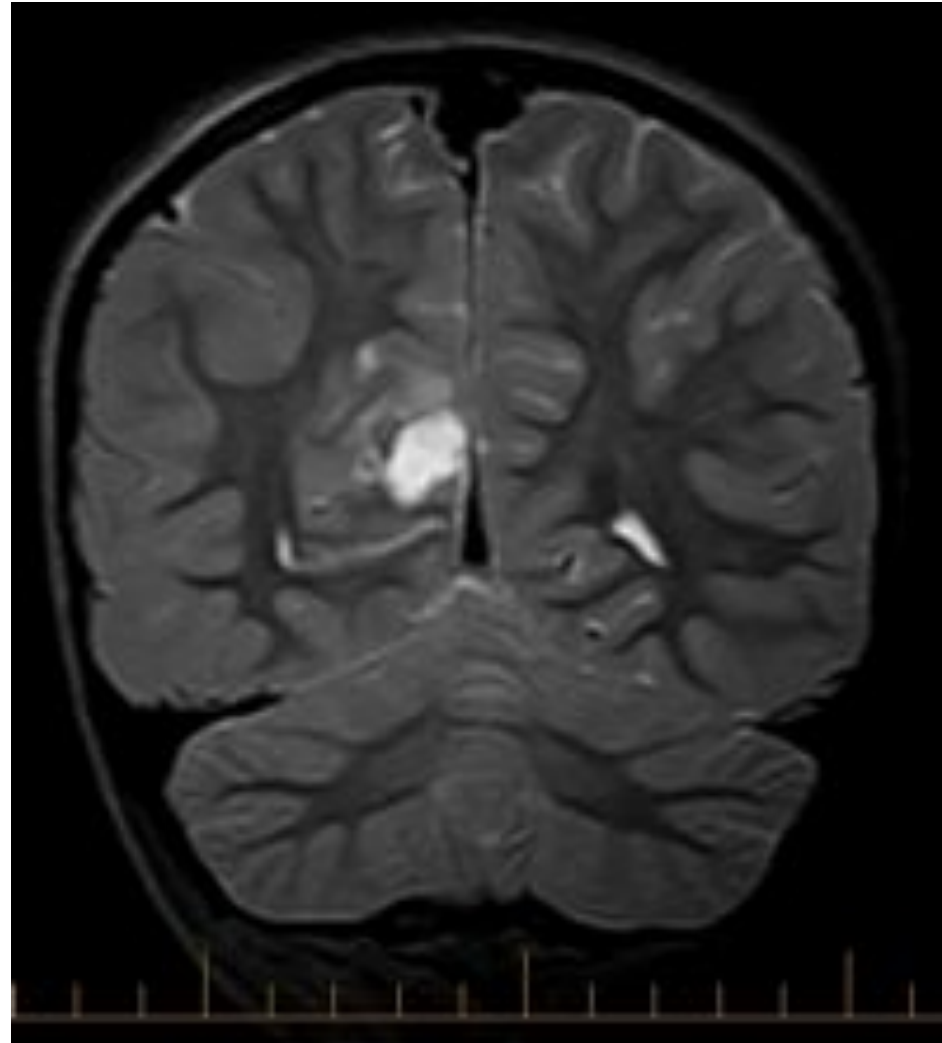
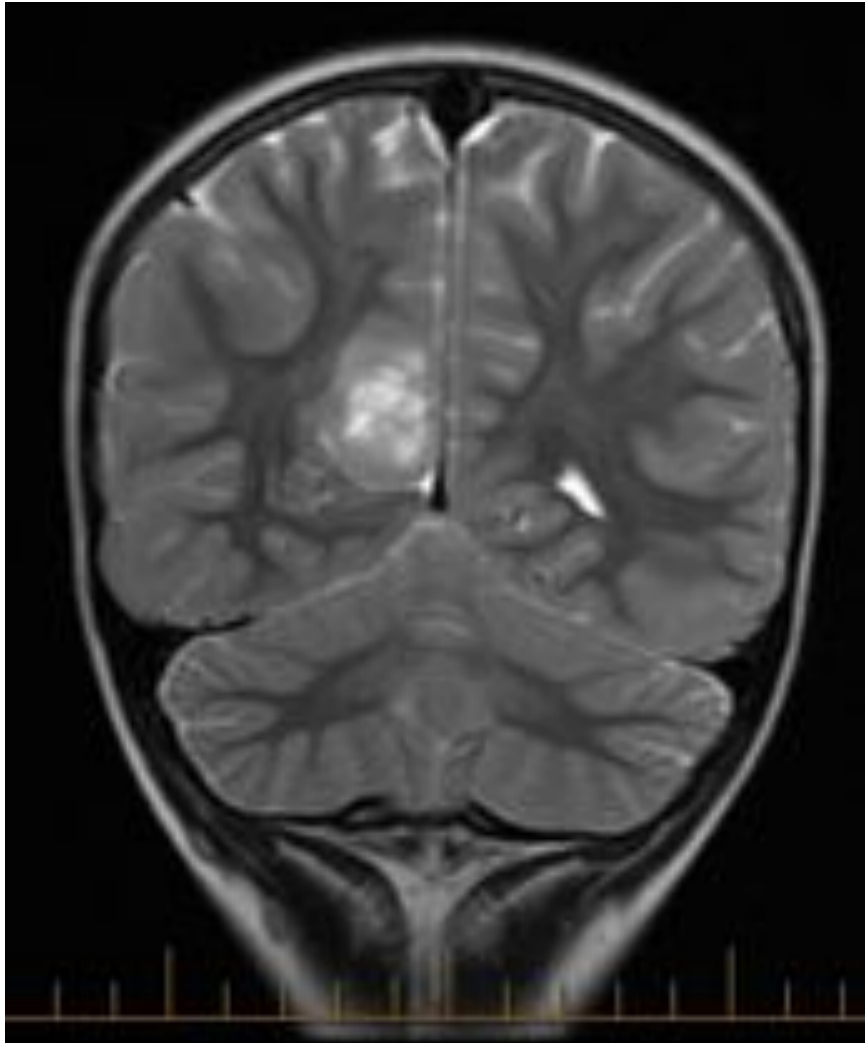


# Mesial-Occipital DNET





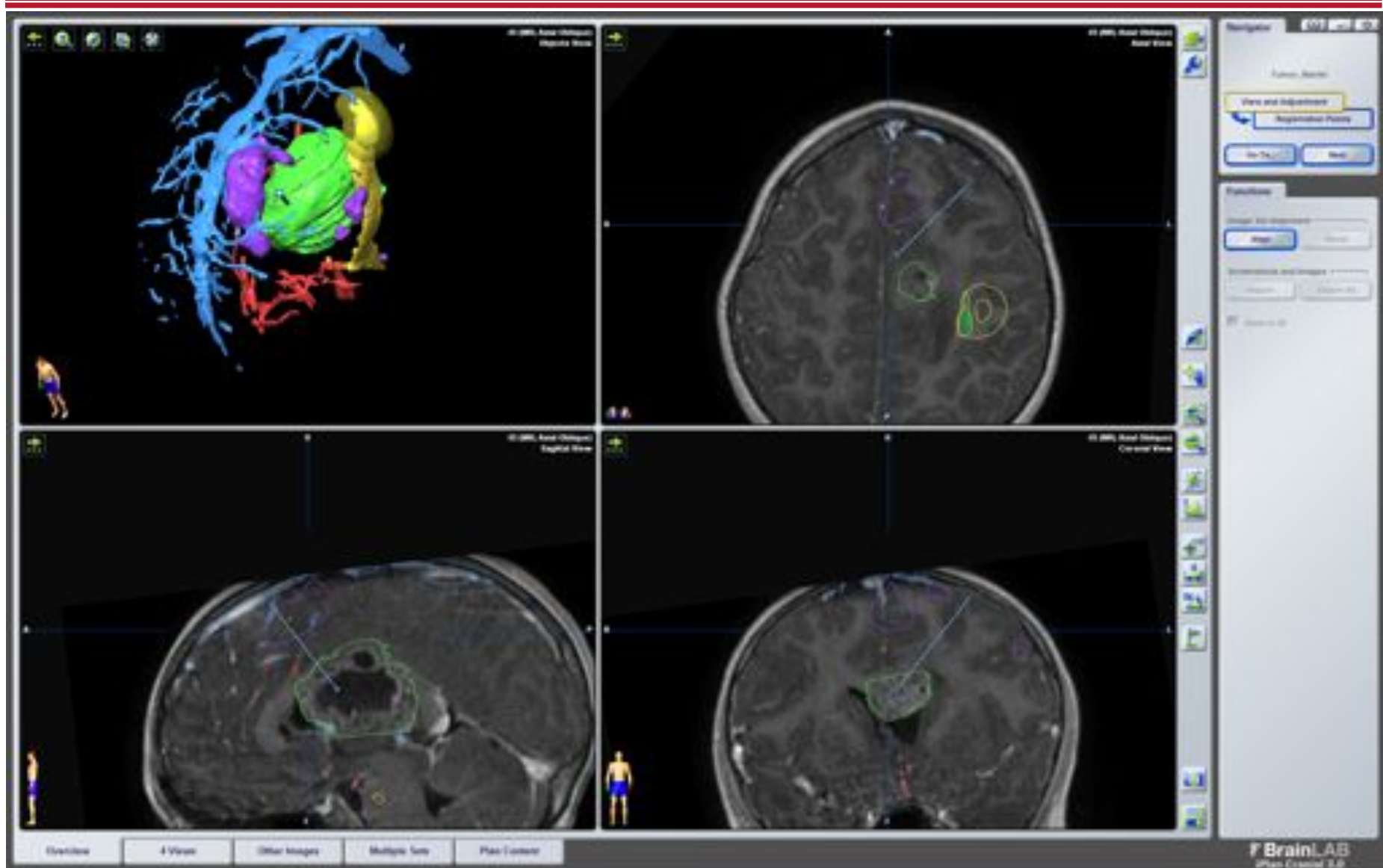
# Mesial-Occipital DNET (Pre/Post)





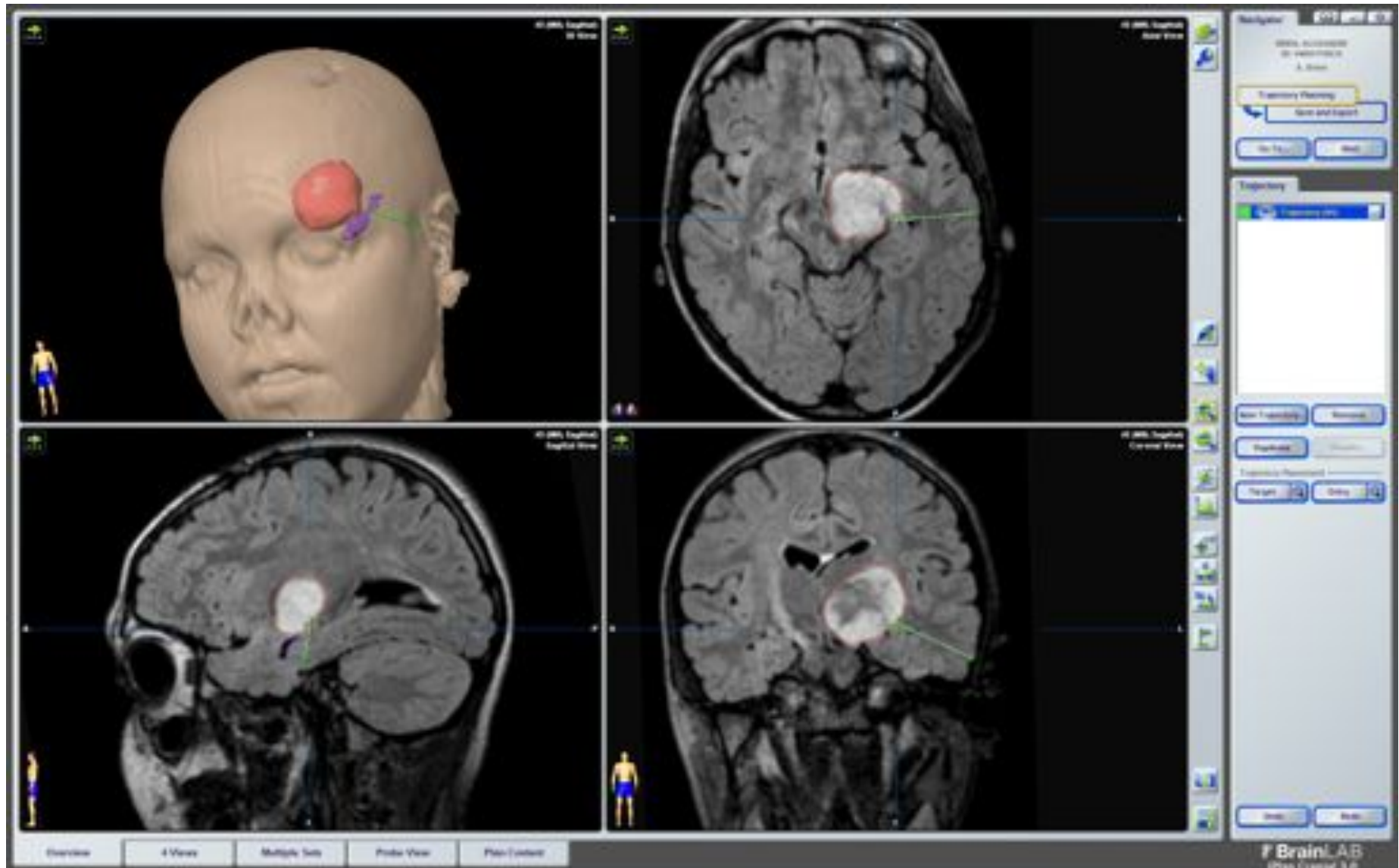


# Virtual Surgery with fMRI and tractography



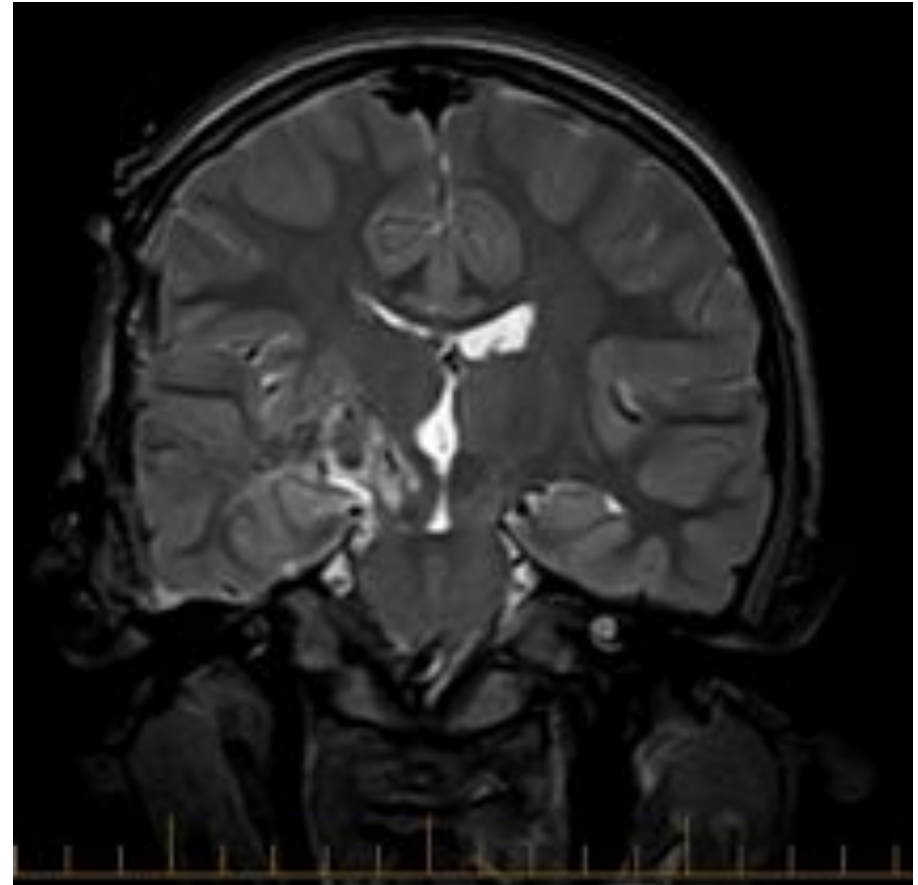
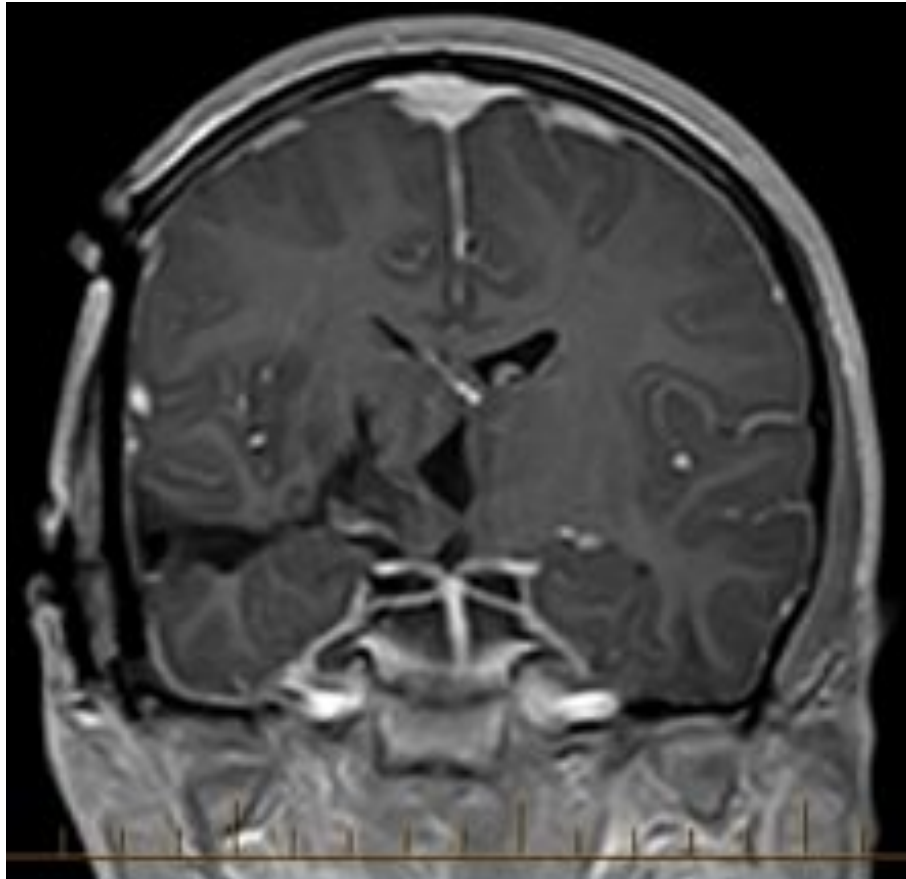


# Impact 3: Planning the approach



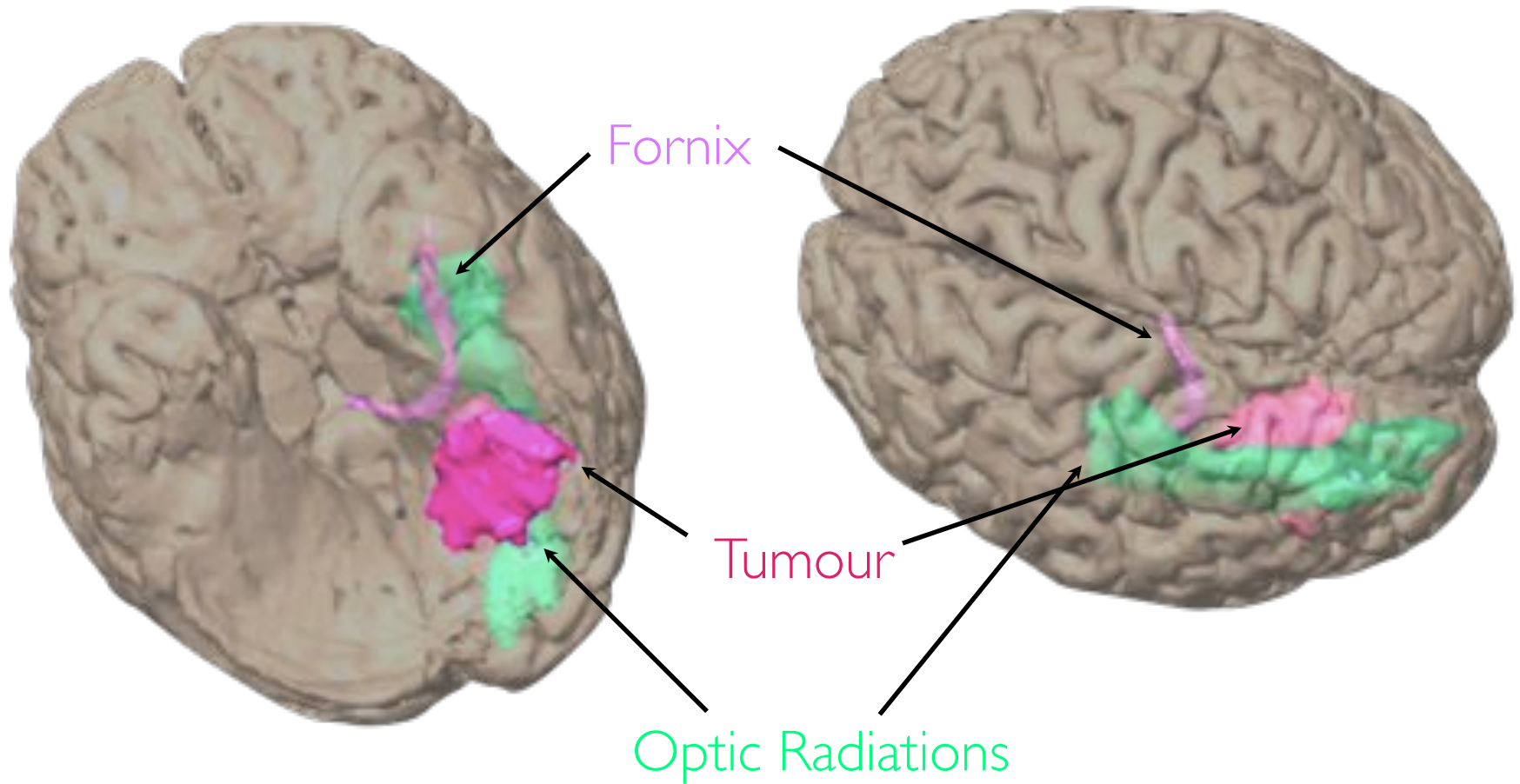


# Thalamo-mesencephalic Tumor





# Impact 3: Planning the approach

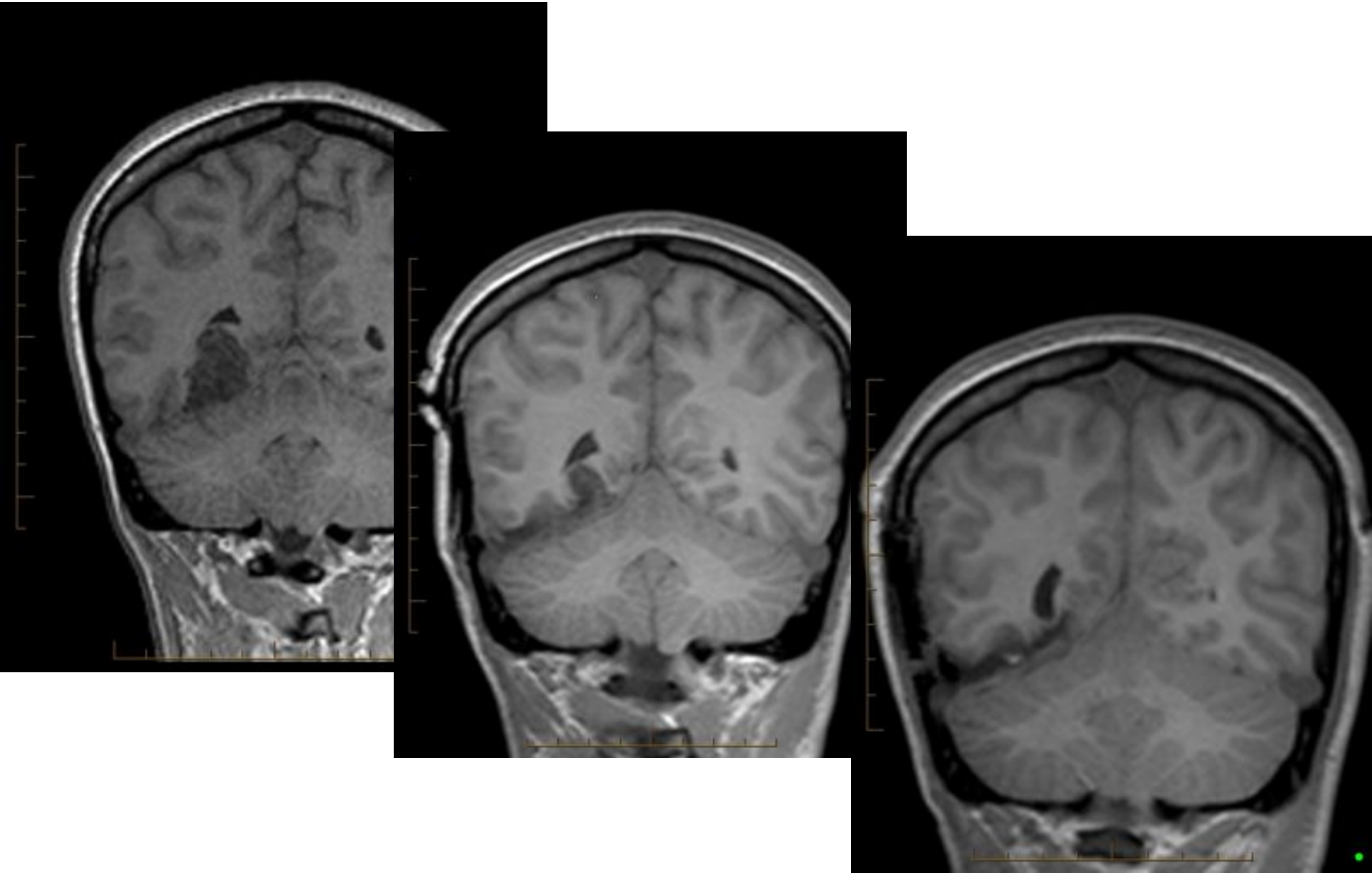


3D Navigation with DTI





# Left Sub-temporal DNET







# Impact 4: Scanning in the Surgical position vs Completeness of resections

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# Impact 4: Tumor Resections



## Pre IoMRI

- 3D T<sub>1</sub>

## Post IoMRI

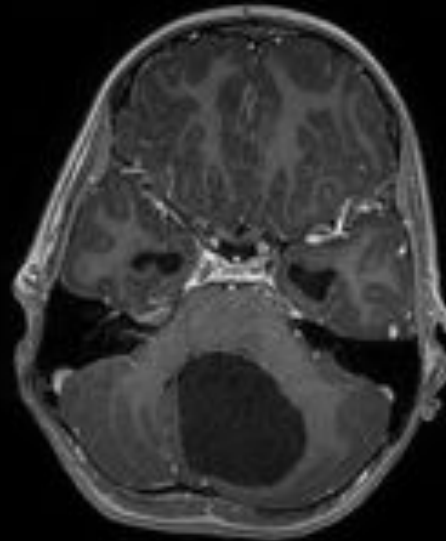
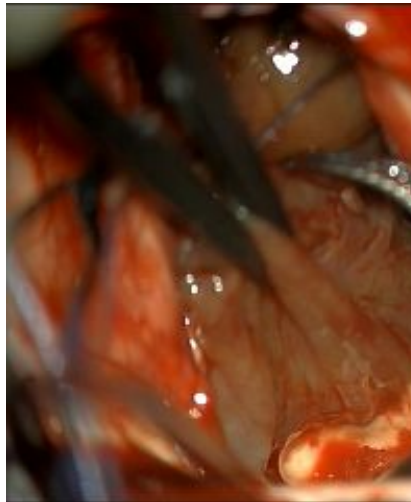
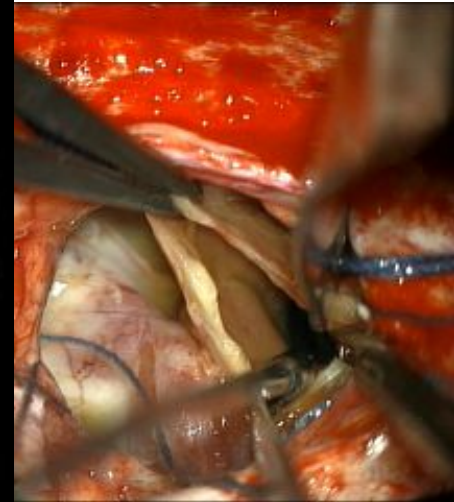
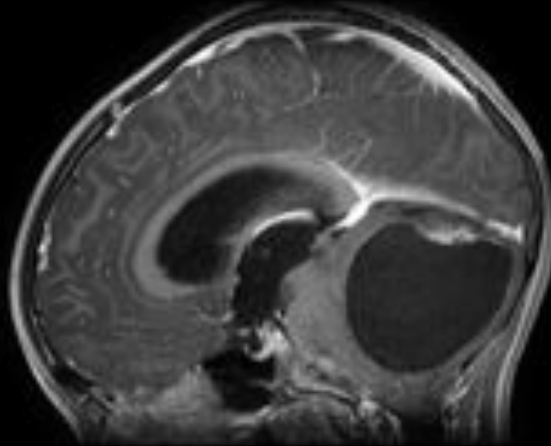
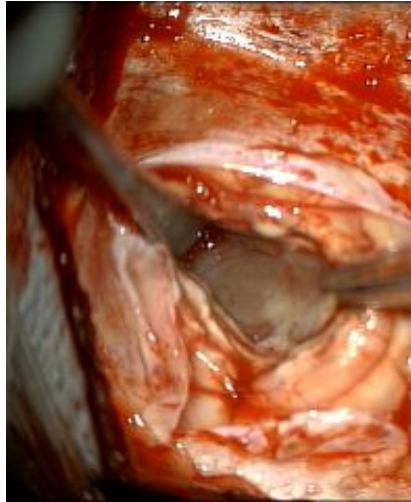
- 3D T<sub>1</sub>
- 3D T<sub>2</sub>
- Ax FLAIR
- 3D T<sub>1</sub>  
Post-Gd

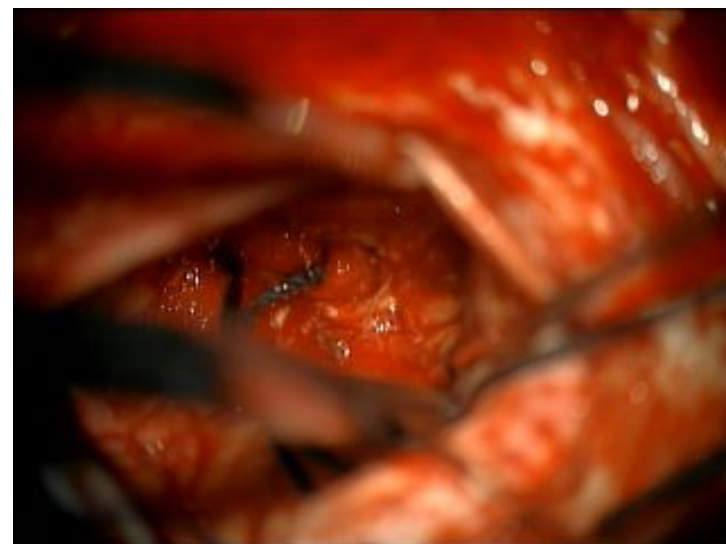
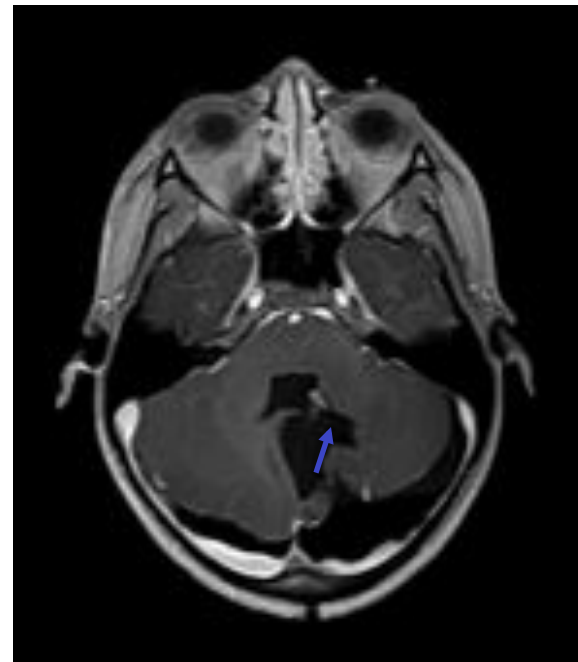
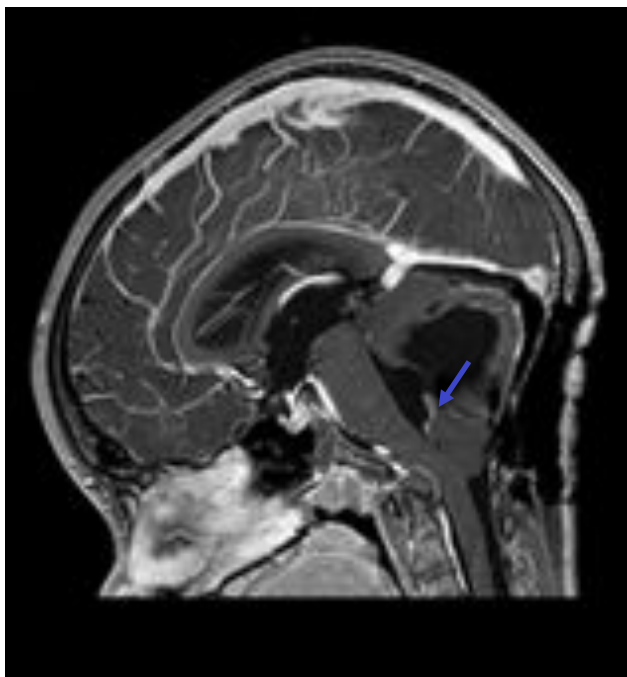
## Follow-up

- 3D T<sub>1</sub>
- Ax T<sub>2</sub>
- Ax FLAIR
- DWI
- 3D T<sub>1</sub>  
Post-Gd



# Tumors: Interpretation Learning Curve

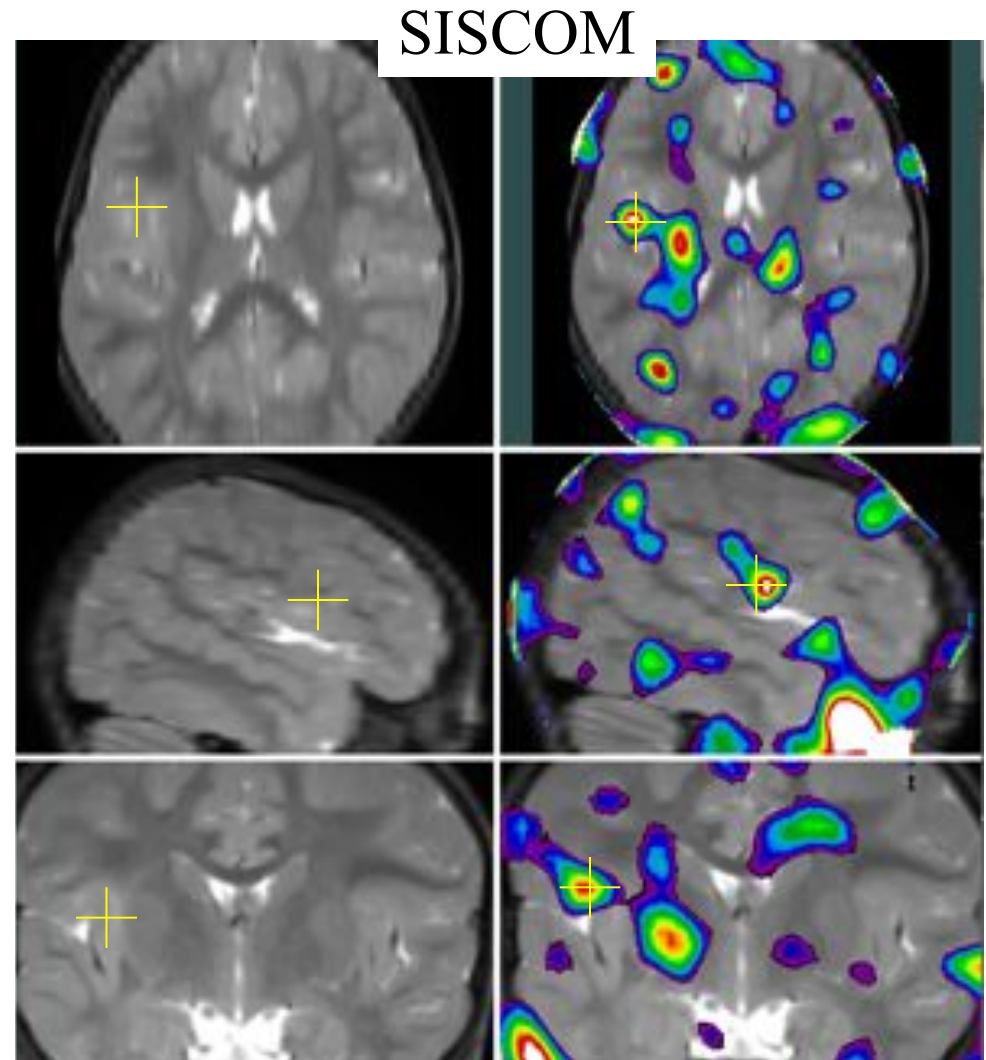
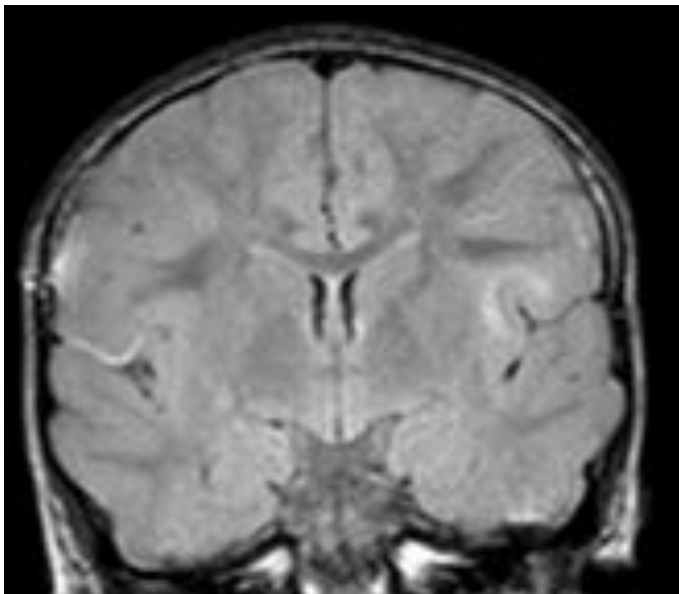
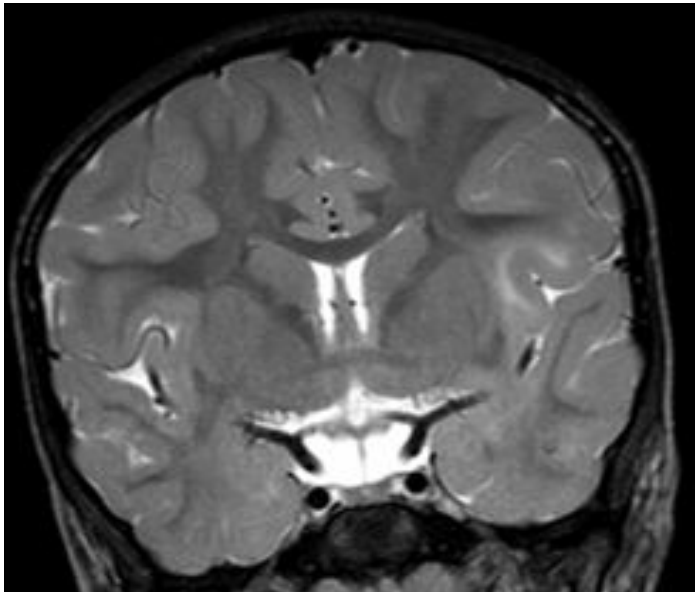






# Impact 4: Quality of Resections

## Study 2- Epilepsy

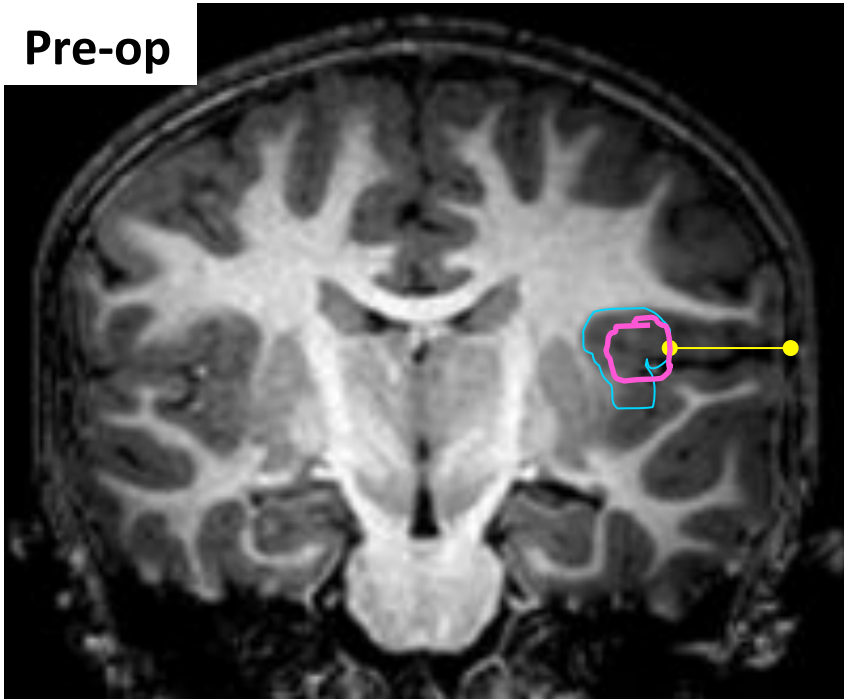


Subtraction Ictal Spect Coregistered to MRI

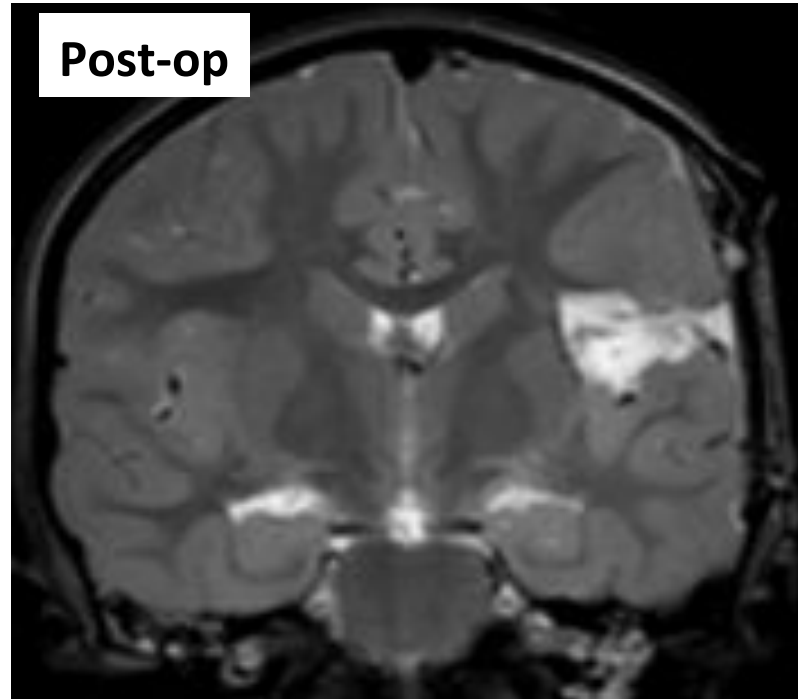


**Case # 13: 2yo girl Intractable Epilepsy (L. Frontal focus on EEG)**  
**Suspected Cortical Dysplasia of Left Frontal Opercular Cortex**

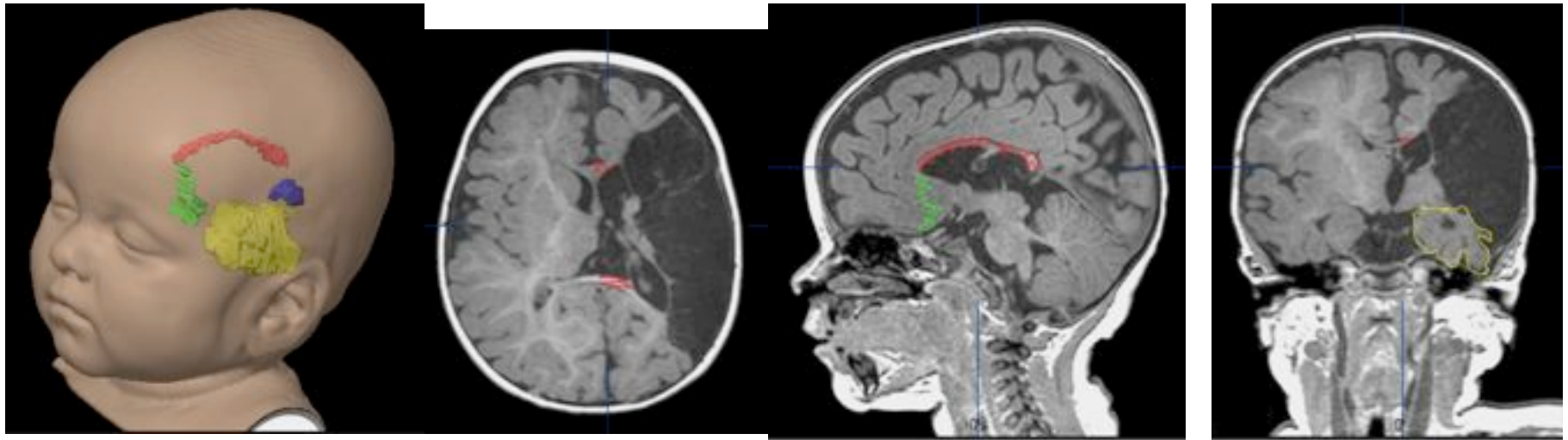
**Pre-op**



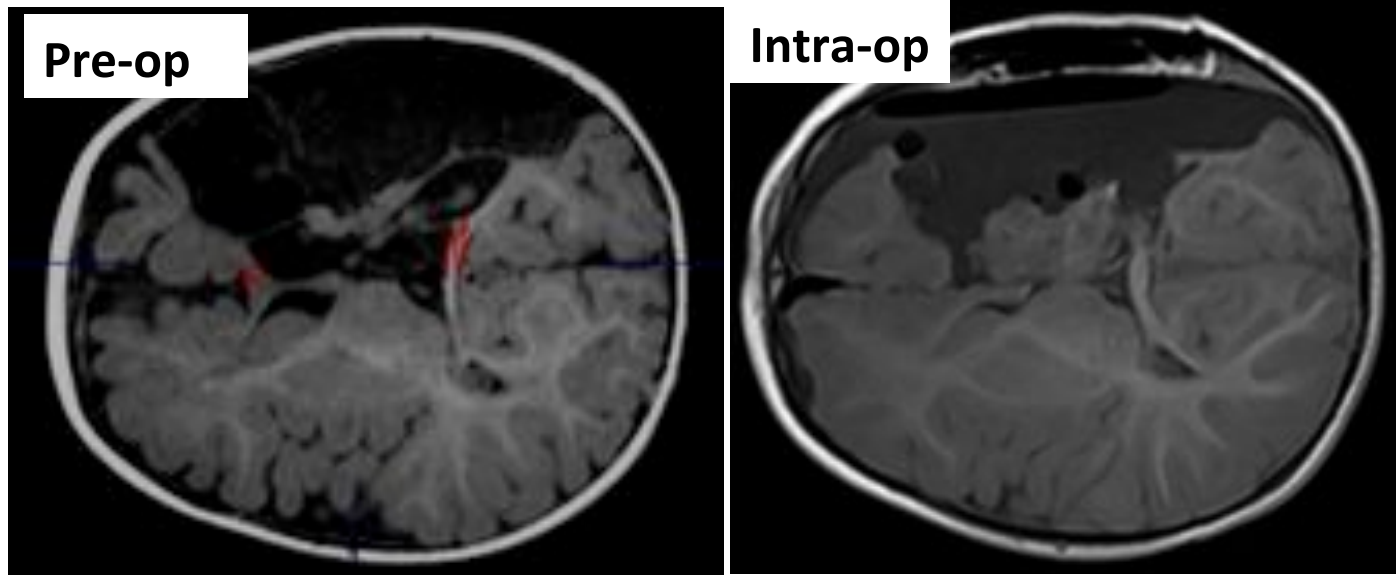
**Post-op**



## Case #19: 11mo girl, R. hemiparesis since birth, epilepsy on 3 meds



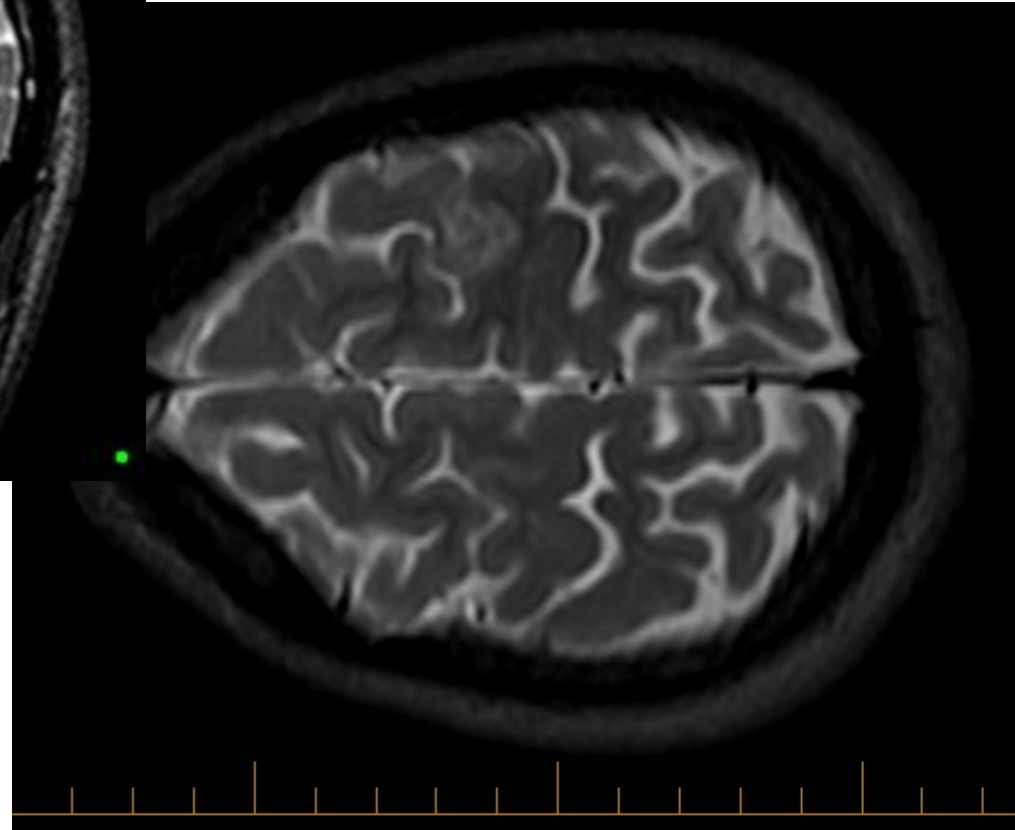
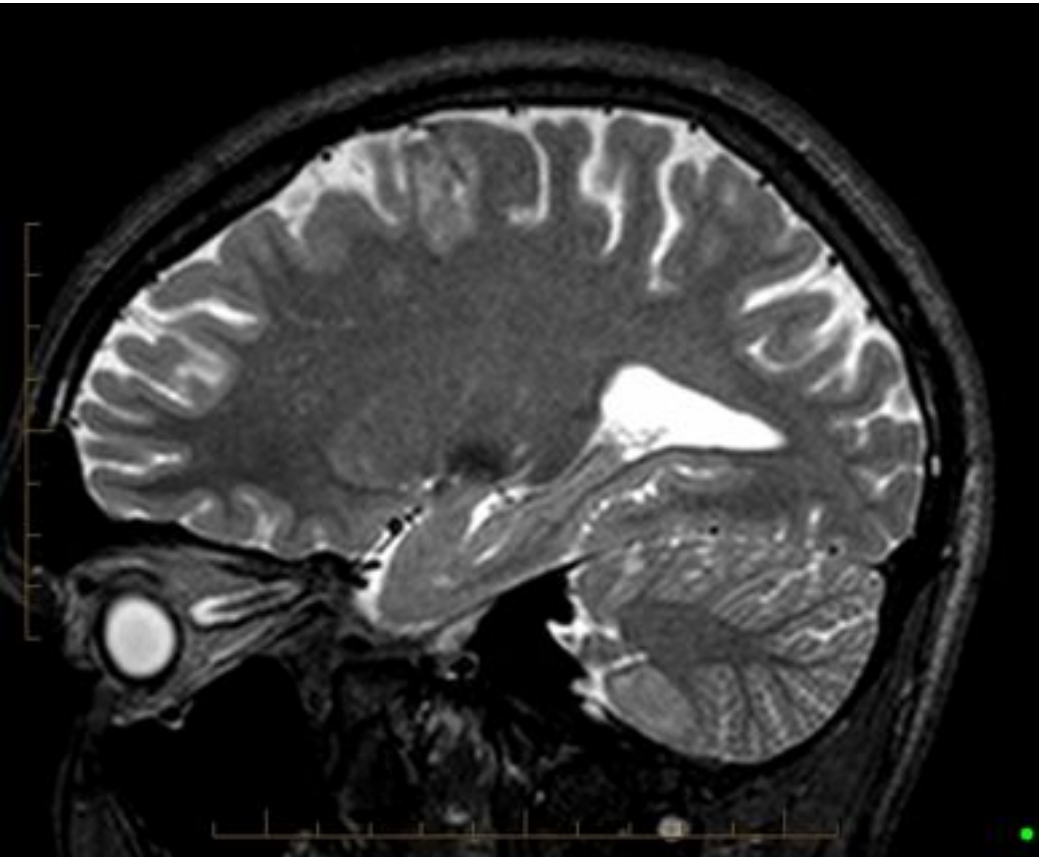
Pre-operative Hemispherectomy Planning



Neuronavigation remained accurate despite collapsed cyst.  
iMRI revealed adequate disconnections as planned

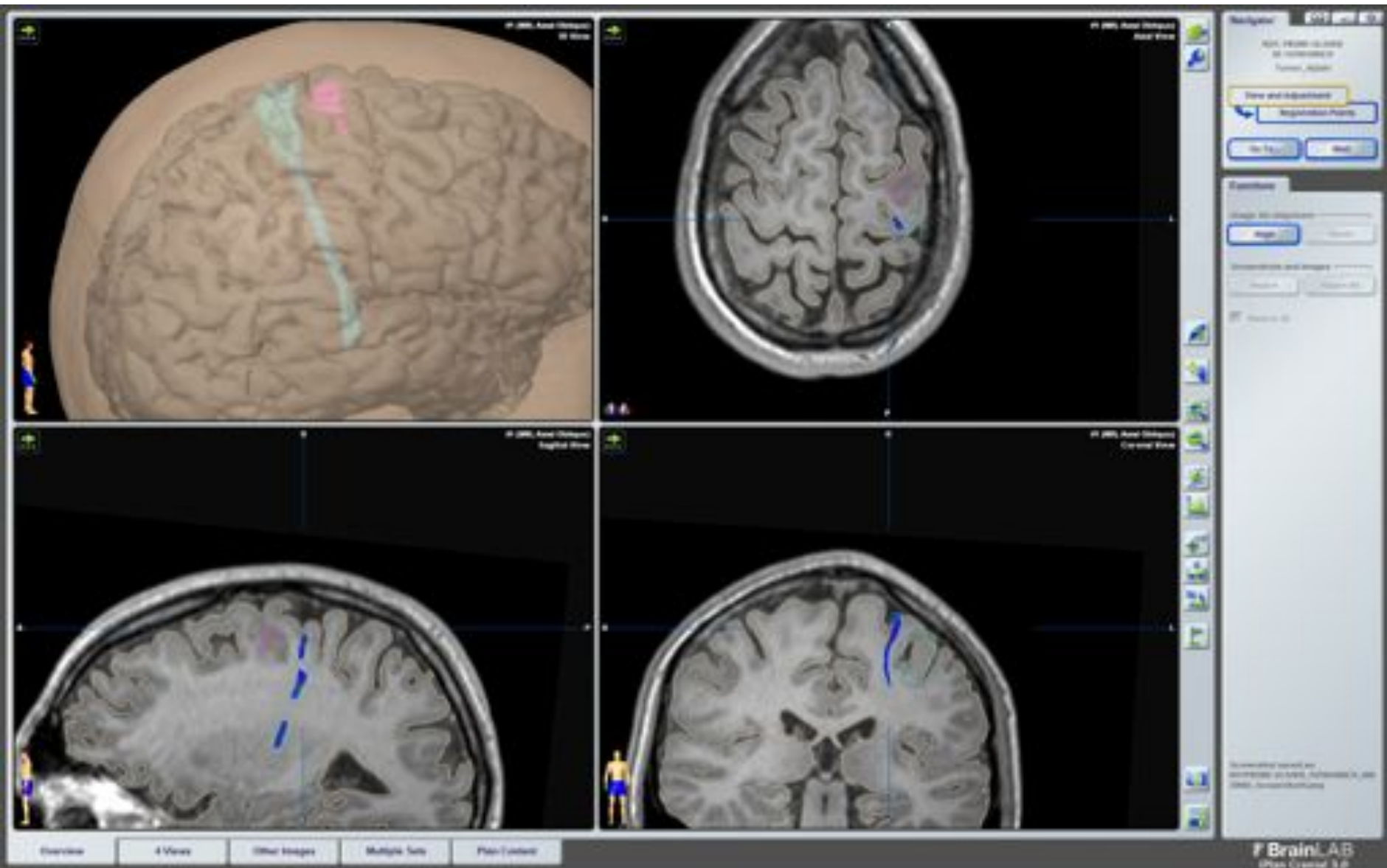


# Dominant Neuro-Glial tumor NYS





# Dominant Central Ganglioglioma







# Dominant Central Neuro-Glial tumor





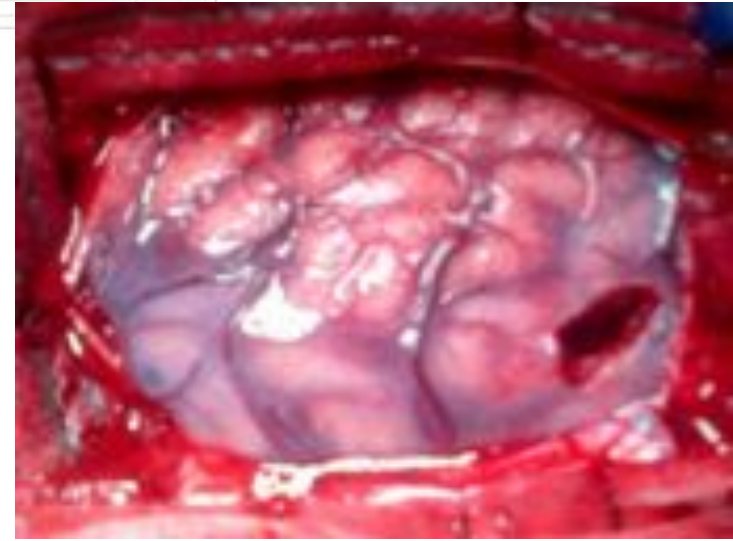
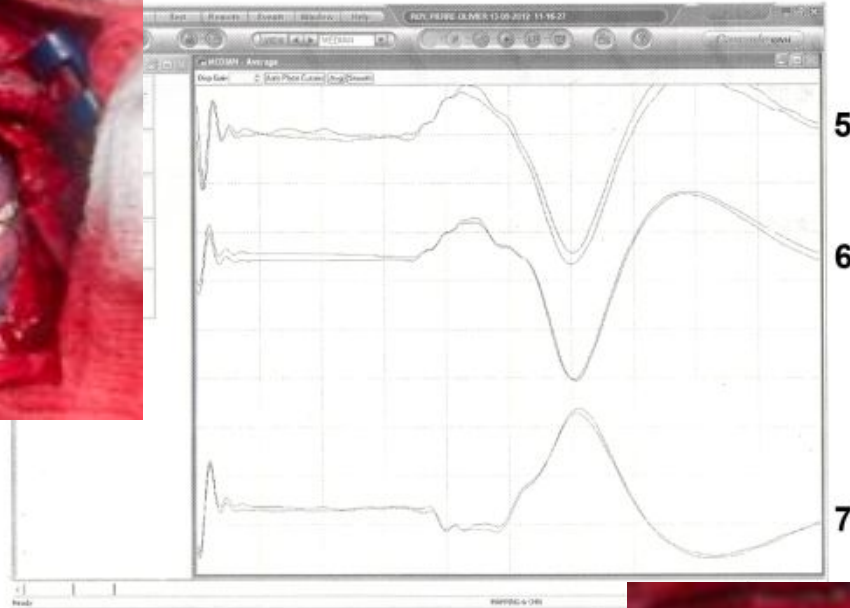
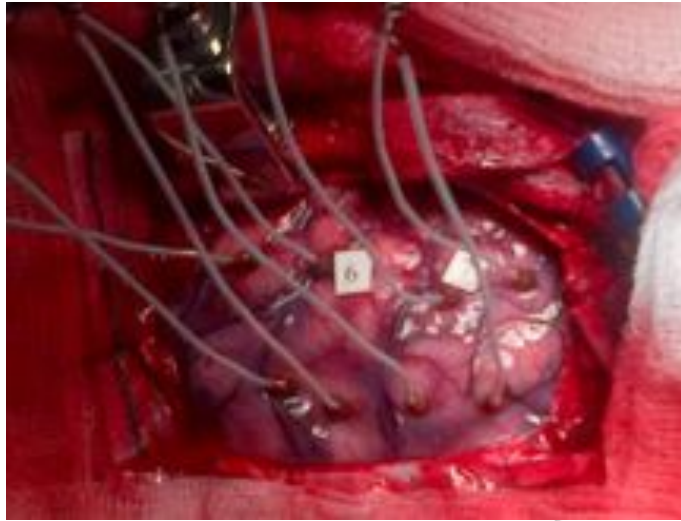


# Dominant Central NG Tumor



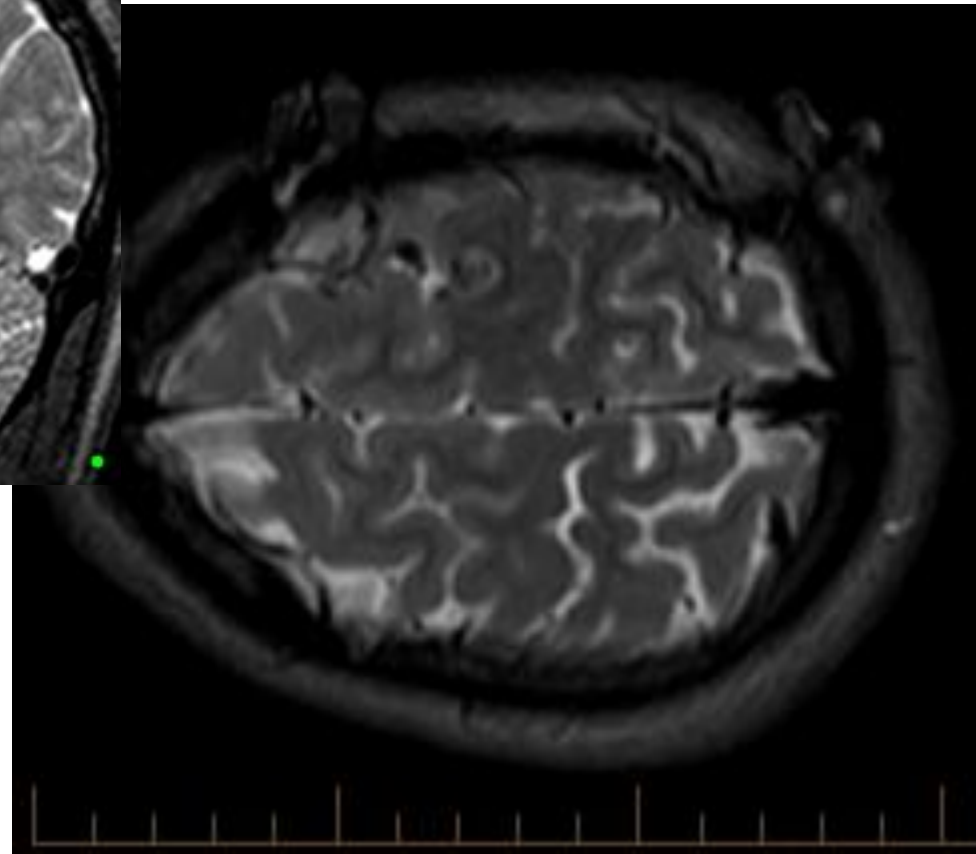
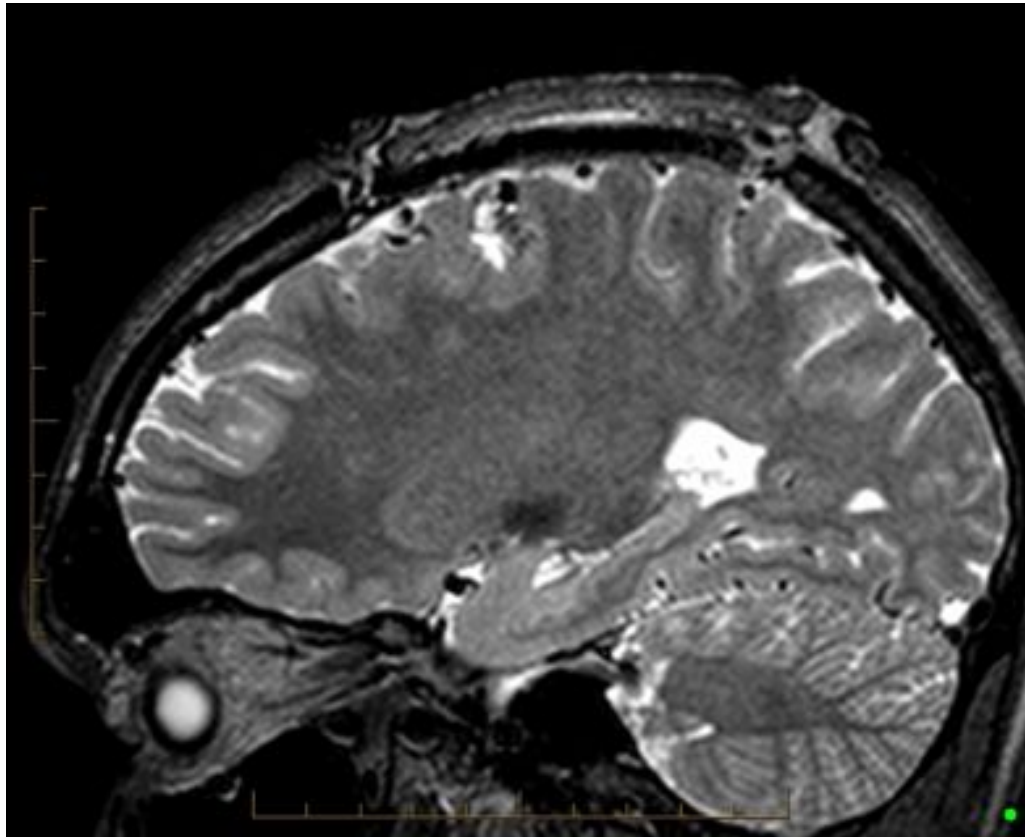


# Dominant Central Ganglioglioma



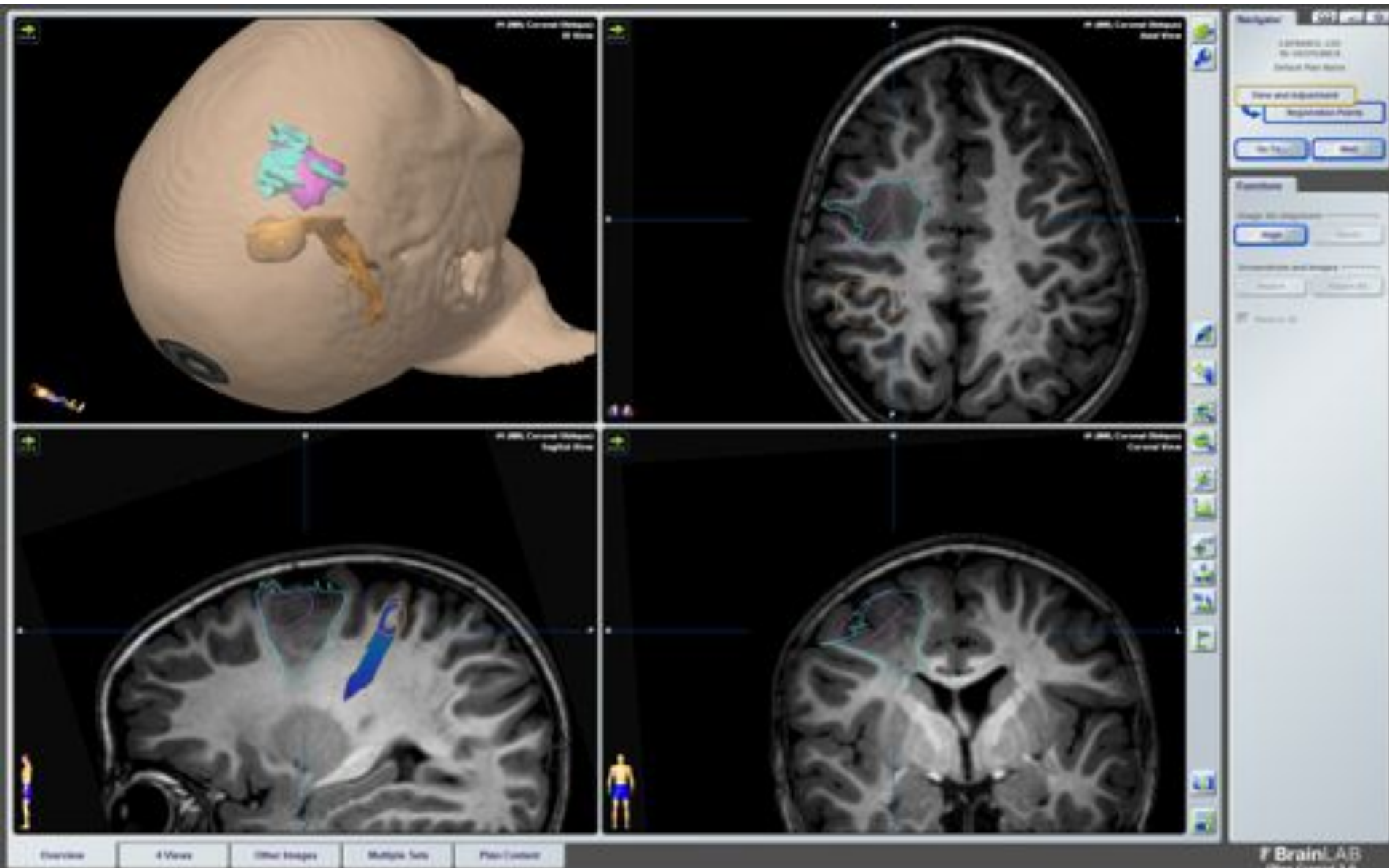


# Dominant Central Neuroglial Tumor





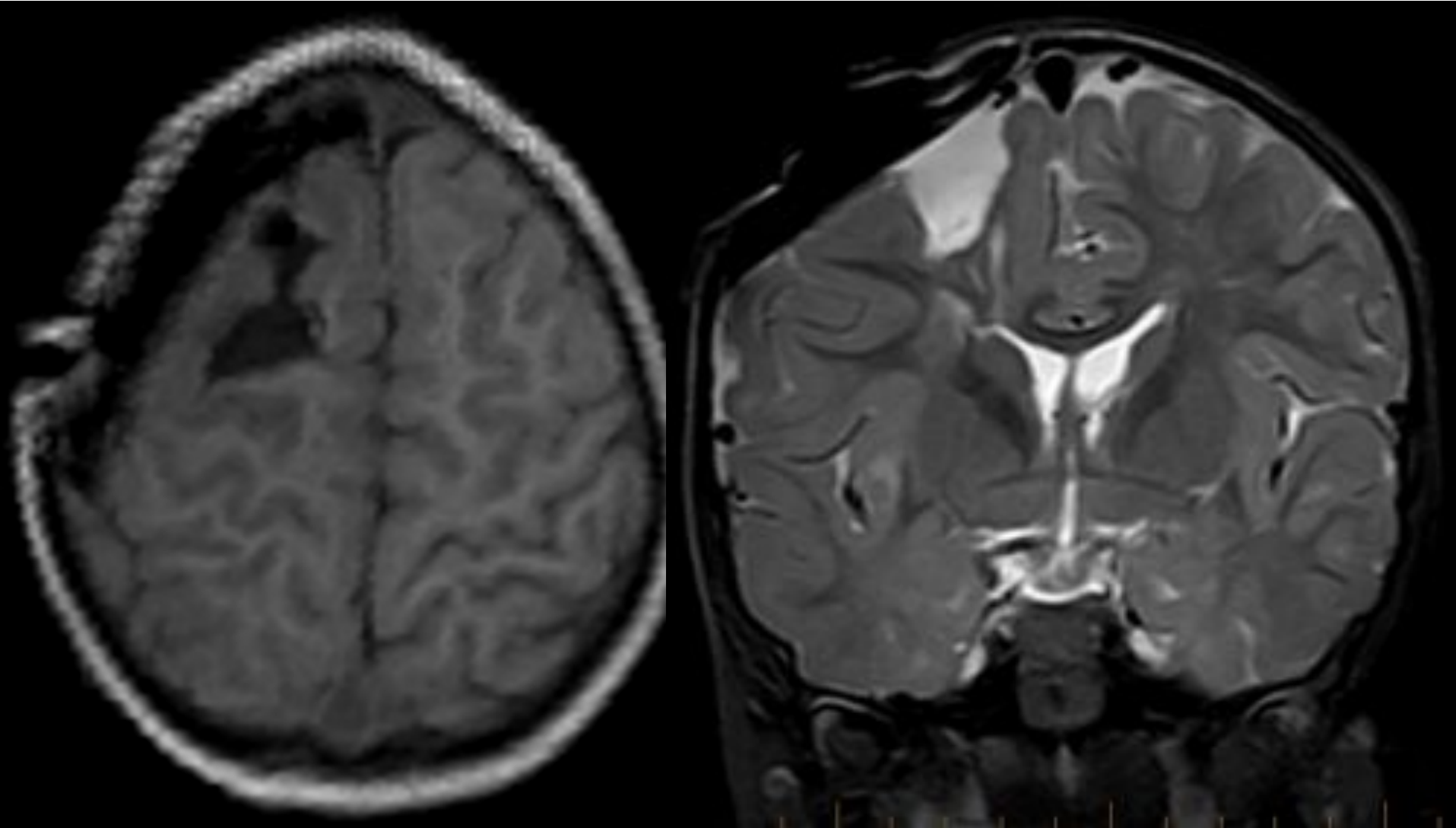
# SMA Cortical Dysplasia







# SMA Cortical Dysplasia







## Impact 4: Epilepsy Resections



Oct 2009-Aug 2011: 25 Pediatric Epilepsy Cases

Age Range (11 months – 19 years)

IMRI performed in 88% (22/25 cases)

Complete resection/disconnection in 85% (20/25 cases)

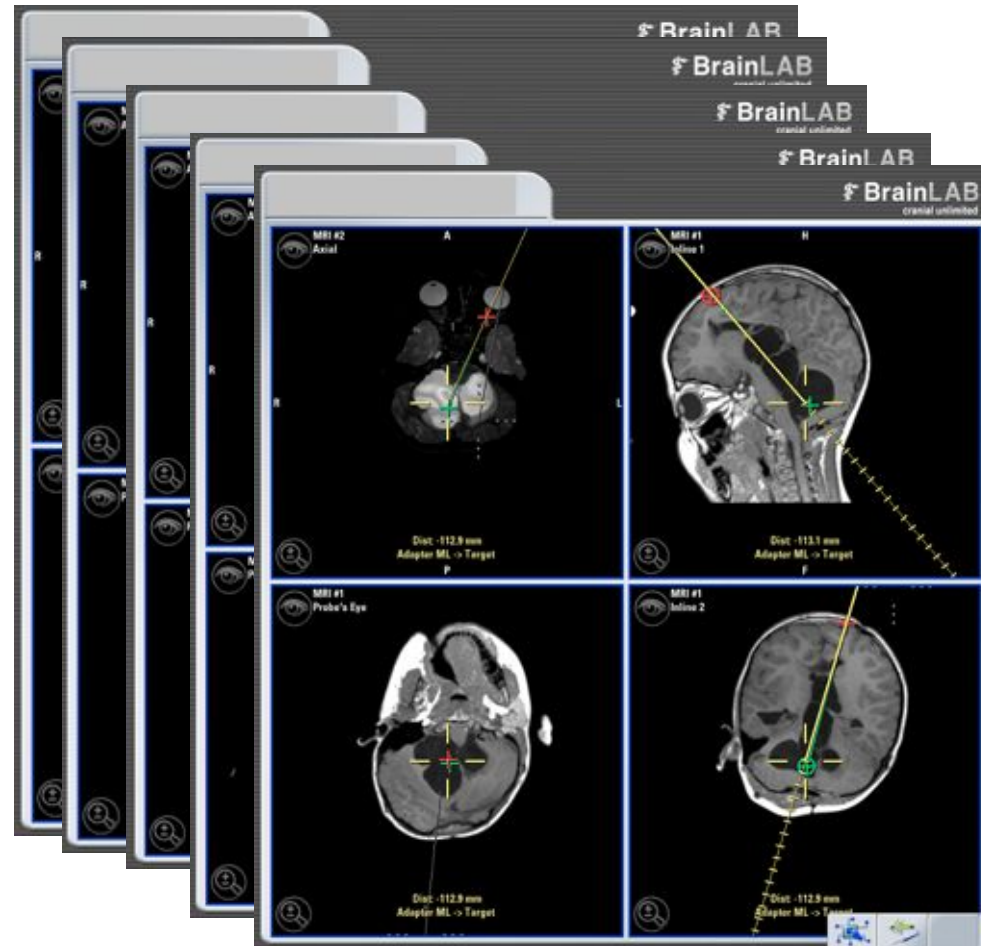
Further surgery needed to extend the resection in 35% (7/20 cases)

Extent of resection improved significantly in 100% (7/7 cases) and total in 72% (5/7 cases)

Incomplete resection in 2/7 (1 case FP , 1 case residual in eloquent area)

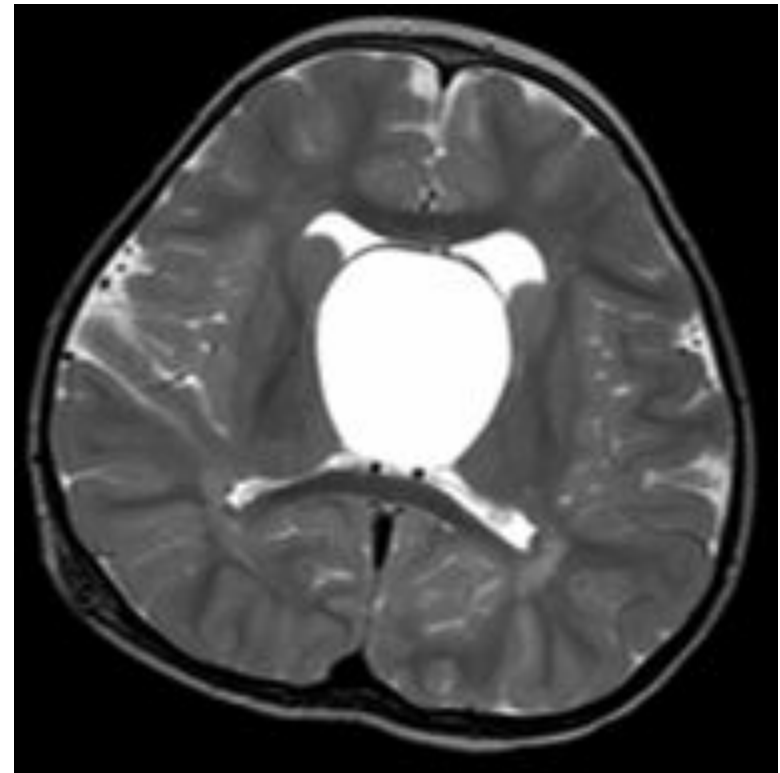
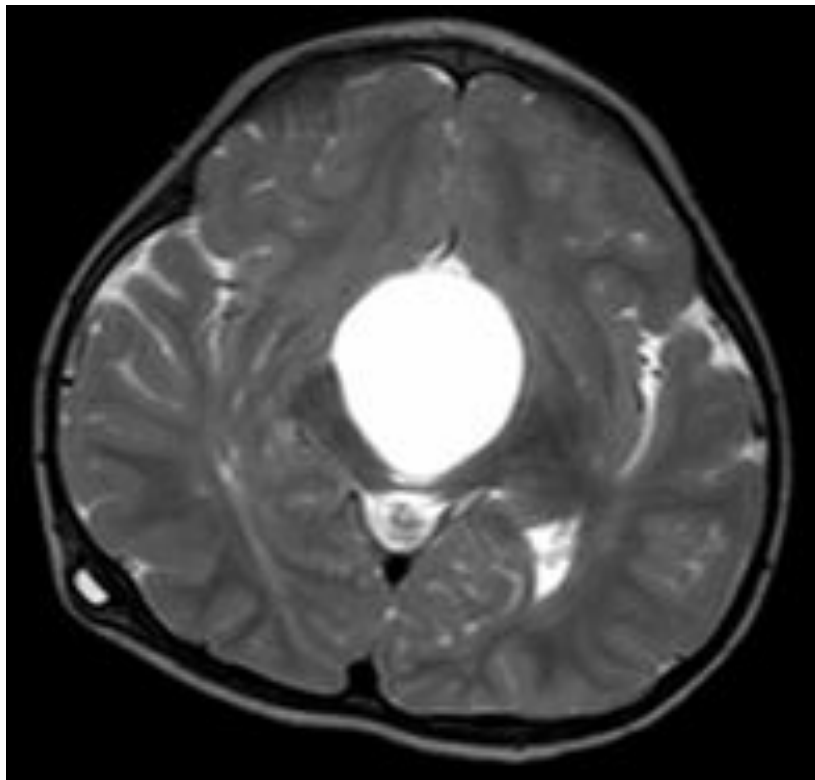


# Brainlab Disposable Shunt Stylet Navigation



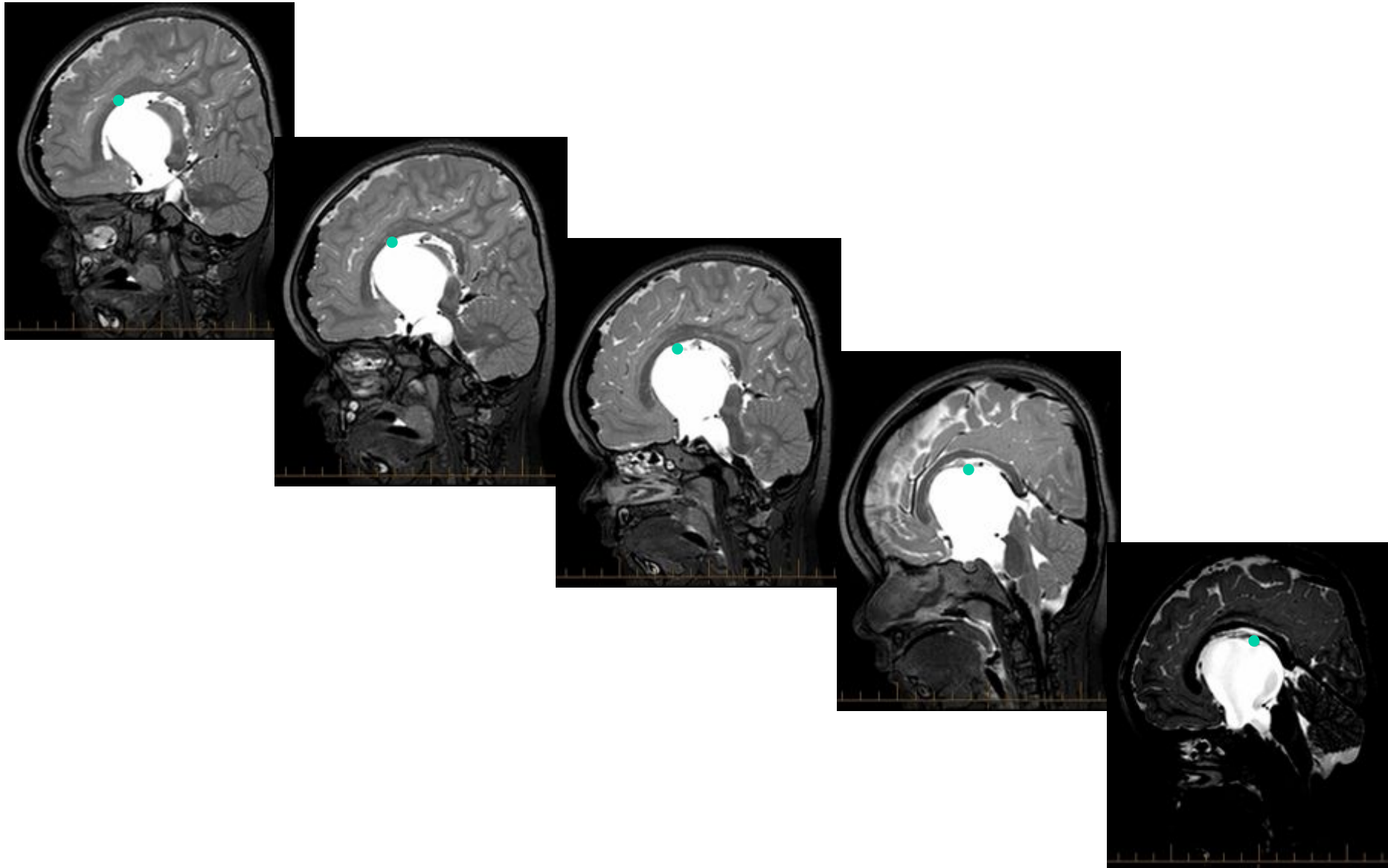


# Suprasellar Cyst





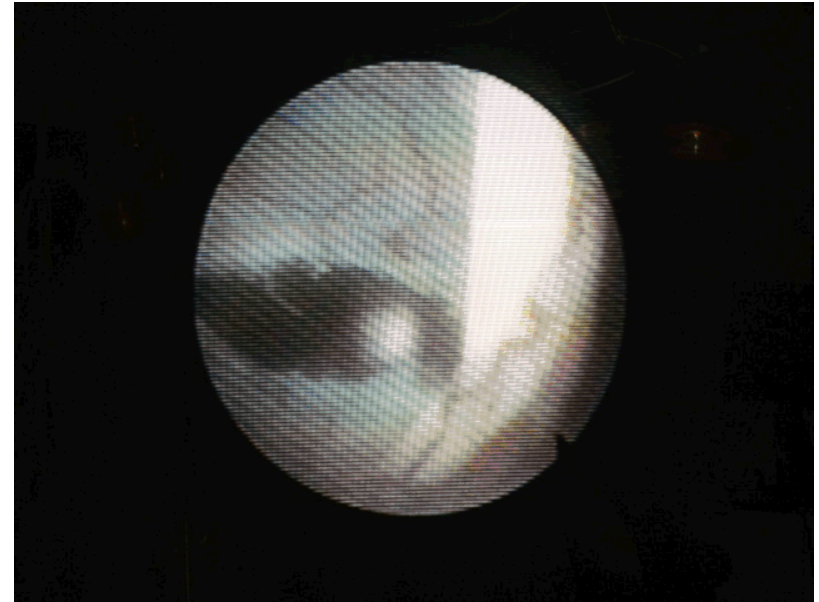
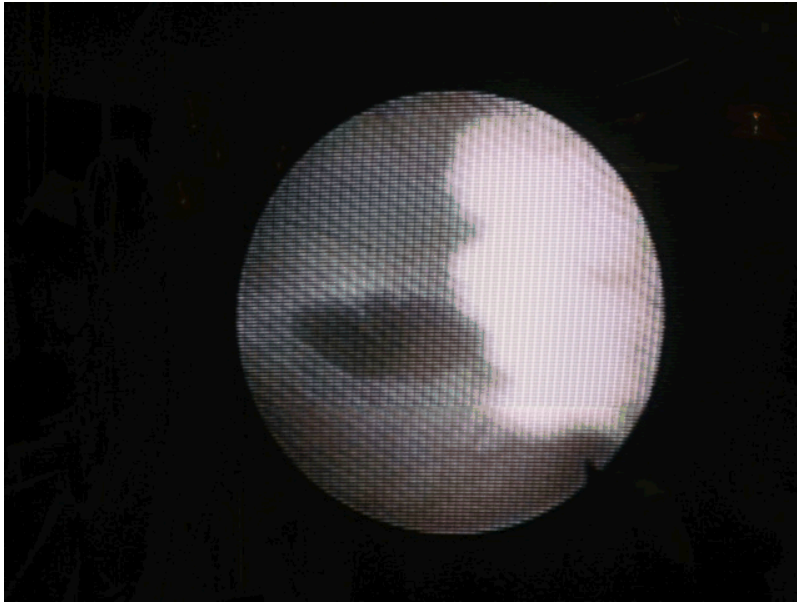
# Stereotactic shunt tracking





# Hydrocephalus

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## Impact 5: Intraoperative / Postoperative Morbidity

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1. Navigation is very ACCURATE because imaging is done in surgical position
2. Completeness of resection verified during surgery and corrected if needed because of availability of UPDATED NAVIGATION
3. Postop MRI is done DURING operative event and is of tumor board quality
4. ICU stay is predictable, is SHORTER and is not associated with repeat sedations for re-imaging
5. Hospital stay is SHORTER



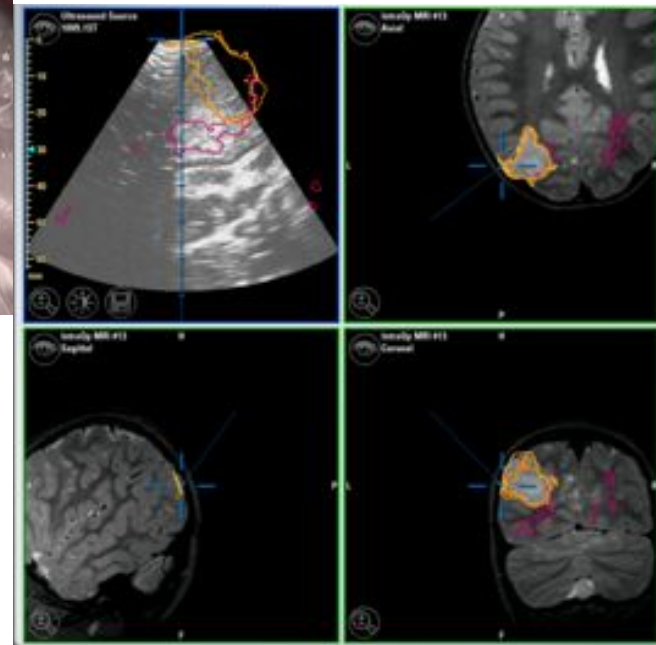
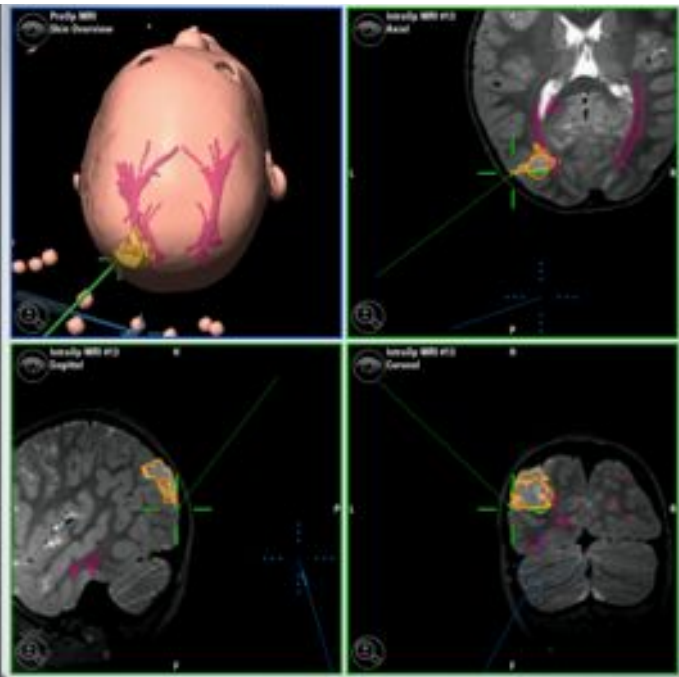
# Immobilisation in Prone Position

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# Impact 5: Morbidity/Hospital Stay







# Trolley Transportation





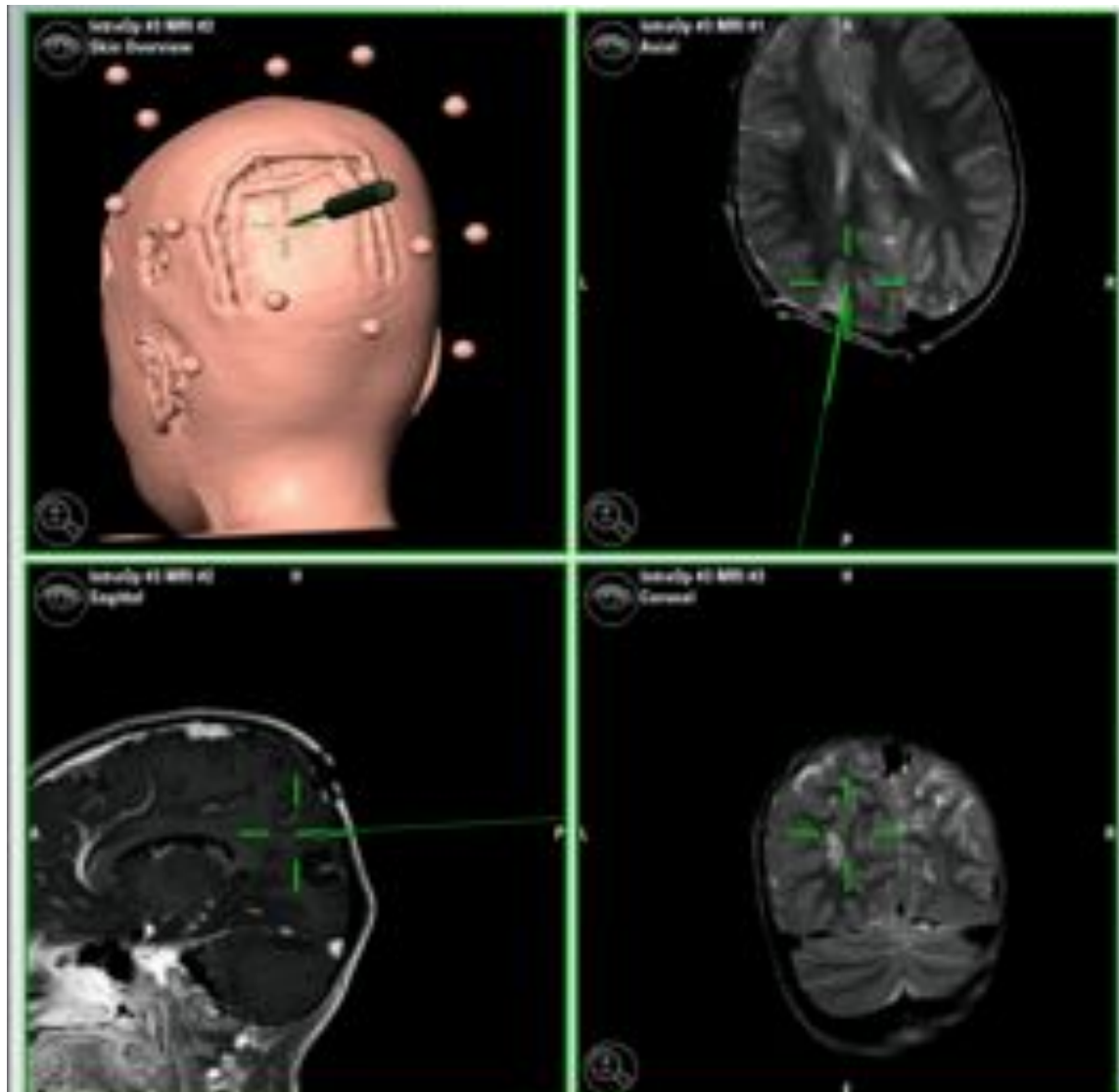
# Automatic Registration





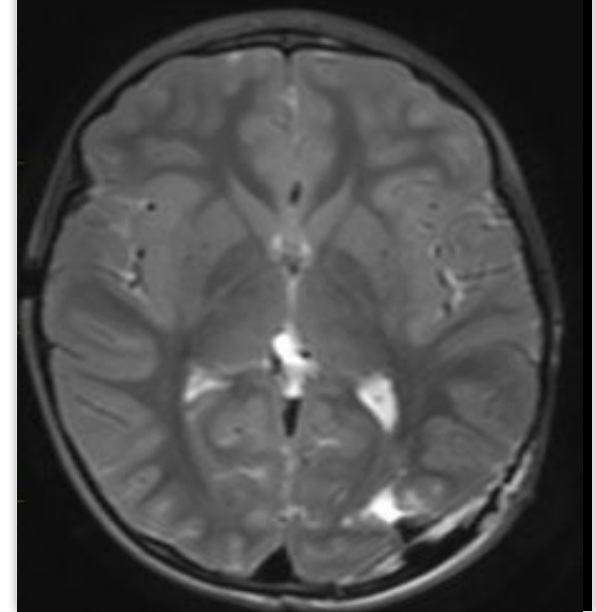
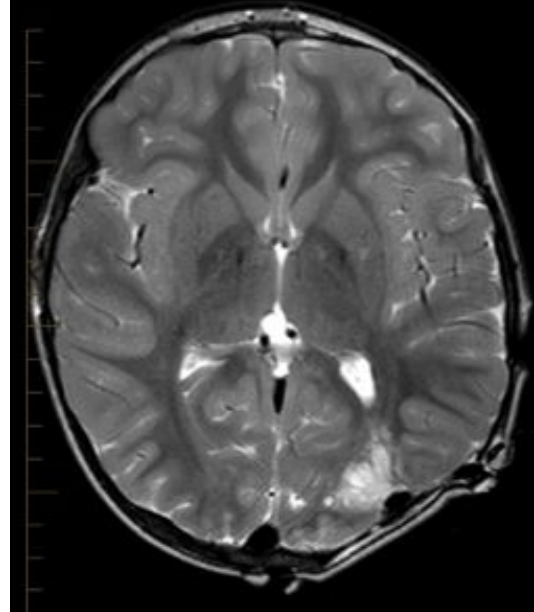
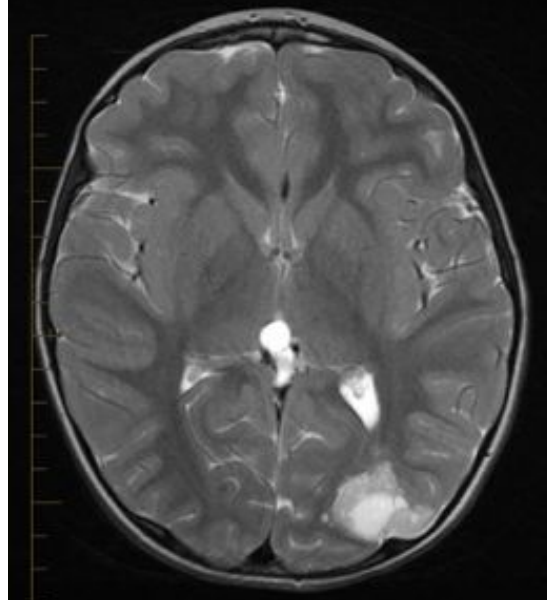
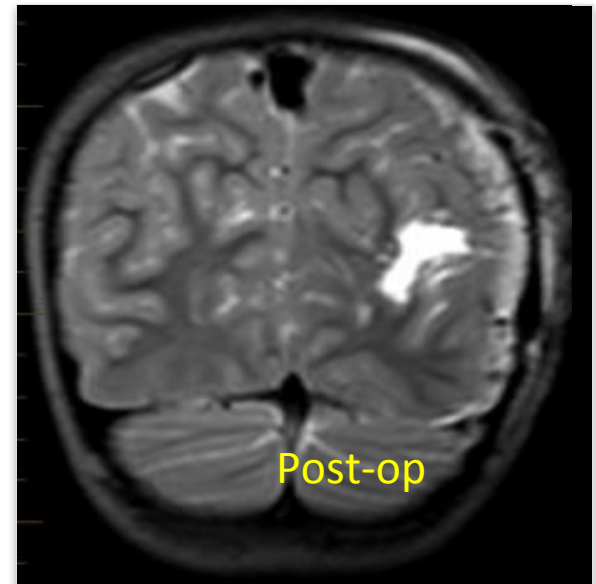
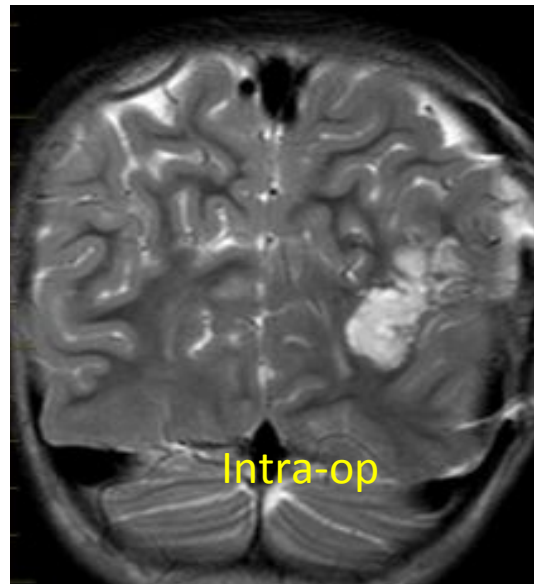
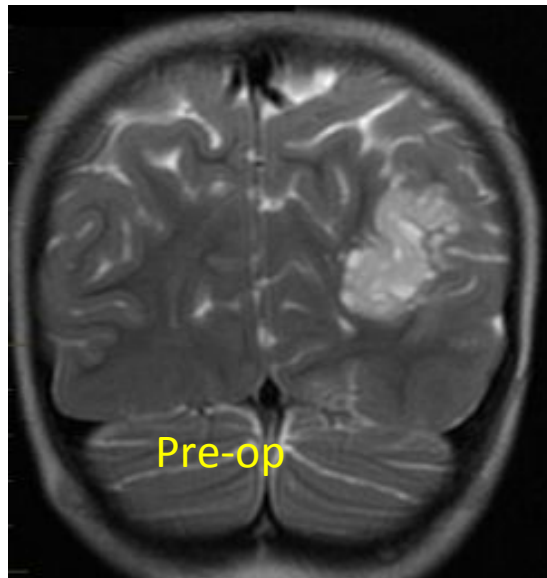


# Intra-operative MR automatic registration/verification





# Staged Resection Evaluation





# Impact 5: Post-op day 5





# Impact 6: Understanding Disease Processes

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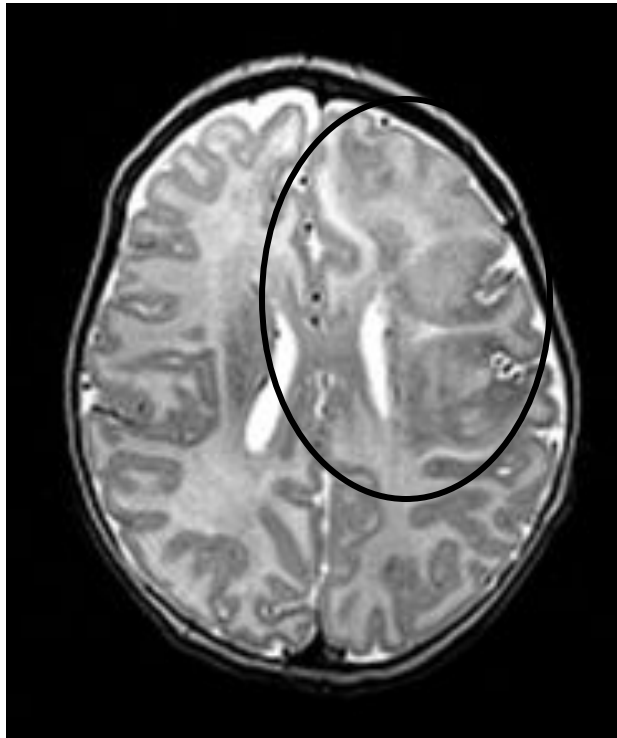


1. Cortical dysplasia
2. Impact of brain cooling on extent of Hypoxic-Ischemic injury in the newborn
3. Selective avoidance for surgery, radiotherapy and IMRT techniques

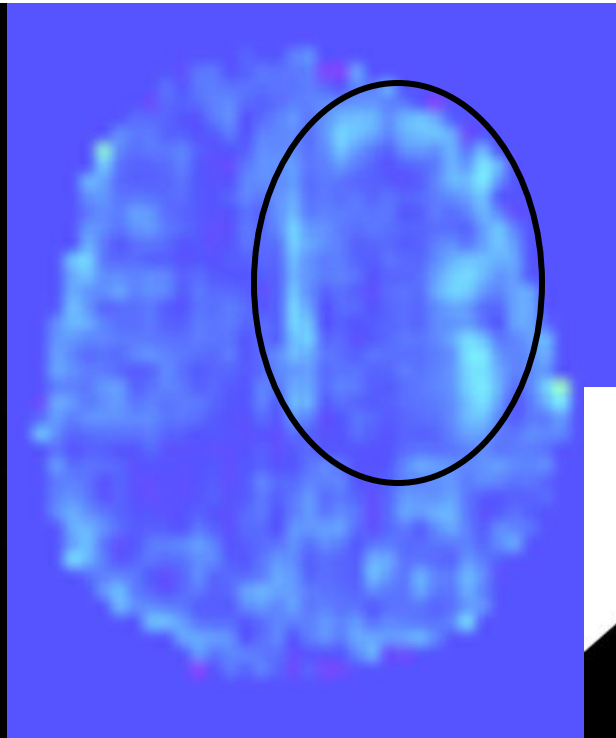


# Newborn Imaging Research:

asphyxia, prematurity, cortical dysplasia, ...

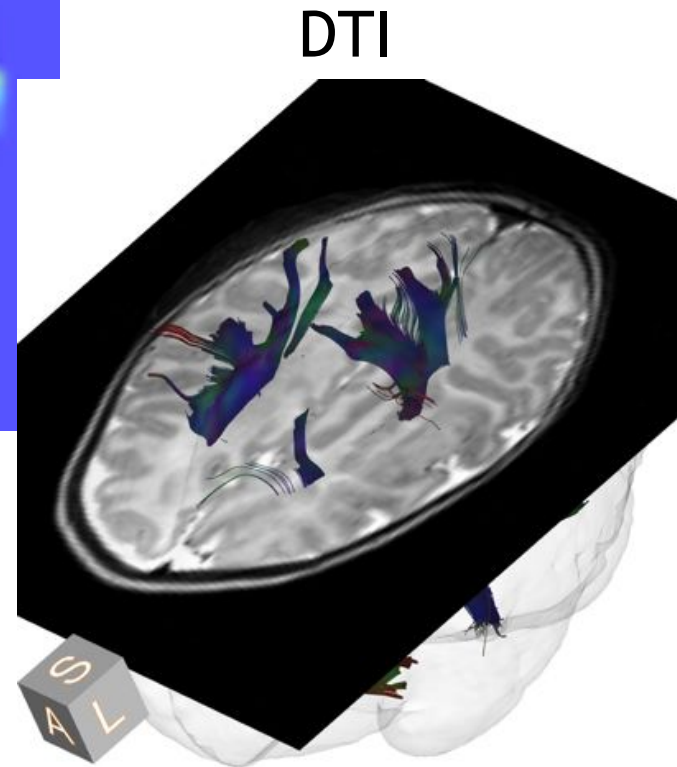


T2W



ASL

e.g.  
cortical dysplasia  
in newborn







# Department of Pediatric Surgery

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# Impact 7: Technology Evaluation

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(What not to “export” to new hospital)

1. Sliding doors (poor acoustic sheilding)
2. Location in radiology
3. Lack of HD on giant screens
4. Draped “VV” interactive screen glare
5. Sterilization process for Noras coil



# IOMRI: Impressions after 4+ years

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1. Pre-op planning is an excellent pedagogical tool.
2. FMRI/TRACTOGRAPHY/ PET/SPECT/EEG updates to the planning scan are important adjuncts for accurate navigation in eloquent areas making tumors/epilepsy resections SAFER yet more COMPLETE.
3. IOMRI most helpful for DEEP SEATED intra parenchymal and skull base TUMORS as well as EPILEPSY generating lesions in ELOQUENT areas and complex hydrocephalus or cyst access.
4. Intra-operative and post-operative MORBIDITY are reduced making length of STAY and parent/family experience more PALATABLE.