MRI in glioma

Beyond Morphology: Advanced MRI for Glioma Stratification and Surgical Planning

Anna Falk Delgado

Associate Professor, Research group leader Karolinska Institutet
Senior consultant in neuroradiology, Department of Neuroradiology

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Why imaging?

What would you…

- Need to know?
- Like to know?

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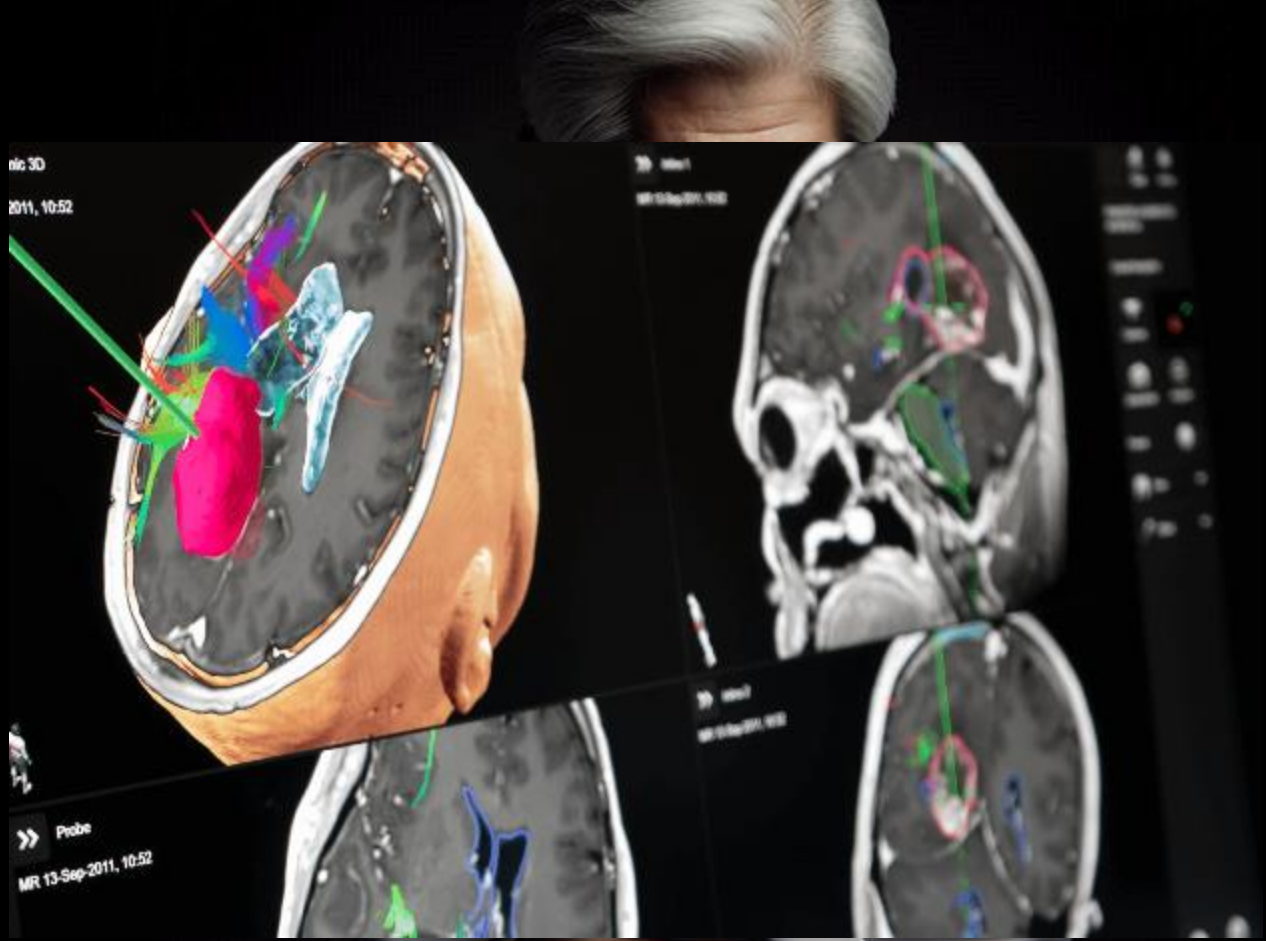
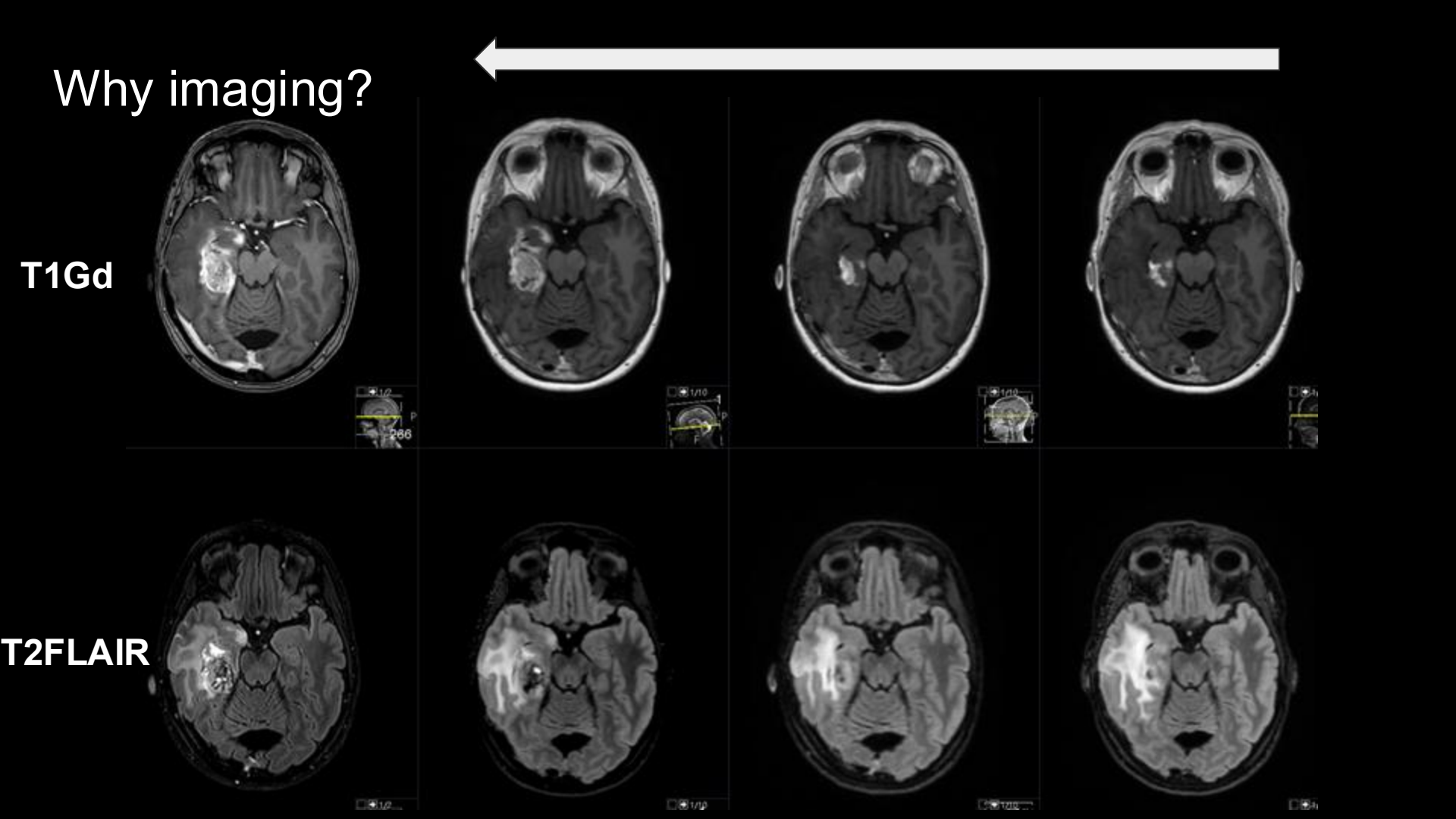


www.brainlab.com

Why imaging?



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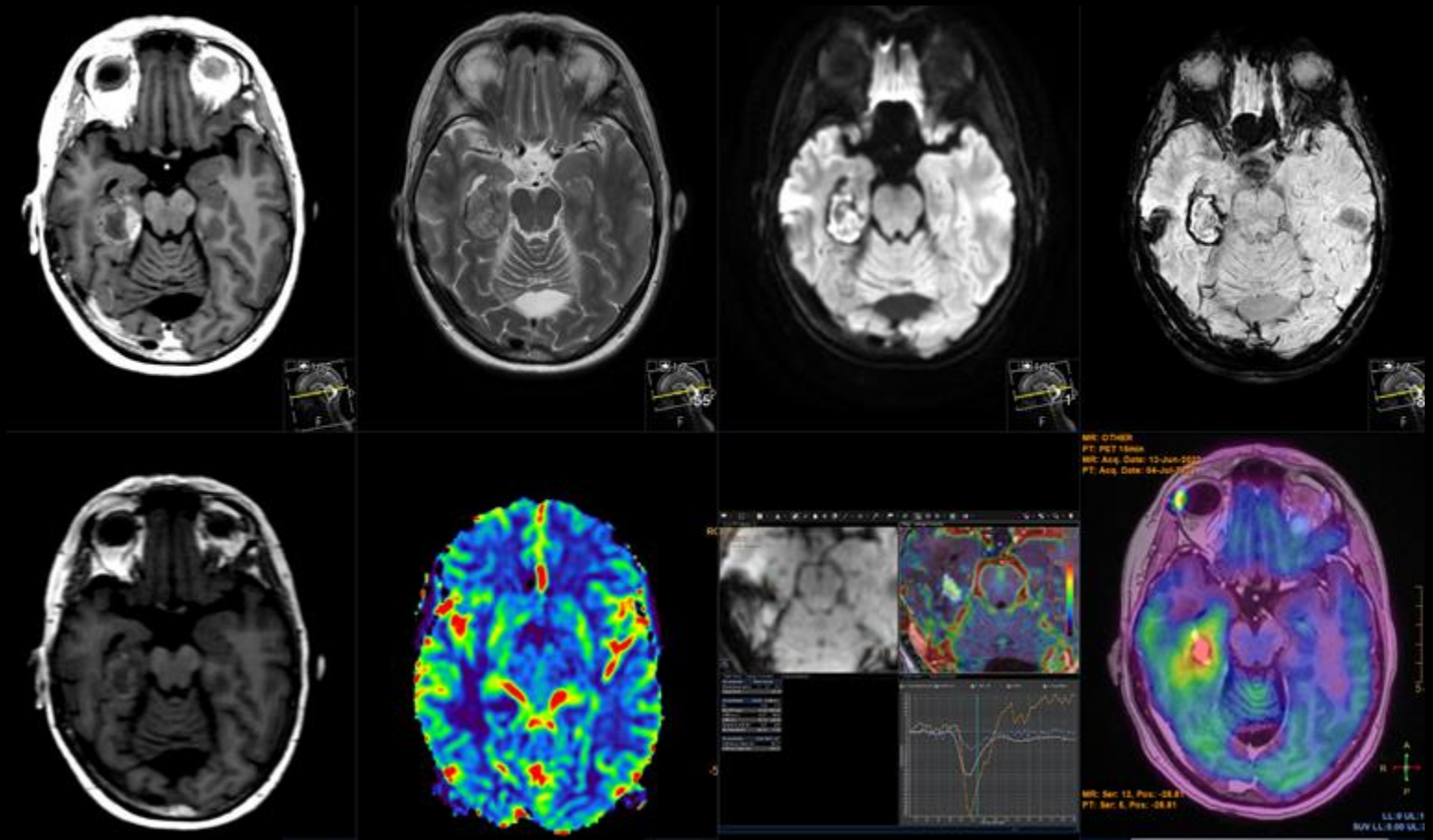


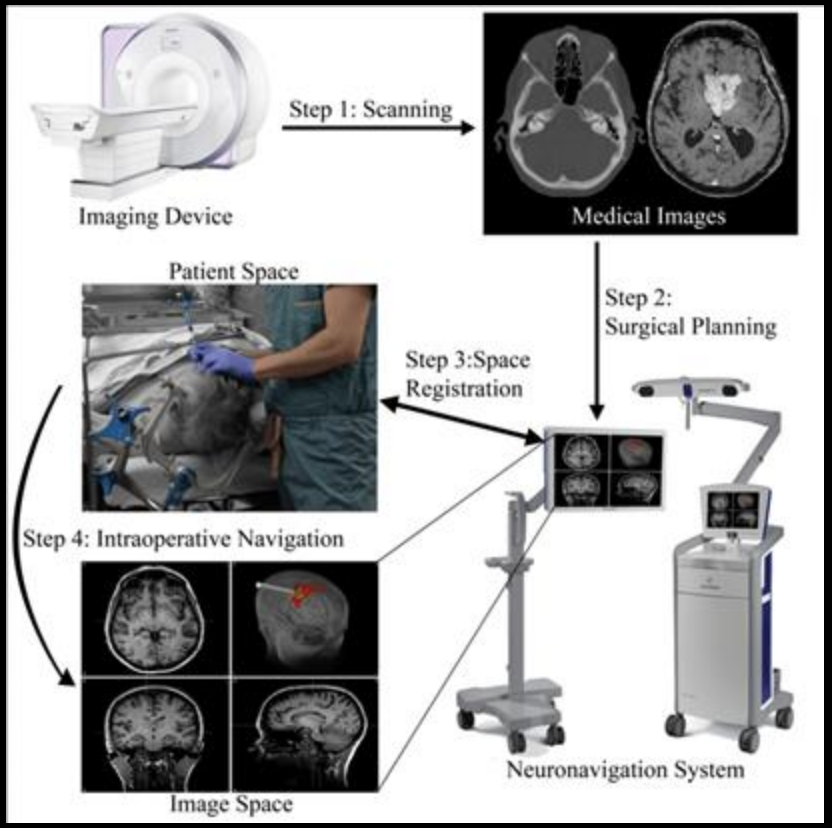
Presurgical MR imaging of high grade glioma

- High resolution T1 3D Gd
- Diffusion tensor imaging
- High resolution 3D T2 FLAIR

Full head including ears and nose, to allow for surgical navigation planning

Gerard 2016

www.brainlab.com



Standardized brain tumor imaging protocol

3DT1- pre gadolinium	<1.5 mm isotropic
3DT1- post gadolinium	<1.5 mm isotropic
3D T2	<1.5 mm isotropic
3DT2FLAIR	<1.5 mm isotropic
DWI	<2 x 2 x 4 mm
Encourage MR-perfusion	Dynamic susceptibility contrast

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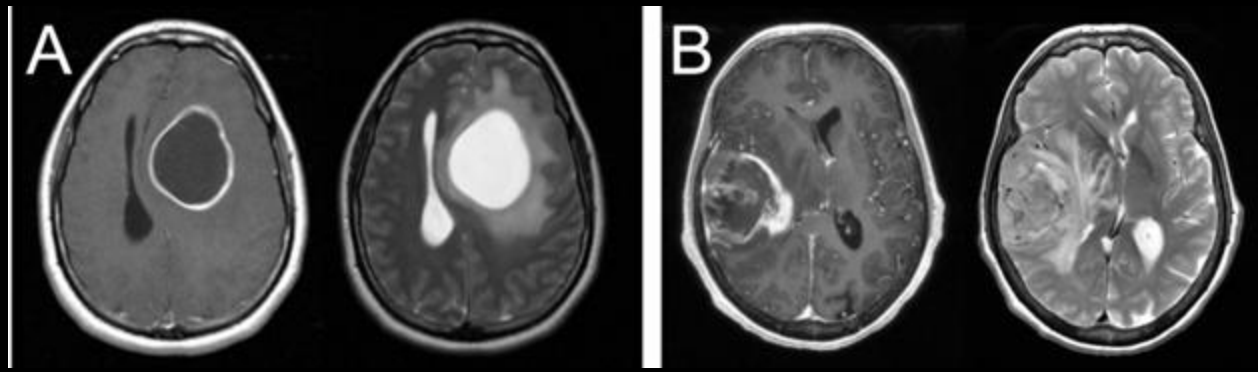

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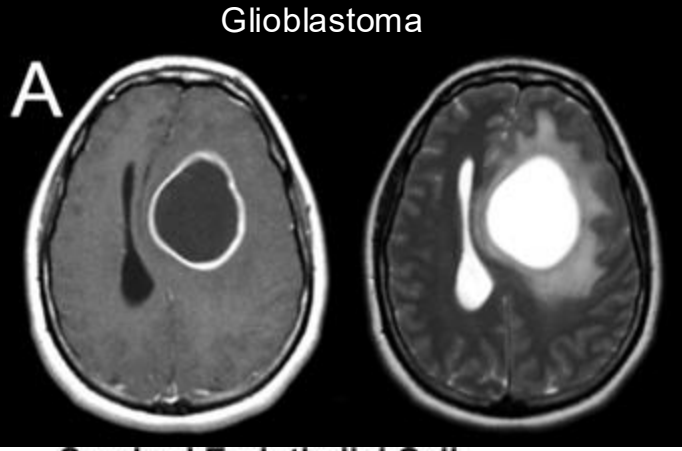
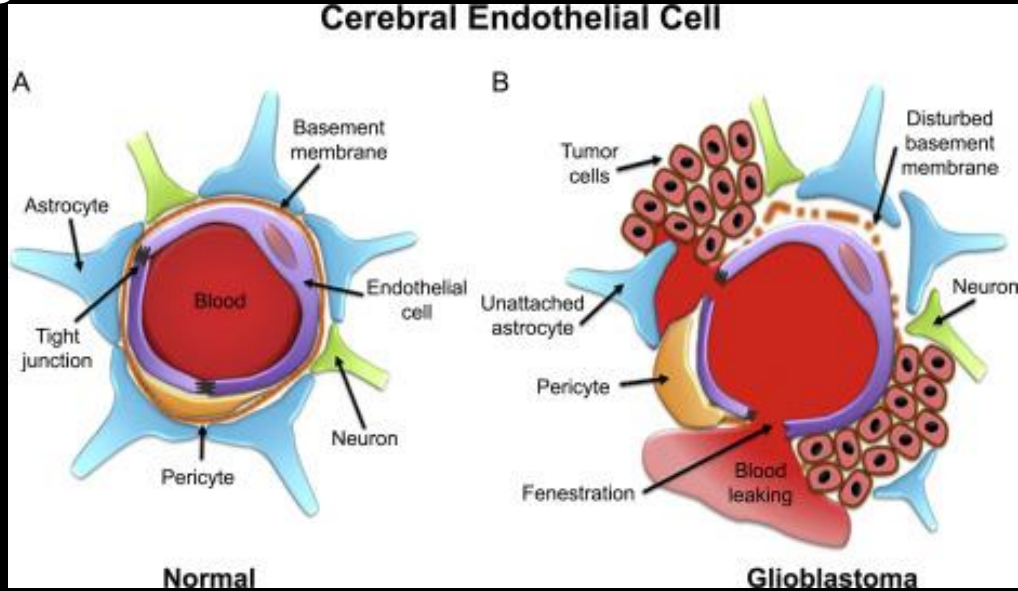


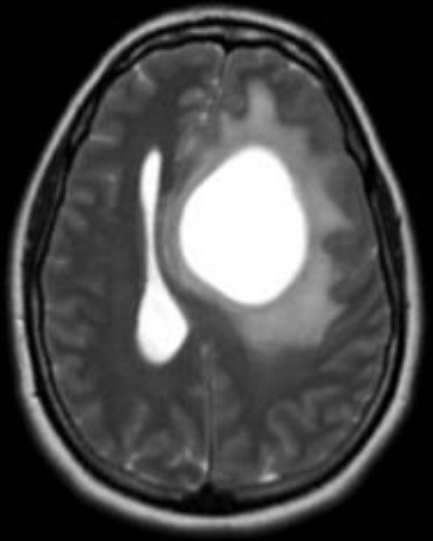


Clavreul 2019

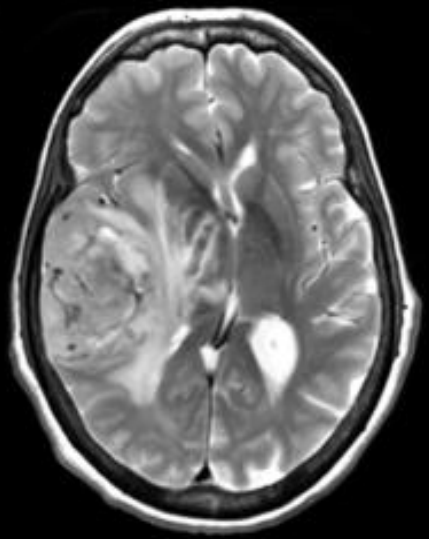
Sharma 2020

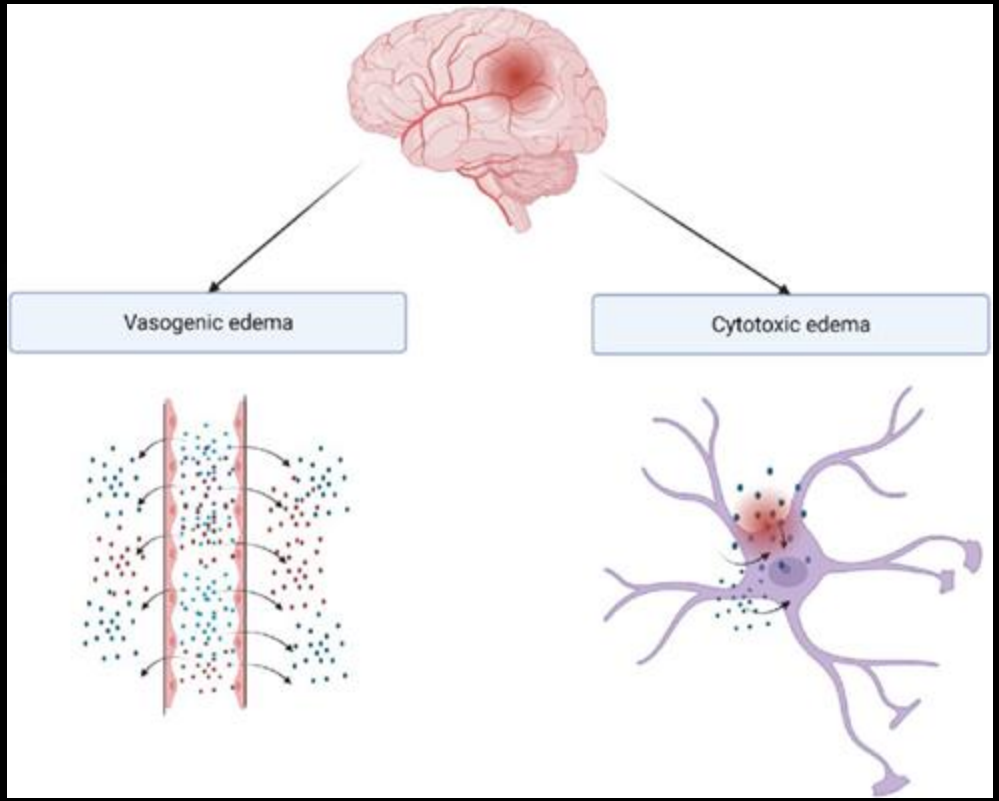
Curtin 2019

Glioblastoma



Glioblastoma





Fiani 2022

Sharma 2020

Curtin 2019

Why imaging?

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Response Assessment in Neuro-Oncology (RANO) criteria in clinical trials (neuro-oncologists)

Assess treatment effectiveness

Increase consistency in evaluations

Why imaging?

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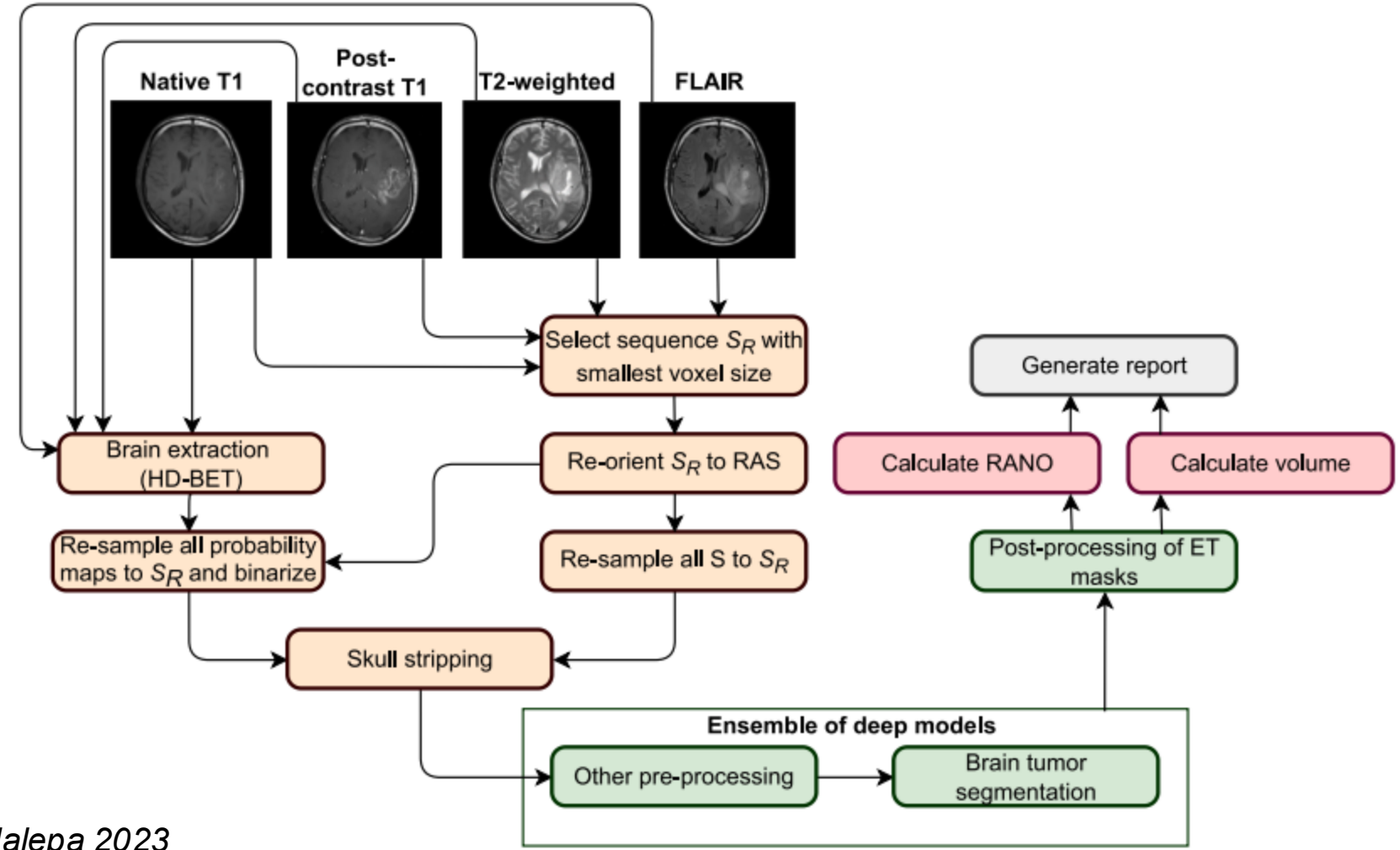

Native T1
Post-contrast T1
T2-weighted
FLAIR
Select sequence S_R with smallest voxel size
Brain extraction (HD-BET)
Re-orient S_R to RAS
Re-sample all probability maps to S_R and binarize
Re-sample all S to S_R
Skull stripping
Ensemble of deep models
Other pre-processing
Brain tumor segmentation
Post-processing of ET masks
Calculate RANO
Calculate volume
Generate report

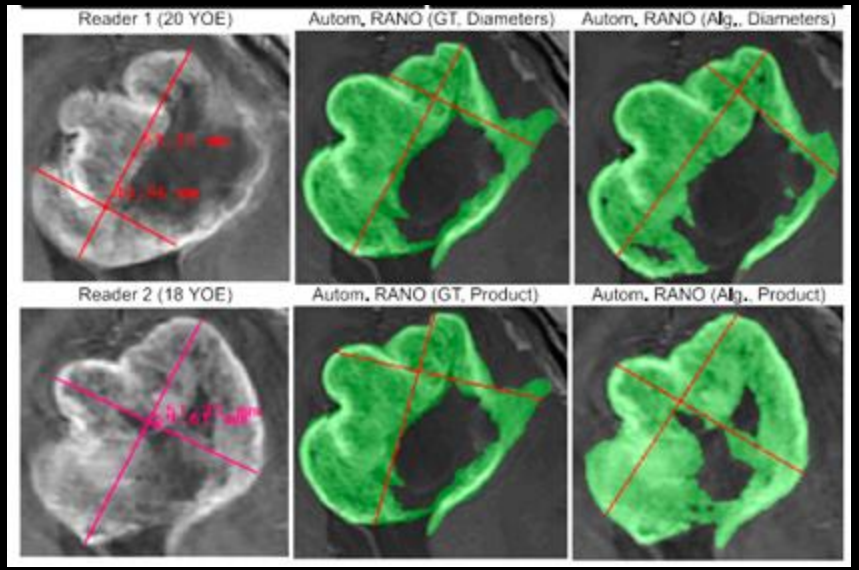
Nalepa 2023

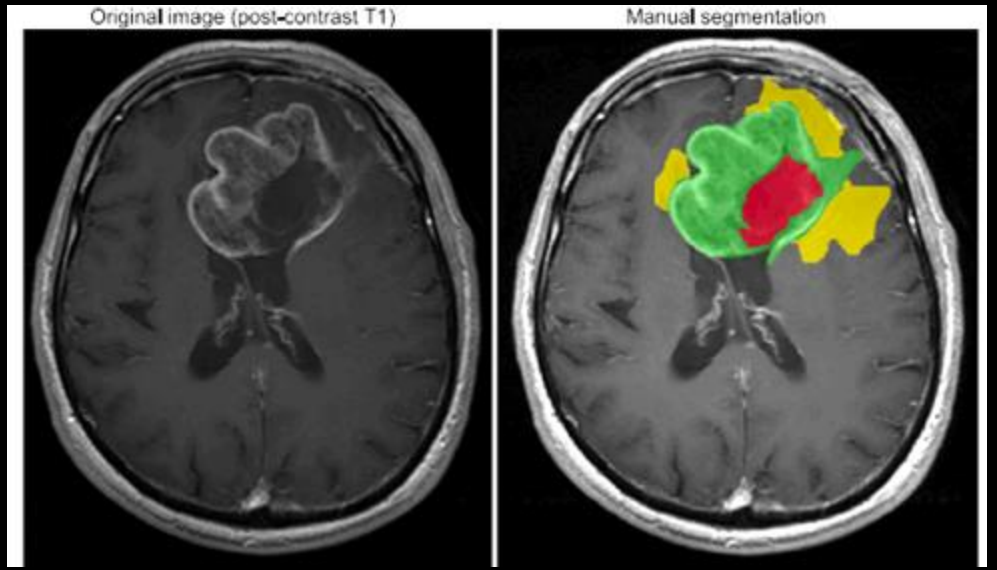
RANO 2.0 criteria

GRAYLIGHT
MEDICAL IMAGING SOFTWARE

	Diameters [mm × mm]	RANO [mm²]	Volume [mm³]
Reader 1 (20 YOE)	59.21 × 40.96	2424.98	–
Reader 2 (18 YOE)	59.61 × 51.35	3061.13	–
Automated RANO (GT, Diameters)	61.93 × 43.84	2715.05	69413.47
Automated RANO (Algorithm, Diameters)	60.94 × 41.30	2516.80	60726.61
Automated RANO (GT, Product)	57.56 × 56.80	3269.61	69413.47
Automated RANO (Algorithm, Product)	57.47 × 51.87	2980.81	60726.61

Nalepa 2023

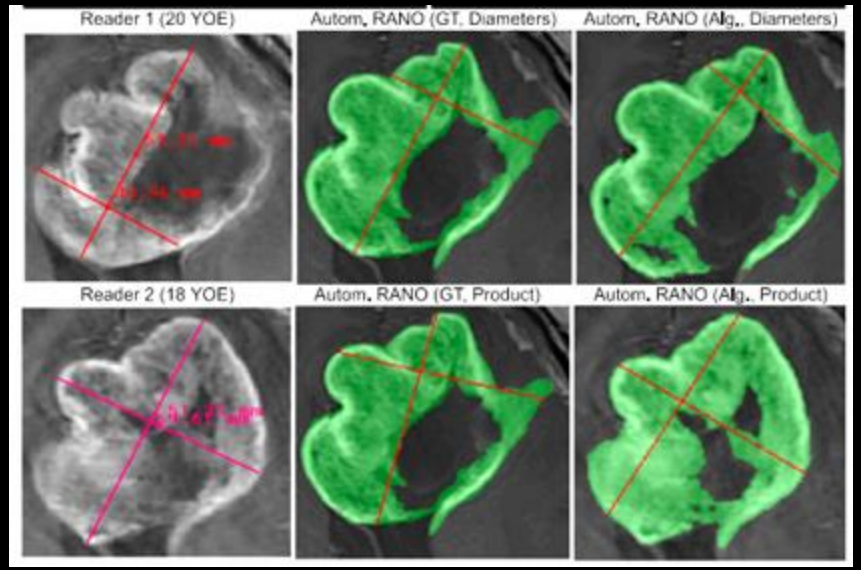


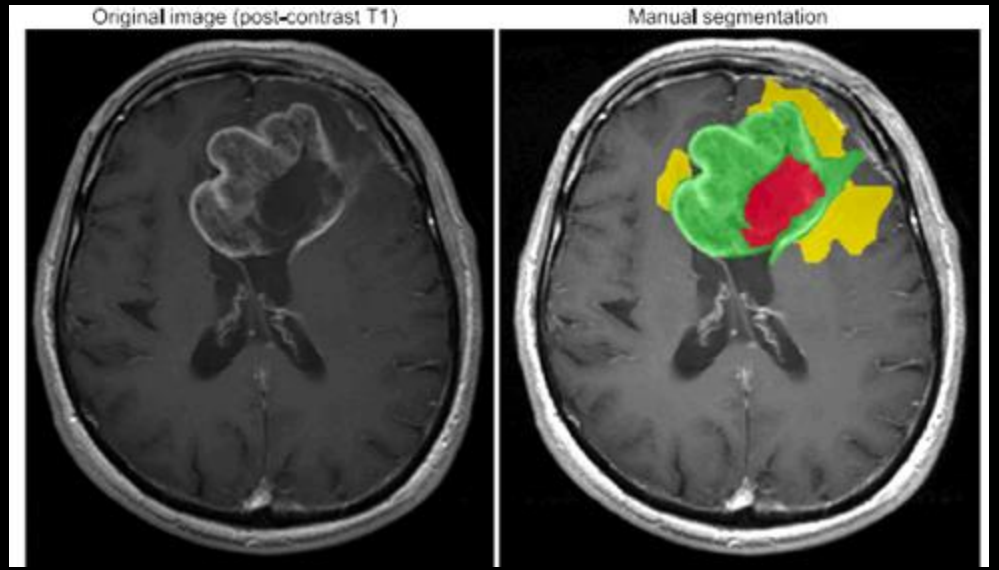


RANO 2.0 criteria

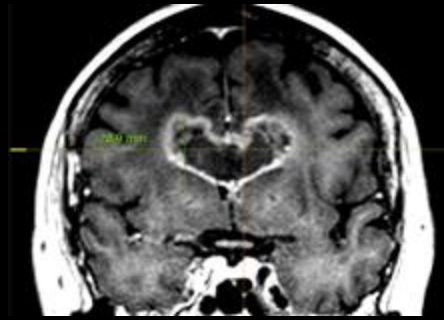
GRAYLIGHT
MEDICAL IMAGING SOFTWARE

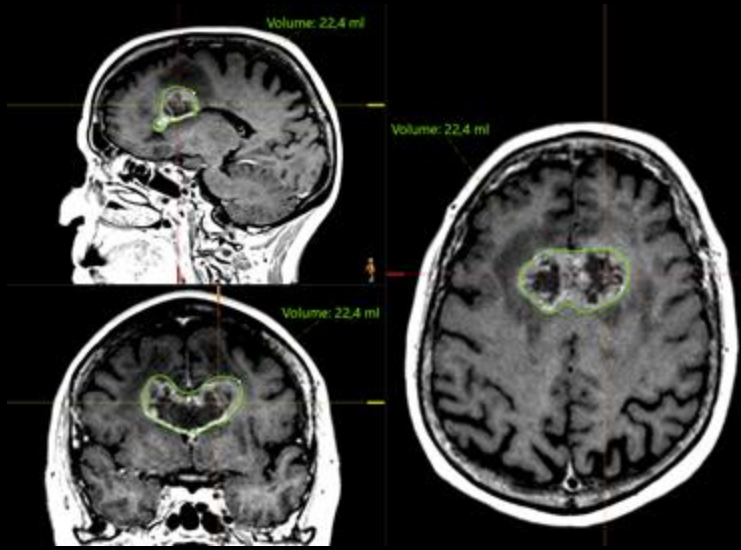
Nalepa 2023

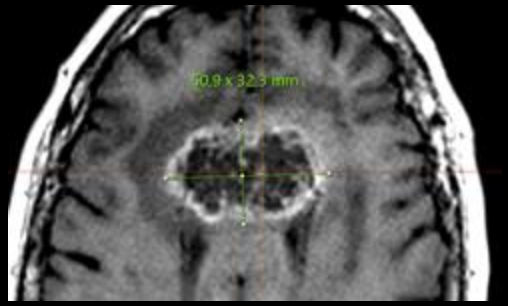


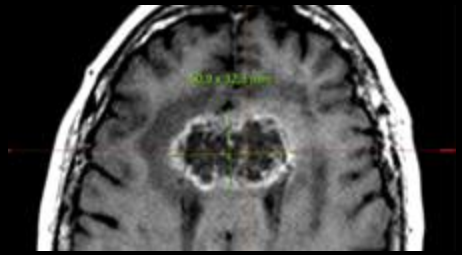


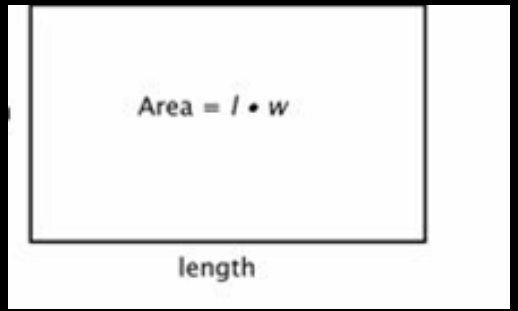
Size and growth rate

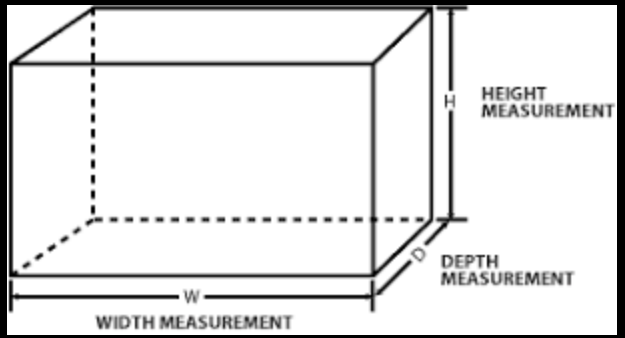


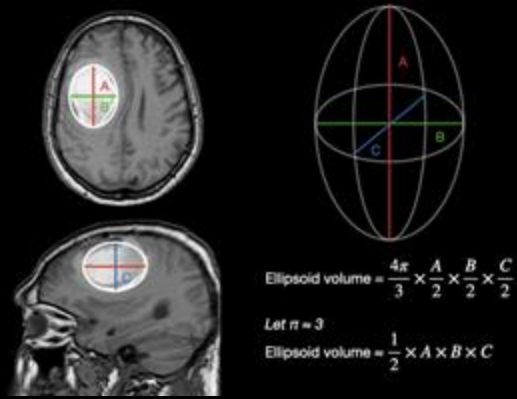












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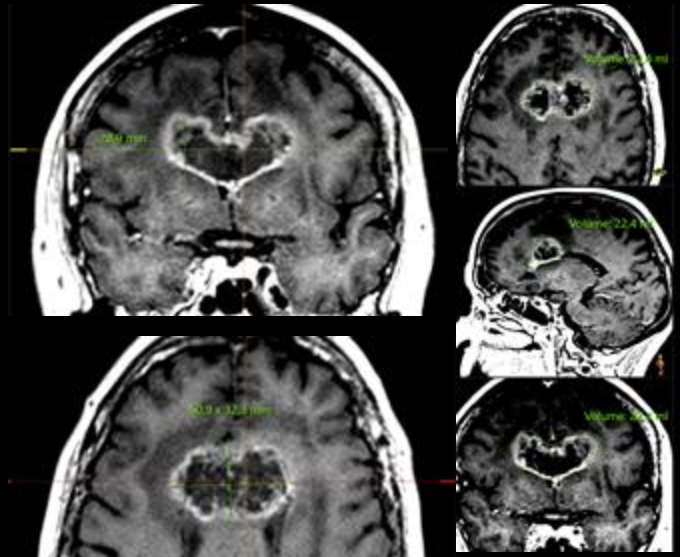

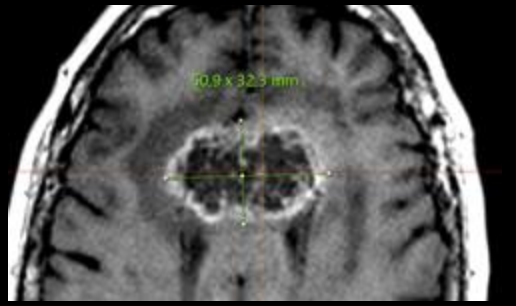

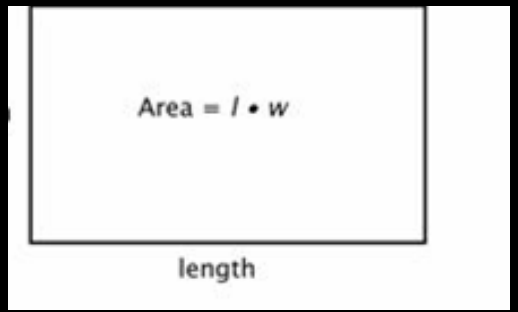

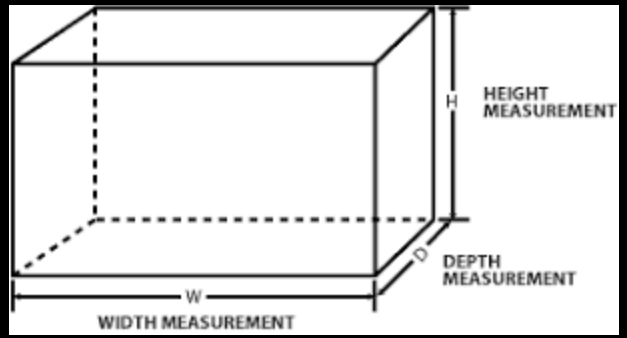

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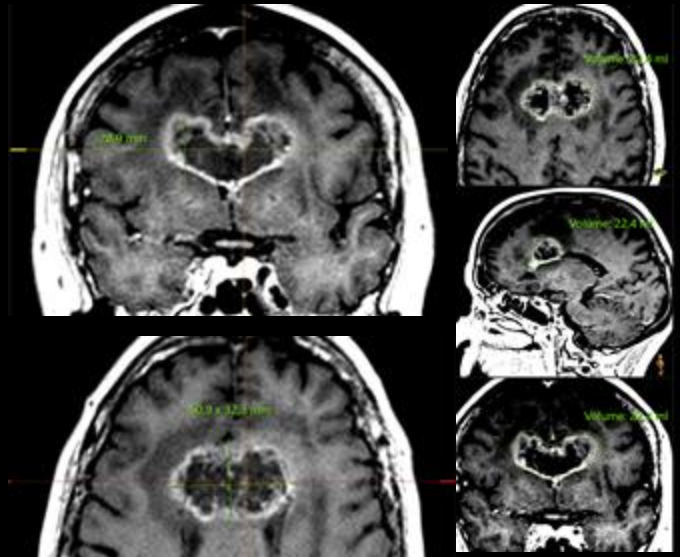
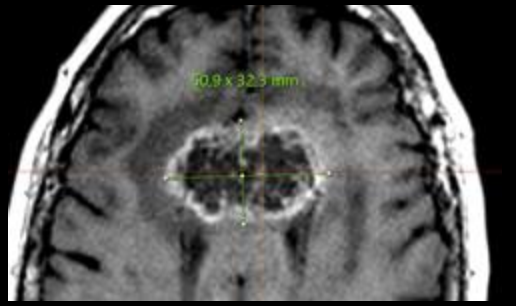
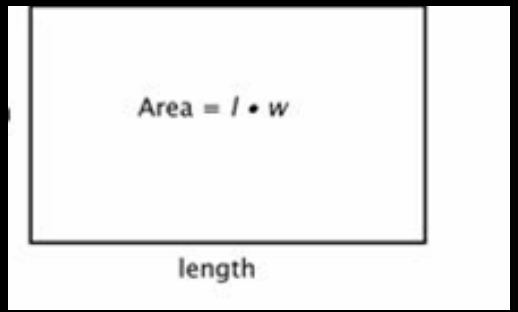
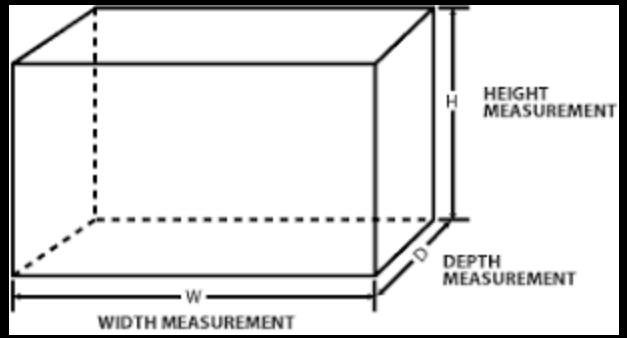


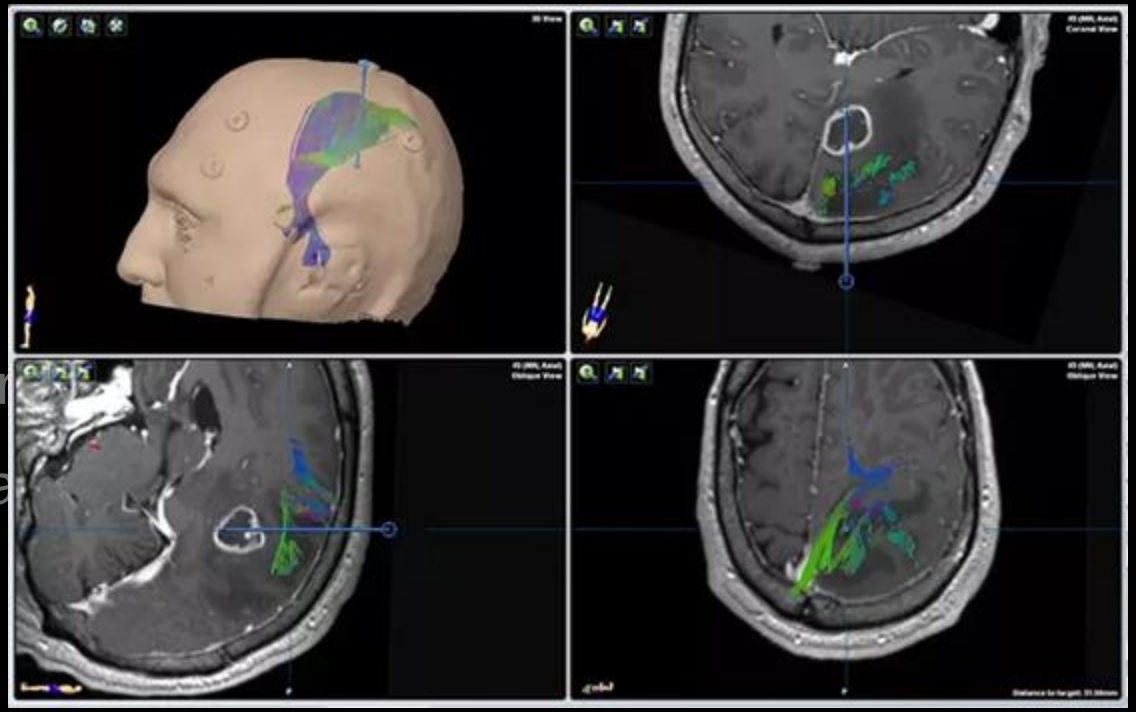






Why imaging?

- Need to know?
    - Size of blood brain bar
    - Size of edema and ma



- Off RANO criteria

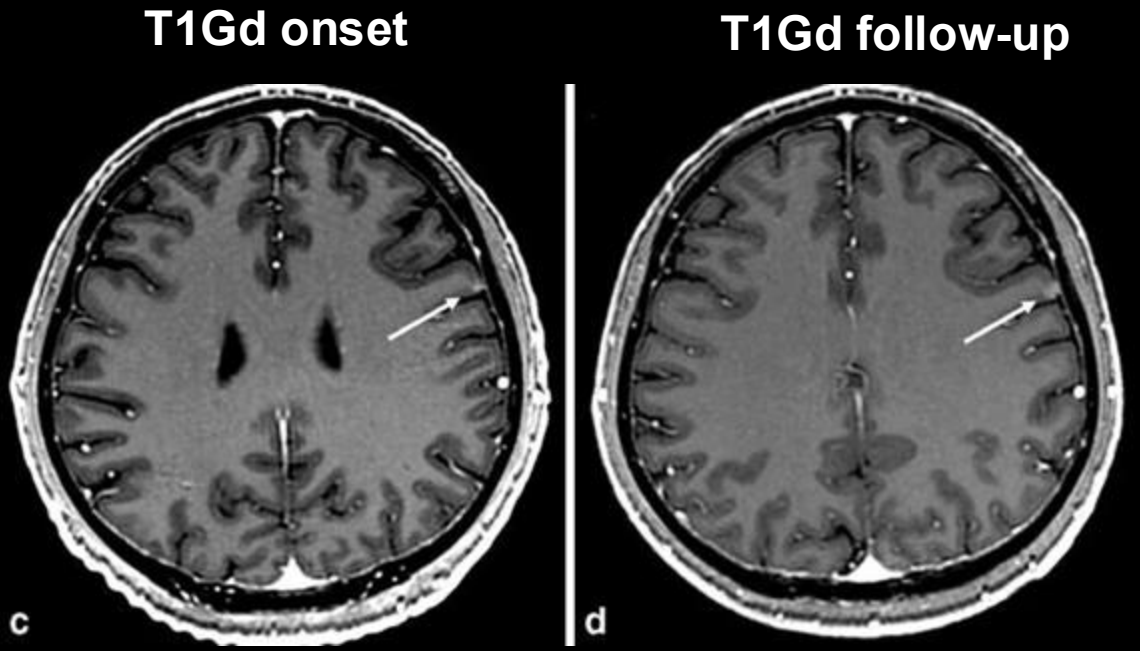
New small contrast-enhancing lesion suitable for gammaknife surgery or laser interstitial thermal therapy

Why imaging?

- Off RANO criteria

New small contrast-enhancing lesion suitable fo gammaknife surgery or lase interstitial thermal therapy

- High resolution 3D T1 with gadolinium



Lung cancer metastasis at diagnosis and 4 month follow-up (contrast enhanced FSPGR)

Kakeda 2007

Why imaging?

- Off RANO criteria

New small contrast-enhancing lesion suitable for gammaknife surgery or laser interstitial thermal therapy

- High resolution 3D T1 with gadolinium

First Gamma Knife Esprit Patient Resumes Life as Usual Only Days After Brain Surgery

UK's National Centre for Stereotactic Radiosurgery in Sheffield is first in the world to begin treating with Elekta's latest Leksell Gamma Knife system

Laser interstitial thermal therapy using the Leksell Stereotactic System and a diagnostic MRI suite: how I do it

Margret Jensdottir[1] · Ulrika Sandvik[1] · Michael Fagerlund[2] · Jiri Bartek Jr.[1,3]

Received: 6 September 2022 / Accepted: 10 December 2022 / Published online: 31 December 2022

Why imaging?

- Need to know?
    Size of blood brain barrier leakage (T1 with contrast)
    Size of edema and mass effect? (T2 FLAIR)

- Like to know?
        A lot!

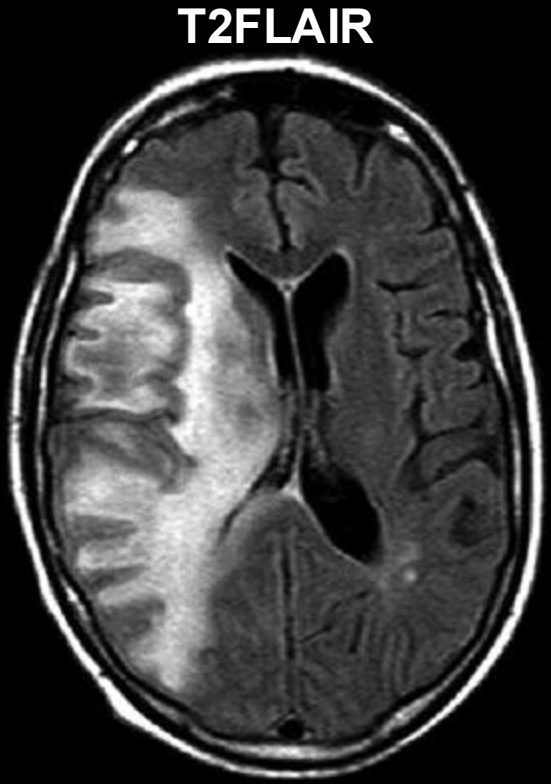
Why imaging?

- Like to know?

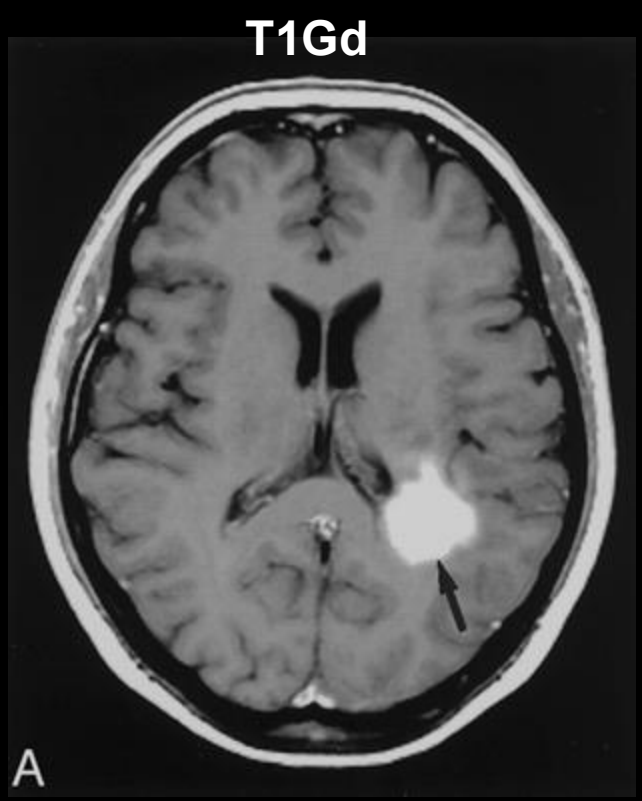
Pre-operatively

Tumor type?

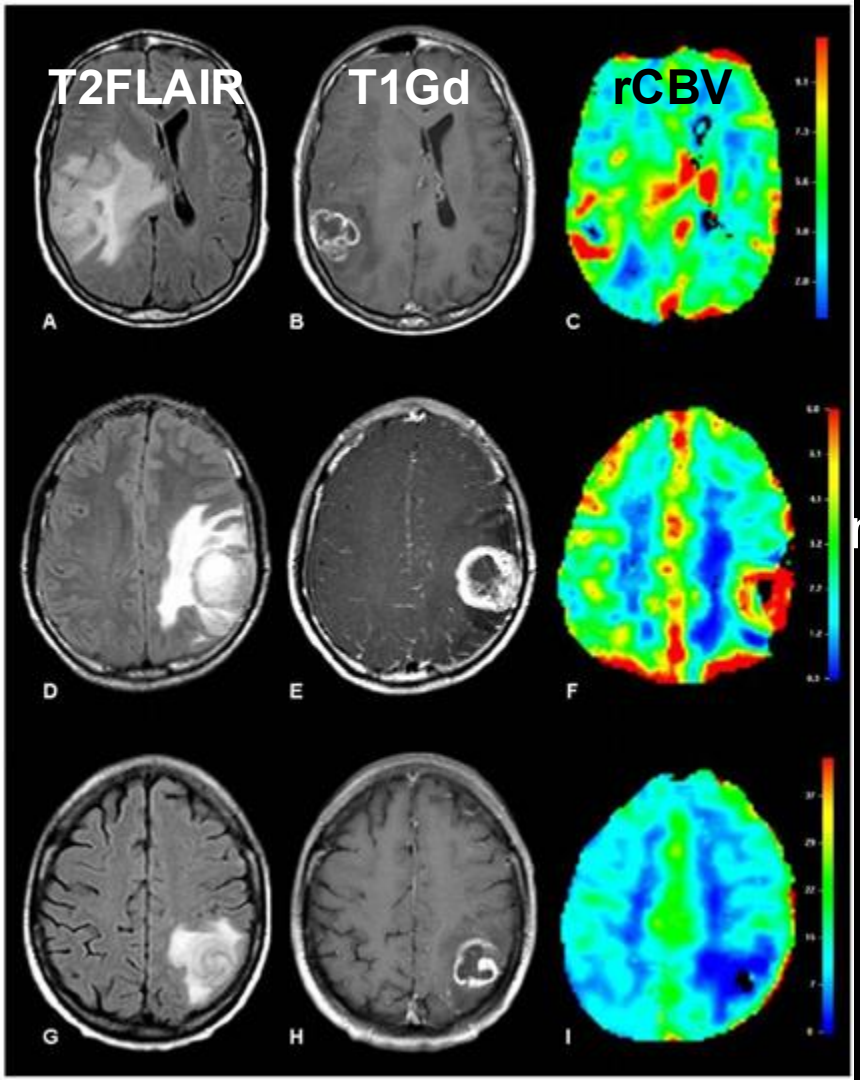
Tumor mimic?



Gliomatosis cerebri
Gupta 2016

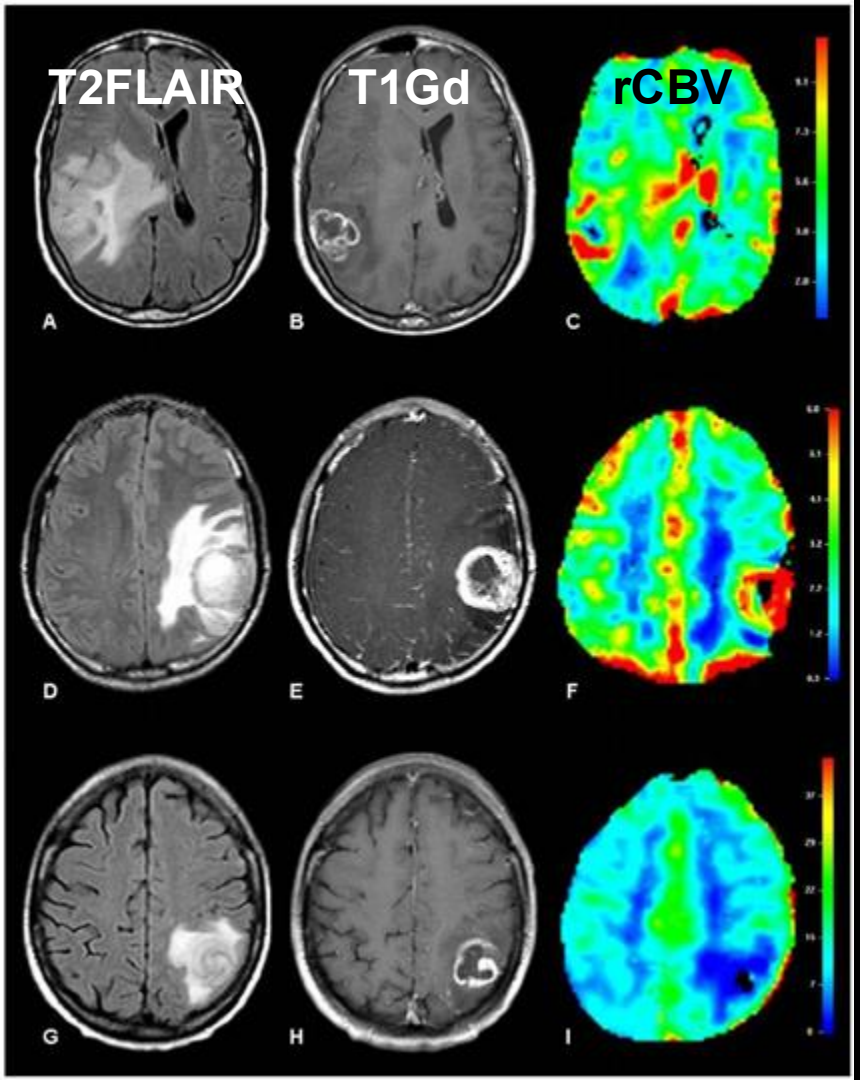


Tumefactive demyelination
Saindane 2002



mic

Floriano 2013



Glioblastoma with **high cerebral blood volume**

Malignant melanoma metastasis with **high cerebral blood volume**

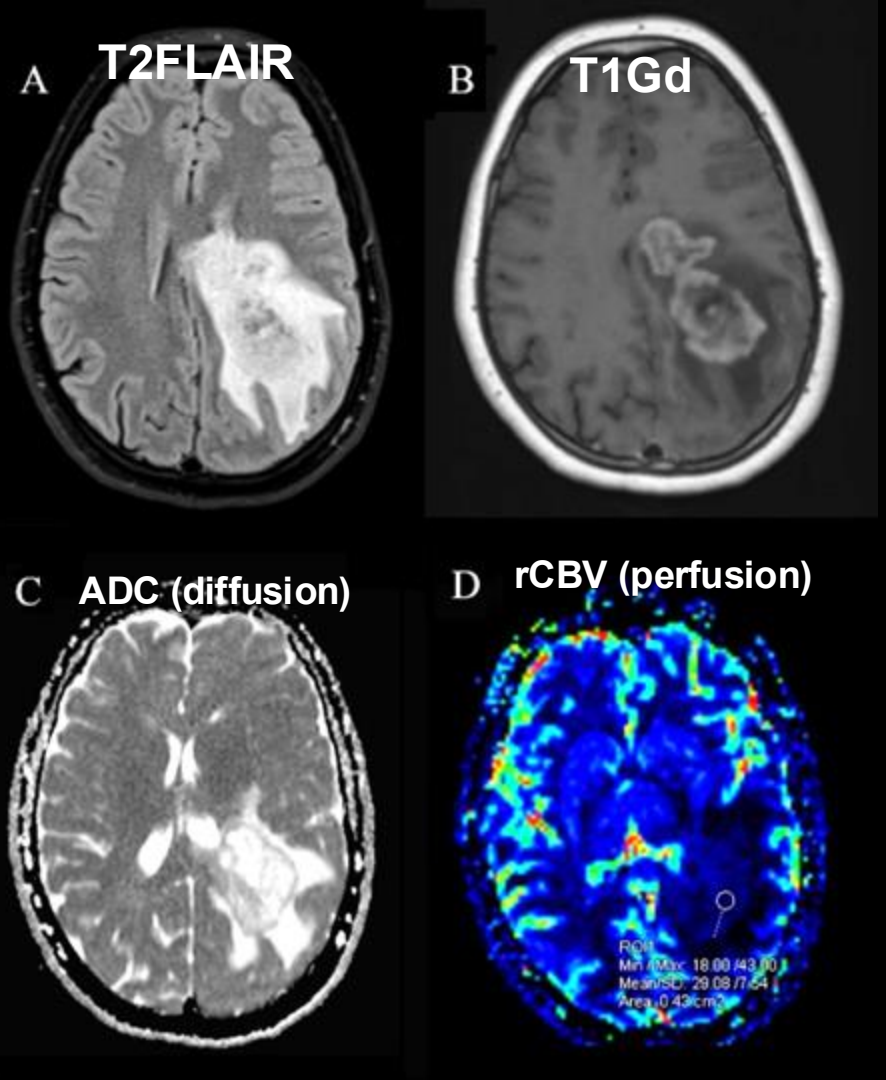
Cerebral toxiplasmosis with **low cerebral blood volume**

Floriano 2013

Tumefactive demyelination

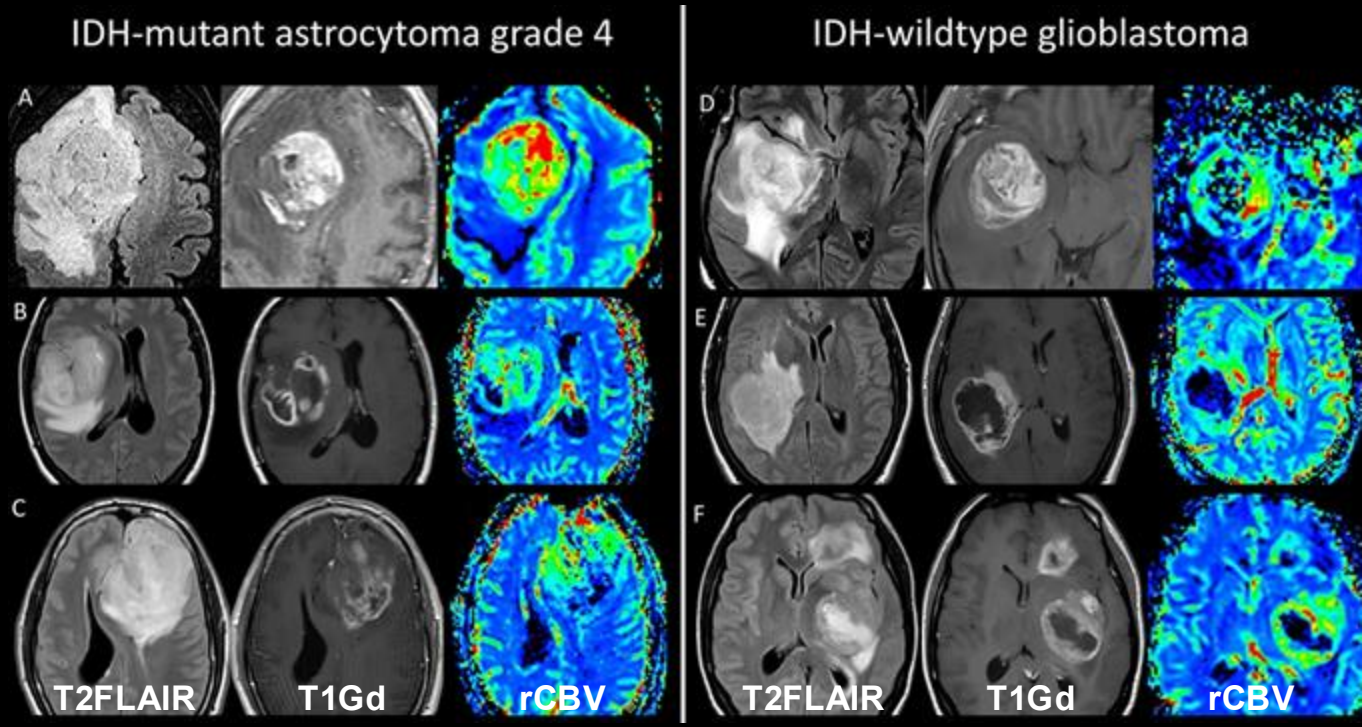
Resemble Glioblastoma on T1 and T2 weighted images

Lower cerebral blood volume than glioblastoma



De Simone 2017

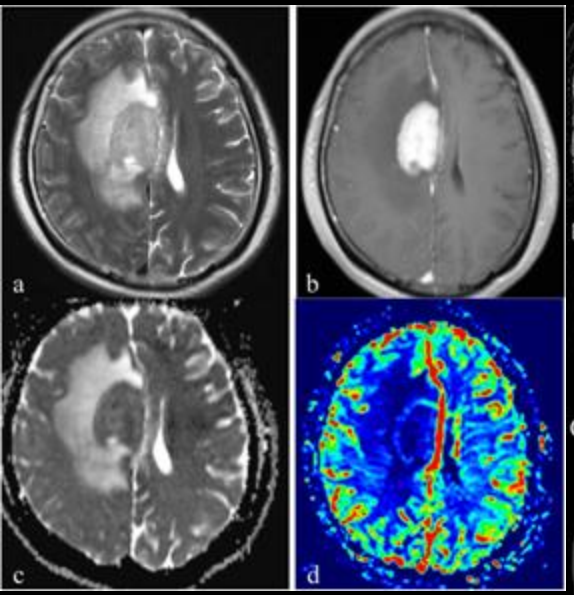
Lymphoma or Glioblastoma



Pons-Escoda 2024

Lymphoma or Glioblastoma

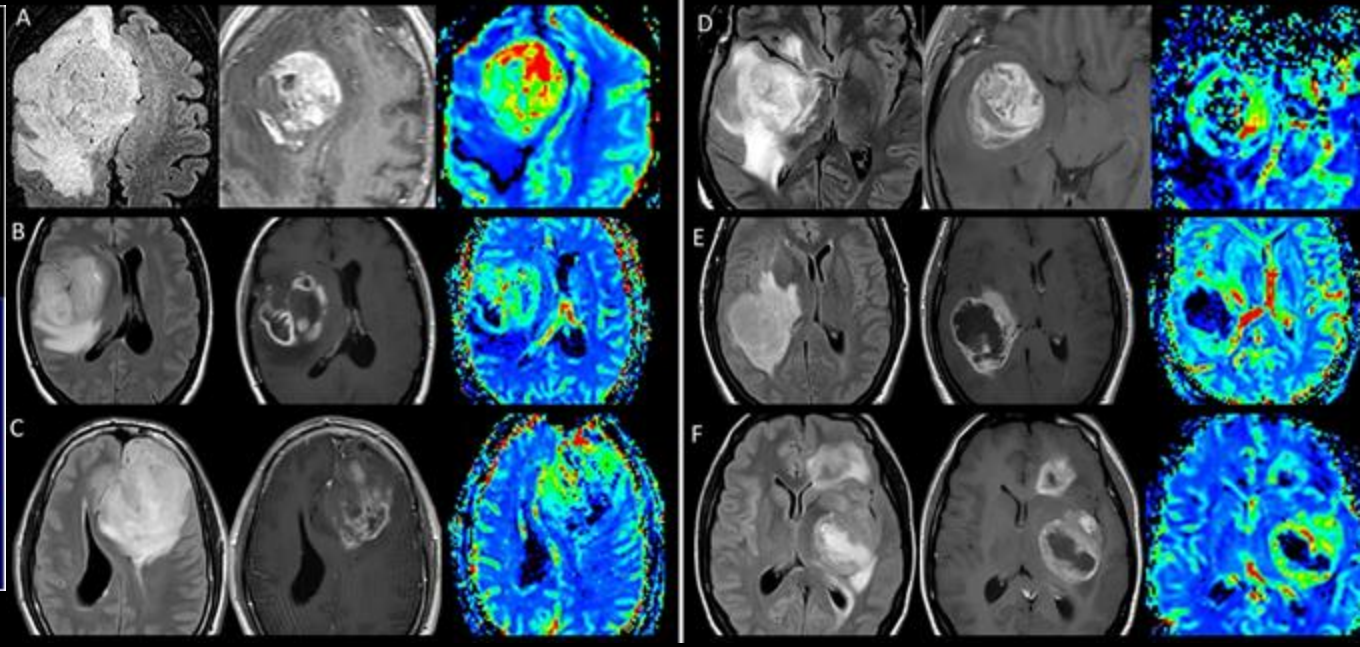
Lymphoma



Xing 2020

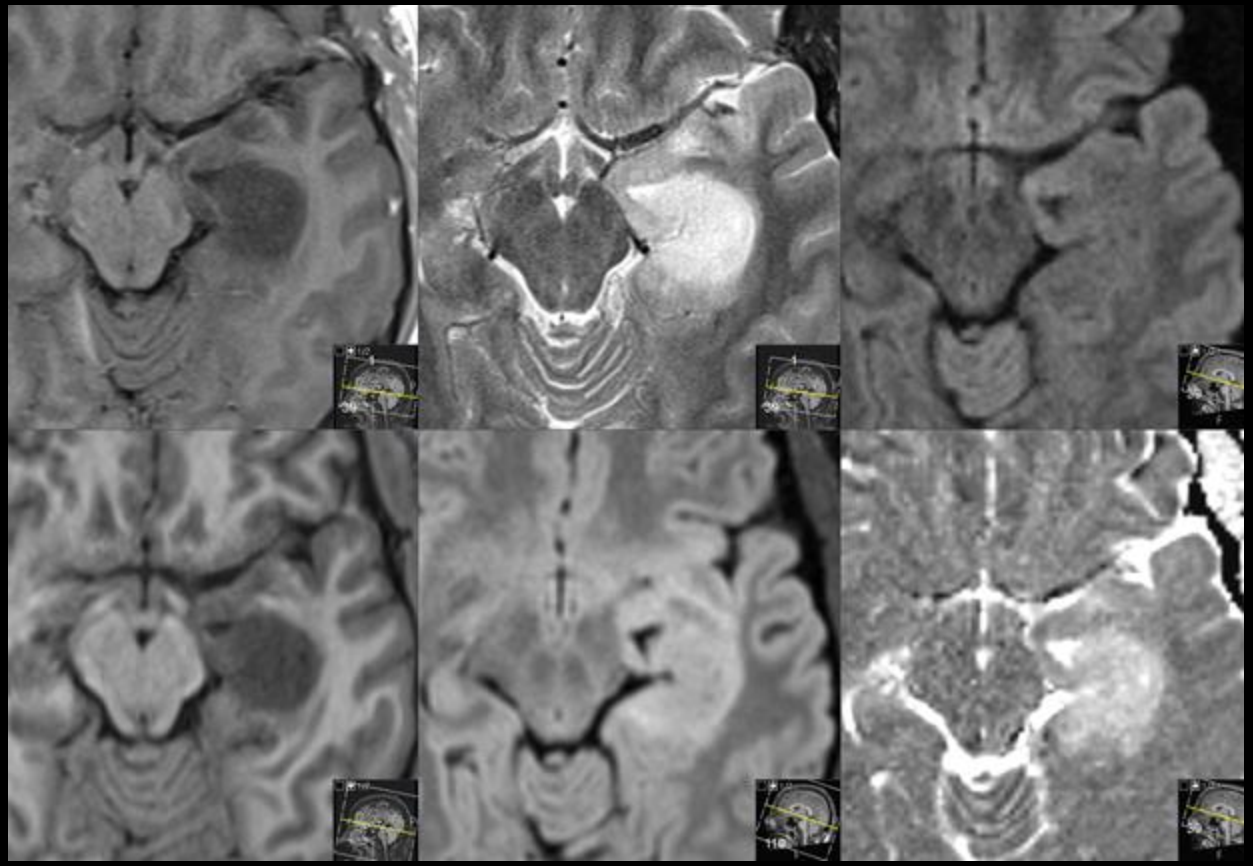
IDH-mutant astrocytoma grade 4

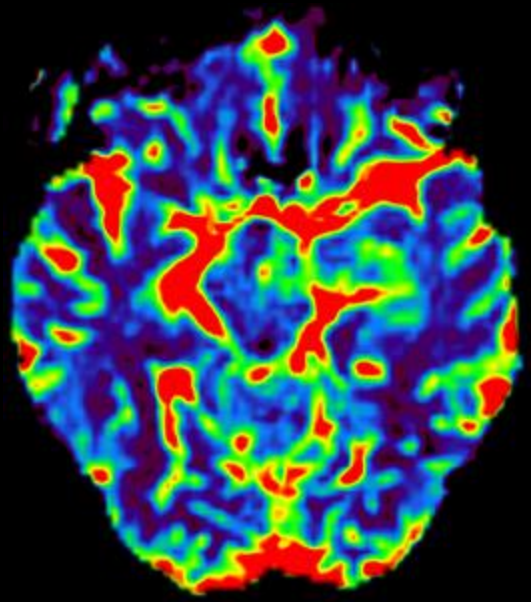
IDH-wildtype glioblastoma



Pons-Escoda 2024

Molecular glioblastoma

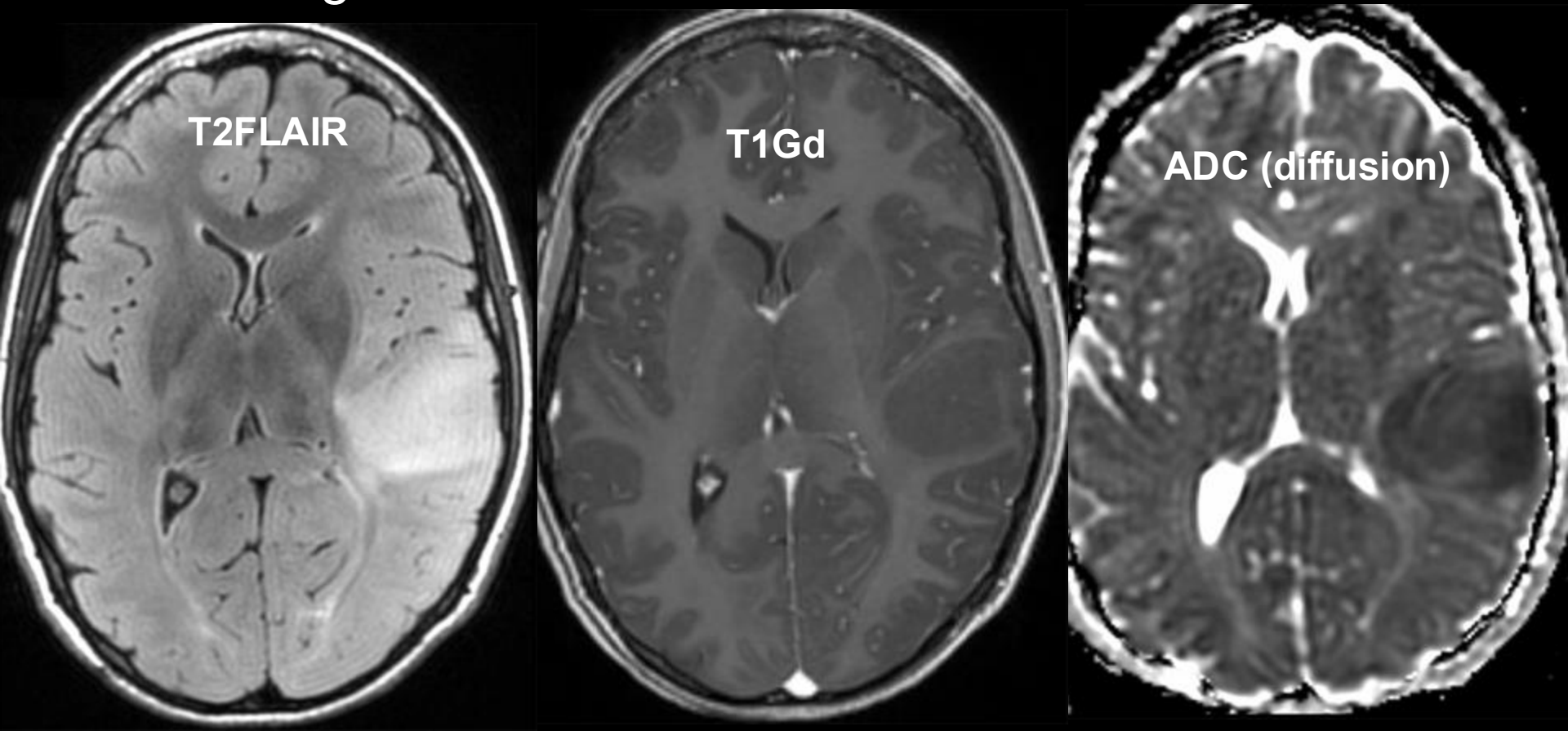




rCBV (perfusion)

Villanueva-Meuer 2017

Molecular glioblastoma



Why imaging?

- Need to know:

  Complications

- Like to know?

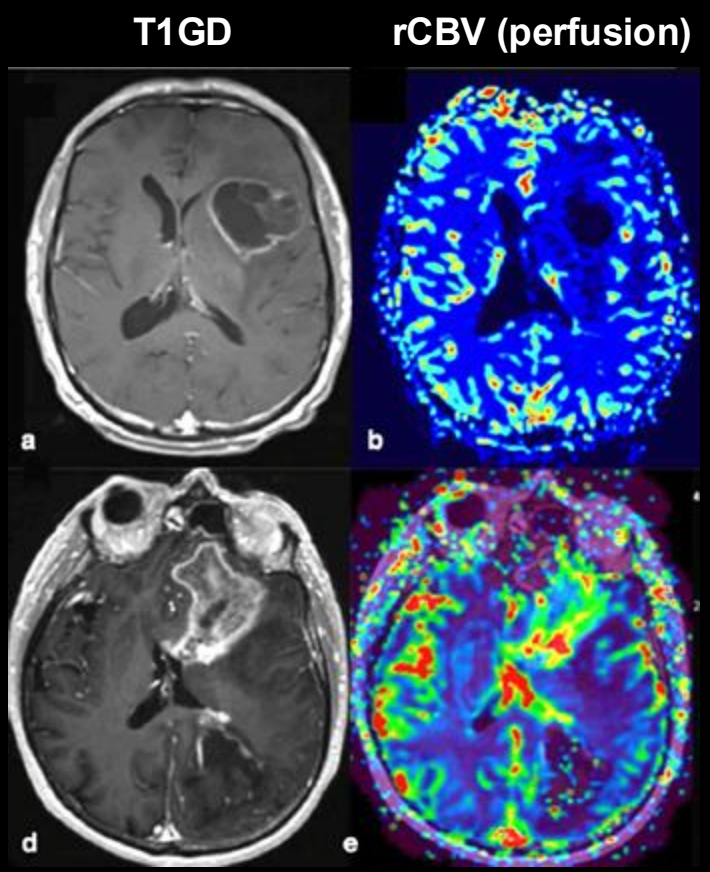
  Post surgery:

  Pseudo-response or pseudo-progression

Pseudo-progression

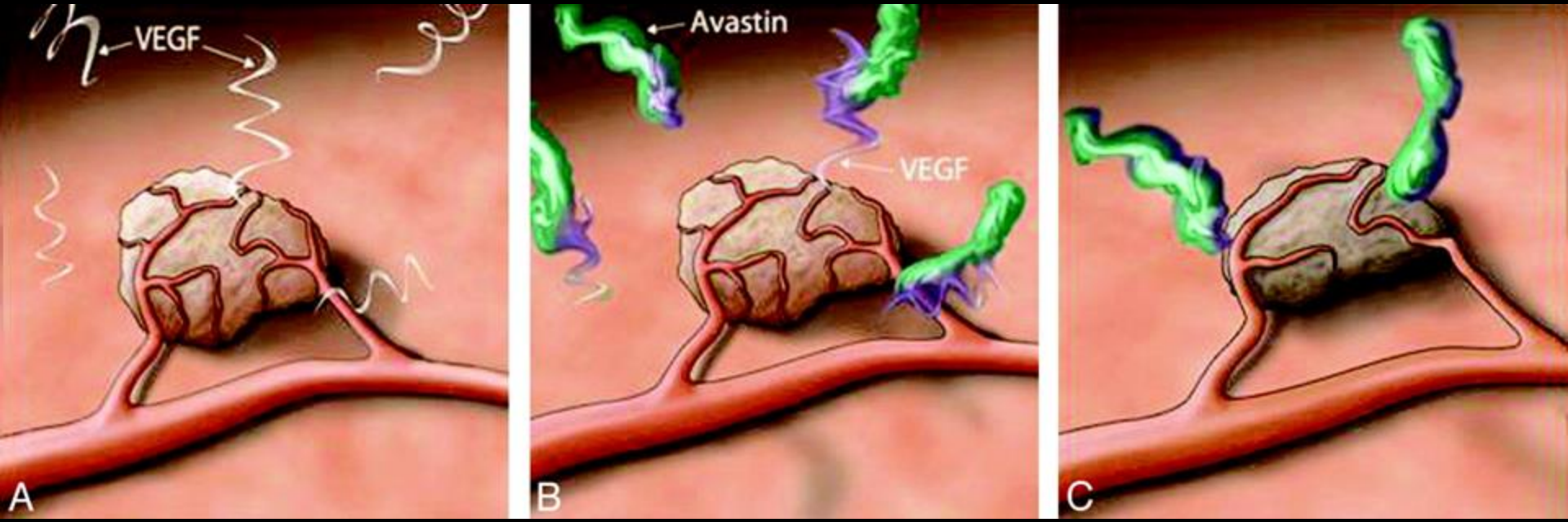
Radiation necrosis has **low cerebral blood volume**

Tumor progression has high cerebral blood volume



Thust 2018

Pseudo-response



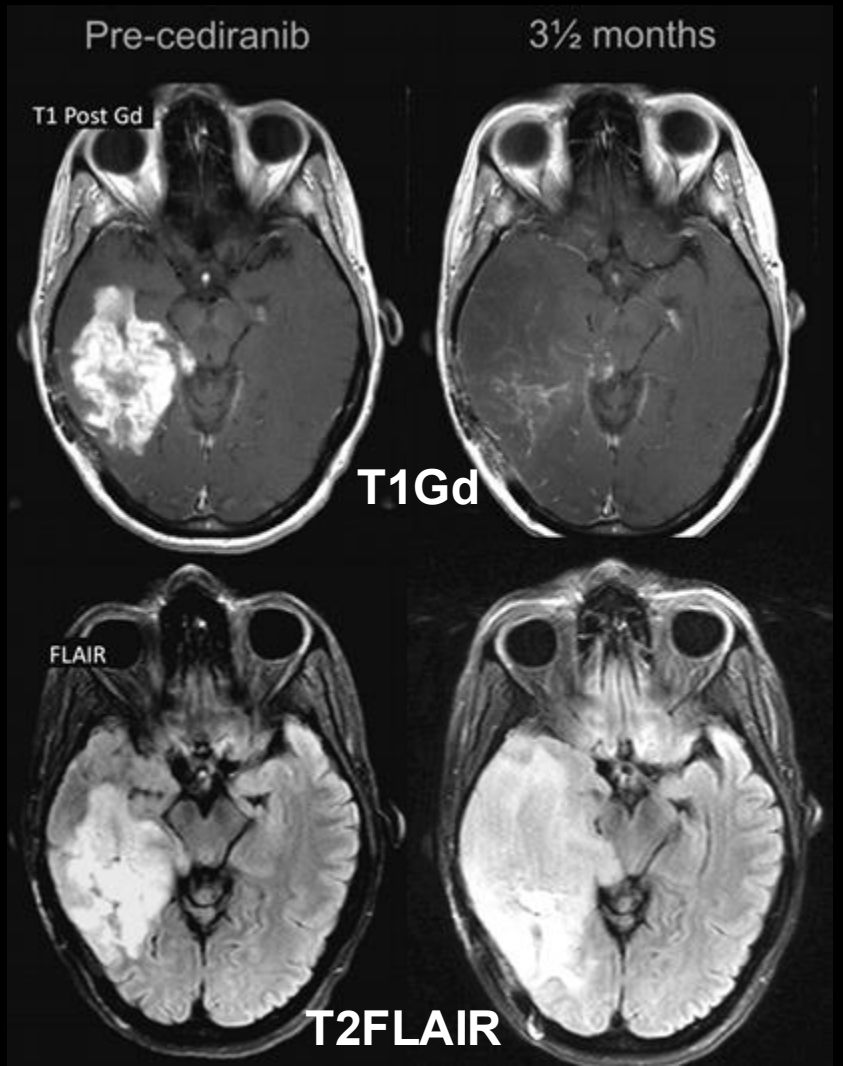
Mukherji 2010

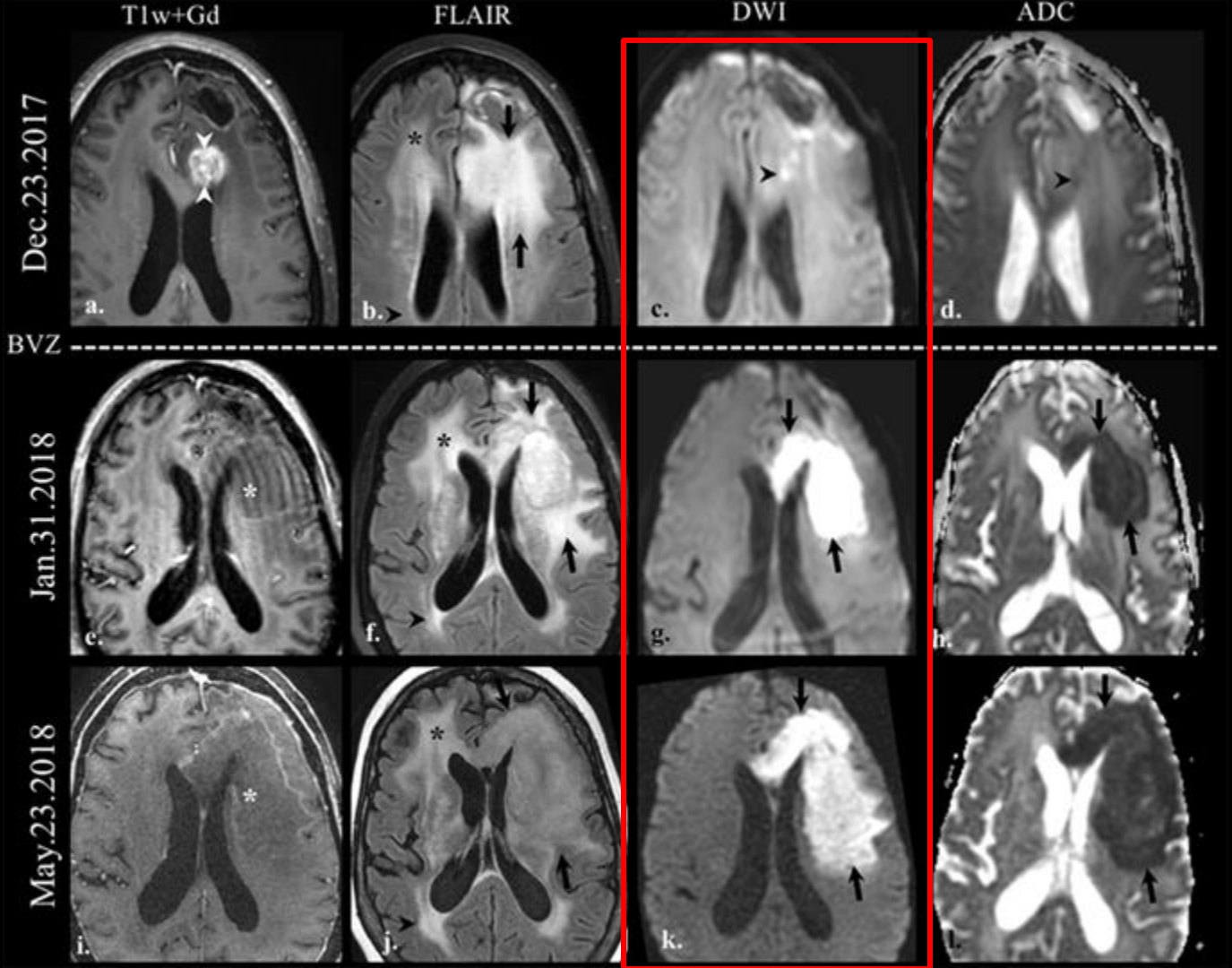
Pseudo regression

Effect of anti-angiogentic (cancer) therapy like Bevacizumab

Loss of contrast enhancement

Progression of expansive non-contrast enhancing tumor areas





Villanueva-Meuer 2017

“Slow”

Why?

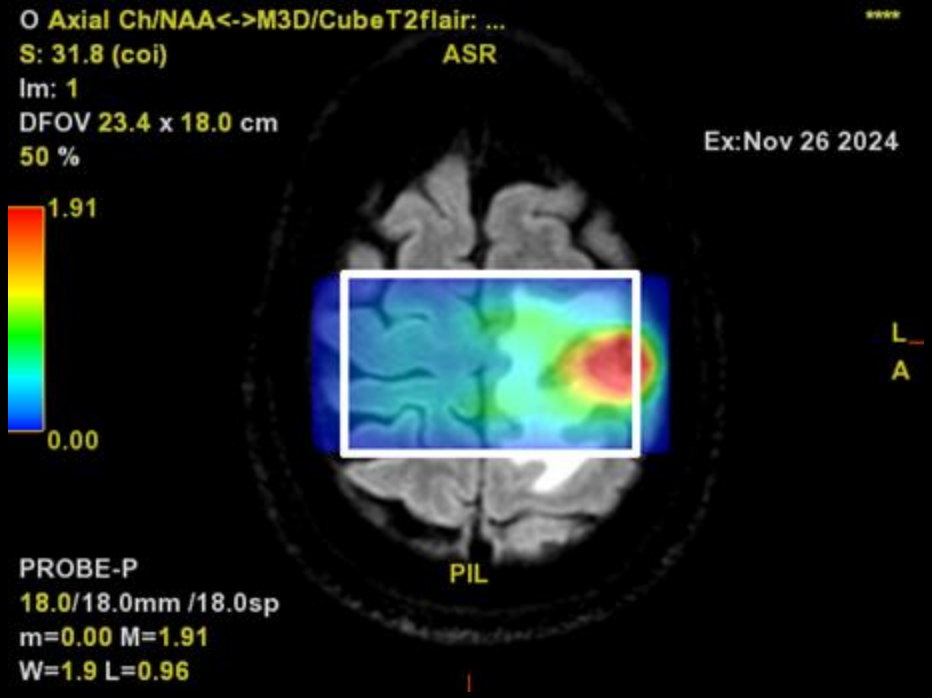
- Accurate diagnosis
- Patophysiological properties
- MRI as the ultimate classificator

Long protocols

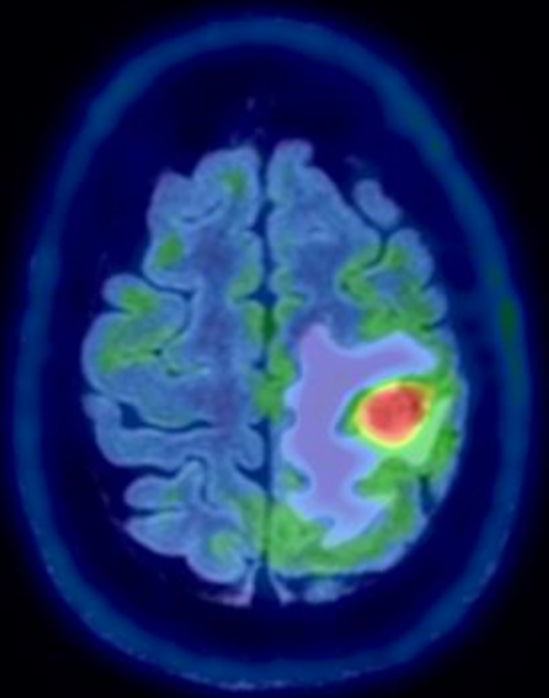
How?

- MRI perfusion
- MRI advanced diffusion
- MRI spectroscopy
- MRI Chemical exchange saturation transfer for example amide proton transfer imaging

MRI spectroscopy against Methionine-PET



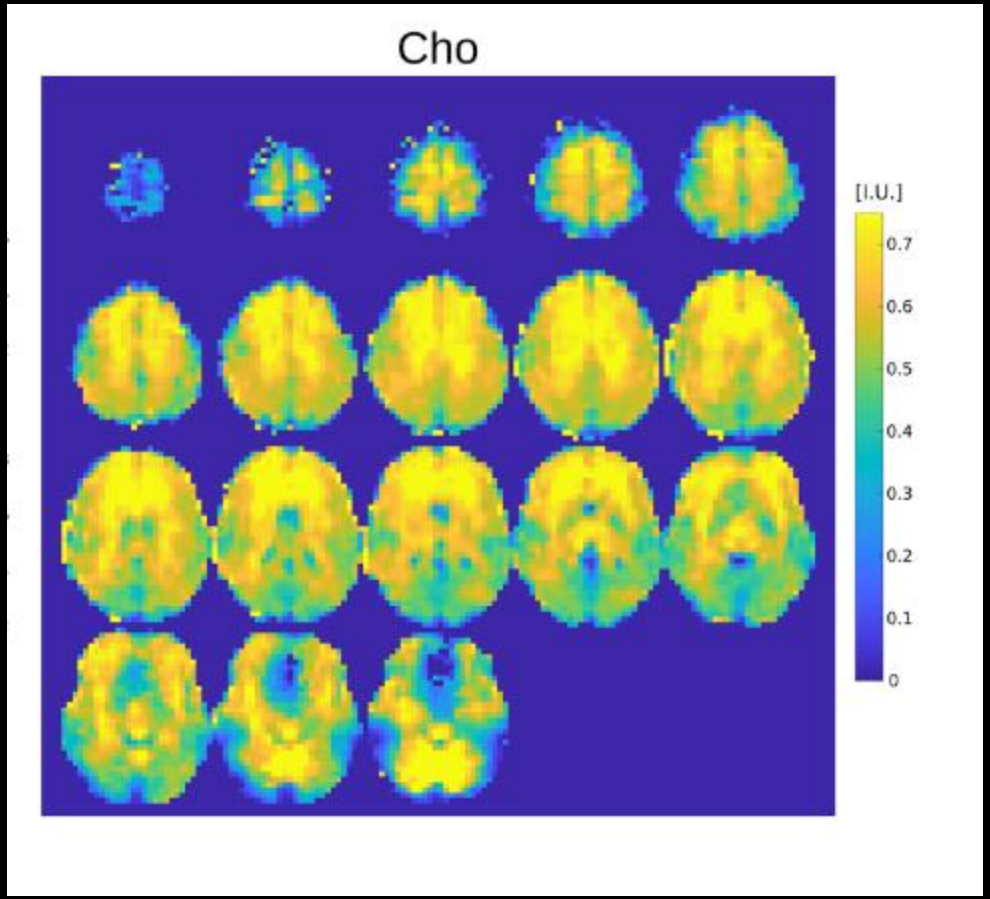
MRI Spectroscopy Ch/NAA



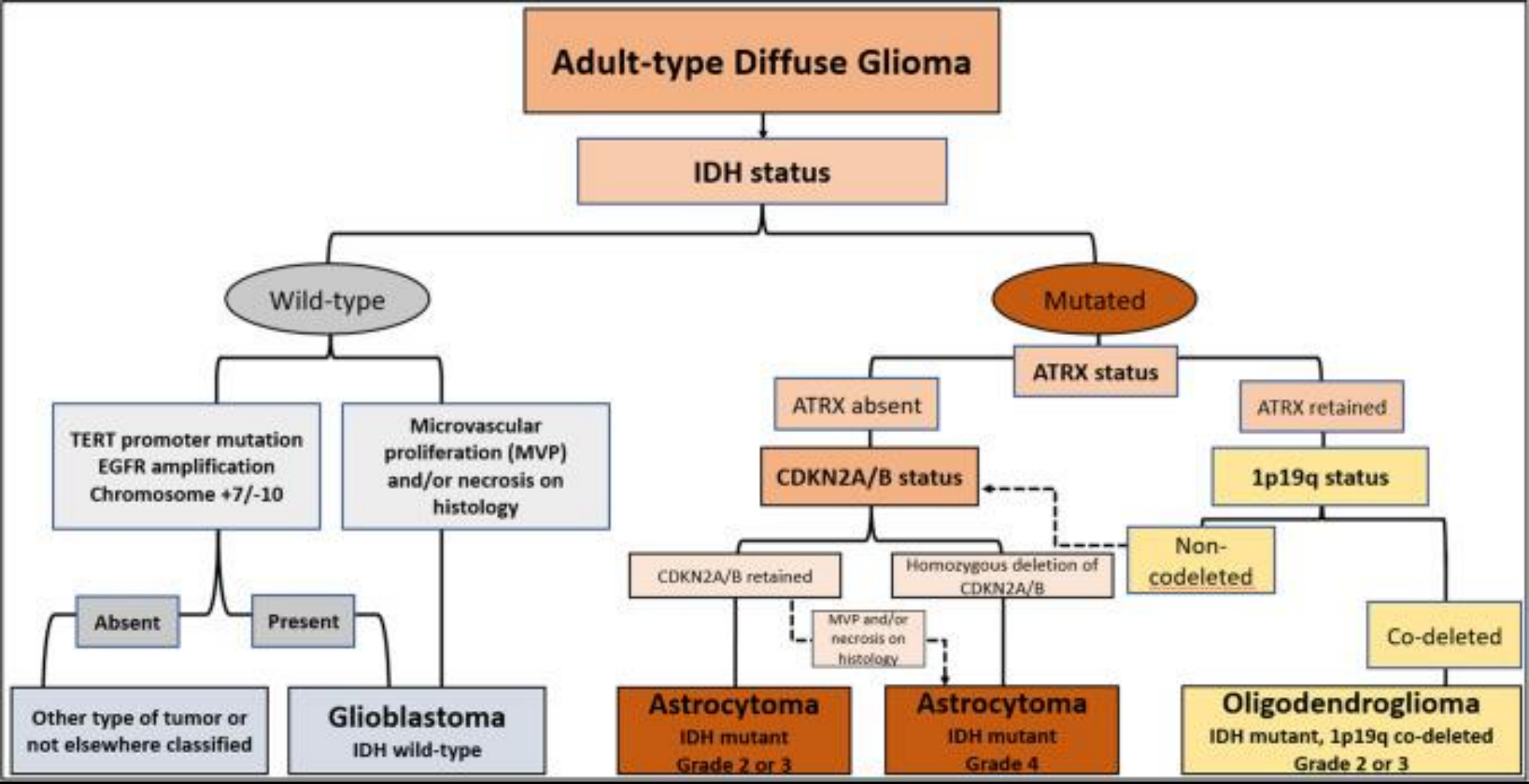
MET-PET

Whole-brain high-resolution metabolite mapping

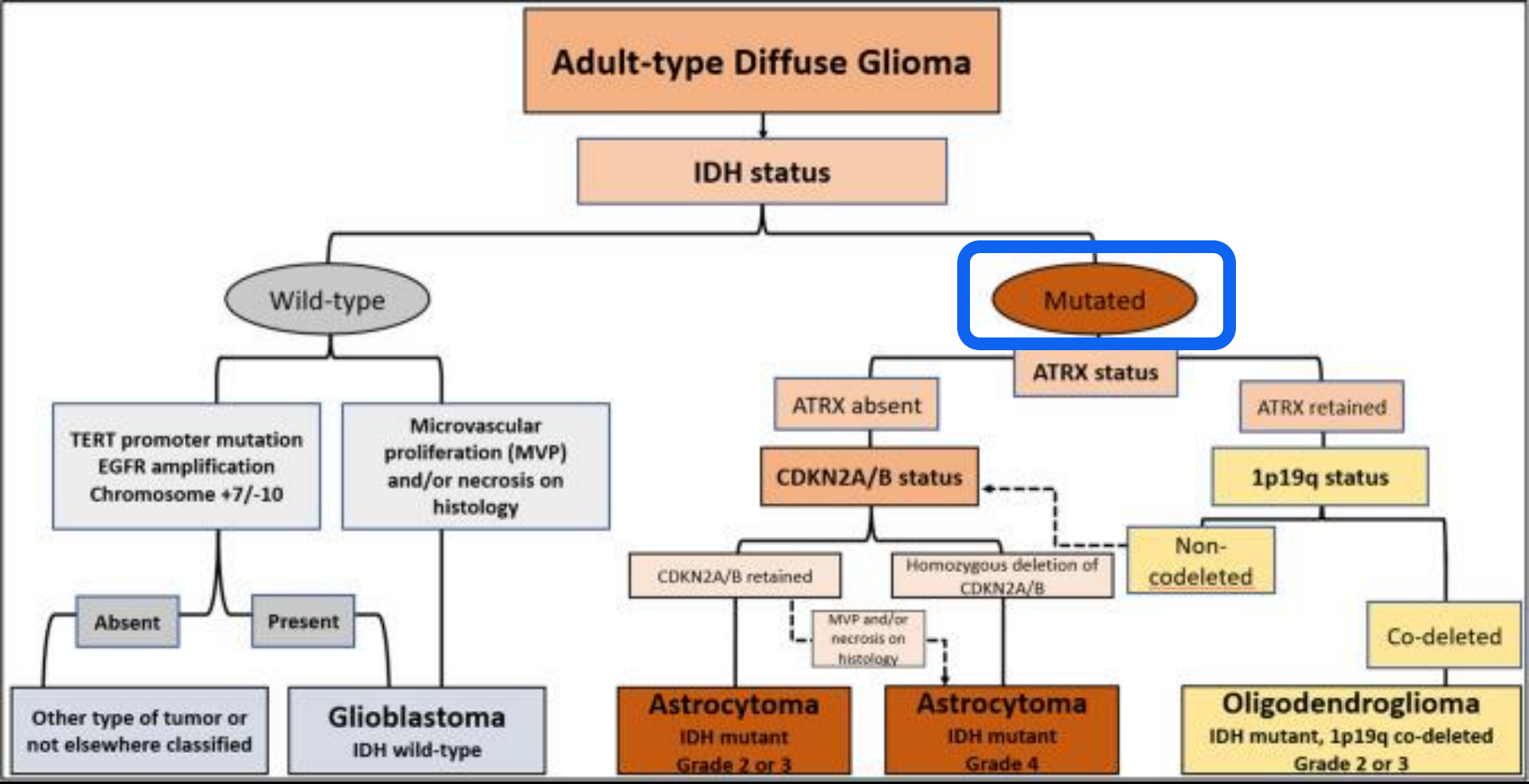
20 minutes



Klauser 2020



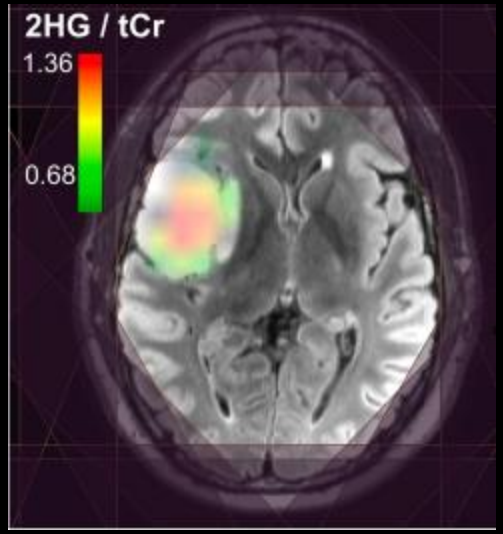
Alshiekh Nasany 2023



Alshiekh Nasany 2023

2HG MRI spectroscopy

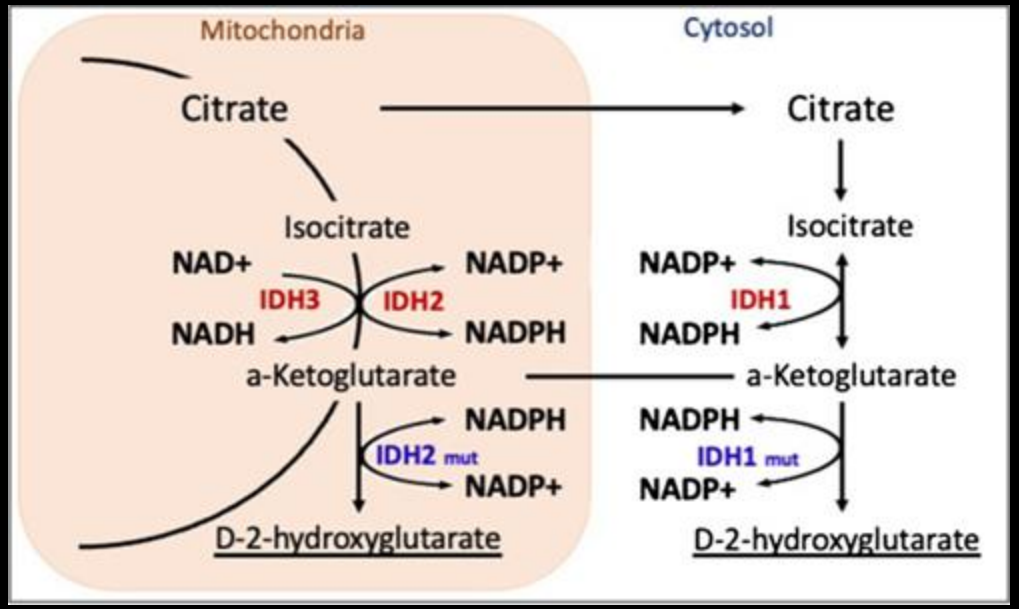
IDH inhibitors

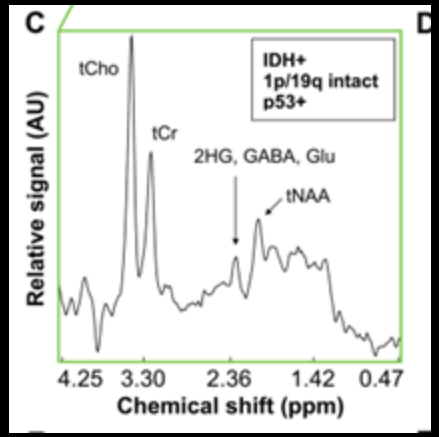


Autry 2022

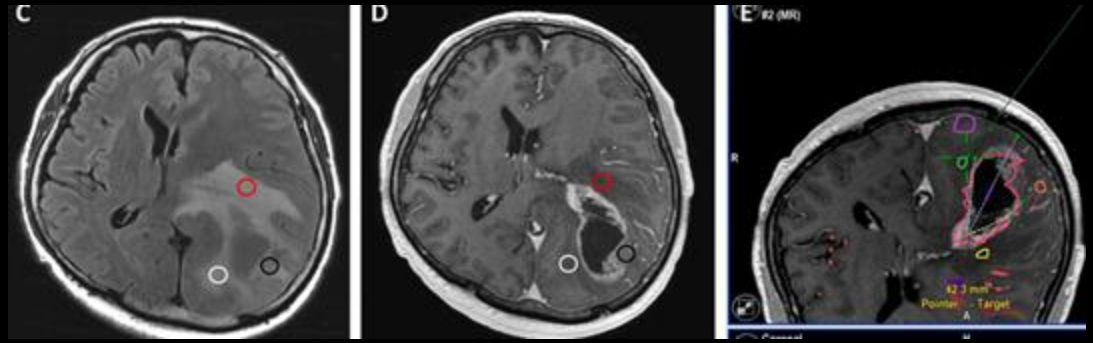
Mellinghoff 2023

Alshiekh Nasany 2023

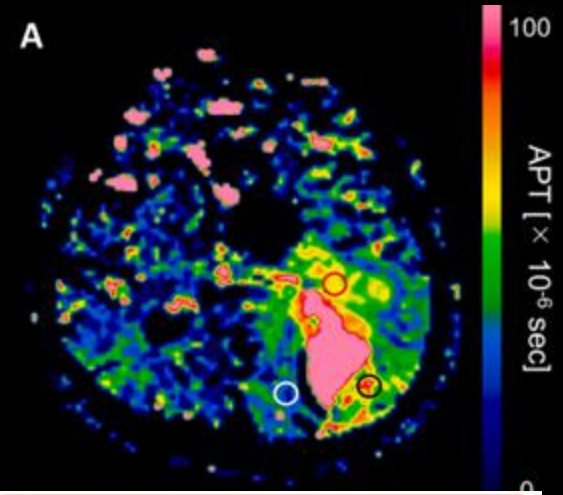




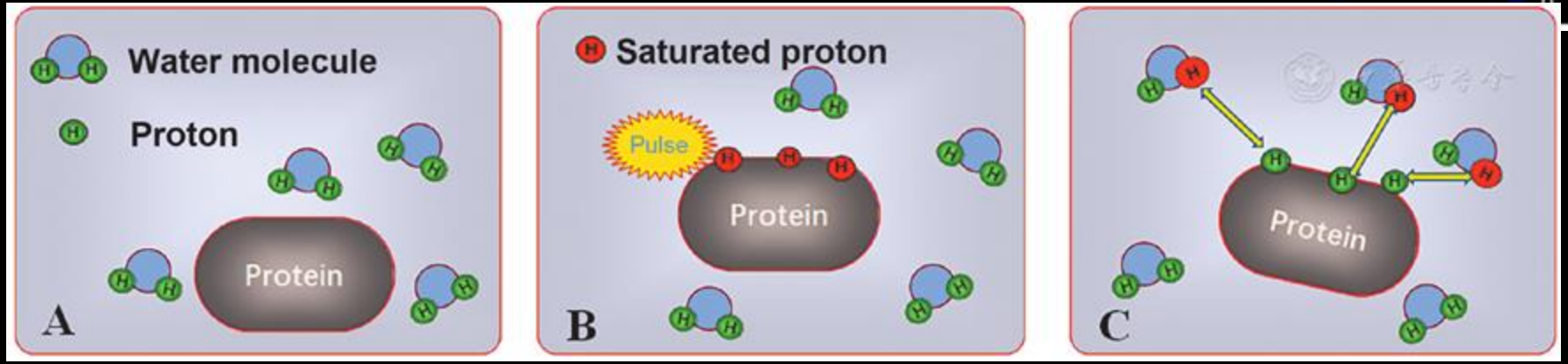
MRI Chemical exchange saturation transfer for example amide proton transfer (APT) imaging



Yamauchi 2022



Meng 2024



PET imaging

Amino acid tracers

- Methionine (MET)
- Tyrosine (FET)
- Phenylalanine (DOPA)
- Choline
- Fluciclovine (FACBC)

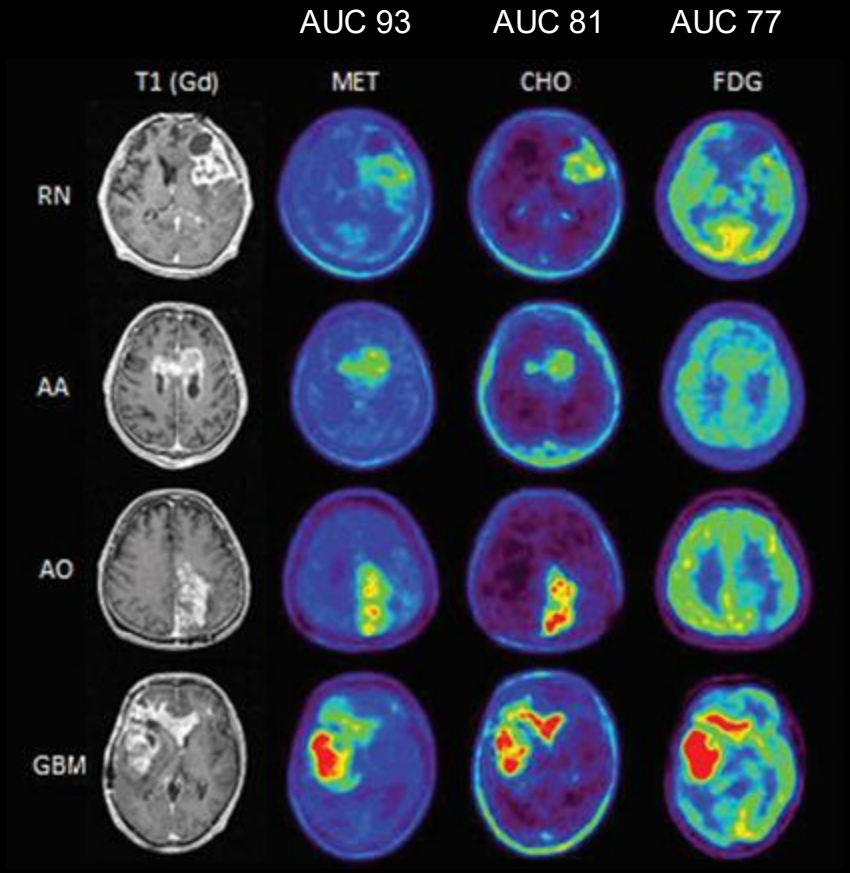
Prostate specific membrane antigen (PSMA)

Royal Brisbane and Women's Hospital (RBWH)
Radiopharmaceutical Centre for Excellence (Q-TRaCE)

PET-imaging: amino acids, FDG

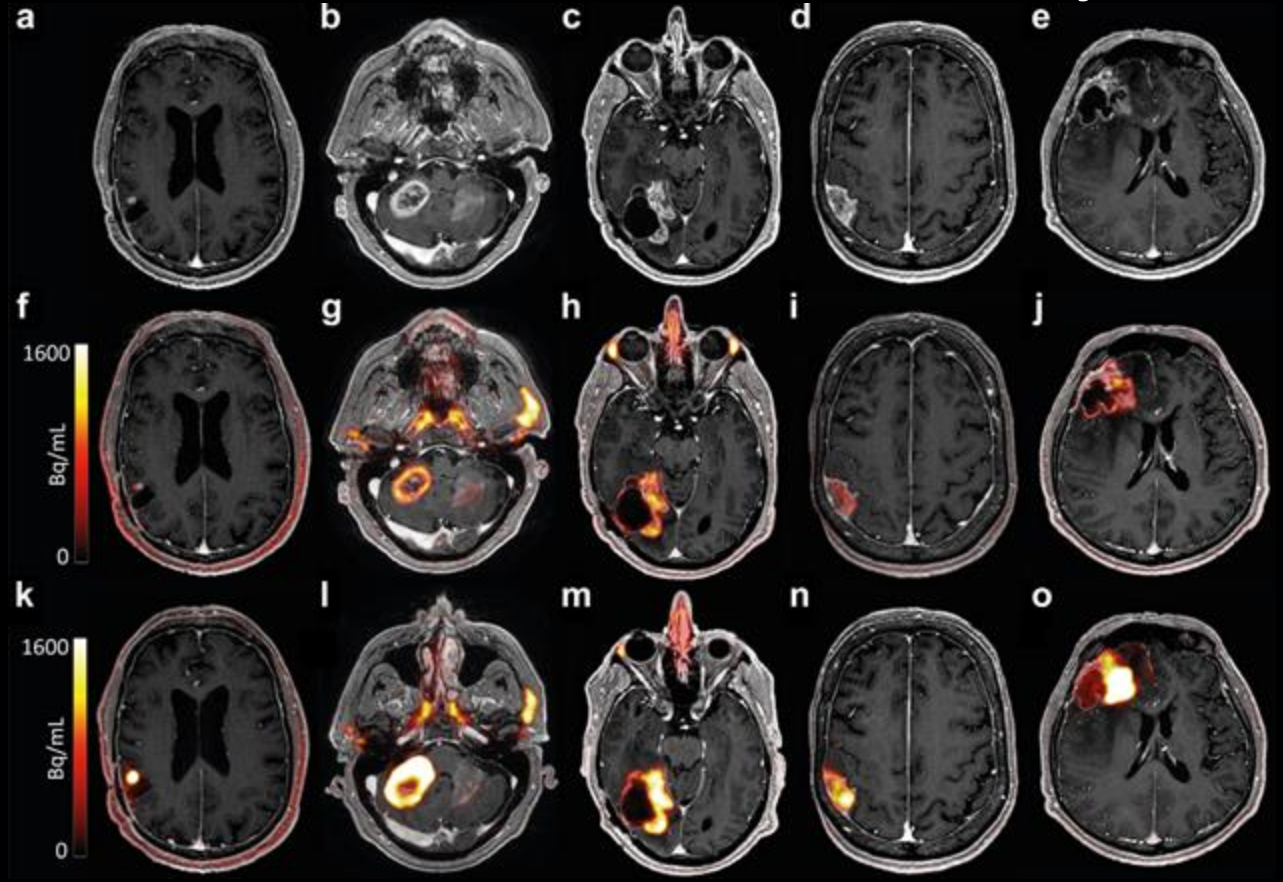
Radiation necrosis has **low uptake**

Tumor progression has high uptake



Takenaka 2013

PSMA - intravenous or intra arterial injection in Glioblastoma

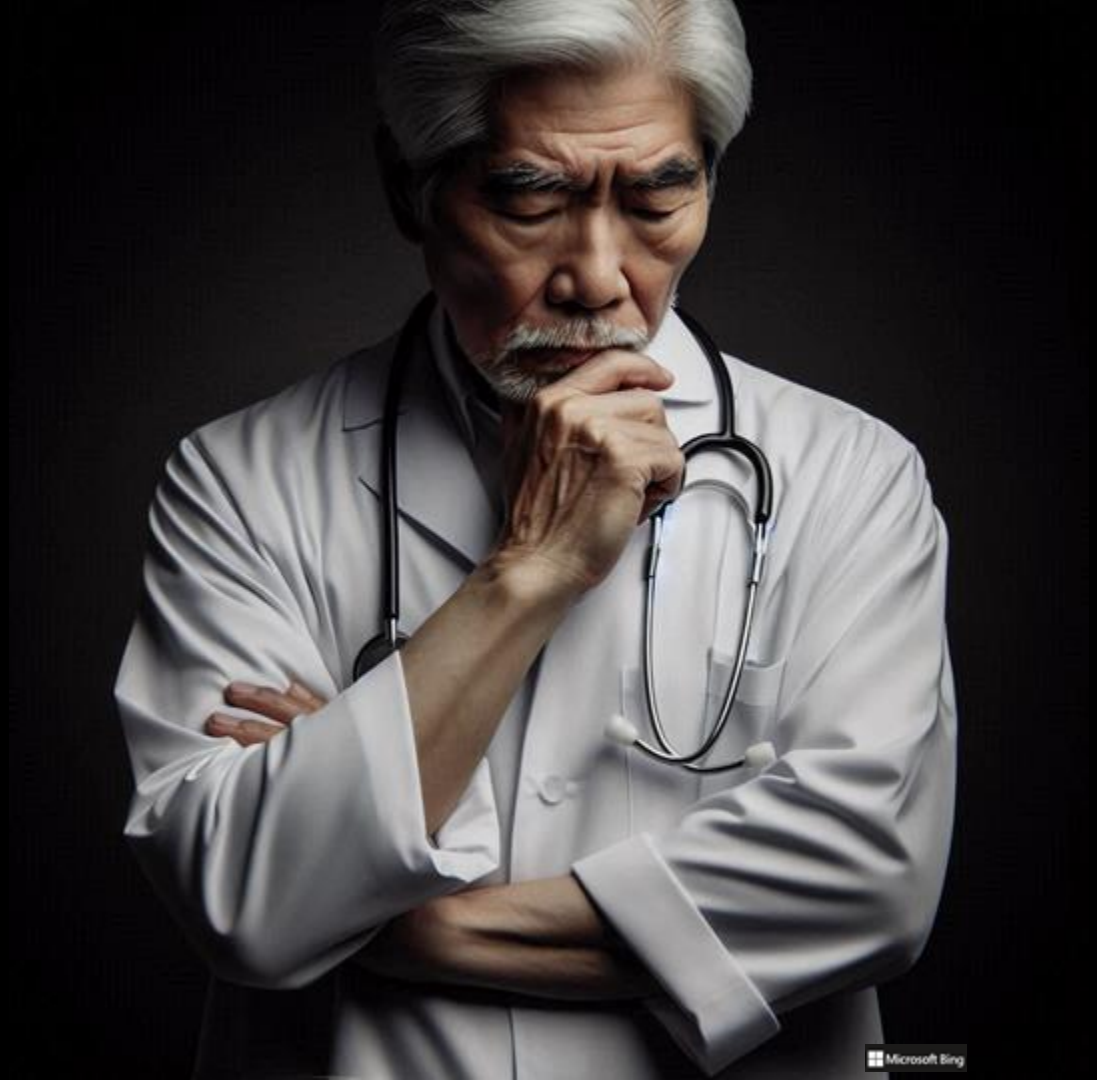


Pruis 2024

Why imaging?

What would you…

- Need to know?
- Like to know?










Thank you!

Stockholm County Council (ALF project)
KI faculty fund (KID)
Åke Wiberg
Magnus Bergvall
Department of Neuroradiology KS (FOU)
Swedish society of Medicine







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