



Tumor vs. Necrosis

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May 2005



The University of Texas
MD Anderson Cancer Center

Albert B. and Margaret M. Alkek Hospital

MD Anderson Cancer Center

The image shows the exterior of a large, modern multi-story building with a grid-like facade of windows and dark panels. The building is illuminated from within, and the sky is a clear, deep blue. The text on the building is in a serif font.

The University of Texas
MD Anderson Cancer Center

Albert B. and Margaret M. Alkek Hospital

Various MDA CC Buildings



MD Anderson Cancer Center

Division of Diagnostic Imaging,

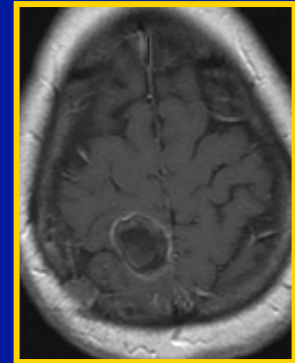
Section of Neuroradiology

- **Neuro:** Chief and 5.5 neuroradiologists
 - (7 faculty on call for neuro), 1-3 residents, 1-2 fellows
 - 35 physicist, one full time for neuro section
 - CNI Lab (computational neuroimaging lab) for post processing:
1 physicist, 1 tech

- **~200 Neuro CT and MRI scans daily + procedures**
 - 9 Clinical GE 1.5T MR scanners
 - 3 Clinical GE 3T MRI
 - 17 multislice CT scanners (4-64 slice scanners)

28 y/o with Anaplastic Oligodendroglioma in 2003, s/p glial wafers and chemoradiation

- Examination: Brain MRI, 6-25-04
- Clinical History: AO
- IMPRESSION:
- **FULL RESULT: Routine brain imaging was obtained. This is the first study at M.D. Anderson and outside imaging is not available.**
- There is an irregularly shaped, 3.0 or so cm, operative site in the right high posterior parietal lobe. There is internal heterogeneity, and on the FLAIR images as well as the other sequences, internal areas of linear-shape that correspond to the wafers that were placed surgically elsewhere. There is a rim of enhancement that is not clearly tumor. I do not see any clearly internal enhancing tumor, and the study is somewhat difficult to interpret in the absence of any prior imaging. This will serve as a baseline M.D. Anderson scan. I do not see surrounding infiltrative tumor or nonenhancing disease elsewhere.



Postradiation Necrosis May Mimic Tumor

- Late delayed radiation injury can be progressive and fatal
- May need surgery
 -Diagnostic dilemma

Dg of Radiation Injury Is Challenging

- The pattern of abnormal enhancement closely mimics that of recurrent brain tumor

Proposed Mechanism of Radiation Induced Neurotoxicity

- **Vascular Injury: thrombosis, infarction necrosis**
- **Glial and white matter damage: oligodendrocytes sensitive to radiation → destruction leads to demyelination**
- **Effect on the fibrinolytic enzyme system**
- **Immune mechanismm (?autoimmune vaculitis)**

Diagnostic Dilemmas...

- Mild form of radiation injury: white matter enhancement: nodular, linear, curvilinear
- Suspect progression to radiation necrosis if: increase in size, edema, mass effect
- Cortical gyral enhancement may simulate infarction

Suspect Chemoradiation Injury on MRI

- Soap bubble or Swiss cheese interior - lace-like appearance
- Cave: can be solid lesion
- Proximity to original lesion:
 - Edge of the treated tumor
 - Several cm from tumor
 - Ipsilateral, but also contralateral
 - Within the tumor site

Brain Has Limited Number of Ways to Respond to Various Insults

Both tumor recurrence and radiation injury can cause:

- Vasogenic edema
- Disruption of BBB
- Cavitations

Follow up of Treated Tumors

- CT, MRI with contrast
- MRS, DWI/ADC
- CT / MR perfusion studies
- PET, SPECT

Follow up of Treated Tumors

- **CT, MRI** anatomical information
- **IV Contrast:** breakdown of BBB
- **Hemodynamic perfusion MRI:** rCBV mapping
- **Diffusion MRI:** ADC: physical & chemical information
- **MRS:** Biochemical parameters

- **PET, SPECT** biological information

Radiation Injury Area

- Irradiated tumor cells
- Coagulation necrosis
- Reactive gliosis
- Active fibrosis

Necrosis & Tumor Recurrence

AJNR Aug 2001, Schlemmer et al.

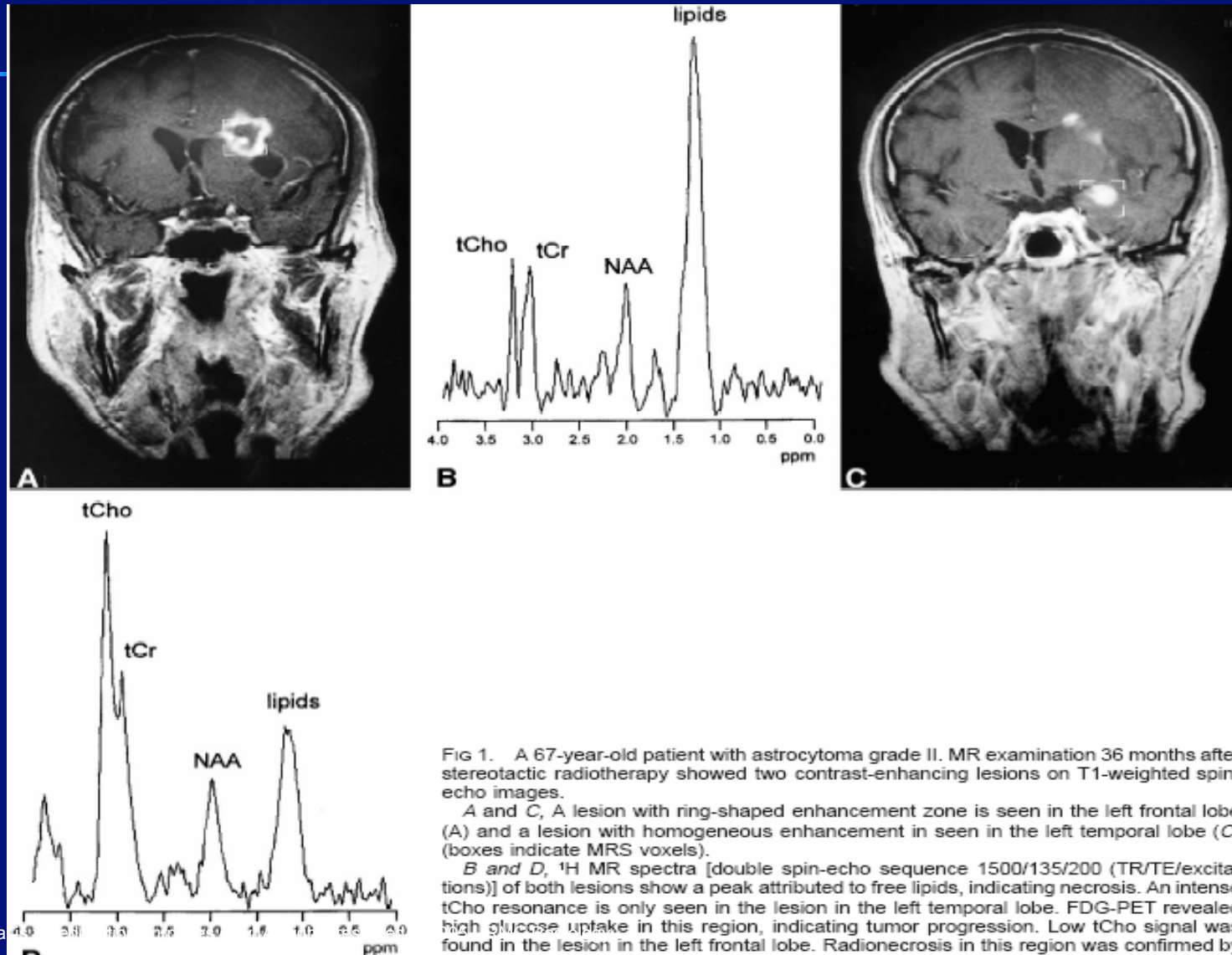
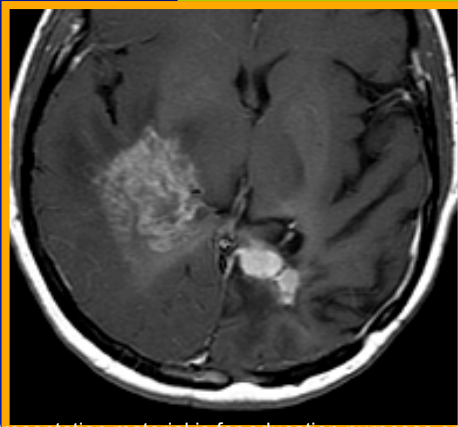
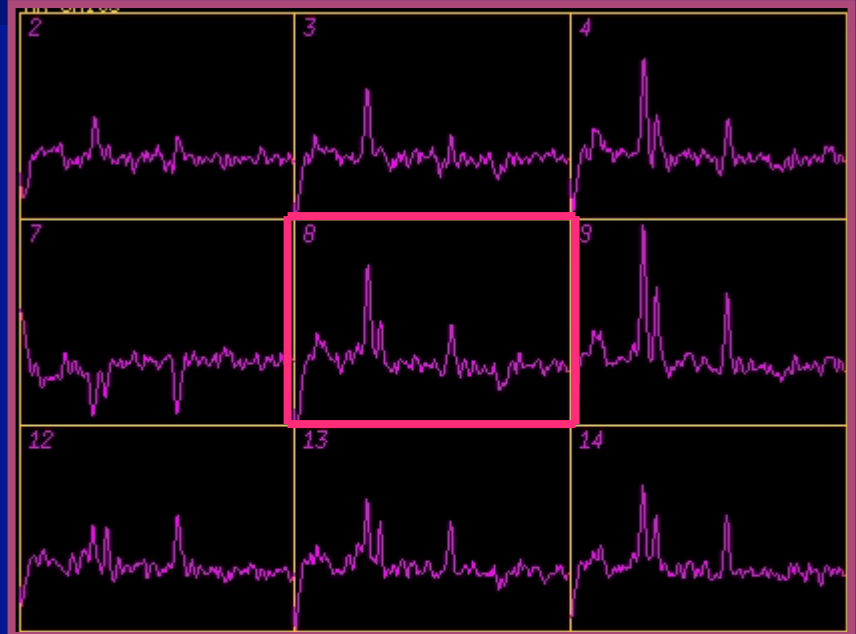
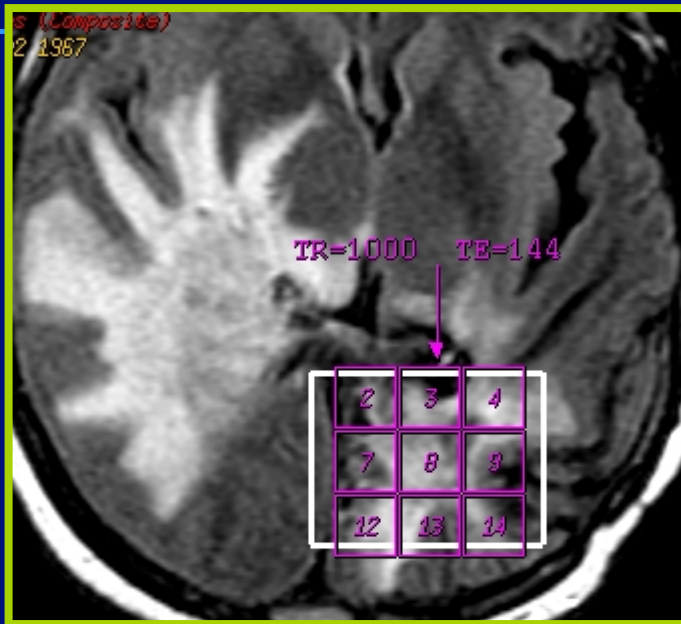


FIG 1. A 67-year-old patient with astrocytoma grade II. MR examination 36 months after stereotactic radiotherapy showed two contrast-enhancing lesions on T1-weighted spin-echo images.

A and C, A lesion with ring-shaped enhancement zone is seen in the left frontal lobe (A) and a lesion with homogeneous enhancement is seen in the left temporal lobe (C) (boxes indicate MRS voxels).

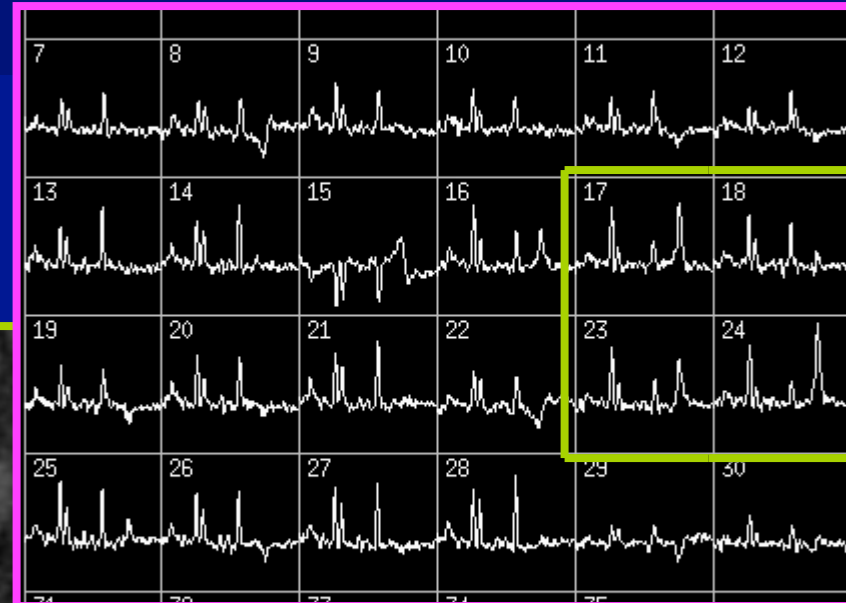
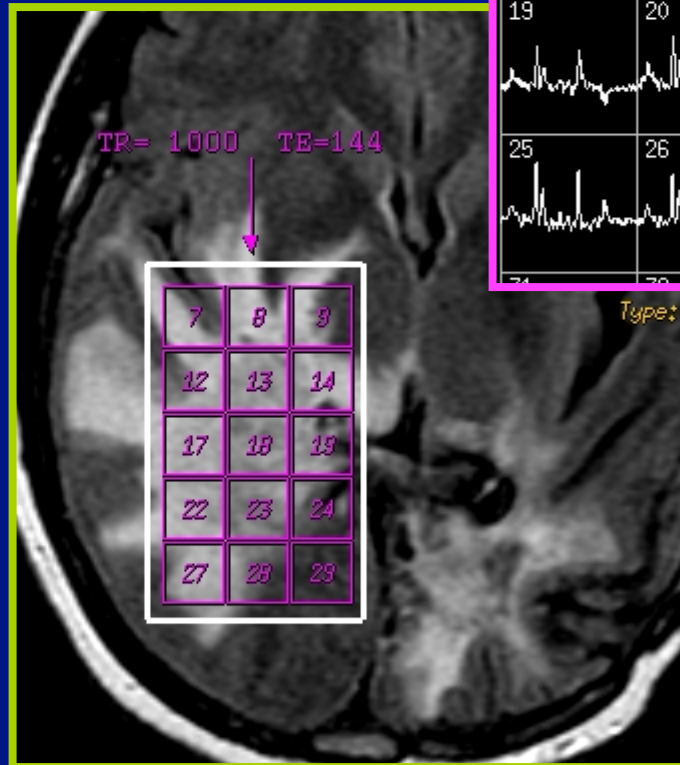
B and D, ¹H MR spectra [double spin-echo sequence 1500/135/200 (TR/TE/excitations)] of both lesions show a peak attributed to free lipids, indicating necrosis. An intense tCho resonance is only seen in the lesion in the left temporal lobe. FDG-PET revealed high glucose uptake in this region, indicating tumor progression. Low tCho signal was found in the lesion in the left frontal lobe. Radionecrosis in this region was confirmed by

38 Year Old Female GBM since 2003, Left Occipital

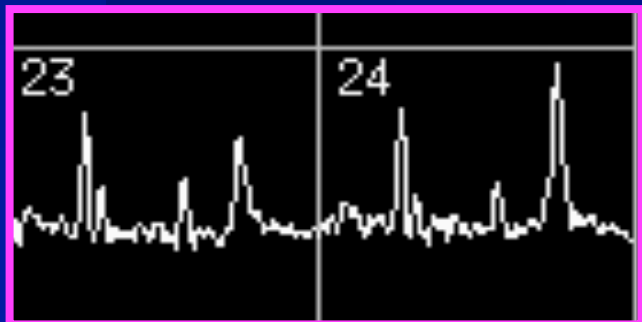
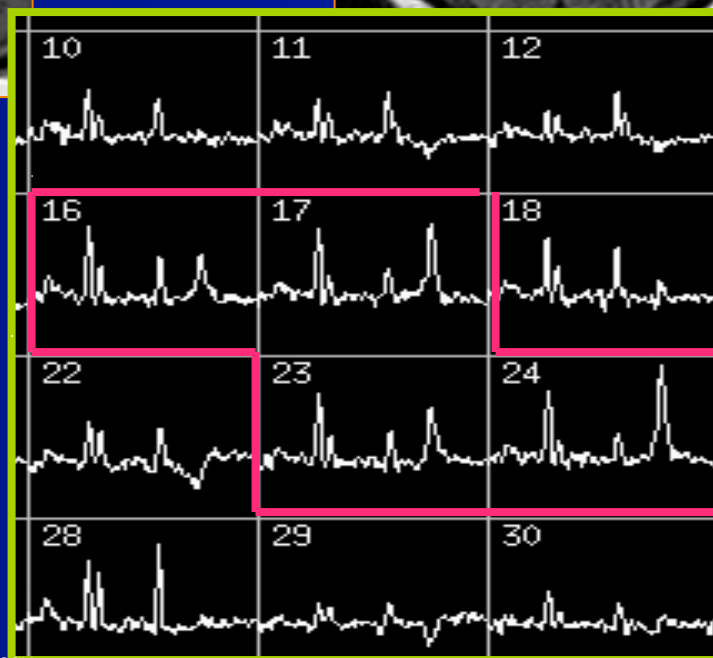
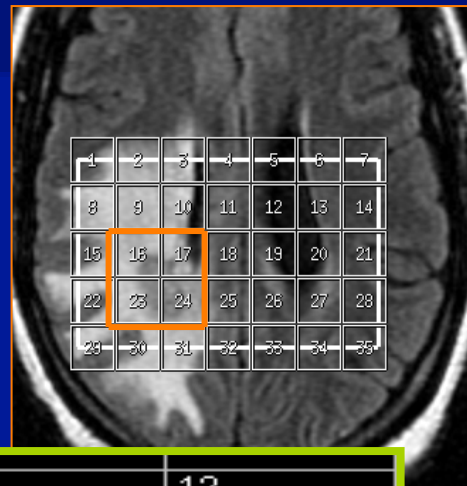
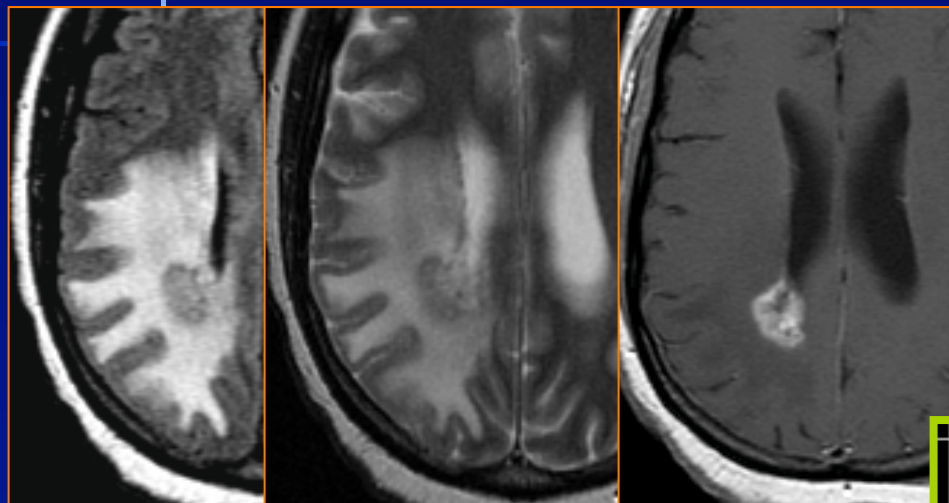


GBM left occipital: First Crani 4/03, Rx 7/' 03. Second Crani 11/' 04

37 year old female

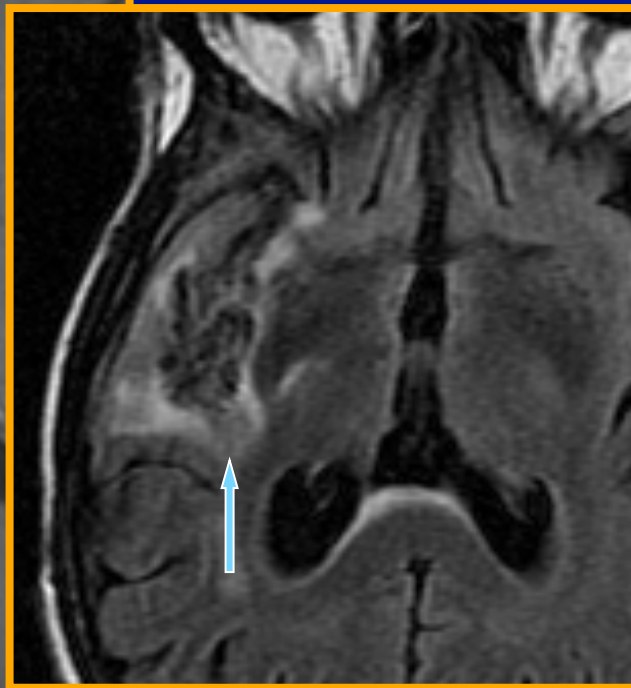
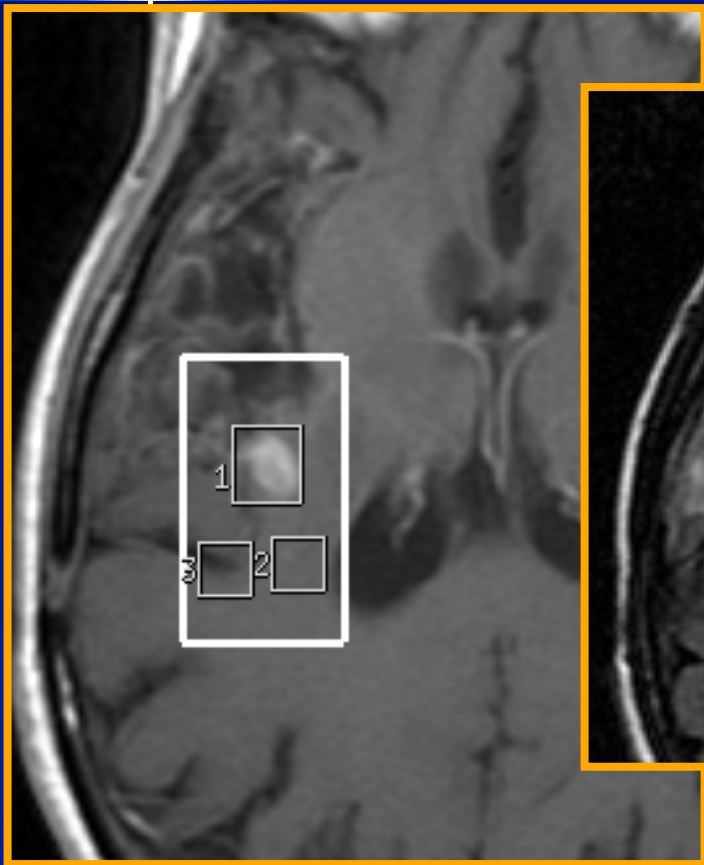


Anaplastic Oligoastrocytoma, status post chemoradiation, follow-up in 3/2005 with new periventricular enhancement

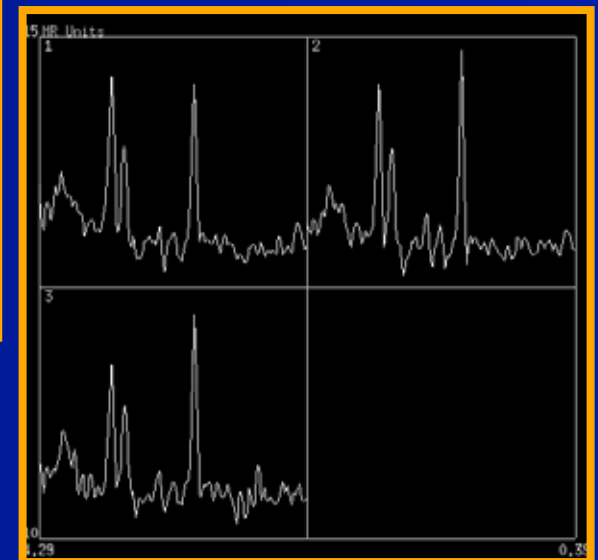


GBM: Tumor recurrence vs necrosis

Crani 10/03. Radiation completed 12/03

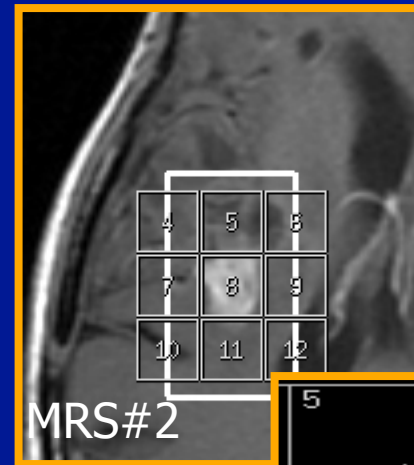
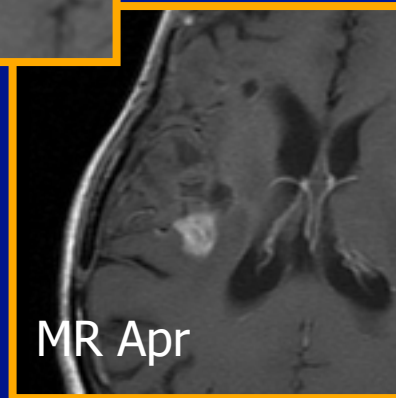
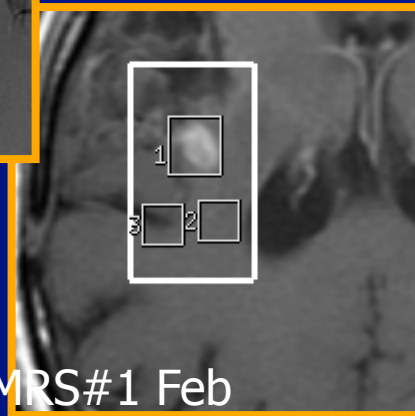


2/10/'05

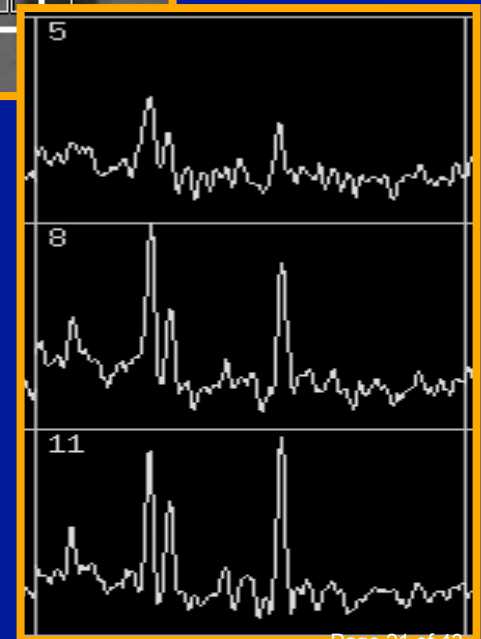


GBM: Tumor recurrence vs necrosis ?

Crani 10/03. Radiation completed 12/03



4/7/'05

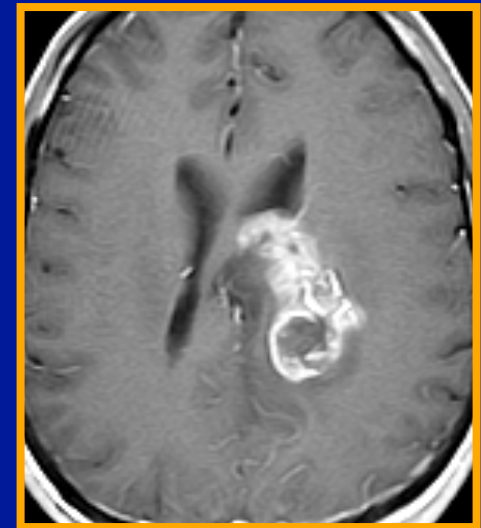
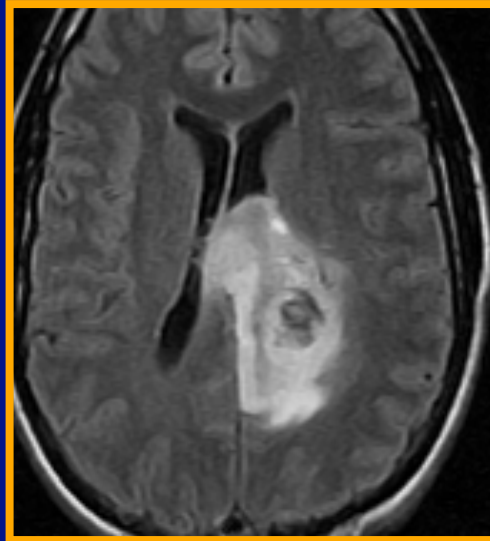
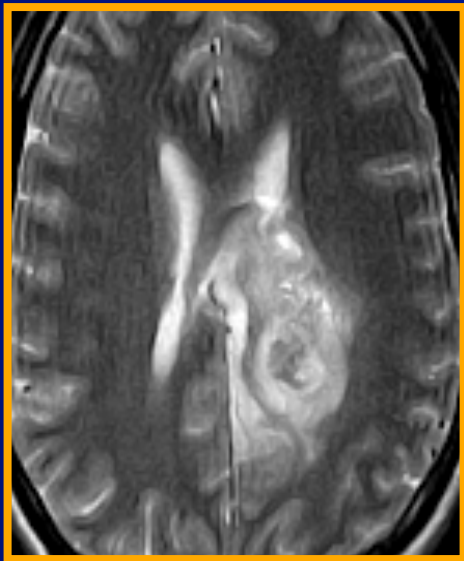


Radiation Injury: Predilection of Periventricular White Matter Involvement

- Poor blood supply from long medullary arteries
- Lack of collateral supply
- Subependymal necrosis may mimic tumor spread

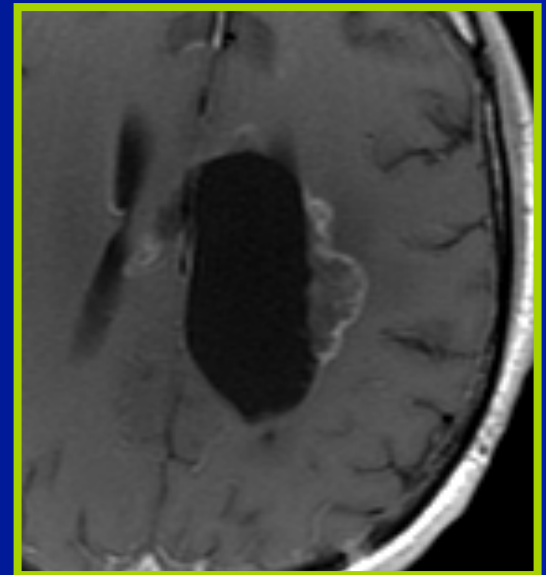
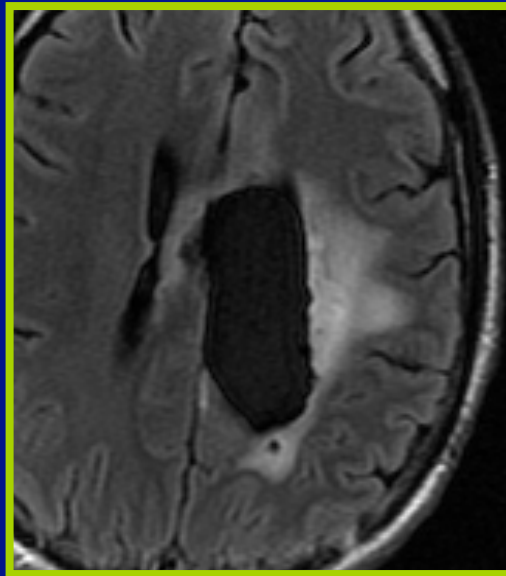
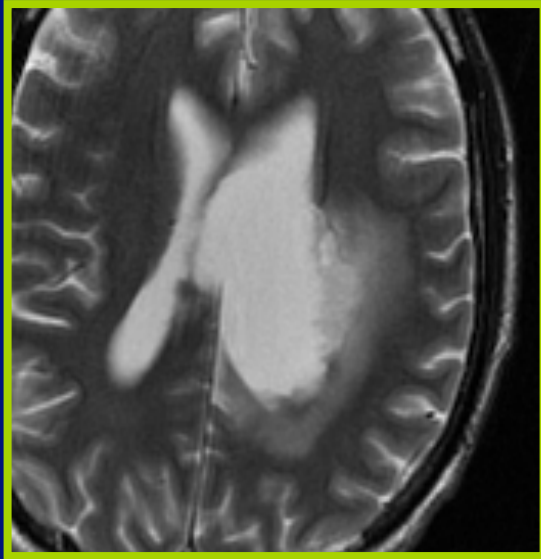
GBM

Sept 2004
36 year old male

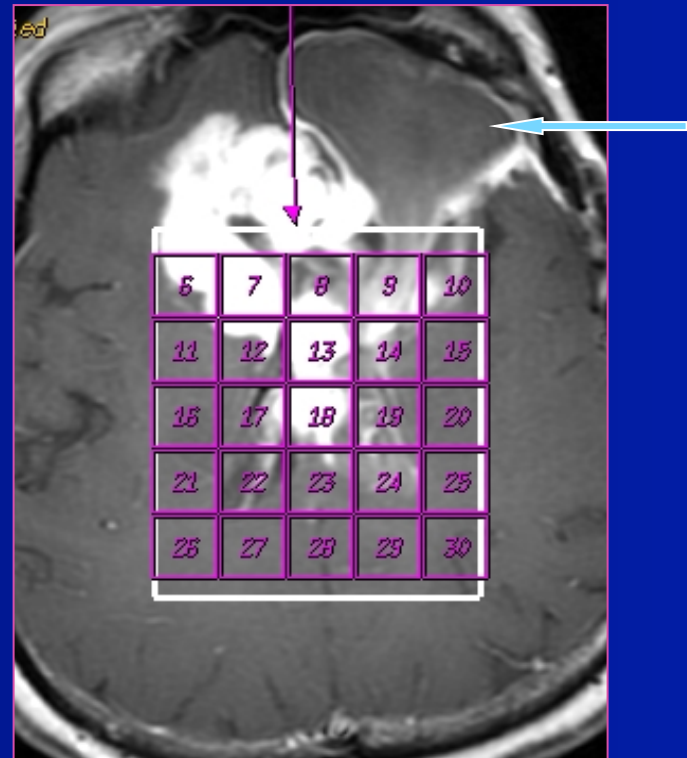
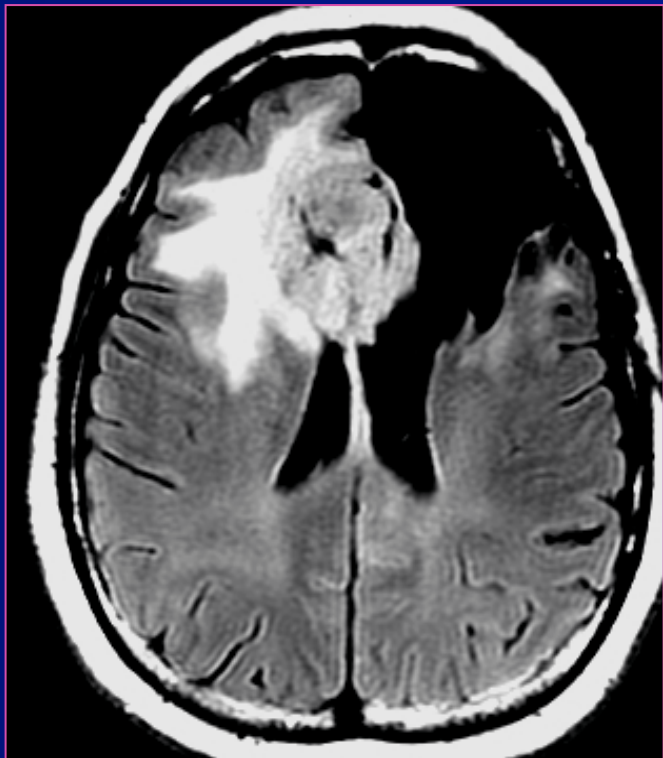


Necrosis

GBM in a 36 year old male, 5 month follow-up post radiation and 3 cycles of temozolomide



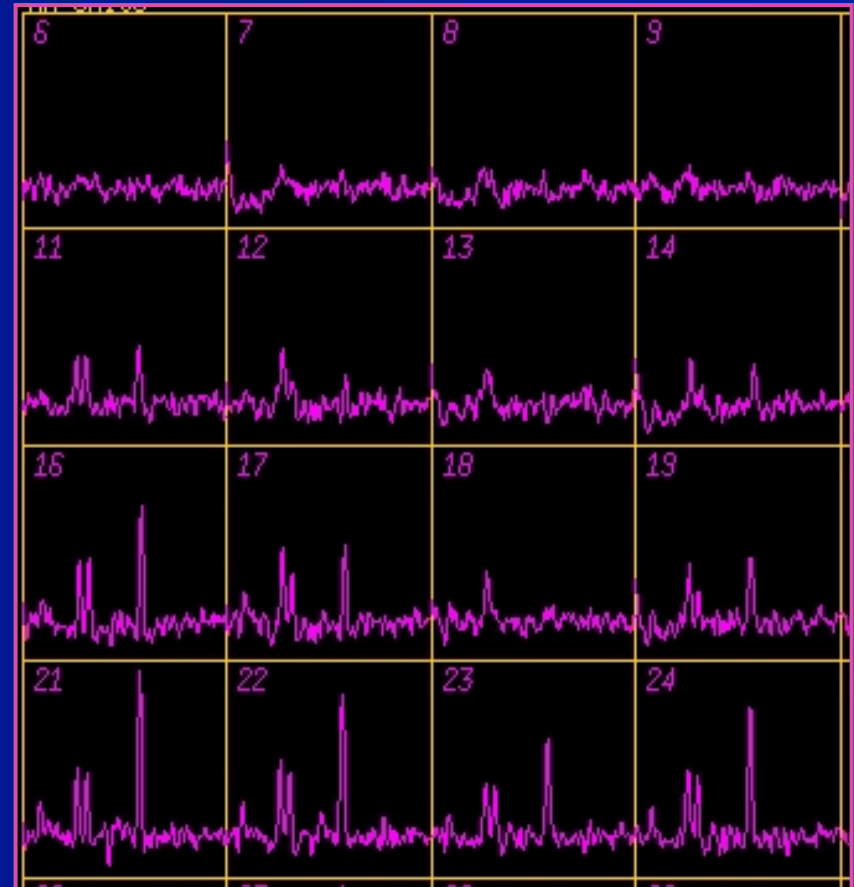
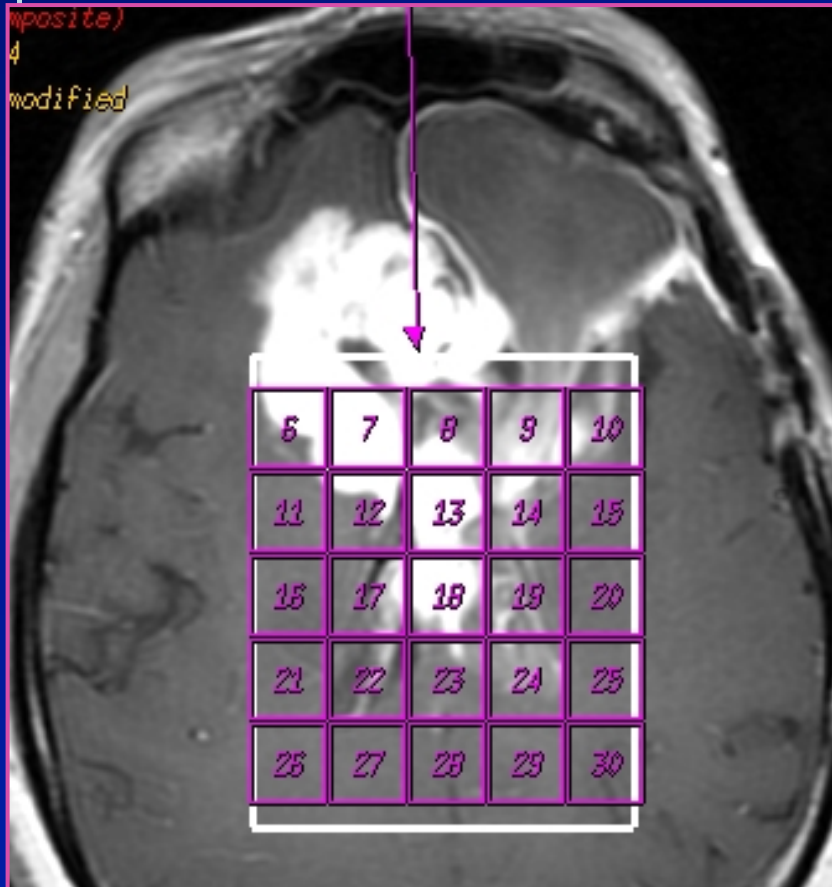
Recurrent GBM, Triple Dose of Contrast, 3T Magnet



MR xxx008

20 min later: Gd leaks into surgical cavity

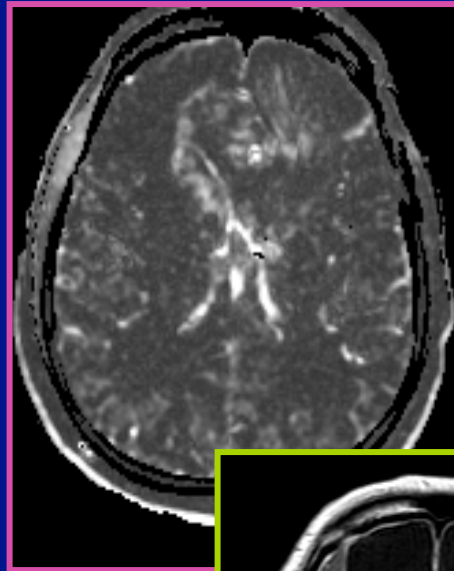
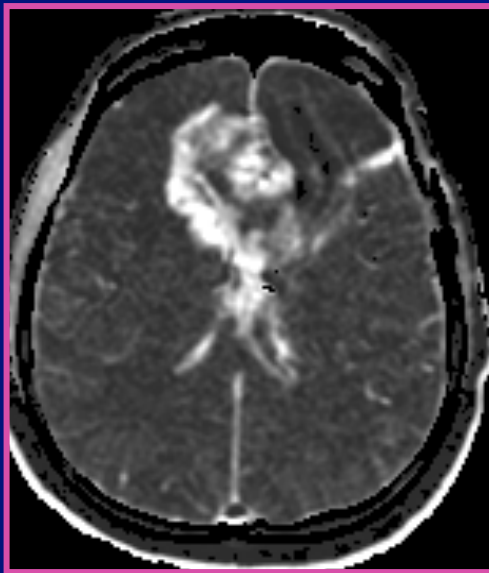
Recurrent GBM, 3T



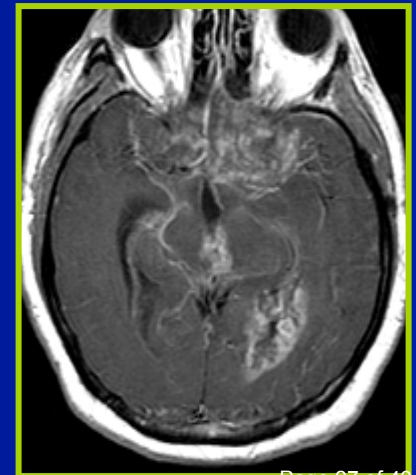
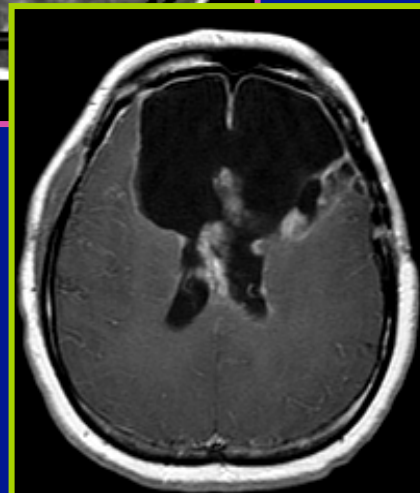
Recurrent GBM, 3T

rCBV: Positive Enhancement
Integral

Maximum Slope of Increase

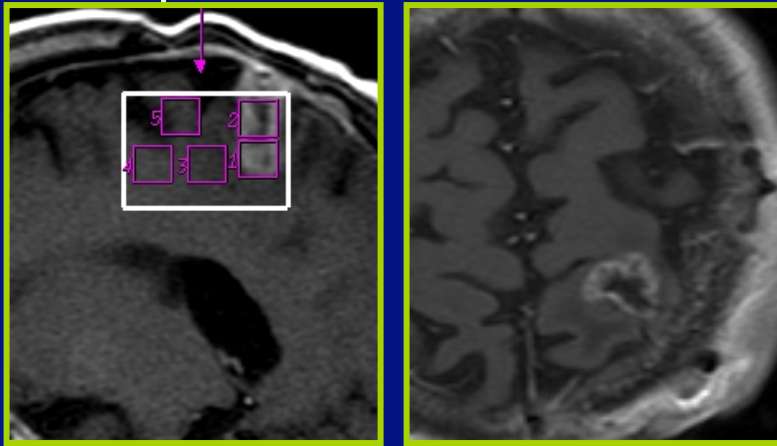


Postsurgical

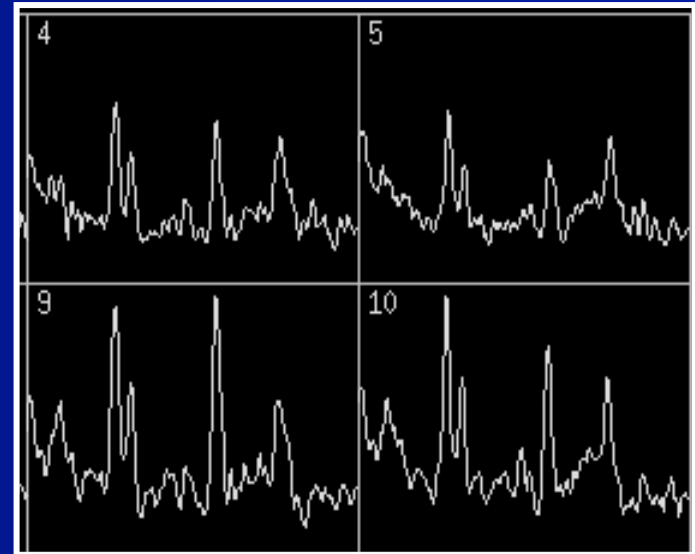
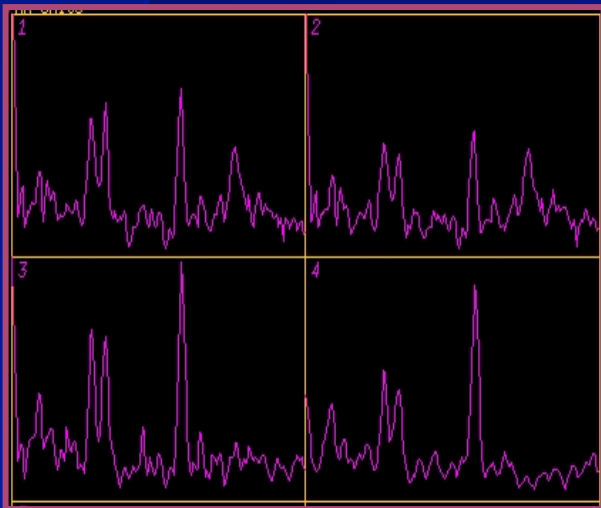
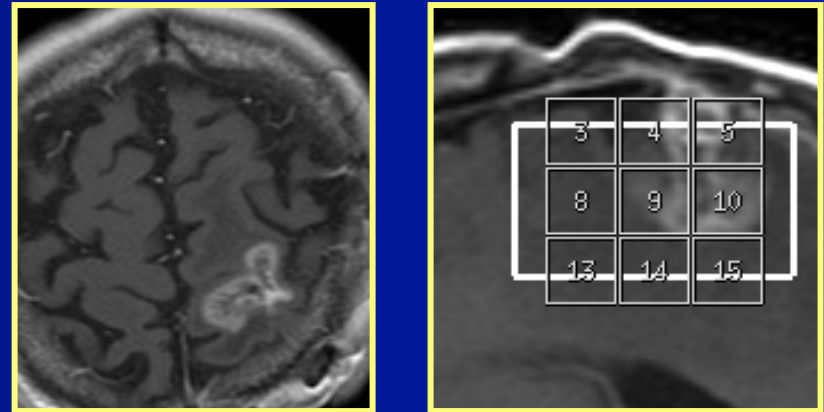


Change In Tumor Grade

12/'04. Radiation Injury



4/'05 Tumor & Rad. injury



TG xxx430

Summary

Suspect Radiation Injury If:

1. If the tumor was nonenhancing before surgery and enhancing foci subsequently develop : more likely radiation injury than progression to a higher grade
2. If an enhancing focus develops at a distance from the primary lesion
3. Enhancing periventricular lesion develops
4. New lesions exhibits soap bubble, Swiss cheese or lace like pattern

MRS Protocols

Tumor vs Necrosis

- TE = ~144msec
- For: Lipid, Cho/Cr

Gliomatosis, Low grade astrocytoma

- TE = 35msec
- TE = 144msec
- For: m-Ins & Gly

MRS

MRS before administration of contrast despite of problems in voxel location, but verify the location in postcontrast image:

- **Decrease of Cho signal intensity after Gd**

Ref:

Sijens PE et al: 1H chemical shift imaging reveals loss of brain tumor choline signal after admin. of Gd-contrast.

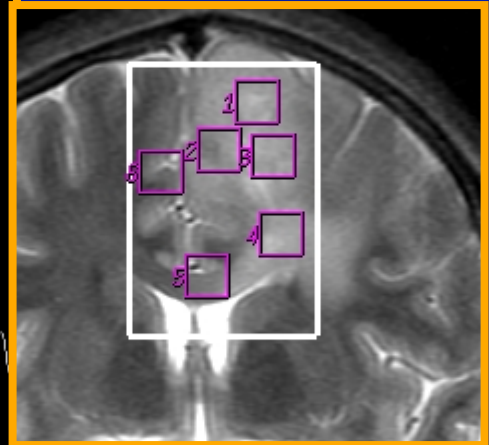
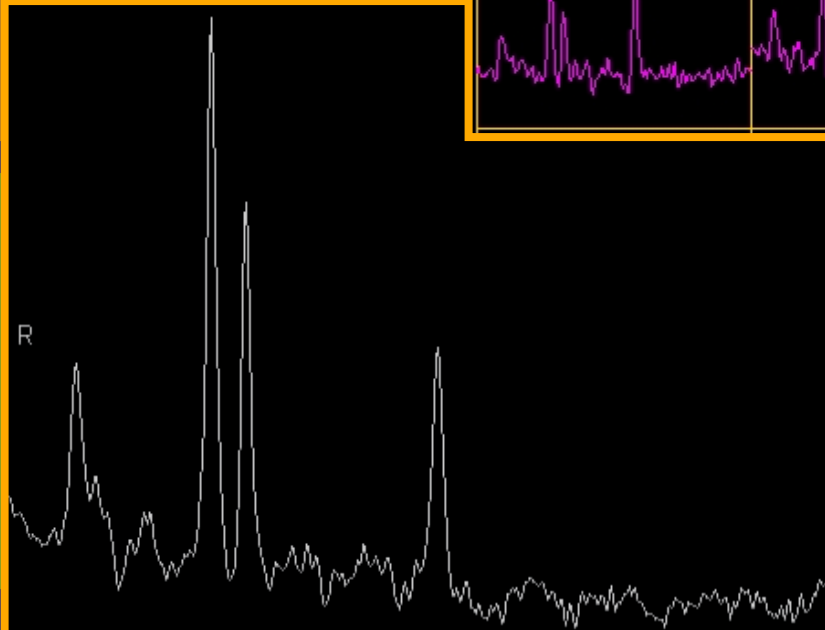
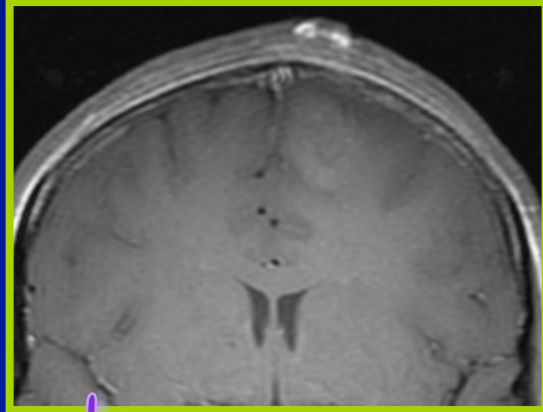
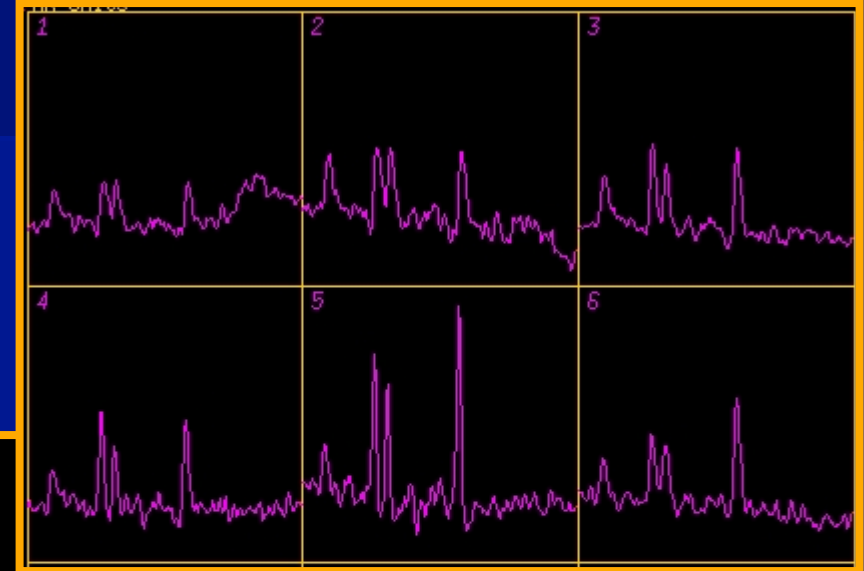
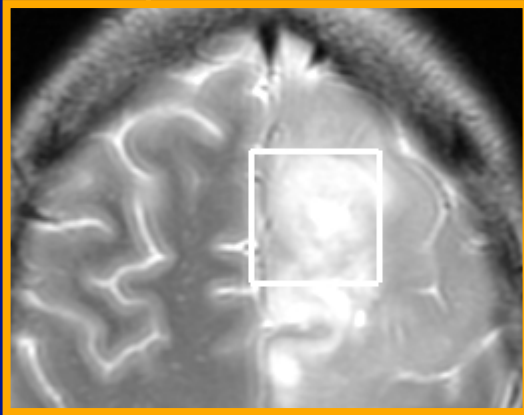
Magn Reson Med (1997) 37;222-225

MD Anderson CC, Alkek Building



Anaplastic Oligo (gr III) (3/22/05)

MRS 3/21/05

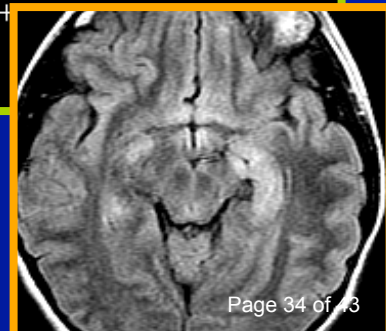
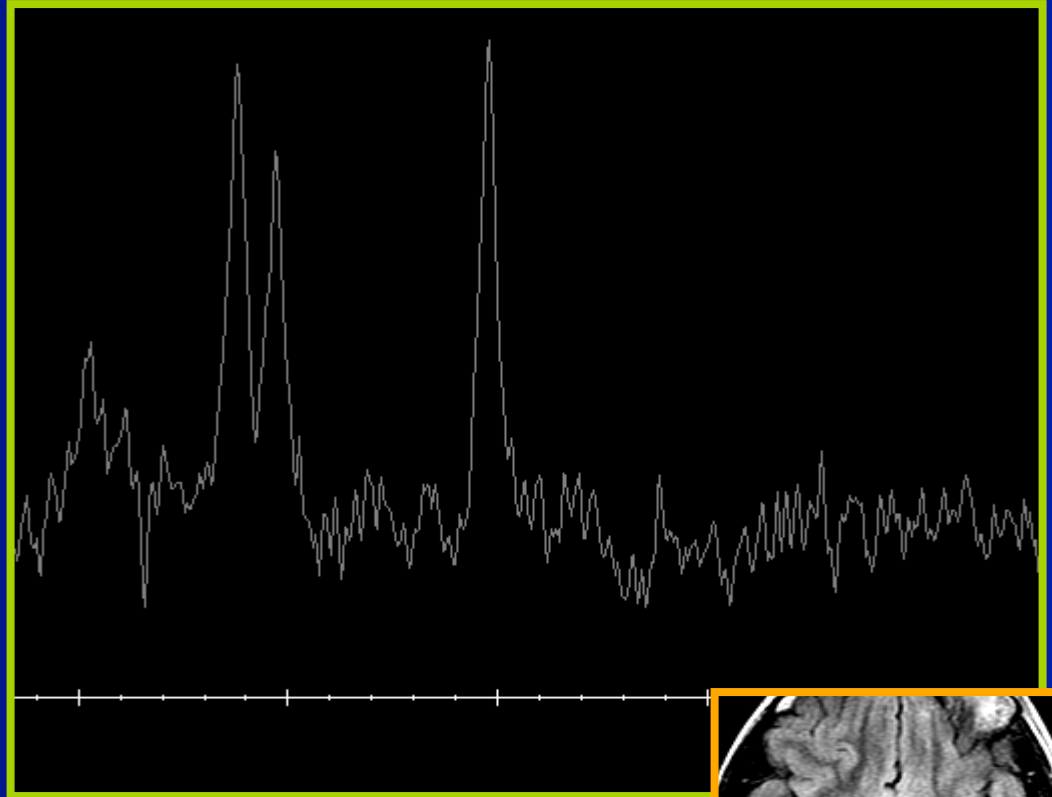
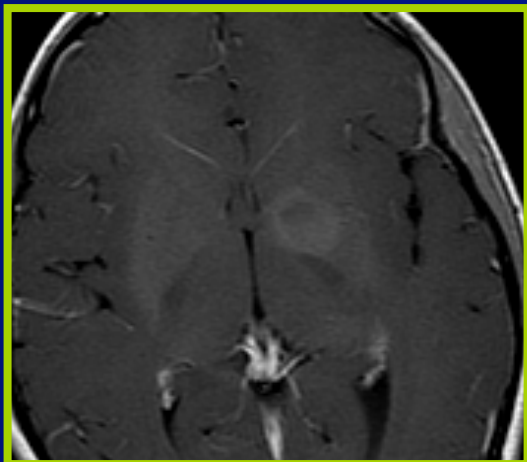
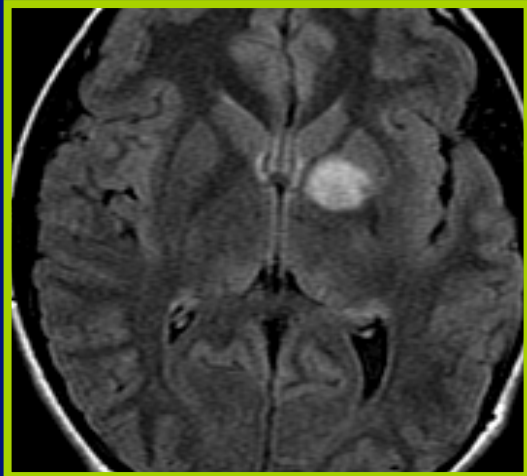


Gd+

FOV: FA:90.0
TR:1500/TE:144/TI:0/ETL:0
CINE:4 GEMS/EDR: GEMS

16 year old female, NF-1

asymptomatic



Gliomatosis Cerebri

TE=20 & 135 msec

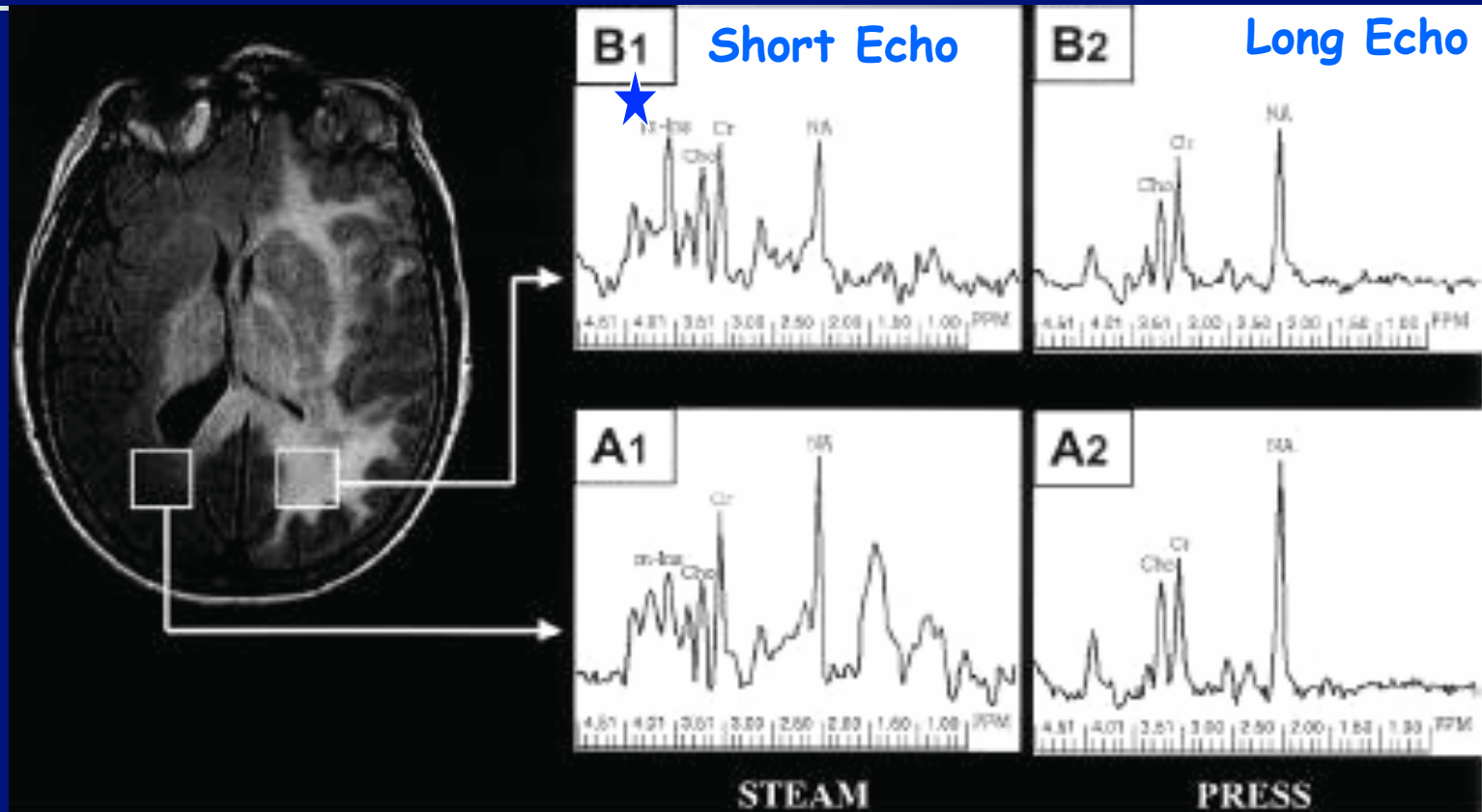
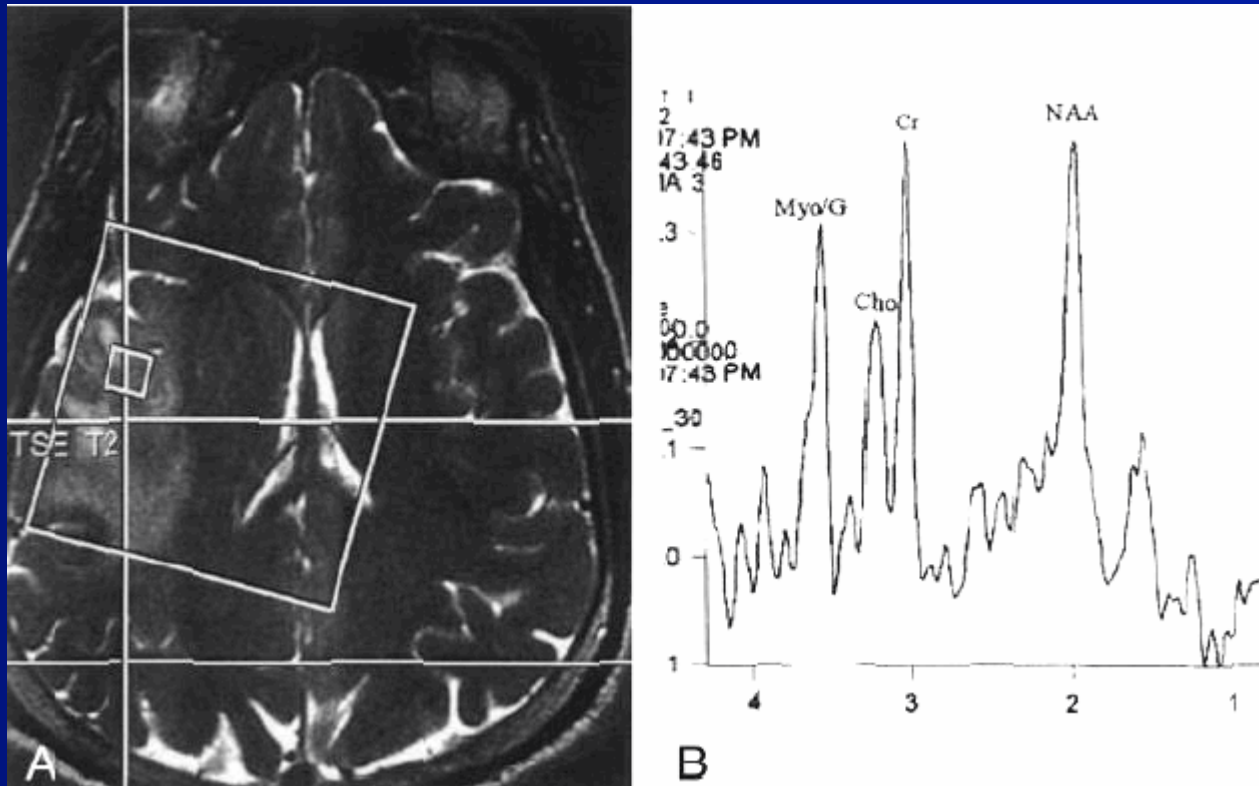


FIG. 2. Single voxel spectroscopy. Localized STEAM (TE 20) spectra were acquired from the normal appearing right peritratral region (A1) and from the hyperintense left peritratral region (B1). PRESS (TE 135) spectra were acquired from the same locations (A2 and B2, respectively). The right and left STEAM spectra are displayed by using the same vertical scale factor, as are the right and left PRESS spectra.

Diffuse Astrocytoma

High m-Ins/Gly



TE=30msec

Summary

- Hyperintense lesion with minimal or No enhancement on post Gd T1WI and
- lack of Cho/Cr elevation does not exclude primary glial neoplasm

m-Ins & Gly

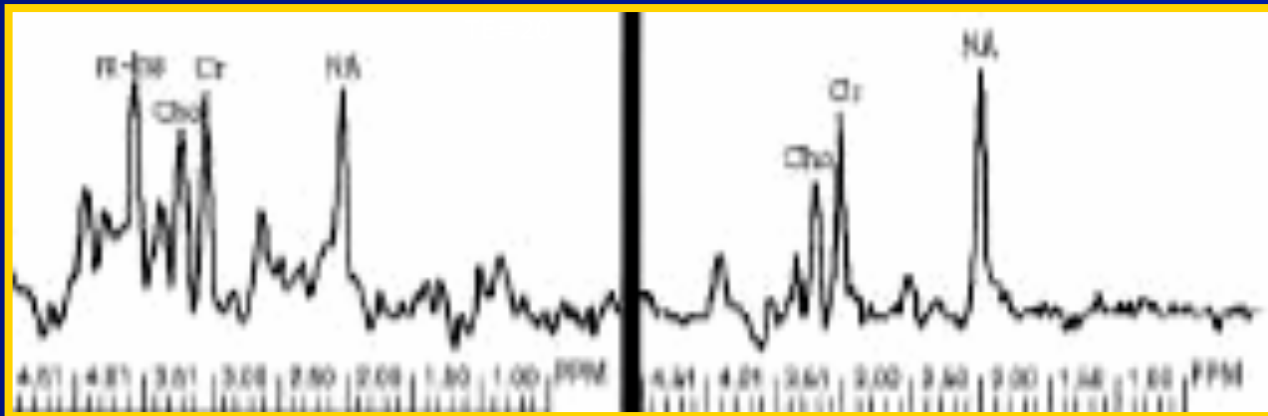
3.5-3.6 ppm

m-Ins

- Long echo: Weak/absent peak
- Short echo: Strong peak

Gly

- Long echo: Weak peak
- Short Echo: Strong peak



TE=20msec

TE=135msec

Summary

MRS

If m-Ins or m-Ins/Cr elevated,
include low grade astrocytoma or
gliomatosis in the differential
diagnosis

Low Grade Astrocytoma

m-Ins: Glial marker

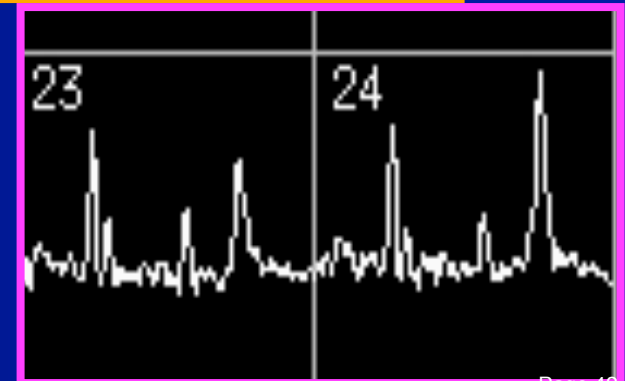
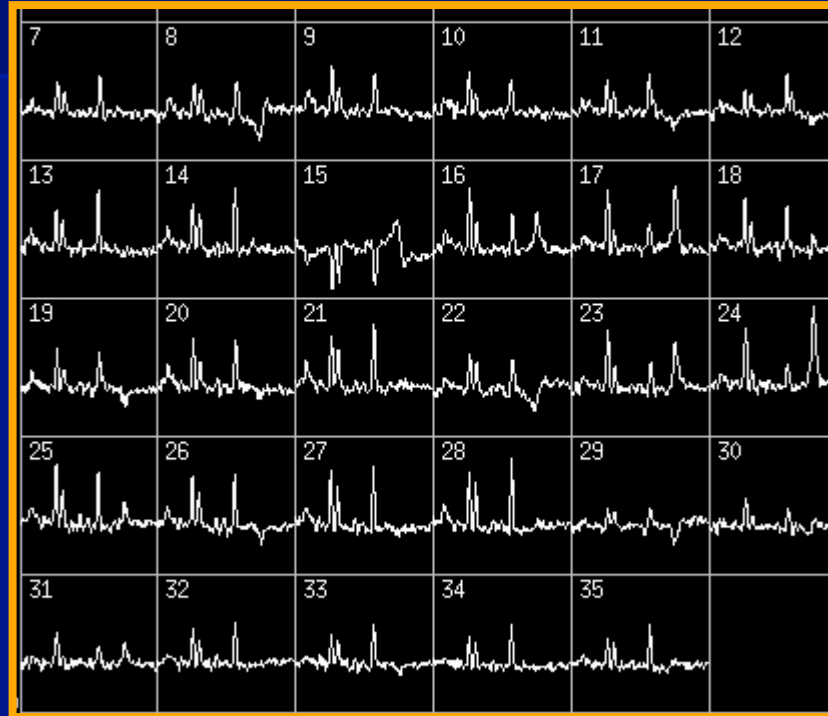
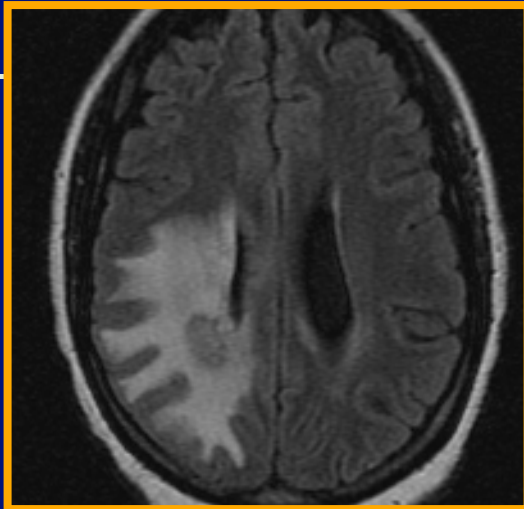
- Change in phospholipid composition or abundance of cell membranes



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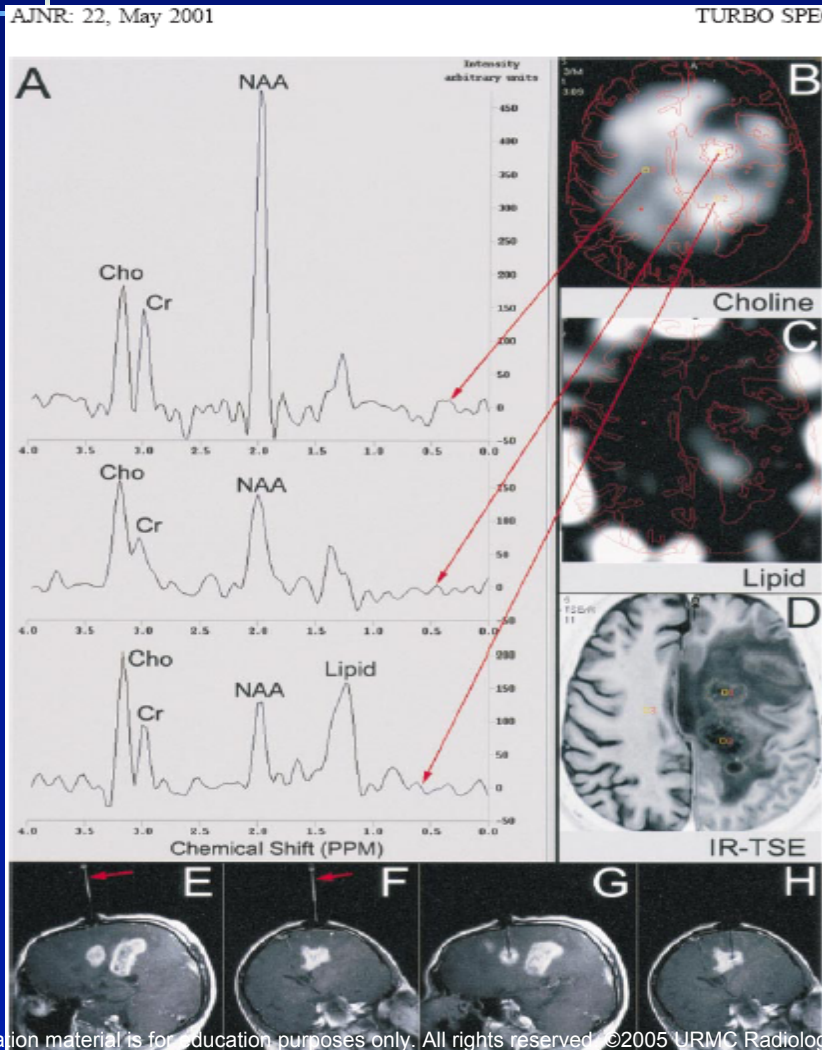
Making Cancer History[®]

Anaplastic oligo (grIII), Crani 12/'03 28 year old female



Oligodendroglioma, Status post surgery and radiation with new enhancing lesions.

Martin et al. AJNR 2001



Posterior lesion most necrotic