

Overview of Brain Tumor Treatment: Radiotherapy

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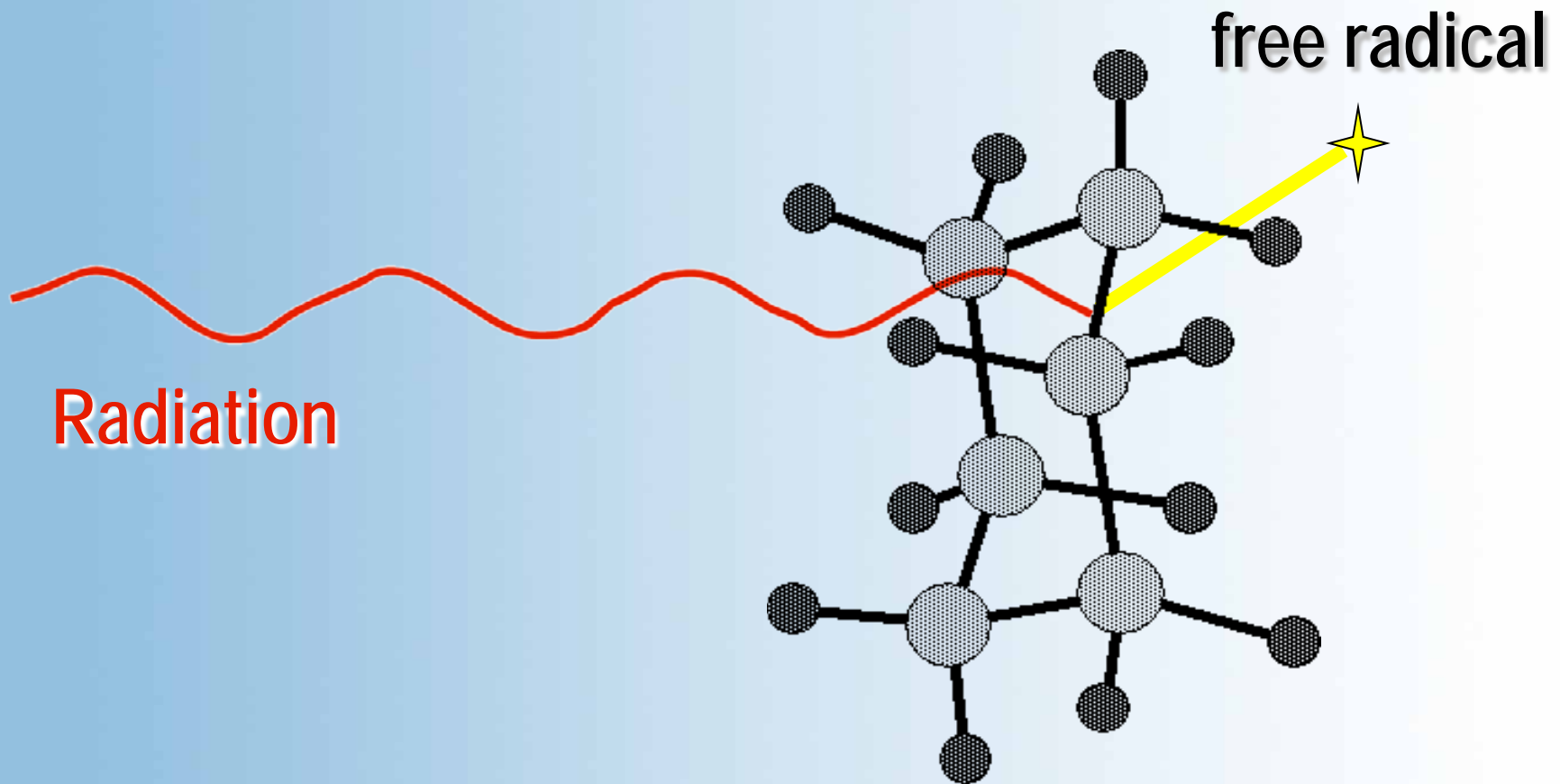
Radiotherapy Can Be Used For

- § Astrocytomas
- § Glioblastomas
- § Meningiomas
- § Metastases
- § Neuromas
- § Glomus tumors
- § Pituitary tumors
- § Ependymomas
- § CNS lymphomas
- § Medulloblastomas
- § Craniopharyngiomas
- § Germ cell tumors
- § Pineocytomas
- § Neurocytomas

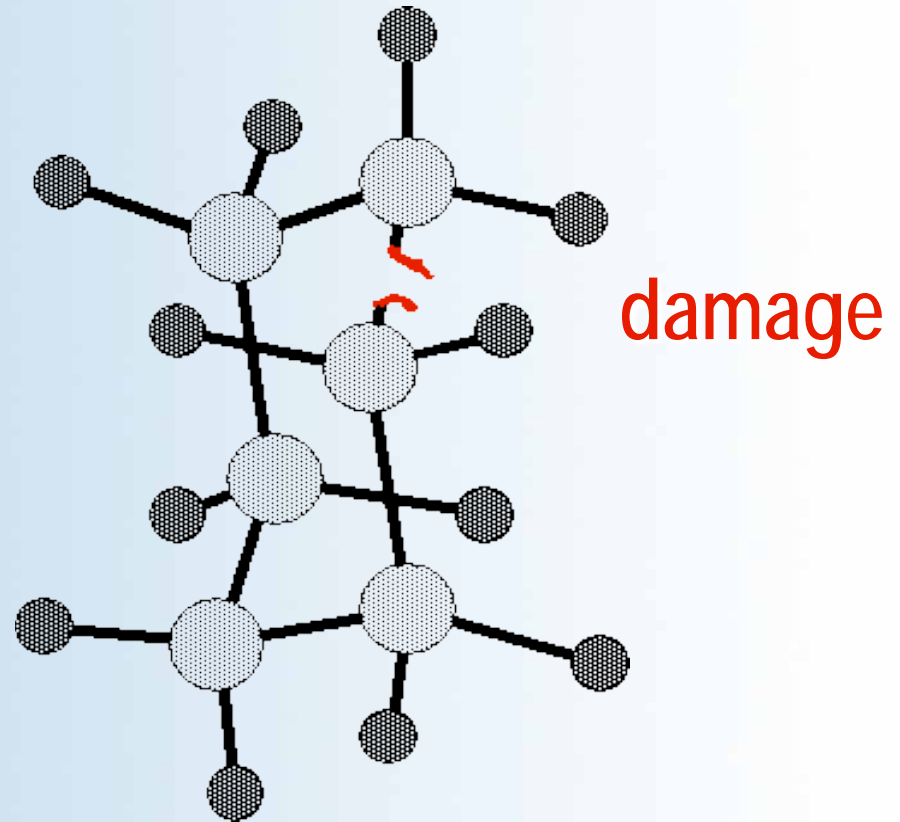
Topics We'll Discuss

- § How does radiation therapy work?
- § How is radiotherapy administered, and what are the side effects?
- § What is the latest technology?

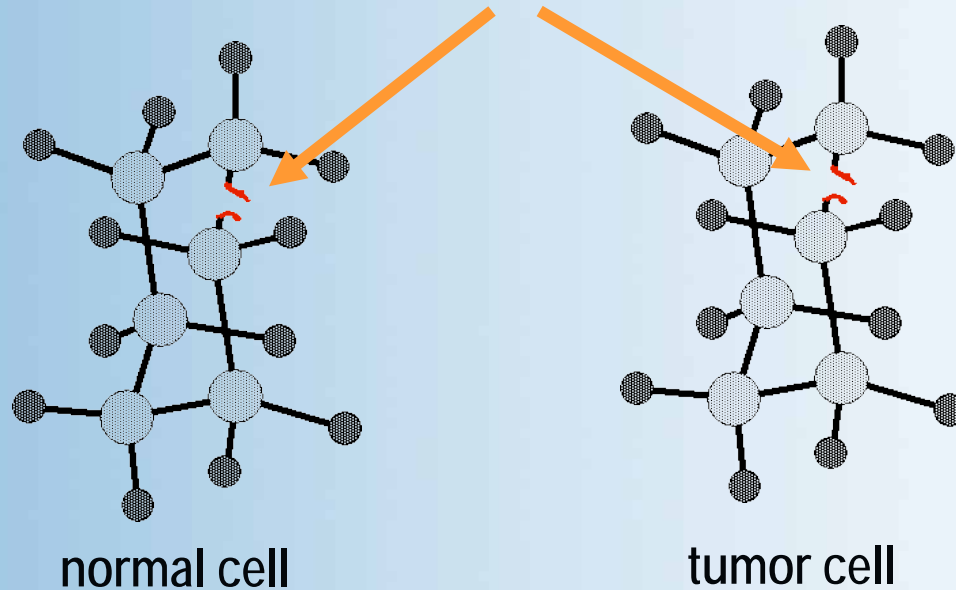
Radiation Creates Free Radicals



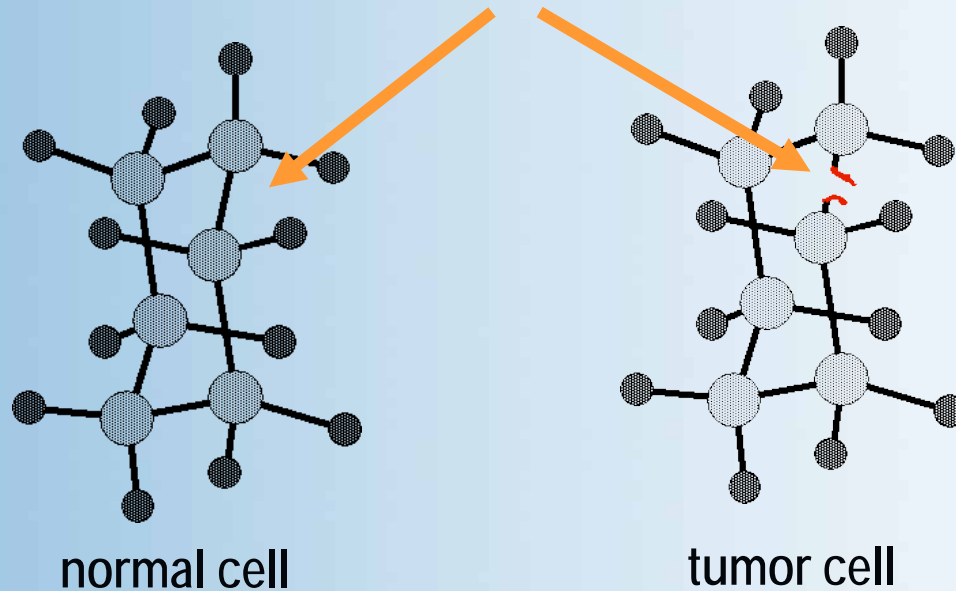
Which Kill the Cells

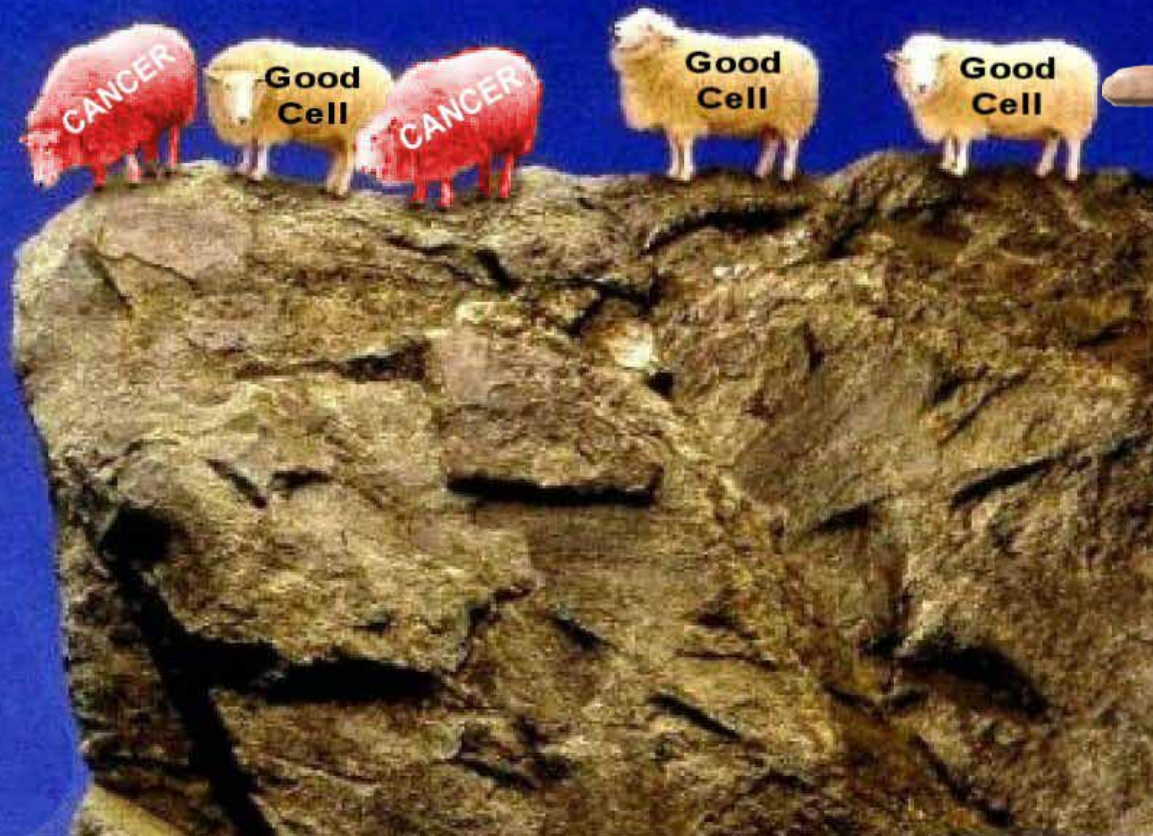


Tumor cells can't repair themselves like normal cells

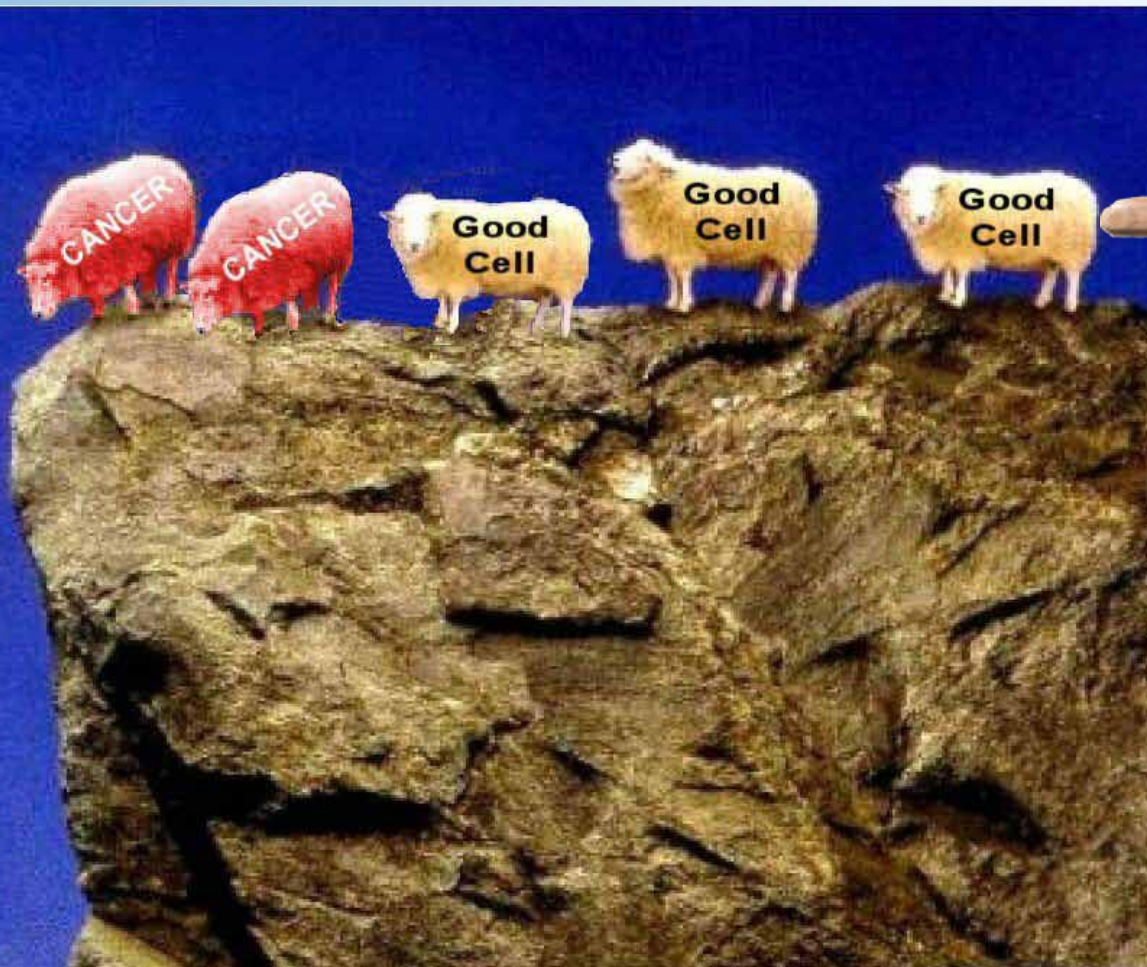


Tumor cells can't repair themselves like normal cells









What Happens During Radiotherapy?



Side effects: Frequent...



Fatigue



Hair Loss

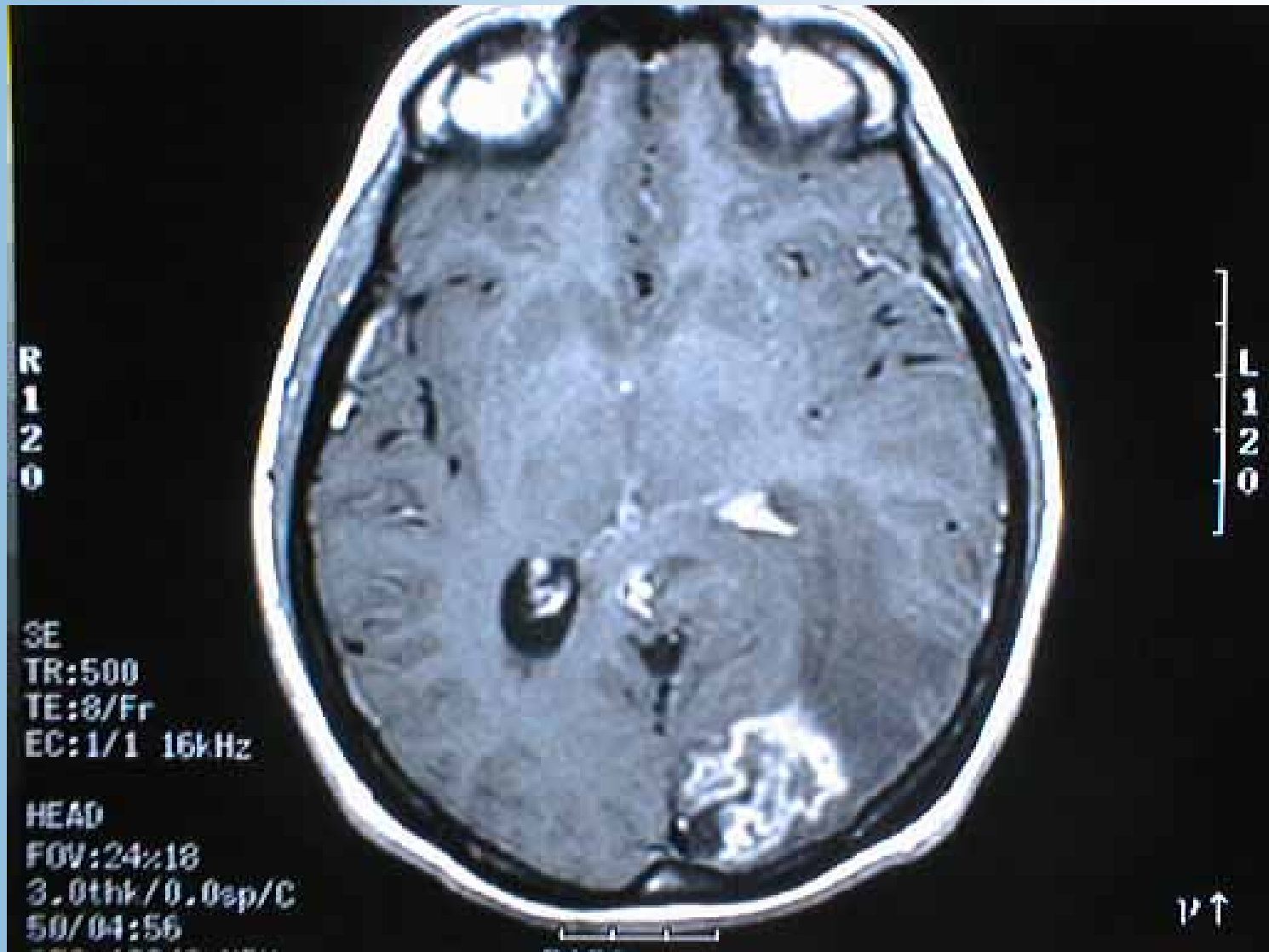
Occasionally..

- § **Short term memory difficulty**
- § **Low thyroid hormones**
- § **Decreased hearing**

Usually not ...

§ Headaches

§ Nausea



Necrosis

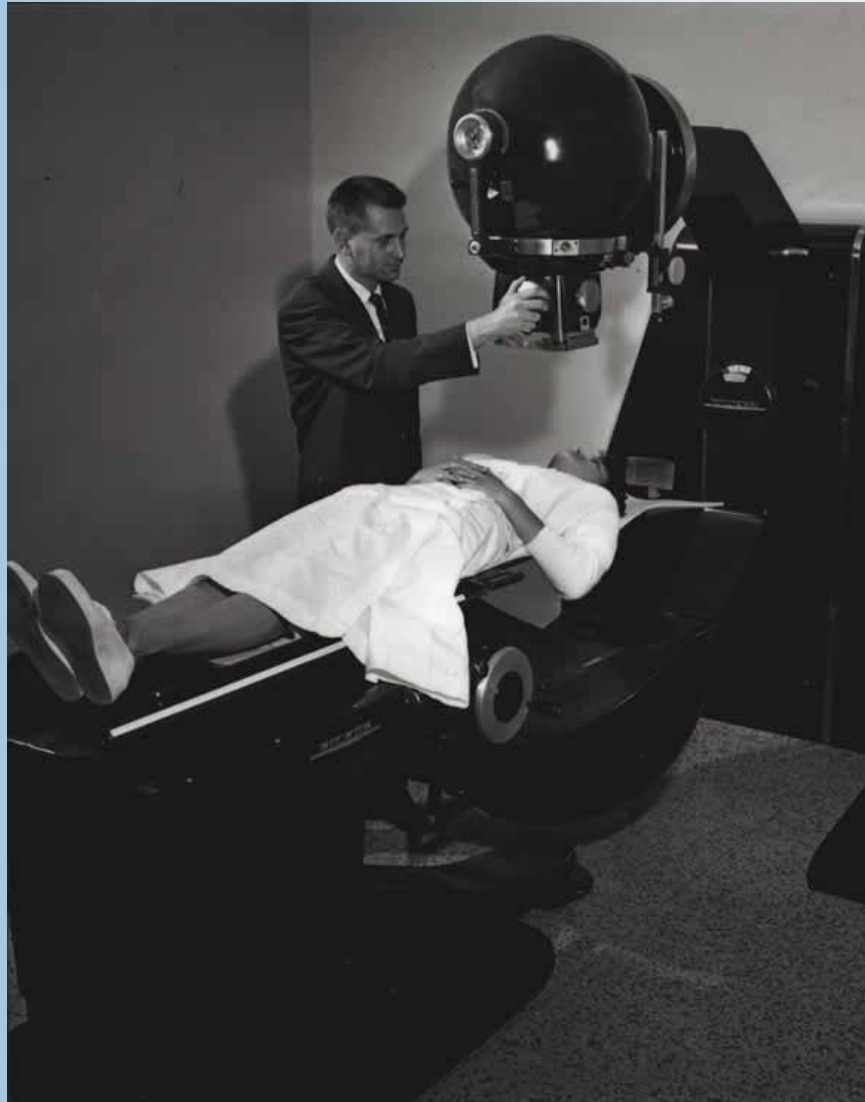
State-of-the-Art Technology



“Orthovoltage” Radiotherapy



“Cobalt” Treatment



Linear Accelerators







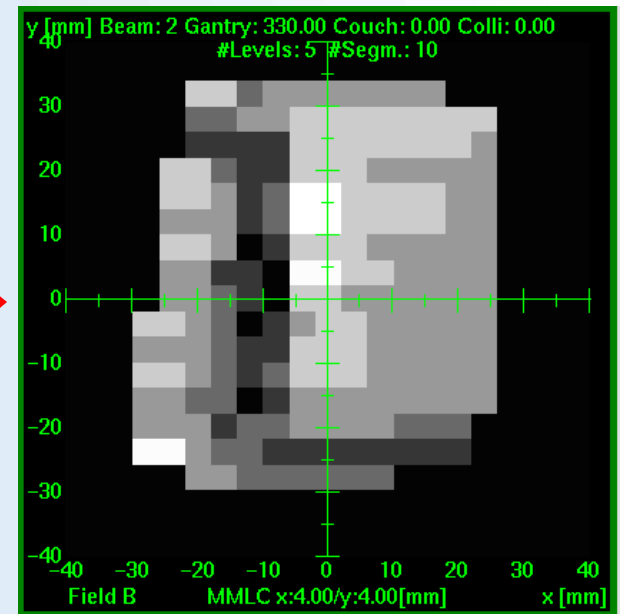
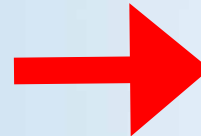
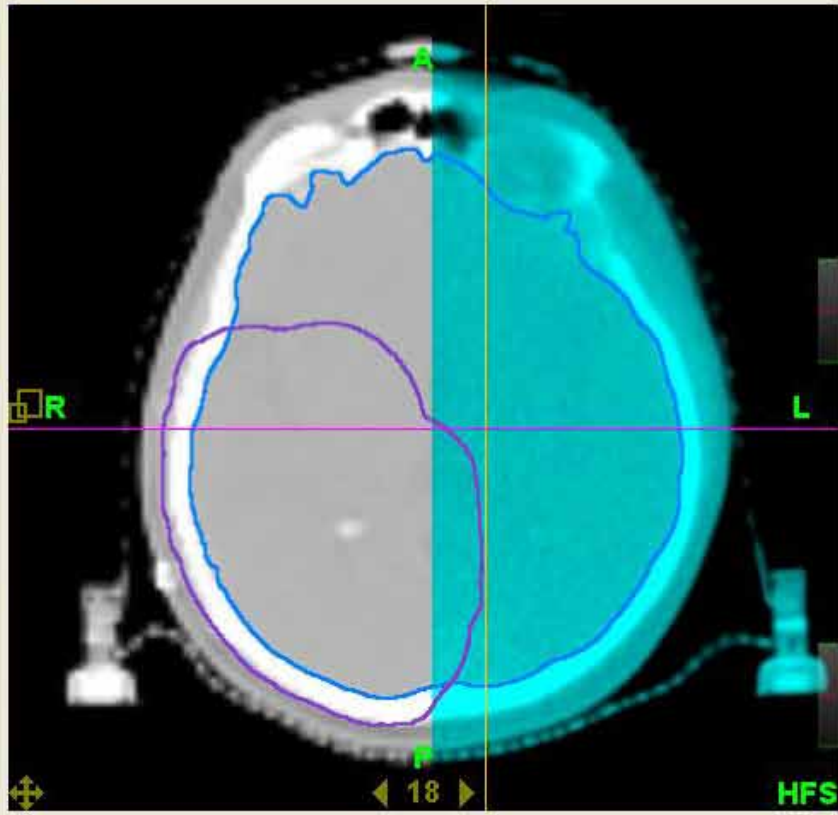


Image Guided Radiotherapy



Transverse



Structure Control Fusion Control

Scan Image Control

Plan Plan Balance Scan

Checker

Coarse Fine

Navigation buttons:

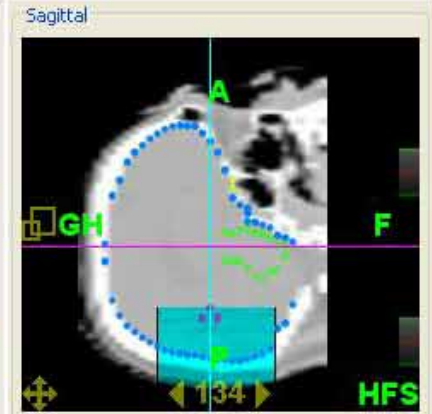
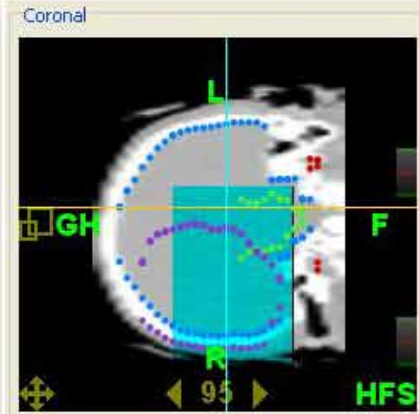
Translational Adjustments (mm)

Lateral	Long.	Vert.
4.8	-9.0	0.4

Rotational Adjustments (degrees)

Pitch	Roll	Yaw
0.0	-1.8	0.0

Restore Original Adjustments



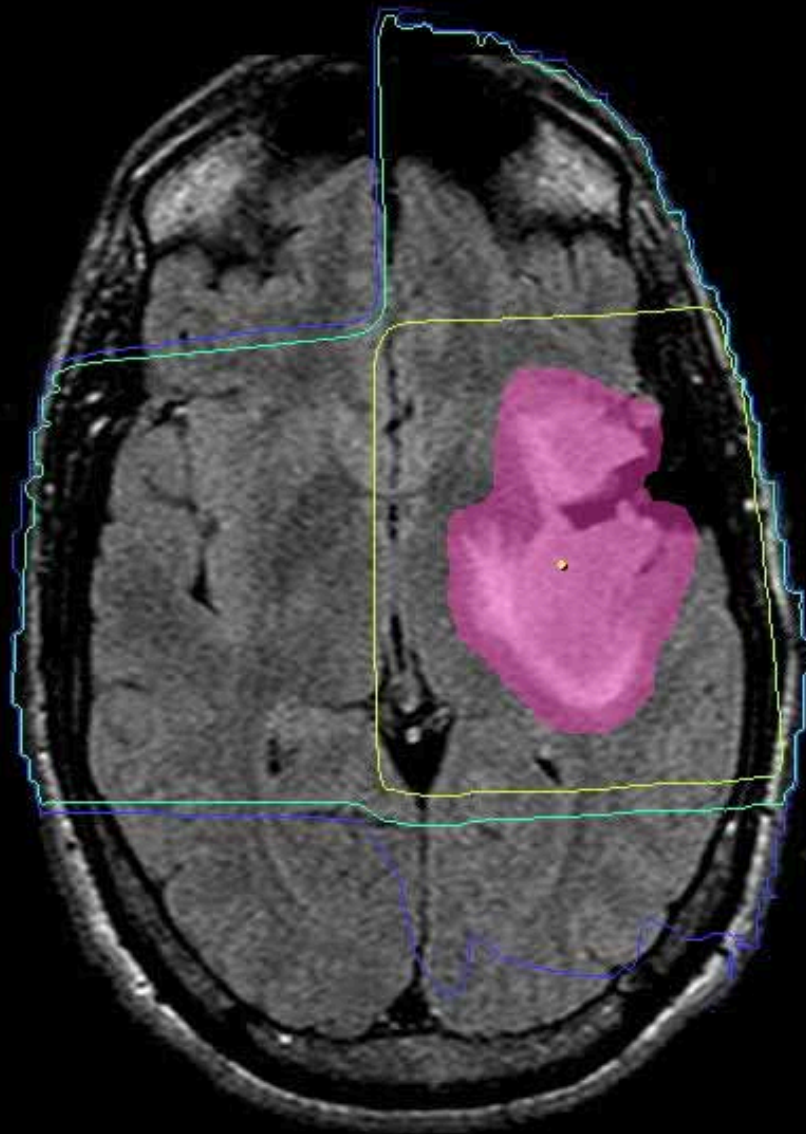
Plan Image Control

13.0 Transverse 36.8 43.7 46 48.3

Isodose

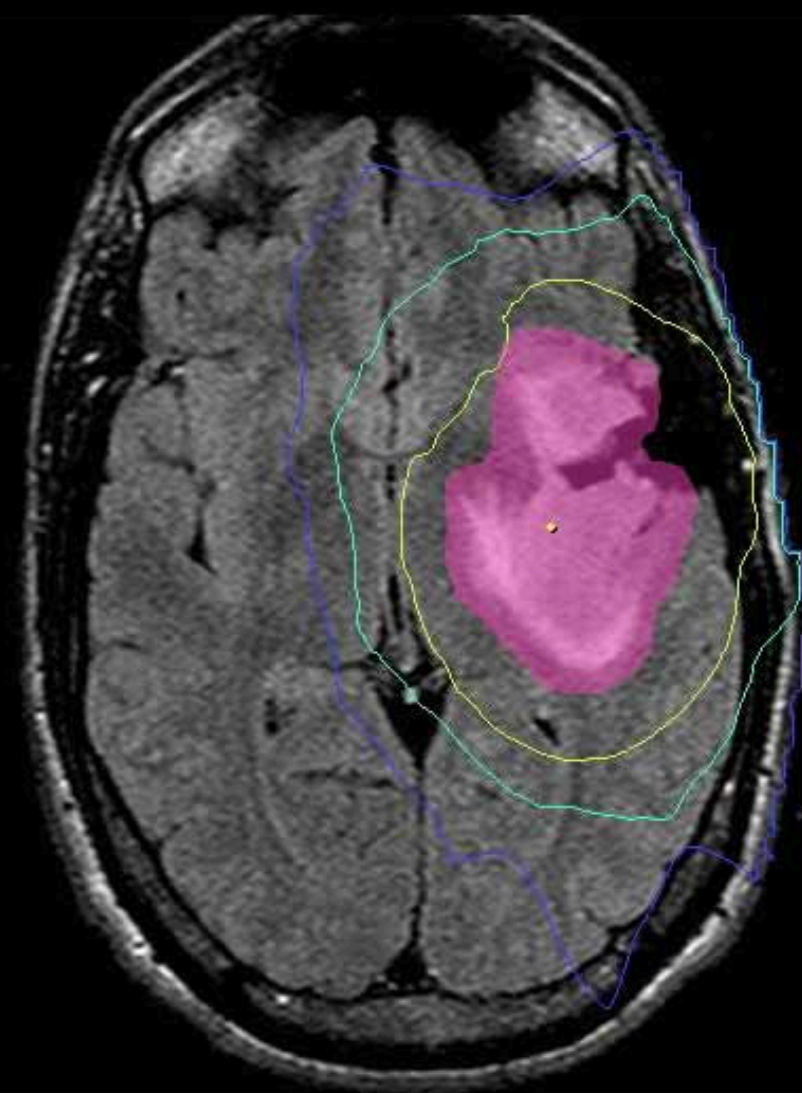
Lasers

Dose 46.0 Gy



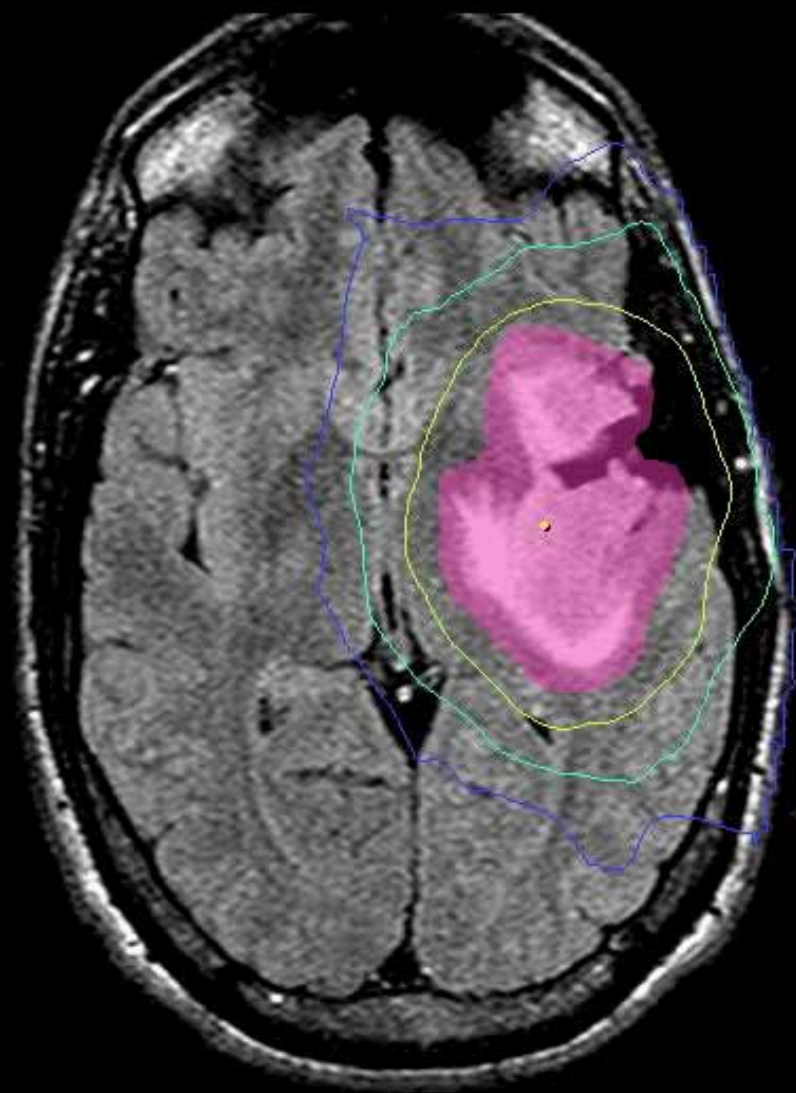
■ 30.0 %
■ 50.0 %
■ 90.0 %

100.0 % = 1.80 Gy



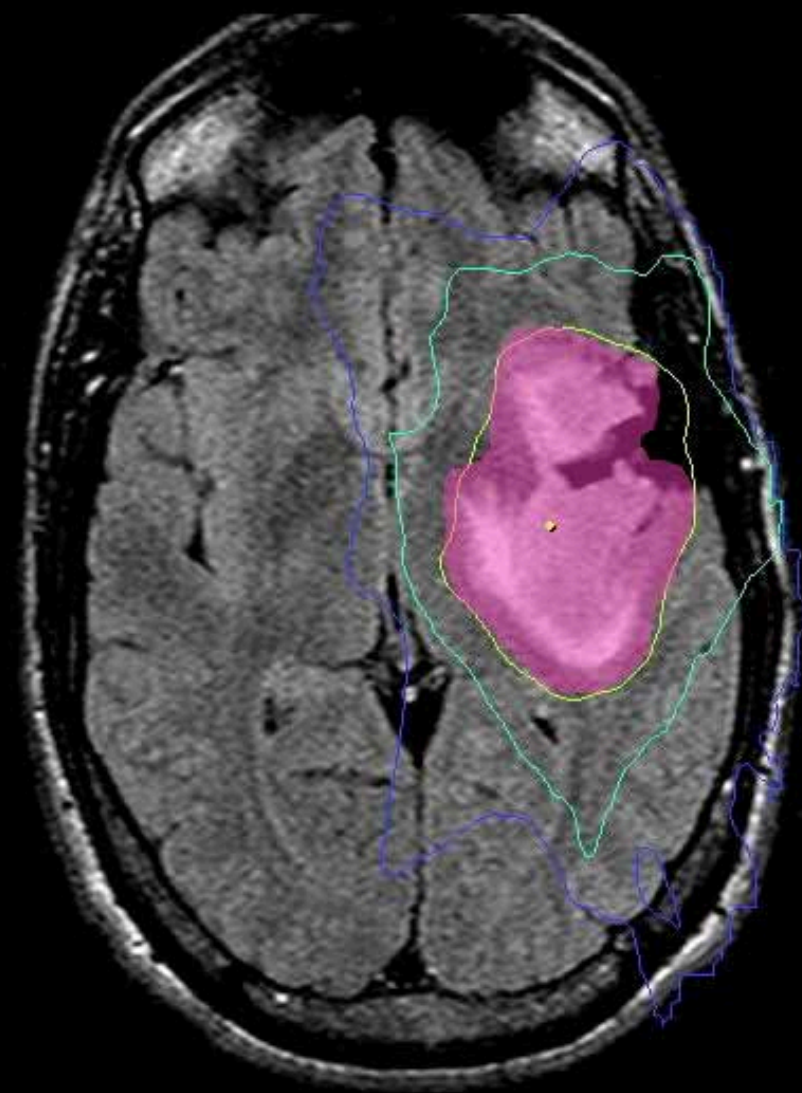
■ 30.0 %
■ 50.0 %
■ 90.0 %

100.0 % = 1.80 Gy



■ 30.0 %
■ 50.0 %
■ 90.0 %

100.0 % = 1.80 Gy



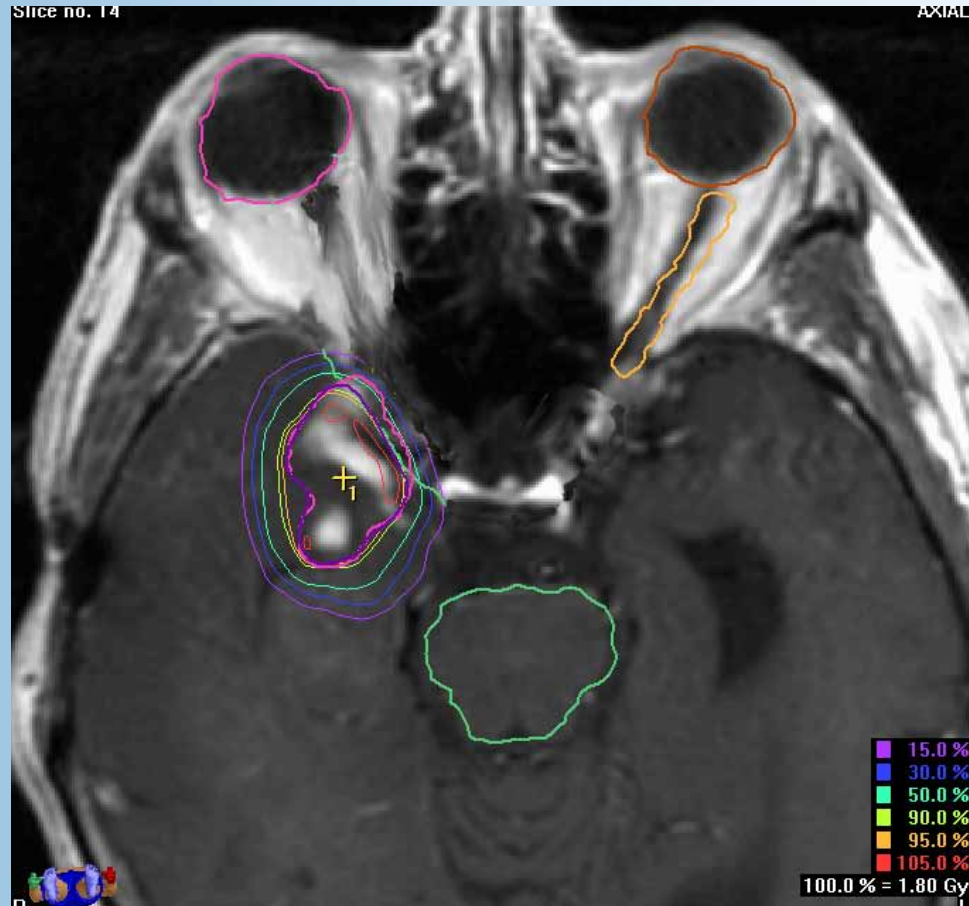
- 30.0 %
- 50.0 %
- 90.0 %
- 105.0 %

100.0 % = 1.80 Gy

Why This Matters

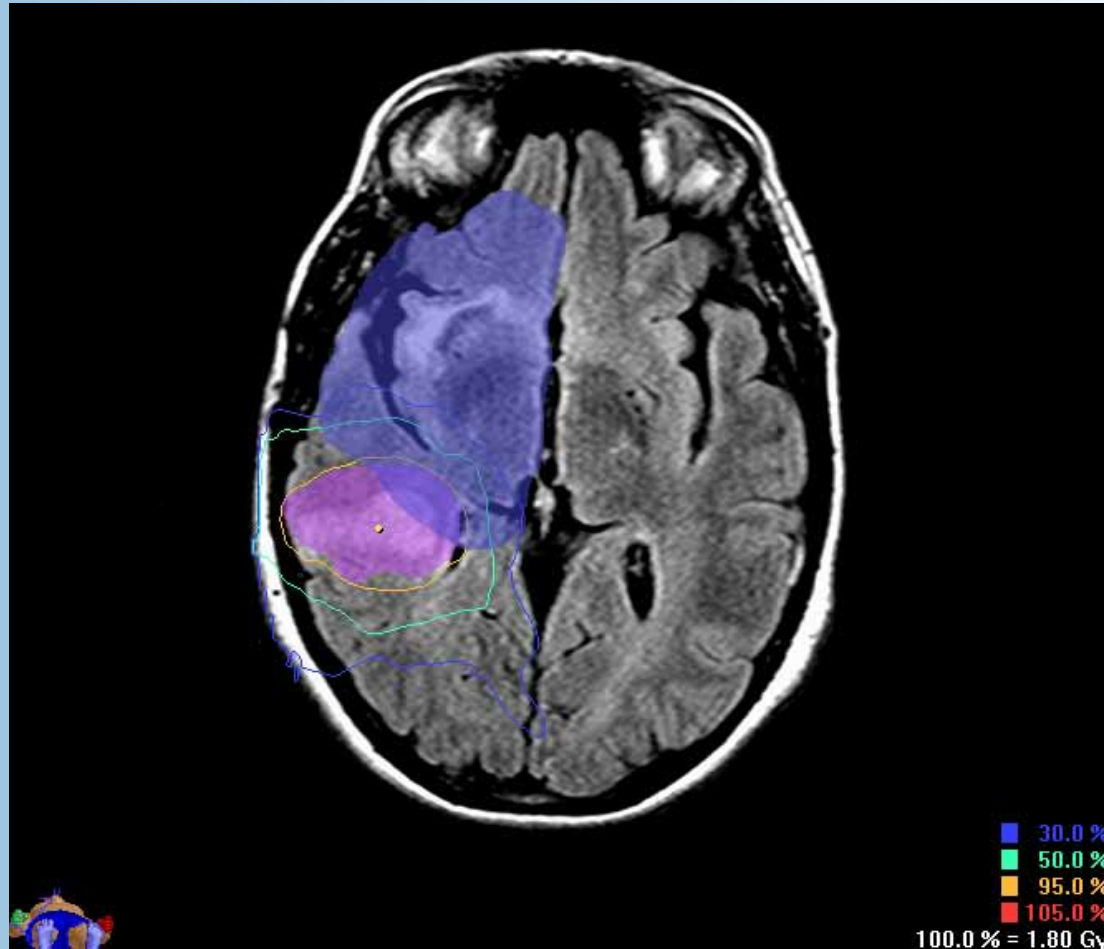
§ Fewer side effects

Why This Matters



More Aggressive Treatment for Tumors

Why This Matters



Re-treatment for Recurrent Tumors

Stereotactic Radiosurgery –

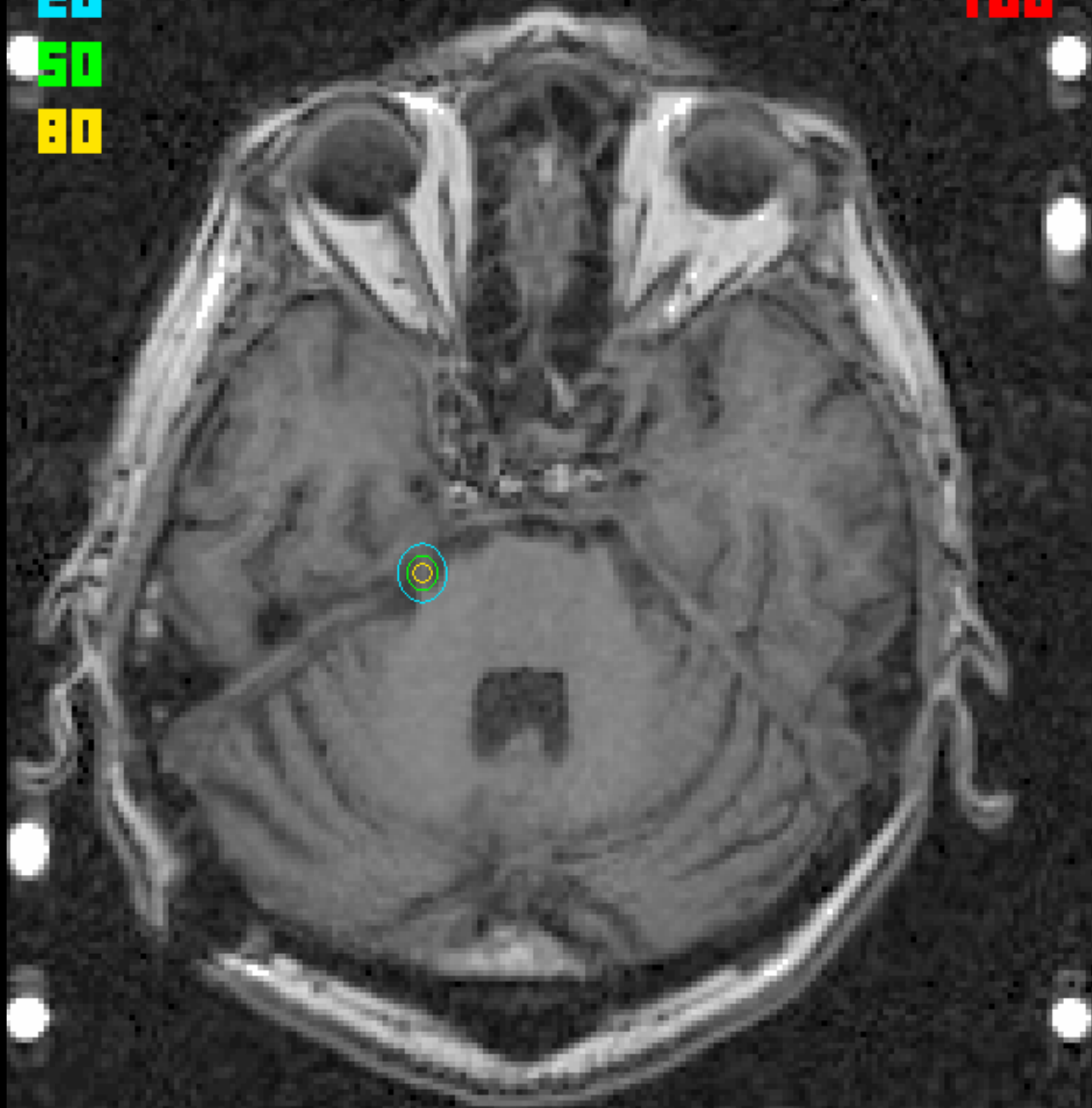
Not surgery, but the application of highly focused, high dose radiation with the intent to kill everything that is targeted

20

50

80

100



Stereotactic Radiosurgery Devices



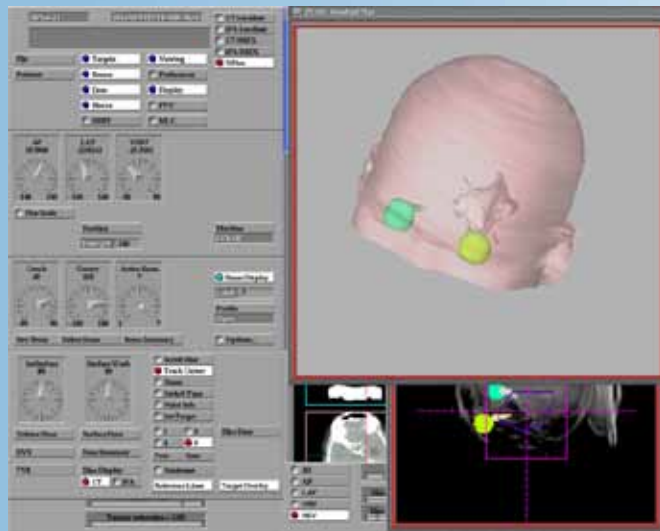
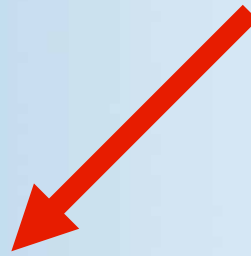
Gamma Knife



Linac



Cyberknife



Frameless Radiosurgery

Ring-based



“Frameless”





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PHYSICS CONTRIBUTION

EVALUATION OF IMAGE-GUIDED POSITIONING FOR FRAMELESS INTRACRANIAL RADIOSURGERY

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Purpose: The standard for target alignment and immobilization in intracranial radiosurgery is frame-based stereotactic and rigid immobilization using a stereotactic head ring. Recent improvements in image-guidance systems have introduced the possibility of image-guided radiosurgery with nonrigid immobilization. We present data on the alignment accuracy and patient stability of a frameless image-guided system.

Methods and Materials: Isometric alignment errors were measured for 100 patients in an anthropomorphic phantom for both frame-based stereotactic and frameless image-guided alignment. Subsequently, in vivo studies assessed alignment accuracy between frame-based and image-guided alignment in patients who underwent frame-based stereotactic radiosurgery. Finally, interalignment target stability was determined by image-guided alignment performed before and after image-guided mask immobilization for radiosurgery.

Results: In vivo isometric target localization errors were comparable for the frameless (7.6 ± 0.8 mm) and image-guided (8.0 ± 0.2 mm) techniques. For in vivo alignment in alignment errors for 9.9 mm (interoperator), 10.2 ± 0.4 mm (operator-to-patient), and 10.2 ± 0.5 mm (overall). For in vivo stability tests, the uncertainties differed between the pre- and post-immobilization positions with mask immobilization radiosurgery by 0.8 ± 0.3 mm.

Conclusions: Frame-based and image-guided alignment accuracy in vitro was comparable for the system tested. In vivo tests showed a consistent trend to the difference of alignment in the anteroposterior direction, possibly due to the ring and assisting system still being used for alignment. The mask system we used appeared adequate for patient immobilization. © 2005 Elsevier Inc.

Neurosurgery, Image-guidance, C-Block, Immobilization.



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CLINICAL INVESTIGATION

FRAMELESS IMAGE-GUIDED INTRACRANIAL STEREOTACTIC RADIOSURGERY: CLINICAL OUTCOMES FOR BRAIN METASTASES

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Departments of ¹Radiation Oncology, ²Brain Tumor Clinic of the University of Cincinnati Neuroscience Institute, ³Radiation Oncology and ⁴Neurosurgery, University of Cincinnati College of Medicine, Cincinnati, OH, and ⁵Department of Neurosurgery, Bruce Fannin Clinic at the University of Cincinnati Neuroscience Institute, University of Cincinnati College of Medicine and Mayfield Clinic, Cincinnati, OH

Purpose: After providing an evaluation confirming the accuracy of image localization for frameless image-guided radiosurgery, we report the clinical outcomes of patients with brain metastases who underwent frameless radiosurgery.

Methods and Materials: Between 2000 and 2006, 88 patients underwent frameless stereotactic radiosurgery using a frameless immobilization system with image guidance for the treatment of 184 brain metastases. The median age was 66 years followed by a single fraction dose range of 12.2 Gy median 80%. Patients were followed with magnetic resonance imaging scans at 3–3-month intervals. Progression-free survival was the primary study endpoint.

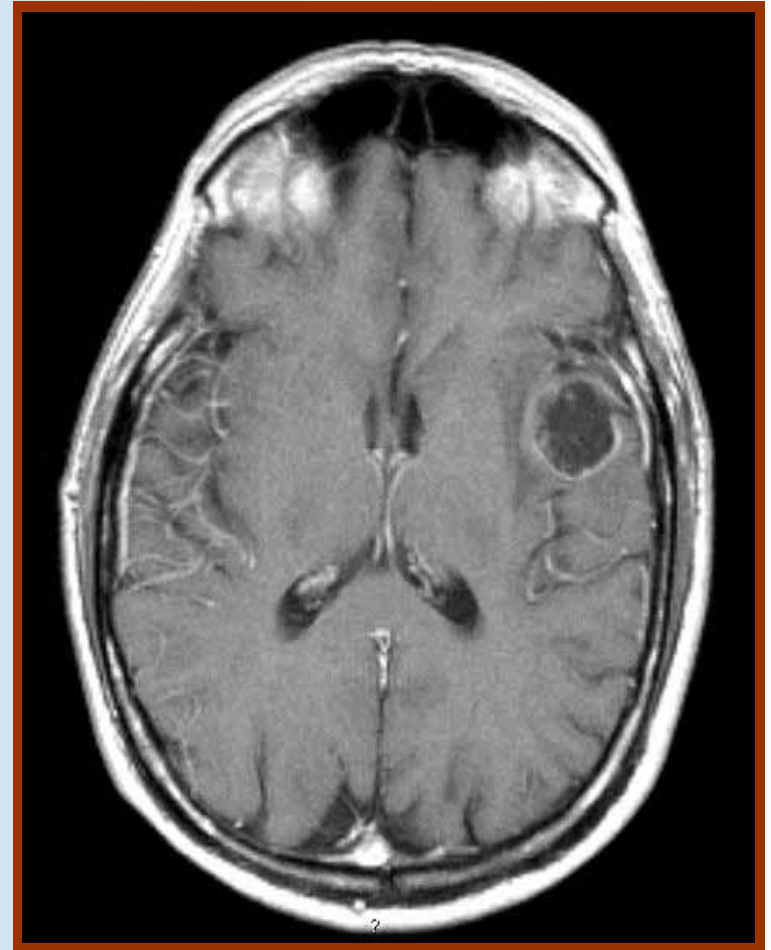
Results: With median follow-up of 10 months (range, 1.8–31.2), disease-free survival rates were 79% at 6 months, 67% at 1 year, 56% at 18 months, and 46% at 24 months. A total of 100 patients were subject to 148 second fractions at 6 months, 96% at 12 months, 79% at 18 months, and 76% at 24 months. Local control (defined as tumor-free follow-up) was 94% at 6 months, 87% at 12 months, 79% at 18 months, and 70% at 24 months. No evidence of imaging change or progression to radiosurgery was found in 100 patients (79%).

Conclusions: The clinical outcomes after frameless stereotactic radiosurgery were comparable to those after frame-based radiosurgery techniques. Given the significant advantages in terms of patient comfort, ability to use frameless immobilization systems, and convenience in scheduling of pre-treatment and post-treatment resources, frameless radiosurgery will likely become a common technique for intracranial radiosurgery. © 2005 Elsevier Inc.

Metastases, Fraction radiosurgery, Image-guided radiosurgery.

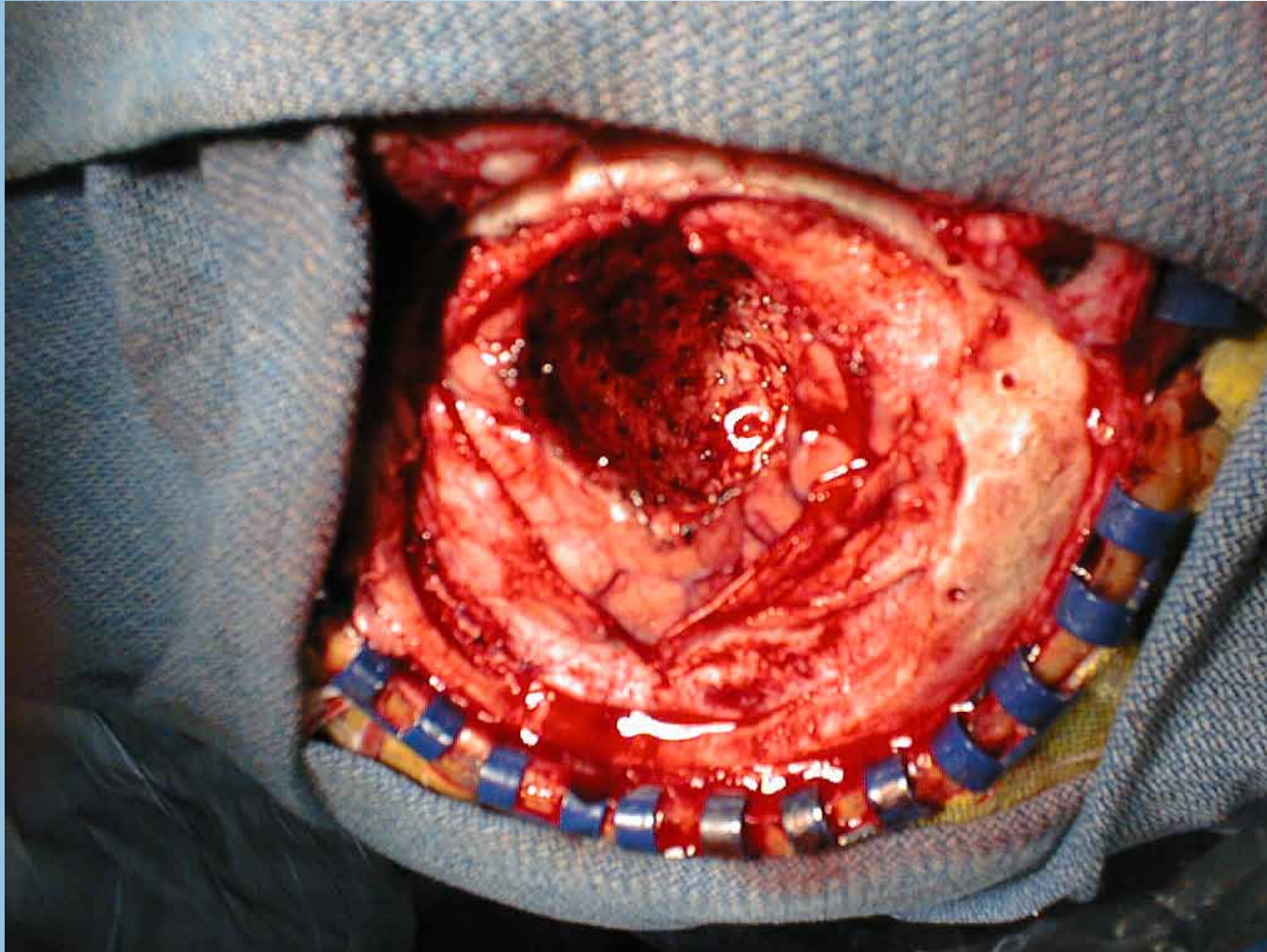


Pre Radiosurgery

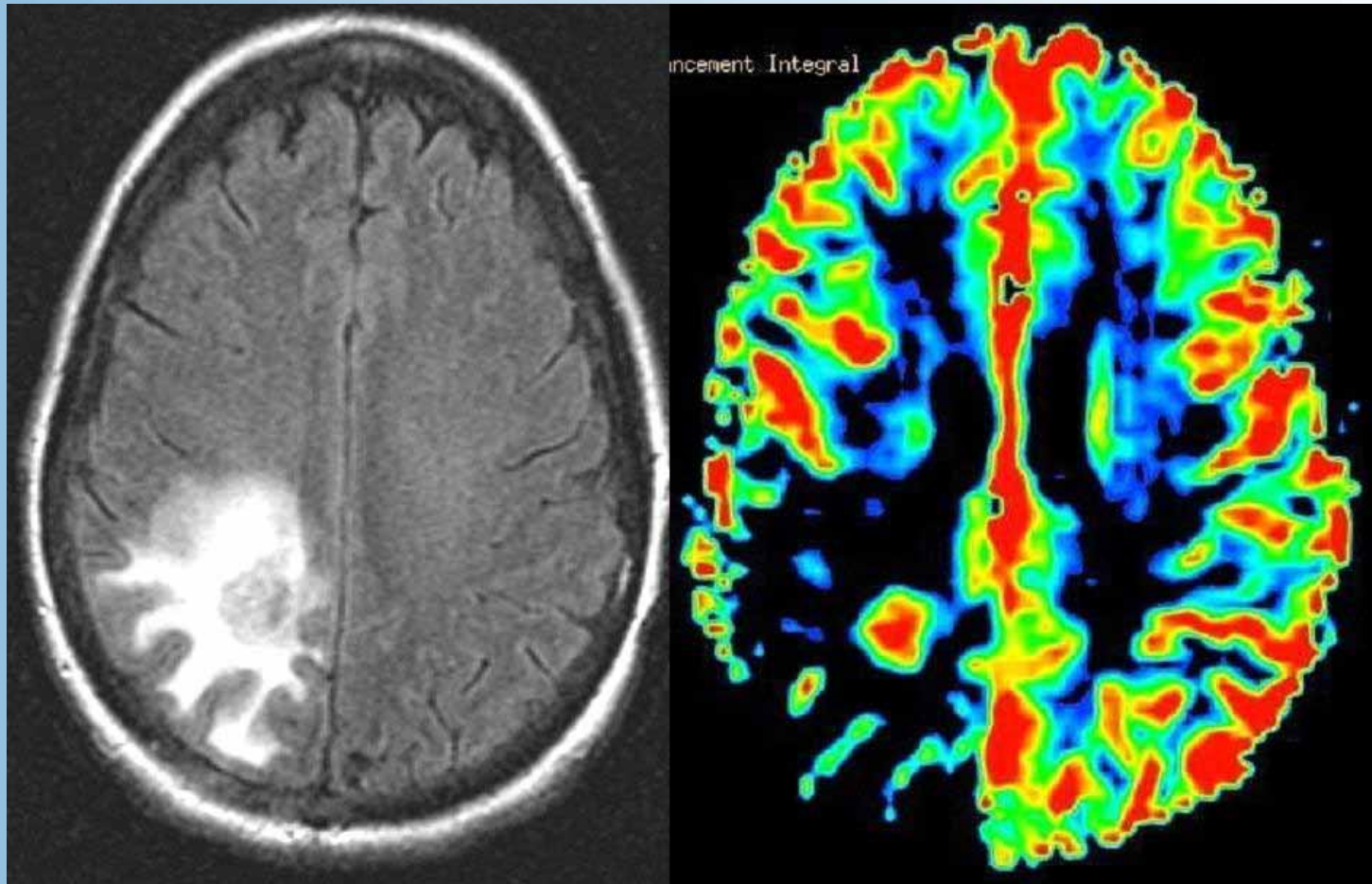


Post Radiosurgery

Brachytherapy



New Developments



Identifying Targets and
Evaluation of Treatment Outcomes

New Developments



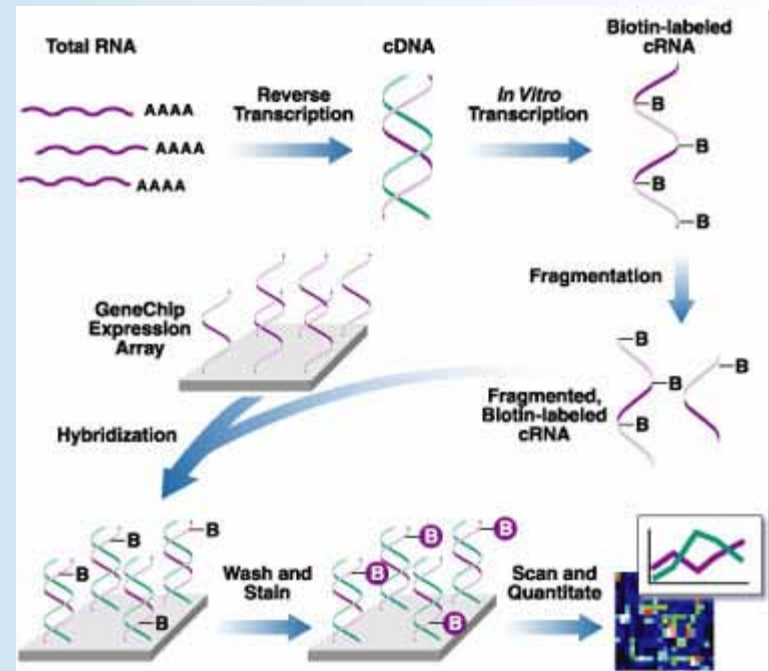
Protons

New Developments



Use of Biologic Agents Concurrently with Radiotherapy

New Developments



Individualizing Treatment for Tumors

