Brain Tumors
Radiotherapy

BIO 389

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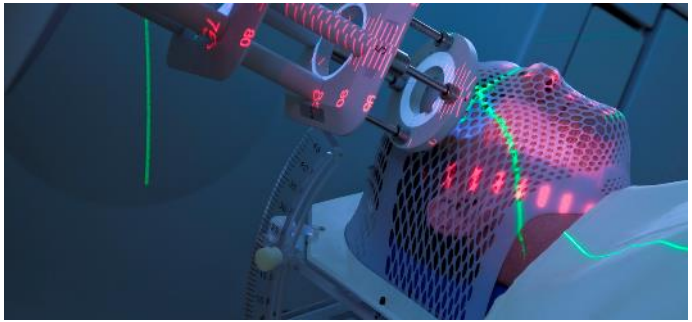

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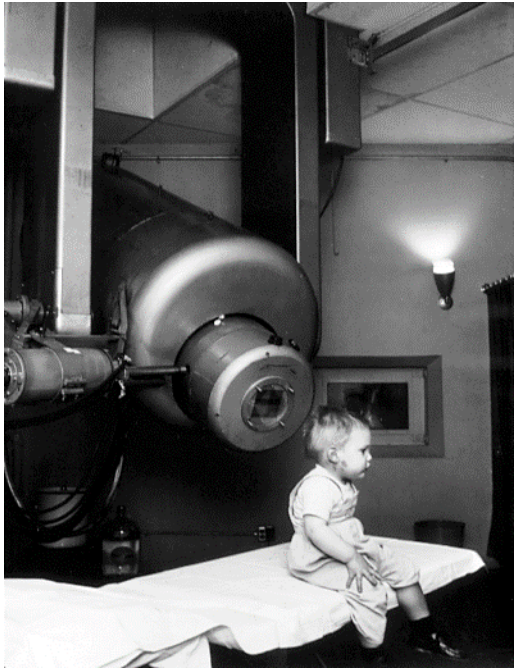
Radiotherapy in cancer

- **Broad application**
  - **Application in almost all kind of brain tumors**

Radiotherapy - History



Gordon Isaacs

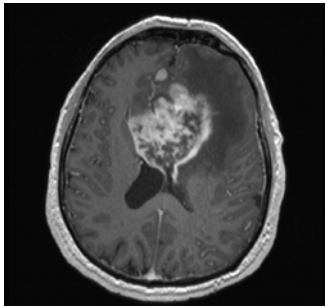
- **Retinoblastoma**
- **First patient treated with the linear accelerator in 1957**
- **Gordon's right eye was removed January 11, 1957 because the cancer had spread; left eye had only a localized tumor that prompted Henry Kaplan to try to treat it with the electron beam**

Radiotherapy - Principles

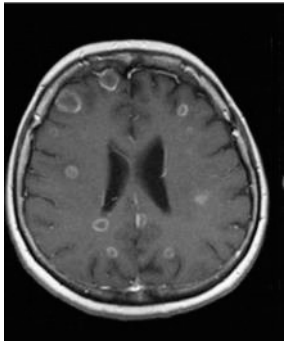
- **External beam radiation (external source of ionizing radiation is pointed at a particular part of the body; most common form)**
  - **High-energy radiation**
    - **Photons (x-rays or gamma-rays) – „energy packets“**
    - **Particles (protons)**
- **Internal radiation therapy (brachytherapy; sealed source; placed precisely in the area under treatment)**
    - **E.g. Jodine^{125} or Iridium^{192} seeds**
- **Systemic radiation therapy (unsealed source; given by infusion, oral ingestion)**
    - **E.g. Lutetium^{177} DOTATATE**

Radiotherapy – Target volumes

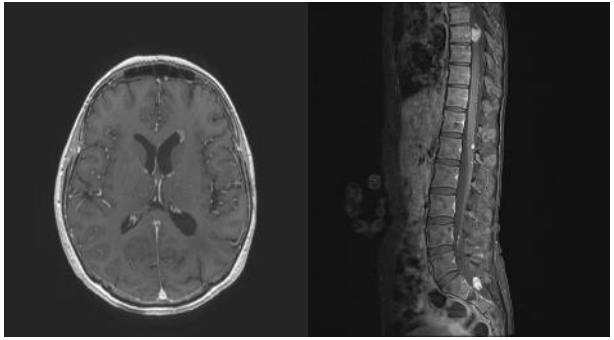
- **Lokal treatment**
  - **e.g. Glioma**



- **Whole brain irradiation**
  - **e.g. Metastasis, CNS lymphoma**



- **Craniospinal irradiation (neuroaxis)**
  - **e.g. Medulloblastoma, ependymoma**



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Radiotherapy – Mechanism of action

- **Direct and indirect damage**
  - **Direct: ionizing radiation energy is deposited in DNA**
  - **Indirect: radicals react with neighbouring molecules and produce secondary DNA or lipid radicals**

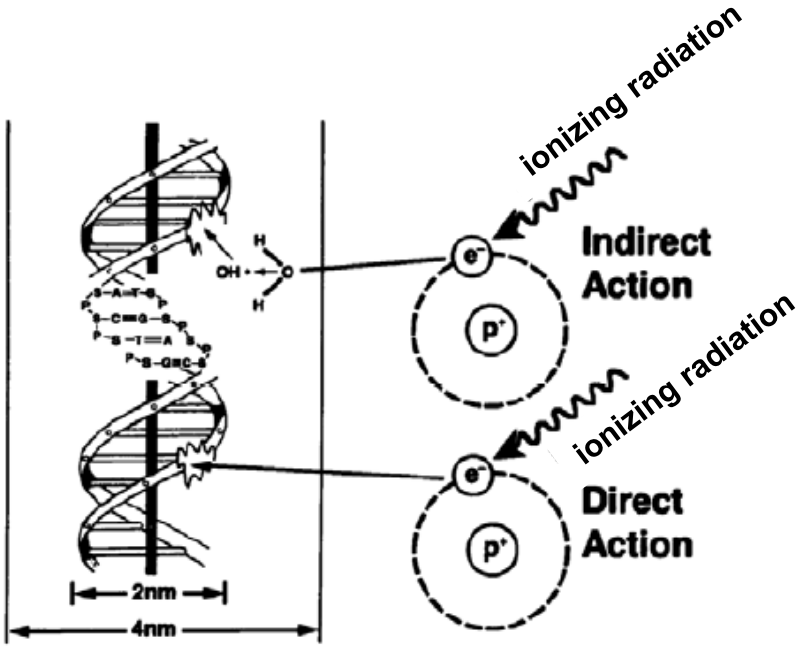


Fig. 2.2 Direct versus indirect action (Hall and Giaccia, 2006).

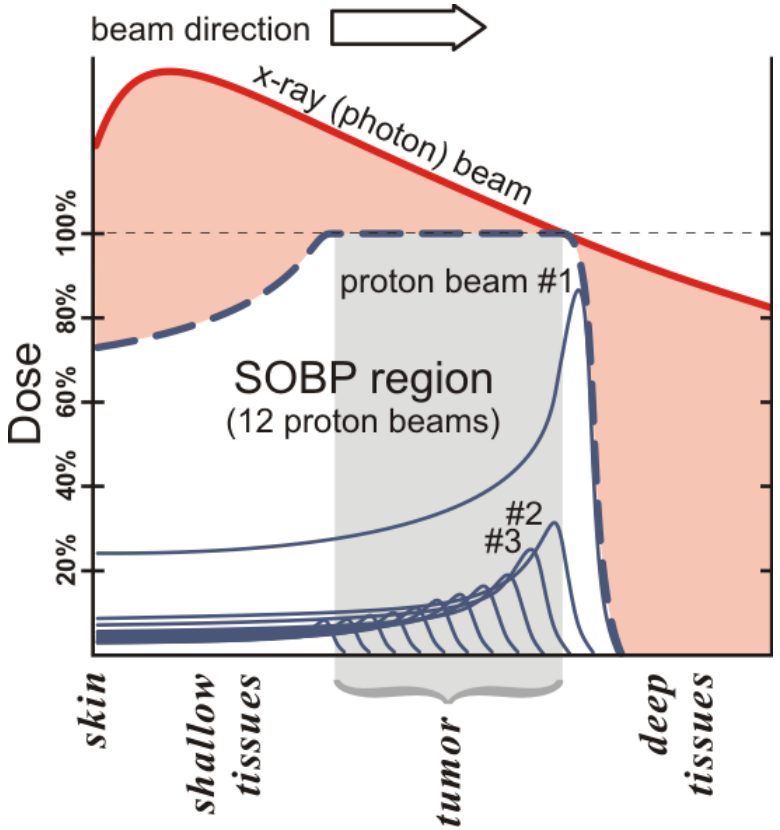
Radiotherapy – Protons and Photons

***Bragg curve*: plots the energy loss of ionizing radiation during its travel through matter**

Proton (particle) therapy: the dose is deposited over a narrow range and there is minimal exit dose

SOBP: spread out bragg peak

Depth-dose plot of an X-ray beam (red line) shows additional doses of X-ray radiotherapy, which can damage normal tissue



Radiotherapy – Practical Issues

- **The full dose of radiotherapy is usually divided into smaller doses -> *fractions***
- **Fractions of radiation are given in a treatment session for some weeks**
- **Unit of radiation energy: Gray (Gy)**
  - **Absorbtion of one joule of energy in the form of ionizing radiation per kilogramm of matter (e.g. body tissue); 1 Gy = 1J/kg**
- **Standard radiation therapy for glioblastoma:**
  - **30 x 2 Gy = 60 Gy; Mon to Fri for 6 weeks (plus concomitant temozolomide; 6 cycles maintenance temozolomide)**

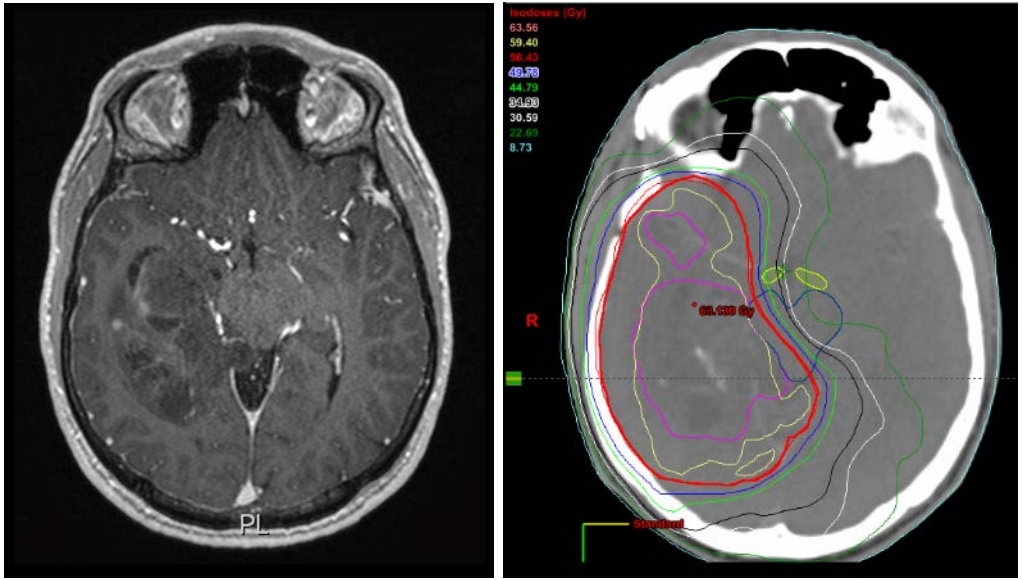
Radiotherapy - Mask

- **Avoid head movements**

Radiotherapy – Planning

- **External beam radiotherapy**
  - **3D-planning**
  - **Gross tumor volume (GTV)**
  - **Planning target volume (PTV)**
  - **Computer simulation based on energy and number of radiation beams and their orientation**

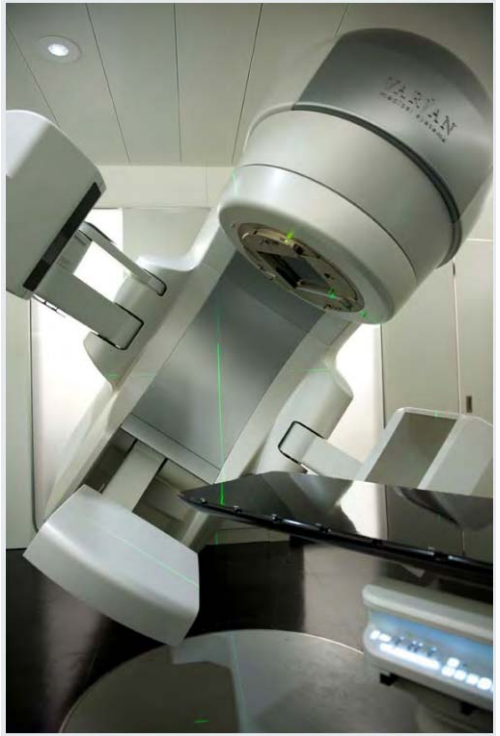
➢ **Leading to isodose contour map**



Dr. Michelle Brown, Radio-Oncology, USZ

Radiotherapy – Technical aspects

- **Photon beams**
  - **Machine: linear accelerator (LINAC)**
  - **USZ: TrueBeam®**
    - **Resolution <1mm**
    - **CT scanner integrated**



Radiotherapy – Technical aspects

- **Protons**
  - **Paul Scherrer Institute**
  - **Expansive**

Radiotherapy – Technical aspects

- **Radiosurgery**
  - **Highly focused irradiation beams precisely collimated to target a small tumor, e.g. a brain metastasis, one treatment session**

Gamma-knife

Cyber-knife