Chapter 8 : Why Use High Energy Beams

Disadvantages of Low-Energy Machines:

Orthovoltage Machines - energies up to ~ 400kVp

Disadvantages:

① low penetration.
low energy photons

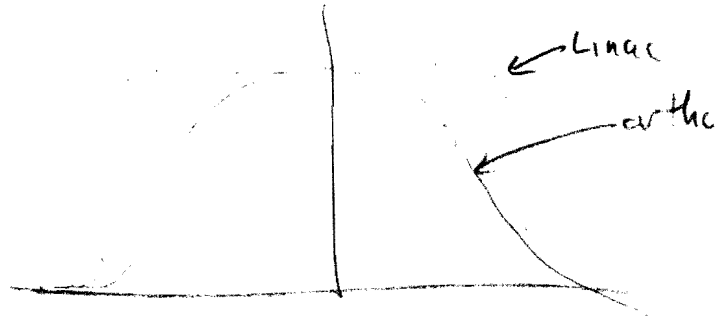
② high skin dose
beam intensity & beam dose are highest at the skin.

③ Machine output is low.
- requires long treatment times

e.g. - ortho output of 100 cGy/min
Linac output of 400 cGy/min

Treatment time ~ 4x as long

④ Beam profiles are not flat
- uneven dose delivery over entire field.

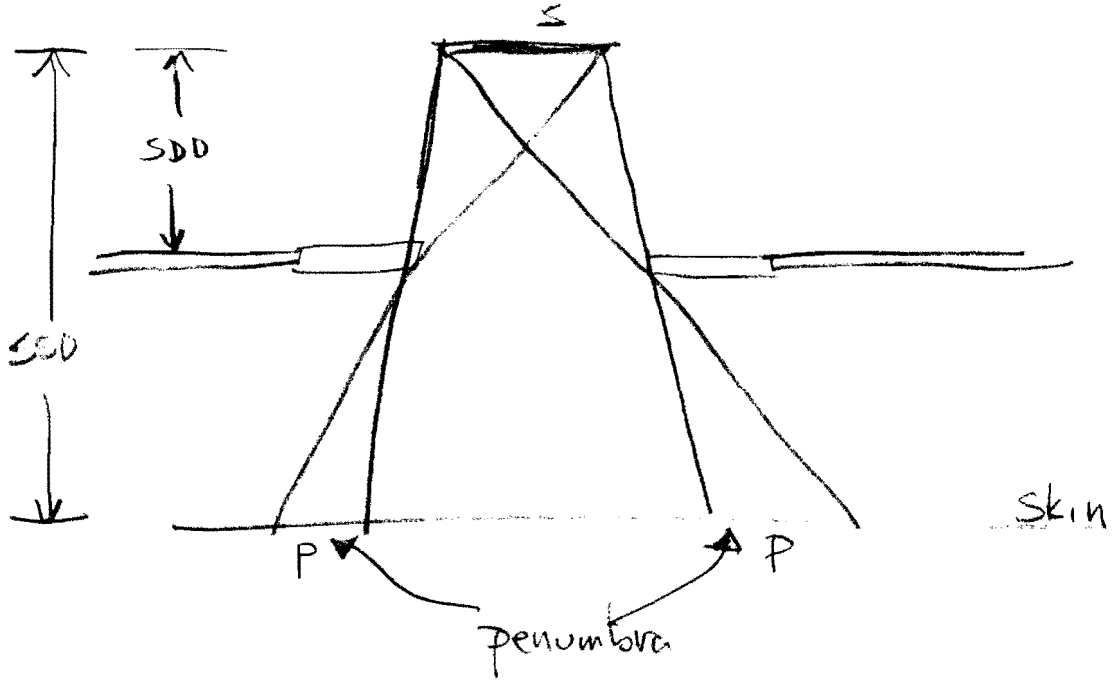


⑤ Large penumbra

Geometric penumbra is the region of partial dose between the "no dose" region outside of the beam and the full dose within the beam.

Penumbra depends on:

a) Source Size (s) (focal spot size)
b) Source-Skin-Distance (SSD)
c) Source-Diaphram-Dist (SDD) (collimators)
d) Depth (d)



$$P = \frac{S(SSD - SDD)}{SDD}$$

example: Ortho

SSD = 40 cm
S = 0.5 cm
SDD = 10 cm

$$P = \frac{S(SSD - SDD)}{SDD}$$

$$= \frac{(0.5)(40 - 1.0)}{1.0} = 1.5 \text{ cm}$$

Linac:

SSD = 100 cm
SDD = 45 cm
S = 0.2 cm

$$P = \frac{0.2(100 - 45)}{45} = 0.24 \text{ cm}$$

⑥ Inability to use Isocentric Techniques

- can't treat site from multiple angles to reduce normal tissue damage.

Advantages of Megavoltage Machines

Aside from addressing the 6 disadvantages of orthe machines,
There are two major advantages associated with megavoltage beams

(1) Beam penetration
(2) Skin sparing.

(1) Beam penetration

- Beams (photons) are absorbed in tissue by photoelectric & Compton processes.
- The interaction of the photons with the material (tissue) depends upon the attenuation coefficient (μ)
- The attenuation coeff depends upon the beam energy and the material.
- As the energy increases, the atten. coeff decreases.
  ∴ higher energy beams are more penetrating

  More penetrating ⇒ deposit dose at deeper depths

See Table 8.1, pg 99

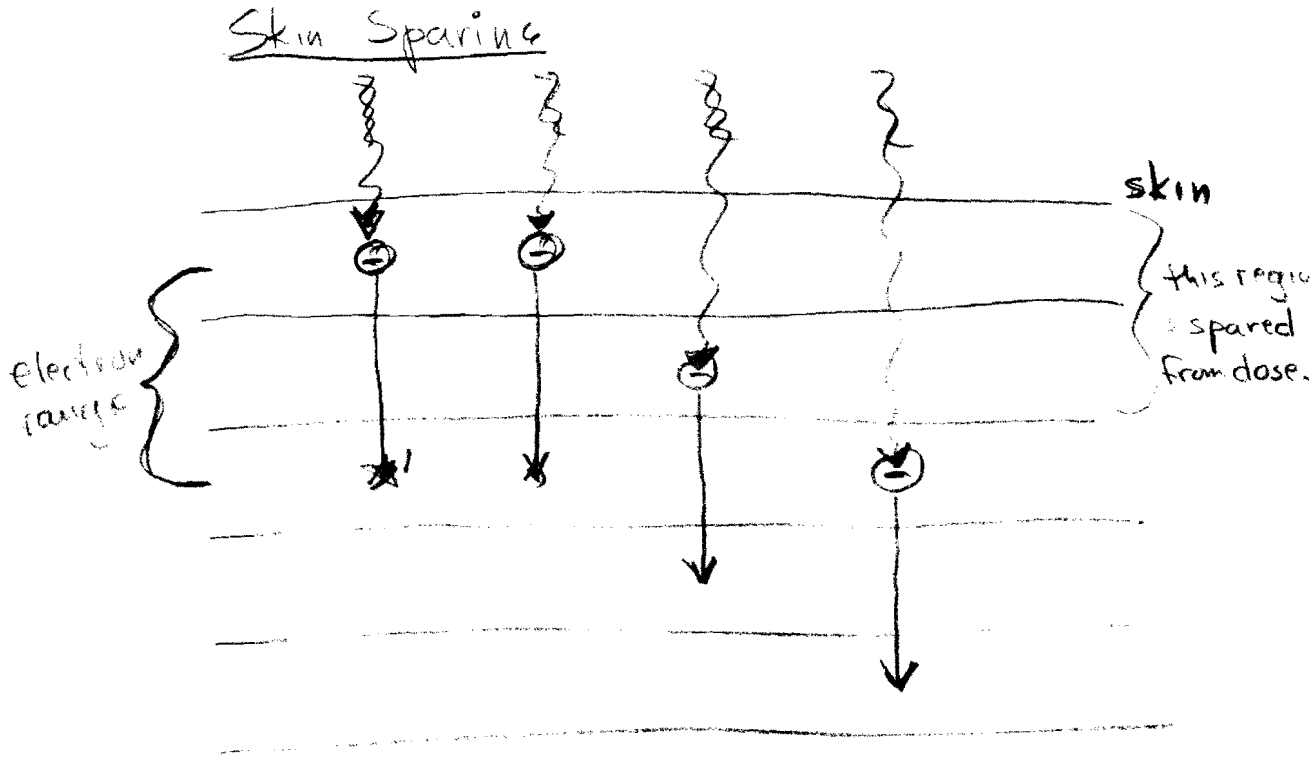
(2) Skin Sparing:

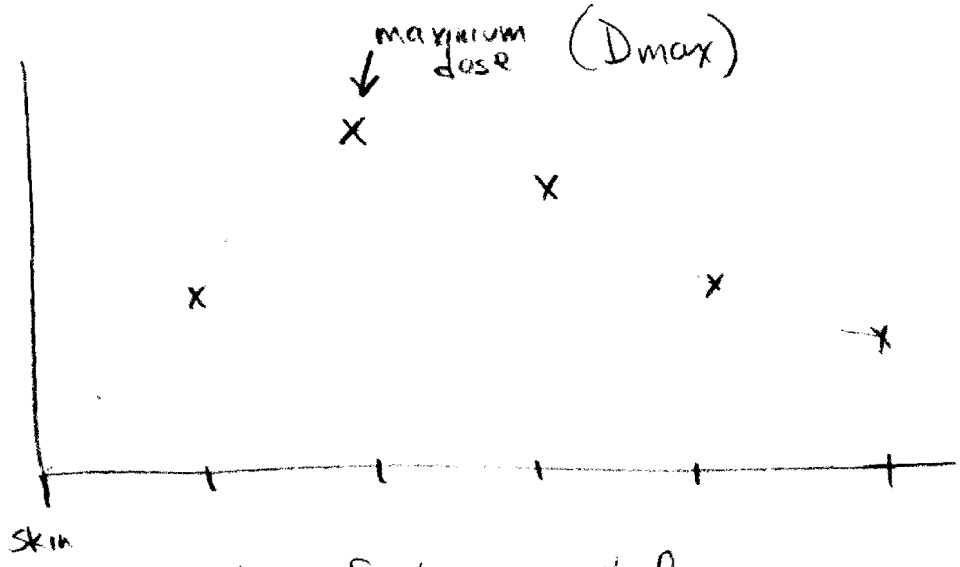
- as photons enter a patient, they set electrons into motion via Compton interactions.
- The electrons scatter forward, eventually slow down and deposit dose.
- The electron distance depends upon the photon energy.
- The region between the skin surface and the distance the electrons travel is "spared" most dose.

The depth of maximum dose is called Dmax.

Dmax increases with increasing energy

see Table 8.2, pg 100





plot of dose deposited.