Brachytherapy
Treatment Planning

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Treatment Planning
Introduction

Brachytherapy treatment delivery requires several different phases to be followed:

- Placement or insertion of the applicator
- Simulation (Radiography or C.T.)
- Source(s) localization
- Treatment planning
- Plan evaluation (isodose distribution)
- Treatment delivery

Gynecology
Aperçu

- Intracavitary Brachytherapy is mostly used for cancers of the uterine cervix, uterine body, and vagina.
- Various applicators are in use to hold the sources in an appropriate configuration.
- A cervix applicator consists of a central tube (tandem) and lateral capsules (ovoids or colpostats)
Gynecology
Aperçu

- The most widely used source for treatment of gynecological cancer is $^{137}$Cs.

- Intracavitary Brachytherapy requires careful placement of sources with respect to the target volume and any surrounding critical structures.

- Necessary to use sources of different strengths to achieve the desired dose distribution.

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Gynecology
Aperçu

- The clinical guidelines that are usually followed result in:
  - adequate dose delivery to the paracervical tissues
  - avoidance of underdose in regions around the cervix
  - respecting mucosal tolerance

- Low dose rate (LDR): 0.4 – 2 Gy/h, at the dose specification points (according to the ICRU).
  
  In practice target a dose rate of 0.4 to 0.6 Gy/h

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Gynecology
Aperçu

- In modern remote afterloading devices, $^{192}$Ir is the most commonly used radionuclide.

- These devices use a single $^{192}$Ir stepping source that has an activity of 10 Ci to 5 Ci.

- High Dose rate (HDR): 10 – 12 Gy/h, at the dose specification points (according to the ICRU).
microSelectron HDR

Iridium-192 Source
(Nominal 10 Ci)

Applicators
Orthogonal Reconstruction Method

Figure 1a. Orthogonal reconstruction. The orthogonal beam setup is obtained by alignment of the X-ray beams along the cross-wires on the target of a reconstruction box (opposite rotated over the patient).

Semi-Orthogonal Reconstruction Method

Figure 1b. Semi-orthogonal reconstruction. This beam setup is obtained by calculation of the localization of the AP and the lateral X-ray foils from the cross-wire images on the radiographs.
Semi-orthogonal Reconstruction Method

- X-rays beams oriented in the AP or PA direction, as well as laterally
- Spatial localization of X-ray foci reconstructed from radiographic images of cross-wire markers on the AP and lateral box faces
- X-ray beams’ central axes need not intersect, need not be perpendicular
- Allows fast reconstruction
- Can be applied with just a mobile x-ray machine without an image intensifier

Isocentric Reconstruction Method

- Extension of the stereo shift method
- Requires a treatment simulator, adaptation of the treatment couch
- Can enlarge angle between central axes of projecting beams up to 60° while still obtaining two projections of the X-ray markers in the catheters
- Especially suited for implants with many catheters or needles
Stereo Shift Reconstruction Method

- Requires use of a treatment simulator
- First gantry angle determined using an image intensifier to
  check that the sources or markers are clearly visible
- First radiograph is then made
- Second gantry angle with good visibility of sources
  determined, second radiograph made
- Allows fast reconstruction
- Especially suited for implants with many catheters or needles

Variable Angle Reconstruction Method

- First gantry angle determined using an image intensifier to
  check that the sources or markers are clearly visible
- First radiograph is then made
- Second gantry angle with good visibility of sources
  determined, second radiograph made
- Allows fast reconstruction
- Especially suited for implants with many catheters or needles
If sources are loaded to the flange level their will be a source protruding between the ovoids, this will increase the dose to the bladder and rectum.

**Loading the Tandem**

Tandem sources should stop at the superior aspect of ovoids.

- Bladder
- Rectum
Loading the Tandem

Superior aspect of ovoids

Inferior end of last tube source

Superior aspect of wall

Flange

Inactive tube insert

FLETCHER-SUIT-DELCLOS OVOID

Shielding in the direction of the anterior rectal wall and the bladder trigone.

Tungsten Shield

Foley Balloon

Posterior Vaginal Wall
Adequacy of treatment is based on the pear-shaped isodose distribution that surrounds the system, producing no “hot spots or cold spots”, while delivering a high dose to the cervix and paracervical tissues and a reduced dose to the bladder and rectum.
Thanks