

Interstitial Breast Brachytherapy Using Multiple Catheters. Rupak K. Das, Ph.D.

Theory and Criterion. Accelerated Partial Breast Irradiation (APBI) for breast cancer patients with High Dose Rate brachytherapy has shown promising results. Patients with the following criteria are well suited for this modality: 1) T1, T2 tumors < 4cm, 2) <3 positive nodes 3) Negative surgical margins, 4) No multi-center disease 5) Negative post-lumpectomy mammogram and 6) Surgical clips or seroma needed for target volume delineation.

Procedure. Catheters are placed by two methods: 1) Ultrasound-guided supine position and 2) Template guided prone position. In both the cases the seroma volume is first mapped either on the skin for the ultra sound method or on a digital mammography in the prone technique. A 2 cm margin is added to determine the implant volume and the catheters implanted as homogeneously as possible. During simulation process each catheter is trimmed, numbered and its length measured. CT scan with CT-compatible wires in each catheter is obtained and transferred to the treatment planning system.

Dosimetry. First the lumpectomy cavity is delineated in each CT slices. Target volume is defined as the lumpectomy cavity + 2cm margin, modified to 5mm deep to the skin surface and also along the pectoral muscle. Each catheter is reconstructed and the dwell positions auto activated by the treatment plan with some additional margins. Geometric optimization for volume implant is done and an isodose line selected to cover the entire target. Manual optimization is then done to cover the target volume optimally and at the same time minimizing the hot spots. Each catheter length is then entered manually. Defining Dose Homogeneity Index (DHI) as $(V_{100}-V_{150})/V_{100}$, where V_{100} and V_{150} are the volume covered by the 100% and 150% isodose line, an ideal implant will have a DHI value of 1.0. The primary objective of the dosimetry is the followings: 1) to cover 100% of the target volume by the prescription isodose line, 2) Target volume = V_{100} and 3) DHI as high as possible.

Quality Management. A Dose Volume Histogram is done to find the volume of the implant covered by the prescription dose. Time for this volume is then calculated from the original Manchester volume implant corrected for modern units and elongation factor, and is then compared to the total treatment time from the computer plan. Length of each catheter in the plan is also compared to the length measured in the simulator.

Discussion. CT based interstitial breast implants with stepping source allows improved treatment volume conformality. It also produces optimal coverage and is much easier and accurate than the conventional orthogonal film dosimetry.

Breast Brachytherapy Using a Single Balloon Catheter. Bruce R. Thomadsen, Ph.D.

Theory and Criterion. For breast cancer patient with very small disease, stages T1 and T2, a novel approach makes use of a single balloon catheter. The catheter is placed in the tyelectomy cavity, and the balloon filled with a mixture of contrast and water. The treatment delivery uses a single high dose-rate (HDR) dwell position, usually centered in the balloon (exceptions discussed below). The target dose is delivered to a radius 1 cm beyond the surface of the balloon. During the inflation, it is believed that the target tissue surrounding the balloon thins, effectively treating a larger radius from the cavity than the physical.

Procedure. Insertion of the treatment catheter usually accompanies the tyelectomy, but occasionally the insertion follows by up to a couple of weeks. A surgical drain helps prevent air from being trapped on the surface of the balloon.

Dosimetry. Because of the dosimetric criteria for aborting the treatment, volume-image based (i.e., CT) localization becomes a necessity. Even if the computer dosimetry system does not allow CT input, the scans are needed. The single dwell position produces a nearly spherical dose distribution, but retracted somewhat within about 30° of the cable axis, resulting in a low dose in those directions. Unlike implants, the spherical dose distribution generally pushes the treatment dose beyond the skin. The skin dose becomes a major factor in deciding to go forward with treatment. The treatment should be aborted if:

- The balloon surface lies less than 0.5 cm deep to the skin;
- The dose to the skin exceed 1.5 times the prescribed dose;
- The shape of the balloon deviates significantly from a sphere; or
- There are significant air pockets around the balloon that push the tissue away from the balloon surface. (“Significant” is not well defined yet, but may be taken as 3 mm radially).

Even in cases with greater than 0.5 cm between the balloon surface and the skin, the skin may receive too much dose. Sometimes the dwell position can be altered from the center of the balloon by a few millimeters away from the skin.

Quality Management. Verification of the treatment plan becomes easy, since a simple calculation at a radial point from the single position suffices. Before each treatment, or at least once a day, a fluoroscopic examination of the balloon diameter verifies that no fluid has been lost, and the target tissues remain at the reconstructed locations (a loss in fluid would increase the doses the patient’s tissues would receive).

Discussion. While a very simple treatment technique, single-catheter breast implants have many limitations. The spherical dose distribution assumes that the target tissues conform to the balloon, with no customizing to the patient. Placements frequently violate a criterion leading to abortion. Treatment durations are as long as multiple-catheter implants, and, in general, the patients are no more comfortable. On the other hand, such insertions require little skill on the part of the radiation oncologist since placement is by the surgeon.