A dosimetric comparison of partial breast irradiation brachytherapy techniques: SAVI, Contura, and Tube and Button applicators

Purpose: A number of partial breast irradiation (PBI) brachytherapy devices have been developed in the past several years and used to treat early stage breast cancer. We evaluated the dosimetry of PBI brachytherapy techniques using the Strut Adjusted Volume Implant (SAVI), Contura, and Tube and Button (T&B) applicators in order to determine how to best use the devices.

Methods: A total of 51 breast-cancer patients were treated with PBI brachytherapy techniques (23 SAVI, 6 Contura, and 22 tube and button applicators). The applicators were selected based on the size, shape, and location of the lumpectomy cavity and cavity-to-skin distance. CT scans were performed for treatment planning. The target (PTV_EVAL) was delineated following NSABP B-39 guidelines (see Figure 1). For the breast T&B cases, the PTV, including the lumpectomy cavity, was contoured directly by physicians. All 3D plans were generated using the Oncentra MasterPlan brachytherapy planning system (Nucletron, Netherlands) and optimized first using the Inverse Planning Simulated Annealing (IPSA) algorithm to deliver 3.4 Gy per fraction to the target and minimize dose to organs at risk (OARs). Graphical optimization was then used to fine tune the final dose distribution. The minimum cavity-to-skin distance was measured. In order to compare dosimetric properties of the PBI techniques, target coverage (D90, V90, V100, and V150) and maximum dose to the OARs (D0.1cc to skin, ribs, and lung) extracted from dose volume histograms were evaluated. Dose homogeneity index (DHI), as represented by the volume ratio (1-V150/V100), was calculated.

Results: The average cavity-to-skin distances for the SAVI and Contura cases were 4.1 mm (0.5-9.6 mm) and 11.7 mm (7.1-15.4 mm), respectively. The average target-to-skin distance for the T&B cases was 8.7 mm (5.0-13.7 mm). The average D90, V90, V100, and V150 to the target for the three modalities were 101.4%, 96.8%, 90.4%, 43.1% (SAVI), 98.7%, 97.0%, 87.5%, 28.4% (Contura), 106.6%, 98.6%, 95.1%, and 23.8% (T&B). The average D0.1cc to the skin, ribs, and lung was 91.5%, 58.8%, 44.5% (SAVI), 93.1%, 51.3%, 40.5% (Contura), 69.1%, 41.5%, and 31.9% (T&B). The average V150 and V200 to the normal breast tissue was 30.4 cc and 14.9 cc (SAVI), 29.5 cc and 7.3 cc (Contura), 18.3 cc and 7.1 cc (T&B). The average DHI for the SAVI, Contura, and T&B cases was 0.55 (0.50-0.60), 0.70 (0.63-0.78), and 0.76 (0.74-0.79).

Conclusions: All applicators provided clinically acceptable target coverage and met all dose constraints for the OARs. The SAVI device provided a lower skin dose at close cavity-to-skin distances while providing excellent target coverage. However, the T&B and Contura applicators produced more homogeneous dose distribution or higher DHI in the target than the SAVI. The correlations between dosimetric properties and follow-up mammogram results are under investigation.

Figure 1. PTV_EVAL (red) covered by isodose lines 200% (magenta), 150% (yellow), 100% (blue), 90% (green), 75% (cyan) and 50% (white) from SAVI (left), Contura (middle), and Tube and button (right) techniques.