SU-E-T-254 Comprehensive Quality Assurance Program for Accelerated Partial Breast Irradiation Using the SAVI HDR Applicator

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Purpose: To present a comprehensive prescriptive quality assurance (QA) program for Accelerated Partial Breast Irradiation (APBI) using the Cianna Medical SAVI (Strut Adjusted Volume Implant) multi-catheter applicator.

Methods: We established a robust QA program for the SAVI technique based on our previous experience with various HDR procedures and documentation provided by the manufacturer. During the simulation, the location of the SAVI in relation to the patient's anatomy is recorded by measuring the distance from the patient's skin to the SAVI's hub, by marking the skin and denoting which catheter aligned with the mark, and by taking AP and lateral scout views. A "SAVI Simulation Worksheet" was developed to denote the key measurements during the simulation QA. Our QA process continues with treatment planning. After the plan is reviewed by the physician, the physicist checks the delineation of each catheter and the dose distributions using a developed "Pre-Plan Check Sheet" as a guide. The third set of the major checks is performed prior to each delivery. The SAVI location is verified via repeating the measurements taken during the simulation including the daily images. A therapist and physician sign-off are required. "HDR Treatment Check" is the last key component of the QA flow, which required 3 independent checks of the catheter connections, dwell positions and time, and post-treatment checks.

Results: 10 SAVI patients have been treated using the QA protocol. There was 1 catheter each for 2 patients that were misconnected. This error was detected by the third independent checker.

Conclusions: We established a robust QA program for the SAVI technique and successfully implemented it for 10 SAVI patients, 100 treatments. We are initiating Failure Modes and Effects Analysis (FMEA) for the SAVI process to better distribute the limited resources and enhance the efficiency and safety of our SAVI program.

SU-E-T-365 Dosimetric Study of An HDR Applicator of SAVI for Partial Breast Irradiation

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Purpose: To investigate the dosimetric effect by experimentally simulating the situation with and without tissue invagination and the potential translation and rotation of the SAVI applicator for partial breast irradiation.

Methods: The SAVI applicator with the cavity filled with air and water was merged into a water phantom and the delivered dose was measured using an ion chamber and film. The measurements were compared with a homogenous dose calculation by the treatment planning system. A dose variation from the SAVI translational shift was measured by moving an ion chamber along with the central axis direction. A dose change from the SAVI rotation was measured by placing an ion chamber at a fixed point while rotating the SAVI device about the central axis.

Results: The dosimetric effects for the SAVI device were found to be related to the cavity dimension, source arrangement, and dwell times. For the single dwell source placed in the center of the applicator, the maximum difference of the dose with the air cavity at 1cm away from the air-water boundary is about 7% higher than that with water filling in the cavity. But the measurements with nearly fully loaded multi-sources for the same situation show a difference of less than 3%. The 3% dose variation in average was found from either the 3 mm translation or 3 degree rotation of the SAVI applicator.

Conclusions: The maximum dosimetric effect of an air cavity is 7% off compared with a water filled cavity when a single dwell source position is used in the center of the central catheter. Multiple catheters of the SAVI applicator with a nearly fully loaded dwell source position produce the discrepancy of less than 3% and allow for optimal and conformal dose distribution to a lumpectomy cavity while minimizing the dose to adjacent normal structures.

SU-E-T-380 Evaluation of Interfraction Motion of the Strut-Adjusted Volume Implant (SAVI) Using 3D Reconstruction From CT Scout Images

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Purpose: The Strut-Adjusted Volume Implant (SAVI) is a partial breast irradiation applicator. We developed a method to reconstruct the 3D device location using scout images to provide applicator position and proper expansion verification. We also used this technique to evaluate interfraction motion.

Methods: The SAVI device was implanted in a lumpectomy cavity. The patient was aligned by CT lasers and skin tattoos to ensure reproducible setup. A post-operative CT scan was performed for treatment planning. The patient was treated in 10 fractions over the course of 5 days. Daily CT scans and anterior and lateral scout scans were acquired prior to each fraction. Radio-opaque markers located on three of the struts were localized using a peak detection filter. The location of each marker on the 2D scout image was backprojected towards the CT x-ray source. Each 3D marker position was reconstructed at the backprojection intersection. The 3D marker position was compared to the location in the 3D CT image. The interfractional displacement of the device was assessed from the reconstructed marker locations.

Results: The average distance (standard deviation) between the marker positions reconstructed using the scout images and the CT images was 0.76 (0.28) mm. Using the scout image data, the average interfractional device movement (standard deviation) in the SI, AP, and LR directions, and 3D was 0.51 (0.46) mm, 0.95 (0.81) mm, 0.73 (0.61) mm, and 1.56 (0.68) mm.

Conclusion: SAVI interfraction motion can be accurately measured using scout images. The patient setup for partial breast brachytherapy can be improved by correcting the applicator displacement. This proposed technique eliminates the need for CT verifications, and therefore additional dose to the patient, while still accurately identifying applicator displacement.

SU-E-T-381 Dosimetric Analysis of Patients Treated with Accelerated Partial Breast Irradiation Using the Mammosite® and SAVI Applicators

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Purpose: To present dosimetric data for patients undergoing Accelerated Partial Breast Irradiation (APBI) using the Mammosite® and Strut-Adjusted Volume Implant (SAVI) applicators.

Methods: We have treated 35 patients with Accelerated Partial Breast Irradiation (APBI) using high dose rate brachytherapy. These patients were treated per guidelines specified in the NSABP B-39/RTOG 0413 protocol. The patients undergoing APBI have been treated with Mammosite® applicator (N=20) and SAVI applicator (N=15). The Mammosite® applicator used for all 20 patients was a single channel applicator. Single or multiple dwell positions were used as warranted by the type of balloon used and other clinical factors. The SAVI Applicator is a single-entry, multi-catheter device available in different sizes with 7, 9 and 11 catheters. The use of multiple catheters facilitates dose sculpting to improve treatment plan quality as well as reduce the skin dose. Each treatment plan was evaluated for conformance of the dose to the PTV using commonly used dosimetric parameters. These parameters included balloon/cavity volume, PTV volume, V90, V100, V150 and V200.

Results: The median V90 for the treatment plans delivered using the Mammosite® applicator was 99.7% (96.7%-99.8%) whereas it was 98.8% (96%-100.0%) for the patients treated with the SAVI applicator. Other data including the V100, V150, V200 and skin dose will be presented. The impact/ importance of the data presented is that it provides useful information about the range of dosimetric parameters to be expected in treatment planning of APBI cases using these applicators.

Conclusions: Our results indicate that both the Mammosite® and SAVI applicators allow treatment planning and delivery of APBI per the guidelines specified in the NSABP B-39/RTOG 0413 protocol.

SU-E-T-596 High Dose Brachytherapy Planning of a Left Breast Cancer Patient with in Situ Pacemaker

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Purpose: To investigate the benefits of multilumen partial breast Brachytherapy device, SAVI, in reducing dose to in situ pacemakers in patients with cancer of the left breast.

Methods: A left breast cancer patient with an in situ pacemaker underwent breast conservative surgery and was referred for Partial Breast Irradiation (PBI) using Ir-192 High Dose Rate Brachytherapy. The preliminary estimation of the pacemaker dose from a pre-insertion CT study was about 8 % of the prescribed dose which exceeded the generally accepted dose of 2Gy. The challenge was to use a suitable applicator to treat the tumor bed and 1cm margin without exceeding the 2Gy limit to the pacemaker and the leads. A seven catheter SAVI device was selected and implanted in the left breast in an optimal direction and a 3D treatment plan was generated following a post insertion CT scan, using the Oncentra Brachy treatment planning system. Several optimization tools available in the planning system namely inverse, graphical, and dose point optimization were utilized to selectively load the catheters and reduce the dose to pacemaker and leads. A set of calibrated TLD chips were used to determine the surface dose on the pacemaker, which was then compared to the calculated surface dose. The pacemaker parameters were monitored before and after the 10 fraction (bid 5days) HDR brachytherapy, by a vendor representative and were found to functioning properly.

Results: Using the seven catheter SAVI device it was possible to limit the pacemaker/ leads dose to less than 2 Gy, with an overall satisfactory dose to the target volume.

Conclusions: By combining the optimization tools of today's Brachytherapy planning system and a multilumen SAVI applicator, HDR partial breast irradiation can be successfully delivered for left breast cancer patients with in situ pacemaker, without the concern of interrupting pacemaker functionality.

SU-E-T-695 Dose Calculation of A Breast Cancer Brachytherapy Treatment Using Monte Carlo Simulation

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Purpose: To develop a dose calculation package based on Monte Carlo simulation for SAVI breast cancer brachytherapy treatment using patient's CT data.

Methods: A realistic model of the patient was created using anonymized patient data including images, structures and plans from the treatment planning system. Images were then voxelized and each voxel assigned a density and material value base on its calibrated Hounsfield units. Materials included were fat, muscle, lung, air, bone, and Nitinol. This data was then imported into the penEasy Monte Carlo code. Each source position from the plan was then run individually and the dose was totaled after weighting each source by its dwell time from the original plan. Energies used were those of the VariSource IR-192.

Results: The resulting dose was compared to the dose from the original plan and plotted side by side. Dose differences were considered that occurred outside the air cavity, particularly in the evaluated planning target volume (PTVeval), which is calculated as 1 cm outside the cavity subtracting the cavity itself, the skin and the chest wall. Dose from the Monte simulation looked similar in shape and intensity to the original plan.

Conclusions: We have developed a Monte Carlo simulation package to calculate dose distributions for SAVI based breast cancer brachytherapy using patient's CT and plan parameters extracted directly from a commercial planning system.

SU-E-T-743 The Comparison of Dose Modification Factors for Two Multi-Lumen Brachytherapy Applicators Used in Partial Breast Irradiation

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Purpose: When using a multi-lumen applicator for partial breast irradiation, the desired result may be to produce an asymmetric dose distribution. An asymmetric dose distribution is necessary when the distance between the applicator and/or chest wall is small (<7mm). This small distance causes the air outside the skin and in the lung to act as a low density and poorly scattering medium. This may be problematic since most treatment planning systems do not account for tissue heterogeneity corrections. The purpose of this investigation is to quantify the inaccuracies of the treatment planning system by utilizing a parameter known as the dose modification factor (DMF).

Methods: The DMF is defined as the ratio of the dose rate at 1 cm beyond the applicator's surface (PTV) with full scatter to the dose rate with a finite tissue thickness beyond the PTV. The two applicators used were Contura (SensoRx, Inc.) and SAVI (Cianna Medical, Inc.). The treatment planning system used to create symmetric and asymmetric plans was BrachyVision (Varian Medical Systems, Inc.).

Results: For both applicators, the DMF increased exponentially as the thickness of tissue beyond the PTV decreased. The maximum measured DMFs for the symmetric plans using the Contura and SAVI applicators are 1.0878 and 1.0962, respectively. The maximum measured DMFs for the asymmetric plans are 1.0858 and 1.1148, respectively. Relative error for all measurements of DMF was less than or equal to ±0.005.

Conclusions: With the DMFs mentioned above, it is obvious that there is a difference between the planned and measured dose distributions. The difference is due to the lack of heterogeneity corrections of the treatment planning system. Depending on the amount of tissue beyond the PTV, the planning system may over-predict the dose by as much as 11%.