Evaluation of interfraction motion of the Strut-Adjusted Volume Implant (SAVI) using 3D reconstruction from CT scout images

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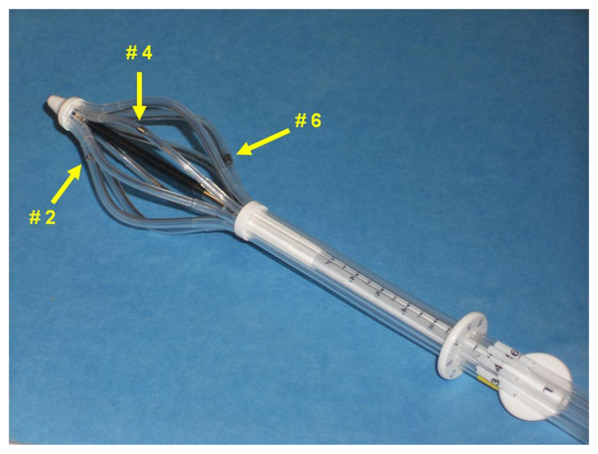
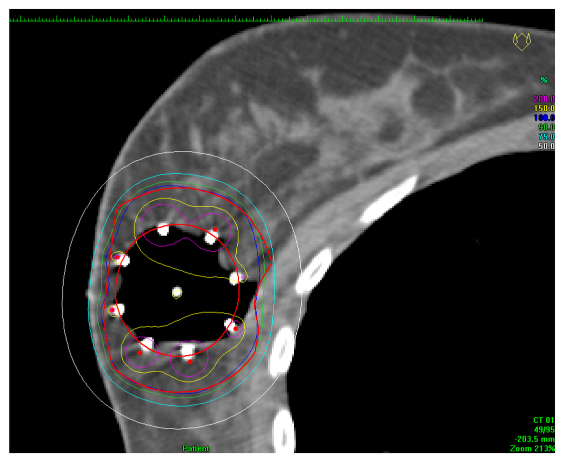
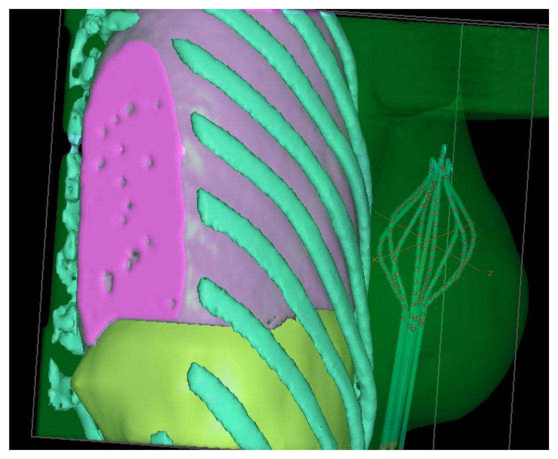
Motivation



SAVI

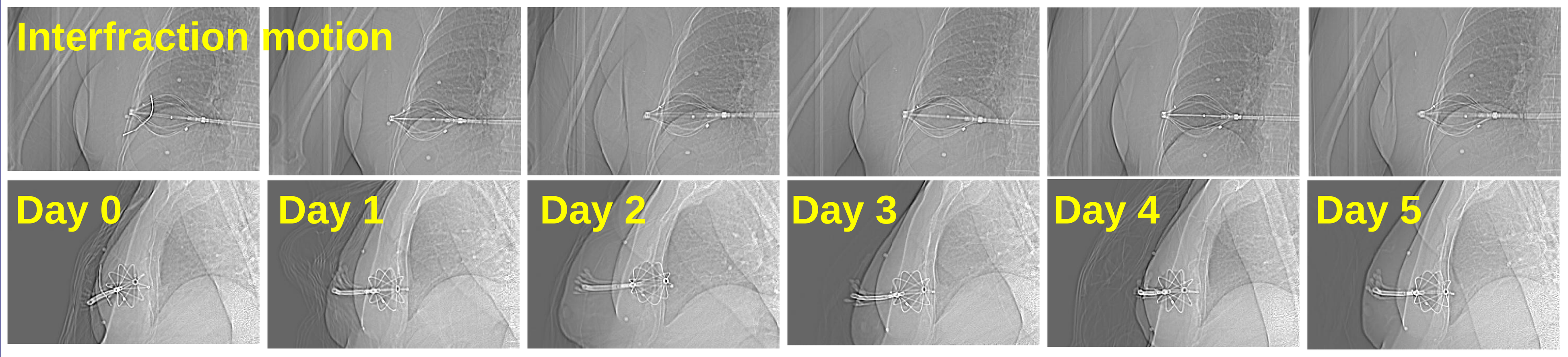


SAVI 8-1



SAVI 3D Image

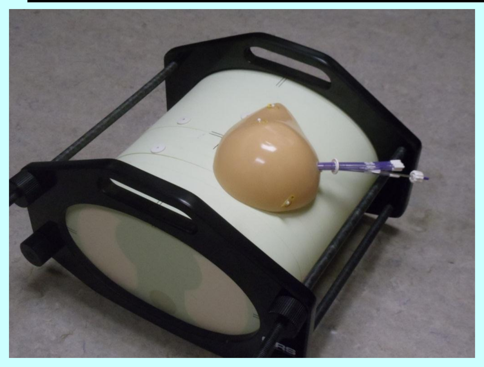
The **Strut-Adjusted Volume Implant (SAVI)** is a **partial breast irradiation applicator**. The SAVI uses multiple catheters to provide excellent target volume coverage and normal tissue (skin and lung) sparing [1-3]. In order to precisely deliver radiation to the target, it is important to ensure the **position of the applicator** and **reproducibility of the patient setup**.

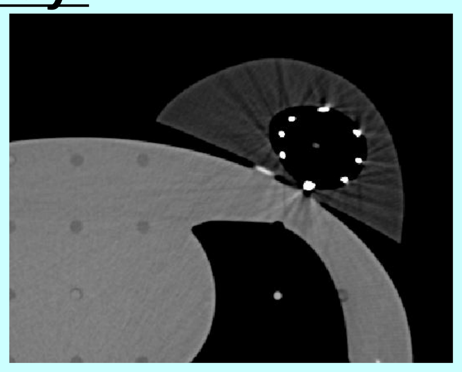


We developed a method to reconstruct the **3D device location using scout images** to provide applicator position and proper expansion verification. We also used this technique to **evaluate interfraction motion**.

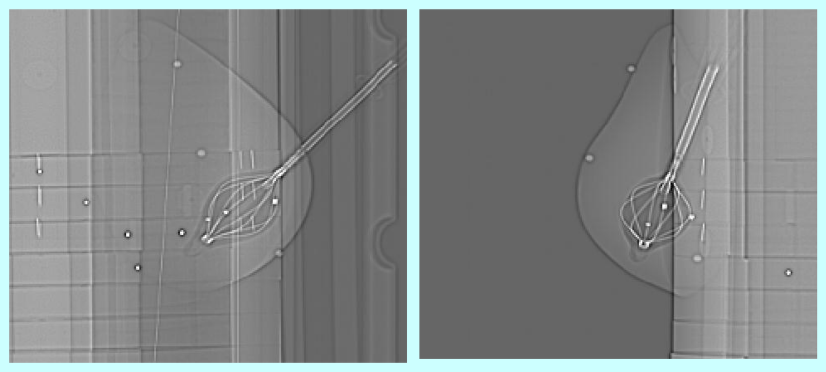
Materials and Methods

Breast Phantom Study:



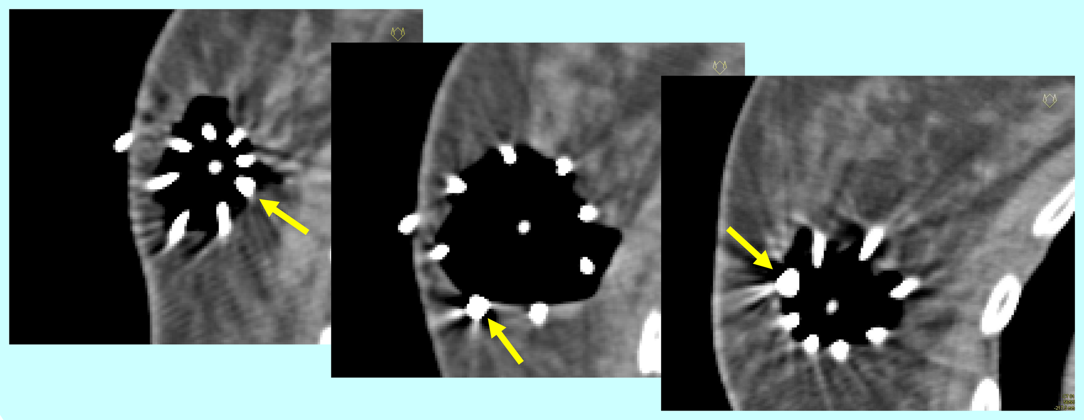


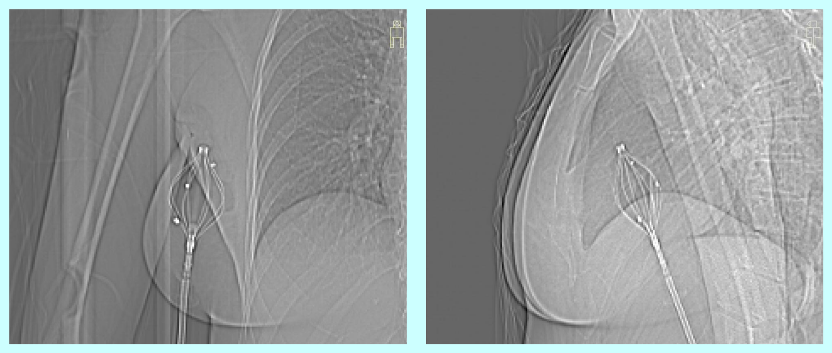
CT images



AP and LAT Scouts

Patient Study:





3D reconstruction and interfractional movement of the SAVI:

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 (numbers 2, 4, and 6) 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** [4]. 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

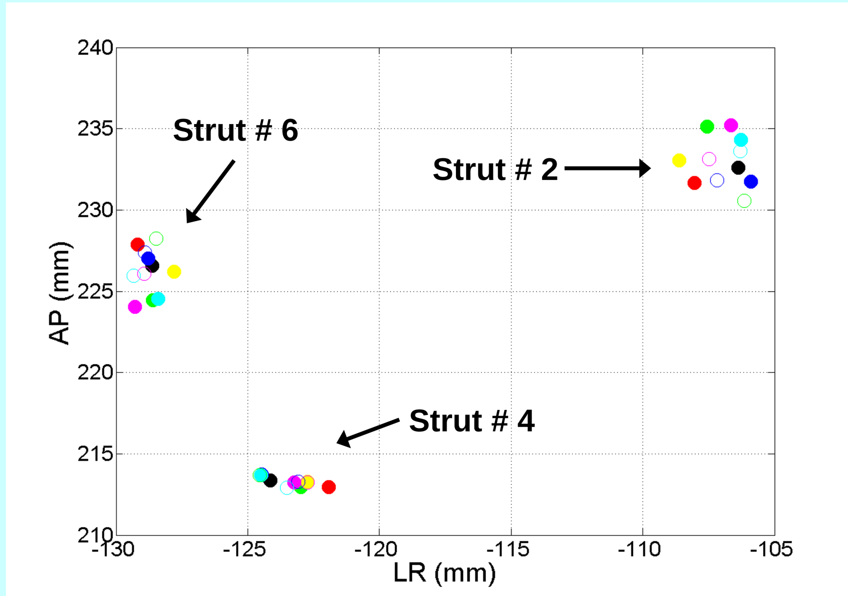
The accuracy of 3D reconstruction:

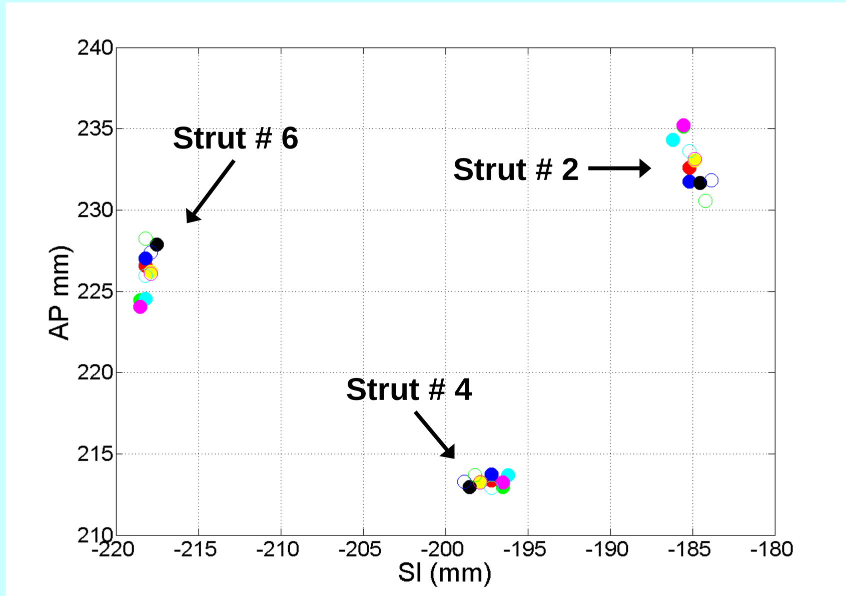
The average distance between the marker positions reconstructed using the scout images and the CT images was 0.76 ± 0.28 mm (0.26–1.26 mm).

Interfractional device movement:

Using the **daily CT images**, the **average interfraction motion of the device** in the SI, AP, and LR directions, and 3D with standard deviation (range) was 0.50 ± 0.41 mm (0.07–1.52 mm), 0.86 ± 0.54 mm (0.17-1.88 mm), 0.68 ± 0.49 mm (0.02–1.67 mm), and 1.37 ± 0.51 mm (0.54–2.0 mm).

Using the **scout image data**, the **average interfractional device movement** in the SI, AP, and LR directions, and 3D was 0.51 ± 0.46 mm (0.00–1.67 mm), 0.95 ± 0.81 mm (0.07-2.62 mm), 0.73 ± 0.61 mm (0.03–2.26 mm), and 1.56 ± 0.68 mm (0.49–2.8 mm) . Three radio-opaque markers from the post-operative scan (black dot) and setup scans prior to each fraction represent interfractional movement of the device.





Conclusions and Future Work

- We developed a novel method to **reconstruct the 3D location of the SAVI** applicator using 2D scout images and validated the 3D reconstruction with 3D CT images.
- We demonstrated that the **SAVI interfraction motion can be accurately measured** using the scout images. The patient setup for *partial breast brachytherapy* can be improved by correcting the applicator displacement.
- In addition, the proposed technique will **reduce the total number of CT scans and dose to patients**. We are currently working on applying this technique to 15 patients being treated with the SAVI applicator.

Bibliography

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