Validation of Reduced Planning Target Margins In a Prospective Clinical Trial for Stereotactic Accelerated Partial Breast Online Adaptive Therapy

Courtney Bosse Stanley[1], John Hoyle, PhD[1], Carlos E. Cardenas, PhD, MS[1], Dennis N. Stanley, PhD[1], Natalie N. Viscariello, PhD[1], Christopher M. Dobelbower, MD[1], Kimberly Keene, MD[1], Michael H. Soike, MD[1], Drexell Hunter Boggs, MD[1] and Joel A. Pogue, PhD[1], (1)University of Alabama at Birmingham, Birmingham, AL

2026 JOINT AAPM | COMP MEETING
JULY 19–22 | VANCOUVER, BC

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

INTRODUCTION/AIM

Introduction: Online adaptive radiotherapy (oART) mitigates interfraction motion and enables potential reduction of planning target volume (PTV) margins relative to standard-of-care approaches. This study evaluates the robustness of 2 mm PTV margins in a prospective stereotactic accelerated partial breast irradiation (APBI) clinical trial utilizing HyperSight-based CBCT-guided oART with surface-guided RT (SGRT).

Aim: Utilize verification and post-delivery CBCT-based dose recalculations to directly quantify CTV coverage robustness with a reduced 2mm PTV margin.

METHODS

- 20 patients treated five fractions free-breathing oART under the RAD 1802 trial for a total of 100 fractions
- Minimum 3 CBCT acquisitions per fraction including planning CBCT, pre-delivery verification CBCT with positional correction, and post-treatment CBCT acquired immediately after beam off with no positional correction
- Two fractions per patient selected for recalculation (n=40/100)
- Fractions with SGRT triggered re-imaging and mid-treatment re-alignment also selected (n=11)
- SGRT triggered re-imaging fractions acquired 4 CBCTs for analysis
- CBCTs fused with planning CBCT for contour transfer
- Select contours edited on verification CBCT and post-treatment CBCT
- Plans recalculated on each CBCT for a total of 128 plan recalculations on 47 fractions
- PTV and CTV V100 and D95 evaluated for planning CBCT and CTV V100 and D95 evaluated for all remaining CBCTs

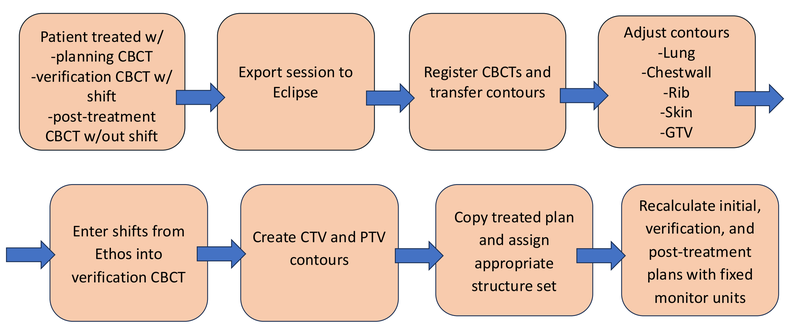
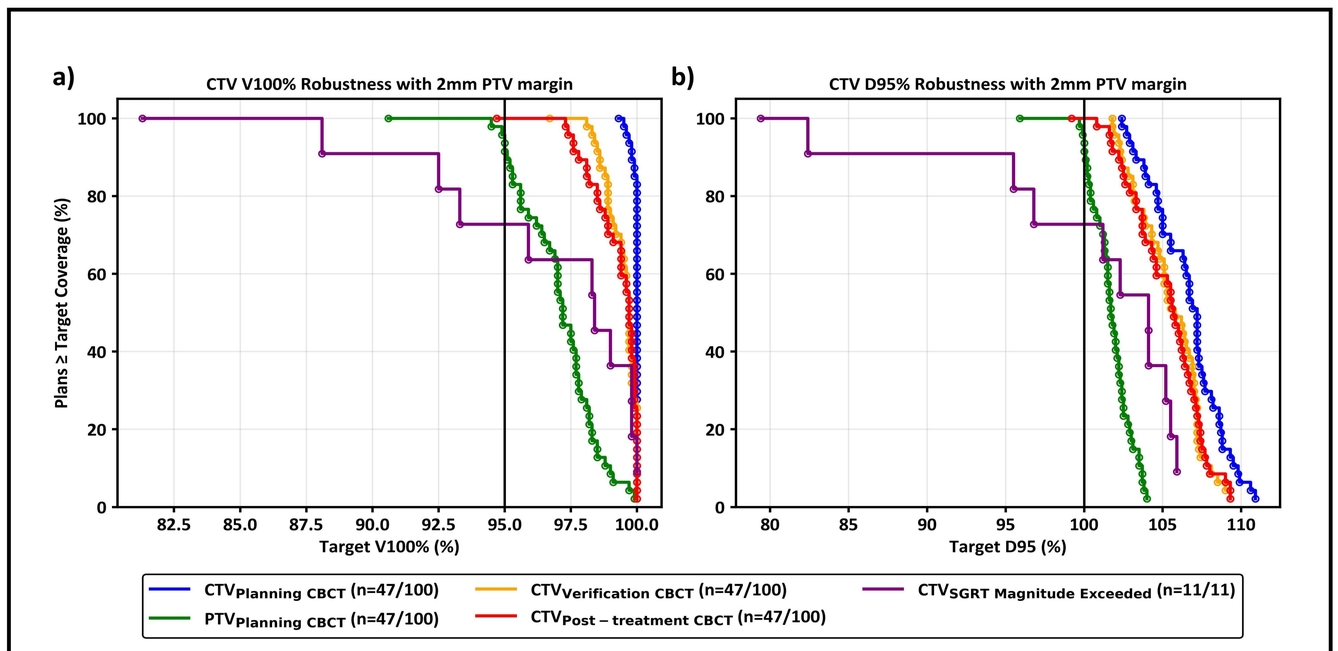


Figure 1. Shows study workflow. Transferred contours (lung, chest wall, ribs, and skin) were edited on the verification and post-treatment CBCTs and combined into a single structure (L+CW+R+S). The CTV was generated by expanding the GTV by 10 mm and subtracting L+CW+R+S, and the PTV was created by a 2 mm expansion with skin excluded. For accurate dose recalculation, pre-treatment shifts were applied to the verification CBCT isocenter prior to recalculation, while post-treatment and SGRT-triggered CBCTs were evaluated without shifts.

RESULTS

Figure 2. CTV V100% (left) and D95% (right) robustness when using a 2mm PTV margin for verification and post-treatment CBCTs, and CBCTs after the SGRT threshold was exceeded. Y-axes illustrate the percentage of plans with target coverage greater than or equal to x-axes values.



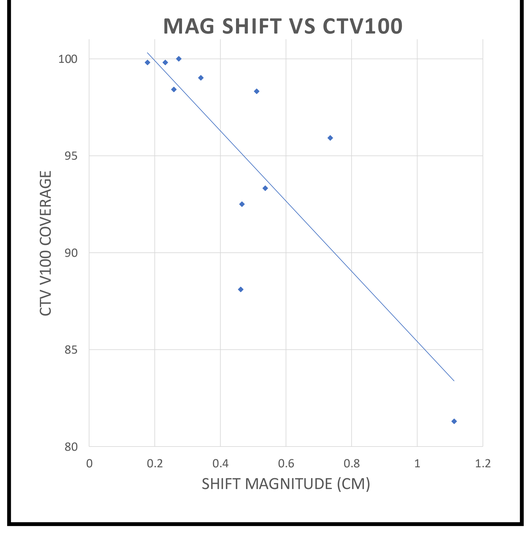


Figure 3. Shows the magnitude of the shift necessary for realignment versus drop in CTV100 coverage before shift is made. Shift of 1.11cm correlates to a coverage drop to 81.3%

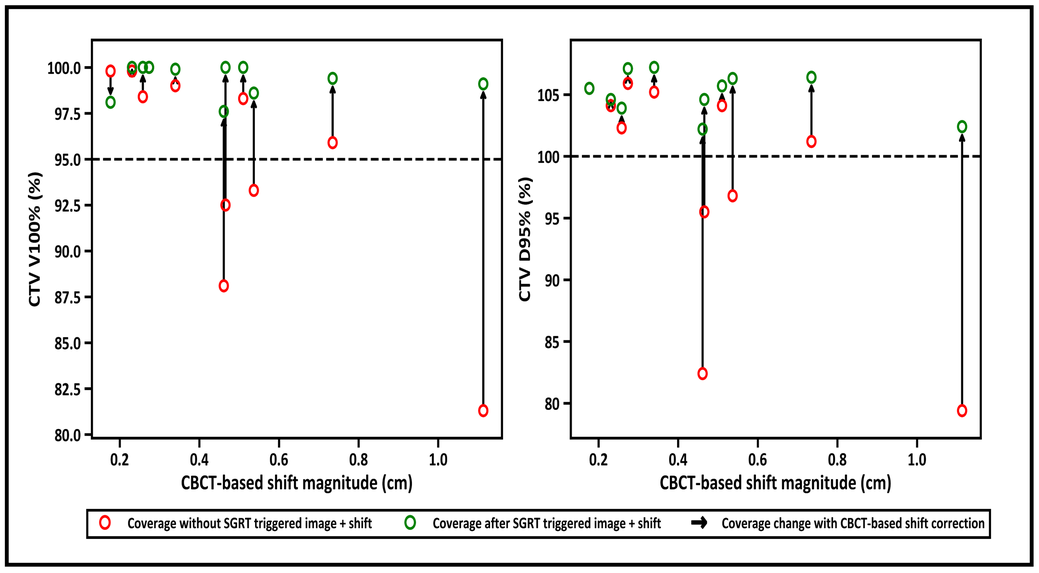


Figure 4. CTV V100% (left) and D95% (right). Shows the increase in coverage after SGRT triggered re-imaging and shift back into alignment. Coverage was increased or stayed the same in all but one instance (decrease of 1.7%), four times bringing the coverage back into acceptable values. Monitoring of patient surface completed by Identify with a re-imaging trigger of a total magnitude shift greater than 0.2cm.

DISCUSSION

CTV coverage remained robust, with the majority of fractions recording V100% > 97% and D95% > 101%. Only one fraction of 47 analyzed had reduced coverage of CTV V100 < 95% after treatment to 94.7%.

Unacceptable coverage was observed in 4 of 11 CBCTs acquired following SGRT-triggered motion events (CTV V100% < 95%). Once shift was completed, coverage returned to > 95%. Reimaging trigger of a 0.2cm total magnitude shift in Identify system was used for all patients.

Online adaptive paired with surface guided radiation therapy allows for smaller margins across many treatment sites. The results of this project show this reduction in margins can be expanded into breast APBI treatments. A reduced PTV margin of 2mm, combined with an SGRT re-imaging and re-alignment trigger of 2mm, will provide above adequate coverage of the CTV and allow patients to receive necessary dose to a tumor volume with reduced dose to uninvolved tissue.

CONCLUSIONS

These findings support the clinical feasibility of a 2 mm PTV margin for APBI delivered using CBCT-guided oART.

Additionally, the results highlight the value of SGRT for detecting intrafraction motion and prompting timely re-imaging and realignment when utilizing tight margins.

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

CONTACT INFORMATION

Courtney Stanley, DMP
Assistant Professor
UAB Medicine
Department of Radiation Oncology
P: 205.934.4368
E: cbstanley@uabmc.edu