DART-CBCT: Dose accumulation for Robust Tangents using CBCT (Focus: Evaluating Open Beam Proportion in 5-Fraction Tangential Breast)

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ABSTRACT

Hybrid tangential radiotherapy is widely used in breast cancer treatment to improve dose homogeneity while minimizing dose to surrounding organs at risk (OARs). This study evaluated the robustness of reducing the open-field contribution from 80% to 70% using CBCT-based deformable dose accumulation. A phantom study was first performed to validate the dose accumulation workflow and quantify baseline methodological uncertainty. Subsequently, twenty breast cancer patients treated with 26 Gy in 5 fractions using an 80/20 hybrid tangential technique were retrospectively analyzed. Daily CBCT images were deformably registered in RayStation to calculate accumulated delivered dose. Clinical plans were then replanned using a 70/30 beam-weighting configuration, and the same workflow was repeated. Phantom validation demonstrated minimal methodological uncertainty, supporting the accuracy of the workflow. For the standard 80% open-field plans, accumulated target dose remained within 2% of the planned dose, mean heart dose varied by only 2 cGy, and ipsilateral lung V8 remained within 2% of the planned value. The 70% open-field plans showed slightly greater target dose variability; however, these differences were clinically insignificant, with no systematic loss of target coverage or increase in OAR dose. These findings demonstrate that reducing the open-field contribution to 70% maintains treatment robustness while preserving target coverage and OAR sparing.

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INTRODUCTION

- Accurate dose delivery throughout the treatment course is essential to ensure adequate target coverage while minimizing radiation exposure to the heart and ipsilateral lung in breast radiotherapy.
- Inter-fraction anatomical changes, including variations in breast shape, patient positioning, and tissue deformation, can result in differences between the planned and delivered dose.
- Conventional treatment plan evaluation is based on the planning CT, which does not account for anatomical changes that occur during the treatment course.
- Daily CBCT imaging, combined with deformable image registration (DIR), enables patient anatomy to be tracked throughout treatment and allows estimation of the cumulative delivered dose.
- RayStation's built-in Dose Tracking module integrates CBCT images, DIR, dose recalculation, and dose accumulation to provide a patient-specific assessment of delivered dose.
- Although 80% open-field and 20% segmented-field weighting is routinely used for hybrid tangential breast treatments, the effect of reducing the open-field contribution on treatment robustness has not been well established.
- This study investigates whether increasing the segmented field contribution to 30% affects target coverage, heart dose, and ipsilateral lung dose using CBCT-based deformable dose accumulation.

METHODS AND MATERIALS

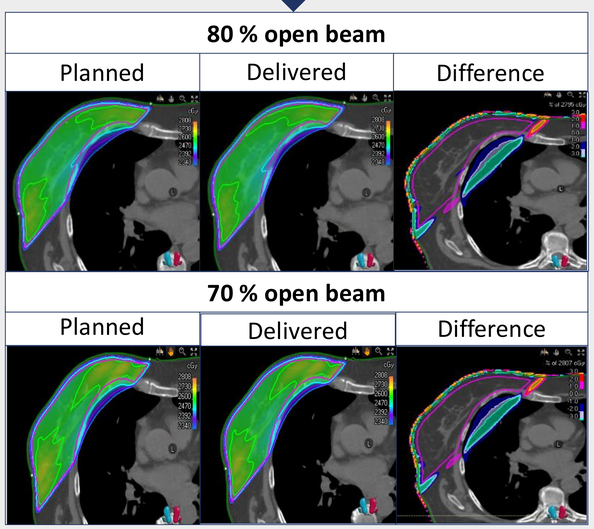
20 Clinical Plans (80 % open field) & CBCT

CBCT Dose tracking & accumulation in Raystation

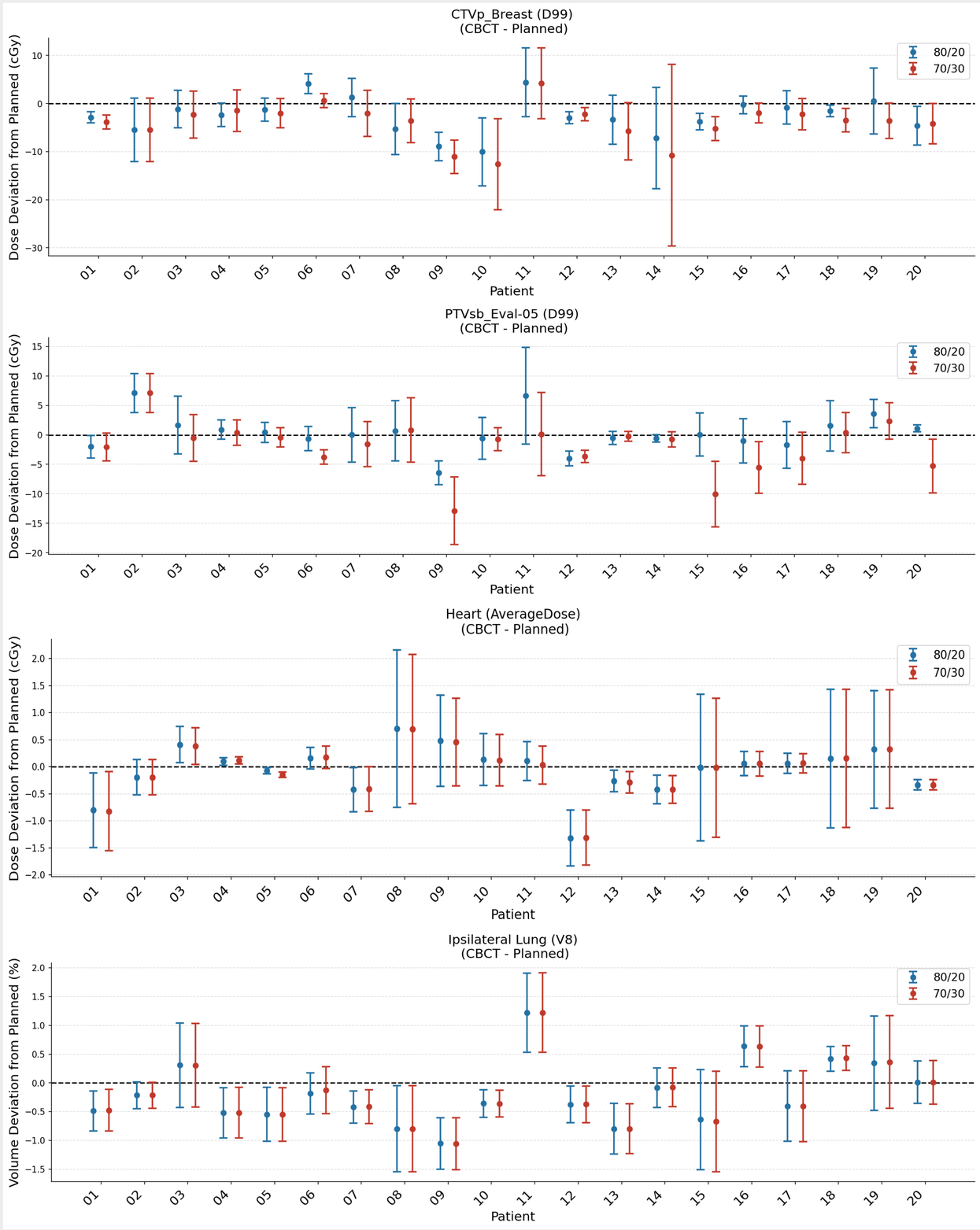
Re-plan using 70% open field

CBCT Dose tracking & accumulation in Raystation

Dose accumulation comparison



RESULTS



DISCUSSION

- Phantom validation showed minimal methodological uncertainty, supporting the accuracy of the workflow.
- **80% open beam:** accumulated dose for target coverage was within 2% of planned dose; mean heart dose showed minimal variation (2cGy); Ipsilateral lung dose (V8) remained within 2% from planned dose.
- **70% open beam:** accumulated target dose shows slightly higher variability than 80% open field; however, differences are clinically insignificant
- No systematic degradation in target coverage or increase in heart and ipsilateral lung dose was observed with the reduced open-field technique, demonstrating comparable treatment robustness.

CONCLUSIONS

- Increasing the segmented field contribution to 30% (70% open field / 30% segmented field) did not compromise treatment delivery robustness.
- The validated CBCT-based deformable dose accumulation workflow demonstrated that reduced open-field hybrid planning is feasible and robust, while maintaining target coverage and OAR sparing.
- These findings support greater planning flexibility while maintaining dosimetric quality and treatment robustness.

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