Knowledge-Based VMAT Planning for Comprehensive Irradiation of Breast/Chest Wall and Locoregional Nodes

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PURPOSE/OBJECTIVE(S)

- VMAT planning provides highly conformal dose distributions and increased delivery speed when compared to 3D techniques.
- Knowledge-based VMAT planning for comprehensive breast/chest-wall irradiation can **spare heart and ipsilateral lung while providing improved coverage to the internal mammary nodes (IMN)** without adversely affecting low dose constraints on contralateral lung.

MATERIAL & METHODS

- A **knowledge-based RapidPlan model** was constructed using **155 IMRT comprehensive breast treatment plans**.
- A standard VMAT technique was developed to spare the heart and ipsilateral lung as much as possible without sacrificing coverage to the IMN.
- The technique is compared against the RTOG 1304 Group 2-Arm2A benchmark case using standard fractionation.
- The dose distribution for 65 comprehensive breast and chestwall plans treated in our institution in 2019-2021 using a hypofractionated approach were analyzed for the following dose metrics: V95% of combined PTV, dose homogeneity index (D95%/D5%), RTOG conformity index, and adherence to the Alliance A221505 trial constraints.

RESULTS

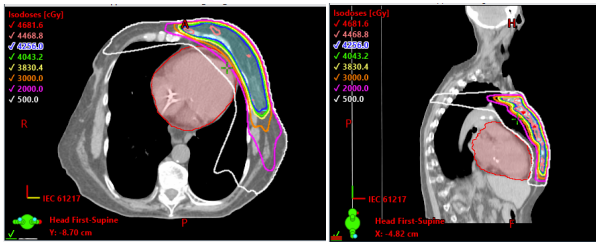

Figure 1: Example isodose lines for the VMAT technique in axial (left) and sagittal (right). VMAT allows concave isodose lines to reduce heart and lung, while maintaining good coverage of the IMN.

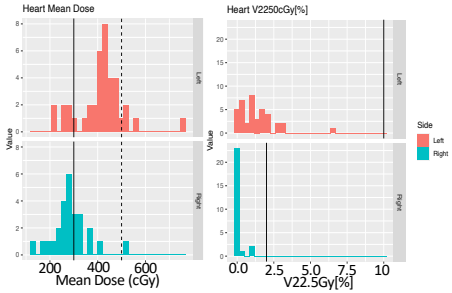

Figure 2: Distribution of mean heart dose and V22.5Gy (preferred) Alliance A221505 trial constraints for clinical VMAT Plans. Solid line represents the preferred constraint while the dashed line represents an acceptable variation. All plans met the preferred 22.5Gy constraints for both left and right sided plans.

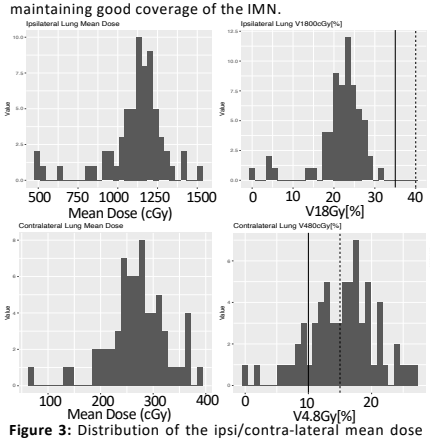

Figure 3: Distribution of the ipsi/contra-lateral mean dose and V18Gy/4.8Gy Alliance A221505 trial constraints for clinical VMAT Plans. Solid line represents preferred constraint while dashed line represents the acceptable variation.

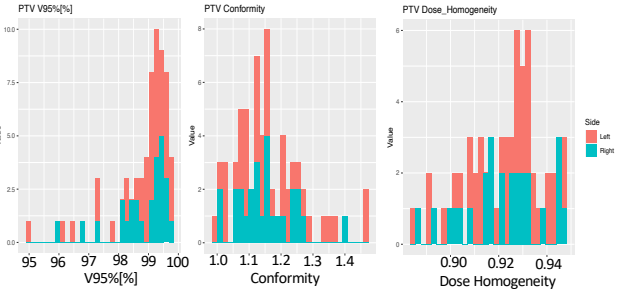

Figure 4: Distribution of Dose coverage, Conformity, and Homogeneity index for the PTV coverage. Conformity is defined as the total volume receiving at least 95% of the prescription dose/ the volume of the PTV. Dose Homogeneity is defined as the D95%/D5%.

- The VMAT plan technique was able to **successfully meet all of the RTOG 1304 Group 2-Arm2A constraints on the benchmark case** with a mean heart dose of 2.96 Gy, ipsilateral lung $V20_{Gy}$=22.7%, and $V5_{Gy}$=6.44%/8.84% for contralateral lung/breast while achieving V95% > 96.7% for all PTVs.
- The evaluation of the clinical cases showed an average: mean heart dose of **416.3 ± 102.16 cGy for LT-sided targets** and **286.1 ± 73.64 cGy for RT-sided targets**, ipsilateral lung $V18_{Gy}$ of 21.8% ± 5.77%, contralateral lung $V4.8_{Gy}$ of 15.4% ± 5.37%. Average total **PTV coverage of 95% RX was to 98.8% ± 1.01**of volume with an average conformity and dose heterogeneity of 1.2 ± 0.10 and 0.92 ± 0.02 respectively.

SUMMARY/CONCLUSION

- Knowledge-based VMAT breast planning can **consistently help reduce heart and ipsilateral lung doses** for comprehensive breast irradiation of the whole breast/chest-wall and locoregional nodes.
- VMAT allows **for highly conformal and homogeneous dose to the target** and only a minor and acceptable increase to low dose constraints to the contralateral OARs.

REFERENCES/ACKNOWLEDGEMENTS

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