

Dosimetric Evaluation and application of Non-Coplanar VMAT with Siddarth-II Superia O-ring Gantry for Improved Cardiac and Left Anterior Descending Coronary Artery Sparing in Left Breast Radiotherapy

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Background and objectives:

Standard O-ring linear accelerators have inherent geometric constraints limiting highly conformal dose distributions near critical organs-at-risk (OARs), leading to a suboptimal therapeutic ratio.

This study evaluates the dosimetric advantages of Non-Coplanar Volumetric Modulated Arc Therapy (ncVMAT) enabled by a novel O-ring gantry that permits simultaneous, multi-axis gantry and couch rotation for Left Breast Cancer patients.



Figure-1: Siddarth-II superia Linear accelerator

Materials and methods:

A comparative dosimetric analysis (N=15 cases) contrasted ncVMAT plans with coplanar VMAT (coVMAT) plans, utilizing the multi-axis geometric freedom (e.g., $\pm 20^\circ$ couch tilt) of a dedicated O-ring system.

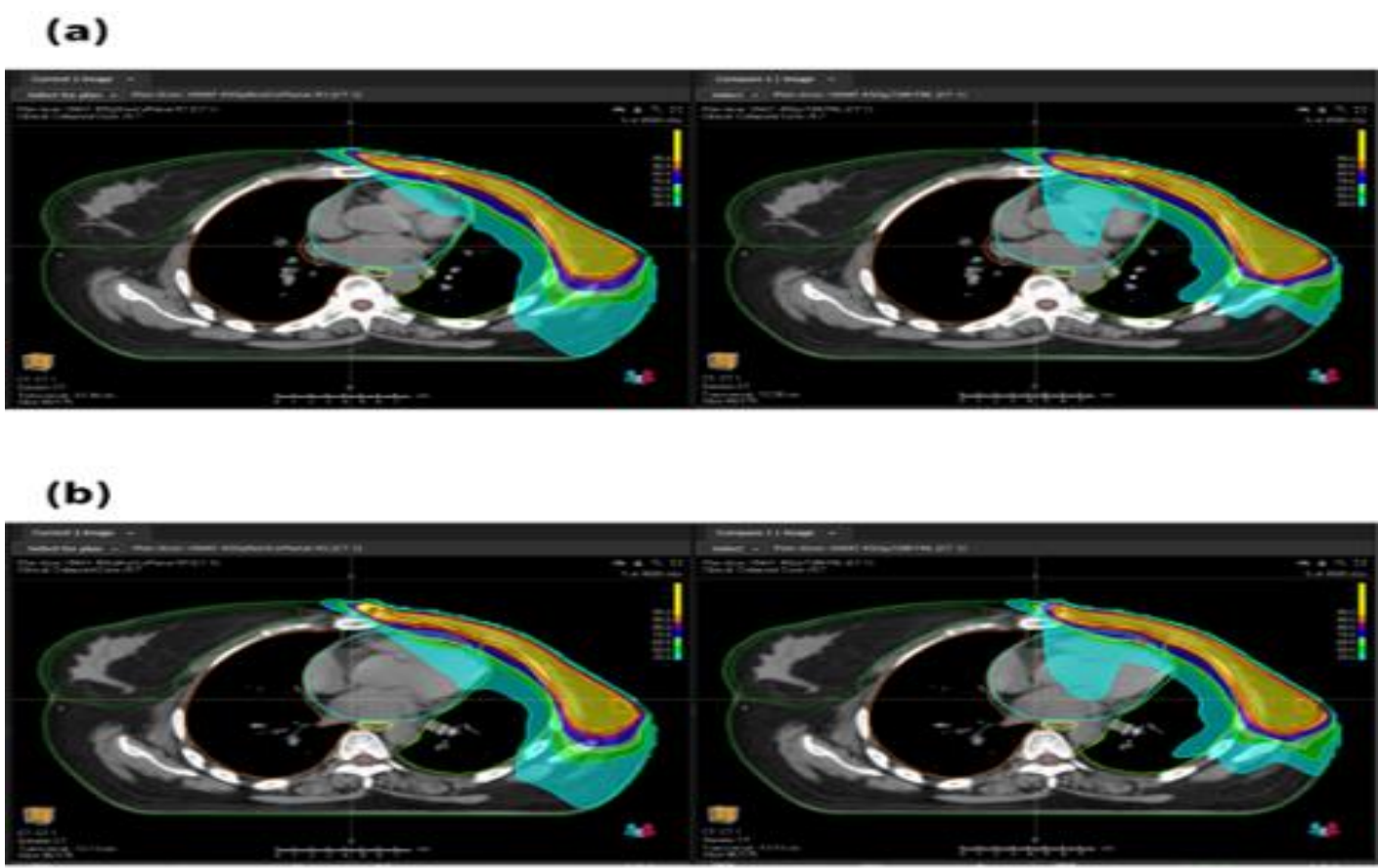


Figure-2: Comprehensive Radiotherapy Treatment Planning and Dose Distribution Visualizations.

All Planning Target Volume (PTV) optimization objectives were identical. Metrics analyzed included PTV Conformity Index (CI) and Homogeneity Index (HI), and Dose-Volume Histograms for the Heart, Left Lung, and the Anterior Descending Coronary Artery (A_LAD).

Results:

NcVMAT consistently yielded superior OAR sparing. An average 15% decrease in mean cardiac dose was achieved (coVMAT 964 cGy vs. ncVMAT 780 cGy). Crucially, the maximum dose (D2) to the A_LAD was substantially reduced (ncVMAT 3140 cGy vs. coVMAT 3470 cGy). PTV quality was maintained or improved, with CI generally ranging from 0.93–0.98 and HI from 0.90–0.92.

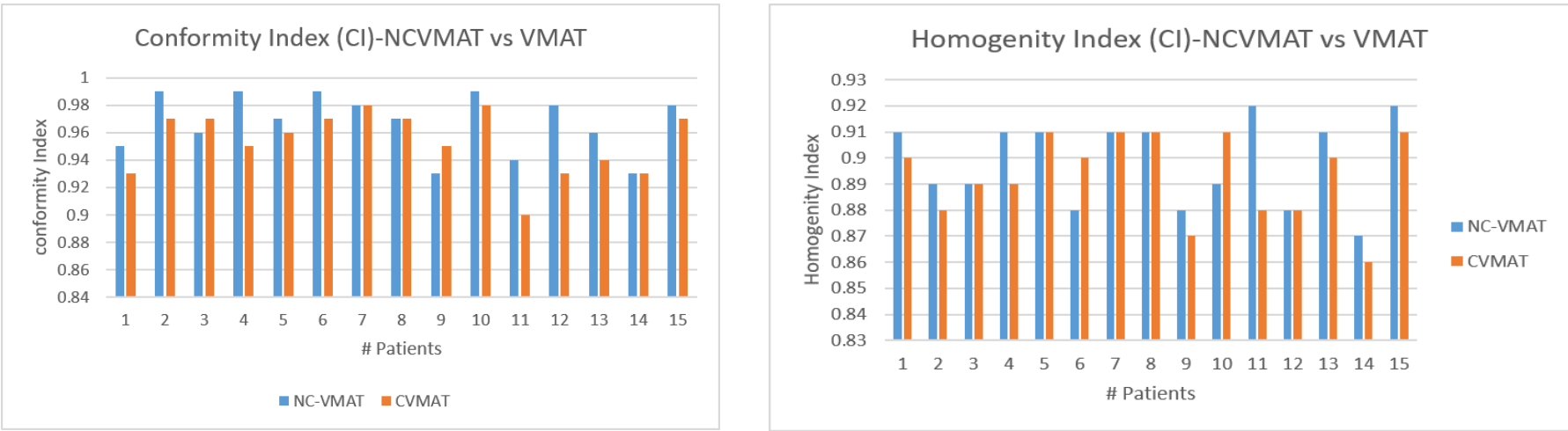


Figure-3: PTV CI and HI with CVMAT AND NCVMAT

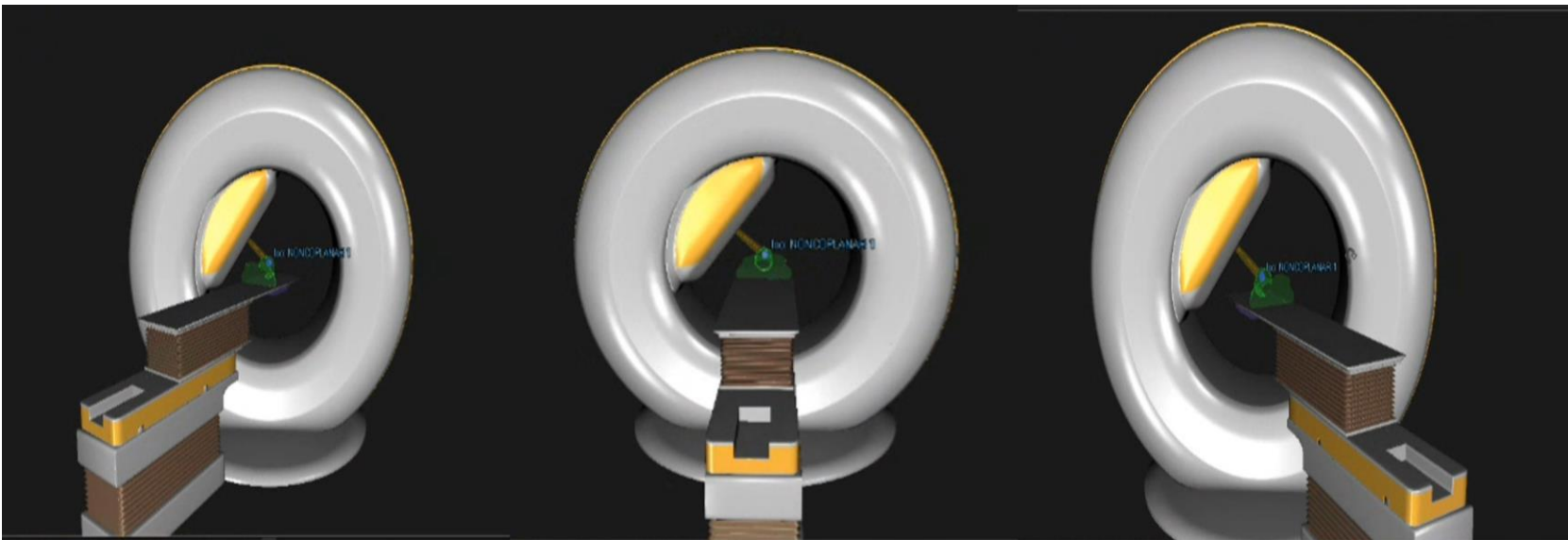


Figure-4: Table angle in O ring gantry LA (Siddarth-II Superia)

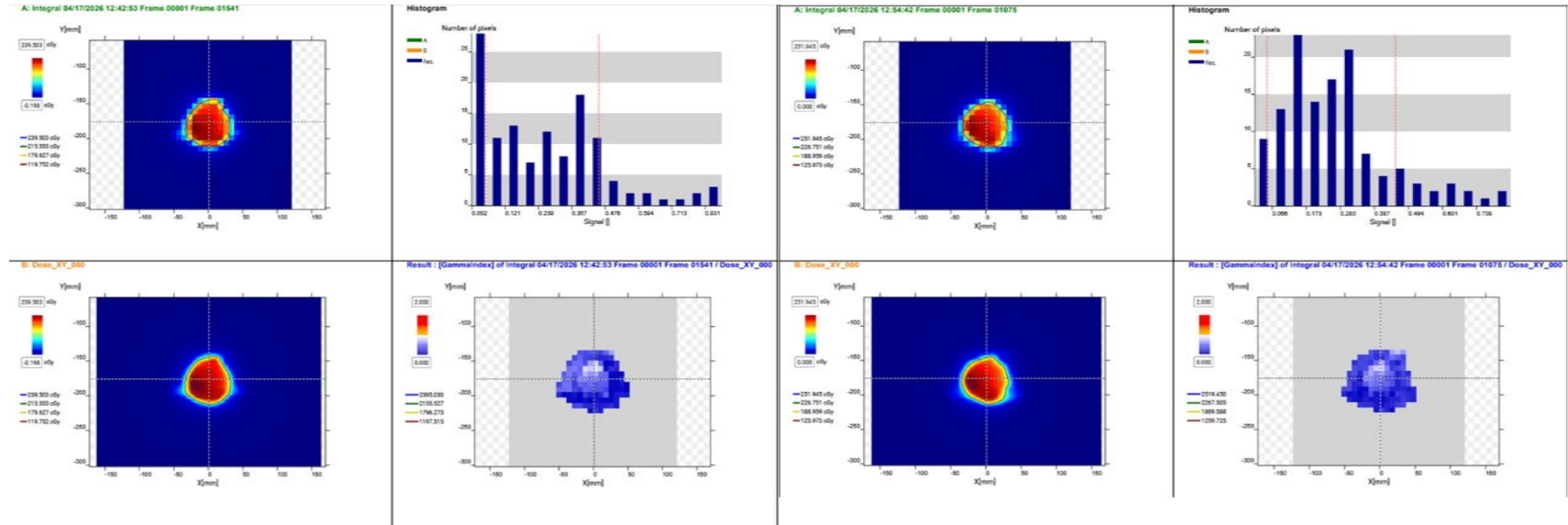


Figure-5: PSQA check in Imatrixx for CVMAT and NCVAMT.

Conclusions:

The integration of ncVMAT on a multi-axis O-ring gantry represents a major clinical advancement. This approach substantially reduces radiation dose delivered to critical OARs (Heart and A_LAD) while maintaining precise tumor coverage. This innovation holds the potential to redefine the standard of care for Left Breast Cancer, leading to improved patient outcomes and reduced morbidity.

Keywords: Non-coplanar VMAT, O-ring gantry, Left Breast Cancer, Cardiac Sparing

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