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abstract

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Recommendation for a Heart Shielding Margin in Left Breast Radiotherapy in Free Breathing Mode

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Introduction: Although Deep Inspiration Breath Hold (DIBH) is increasingly recognized as the preferred technique for left breast radiotherapy, many institutions worldwide continue to treat patients in free breathing mode due to limited access to DIBH technology. This study aimed to assess and quantify the amplitude of heart motion due to cardiac and respiratory activity during free breathing in tangential breast radiotherapy, and to evaluate the dosimetric impact of adding a safety margin to MLC heart shielding.

Methodology: Heart displacement due to respiration and cardiac motion was evaluated using cine-MR scans of the thorax in nine patients. Additionally, simulation CT scans from 20 left breast cancer patients previously treated were retrospectively replanned in free breathing mode. In the baseline plan (Plan 1), the heart was contoured and shielded by the multileaf collimator (MLC). Then, to simulate the effect of heart motion, the heart contour was shifted into the treatment field by the magnitude of the displacement measured on cine-MR images, thereby moving it outside the original MLC shielding, and the plan was recalculated (Plan 2). Subsequently, the shielding MLCs were extended to re-cover the displaced heart contour, and a replan was done (Plan 3). Dosimetric parameters for the heart and left anterior descending artery (LAD) were compared between Plans 2 and 3, with reference to DEGRO and RTOG 0617 dose constraints.

Results: The average heart displacement amplitude into the tangential fields was 6.3 mm. Incorporating this MLC shielding margin substantially reduced cardiac and LAD exposure. Across all patients, the mean heart dose decreased from 1.9 GY to 1.4 GY, the mean LAD dose from 9.1 GY to 3.6 GY, LAD V15GY from 20.9% to 1.4%, LAD V30GY from 11.3% to 0.1%, and the LAD V40GY from 5.0% to 0.0%. While the 6.3 mm MLC extension partially compromised target coverage in some cases when first implemented, planning objectives (including target coverage) remained clinically achievable by careful re-planning.

Conclusion: A planning margin of approximately 6 mm beyond the CT-defined heart contour effectively accounts for free breathing heart

motion, significantly reducing heart and LAD dose while maintaining adequate target coverage. This approach may mitigate long-term cardiac toxicity in centers where DIBH is unavailable.

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