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Heart and LAD Artery Dose Comparison for Left Sided Breast Cancer Using 4DCT

Introduction

Whole breast irradiation (WBI) for left-sided breast cancer is associated with a slightly increased risk of coronary heart disease. Research has shown that the risk of complications to the heart post-WBI increases by 4-7% for each 1 Gy in mean heart dose with no set threshold dose for post-radiation effects.

Special considerations must be made for treatment field creation for women with other risk factors for heart disease. Deep inspiration breath hold (DIBH) has been developed to reduce heart and left anterior descending (LAD) artery dose, but this technique is not available in all clinics.

A 4DCT is routine for lung and liver planning due to motion during the respiratory cycle. The heart is also a moving organ and 4DCT may be an asset for left sided breast cancer planning.

Methods

This study is a retrospective dosimetric analysis of 10 randomly selected female left sided breast cancer patients. Each patient had a 10 phase 4DCT and a reconstructed average (AVG) scan and a maximum intensity projection (MIP) scan created.

Two plans were created, one on the AVG scan and one on the FB scan. Patients were treated with 2 tangential fields using the ECOMP technique. For each plan, the block margin was created to ensure 1.5 to 2 cm of lung in the field; and to shield the FB heart for the FB plan and the AVG heart for the AVG plan. Jaw sizes were kept the same for both plans.

The MIP heart was contoured on the AVG scan using the blended fusion between the AVG and the MIP scans. The FB heart was contoured on the FB scan.

The MIP heart volume was copied over to the FB scan for dose evaluation, and any part that contained lung was given a density override. The density override value was assigned based on the average HU for the heart of each patient.

Results

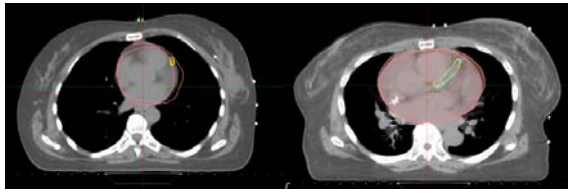


Fig. 1. MIP and FB heart volume and MIP and FB LAD artery for 2 study subjects.

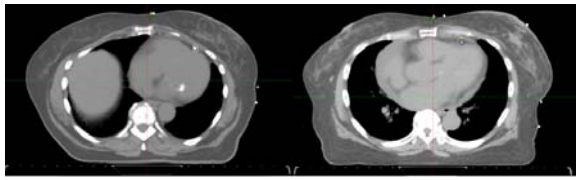
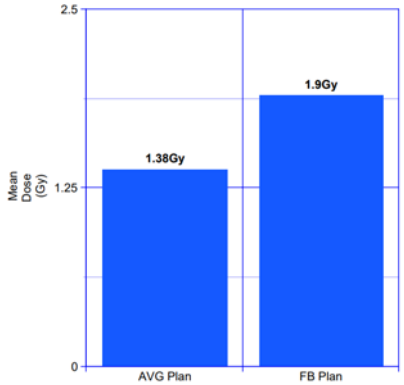


Fig 2. LAD artery delineation for 2 subjects.



Graph 1
MIP heart mean dose is significantly higher for FB plans than for AVG plans, $p = 0.004$

Conclusion

The results indicated statistically significant lower MIP heart dose on AVG plans than on FB plans. The FB heart mean dose was higher on FB plans than on AVG plans. The MIP heart volume in cc was statistically higher for the MIP heart than for the FB heart. The LAD artery mean and maximum point doses were higher on AVG plans than on FB plans. The left lung mean dose was greater on AVG plans than FB plans.

The difference between the average mean dose for the MIP heart was 0.7 Gy between plans and for the FB heart was 0.3 Gy between plans. The dose to the MIP heart volume of the treatment plan is an overestimation of what the heart is actually receiving in dose during the entire course of treatment due to the difference in displacement during the entire course of the respiratory cycle.

The LAD artery is very difficult to delineate with a standard CT scan, a 4DCT allows the LAD artery to be somewhat visible, while a CT angiogram is optimal for delineation. The dose to the LAD artery indicates that the mean and maximum dose ranges greatly in the AVG and FB plans, due to the uncertainties in the exact location and exact extent and motion of the LAD artery during respiration. Currently, there are no dose guidelines for LAD artery dose.

References

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