# Evaluation of cardiac dose after breast irradiation

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## Purpose

Standard tangential radiotherapy techniques for left breast irradiation often result in the irradiation of part of the heart, i.e. tip of the left ventricle and left anterior descending coronary artery (LAD). The importance of minimizing dose to the heart during left sided breast irradiation has become apparent over the years. Major coronary events are avoided if a mean dose of less than 3Gy is delivered to the heart. Above this 3 Gy threshold the risk of coronary disease increases linearly by 7.4% per Gy. Moreover above this 3 Gy threshold there is a 4% increase in risk of other cardiac malfunctions. Current constraints for long term cardiac morbidity state that the volume of heart receiving more than 40Gy needs to be kept lower than 5% ($V_{40}$<5%) and the volume receiving more than 20Gy be kept under 10% ($V_{20}$<10%). Treatment planning techniques used to reduce the dose to the heart during irradiation are discussed.

## Methods

A retrospective study of 100 patients(50% right breast and 50% left breast) treated at our centre, was carried out, to evaluate the mean dose to the heart (MHD). These patients were treated with two tangential fields. Angles were chosen to avoid delivering excessive dose to the OARs (lungs and heart) and at the same time not to compromise the target coverage or increase the contra-lateral breast dose.

The MHD for right sided breast patients resulted in an average value of 55.52cGy. 4% of the right breast in our sample has MHD greater than 3Gy.

After evaluating the OAR doses, a simple planning technique was used by blocking the heart with the use of MLCs (MbT) on the medial tangential field. This was applied for all patients with left sided breast cancer looked at in this retrospective study, whose CTV was at least 2cm away from the chest wall and who had a MHD ranging from 4.2-8Gy.

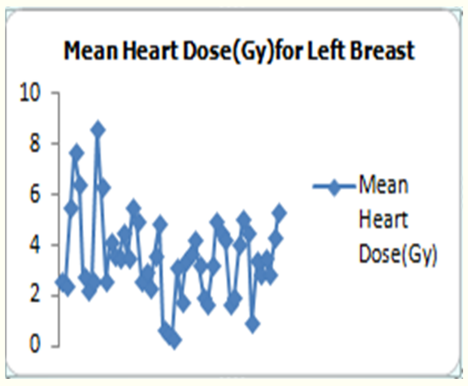
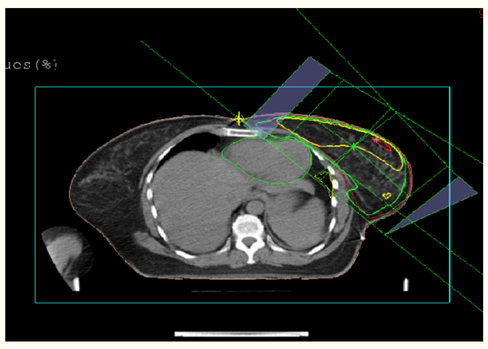



**Fig.1** Mean Heart dose for right breasts with max value of 3.55Gy.



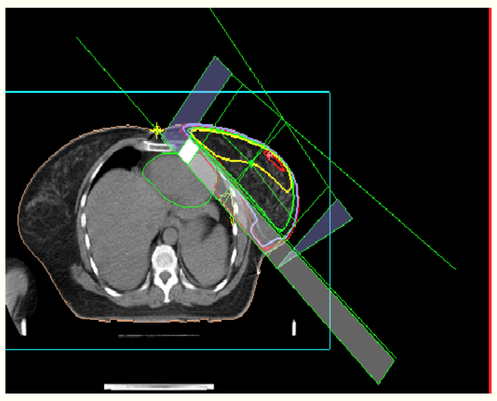


**Fig2 a,b:** Primary Treatment plan for large breast vs. treatment plan after adding Mlcs to block the heart in the medial field.

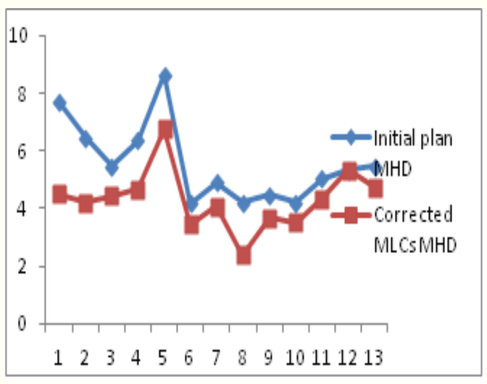



**Fig3:** MHD ranging from 4.2 - 8 Gy after applying Mlcs.

## Results -Discussion

In this retrospective study for left sided breast patients the MHD resulted in a value of 3.54Gy. 60 % of the left sided breast patients in our sample had a mean heart dose greater than 3Gy. 32% of the left sided breast sample patients violated the V40 constraint and 10% of them violated the V20 constraint.

The most accurate technique to reduce heart dose for left sided breast external beam irradiation, is the moderate deep-inspiration breath hold using an active breathing control device (Fig.4).

Prone positioning has also shown a reduction in cardiac dose although in some cases the heart may fall toward the breast (Fig. 5).

In the absence of the above the MbT method was used in this retrospective study. The dose to the heart was reduced with a maximum reduction of the MHD of 3Gy and the criteria of V20 and V40 were achieved.

**Fig4**: Patient immobilized using active breathing control device.

**Fig.5**: Patient immobilized in prone position.

## Conclusions

The necessity of minimising irradiated heart amount especially for young left sided-large breast patients and planning techniques to achieve this, were examined in this retrospective study. Although the ideal technique is using an active breathing control device for non-invasive, internal immobilization of OARs, due to lack of such a device the Mbt technique is suggested instead. This technique requires the outlining of the GTV in order to avoid blocking part of the breast that needs to be treated.

Alternatively, a Voluntary Deep Breath Hold Technique can also be implemented, providing heart dose sparing that can be applied for young patients only, after guidance and specific instructions given by the Radiotherapy Technologists in collaboration with the Medical Physics and Radiation Oncologists.