Effect of inter-fraction breast position and shape changes on breast IMRT dose distribution

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Introduction

Breast radiotherapy is planned on image data acquired pre-treatment, however the delivered distribution of radiation may vary from the plan due to changes in position and shape of the breast at the different fractions of treatment. This study uses anatomical information from repeated cone beam CT (CBCT) imaging at the point of treatment to assess the delivered dose distribution at different fractions of treatment.

Materials & Methods

Breast surface and lung contours were defined for CBCT images acquired immediately following treatment of 10 patients undergoing forward planned IMRT breast radiotherapy. Between 9 and 14 images were acquired per patient. The dose that was delivered on each day was re-calculated using the Pinnacle treatment planning system. Beam segments and monitor units were taken from the original treatment plan, and bulk density corrections were applied based on the CBCT contours for each day. Daily CTV outlines were also created using the breast surface and back edge of the beam as defined by skin markers visible in the CBCT image. This matches the way the original CTV was defined, on which the IMRT plan is based.

Dose-volume histograms for the CTV on each day of treatment were calculated for the IMRT technique. Volumes of the CTV receiving greater than 105% or less than 95% of the prescribed mean CTV dose were found for each day of treatment, and compared to the planned dose distribution.

Results

For IMRT treatments, the mean percentage volume of the CTV receiving greater than 105% of the prescribed dose (V105) was 0.5% for the original treatment plan, and 1.8% when the dose was recalculated using the CBCT contours. The mean percentage volume of the CTV receiving less than 95% of the prescribed dose (V95) was 2.7% as planned, increasing to 8.5% when recalculated using the CBCT contours.

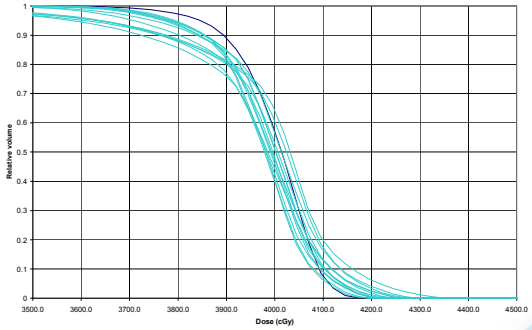

Figure 1: The CTV DVH at planning (dark blue) and on each imaged fraction (light blue) for one of the patients.

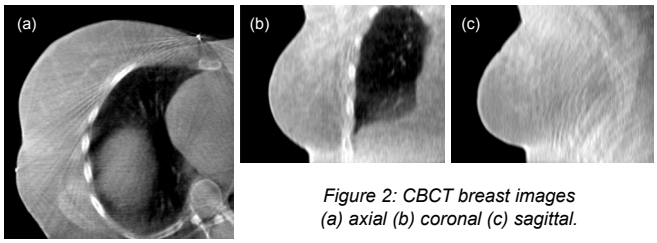

Figure 2: CBCT breast images (a) axial (b) coronal (c) sagittal.

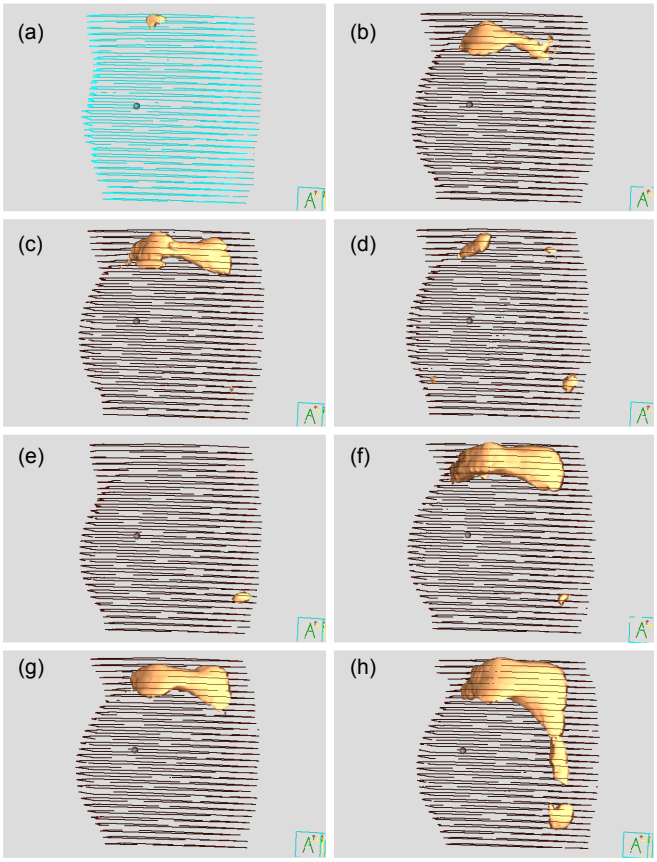

Figure 3: 3D images showing CTV (wire frame), isocentre (grey sphere) and rendered dose hotspot (> 105%) for (a) the planned dose distribution and (b-h) on each of seven days during treatment for one of the patients.

Conclusion

Daily variations in breast shape and position increased the volume of tissue within the CTV receiving less than 95% of the planned dose and, to a lesser extent, the volume receiving greater than 105% of the planned dose.

Further aims are to validate the CBCT surfaces using an optical surface sensor, and to compare the observed degradation in IMRT dose distribution to the effect on conventional tangent pair dose distributions.

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