Partial breast irradiation margins with two deep-inspiratory breath-hold techniques


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Background
Partial external beam breast irradiation (PBI) is being investigated in a number of ongoing phase III trials (IMPORT LOW, NSABP B-39, RAPID) and it is hoped that this technique will, in selected patients, reduce normal tissue doses whilst maintaining local control rates. Deep inspiratory breath-hold with the active breathing coordinator (ABC_DIBH) significantly reduces the volume of heart irradiated, and voluntary deep inspiratory breath-hold (v_DIBH) significantly reduces median heart and LAD volumes receiving >50% of the prescription dose. These dosimetric savings are projected to equate to a 10-fold reduction in cardiac deaths. Combining PBI with DIBH would be expected to reduce normal tissue doses yet further, however, data is lacking on suitable PBI margins to account for setup error and organ motion with DIBH. This study aimed to estimate appropriate CTV-PTV margins for using DIBH in combination with PBI.

Material and Methods
The UK HeartSpare Study (Stage IA) compared v_DIBH with ABC_DIBH in terms of positional reproducibility and normal tissue sparing. Patients were randomised to receive one technique for fractions 1-7 and the second technique for fractions 8-15 (40 Gy/15 fractions total). Cone-beam CT (CBCT) images were acquired for 6/15 fractions and matched to planning-CT data. Using clip-based matches, population systematic (S) and random errors (s) were estimated. By applying the margin recipe proposed by van Herk (2.5 S + 0.7 s), appropriate CTV-PTV margins were estimated for both DIBH techniques.

Results
Twenty-three patients were recruited between February and August 2012. Twenty-two patients underwent CBCTs and clip-based matches were possible in 18 (4 patients underwent mastectomy). In all, 126 CBCTs were analysed and uncorrected data was used. S for v_DIBH were 2.4 mm (right-left (R-L)), 3.6 (superior-inferior (S-I)), 3.0 mm (anterioposterior (A-P)) and s were 2.3 mm (R-L), 2.7 mm (S-I) and 2.7 mm (A-P). S for ABC_DIBH were 3.2 mm (R-L),
2.9 (S-I), 2.7 mm (A-P) and s were 2.3 mm (R-L), 3.4 mm (S-I) and 3.5 mm (A-P). Estimated CTV-PTV margins for v_DIBH were 8 mm (R-L), 11 mm (S-I) and 9 mm (A-P) and for ABC_DIBH were 10 mm (R-L), 10 mm (S-I) and 9 mm (A-P).

**Conclusions**
Using either DIBH technique, a minimum uniform CTV-PTV margin of 10 mm is suggested for PBI.