The Dosimetric Benefits of Voluntary Deep Inspiration Breath Hold, v-DIBH, Treatments for Left Breast Irradiation

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Purpose/Objectives

Adjuvant radiation therapy delivered to the whole breast using two opposed tangential beams is the standard of care for women following breast-conserving surgery for breast carcinoma. When treating the left breast, in order to deliver adequate dose to the breast tissue, portions of the cardiac structures and left lung receive sizable doses of radiation due to their proximity to the chest wall. v-DIBH treatment is a technique in which patients hold their breath on deep inspiration during beam delivery. v-DIBH can be used to reduce dose to the cardiac structures, such as the cardiac ventricles, whole heart, and left anterior descending coronary artery, by pushing the heart posteriorly and inferiorly from the chest wall, increasing distance from the radiation fields (See Figure 1-4). The purpose of this study is to determine the dosimetric benefits of v-DIBH expressed as the reduction in dose to the cardiac ventricles, heart, and left lung in comparison to the dose that would be received if the patient were to be treated utilizing standard free breathing.

Materials/Methods

14 left-sided breast cancer patients that had undergone tangent beam radiation to the whole breast using v-DIBH were retrospectively selected. Each patient had a CT simulation using a Philips Big Bore CT Simulator. Both FB and v-DIBH scans were obtained during the simulation. Clinical plans were developed on the v-DIBH scans using the Pinnacle treatment planning system. These optimized plans used for treatment with v-DIBH were transferred and registered to the FB image set. A visual inspection was performed for each case to ensure the dose distribution on the FB scan was considered clinically acceptable. The DVHs for the heart, cardiac ventricles and left lung were extracted for both breathing modalities and processed outside of the treatment planning system. Mean heart dose, the volume of the left lung receiving 20Gy (V_{20}), the mean dose to the cardiac ventricles and the volume cardiac ventricles receiving 25Gy (V_{25}) and 35Gy (V_{35}) respectively were tabulated for each modality. The samples were compared using a t-test: two-sample assuming unequal variances statistical analysis.

Results

The composite average DVHs for the cardiac ventricles, heart and left lung show significantly lower dose using v-DIBH treatment modality compared with FB. Compared with FB plans, the v-DIBH plans show a reduction of the mean dose to the cardiac ventricles of 212 cGy (207 cGy versus 419 cGy). The statistical analysis shows the following results: the mean dose to the cardiac ventricles is reduced by about 130 cGy (p=0.045), V_{25} by 2.5% (p=0.038), and V_{35} by 1.5% (p=0.048). For the heart, the mean dose was reduced by 70 cGy (p=0.049) while for the left lung the dose was reduced by 7% (p=0.032). See Table 1 and Figure 5.

Organ	*Cardiac Ventricle*	*Heart*	*Left Lung*
Mean dose FB	419 cGy	289 cGy	19.0%
Mean dose v-DIBH	207 cGy	141 cGy	15.9%
Hypothesized Mean Difference	130 cGy	70 cGy	7.0%
p-value	0.045	0.049	0.032

Table 1: Dosimetric parameter comparison using t-test analysis

Results (continued)

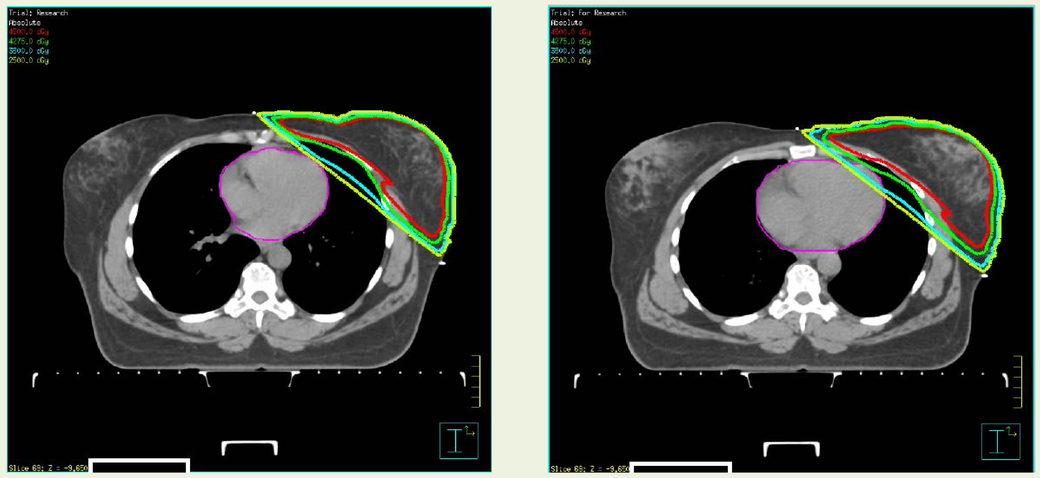

Figure 1: Heart position on the same axial slice during v-DIBH (left) vs FB (right)

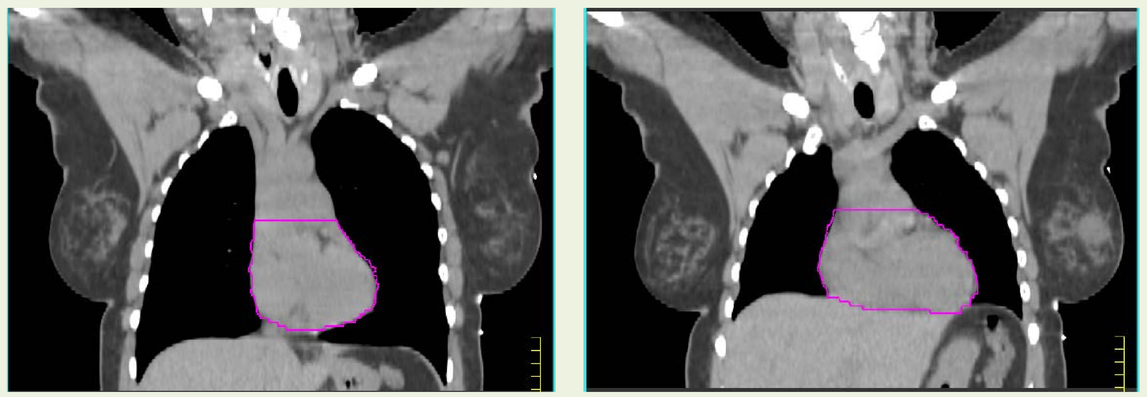

Figure 2: Heart position on same coronal slice during v-DIBH (left) vs FB (right). The v-DIBH image also shows increased lung volume vs. FB (2080 cc vs 1146 cc)

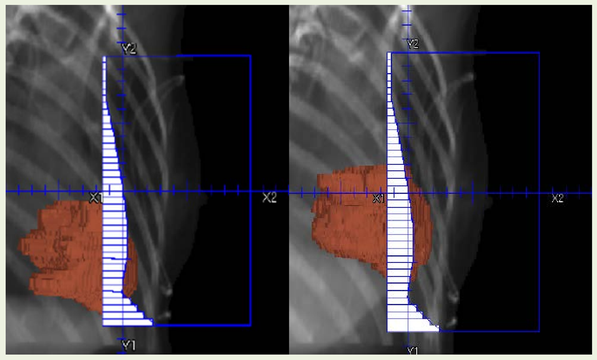

Figure 3: Cardiac ventricle position in v-DIBH (left) vs FB (right)

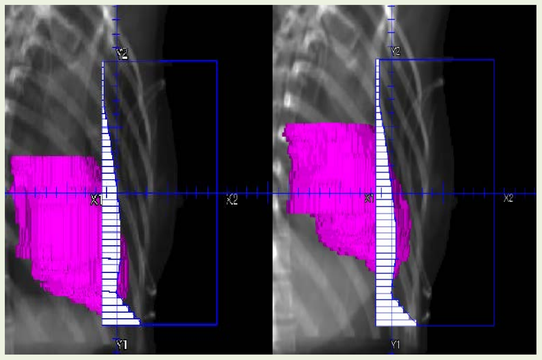

Figure 4: Heart position in v-DIBH (left) vs FB (right)

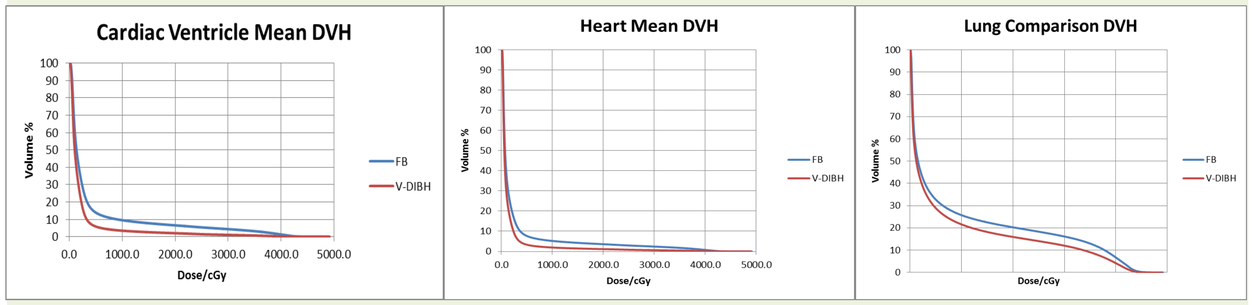

Figure 5: DVH comparison for cardiac ventricle (left), heart (center), and left lung (right)

Conclusion

By employing the v-DIBH technique a statistically significant reduction in dose has been obtained, primarily, for the cardiac structures and to some extent for the ipsilateral lung. Although, the long term clinical benefits of this technique are still under investigation and will require a long term follow up, the expectation is that lower doses will translate in a lower risk of major coronary events for this patient population.