Background and Purpose

Tangential photon beam radiotherapy is used to achieve optimal target coverage while minimizing dose to normal tissues. However, exposure to the heart and ipsilateral lung may result in late radiation-induced cardiac and pulmonary complications. Deep-inspiration breath-hold (DIBH) is a maneuver that provides increased heart distance from the target (deep inspiration) and relatively large window for target immobilization (breath hold) during the irradiation period. The key to success of this technique is to accurately correlate the target position with gating amplitude and actively monitor the target motion during the gated treatment. Here we present our clinical experience of respiratory gated DIBH technique for left breast irradiation after lumpectomy or mastectomy, incorporating AlignRT (Vision RT Ltd, London, UK) real-time 3D surface optical tracking for patient position verification prior to and during treatment.

Material and Methods

Fourteen stage I/II left-sided breast cancer patients (7 left breast and 7 left chest wall (CW)) who were treated with DIBH have been selected for retrospective study. CT scans with free breathing (FB) and DIBH were performed on each patient to determine whether DIBH was beneficial. Patients received 50-50.4 Gy to the whole breast or CW in 25-28 fractions with matched field to supraclavicular nodal region (breast n=0; CW n=5) and boost to the lumpectomy cavity (breast n=4; CW n=7). Treatment Plans were generated using DIBH CTs. For dosimetric comparison, two more plans were generated for each patient: a verification plan on the FB CT using DIBH plan fields and a new plan on the FB CT as if treated with FB CT. On top of the weekly gated 2D pair-imaging verification (gold standard), three advanced techniques were cross-verified for precise delivery:

1) Variably Real-time Position Management (RPM) gating system -- the standard method for gating the beam (Gate window: +/- 2.5mm).
2) The AlignRT system employs stereo vision technology by viewing an object through two cameras from different perspectives and derive 3D surface information of an object through computer vision algorithm. This system is used for positioning prior to treatment and real-time target monitoring (Threshold: +/- 3mm).
3) Daily integrated Mega-voltage Cine imaging acquired for field-by-field treatment verification (field edge to chest wall can be measured and compared, threshold +/- 3mm).

Conclusion

DIBH can significantly benefit left breast and chest wall patients by increasing the CW excursion thus separating the heart from radiation fields. With three daily verification methods, target motion can be closely monitored, so that DIBH can be accurately gated and delivered.

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**Figure 1**

Anatomy and isodose comparisons for left breast (left column) and CW treatments (right column) (first row: FB CTs; second row: DIBH CTs). DIBH should be considered if the increased CW excursion is larger than 1cm.

**Figure 2**

Shows the dose and target correlation index comparisons on DIBH plans, verification plan on the FB CT and FB plans. Dashed lines on the left panel show the average of max heart doses. DIBH significantly lower the max heart doses from 32.2Gy (FB) to 9.9Gy. However, if patients were not treated as planned, it will cause increased heart doses (18.9Gy) and decreased coverage.