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Clinical validation of ExacTrac Dynamic DIBH for left-sided breast patients: a comparison with gated CBCT

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Purpose

Left-sided breast cancer patients often receive deep inspiration breath-hold (DIBH) radiotherapy (RT) to reduce the relative risk of heart disease mortality. The purpose of this study is to validate the ExacTrac DIBH (Brainlab, Munchen, Germany) workflow (surface-guided RT (SGRT) combined with image-guided RT (IGRT) against our reference, gated CBCT, and to analyze intra-breath-hold stability and reproducibility in clinical practice.

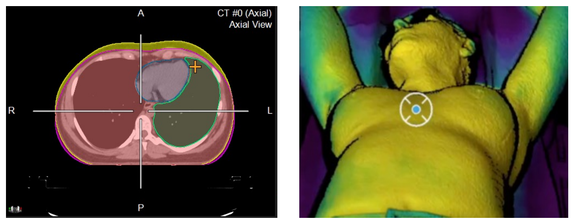

Fig 1. Example of FB and DIBH contours used for breath hold amplitude (left) and respiratory point for breathing pattern (right).

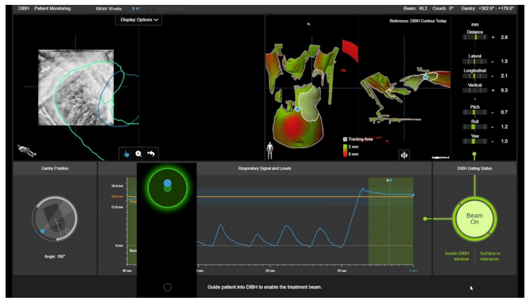

Fig 2. Patient treatment with surface and x-ray monitoring.

Materials and Methods

20 left-sided breast cancer patients treated with 40 Gy with a simultaneous integrated boost of 48 Gy in 15 fractions were included. Both a free-breathing (FB) and DIBH CT simulation were acquired, and appropriate skin was delineated to quantify the rise of the surface due to DIBH (Fig 1). Automated gating control (beam on/off) was performed using an audio-visual patient feedback system. Once the patient is within the DIBH gate, stereoscopic X-rays are taken for positioning. This workflow was compared to our standard: RGSC (Varian, CA, USA) in combination with a gated CBCT. Patients were positioned and gated for 7 consecutive fractions with our standard CBCT workflow and residual setup errors with stereoscopic X-rays were measured. For another 7 consecutive fractions, the new ExacTrac Dynamic workflow was used and residual setup was analyzed with gated CBCT (Fig 2). Intra-breath-hold stability and reproducibility across all fractions of the entire treatment course were analyzed per patient.

Results

The mean and standard deviation of residual setup errors after gated CBCT, verified with stereoscopic x-rays were 0.2(0.2) mm, 0.2(0.3) mm, and 0.3(0.4) mm for vertical, longitudinal, and lateral directions, respectively, and 0.6(0.8)°, 1.2(1.4)° and 1.1(1.4)°, respectively, for yaw, pitch, and roll (Fig 3). The mean residual setup errors of stereoscopic x-rays was analyzed based on gated CBCT, 0.3(0.4) mm, 0.4(0.4) mm, and 0.3(0.4) mm for vertical, longitudinal, and lateral directions, respectively, and 0.8(1.0)°, 1.1(1.5)° and 1.3(1.6)°, respectively, for yaw, pitch, and roll (Fig 3). Average intra-breath-hold stability was 1.1(0.7) mm and 2.3(1.3) mm for ExacTrac and RGSC, respectively (Fig 4).

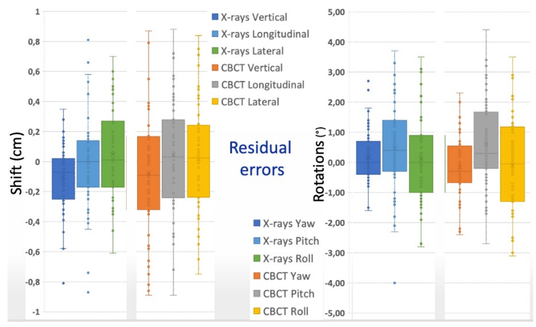

Fig 3. Residual setup errors after gated CBCT and stereoscopic x-rays, in terms of shifts and rotations.

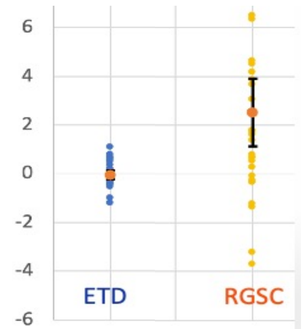

Fig 4. Average upstroke for ETD and RGSC

Conclusion

- Stereoscopic X-rays are equally accurate as gated CBCT positioning for left-sided breast DIBH.
- X-ray imaging offers the possibility of evaluating the intra-DIBH stability to control the thoracic wall during irradiation.
- ExacTrac Dynamic enables a stable and reliable DIBH treatment delivery in clinical routine, as upstroke of simulation DIBH is considered and used for guidance.
- It also adds surveillance and confidence of intrafraction motion based on surface, and internal anatomy based on x-ray triggering