Comparison of Setup Accuracy of a Surface Imaging System and kV Images vs. CBCT in Radiotherapy for the Left Breast with DIBH

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AIM

To compare the setup accuracy of a surface imaging system (AlignRT) and orthogonal kV Images (standard of practice) vs. CBCT (ground truth) in radiotherapy for left breast with deep inspiration breath hold (DIBH).

METHODS

Ten left breast patients treated with volumetric modulated arc therapy (VMAT) were studied retrospectively. Weekly AlignRT surface images, CBCT, and orthogonal kV images were acquired in DIBH, resulting in a total of 50 sessions/sets of images. AlignRT image was registered to planning CT by matching a breast ROI on patient's surface, kV images were registered to planning DRRs and CBCT to planning CT by matching bony anatomy (chestwall and sternum). The registration provided couch shifts for each imaging modality. Using CBCT as the ground truth, the differences in the resulting couch shifts between AlignRT and kV images were compared. A second AlignRT image was acquired during last beam delivery to evaluate intrafraction motion.

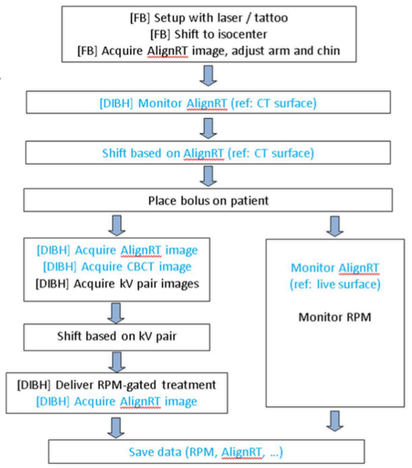

Fig 1 Flow chart.

Translational differences

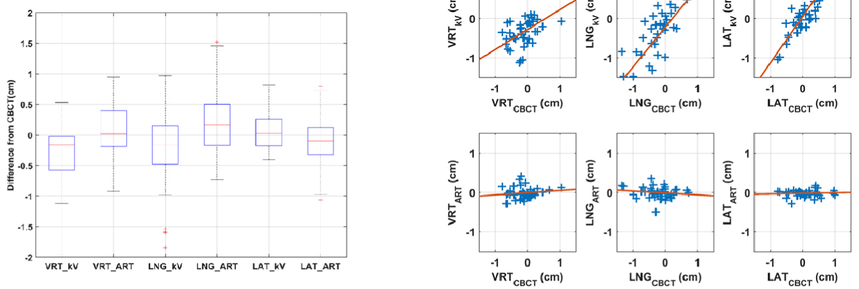

Fig 1. Box plots and scatter plots for the differences between the translational part of couch shifts calculated by AlignRT and CBCT, and kV and CBCT.

Rotational differences

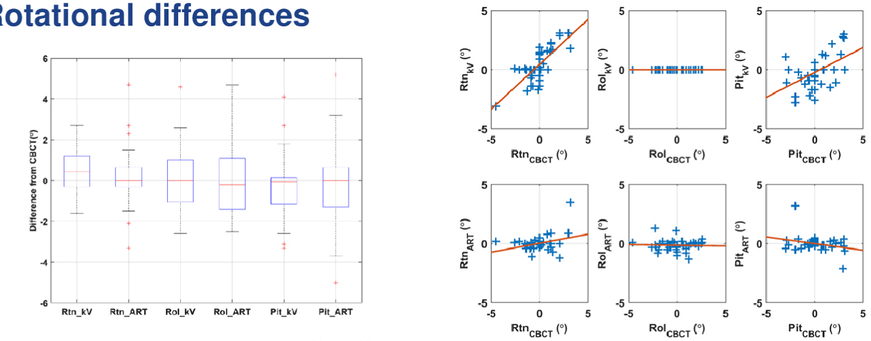

Fig 2. Box plots and scatter plots for the differences between the rotational part of couch shifts calculated by AlignRT and CBCT, and kV and CBCT.

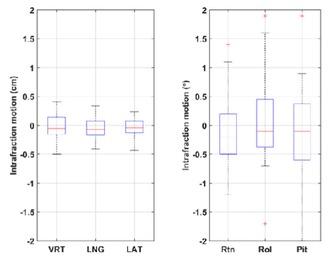

Fig 3. Box plots for the intrafraction motion in DIBH monitored by AlignRT.

Fig 4. CBCT detected a drastic shrinkage (2.0 cm) of breast tissue in an aggressive breast cancer treated with definitive RT. kV and AlignRT did not detect this.

RESULTS

Both AlignRT and kV images achieved clinical acceptable accuracy in most patients, with absolute mean difference in translations <0.5 cm and rotations <2.0° from CBCT. However, large differences greater than 1.0 cm (3 sessions) and 4.0° (3 session) were observed, reflecting poor correlation between surface position and internal anatomy position. The mean absolute translational differences in (VRT, LNG, LAT) from CBCT were (0.3, 0.4, 0.3 cm) for AlignRT and (0.3, 0.5, 0.2 cm) for kV images, with p-values (0.59, 0.41, 0.02). The mean absolute rotational differences in (RTN, ROL, PIT) were (0.9°, 1.4°, 1.4°) for AlignRT and (0.9°, 1.2°, 1.1°) for kV images, with p-values (0.76, 0.07, 0.26). kV images had a systematic bias of -0.2 cm in both VRT and LNG, likely because they were acquired at the lower DIBH gating threshold. The intrafraction motion in DIBH monitored by AlignRT was small with absolute mean translations <0.2 cm, and rotations <0.7°.

DISCUSSIONS

- No correlations were observed between AlignRT and CBCT, likely due to different registrations (surface to surface for AlignRT-CT, and bone to bone for CBCT-CT).
- With RPM, images were acquired at a shallower breath level. A delay of 0.5 s for triggering imaging was adopted.
- As a surface imaging, AlignRT lacks depth information.

CONCLUSIONS

- AlignRT provided similar setup accuracy as kV images for VMAT breast DIBH radiotherapy.

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