Evaluation of SGRT-Guided Breath-Hold for Motion Control in CBCT-Guided Online Adaptive Radiotherapy

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ABSTRACT

Purpose
To evaluate whether in-bore SGRT can reliably guide breath-hold (BH) during CBCT-guided oART and to assess the impact of SGRT-guided BH on workflow time for breast and abdominal lymphoma treatments.

Methods
Ten breast and ten abdominal lymphoma patients were treated using BH with in-bore SGRT on Ethos. CBCT-based shifts were analyzed across 49 breast and 65 lymphoma fractions. Workflow times were compared with matched free-breathing cohorts.

Results
Mean mid-treatment shifts remained below 1 mm in all directions for both sites. Pre-treatment shifts were larger and corrected before treatment. BH produced modest workflow time changes compared with free-breathing treatments.

Conclusion
In-bore SGRT-guided BH demonstrated stable intrafraction motion with limited impact on overall workflow time.

INTRODUCTION

BH motion management: Breath-hold (BH) is routinely used for selected breast and abdominal patients to manage respiratory motion.

oART challenge: CBCT-guided oART requires longer on-couch time than conventional IGRT due to online adaptation, making reliable and efficient BH monitoring important.

In-bore SGRT: For the Ethos ring-gantry platform, AlignRT In-Bore SGRT enables BH monitoring during CBCT acquisition and treatment delivery.

Objective: This study evaluated BH consistency and impact on workflow time for breast and abdominal lymphoma patients treated with in-bore SGRT-guided oART.

METHODS AND MATERIALS

Cohort/fractions: Ten whole-breast and ten abdominal lymphoma patients were treated with BH using AlignRT In-Bore SGRT on Ethos. A total of 49 breast and 65 lymphoma fractions were analyzed.

Motion assessment: Pre-treatment and mid-treatment verification CBCT shifts were referenced to the planning CBCT and recorded in LR, AP, and SI directions.

BH monitoring: A 3-mm SGRT action threshold was used during CBCT acquisition and treatment delivery, with manual beam hold when needed.

Workflow comparison: Workflow times were compared with matched free-breathing (FB) cohorts consisting of 50 breast and 53 lymphoma fractions.

RESULTS

Motion stability: For breast treatments, mean mid-treatment shifts were 0.77 ± 1.01 mm (LR), 0.91 ± 0.95 mm (AP), and 0.89 ± 1.04 mm (SI), with a maximum shift of 5.1 mm. For abdominal lymphoma, shifts were 0.83 ± 1.10 mm (LR), 0.79 ± 1.19 mm (AP), and 0.81 ± 1.09 mm (SI), with a maximum shift of 5.7 mm.

Pre-treatment correction: Pre-treatment shifts were larger than mid-treatment shifts and were corrected before treatment delivery.

Workflow time impact: Figure 3 summarizes workflow time comparisons. Total session time remained comparable between BH and matched FB treatments despite modest changes in setup or beam delivery time.

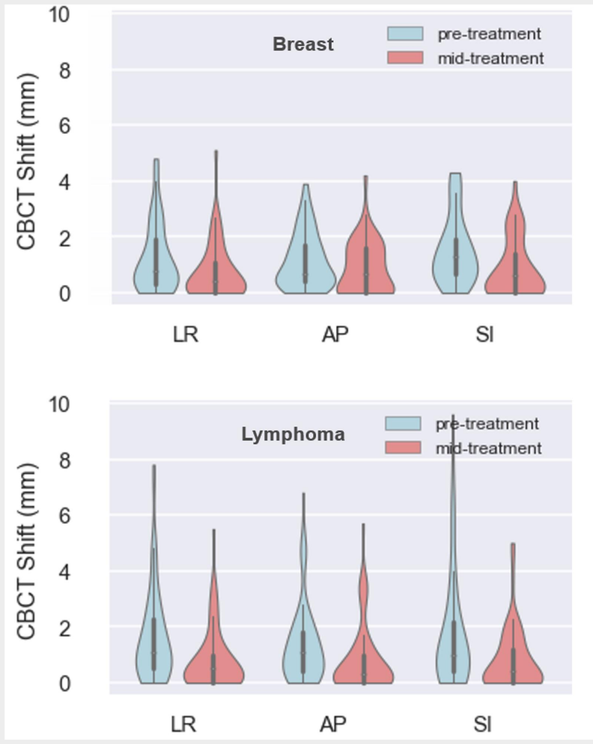

Figure 2. Pre-treatment and mid-treatment CBCT shifts during SGRT-guided BH for breast and abdominal lymphoma treatments.

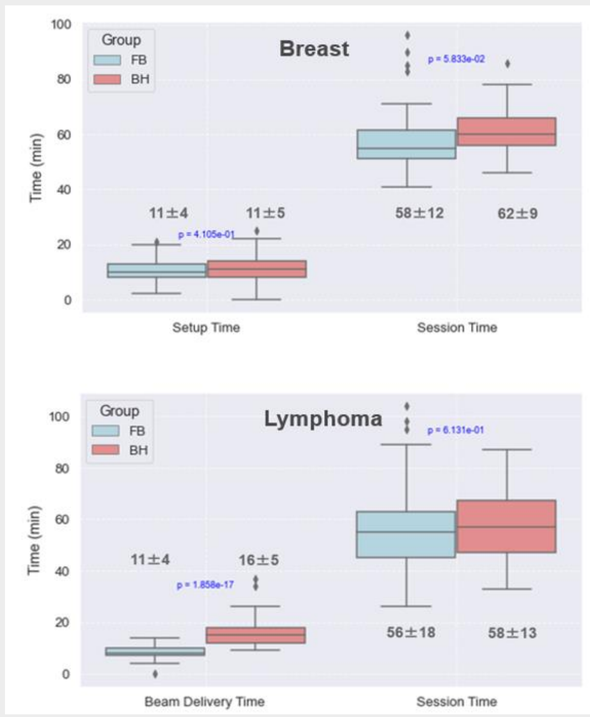

Figure 3. Workflow time comparison between BH and matched FB cohorts, including setup, beam delivery, and total session time.

DISCUSSION

Interpretation: Across both treatment sites, in-bore SGRT-guided BH maintained stable intrafraction motion during prolonged CBCT-guided oART workflows.

Clinical relevance: Pre-treatment shifts were identified by verification CBCT and corrected before delivery, while mid-treatment shifts remained small.

Workflow implication: BH introduced modest changes in measured workflow times, including setup and/or beam delivery time, but did not substantially prolong total session time.

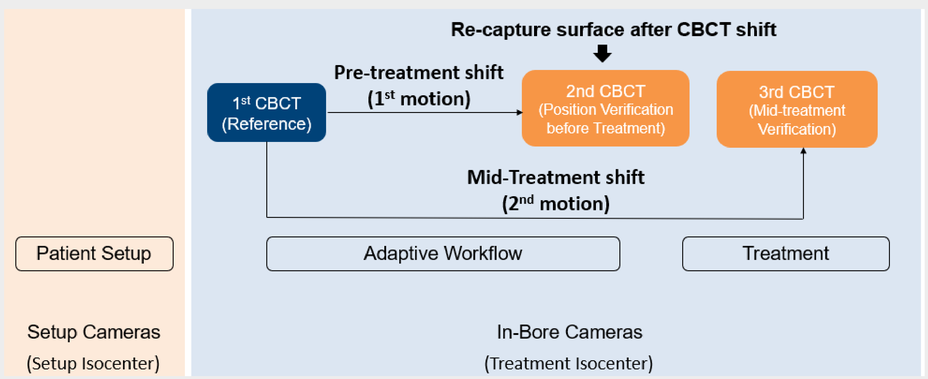

Figure 1. In-bore SGRT-guided BH workflow on Ethos.

CONCLUSIONS

- In-bore SGRT-guided BH maintained stable intrafraction motion during prolonged CBCT-guided adaptive radiotherapy.
- Total session time remained comparable for BH and matched FB treatments, despite modest changes in setup or beam delivery time.
- These findings support the feasibility of in-bore SGRT-guided BH for breast and abdominal lymphoma oART workflows.

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