



# Real-time verification and quantification of breath-hold reproducibility during treatment for liver and lung SBRT

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## INTRODUCTION

For patients treated with SBRT to the liver or lung using breath-hold techniques for motion management, breath-hold reproducibility is assessed during CT simulation through acquisition of repeated CT scans and accounted for by and ITV encompassing the range of tumor motion. There are no clinically accepted methods to verify the reproducibility of the internal anatomy for these patients during the course of treatment.

## AIM

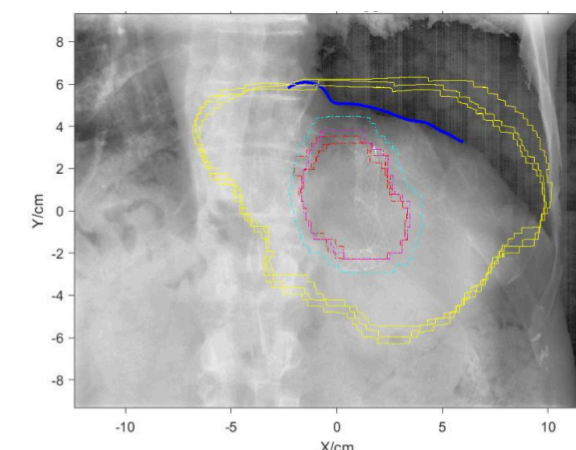
To provide a valuable tool for the radiation oncology department by providing a real-time verification of the liver dome or GTV location for each breath-hold during radiation therapy treatment delivery.

## METHOD

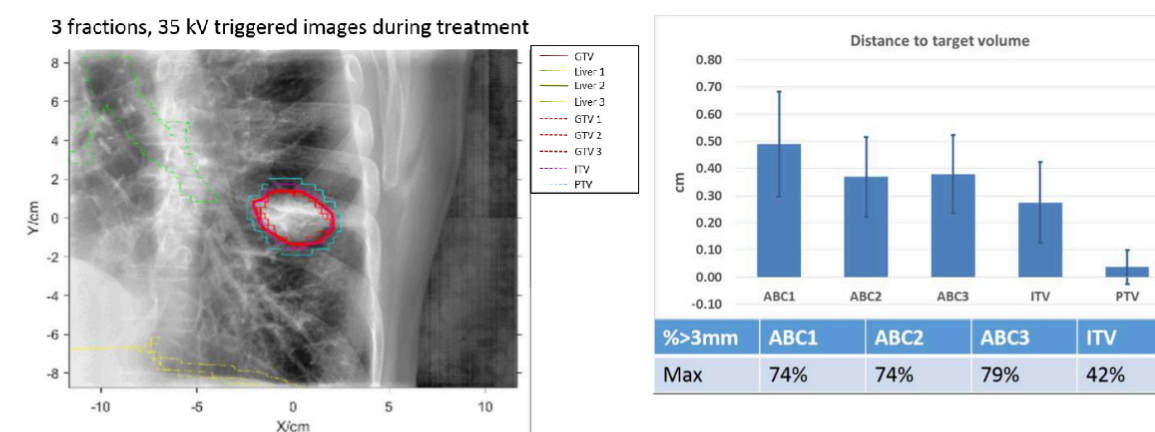
- Evaluate 8 patients treated with SBRT to the liver dome or lower lobe of the lung using the Active Breathing Coordinator (ABC) breath-hold device
- Acquire kV planar images every 60 degrees of the gantry rotation during VMAT delivery
- Treatment was triggered manually on/off based on the location of the diaphragm or GTV on the kV triggered images
- Physician drawn contours from three repeated CT simulation scans were overlaid onto the kV images and used to guide the triggering
- Post-treatment, triggered images were exported from the treatment console for further analysis
- The distance from a manually drawn contour on the triggered images to the physician drawn contours was calculated and compared to clinically acceptable positional tolerances

## RESULTS

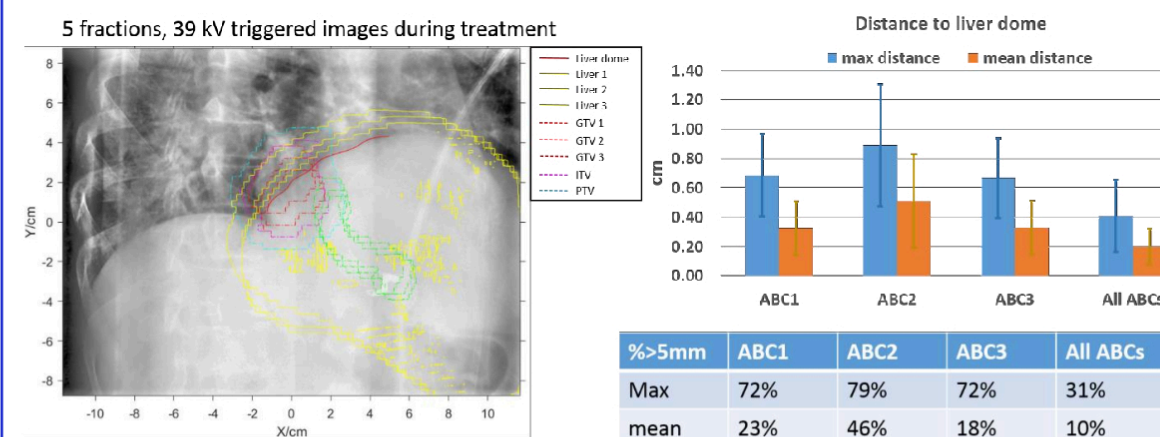
- For these patients, there were multiple instances where the beam was manually triggered off due to breath-hold irregularity, demonstrating the immediate clinical value of this technique (**Figure 1**)
- The liver dome/diaphragm was delineated on the kV planar images for liver SBRT patients and the GTV was delineated for lung SBRT patients
- For liver SBRT, the maximum and mean distance from the triggered image to the physician contour of the liver was greater than the 5 mm PTV margin value for 37% and 11% of all triggered images, respectively
- Of note, the chance that the liver dome is greater than 5 mm from the liver contour is reduced when all three liver contours are considered together in the comparison
- For lung SBRT, the GTV from the triggered images was outside of the physician drawn PTV contour for 42% of all triggered images with an average deviation outside of the PTV of 0.4 mm
- Results from one lung and one liver SBRT patient are summarized in **Figures 2 and 3**, respectively



**Figure 1:** Triggered image from a liver SBRT patient demonstrating significant breath-hold reproducibility.



**Figure 2:** Breath-hold reproducibility results from a lung SBRT patient. The percentage of triggered images where the maximum distance of the GTV from kV planar imaging is greater than 3 mm from the target volume contours is summarized in the table. These results show the improvement in breath-hold reproducibility when using three CT simulation scans.



**Figure 2:** Breath-hold reproducibility results from a liver SBRT patient. The percentage of triggered images where the maximum and mean distance of the liver dome from kV planar imaging is greater than 5 mm from the liver contours is summarized in the table. These results show the improvement in breath-hold reproducibility when using three CT simulation scans in the analysis.

## CONCLUSIONS

- The verification technique for breath-hold reproducibility presented in this work was able to identify breath-hold variations that were outside of planned margins according to the internal anatomy of the liver and lung for SBRT patients during treatment
- The practice of acquiring three repeated CT simulation scans improves the reproducibility of the diaphragm/GTV location during treatment
- Future work will increase the size of the data while improving contour definition and evaluating the dosimetric impact of the breath-hold variability in these patients

## ACKNOWLEDGEMENTS

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## CONTACT INFORMATION

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