

Impact of Respiratory Motion on the Image Quality of Fast and Slow Thoracic HyperSight CBCT: Implications for Online Adaptive Radiotherapy

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Background & Objectives

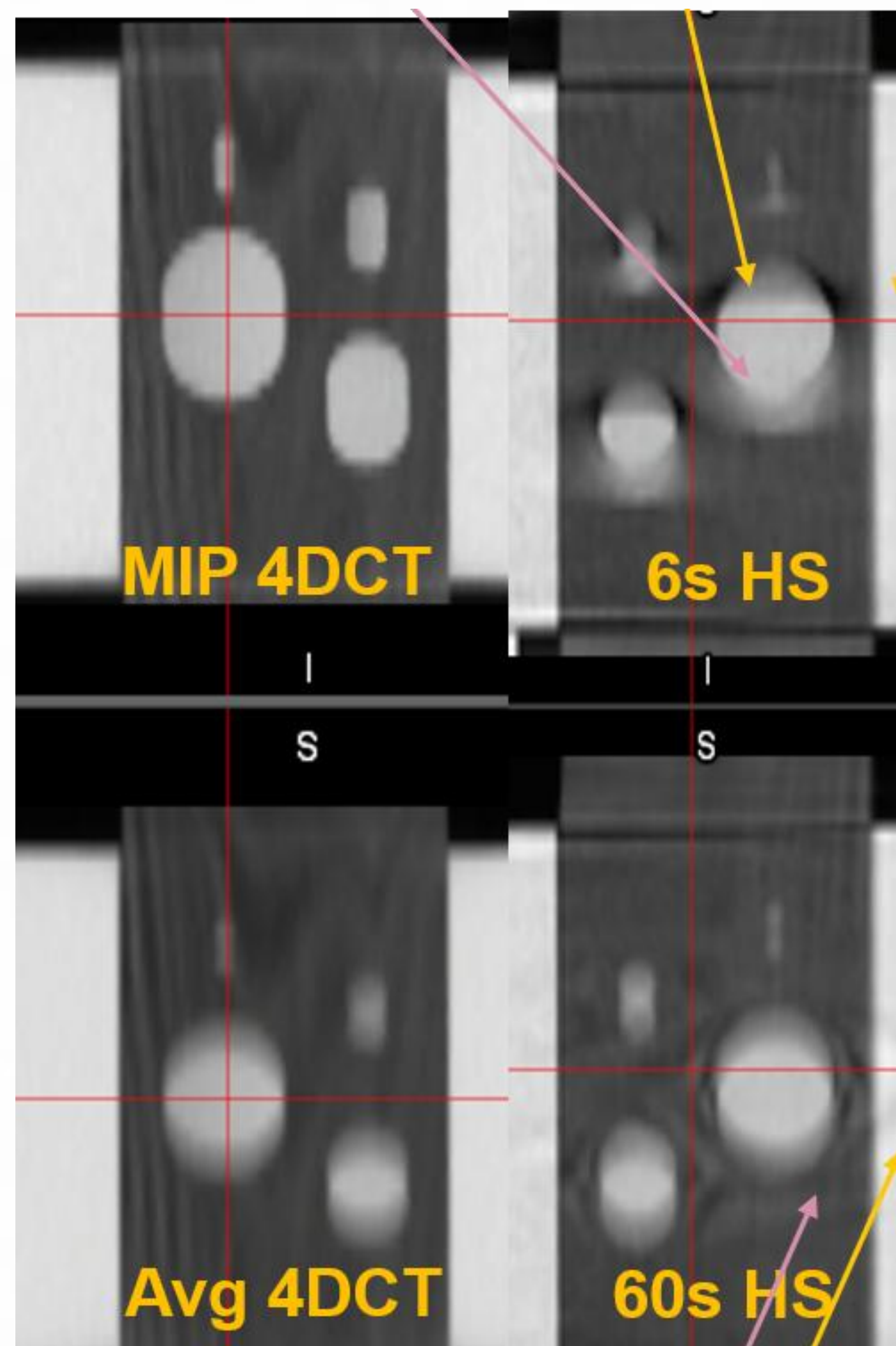
HyperSight CBCT provides improved image quality and quantitative imaging for adaptive radiotherapy, but the impact of respiratory motion on target delineation and HU accuracy remains unclear. The aims of this research are:

- Quantify ITV accuracy and HU reliability under respiratory motion.
- Compare fast (6 s) and slow (60 s) acquisition modes.
- Assess clinical reliability for target localization and quantitative imaging.

Methods

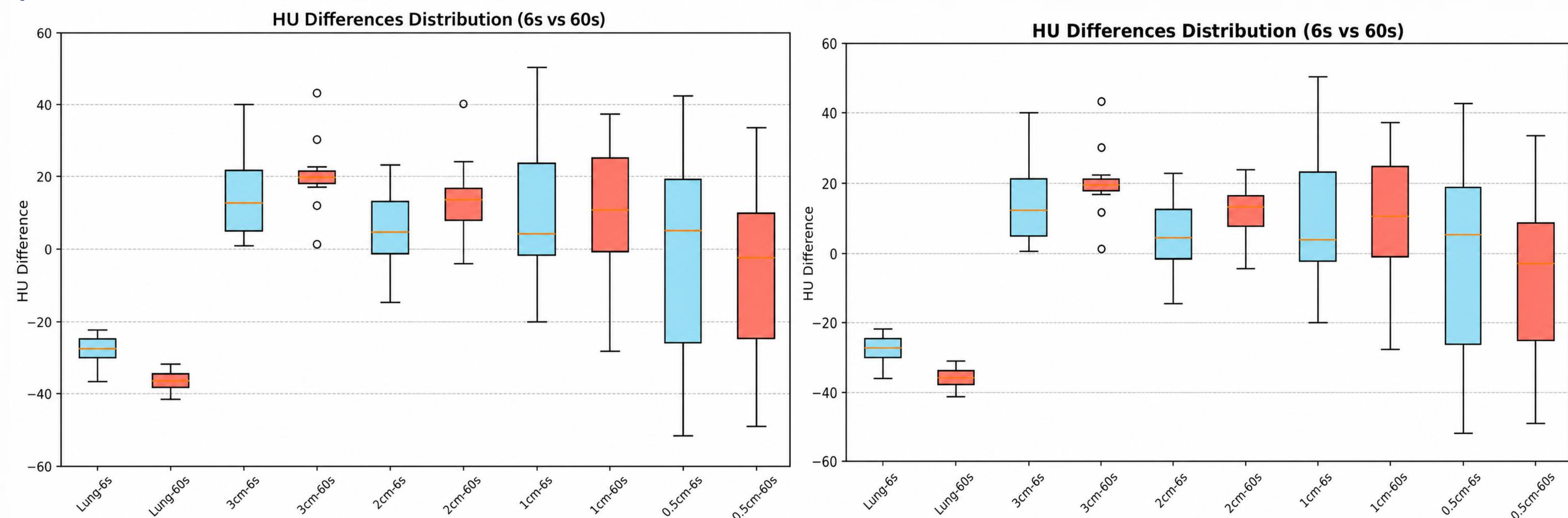
A QUASAR respiratory phantom with four spherical targets (0.5–3.0 cm) was scanned under sinusoidal motion (5–15 mm amplitudes; 3–7.5 s periods). Reference images included 4DCT MIP for ITV definition and average 4DCT for HU evaluation.

HyperSight CBCT was acquired in 6-s and 60-s thoracic modes using iCBCT Acuros reconstruction. Dice similarity coefficients and mean HU differences relative to average 4DCT were analyzed across motion conditions using paired t-tests.



Results

- Static scans showed good agreement with CT (HU within ± 15 ; Dice > 0.80).
- Motion degraded image quality, especially for small targets.
- 60 s scans improved Dice similarity but increased density bias.
- Both scan modes underestimated ITV; errors increased as target size decreased.
- Target size affected accuracy more than acquisition time.
- 6 s scans provided HU values closer to 4DCT.
- Targets ≤ 1 cm showed high variability and reduced quantitative reliability.



Region	Mean_6s	SD_6s	Mean_60s	SD_60s	p_value	Mean_HU_6s	Mean_HU_60s	p_value
Lung	-	-	-	-	-	-27.16	-35.50	0.00
3cm	0.86	0.02	0.89	0.02	0.00	14.85	20.13	0.19
2cm	0.80	0.03	0.83	0.03	0.02	4.72	13.49	0.03
1cm	0.66	0.07	0.68	0.08	0.36	10.68	10.29	0.96
0.5cm	0.42	0.16	0.51	0.10	0.02	-1.74	-7.29	0.44

Conclusion

- Further analysis is ongoing to fully validate findings.
- 6-s HyperSight provides sharper images but may miss parts of tumor motion.
- 60-s CBCT captures motion more completely but increases blurring and HU bias.
- Small targets are most susceptible to motion-related localization and dose errors.
- Motion-induced lung density changes may affect dose calculation accuracy.