Clinical utility of external and internal surrogates for respiratory motion management in pancreas SBRT

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INTRODUCTION

International consensus guidelines for management of pancreatic cancer recommend exploration of stereotactic body radiation therapy (SBRT) in a clinical trial setting[1].

Motion management is a key component for safe delivery of pancreas SBRT. Reducing treatment volumes can be enabled through use of respiratory gating in free-breathing or breath hold.

Validation of the motion management strategy using beam level imaging enables assessment of the clinical utility of external and internal surrogates.

AIM

To evaluate the geometric correlation of internal fiducial markers and patient external surface to:

- Assess the correlation of external and internal surrogates
- Explore potential role for internal-external motion models

METHOD

A pancreas SBRT clinical trial[2] prescribing 40 Gy in 5 fractions was delivered on a standard linear accelerator.

1-4 fiducial markers were inserted in or near the gross tumour. The superior-inferior (SI) position of fiducial markers were assessed on all patient imaging i.e. Cone Beam CT (CBCT) and beam-level kV imaging.

Anterior-posterior (AP) external patient surface position was measured using the Varian Real-time Position Management (RPM) system.

The external and internal surrogate motions were aligned online at the exhale phase and retrospectively compared to determine positional deviation and correlation.

RESULTS

Figure 1 and **Figure 2** below demonstrate the motion analysis performed for exhale breath hold and free-breathing gating, respectively. Fiducial centroid and RPM motion is shown during (a) CBCT and (c) intra-fraction imaging. The respective differences between fiducial centroid and RPM is shown in (b) and (d). The fiducial centroid and RPM motion correlation is shown for (e) pre-treatment CBCT and (f) intra-fraction imaging.

Amplitude differences between fiducial centroid and RPM are less than 0.3 cm, independent of total observed motion magnitude (range: 0.2 – 1.2 cm).

The maximum observed deviation between fiducial centroid and RPM during treatment was 0.15 cm.

Figure 1: Exhale breath hold

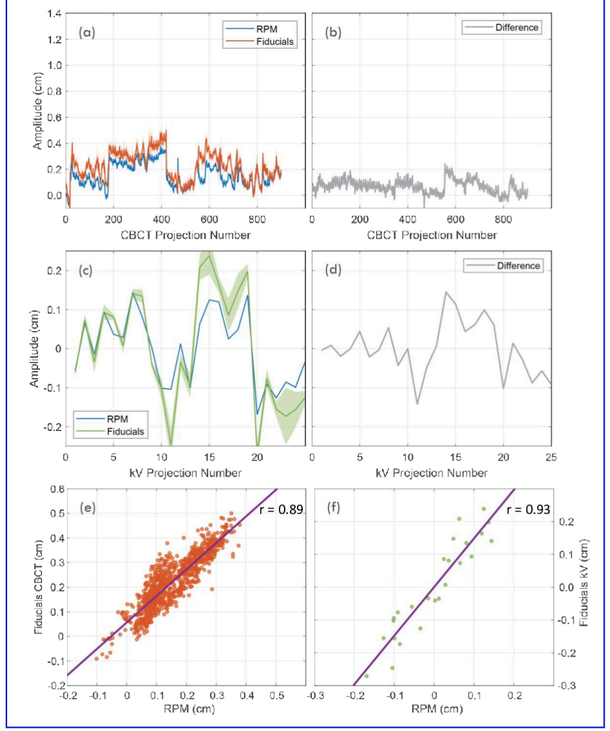
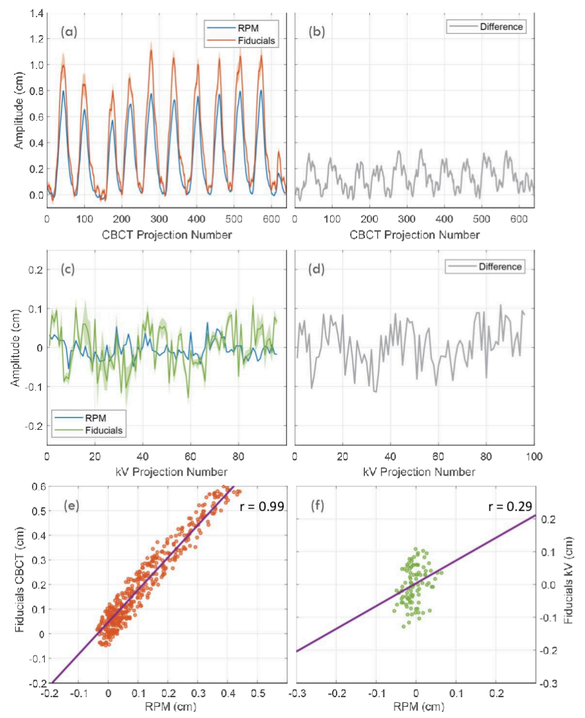


Figure 2: Free-breathing, gated at exhale



KEY FINDINGS

Fiducial motion is underestimated by the Varian RPM external motion.

Surrogate correlation can vary on the intrafraction timescale, however should be viewed in context of total motion magnitude.

Use of motion models in gated treatment pathways without an internal anatomy assessment require evaluation of surrogate uncertainty and correlation.

CONCLUSIONS

Patient specific evaluation of internal to external surrogate correlation and uncertainty can facilitate use of motion models, enabling more streamlined workflows and reduced imaging frequency and therefore dose.

FUTURE WORK

This study has recruited 13 out of 40 patients. Final outcome and generalizable findings of this work is pending full recruitment.

ACKNOWLEDGEMENTS

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REFERENCES

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2. ClinicalTrials.gov; Stereotactic Body Radiotherapy for High Risk Localized Pancreatic Cancer: a Phase II Study of the Department of Radiation Oncology Royal North Shore Hospital; NCT03505229

Available from https://www.clinicaltrials.gov/ct2/show/NCT03505229

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