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Impact of respiratory motion management with patient biofeedback on diffusion weighted imaging of liver cancer patients pre- and post-SBRT

B. LEWIS [1], S. KIM [2], and T. KIM [1]
1 Washington University in St. Louis, St. Louis, MO
2 Virginia Commonwealth University, Richmond, VA

SITEMAN CANCER CENTER
BARNES-JEWISH Hospital BJC HealthCare
Washington University in St. Louis SCHOOL OF MEDICINE

INTRODUCTION

Performing diffusion weighted imaging on abdominal organs can be extremely difficult due to respiratory motion causing anatomical mismatch of b-value images acquired over time and used to calculate ADC values on a pixel-by-pixel basis. Accurate ADC values provide valuable information clinicians on tumor function and internal anatomy that is not provided by non-functional imaging methods.

This study compares the current clinical free breathing DWI protocol to a proposed protocol which utilizes an increased number of b-value acquisitions and imaging during exhalation breath hold with an in-house respiratory motion management system with real-time patient biofeedback.

AIM

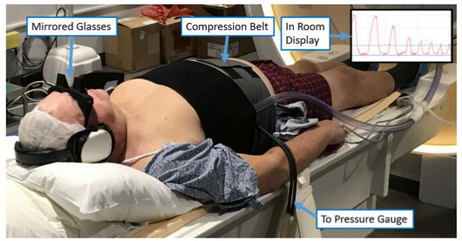
This work presents the impact of respiratory motion management (RMM) with patient biofeedback on DWI of liver SBRT cancer patients. To do this two cohorts of patients were used. The first imaged on a 1.5T MRI under free breathing, and a second imaged on a 3.0T MRI using a RMM system with patient biofeedback to acquire images under exhalation breath hold.

METHOD

Cohort without RMM:
- 8 patients imaged pre- and post-treatment
- 1.5T MRI with DWI b-values of 50, 400, and 800s/mm^2

Cohort with RMM:
- 2 patients imaged once before and twice after treatment
- 3.0T MRI with 8 DWI b-values from 0-1000s/mm^2

RMM method:
An in house RMM system utilizing a respiratory bellows and an MRI safe monitor displaying real-time breathing traces to the patient.



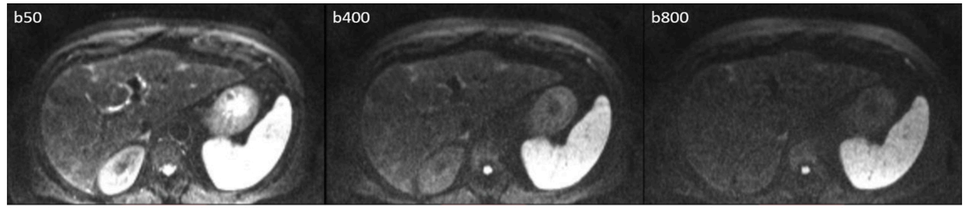
Respiratory motion management system setup on patient at 3.0T MRI with respiratory trace in upper right hand corner.

ADC calculation:
ADC values were calculated in ROIs using least squares fitting of all b-values
ROIs were drawn in the GTV, liver, and spleen of all patients, and dose regions >50Gy, 25 to 50Gy and <25Gy.

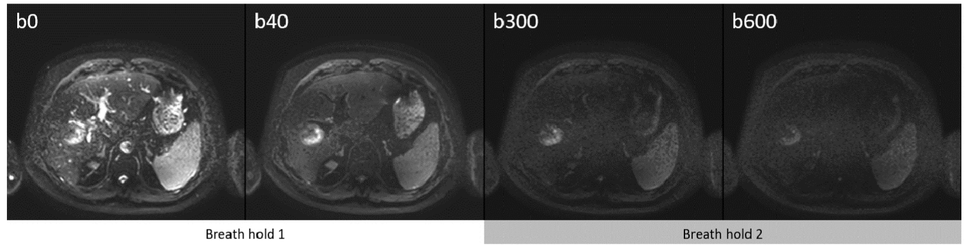
RESULTS

Liver dome superior-inferior position:

- *Without RMM the liver dome position varied by **3.1 ± 2.3 mm** between b50 and the other b-values*
- *With RMM the liver dome position varied by **1.0 ± 0.8 mm** between b0 and the other b-values*



Axial DWI images from the 1.5T scanner showing slices labeled with the same superior-inferior position across multiple b-values

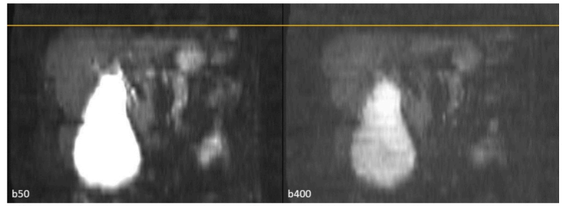


Axial DWI images from the 3.0T scanner showing slices labeled with the same superior-inferior position across two breath holds required to acquire all b-value images.

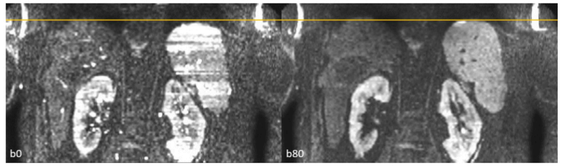
Average ADC values with standard deviation for 1.5T and 3.0T images pre- and post-treatment.

	ADC (mm^2/s)			
	GTV	Liver >50Gy	Liver <25Gy	Spleen
1.5T Pre-treat	1321.0	953.3	864.0	838.6
1.5T Post-treat (Within 1 month)	1385.0	1022.8	842.2	801.6
3.0T Pre-treat	1611.2	1396.5	1414.5	1510.0
3.0T Post-treat 1 (Within 2 weeks)	1460.7	1317.7	1468.4	1565.5
3.0T Post-treat 2 (5 Months)	1337.7	642.9	1377.0	1523.4

RESULTS



Coronal DWI images from the 1.5T scanner showing liver dome position at different b-values



Coronal DWI images from 3.0T scanner showing liver dome position at different b-values

CONCLUSIONS

Acquiring diffusion weighted images under breath hold resulted in reduced motion between b-value images.

Because of the increased number of b-values used with the proposed protocol, two breath holds were required to acquire all b-values.

Due to small patient cohorts, changes in ADC values between pre- and post- imaging can not be applied clinically.

This study demonstrates changes in ADC of the GTV and high dose liver pre- and post-SBRT with the proposed protocol but requires an expanded study for clinical significance.

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CONTACT INFORMATION

Taeho Kim, Ph.D.
taehokim@wustl.edu

Benjamin Lewis, Ph.D.
bclewis@wustl.edu