

Purpose:

Respiratory motion management is a major focus of research and ongoing clinical advancement in radiotherapy. Current methods for resolving motion, e.g. planar x-ray fluoroscopy or respiratory-correlated- (4D-) CT, fail to address variability and result in imaging dose to the patient. Meanwhile, "4D" radiotherapy methods, which optimize the target and OAR dose-volume considering breathing motion, tend to rely on a robust motion characterization for safe clinical deployment. The purpose of this SAM symposium is to explore the application of dynamic Magnetic Resonance Imaging (dMRI) to radiotherapy.

Method and Materials:

Over the past decade, dMRI imaging techniques have improved significantly. Sequences are now available on commercial systems which allow for entire 3D volumes to be captured in cine mode. At present, these direct 3D approaches require critical tradeoffs between frame rate (volumes/second) and image quality (spatial resolution and SNR). On the other hand, 2D cine approaches have been successfully employed by numerous investigators to study motion variability, evaluate tumor-surrogate correlations and derive time-resolved 3D images. A selection of published literature will be reviewed; the presenter will also highlight dMRI work ongoing at Johns Hopkins.

Results:

2D dMRI sequences presently provide frames rates of ≤ 10 frames/second which allows for sufficient image quality in the thorax and abdomen. Meanwhile, longer duration scanning (tens of minutes) allows for the characterization of breathing motion variability over timescales consistent with radiotherapy treatments without conferring unacceptable risk to patients.

Conclusion:

More work is needed to directly demonstrate the clinical advantage of "4D-MRI" over present techniques. Nevertheless, dynamic MRI is a promising modality for advancement of 4D techniques and is ripe for streamlined development for radiotherapy applications. Present barriers to large-scale deployment of "4D-MRI" include cost, a lack of accessibility and lack of clinic-ready solutions.

Learning Objectives:

1. Audience will learn about present capabilities of dynamic MRI, with a focus on published radiotherapy literature as well as ongoing work at Johns Hopkins
2. Audience will learn about proposed image processing techniques to derive "4D-MRI"
3. Audience will learn about current limitations of "4D-MRI" and barriers to deployment