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6th MR in RT Symposium 2018

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PRESENTATION TITLE

A systematic review of organ motion management techniques for CT/MRI simulation for lung and abdominal radiotherapy

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ABSTRACT

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Purpose: Radiotherapy treatment planning is often guided by images acquired with CT for its electron density and MRI for its soft-tissue contrast. Organ motion (inter- and intra-fraction) causes a reduction in accuracy in radiotherapy treatment planning due to loss of image quality or geometric uncertainty in contoured structures. In the literature different methods have been proposed to manage organ motion (either reducing or accounting for motion) when acquiring both CT/MRI images for radiotherapy. The purpose of this study was to perform a systematic literature review to explore the techniques for organ motion reduction for CT/MRI simulation for both lung and abdominal radiotherapy patients.

Materials & Methods: A systematic literature review was conducted for relevant data on organ motion management techniques for CT/MRI simulation for radiotherapy treatment of lung and abdomen patients. The review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines. Embase, Web of Science and PubMed databases were searched with the following inclusion criteria: full journal articles; publication date range 2002-2017; written in English; related to CT/MRI simulation for radiotherapy purposes. Records were screened by reading abstracts and excluded if: not used for radiotherapy purposes; used for PET purposes; or not discussing lung/abdominal patients.

Results: 138 studies were found in the initial search, 84 were removed by the screening process and 3 were removed as full text articles were not available, leaving 51 studies to be systematically analysed. The review found that organ motion management techniques can be grouped into five categories:

1. Forced shallow breathing: using abdominal compression via a compression arch or belt. It was reported that this technique is not effective for severely obese patients, especially males.

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2. Respiratory gating: treats only when the target volume is within a predefined position of the respiratory cycle. This is very comfortable for patients at the cost of increasing treatment time.
3. Motion-encompassing: allows treatments to conform the dose to encompass all possible motion of the GTV with a defined probability. This is a comfortable treatment option for the patient at the cost of increased dose and uncertainty in dose for normal tissues.
4. Breath-hold: patients imaging and treatment is acquired/delivered at a pre-determined breath-hold position that can be conducted either voluntarily or assisted. This technique can reduce motion at the cost of discomfort for the patient.
5. Respiration-synchronized: uses real-time tracking during treatment to adjust the treatment to follow the target. This involves monitoring the tumour and moving either the patient or the radiation beam in real-time.

Conclusions: A variety of motion management techniques have been applied to CT/MRI simulation of the abdominal and lung patients in the literature. Each technique has reported advantages/disadvantages and can be split into techniques that either reduce or account for the motion. The clinical development of 4D-MRI will allow some of the techniques to move from research to a clinical setting. The development of the MRI linac makes continuous real-time monitoring of motion feasible and has the potential to aid in motion management techniques discussed.