Magnetic Resonance Imaging optimization for liver SBRT: breath-triggered acquisition in treatment position to improve lesion contouring

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Résumé

Introduction

Magnetic Resonance Imaging (MRI) acquisition in treatment position was implemented in our institution for the need of stereotactic body radiotherapy (SBRT) program. During imaging acquisition, significant liver motion is usually observed due to breathing motion. The aim of this study is to report the benefits of setting out a breath-triggered MRI protocol optimized for radiotherapy (RT) planning in order to account for liver motion.

Material and methods

Prior to imaging, three internal gold fiducials were implanted under echo or CT guidance in the vicinity of the lesion site in order to improve images registration, patient's positioning and target volume tracking during SBRT treatment.

A 4D CT scan was acquired in treatment position. Images were reconstructed in six phases across the respiratory cycle with CT50 being the exhale image set used for MR image registration.

MRI was acquired with a 18-channel design body flex coil on a 1.5T MR scan. The patients were set up with the same immobilization and positioning devices as for CT imaging thanks to a MR compatible table.

The three sequences were systematically used:

- For lesion visualization, axial single shot fast spin echo T2-weighted (T2) with fat saturation was first acquired with breath triggering on exhale.

- Fiducials are visible on ultra-fast gradient echo T1-weighted DIXON (T1 DIXON) water reconstructed images acquired in exhale breath hold.

- Lesion are also well defined after injected T1-weighted Fast Low Angle Shot (T1 TFL)

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imaging sequence acquired with breath triggering on expiration phase. Gold fiducials are also visible on this sequence.

Slice thickness was set to 2 mm and all sequences were acquired in the same plane with the same slice position in order to ease image registration in the treatment planning software.

The entire MRI protocol acquisition lasts around 20 min depending on the regularity of the patient's breathing pattern.

Results

The lesion was not always visible on 4D CT scan, even on images with contrast enhancement hence the need of MRI to better define the lesion. Target motion range was assessed based on fiducials' displacement. Most frequently, treatment planning is performed on expiration phases but when lesion movement is small with breathing, target contouring is done over all phases and treatment planning is achieved in free breathing.

The use of the same table and immobilization device for MRI minimized uncertainties due to patient position for image registration.

An example of MR/CT50 registration and target volume definition is illustrated on Figure 1.

Conclusion

The use of MR imaging sequences optimized to account for fiducial visualization and tumor delineation allow high precision target delineation for treatment planning. Increasing cases of patients eligible for SBRT and its proof of benefit have stimulated the effort to set up and improve new imaging protocols at our institute for a personalized and optimal SBRT treatment.

Recent developments in 4D MRI demonstrated the possibility to sort and reconstruct the images according to the respiratory phases [1-3]. Future implementation of 4D MRI in our institution would allow better registration with 4D CT planning over the entire breathing cycle and delineation accuracy will benefit from significant improvements.

von Siebenthal et al. Phys. Med. Biol. 2007.

Paganelli et al. Med. Phys. 2015.

Bernatowicz et al. MAGNETOM Flash, 2015.

Mots-Clés: stereotactic body radiation therapy, MRI in treatment position, liver, breath, triggering