INVESTIGATION OF MAGNETIC RESONANCE IMAGING FOR PROSTATE RADIATION THERAPY PLANNING WITH CONE-BEAM CT-BASED IMAGE GUIDED RADIATION THERAPY

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ABSTRACT

One of the most common methods of treating prostate cancer is to use external beam radiotherapy, which currently involves the use of both computed tomography (CT) and magnetic resonance (MR) images. It would be advantageous to remove the need for CT images completely – the CT is only used for dose calculations and the patient will gain the benefits of only requiring one image set to be obtained. However, in order for this to occur, a method of calculating doses using MR images is needed because MR images do not contain the necessary data required to calculate dose. Additionally, it must be ensured that the treatment is as accurate as possible. In this project the feasibility of MR-based planning was examined using existing patient data and new data from simulation phantoms.

The plans from 39 prostate cancer patients were copied from the original planning CT to the MR images. Doses were calculated by applying density overrides to the image sets, using both manually defined contours and contours generated using atlas-based segmentation. Plans were also copied to, and doses calculated on, pseudo-CT images generated using a CT-atlas (i.e. CT images deformed to match MR geometry). Dose differences were evaluated by comparing point doses, Dose Volume Histograms (DVHs), and dose planes of each modified plan against doses calculated on the original planning CT scan. Provided bone was included in the dose calculations, the results agreed well with the original CT plan. The only major discrepancy arose due to differences in the external contour between CT and MR datasets, indicating that applying density overrides or using images obtained with a CT atlas are both accurate methods of dose calculation.

The same method of using density overrides was applied to plans on cone-beam CT (CBCT) images of 12 separate prostate cancer patients, and again showed an improvement in dose compared to the original CT. The effects of different image-guided radiotherapy (IGRT) alignment methods on the final dose were also examined, as were the effects of different planning target volume (PTV) margins. The results suggest that ideally implanted fiducial markers should be used for alignment, and the improved positional accuracy will allow for a reduction in PTV margins.

The entire MR-based process was tested using a custom made phantom. CT and MR images were obtained of the phantom, and the planning process was carried out on
each image set in parallel, using the density override method to calculate doses. The two plans agreed well with each other, demonstrating the feasibility of an MR-based workflow.