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PRESENTATION TITLE

MRI-only based radiation therapy – Hip prostheses are not an exclusion criterion for prostate cancer patients using MRI-only radiotherapy

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ABSTRACT

Purpose: MRI is becoming an irreplaceable part of the radiation therapy workflow and increasing number of clinics have the modality in their disposal or gaining access in the coming years. This has led to numerous publications studying the MRI-only approach – how to execute the entire radiotherapy treatment planning (RTP) workflow using only MR images? Several research and commercial methods have been introduced for synthetic CT (sCT) image reconstruction. These techniques utilize variable MR sequences and rely different calculation models, but generally these methods are infeasible for patients with atypical anatomy or metallic implant. Bilateral prostheses create large HU uncertainties in the target volume for prostate cancer patients, reducing dose calculation accuracy and soft tissue visualization. This study evaluates feasibility of MRI-only RTP workflow for patients with hip prosthesis/prostheses. The work applies in-house sCT method that is used clinically for MRI-only RTP of prostate cancer patients. Dose calculation accuracy in sCTs is compared to a CT image – with and without iterative metal artefact reduction (iMAR)

Materials & Methods: A standard Dixon dual echo MR sequence in clinical use and RTP simulation CT images were utilized for the study. Both unilateral and bilateral hip prosthesis cases were present. Two separate patient groups were applied for this study. Group 1 (n=8) consisted cases having MR images accompanied with CT images (only iMAR or iMAR and conventional CT) for sCT creation and dose comparison. Group 2 (n=5) contained cases without MR images but with both iMAR and conventional CT for comparing dose differences arising from HU uncertainty in CT images.
Figure 1: MR, sCT and iMAR images for patient A to compare sCT conversion. Patient B has CT images with and without metal artefact reduction, but no MR image and corresponding sCT - note the HU distortion in the target region.

Results: Using MRI-only workflow it is possible to utilize the soft tissue contrast in the target region and achieve smaller HU uncertainty for the target volume compared to CT image without metal artefact reduction, see Figure 1. Conventional CT images present higher dose inaccuracy in bilateral cases than in unilateral ones compared to iMAR images, yet sCT images enable reliable dose calculation in both cases. Dose comparison results between conventional CT and iMAR images: unilateral (n=5) dose difference (CT-sCT) (PTVmean) = 0.0±0.1%, bilateral (n=2) ΔD (PTVmean) = 1.3% and 0.7%. Dose comparison between sCT and iMAR images: unilateral (n=5) ΔD (PTVmean) = -0.2±0.1%, bilateral (n=3) ΔD (PTVmean) = 0.2±0.1%. Dose volume histogram (DVH) comparison between sCT and iMAR images for patient A is shown in Figure 2.

Conclusions: This study shows that it is feasible to conduct MRI-only RTP also for the prostate cancer patients with hip prosthesis. High quality sCT images enable as accurate dose calculation as with CT images corrected by advanced metal artefact correction algorithm. The MRI-only workflow has superior dose calculation accuracy compared to CT images without metal artefact reduction.