

Clinical feasibility of MR-only radiotherapy workflow for prostate cancer

PURPOSE OF THIS STUDY

This study was performed by Memorial Sloan Kettering Cancer Center (MSKCC) to assess the clinical feasibility of an MR-only workflow for simulation and planning of prostate cancer radiotherapy. The following is a summary of the study published by N. Tyagi et al in Radiation Oncology (2017).

Overcoming barriers to MR-only simulation and planning

MRI is superior to CT for the delineation of prostate and adjacent tissues, as CT often overestimates prostate volume and is prone to segmentation errors. However, MRI has not been used extensively due to difficulties in CT and MR co-registration, and time and resource-related challenges. With an MR-only simulation approach, clinicians could realize several benefits such as:

- Reduced dosimetric errors introduced by CT-MR registration
- Improved efficiency
- Decreased redundant imaging and less cost/inconvenience to the patient

Using Philips' MRCAT (MR for Calculating Attenuation) MR-only radiotherapy simulation in prostate, the institution was able to satisfy all the requirements for implementing an MR-only clinical workflow in their clinic:

1. Synthetic CT images (MRCAT) generated from MR data with high geometric and dosimetric accuracy, providing the necessary density information for dose calculations
2. MR-only simulation and isocenter marking
3. MR images with sufficient soft tissue contrast for contouring
4. 2D digitally reconstructed radiographs (DRRs) or 3D reference images with sufficient bone, soft tissue, and/or implanted fiducial visualization to guide image-based patient setup and treatment

MRCAT-based process condenses radiotherapy workflow

Forty-two¹ prostate patients scheduled for external beam radiation therapy (EBRT) underwent MR-only simulation² on the center's Philips Ingenia 3.0T with MR-RT option. Using a dedicated ExamCard with fixed imaging parameters, MR images were acquired for contouring, MRCAT creation and fiducial identification. In the ExamCard workflow, MRCAT images were generated and MRCAT was assigned as the primary image set.

The planning workflow included contouring using multi-planar T2W MR images and fiducial delineation using a dedicated scan to visualize gold seeds. When contouring was finalized, the studies were exported for treatment planning.

Treatment setup involved matching the MRCAT-based DRRs with orthogonal kV radiographs based on either fiducial ROIs or bones. 3D cone beam CTs were acquired and compared with the MRCAT images to assess rectum and bladder filling. All 42 MRCAT cases were planned successfully and met the department's clinical objectives. The patients subsequently had EBRT or EBRT + brachytherapy boost.

CT + MR simulation



MR-only simulation



Faster workflow with MR-only simulation

In addition to benefiting from the enhanced soft tissue contrast provided by MRI, the institution was able to eliminate the need for CT simulation for the patient group. As a result, an average time savings of ~15 minutes was realized with MR-only simulation versus CT + MR-based simulation.

In addition, the authors determined that MR-only planning can provide comparable, if not superior, geometric and dosimetric accuracy compared to CT alone or CT + MR-based planning.

The authors concluded that diagnostic MR images can be obtained with the patient in the treatment position, facilitating more precise target and normal structure contouring on MR versus CT. Contouring on MR was easier, as well as more rapid and precise compared with CT + MR images because there were no temporal disparities in normal structures (e.g., bladder, rectum). The ability to load MR images as the primary CBCT localization reference also enabled the authors to implement an MR-only workflow that incorporated all steps from simulation to delivery.



15 min. time savings in simulation



Easier, more rapid contouring



No CT-MR registration and no temporal disparities

1 Initial cohort was 48 patients. Six patients were not candidates for MR-only simulation due to the presence of a hip prosthesis or excessive body size.

2 For the Institutions QA purposes, the customized MR-only radiotherapy workflow still includes the acquisition of CT orthogonal scout images to confirm the location of gold seed fiducials.



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