A two-year clinical experience with MR-only planning for prostate

AUTHOR(S)

N Tyagi¹*, M Zelefsky², L Happerset¹, S Fontenla¹, A Halkola², M Kadbi², E Alberts² and M Hunt¹

¹Memorial Sloan-Kettering Cancer Center, NY, USA
²Philips healthcare, OH, USA

ABSTRACT

Purpose: MR-only workflow for prostate has been used at our institution since 2016. We report on two years of clinical experience with MR-only planning using a commercial synthetic CT (Syn-CT) software.

Materials & Methods: Prostate patients receiving external beam radiation therapy were scheduled to undergo MR-only planning. MR simulation included images for contouring (2D T2w axial, coronal, sagittal), synthetic-CT generation (3D FFE-based) and fiducial identification (3D bFFE-based). Syn-CT was generated at the console using commercial software called MRCAT (MR for Calculating Attenuation). Our current combined CT+MR simulation process was modified to accommodate a MRCAT-based MR-only simulation workflow. An automated step-by-step process using a MIM™ workflow and atlas was created for physicians and planners. Patient setup for treatment was achieved by matching the MRCAT DRRs/MRs with the orthogonal KV radiographs/CBCT based on either fiducial ROIs or bones.

Results: 540 patients have been simulated with MR-only MRCAT planning between April 2016 – Feb 2018. Out of these, 510 patients successfully underwent MRCAT-based MR-only simulation. Fourteen patients failed MRCAT reconstruction due to patient size, femur angulation, blurry MRCAT MRs, bony metastases and failure to determine the body contour. Sixteen patients had to undergo a repeat/backup CT scan because of artifacts on the MR such as blurry images due to patient motion that limited the ability to identify implanted fiducial markers. A few MRCAT CTs showed extended coccyx while one of the MRCAT CT reconstructed unrealistic femurs (Figure 1a, b). MRCAT source MR initially acquired using mDixon FFE was upgraded to mDixon XD in 2017 and was found to appear blurrier than the mDixon FFE version. Biopsy artifacts on the water image of mDixon FFE XD images appeared much more severe as compared to mDixon FFE (Figure 1c). For a few patients with nodal volume treatments, a single sequence with two stack T2 resulted in large inhomogeneity due to dielectric effect. The issue was later resolved by acquiring the two stacks separately and using adaptive inhomogeneity correction.
The separate stacks were combined using Philip’s mobiview merge software. Two of the patients with unilateral hip implant reconstructed successfully although hip implant is a contraindication for MRCAT syn-CT. These two cases were planned with MR-only by avoiding beam entry through the implant. Overtime, bowel prep guidelines were modified. Rectum/gas issues were more of a problem for MR-only as compared to CT-only simulation due to longer MR scan time. Even after using a rectal catheter prior to MR simulation, new gas would move down during the 20-25 minutes simulation and affected the relevant sequences. Rectal catheter needed to be used multiple times which often prolonged MR simulation time.

Conclusions: MR-only simulation and planning has been successfully implemented in the clinic and provide unique advantage for target delineation and planning. Patient compliance to new bowel guidelines has improved the bowel issues over time. Future upgrades to mDixon FFE XD and MRCAT synthetic CT software will improve blurriness and unrealistic bone reconstruction. Future work will also evaluate clinical efficacy of MR-only planning for these patients in terms of clinical outcomes.

Figure 1: Examples of challenging MR-only cases (a) Extended coccyx visible on sagittal MRCAT synthetic CT and MRCAT source MR (b) unrealistic femurs visible on coronal MRCAT Synthetic CT and MRCAT source MR (c) biopsy artifacts on the water image of mDixon FFE XD precluding fiducial visibility