Volumetric and dosimetric variations of target and critical structures for post-prostatectomy patients undergoing radiotherapy with daily endorectal balloon

Six post-prostatectomy patients treated with radiation therapy were prospectively enrolled on this IRB approved study at the Hospital of University of Pennsylvania. All patients underwent CT/MRI simulation before the treatment. Six weekly T2-MRI scans were acquired during the treatment. Endorectal-ballons were placed during each CT and MRI scan, as well as the treatment. Bladder, rectum and clinical target volumes (CTV) were contoured by physician on each of the weekly MRI scans in conjunction with, two sets of CTVs contoured according to the RTOG and EORTC guidelines (CTV-RTOG and CTV-EORTC volumes, Michalski JM et al. 2010, Poortmans P et al. 2007). The MRI scans were rigidly fused to the CT simulation images mimicking the daily KV-KV bony alignment. The bladder, rectum and CTVs information were extracted from the TPS and analyzed in MatLab to quantify the volume differences, displacement between contours and dosimetric differences.

We found that:
1. A consistent trend of decreasing bladder volume was found after the first week of treatment. Meanwhile the bladder displacement was found mostly in the anterior direction. Due to decrease in bladder volumes, on average ~14% increase of bladder V65Gy volume can be expected based on the MRI images acquired at the end of the course.

![Figure 1. Average and standard deviations of relative bladder volumes](image1)

Displacement of bladder contours was found within 4mm in lateral and posterior directions, movement in the anterior direction (~8mm at the end of the course) was found larger than the other directions.

2. The volume of the rectum with ERB was found to be relatively consistent during the course of treatment. Differences are within 5% throughout the course. Displacement of rectum contours was within 2mm in all directions. On average, less than 2% variation in the V60Gy volumes was found.

3. We found that the CTV volumes contoured per EORTC guidelines exhibits a larger variation than those drawn according to the RTOG guidelines (p=0.06 in Wilcoxon signed-rank test). The average variation of RTOG based CTV volume was found to be within 5%. However, due to large variation of bladder volumes, the variation of CTV-EORTC volumes was found statistically larger than the CTV-RTOG volumes (Figure 2), most likely due to the bladder exclusion criteria for the bladder volume. Average volume differences can be more than 10% for certain patients.

![Figure 2. Average and standard deviations of relative CTV-RTOG/EORTC volumes](image2)

In conclusion: In post-prostatectomy patients treated with radiotherapy and daily endorectal-ballon, consistent decrease in the bladder volume during the treatment is found. This leads to increased bladder irradiation as compared to the initial treatment plans especially in the anterior direction, and changes in the CTV-EORTC volumes. In contrast, RTOG guideline produces more consistent CTV volumes throughout the treatment than the EORTC based CTV, however a larger sample size should be used to further examine these findings.