ABSTRACT SUBMISSION FORM

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6th MR in RT Symposium 2018

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PRESENTATION TITLE

Simplified CT images for dose calculation for pelvic tumour patients

AUTHOR(S)

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ABSTRACT

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Purpose:
To investigate the number of necessary tissue classes for synthetic computed tomography (sCTs) of pelvic cancer patients by comparison to known uncertainties in conventional radiotherapy as a baseline for MR-only treatment planning.

Materials & Methods:
Simplified CTs (simCT) were created from a reference CT (refCT) for six pelvic cancer patients. Four simCTs were created: one representing the patient by water (WE) only and three with one, two or four tissue classes, respectively (1t, 2t, and 4t). Cohort-mean (CM) and patient-specific (PC) bulk densities (BD) were investigated. With regard to magnetic resonance (MR)-only treatment planning, CM values could be used for sCT generation, whereas PC values require at least one CT of the patient. Tissue classes of interest were: one surrogate BD value to represent the fat/soft tissue ratio (1t); fat and soft tissue (2t); and fat, soft tissue, air, and bone (4t). WE, 1t, and 2t simCTs were chosen, because in an MR-only workflow these could be generated from standard MR sequences, for example T2-weighted images, whereas 4t sCTs require special sequences or other bone/air separation techniques. Treatment plans for intensity modulated radiotherapy were optimized on simCT and refCT with same objective and constraints; plans from simCTs were re-calculated on refCT. Range and positioning uncertainties were simulated to create confidence intervals, which represent the interquartile range of simulated dose volume metrics (D_2, D_{50} and D_{98} for targets; D_2 and D_{mean} for organs at risk (OARs)). An example is given in figure 1 for D_2 of the PTV for one patient. Bowel, bladder and spinal cord were investigated as common OARs. Gamma analysis was performed using 2mm/2% criteria.

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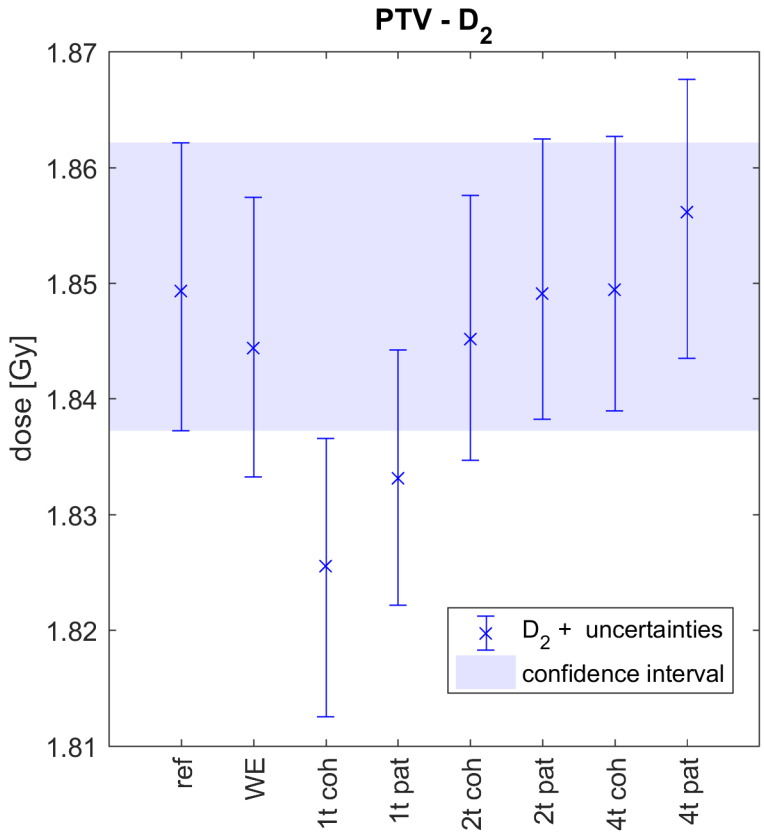

Figure 1: Example of D_2 dose volume metric for the PTV. Crosses indicate the D_2 value for reference (ref) and simplified CTs (WE; 1t, 2t, 4t); the error bars represent the interquartile range of simulated uncertainties. The blue confidence interval is the respective interquartile range of the reference CT. "coh" and "pat" refers to the cohort-mean and patient-specific bulk densities.

Results:
The best mean gamma pass rate (GPR) averaged over all patients was obtained by 2t-simCT with CM BD values (mean: 98.79%; range: 94.81%-99.95%). For this simCT, one patient exceeds the confidence interval of D_2 for the PTV. Both CM and PC 4t-simCT performed well with the confidence intervals with no (PC), or only one (CM) exceeding of all confidence intervals. No QUANTEC recommendations were violated in any case. Corresponding GPRs were 98.73% (93.33% - 100%) and 96.80% (81.79% - 100%). 1t-simCTs mostly exceeded the confidence intervals, which was also reflected in lower mean GPRs of 87.19% and 88.00%, respectively.

Conclusions:
The presented study compared the dosimetric impact of BD CT images to uncertainties during treatment planning. For simCTs with two to four tissue classes, the BD assignment led to smaller deviations from the reference plan than the uncertainties. With regard to MR-only workflows, this could reduce complexity of sCT generation. A similar study for protons is in progress.