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## PRESENTATION TITLE

Feasibility of MRI-only photon and proton dose calculations for abdominal pediatric patients

## AUTHOR(S)

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## ABSTRACT

**Purpose:** A magnetic resonance imaging (MRI)-only radiotherapy treatment (RT) can reduce costs, patient radiation exposure and treatment uncertainties. An essential step in this workflow is the synthetic computed tomography (sCT) generation from the MRI-scans for the dose distributions calculation. Many sCT generation methods have been already proposed for brain, head & neck and pelvis in adult patients, but nothing yet was reported for children. Hence, in the current study we developed a technique enabling sCT generation of the whole body for pediatric abdominal patients. The accuracy of the dose calculation of the sCTs was verified for volumetric modulated arc therapy (VMAT) and pencil-beam scanning proton therapy (PBS-PT).

**Materials & Methods:** Data from 20 pediatric patients (mean age 3 years) were included. The proposed sCT method relies on an automatic-atlas-based segmentation of bone and lungs followed by a MRI intensity conversion to synthetic Hounsfield Units (sHU). Separate conversion algorithms were used for the bone, lungs and soft-tissue (muscle, adipose tissue, fluid). Rigidly registered CT and T2-weighted MRI-scans were used for the atlas construction and the conversion algorithms. sCTs were generated for the same patients with a leave-one-out strategy. On the sCTs, bowel gases were assigned as muscle HU while no density override was performed on the planning-CT. Moreover, the same skin surface was defined for both planning-CT and sCT-scans. VMAT and PBS-PT treatment plans with prescription doses ranging between 14.4-36Gy, depending on the patient case, were calculated using the planning-CT and a 3mm dose grid. For both delivery techniques, plans were robust optimized against patient set-up uncertainty (5mm) on a patient-specific internal target volume (ITV). For the PBS-PT, plans with two/three posterior-oblique fields were constructed and no robustness against proton range uncertainty was accounted for. The sCT quality was...
evaluated by calculating the mean error (ME) between the HU and sHU on the CT and sCT, respectively. CT and sCT dose calculations were compared by dose-volume statistics and gamma analysis (2mm_2%).

**Results:** The mean MEs were 1±112, 4±49, and 19±9 HU for the bone, lungs and soft-tissue segments, respectively. Mean differences between CT and sCT dose calculations for the organs at risk were <0.5%/0.1Gy (maximum 1.7%/0.4Gy) and <0.6%/0.1Gy (maximum 5.3%/0.8Gy) for the VMAT and PBS-PT, respectively. Mean differences for the ITV were <0.9%/0.2Gy (maximum 5.0%/0.8Gy) and <0.3%/0.1Gy (maximum 0.7%/0.2Gy) for the VMAT and PBS-PT, respectively. For the VMAT plans re-calculated on the sCTs, ITV coverage (V_{95%}>99%) was not reached for 2 patients due to the presence of large gas volumes in the vicinity of the ITV on the planning-CT and not on the sCT-scans. A mean gamma pass-rate of 98.6±1.4% and 97.1±1.7% was achieved for VMAT and PBS-PT, respectively.

**Conclusions:** According to the authors knowledge, the present study is the first evaluating the feasibility of generating high-quality sCTs for dose calculations proposes for pediatric patients and for any other body parts than just pelvis, head & neck and/or brain. With the proposed whole-body sCT method, results show that accurate MRI-based photon and proton dose calculations are feasible for abdominal pediatric patients.

![Figure 1](attachment:image1.png)

*Figure 1.* On the left side, boxplots denoting the relative differences in dose (CT – sCT %) at a given cumulative volume for the ITV (top row) and the kidneys (bottom row) are shown. The dashed lines represent the ±1% dose difference. On the right side, one sagittal slice of the planning-CT (top row) and the sCT (bottom row) are shown for one patient. The ITV contour is represented in green.