The submission is to be considered in the following category

☐ Oral presentation preferred
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Trainee status
☐ I am a trainee (student or postdoctoral fellow)
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PRESENTATION TITLE
MR-based pseudo-CT conversion for Radiation Therapy Planning in the pelvis using Zero TE and LAVA-Flex

AUTHOR(S)
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ABSTRACT
Purpose:
Converting MR images into pseudo-CT suitable for radiation therapy planning (RTP) is a prerequisite for enabling an MR-only workflow [1]. The advantage, in addition to the excellent soft tissue contrast, is the elimination of systematic registration errors between MRI and CT, particularly when dealing with prostate cancer patients. The purpose of this study is to demonstrate ZTE and LAVA-Flex based derivation of pseudo-CT for MR-only RT planning in the Pelvis.

Materials & Methods:
Thirty patients were enrolled in this study. A 3-tesla GE SIGNA PET/MR scanner (GE Healthcare, Chicago, IL) and a GEM body array coil was used for proton density weighted ZTE imaging: FA=1deg; BW=±62.5kHz; FOV=46cm; res=2.4mm. A CT scan was also provided for each patient. A stepwise conversion of the MR data into pseudo-CT images was developed. After normalization and bias correction [2], a connected component analysis based on ZTE intensity threshold was applied for a first bone structure identification. A bone mask generated from 3 averaged CT pelvic bones was rigidly co-registered to the largest connected ZTE bone structures. An iterative thresholding was then applied to the ZTE data to recover low density bone pixels in the regions overlapping with the co-registered and smoothed CT mask. The mask guidance prevented also from assigning false positive bone to air pockets in the abdomen. Fat and water information from the LAVA-Flex acquisition was used to complete the femur head structure along the mask position and to define outer body contours. Rigid registration was used to match corresponding CT scans for each patient. The ZTE based pseudo-CTs were imported into the RTP software (RayStation, RaySearch, Stockholm, Sweden) and currently N=14 patient datasets have been compared. The outer body contouring and air distribution from the CT dose plan was exported to the MRI data to avoid registration issues and differences in
the pelvic air distribution between the CT and the MRI scans. Pixels outside the CT external contour were set to -1000 HU for the pseudo-CT, and any gas pocket inside the external contour were set to 42 HU for both the pseudo-CT and the CT. A treatment plan was finally computed on the CT set, evaluated on both sets and compared.

**Results:**
In Figure 1 the ZTE raw data, the ZTE bias corrected data, the pseudo-CT and the original CT data are shown. The target volume (TV) average dose difference for all evaluated patients is ≤1%. Registration and motion errors are minimized by using the same CT-defined body contour and internal air distribution in both cases.

**Conclusions:**
The feasibility of the ZTE pseudo-CT conversion for MR based RTP for Pelvis was demonstrated. The correspondence between pseudo-CT and real CT for both imaging modes was shown. The deviations on the TV are ≤1% for all analysed patients demonstrating that the ZTE plus LAVA-Flex protocol and the derived pseudo-CT are suitable for MR-only based RTP. In the future we expect Deep Learning conversion methods to provide a faster and superior method for pseudo-CT generation as shown in Figure 2.

![Figure 1](image1.png)

Figure 1: a) ZTE raw data; b) ZTE bias corrected with outer body segmentation; c) pseudo-CT converted data; d) corresponding CT data highlighted in green.

![Figure 2](image2.png)

Figure 2: Deep Learning pseudo-CT converted image of the same patient as in Figure 1

References