region are closer to the real values with deviation +5.3%, +0.4% and +10.2% for bone, aluminum and titanium respectively.

Conclusion: Our proposed empirical post-reconstruction method works well in beam hardening correction.

EP-1827
Dual energy Computed Tomography based tissue characterisation for Radiotherapy treatment planning
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Purpose or Objective: It is known that both kVp settings, as well as geometric distribution of various materials, lead to significant change of the HU values, being the largest for high-Z materials and lowest kVp setting used for CT scanning. On the other hand, it is well known that dose distributions around low-energy brachytherapy sources (103Pd, 125I) are highly dependent on the architecture and composition of tissue heterogeneities in and around the implant. Both measurements and Monte Carlo calculations show that the errors caused by improper tissue characterization are around 10% for higher energy sources and significantly higher for low energy sources. We investigated the ability of dual-energy CT (DECT) to characterize more accurately tissue composition.

Material and Methods: Figure 1.a shows the RMI-467 heterogeneity phantom scanned in DECT mode with 3 different setups: the first setup in which we placed high electron density (ED) plugs within the outer ring of the phantom is called Normal one, as we assume that in clinical practice this would be the most commonly used geometrical distribution of tissue ED plugs around low-energy brachytherapy sources (103Pd, 125I) are highly dependent on the architecture and composition of tissue heterogeneities in and around the implant. Both measurements and Monte Carlo calculations show that the errors caused by improper tissue characterization are around 10% for higher energy sources and significantly higher for low energy sources. We investigated the ability of dual-energy CT (DECT) to characterize more accurately tissue composition.

Results: Figures 1.b-d represents HU to ED calibration curves for monochromatic CT images at 50, 80 and 140 keV respectively. As expected, the dynamic range of HU shrinks with increased photon energy as the attenuation coefficient ranges decrease. The same figures also suggest that the spread of HUs for the three different geometrical setups is the smallest at 80 keV. To quantify variation in HUs with photon energy, we calculated relative variation for various tissue equivalent materials (LN 450 Lung, Breast, Liver, CB2-30%, CB2-50%, Cortical Bone) and plotted for several different photon energies in Fig.1.e.

Conclusion: Spectral Hounsfield unit curves demonstrate the lowest HU variation at 80 keV for the three different geometries used in this work. Among all the energies and all materials presented, the largest difference appears at high Z tissue equivalent plugs. This suggests that 80 keV virtual monochromatic DECT reconstructions may enable more accurate dose calculations at both megavoltage and kilovoltage photon energies.

EP-1828
Liver SBRT: benefits from breath-triggered MRI in treatment position for accurate lesion contouring
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Purpose or Objective: As part of the stereotactic body radiotherapy (SBRT) program in our institution, magnetic resonance imaging (MRI) acquisition in treatment position for the liver was implemented. Significant liver motion can be observed due to breathing motion. The aim of this study is to report the benefits of setting out a time-correlated and breath-triggered MRI protocol optimized for radiotherapy (RT) planning in order to account for liver breathing motion.

Material and Methods: Figure 1.a shows the RMI-467 heterogeneity phantom scanned in DECT mode with 3 different setups: the first set-up in which we placed high electron density (ED) plugs within the outer ring of the phantom is called Normal one, as we assume that in clinical practice this would be the most commonly used geometrical distribution of tissue ED plugs. In the second set-up, we arranged high ED plugs within the inner ring and in the third one, ED plugs were randomly distributed. All three setups were scanned with the same DECT technique using a single-source DECT scanner with fast kVp switching (Discovery CT750HD; GE Healthcare). Images were reconstructed into 1.25-mm slices with a 40-cm display field of view and a 512 X 512 matrix and transferred to a GE Advantage workstation for advanced DECT analysis. Spectral Hounsfield unit curves (SHUACs) were then generated from 50 to 140-keV in 10-keV increments, for each tissue equivalent plug.

Results: Figures 1.b-d represents HU to ED calibration curves for monochromatic CT images at 50, 80 and 140 keV respectively. As expected, the dynamic range of HU shrinks with increased photon energy as the attenuation coefficient ranges decrease. The same figures also suggest that the spread of HUs for the three different geometrical setups is the smallest at 80 keV. To quantify variation in HUs with photon energy, we calculated relative variation for various tissue equivalent materials (LN 450 Lung, Breast, Liver, CB2-30%, CB2-50%, Cortical Bone) and plotted for several different photon energies in Fig.1.e.

Conclusion: Spectral Hounsfield unit curves demonstrate the lowest HU variation at 80 keV for the three different geometries used in this work. Among all the energies and all materials presented, the largest difference appears at high Z tissue equivalent plugs. This suggests that 80 keV virtual monochromatic DECT reconstructions may enable more accurate dose calculations at both megavoltage and kilovoltage photon energies.
ORFIT dedicated thermo-plastic nets, supports and cushions. Images were reconstructed in six phases across the respiratory cycle with CT50 being the exhale image set used for MR image registration. MRI was acquired with a body coil on a 1.5T SIEMENS Aera. The patients were set up with the same patients’ immobilization and positioning devices as for CT imaging thanks to a MR compatible ORFIT table. Axial Single Shot Fast Spin Echo T2-weighted with fat suppression Spectral Adiabatic Inversion Recovery (SPAIR) and motion reduction method (BLADE) was first acquired with breath triggering on exhale. Then ultra-fast gradient echo T1-w with parallel acquisition and Dixon reconstruction techniques (VIBE DIXON) allowed the acquisition in exhale breath hold. Finally injected T1-w Fast Low Angle Shot (Turbo FLASH) imaging sequence was acquired with breath triggering on exhale.

Results: The lesion was not always visible on 4D CT scan, even on images with contrast enhancement hence the need of MRI to better define the lesion. Target motion range was assessed based on fiducials’ displacement. The use of the same table and immobilization device for MRI minimized uncertainties due to patient position for image registration. T1-w VIBE DIXON sequence was useful to register MR sequences based on fiducials’ position, as they were the most visible on this sequence. The two breath-triggered (expiration phase) sequences (T2 SPAIR BLADE and injected T1-w Turbo FLASH) provided a motion artifact free image necessary to accurately delineate the lesion. An example of MR/CT50 registration and target volume definition is illustrated on Figure 1.

Figure 1: Example of registered image for a breast metastasis in liver segment V (a): injected CT50 with target contour delineated in red thanks to the MRI sequences. (b): T1 DIXON w. (c):T2 SPAIR BLADE, (d): injected T1-w Turbo FLASH

Conclusion: The use of the same table and immobilization device for CT and MRI combined with the use of MR imaging sequences optimized to account not only for the dedicated table and immobilization devices but also for the gold seeds visualization and the tumor delineation allow high precision target delineation.

Material and Methods: Six patients with a bilateral hip implant were selected for this study. For every patient, 3 series of images were compared. The two first ones were performed with GE Optima CT580 simulator, one by using the metal artifacts reduction (MAR) algorithm and the other one without. The third series was acquired by Cone Beam Computed Tomography (CBCT) during the first session of treatment. For every series, the same rectangular ROI was drawn on a frontal slice, in the soft tissues situated between the two protheses. The average Hounsfield Units (HUm) and the standard deviation (σ), corresponding to the noise in the image, were collected. According to the same methodology, the images of 12 patients without hip implant were studied in order to have a reference of the average Hounsfield Unit (HUmref) in this anatomic region and to compare it with the obtained results for images of patients with a bilateral hip implant.

Results:

For the cohort of patients without hip implant, HUmref was of 11,2 ± 43.5 HU. For the bilateral hip implant cohort, the HUm results with MAR algorithm were the closest of HUmref (HUm(MAR)= -37.1 HU ; HUm(CBCT)= -262.6 HU ; HUm(no MAR)= -409.5 HU). The noise in the image was reduced too in comparison with images without MAR reconstruction and CBCT (σ(MAR)= 104.9 HU ; σ(CBCT)=153.2 HU ; σ(no MAR)= 211 HU).

Conclusion: The reconstruction quality of soft tissues between a bilateral hip implant was improved with MAR algorithm by reducing artifacts, noise and by increasing the HU accuracy. Dosimetric impact remains to be assess (σ(MAR)= -409.5 HU). The noise in the image was reduced too in comparison with images without MAR reconstruction and CBCT (σ(MAR)= 104.9 HU ; σ(CBCT)=153.2 HU ; σ(no MAR)= 211 HU).

EP-1830
Comparison of the MRI sequences in ideal fiducial marker-based radiotherapy for prostate cancer
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Purpose or Objective: Image guided radiotherapy for prostate cancer is a sophisticated treatment modality. However, the contouring the prostate is difficult to achieve with CT alone. To overcome the uncertainty of contouring the target on CT images, MRI is used in the registration of CT in addition to MRI using a fiducial marker. However, the visualization of the markers tends to be difficult in MRI. The aim of the present study is to find an optimal MRI pulse sequence for defining the marker as well as the prostate outline by comparing five different sequences.

Material and Methods: A total of 21 patients were enrolled in the present study. The two gold fiducial markers were placed on the prostate 3 weeks before the CT/MRI examination. MRI was performed using a five-channel sense cardiac coil. We obtained five T1-weighted spin echo sequences (repetition time [TR]/echo time [TE] in milliseconds: 400/8) (T1WI), T2-