to the possibility of induced artifacts or loss of information that we observed, a visual comparison of each MAR scan with the original scan is performed, and the HU values in the artifact-reduced area are spot checked for reasonability relative to known tissue HU values. Future studies will investigate the impact of this type of MAR on contouring variability and accuracy.

Figure 1: Example of a plan for a patient with bladder cancer and double hip prostheses without (top) and with (bottom) MAR, where the PTV identical in both images (colorwash 15-68 Gy). In the top image, the dose was calculated after manual override of artifact to 0 HU. The mean dose to the PTV was 63.8 Gy and 64.0 Gy, respectively.

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MR-based treatment planning for intracranial glioma patients
M.A. Palacios1, M. Bennis1
1VU University Medical Center, Radiation Oncology Department, Amsterdam, The Netherlands

Purpose or Objective: To assess the dosimetric accuracy of CT-substitute attenuation correction (AC) maps generated from existent clinical MR data for radiation treatment planning in glioma patients.

Material and Methods: CT substitute AC maps were obtained with Statistical Parametric Software (SPM) software applied on 3D T1-weighted Inversion Recovery scans (IT 650 ms; TR/TE 4.6/2.0 ms). Three probability maps (PM) were obtained: air, tissue and bone. To derive corresponding AC maps, air-PM was multiplied by -1000, tissue-PM by 30 and bone-PM by 1000 and 300 when the probability for bone tissue was >0.8 and <0.8, respectively. A composite AC map was derived by multiplying the aforementioned values. Difference in bone segmentation exhibited an average DSC of 0.81±0.07 (SD) between clinical CT and MR-based CT segmentation, detecting SPM software less bone than in the clinical CT. Recalculated VMAT plans on the MR-based CTs exhibited a very good agreement with the clinical plans. Average Dmean, D2% and D98% for CT and PTV differed less than 0.5%. Difference in D2% for brainstem and optical system between the clinical plans and recalculated plans using an MR-based CT were 0.4% and 1.1%, respectively. All metrics were found not significantly different (p>0.05) from the clinically approved plans.

3D-dose distributions for the CTV and PTV in MR-based plans resulted in γ-passing rates higher than 0.99±0.01 for both structures. Average γ-value for CTV and PTV was 0.16±0.08 and 0.23±0.16, respectively.

Results:

Differences between both plans were assessed according to the D2%, D98%, Dmean and γ-index (3%/3mm) for the relevant structures: CTV, PTV, brainstem and optical system.

Conclusion: MR-based CTs were generated using SPM software and current clinical MR examinations without the need of adding extra sequences to the clinical protocol. Bone segmentation exhibited an average DSC of 0.81±0.07 (SD) between clinical CT and MR-based CT segmentation, detecting SPM software less bone than in the clinical CT. Recalculated VMAT plans on the MR-based CTs exhibited a very good agreement with the clinical plans. Average Dmean, D2% and D98% for CT and PTV differed less than 0.5%. Difference in D2% for brainstem and optical system between the clinical plans and recalculated plans using an MR-based CT were 0.4% and 1.1%, respectively. All metrics were found not significantly different (p>0.05) from the clinically approved plans.

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ca. patients treated in our institution. First, pattern statistics were compared to population data in literature to establish validity of the data used for testing. Second, patterns representing highest irregularity were selected: variance in amplitude (1), periodicity (2), and a pattern with a baseline drift (3). A periodical computer generated sinusoid (4) was used for comparison. Patterns were fed into a QUASAR™ Respiratory Motion Phantom (Modus Medical), with “lung tumour insert” (cork/polystyrene). Each pattern was scanned 5 times using a 16 slice lightspeed RT series scanner (General Electric).

“Lung tumour” contours were extracted using automatic segmentation of average (AVE) and MIP CT data. Contour volumes were compared using Dice coefficients (DC) and to expected volumes.

Results: The average breathing amplitude in our patient population was 8.70 ± 3.0 mm. The average period was 3.99 ± 1.0 seconds per breath. Both compared well with literature values.

Based on repeat CT data, DC was ≥ 0.90 for group (1) and (3) and (4). However, DC for group 2 (“irregular periodicity”), was only 0.83, which is significantly lower (p<0.002). Computed volumes were nearer to expected volumes using AVE CT, but using AVE always leads to under-differentiation. Volumes computed in MIP CT reconstructions cover the expected volumes better, but there is a chance of overestimation of up to 20% in volume.

Conclusion: Even though 4D CT scanning has been around quite some time, this is one of the first studies to address the effects of clinically found breathing irregularities. The selected test data seem to be adequate for lung ca. patients, and selected types of irregularities are commonly seen by therapists operating CT scanner and linac.

The study indicates that irregular respiratory patterns introduce the element of “chance” in the position and size of delineated tumour volumes, depending on amount and type of irregularity. Therefore, it is recommended to always take into account effect of breathing pattern irregularity in scanning and treatment planning for lung tumours. Since 4D imaging typically consists of scanning while tracking a marker position, the recommendation probably holds for every CT scanner used in radiotherapy, and possibly also for PET and MRI scanners.

M. T. Jones, J. Stojadinovic, J. A. S. Salas, W. A. Meyer-Streit, S. Pimentel, L. B. K. Greco

Purpose or Objective: Most institutes use the ITV approach to account for breathing motion in treatment planning, generally yielding too large treatment volumes. Recent publications showed that use of a mid-ventilation CT (midV-CT) representing the mean breathing phase) and treating former breathing amplitudes as a random error, led to high differences in dose volume histograms between the ITV and the midV-CT approach.

Results: The mean CTV volume was 24.7±22.0 cc (1SD) and the mean marker to CTV COM distance was 12.7±5.2 mm (1SD). The midV-CTs are generated by 3DSlicer within 30 minutes using a PC. Motion validation results are shown in Table 1. Differences in the mean COM of the marker in Eclipse and in midV-CT are within 1 mm, indicating an accurate midV-CT generation by our software. Average amplitude differences are within 1 mm but Eclipse motions tend to be slightly larger, possibly due to the uncertainty of manually finding the marker in the 4D phases. Correspondingly, RMS differences between motion curves of Eclipse and 3DSlicer were therefore 0.2-0.6 mm, whereas the RMS differences between marker and CTV motion in 3DSlicer only 0.1-0.2 mm (Fig 1a). The latter suggests that well-placed markers can estimate CTV motions. Fig 1b shows differences in dose volume histograms between the ITV and the midV-CT approach.