In the lower graph (Fig. 1C), we can observe an increase in ΔADC as dose increases, although the data are not relevant enough because of the few number of patients analyzed.

**Conclusions:** ADC maps can be used not only for treatment assessment, but also for quantification of tumour response voxel by voxel. Even more, the joint use of MRI diffusion data and PET/CT can be useful for delimiting the hypoxic areas, due to glucose consumption enhancement by Pasteur effect. The main weakness of this method is the rigid registration process, and non rigid registration algorithms are needed for the registration of highly distorted images from diffusion studies.

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**PO-0861**

**Prediction of normal tissue morbidity in radiotherapy of prostate cancer using motion inclusive dose distributions**


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**Purpose/Objective:** In radiotherapy (RT) of prostate cancer the key organs at risk (ORs) - the rectum and the bladder - display considerable motion, which may influence the dose/volume parameters predicting for morbidity. In this study we compare motion-inclusive doses to planned doses for the rectum and bladder and explore their associations with prospectively recorded morbidity.

**Materials and Methods:** The study included 38 prostate cancer patients treated with hypo-fractionated image-guided intensity-modulated RT that had an average of nine repeat CT scans acquired during treatment. These scans were registered to the respective treatment planning CT (pCT) followed by a new dose calculation from which motion-inclusive dose distributions were derived. The pCT volumes, the treatment course averaged volumes as well as the planned and motion-inclusive doses were associated with acute and late morbidity (morbidity cut-off: ≥1). Non-significant differences were only found for median values of $D_{0.1}$.

**Conclusions:** Variation in rectum and bladder volumes leads to deviations between planned and delivered dose/volume parameters that should be accounted for to improve the ability to predict morbidity following RT.

**PO-0862**

**Cross-institutional comparison of pharmacokinetic parameters from DCEMRI of cervical cancers: initial results**

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**Purpose/Objective:** Biomarkers extracted from functional images may be subject to cross-institutional variations, and are thus in need of standardization. Pharmacokinetic parameters derived from dynamic contrast enhanced (DCE) MRI of cervical cancers have shown a predictive value in identifying patients at risk of relapse following radiotherapy. The aim of the current work was to compare pharmacokinetic parameters obtained from DCEMR images, acquired at different institutions, of patients with locally advanced cervical cancers.

**Materials and Methods:** DCEMRI images from 2 centers have so far been collected. At center 1 (Oslo University Hospital), 78 patients have been included. Here, DCEMRI was performed using Magnevist (Gadopentetate Dimeglumine) as contrast agent and an FSPGR sequence with temporal resolution of 15 s and spatial resolution of 0.8x0.8x5 mm at a 1.5T Signa Horizon LX scanner (GE Medical Systems). At center 2 (University Medical Center, Utrecht), 23 patients have been included. In this case, DCEMRI was performed using Magnevist and a 3D FLASH sequence with 2.4 s temporal resolution and spatial resolution 0.9x0.9x3mm at a 1.5T Gyroscan NT Inter scanner (Philips Medical Systems). Pharmacokinetic analysis with the ‘Brix’ model was performed in an identical manner for the two cohorts. The model analysis of the dynamic series was done voxel by voxel in the tumors, providing maps of the $\Delta D_{0.1}$ (amplitude), $T_{1\text{p}}$ and $k_{pe}$ parameters. The median of a given parameter was extracted for each patient, in addition to a relative measure of tumor heterogeneity (difference between 66th and 33rd percentile, divided by the median). Cohort data for each center was compared using Mann-Whitney tests. P-value<0.05 was considered statistically significant.

**Results:** The cohort-based median values for center 1 versus center 2 were 2.20 vs 3.41 (relative units), 1.59 vs 0.68 (min⁻¹) and 0.076 vs 0.080 (min⁻¹) for $D_{0.1}$, $T_{1\text{p}}$ and $k_{pe}$, respectively. For the heterogeneity measure, values obtained were 0.40 vs 0.55, 0.54 vs 0.99 and 1.10 vs 1.70, respectively. Non-significant differences were only found for median values of $k_{pe}$.

**Conclusions:** Five out of six pharmacokinetic tumor parameters obtained from DCEMRI performed at the two different institutions were significantly different in this preliminary analysis, possibly pointing at differences in MR scanners and acquisition protocols. We aim at including patients from more institutions, at introducing the ‘Tofts’ pharmacokinetic model and at using reference tissue for normalization. Furthermore, data are to be analyzed in a multivariate setting, accounting for variations in stage, tumor volume and other relevant clinical factors.

**PO-0863**

**Ultrasound IGRT: Deformable image registration of daily ultrasound images to derive daily CT images**

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**Purpose/Objective:** Nowadays, quantitative 3D Ultrasound (US) Image Guided Radiotherapy (IGRT) systems are available which can assess absolute volumetric information on soft tissue. Acquiring daily US images is quick and imposes no extra radiation burden to the patient. For Intramodality US systems only the reference CT (planning) image is available. Nevertheless, CT images for every treatment fraction would be useful, e.g. for dose recalculation, and assessing margins. To this end, deformable image registration (DIR) was applied to calculate the deformation field between reference and daily US images. This field was then applied to the reference CT.

**Materials and Methods:** To validate the procedure a deformable phantom was developed, existing of a PMMA box filled with demineralized water, containing two balloons filled with either saline solution or sunflower oil with a variable volume. Four different configurations were imaged with CT as well as US. Deformation fields are computed between several pairs of US images and then applied to the corresponding CT of the first US of the pair (see figure). This reconstructed new, matching CT for the second US is then compared to the real corresponding CT of the second US using the sum of squared differences (SSQD) metric. The deformation fields are calculated using an elastic registration algorithm (REGGUI; morphons). The SSQD metric was limited to the area where US information was available.
between 4x10^9 and 5x10^9. For comparison, the difference between the deformed CTs and the real CTs ranged from 0.45 to 0.59.

**Results:**

The DIR performs well visually and the sum of squares for the difference between the deformed CTs and the real CTs ranged between 4x10^9 and 5x10^9. For comparison, the difference between four volumes in which only noise generates differences between the images, gave a comparable SQD of around 3.7x10^9. For all the image pairs, the SQD of the deformed CTs is approximately half of that of the non-registered images (ranging from 0.45 to 0.59).

**Conclusions:** A limitation of an US based deformation field is that the area of the CT on which one can perform the deformation field is limited to the area of which US data is available. However, this phantom experiment does show that the application of such an US based CT DIR in principle could work. Whether the US based CT DIR is also valid for patient cases, has to be studied further with patient examples.

**PO-0864**

**Gated reconstruction in 18FDG PET-CT quantitative imaging: impact on SUV estimation in lung tumors**

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**Purpose/Objective:** To assess the impact of respiratory-gated PET-CT (4D-PET-CT) on SUV quantification in lung tumors.

**Materials and Methods:** 19 patients with lung tumors who had 18FDG-PET/CT scans performed in a 4D-PET/CT system were studied. For comparison, the volumes obtained with the non-registered images (ranging from 0.45 to 0.59).

**Results:** The observed maximum range of motion was 5.5mm (L-R), 16.5mm (A-P) and 22.2mm (S-I). SUVmax was on average 67.4% higher in the gated acquisition (10 phases) compared to the non-gated case (range 13.1%-228.3%). When comparing reconstructions in 4 and 10 phases, the average increase in SUVmax reduced to 13.3% (range 2.3%-31.2%).

Corresponding volumes for 6 to 10-phase comparison were 6.8% and range 0.0%-23.1%. In general, volumes estimated by the fixed-threshold method increased with increasing phase number, volumes obtained with the percentage method decreased and volumes obtained with the gradient-based method did not show a significant trend. On average, volumes calculated in the 10-phase ph(0) image by method a) were 8.9% higher than volumes obtained by method b), while in the static acquisition (no gating) method a) gave volumes 20% smaller than method b), on average.

**Conclusions:** 4D-PET-CT offers a clear advantage in 18F-FDG SUV estimation for tumors with respiration. The balance between acquisition/reconstruction time, signal-to-noise ratio and SUV estimation accuracy seems to be achievable splitting the respiratory cycle into 4 to 6 phases, depending on lesion location. The same observation holds for lesion volumes, however further research is needed to determine the optimal segmentation method. Gradient-based methods are less sensitive to the number of phases for volume estimation, however further study is necessary to fine-tune and validate their results.

**PO-0865**

**Quantitative clinical image quality comparison of pelvic CBCT for two imaging systems**

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**Purpose/Objective:** Quantitative objective analyses are widely used in radiology. These are relevant in oncology as well, since the use of pelvic CBCT for adaptive RT requires a certain level of image quality. The purpose of this study is to objectively evaluate the clinical image quality of two systems: a state-of-the-art CBCT system and a new CBCT system with improved reconstruction and hardware.

**Materials and Methods:** The patients included in this retrospective study had a planning CT and CBCTs from Clinac iX as well as Truebeam (Varian Medical Systems). Based on European Guidelines provided by CEC seven quality criteria in relation to the bladder on CBCT were defined along with an ordinal rating scale reflecting the fulfillment of a particular criterion. The corresponding author and a number of physicians rated in a randomized order the CTs and the pelvic CBCTs. The resulting data were evaluated by a statistical analysis called Visual Grading Characteristics (VGC) in the free software DBM MRMC 2.32 Build 3. The difference in image quality between the two modalities was evaluated by the area under the curve (AUC) and ANOVA. An AUC of 0.5 indicated equally image quality whereas higher values indicated superior image quality. If 0.5 was not included in the 95% confidence interval the difference in image quality of the systems was significant. A VGC curve comprising the total image quality criteria was found for each observer. Furthermore, the impact of the individual criteria was demonstrated by a VGC curve and the respective AUC. The Image Criteria Score (ICS) was calculated for the total and individual criteria and ideally ICS would equal 1.0. As a reference the VGC analysis of the CT was performed.

**Results:** An excerpt of the results of the corresponding author is included for five criteria (Figure 1). The VGC curves clearly illustrate better performance of Truebeam than Clinac iX for criterion I-IV, whereas the performance is more equivocal regarding criterion V. The AUC was 0.68 for the total quality criteria and the 95% confidence interval was [0.55, 0.80]. For criterion I the AUC was 0.72, criterion II yielded an AUC of 0.71, criterion III an AUC of 0.73, criterion IV an AUC of 0.70 and for criterion V AUC was 0.47. The total ICS for Truebeam and Clinac iX was 0.49 and 0.27, respectively. For the individual criteria the ICS was higher for Truebeam than Clinac iX. The percentage difference ranged between 11.1 and 33.3 percentage points.

**S331**

**Figure:** The DIR is computed between the two US images (US1 and US2) and then applied to the CT (CT1) to obtain a new, matching CT for US2. The new reconstructed CT (CTdef) is compared to the true corresponding CT of US2 (CT2).

**PO-0864**

**Gated reconstruction in 18FDG PET-CT quantitative imaging: impact on SUV estimation in lung tumors**

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**Purpose/Objective:** To assess the impact of respiratory-gated PET-CT (4D-PET-CT) on SUV quantification in lung tumors.

**Materials and Methods:** 19 patients with lung tumors who had 18FDG-PET-CT were studied with a 4D-PET-CT additional acquisition after a whole body scan. Patients were selected among the group that showed respiratory-induced tumor motion greater than 5 mm. 4D-PET-CT was performed by means of a Philips Gemini BigBore TOF scanner capable of time-of-flight reconstruction, using the Varian RPM gating system. Administration and acquisition parameters were 3.0 MBBq/kg 18FDG, 2 min/bed, retrospective-mode for both PET and CT modalities. Patients were instructed to breath as regularly as possible.

Data were reconstructed in 1 (no sorting), 4, 5, 6, 7, 8, 9 and 10 breathing phases. SUVmax values within the lesion were studied as a function of the number of phases in phase(0%) (max expiration). Lesion volumes were also obtained by three different methods: a) fixed SUV=2.2 threshold, b) 40% of SUVmax isocontour and c) gradient-based method. The volumes were also studied as a function of the phase of phase(0%).

**Results:** The observed maximum range of motion was 5.5mm (L-R), 16.5mm (A-P) and 22.2mm (S-I). SUVmax was on average 67.4% higher in the gated acquisition (10 phases) compared to the non-gated case (range 13.1%-228.3%). When comparing reconstructions in 4 and 10 phases, the average increase in SUVmax reduced to 13.3% (range 2.3%-31.2%). Corresponding figures for 6 to 10-phase comparison were 6.8% and range 0.0%-23.1%. In general, volumes estimated by the fixed-threshold method increased with increasing phase number, volumes obtained with the percentage method decreased and volumes obtained with the gradient-based method did not show a significant trend. On average, volumes calculated in the 10-phase ph(0) image by method a) were 8.9% higher than volumes obtained by method b), while in the static acquisition (no gating) method a) gave volumes 20% smaller than method b), on average.

**Conclusions:** 4D-PET-CT offers a clear advantage in 18F-FDG SUV estimation for tumors with respiration. The balance between acquisition/reconstruction time, signal-to-noise ratio and SUV estimation accuracy seems to be achievable splitting the respiratory cycle into 4 to 6 phases, depending on lesion location. The same observation holds for lesion volumes, however further research is needed to determine the optimal segmentation method. Gradient-based methods are less sensitive to the number of phases for volume estimation, however further study is necessary to fine-tune and validate their results.