and pulmonary dose. To prevent patient lifting, patients should not be pushed to perform too high amplitudes. There are no benefits regarding reproducibility, stability and P_{GW} of changing gating method from EIG to DIBH if no visual guidance can be provided.

EP-1488

Updated verification system for VMAT for SBRT using in-treatment 4-dimensional cone beam CT

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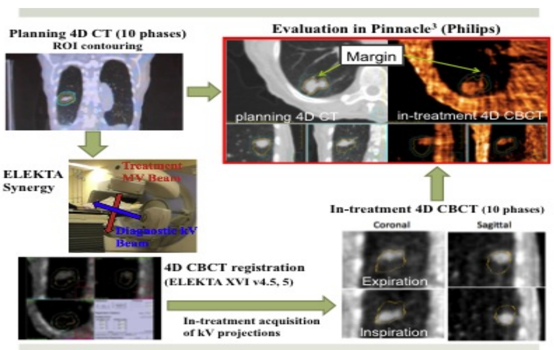
Purpose/Objective: For volumetric modulated arc therapy-stereotactic body radiation therapy (VMAT-SBRT), in-treatment four-dimensional cone-beam CT (4D CBCT) images are the most reliable tool for evaluating setup error and the intrafractional location of the moving target. We established and updated a novel verification system and quantitatively assessed the accuracy of our VMAT-SBRT delivery through the use of it.

Materials and Methods: Five patients undergoing VMAT-SBRT at our hospital were included in this analysis. All patients had stage I non-small cell lung cancer or single lesion oligometastatic lung tumors. In the supine position, an abdominal compressor and the Elekta stereotactic body frame were used. The gross tumor volumes (GTVs) were contoured on all 10 phases of the 4D planning CT. GTVs were merged into the internal target volume (ITV). The planning target volume (PTV) was created by adding a 5 mm margin to the ITV in all directions. Fifty-five Gy in 4 fractions was prescribed to cover 95% of the PTV. Before each treatment, registration was manually performed using pre-treatment 4D CBCT with the Elekta XVI system, v4.5 or v5.0. During each fraction, in-treatment 4D CBCT images, subdivided into 10 phases were obtained and exported to Pinnacle3. The respective tumor locations during beam delivery, as determined with the 4D CBCT, were merged to form the 'actual ITV.' We could then evaluate discrepancies between the 'actual ITV' and the planning ITV. To assess the adequacy of the PTV margin, we also analyzed whether PTV covered the 'actual ITV' completely.



Results: From the 5 patients, 200 4D CBCT image sets taken during VMAT-SBRT were successfully obtained and the intrafractional tumor motions during beam delivery were reasonably reproduced. Under suppressed respiration, the average amplitude of tumor motion was 4.2±3.0mm in the cranio-caudal direction. On average, the 'actual ITV' covered 87.2±5.6% of the planning ITV. In addition, the respective PTV encompassed all tumor locations in all phases.

Conclusions: By using in-treatment 4D CBCT, we proved the adequacy of our ITV-PTV margin setting for VMAT-SBRT when the registration for moving lung tumors was performed using pre-treatment 4D CBCT. This result also provides valuable information prior to starting adaptive SBRT for lung tumors.

EP-1489

Kilovoltage intrafraction monitoring trial for gated prostate radiotherapy: initial dosimetric results

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Purpose/Objective: Internal intra-fraction motion during radiotherapy can result in sub-optimal treatment delivery and thus real-time adaptation strategies such as MLC tracking or gating are currently being investigated in the clinic. The goal of this study is to investigate the dosimetric effect of gated prostate cancer radiotherapy utilising kilovoltage intrafraction monitoring (KIM) in the first prospective clinical trial. In KIM, prostate position monitoring by kV flouroscopy is used to gate off the beam and re-position the patient if the prostate moves outside a predefine region.

Materials and Methods: KIM is being evaluated for real-time target localisation in a 30-patient prostate radiotherapy trial. So far, one patient has completed the 40 fraction treatment, and another two patients are currently undergoing treatment. The dose delivered during each fraction with KIM was calculated using an isocenter shift dose reconstruction method. For the fractions where a gating event (with motion exceeding 3mm for 5 seconds) occurred, dose calculation was also performed for a simulated treatment scenario with no KIM gating correction. Dosimetric impact of KIM gating was evaluated through comparison of target and normal tissue dose volume statistics for the planned treatment delivery, delivery with KIM gating and delivery with no KIM correction (see Figure 1), for each of the gated fractions.

Results: In this preliminary work, all fractions from the first patient's treatment were studied. Four fractions (out of 40) had successful KIM gating corrections. Prostate motion (mean ± standard deviation) with KIM corrections and simulated with no KIM corrections were 2.2±1.4 mm and 4.1±0.7 mm respectively. Ranges of differences between the planned and KIM corrected doses and the planned and no KIM correction doses were respectively: PTV D95% (-2.75, -0.26) & (-4.29, -2.27); CTV D100% (-2.41, -0.06) & (-0.95, 0.31); rectum V65% (-2.30, -0.48) & (-6.09,-3.20); and bladder V65% (-0.86, 0.50) & (-1.02, 1.72). In these fractions, PTV V105% was higher than the planned value with both KIM gating (2.98-22.18%) and with no KIM correction (17.16-27.25%). It should be noted that the KIM has a finite gating threshold and therefore, in the presence of motion, it will deviate from the planned treatment.

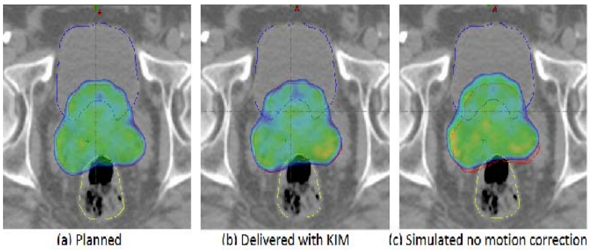

Figure 1. (a) Planned, (b) delivered with KIM gating, and (c) simulated delivery without KIM gating correction isodose distributions for a fraction of patient 1. Dose levels >95% are shown.

Conclusions: The initial results indicate that KIM gating improves the agreement between the planned and delivered treatments for prostate radiotherapy. A more accurate delivery with KIM can facilitate dose escalation and also potentially improve treatment outcomes. Future work will include investigation of more patients and fraction data, and statistical analysis.

EP-1490

Accuracy results from the first clinical trial of a new real-time IGRT system, Kilovoltage Intrafraction Monitoring

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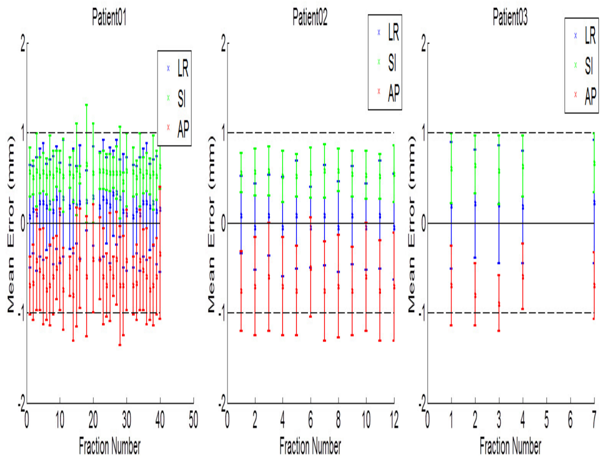
Purpose/Objective: Kilovoltage Intrafraction Monitoring (KIM) is a new real-time IGRT system undergoing first-in-world clinical use. With KIM, the kV imager is employed while the MV beam is on. Radio-opaque markers implanted into the target are detected in the kV images, and 2D-to-3D reconstruction is performed to compute the 3D target position in real-time. The 3D target position is displayed to the clinical team during treatment and is used to make guidance decisions. KIM has shown sub-millimetre accuracy from phantom experiments and retrospective prostate and liver cancer patient studies. However to date there have been no prospective patient results where KIM is employed in real-time to make guidance decisions. We report the accuracy measurements from the first prospective clinical trial of KIM for prostate cancer VMAT patients.

Materials and Methods: Simultaneous intratreatment kV and MV images of the 52 fractions from the three prostate cancer patients treated with KIM real-time guidance to date were acquired. For each treatment fraction the KIM real-time measurements of the prostate implanted marker positions were compared to retrospectively measured kV-MV triangulated marker positions. The kV-MV triangulated positions were considered to be the ground truth. The mean and standard deviation of the measured position differences between KIM and kV-MV triangulation in the left-right (LR), superior-inferior (SI) and anterior-posterior (AP) directions were recorded and analysed. Due to the VMAT MLC modulation, the markers were not visible in all MV images, however at least one marker was visible in 6461 (of 47320 total) images, with the number of images available for analysis in any one fraction ranging from 66 to 167.

Results: The mean error of KIM in the LR, SI and AP directions was 0.17, 0.55, and -0.61 mm respectively, with standard deviations of 0.56, 0.29 and 0.48 mm respectively. The accuracy results for each fraction of each patient are shown in the figure. The accuracy and precision are both sub-millimetre. The results across the fractions and patients are quite similar, indicating that further improvements to the accuracy could be performed to reduce the residual small systematic accuracy error.



Conclusions: A new real-time tumour position monitoring system, Kilovoltage Intrafraction Monitoring (KIM), has been clinically implemented and demonstrated to have sub-millimetre accuracy and precision in the results to date. As KIM is implemented on a standard linear accelerator with little modification, this accurate technology can potentially be widely used on existing cancer radiotherapy systems.

EP-1491

Deep inspiration breath hold in breast radiotherapy: are significant reductions in cardiac doses observed?

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Purpose/Objective: Radiotherapy treatment for breast cancer increases the risk of major coronary events[1], with dose received by the Left Anterior Descending (LAD) coronary artery an area of particular concern[2]. Deep inspiration breath-hold (DIBH) is demonstrated as an effective method to reduce cardiac doses during breast irradiation[3]. Following its implementation across our centres a reduction of mean heart dose was observed for left sided breast radiotherapy. This study will further investigate these changes in cardiac dose and explore LAD mean and maximum doses.

Materials and Methods: This retrospective study investigated 275 left-sided breast cancer patients treated with DIBH