the designed dynamic DQA process. Appropriate method was applied to correct the effect of moving phantom structures in the dose calculation, and DVH data of the real volume of target and OARs were created with the recalculated dose by the 3DVH program.

Results: We confirmed the valid dose coverage of a real target volume in the ITV-based RapidArc. The variable difference of the DVH of the OARs showed that dose variation can occur differently according to the location, shape, size and motion range of the target.

Figure : Total calculated DVH data through dynamic DQA process. Solid line: DVH in the real volume of target and OAR, Dashed line: DVH calculated in the ITV-based RapidArc plan

Conclusion: The conventional DQA method in a static status for the ITV-based RapidArc, without a gating system, can only verify the mechanical and dosimetric accuracy of the treatment machine. An additional DQA method should be devised for evaluating the dosimetric characteristics in the real volume of the target and OARs under respiratory organ motion. The dynamic dose measurement using the moving phantom, which can simulate respiratory organ motions, and techniques employing the measured data to calculate the dose delivered to patients were devised in this study, and proper dose analysis was possible in the real volume of the target and OARs under the moving condition. The devised DQA process appears to be helpful for evaluating the real dosimetric effect of the target and OARs in the ITV-based RapidArc treatment.

EP-1519
Automatic detection of MLC position errors using an EPID based picket fence test
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Purpose or Objective: The correct calibration of multi-leaf collimator (MLC) leaves is essential in the accurate delivery of radiotherapy treatments, particularly IMRT. In this study EPID picket fence test images are analysed to investigate the possibility to automatically detect intentional errors greater or equal to 0.5mm from baseline MLC errors.

Material and Methods: Picket fence tests were delivered as part of weekly Linac QA in RapidArc mode on Varian iX and 2100CD Linacs equipped with the a51000 and a5500 EPID respectively. In each QA session a picket fence test was delivered with intentional errors of 0.5mm and 1.0mm; additionally a baseline test was delivered without any intentional errors. A total of 96 picket fence tests were retrospectively analysed covering a period of 6 months. Using Python v2.7.10 for Windows, an algorithm was implemented to quantify the errors in the MLC positions. Briefly the steps of the algorithm were: 1) Image range calibration, 2) Collimator rotation correction, 3) Isocentre position determination, 4) Derivation of relative leaf positions, 5) Calculation of MLC error from median value at each picket fence field position, and 6) Addition of the errors of opposing leaves at each field position to calculate the combined error (CEr) for each leaf-pair.

The mean and median were calculated from the CEr values of each leaf-pair across the different picket fence field positions. The distribution of the mean and median values calculated was compared between baseline and the intentional MLC errors. Furthermore the normal distribution probability density function was fitted onto all of the baseline CEr data. The mean and standard deviation of the fit were obtained. The t-test and Kolmogorov-Smirnov (KS) statistical tests were used to compare each sample of CEr values obtained from each leaf-pair to the corresponding normal baseline distribution of each Linac examined.

Results: For the Varian iX Linac equipped with the a51000 EPID the distribution of values of the mean CEr for intentional errors varied between 0.43-1.18mm whereas for the baseline the mean CEr values were between 0.00-0.25mm (Fig. 1). This result showed that the mean CEr can be used to automatically detect MLC errors greater or equal to 0.5mm by setting the detection threshold between 0.25mm and 0.43mm.

The p-values of the t-tests performed on the data from the Varian 2100CD Linac for the baseline CEr varied between 1.18E-7 and 1.00, whereas for the intentional CEr the p-values were between 0.00 and 5.07E-05. This overlap between the p-values resulted in a false-positive rate of 4.3% if the p-value of 5.07E-5 was to be used as the CEr detection threshold. Table 1 summarizes all the results from the statistical analysis.
Material and Methods: Dose measurements in small fields can be problematic. DAP methods with a detector much larger than the radiation field provide an alternative to conventional central-axis (CAX) dose measurements. DAP is the integrated dose over the area of the detector (Equ. 1) with units of Gy.cm². In order to convert the measured DAP to the CAX dose the equivalent area of the beam is required. This is the area of an equivalent field with no penumbra (i.e. a step function profile).

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DAP = \int \int D(r) \, dr
\]

(1)

Uncertainties have been assessed for scan repeatability, scanner corrections, scanning conditions of calibration films, selection of normalisation value and the dynamic range of the film.

Results: The most important contribution to the uncertainty in DAP measurements is the calculation of the beam area. In the IMBL beam dose rates are typically 50 – 3000 Gy/s depending on distance from the source. High dose film such as HD-V2 is necessary to measure the large doses, however the dynamic range of the film is not suited to low dose measurements.

Preliminary measurements suggest an uncertainty of 1% to 1.5% in the background dose (relative to CAX dose) can be expected. For a 10x10 mm² field measured with a detector 40 mm in diameter, a 1% uncertainty in background dose will result in a 12% uncertainty in DAP measurement. This is likely to be the limiting factor for DAP film measurements. Scan repeatability, scanner light intensity variation in the horizontal plane, scanner resolution and air gap between film and scanner window all introduce small uncertainties. These can be reduced by using systematic scanning techniques and averaging over multiple scans.

Conclusion: Determination of the out of field dose was found to the dominant uncertainty in film DAP measurements. Further work is required to determine if a two-film approach can improve the uncertainty. The desired accuracy of <5% will require additional steps to reduce the uncertainty in the out of field dose.

EP-1521
Comparative study of three pre-treatment verification methods: Portal Dosimetry, Delta4 and Epiqa

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Purpose or Objective: To assess the feasibility of using radiochromic film to aid the calorimetric determination of the dose-area product (DAP) in small fields by determining the uncertainty in film DAP measurements.

Results: The comparative study is carried out on 100 patients. The acceptance criteria used for gamma analysis are: local, dose difference from 3% to 4% and distance-to-agreement from 3mm to 4mm. For Head & Neck treatments, the average value of Gamma Agreement Index (GAI) given by Portal Dosimetry is 98.17% with standard deviation of 1.41% , Delta4 gives 97.77% with standard deviation of 1.58% and Epiqa 97.54% with standard deviation of 1.60%.

For Pelvis treatments, the average value of Gamma Agreement Index (GAI) given by Portal Dosimetry is 98.09% with standard deviation of 1.54%, Delta4 gives 98.19% with standard deviation of 1.30% and Epiqa 97.83% with standard deviation of 1.84%.

For Thorax & Abdomen treatments, the average value of Gamma Agreement Index (GAI) given by Portal Dosimetry is 98.31% with standard deviation of 1.49%, Delta4 gives 98.04% with standard deviation of 1.56% and Epiqa 99.01% with standard deviation of 1.38%.

For Encephalon treatments, the average value of Gamma Agreement Index (GAI) given by Portal Dosimetry is 98.19% with standard deviation of 1.54%, Delta4 gives 98.19% with standard deviation of 1.30% and Epiqa 97.83% with standard deviation of 1.84%.

For Thorax & Abdomen treatments, the average value of Gamma Agreement Index (GAI) given by Portal Dosimetry is 98.31% with standard deviation of 1.49%, Delta4 gives 98.04% with standard deviation of 1.56% and Epiqa 99.01% with standard deviation of 1.38%.

For Encephalon treatments, the average value of Gamma Agreement Index (GAI) given by Portal Dosimetry is 98.19% with standard deviation of 1.54%, Delta4 gives 98.19% with standard deviation of 1.30% and Epiqa 97.83% with standard deviation of 1.84%.

Then, intentional errors were introduced in 3 plans in order to evaluate the capacity of each method to detect these errors. It was errors in terms of Monitor Units (MU) and...