with an average of 97.3% (see Figure 1 for an example of pass-rate vs. gantry angle result). Using this method, a problem with the gantry motor control with one linac at our centre was found, which was corroborated (albeit at a much higher time cost) by commercial VMAT QA products, further proving its utility in a clinical setting.

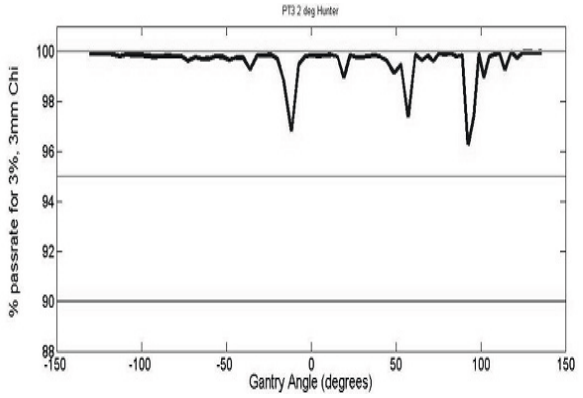

Figure 1. Chi results comparing EPID images to predicted images for each sub-arc during a complete VMAT delivery.

Conclusions: The method provides a comprehensive and highly efficient pre-treatment verification of VMAT delivery using EPID. Dose delivery accuracy is assessed as a function of gantry angle to ensure accurate treatment. Individual Chi maps for small sub-arcs provide a useful tool for error diagnostics.

OC-0157

Sensitivity of EPID-based in vivo dosimetry to detect errors during VMAT delivery

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Purpose/Objective: In volumetric-modulated arc therapy (VMAT) gantry speed, multileaf collimator configuration, and dose rate vary continuously during delivery. For a safe clinical implementation of VMAT, accurate 3D dose verification is essential but also complicated. In our department, EPID-based *in vivo* dosimetry using a semi-empirical back-projection model is clinically employed to verify all VMAT treatments. The purpose of this study was to investigate the sensitivity of our 3D *in vivo* EPID dosimetry approach to detecting patient-related errors during VMAT delivery.
Materials and Methods: Treatment planning of VMAT was performed using the SmartArc module of the Pinnacle treatment planning system. In order to assess the sensitivity of our EPID-based *in vivo* dosimetry method, patient-related errors were simulated by changing position and dimension of an anthropomorphic (Alderson) phantom. The phantom was irradiated using a 2-arc head-and-neck (6 MV), prostate (10 MV) and lung (10MV) VMAT technique. The errors comprised a vertical and horizontal phantom shift of 2 cm, a 10 degree rotation, and the addition of 1cm tissue-equivalent material. Dose distributions reconstructed from EPID images and the original planned dose distributions were compared using 3D γ evaluation using 3% dose difference relative to the maximum dose, and 3 mm distance-to-agreement as criteria.
Results: Table 1 shows the 3D gamma evaluation of the total dose relative to the situation without errors. For the prostate treatment, the effect of the introduced errors is negligible, except that the reconstructed dose at the prescription point was 4.2% higher for a change in thickness of 1 cm. For the head-and-neck treatment, results for the gamma evaluation showed a larger sensitivity for the introduced errors. Also the dose difference at isocenter for the thickness error was larger: -7.8%. The results for the lung plan were similar to those for the prostate plan.

Table 1. Gamma Evaluation Results (3%, ±3mm) and Relative Dose Differences at Isocenter for Introduced Errors

Treatment Site	Error Type	γ_{mean}	$\gamma_{1\%}$	$\gamma_{\leq 1}$(%)	Relative Dose Difference at Isocenter(%)
Prostate	Vertical shift	0.41	1.2	96.7	0.8
	Horizontal shift	0.30	0.8	99.9	0.4
	Rotation	0.30	0.9	99.5	0.6
	Thickness	0.66	1.4	86.9	-4.2
Head-and-Neck	Vertical shift	0.90	3.8	69.6	1.1
	Horizontal shift	2.23	8.3	36.1	5.1
	Rotation	0.77	3.9	77.5	-1.2
	Thickness	0.81	2.5	72.1	-7.8
Lung	Vertical shift	0.42	1.2	97.4	-0.7
	Horizontal shift	0.35	1.0	98.9	-1.2
	Rotation	0.49	1.8	92.7	0.1
	Thickness	0.59	1.5	91.9	-7.0

Conclusions: Our verification results show that vertical and horizontal shifts and a rotation of the order of 2cm and 10 degree, respectively, do not result in significant deviations between EPID reconstructed and treatment plan dose distributions for both prostate and lung VMAT treatments. The head-and-neck VMAT treatments are more sensitive for position errors. With VMAT, EPID dosimetry is often not able to detect patient position discrepancies, and should be combined with IGRT. However, changes in patient thickness are easily detected.

OC-0158

Correlation of 3D gamma evaluation with DVH and EUD parameters from in vivo portal dosimetry of head-and-neck VMAT

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Purpose/Objective: For *in vivo* verification of IMRT and VMAT treatments a 3D dose reconstruction method based on EPID dosimetry is routinely applied in our clinic. After reconstruction, the *in vivo* dose is compared to the planned dose by means of a 3D γ analysis. Although this method is capable of detecting treatment deviations, the clinical relevance of γ parameters is far from obvious. Therefore, we wish to correlate the 3D γ evaluation results with other, clinically more common parameters used to determine the quality of a dose distribution, such as DVH and EUD parameters for specific regions of interest (ROIs). As a pilot study, head-and-neck (H&N) VMAT treatments were investigated.
Materials and Methods: 18 treatments were selected having a variety of deviations in the *in vivo* dose, combined with a few treatments showing no deviations. For 56 fractions of these treatments, the 3D *in vivo* dose distribution was reconstructed. Several parameters were calculated for three different ROIs: the PTV, the volume enclosed by the 50% isodose surface and the volume enclosed by the 30% isodose surface minus the PTV. These ROIs were chosen to be representative for our current clinical portal dosimetry evaluation, and to clearly separate high- and low-dose regions. The calculated γ parameters were the γ pass rate, 99th percentile of the γ-distribution (γ1%) and the mean γ value. Differences between planned and reconstructed dose distributions were next evaluated for each ROI using DVH parameters D1, D50 and D99 and EUD(1), i.e., the mean dose and EUD(7), i.e., focusing on hot spots. Since γ values carry no sign, correlations between absolute deviations of DVH and EUD parameters and γ parameters were evaluated.
Results: The table shows the obtained correlation coefficients. For all ROIs, strong correlations are observed between γ1%, mean γ and DVH and EUD parameters. The D99 parameters, however, hardly correlated with anything, except weakly with parameters of the 50% and 30%-PTV ROIs.