monitor for quality assurance purposes. The ability of the IQM to detect additional error modes needs further investigation.

EP-1529

A real-time monitor system for QA and VMAT: sensitivity analysis in clinical practice

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Purpose or Objective: The iQM® monitor system was tested to provide a method for treatment field verification using an independent monitor system mounted below the gantry. Real-time monitoring allows delivery errors to be detected during treatment, including record & verify mismatch, calibration errors or malfunctions in multi-leaf collimator (MLC), increasing patient safety.

Material and Methods: The iQM® system consists of a large area ion-chamber with a spatial gradient. The ionization chamber and the data acquisition software system were interfaced to an Elekta Synergy accelerator. During 6 months of VMAT quality assurance (QA) sessions, more than 70 sessions of measurements were carried out to validate the repeatability of the detector as a dedicated QA instrument. To evaluate efficiency in clinical practice, a dummy plan and a Head and Neck (H&N) VMAT plan were delivered and investigated using the system. The dummy plan was composed of 18 segments (17 segments 4x4 cm2 and 1 segment 10x10 cm2) and was delivered more than 100 times with constant 50 MU per segments. The VMAT plan was composed of 140 control points delivered by an arc, with low gantry speed, high MU and low dose rate. The sensitivity was then tested by introducing specific dosimetric increases of MU (1%,2%,3%,4%,5%,10% and 20%) in the H&N plan (VMATError Plan). Rotational analysis and validation were investigated; correlation with gantry and collimator angles was quantified using SPSS ANOVA analysis.

Results: The dummy plan delivered in standard condition (gantry and collimator angles=0°) revealed a mean variation in signal counts of 0.7±1.0% compared with the commissioning day. Independence of the detector with gantry position were investigated (gantry angle: 0°-90°-180°-270° and collimator angle: 0°-45°-135°-225°-315°). No statistical difference (significance ≈ 1) was detected for all segments, confirming the high quality of the instrument for daily QA. In the H&N plan, a decrease in measured counts was observed in the particular range of gantry angles from 120° through 240°. Statistical analysis showed a mean dose discrepancy of 2.8±1.0% between planned and measured errors from the original plan. For the VMATError Plan, the system is capable of detecting the error introduced with an agreement of 0.2±0.5% (R2=0.99). No correlation related to collimator angle and delivered MU was detected.

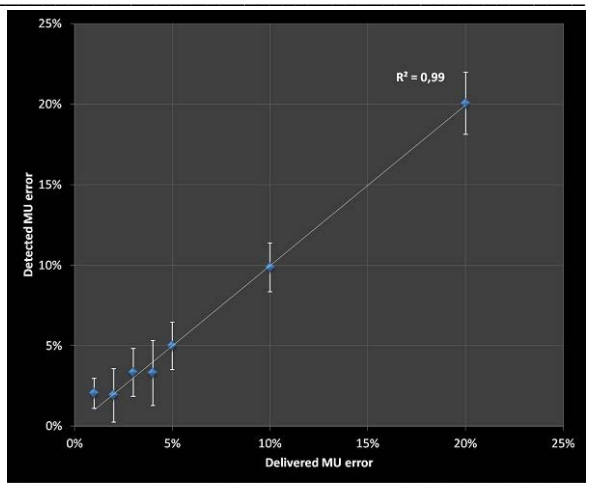

Figure 1 Correlation of MU detected vs. MU delivered with ad-hoc errors (1%,2%,3%,4%,5%,10%,20%)

Gantry angle (°)	MU error						
	1%	2%	3%	4%	5%	10%	20%
0	0,2%	1,0%	2,1%	1,8%	2,9%	7,9%	16,8%
20	2,5%	2,4%	3,1%	5,4%	4,1%	9,1%	21,1%
40	3,6%	4,6%	6,2%	5,6%	6,7%	12,3%	20,4%
60	1,4%	2,4%	3,1%	4,0%	5,4%	10,0%	20,3%
80	1,3%	0,8%	4,4%	2,7%	5,1%	9,1%	19,1%
100	2,4%	2,3%	3,5%	2,2%	4,5%	9,3%	19,6%
120	2,8%	1,2%	3,4%	3,6%	5,6%	9,3%	21,9%
140	1,6%	1,6%	4,8%	2,1%	4,4%	11,9%	18,9%
160	2,9%	2,8%	3,5%	3,3%	4,5%	8,4%	19,9%
180	1,8%	-1,8%	-0,3%	-0,4%	6,1%	9,2%	18,3%
200	1,8%	-0,4%	2,1%	0,9%	2,5%	9,3%	19,2%
220	0,9%	1,0%	1,4%	1,6%	2,5%	8,6%	18,7%
240	1,9%	1,7%	4,6%	3,3%	5,3%	8,9%	19,5%
260	2,8%	2,6%	3,8%	2,5%	5,6%	9,1%	20,1%
280	4,0%	5,2%	5,0%	8,0%	7,8%	12,9%	25,8%
300	2,1%	3,4%	3,1%	5,3%	4,5%	9,8%	20,5%
320	2,0%	3,4%	3,6%	4,5%	6,4%	12,0%	21,2%
340	2,0%	2,4%	4,6%	5,1%	6,8%	11,7%	22,4%

Table 1 Detected MU errors vs. Gantry angle

Conclusion: The system was shown to be stable for daily QA and could add many advantages to the patients' safety during treatment. Taking into account all the treatment factors, the detector provides punctual and cumulative output for each beam segment, which is compared in real time to each segment's expected value. The robustness of the measurement results suggests that the system could recognize errors or inadequate MU during the delivery. The significant signal deviation seen at particular gantry rotations could be investigated in order to improve the results obtained.

EP-1530

Machine performance check tool data analysis

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Purpose or Objective: Machine Performance Check (MPC) is a tool provided with Varian TrueBeam linear accelerators to verify, prior to treatment, that critical functions of the system are within the established tolerances. An evaluation carried out by Clivio et al. compared the results of the checks they made using the MPC application and their independent measurements. The purpose of this analysis is to compare the result obtained with the MPC tool at our institution with those acquired in the mentioned study.

Material and Methods: In order to perform the MPC checks, the IsoCal phantom has to be mounted to the couch top using an appropriate holder. The system acquires a series of MV and kV images and analyses them in order to obtain values for different parameters. Two distinct types of checks can be carried out with MPC: beam constancy checks and geometry checks. With the first ones beam output, uniformity and center shift can be evaluated. Geometry checks give us information about isocenter's size, imaging devices positioning, gantry, MLC, collimator, jaws and couch positioning. We analyzed the data obtained over 15 weeks of measurements in a TrueBeamSTx 2.0 with a Millenium HD120MLC and a DMI imager. Beam checks were done for all