Clinical implementation of calculation-based patient specific QA for lattice radiotherapy treatments

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INTRODUCTION

- Lattice radiotherapy (LRT) is a novel form of spatially fractioned radiation therapy used to de-bulk large tumors [1].
- A LRT treatment plan (shown in Fig 1) consists of multiple co-planar VMAT arcs that have been inversely optimized to deliver 3 Gy to the gross tumor volume (GTV) and 12-18 Gy to a 3D lattice of spheres contained the GTV.

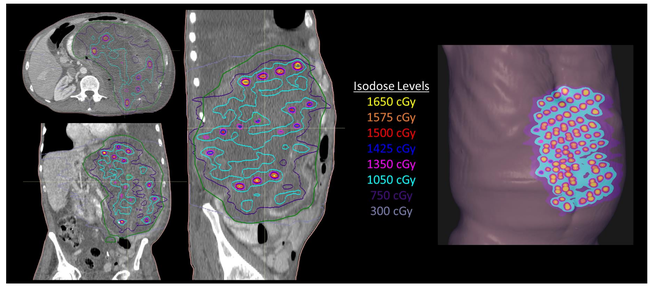

Fig 1. Illustration of an LRT treatment plan
(Left) Planar and (Right) 3D renderings of a LRT treatment plan dose distribution. The GTV is shown in green.

- These LRT plans are often highly modulated and contain many small fields. As a result, the accuracy of the 3D calculated dose needs to be verified – often with laborious measurement-base techniques.

Question: Could more time efficient calculation-based IMRT QA techniques be used instead for patient specific QA.

METHODS

Patient Cohort:
- 7 patients who were previously treated with LRT to the pelvis, abdomen and lung were evaluated in this study.
- We compared the results from measurement-based and calculation-based IMRT QA.

METHODS (CONT.)

Measurement-based IMRT QA:
- MapCheck 2 device was used for measurements.
- Two measurements were acquired with the device offset 5mm.
- These measurements were then merged into a single higher-resolution measurement using custom software (Fig 2).
- 2D gamma analysis was performed with a 3%, 3mm acceptance criteria using the high resolution measurement.

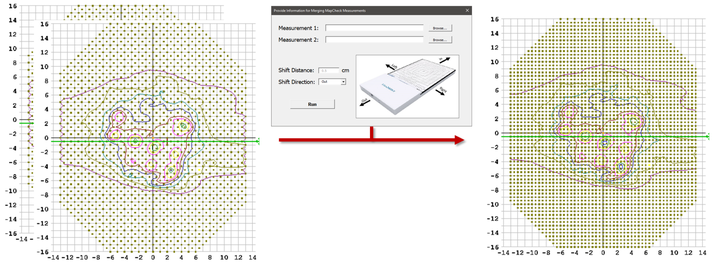

Fig 2. Overview of the measurement merging software
(Left) Two measurements were acquired with the device offset 5mm. A custom program (Middle) read the measurement files in and wrote a single higher-resolution measurement file (Right).

Calculation-based IMRT QA:
- Mobius3D was used for calculation-based IMRT QA.
- 3D gamma analysis was performed with a 3%, 3mm acceptance criteria using the original patient CT images.

Comparison:
- The 2D MapCheck gamma analysis results were compared with the 3D gamma analysis results from Mobius3D.
- Factors such as the treatment location, GTV volume, and the ratio of MU to prescription dose (modulation factor) were also recorded.

RESULTS

- The result of the gamma analyses are provided in Table 1.

Location	GTV Volume (cc)	Modulation Factor	Gamma Pass Rate (3%, 3mm) MapCheck	Mobius3D
Hip	798.18	4.59	99.8%	99.9%
Lung	758	4.75	98.4%	100.0%
Pelvis	1575.51	6.26	96.1%	99.6%
Lung	319.43	2.16	99.6%	100.0%
Pelvis	1626.69	7.15	99.5%	100.0%
Abdomen	6453.58	8.54	99.7%	99.8%
Lung	548.79	4.48	99.1%	99.9%

Table 1. Results of the gamma analysis along with patient & treatment related factors.

- The median (min, max) gamma-passing rate was 99.9 (99.6, 100) % with Mobius3D and 99.5 (96.1, 99.8) % with MapCheck. Neither the treatment location, GTV volume, nor modulation factor appeared to correlate with the passing rates.

DISCUSSION

- The overall gamma pass rates of LRT treatment plans agreed well between MapCheck 2 measurements and more time-efficient Mobius3D calculations.
- As a result, more time-efficient calculation-based IMRT QA can be used in place of measurements for LRT treatment plans when combined with weekly ML QA measurements to verify MLC delivery accuracy.

ACKNOWLEDGEMENTS

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REFERENCES

[1] X Wu, MM Ahmed, J Wright, S Gupta, and A Pollack. On Modern Technical Approaches of Three-Dimensional High-Dose Lattice Radiotherapy (LRT). Cureus 2(3): e9. doi:10.7759/cureus.9