Patient Specific Quality Assurance of Single Isocenter Multiple Targets Radiosurgery Plans Using a High-resolution Digital Detector Array

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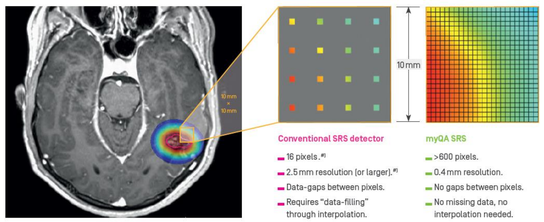
Introduction

Single isocenter multiple target (SIMT) radiosurgery treats several targets in the same plan and thus reduces treatment time significantly compared to single isocenter per target treatment. Besides the complicated treatment planning process, the patient specific quality assurance (QA) is often challenging due to limited detector resolution and active measurement area of the QA devices. A novel myQA SRS device includes a detector, a 3D phantom (Figure 1), and various inserts for film and ion chamber measurements. It uses the complementary metal-oxide technology (CMOS) and provides 0.4mm resolution (Figure 2). Additionally, the device has a large measurement area of 120x140 mm. This allows myQA SRS to be an effective tool for patient-specific quality assurance of SIMT plans, as well as for treatment planning system (TPS) commissioning.

Figure 1. myQA SRS device within the myQA SRS Phantom.

Figure 2. Comparison of resolution of 2D array device to myQA SRS.



Aim

An investigation was conducted to evaluate the performance of myQA SRS in patient-specific QA of SIMT plans. The effectiveness of using myQA SRS for TPS commissioning, including Elements, was quantified.

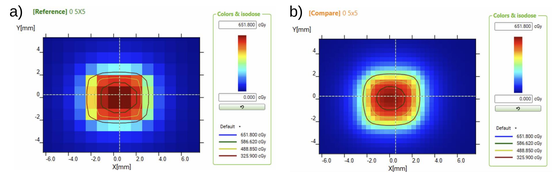
Methods

To investigate the potential of using myQA SRS for small field commissioning, a 5x5 mm, a 10x10 mm, and a 100x100 mm field sizes were created in the Elements TPS and measured with myQA SRS. Relative dose comparison was used to exam the field size. A 20x20 mm off-axis square field size and picket fence pattern created in Raystation were also measured with myQA SRS to further study the device's ability to be used for TPS modelling. Calculated and measured patterns were compared.

A single isocenter single target plan and a single isocenter multiple target plan were presented to show the efficiency of myQA for patient-specific QA. Gamma analysis were performed with 2mm distance to agreement (DTA), 2% dose difference (DD), global, and 10% threshold.

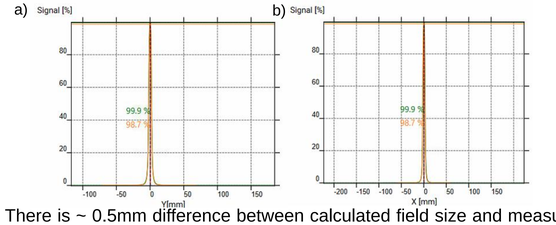
Results: TPS Commissioning

Figure 3. 5x5 mm MLC field created in Elements TPS. a) Calculated and b) measured.



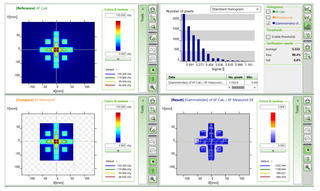
Calculated dose for a 5x5 mm MLC plan on the left compared to the measured dose on the right. Measured plan captures great resolution.

Figure 4. Relative dose comparison of calculated vs measured 5x5 mm MLC field. a) X-axis and b) y-axis.



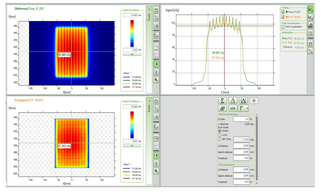
There is ~ 0.5mm difference between calculated field size and measured field size for 5x5 mm MLC field.

Figure 5. 20x20 mm jaw size off-axis square field created in Raystation.



Calculated and measured doses matched well for 6FFF.

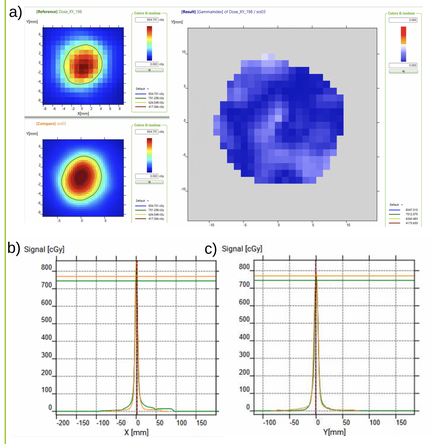
Figure 6. Picket fence pattern created in Raystation.



The resolution was great to provide feedback for MLC parameter adjustment.

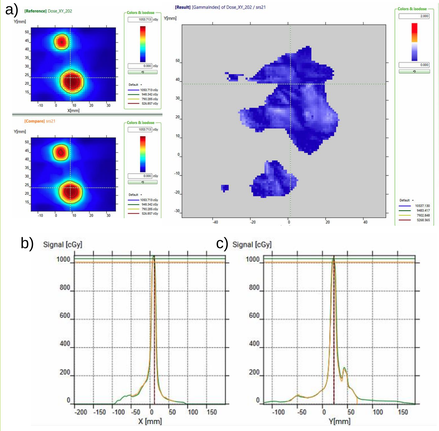
Results: Patient Treatment Plans

Figure 7. Single isocenter single target plan. a) Gamma map of calculated vs measured doses, b) absolute dose comparison along the x-axis, and c) absolute dose comparison along the y-axis.



Gamma index was 100% at 2mm DTA 2% dose DD.

Figure 8. SIMT plan. a) Gamma map of calculated vs measured doses, b) absolute dose comparison along the x-axis, and c) absolute dose comparison along the y-axis.



Gamma index was 100% at 2mm DTA 2% dose DD.

Conclusion

With high resolution comparable to that of film, the myQA SRS device provided accurate dose measurements for small field, which makes it an effective tool for TPS commissioning. The large active area and high resolution also improved the SRS/SBRT QA efficiency, especially for single isocenter multiple targets SRS plans.

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