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Abstract

An Evaluation of a High Resolution Film-Less Patient Specific Quality Assurance Solution for Mono-Isocentric Multiple Metastasis Radiosurgery Plans with Non-Coplanar Fields

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Objective(s): To evaluate a commercially available tool, SRS MapCheck/StereoPHAN (Sun Nuclear Corporation/SNC, Melbourne, FL) for suitability as a film-less quality assurance (QA) device for simple and complex stereotactic radiosurgery treatments involving multiple metastasis and non-coplanar fields.

Methods: The SRS MapCheck is a 2D array of detectors with a spacing of 2.47mm and an active array area of 77mm by 77mm. When embedded in the SNC StereoPHAN, it provides the buildup and geometry needed to perform measurements in non-coplanar field arrangements. The 2D array can be rotated in a vertical plane to acquire measurements in a coronal, sagittal and oblique plane. The device was calibrated for array relative sensitivity as well as absolute dosimetry following manufacturer specification for four photon fields, 6MV, 10MV, 6MV-FFF, and 10MV-FFF. Reference fields were planned and measured with a micro ion chamber, Exradin A16 (Standard Imaging, Middleton, WI), at an SAD of 100cm for the four photon energies. Simple plans involving open fields were also generated and delivered with field sizes ranging from 5x5mm to 5x5cm. The 2D planned and measured dose distributions were compared using the gamma index (GI) analysis with a 2% dose difference, 2mm distance to agreement and a 10% dose threshold, henceforth referred to simply as 2%/2mm GI criterion. Furthermore, we generated and delivered clinical volumetric modulated arc therapy (VMAT) plans based on targets whose maximum diameters were 5cm, 3cm, 1cm, 0.6cm, 0.3cm denoted PTV-Xcm (where X=diameter). Finally, we performed patient specific QAs on 4 previously treated cases that evaluated special functionalities of the phantom, namely Patient1-Couch45, Patient2-couch270 which were non-coplanar SRS plans with one arc at 45 and 270 degrees couch angle respectively; Patient3-SRSMapCheckArray-Sagittal, Patient4-SRSMapCheckArray-40deg, which were coplanar SRS plans with 2 targets and the SRS MapCheck 2D array oriented in the sagittal and 40 degree angle, respectively, to capture the multi-targets in a single measurement.

Results: The ion chamber measured dose agreed well with the planned dose with an observed percent difference of -1.10%, -2.27%, -0.68%, -1.59% for the 6MV, 10MV, 6MV-FFF, and 10MV-FFF energies respectively. Based on a 2%/2mm GI criteria, the average GI passing rate across all

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energies for the field sizes 5x5cm, 3x3cm, 2x2cm, 1x1cm, 0.5x0.5cm were 100%, 100%, 98%, 96%, 87% respectively. The corresponding analysis for the VMAT plans, PTV-5cm, PTV-2cm, PTV-1cm, PTV-6mm, PTV-3mm were GI passing rates of 100%, 100%, 100%, 97.1%, 100% respectively when an energy of 6MV-FFF were used and 100%, 99.6%, 99.5%, 99.1%, 98.3% respectively when 10MV-FFF were used. Finally, the results of the patient specific QA done on the stated previously treated cases were 100%, 99.5%, 97.2%, and 95.3% for Patient1-Couch45, Patient2-couch270, Patient3-SRSMapCheckArray-Sagittal, and Patient4-SRSMapCheckArray-40deg, respectively.

Conclusion(s): We have successfully evaluated the SRS MapCheck/StereoPHAN for use as a film-less QA device for SRS. Our results are satisfactory for targets as small as 3mm diameter and for complex plans involving non-coplanar fields. It should be underscored that these or similar validation tests should be performed at each facility before using the device for routine patient QA.