The myQA SRS detector: clinical validation to clinical application in SRS/SBRT Patient QA

Clinical evaluation confirms that IBA Dosimetry's myQA SRS provides a unique Patient QA capability, verifying stereotactic treatment plans with film-class resolution and the proven workflow efficiency of a digital detector.

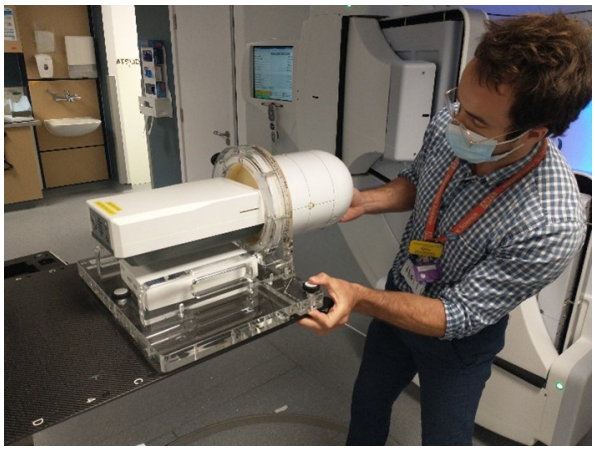
The myQA SRS is being billed as a "game-changer" when it comes to the complex task of verifying stereotactic treatment plans in the radiation oncology clinic – enhancing treatment quality, workflow efficiency and patient safety in the process. Developed by IBA Dosimetry, this next-generation 2D digital detector array is designed to support the medical physics team with patient-specific QA and commissioning of their stereotactic radiosurgery (SRS) and stereotactic body radiotherapy (SBRT) systems.

Following commercial release in March, IBA Dosimetry is now focused on real-world implementation, evaluation, and validation of myQA SRS in the clinical setting, synthesizing inputs from a mix of early-adopting customers and beta sites. The detector's capabilities are being tested by several clinics in the US and Europe, creating data on the benefits of myQA SRS for patient safety and throughput within the SRS/SBRT workflow. Related abstracts will be presented at the AAPM Annual Meeting in July and the ESTRO 21 Annual Congress in Madrid at the end of August.

Innovate, evaluate, validate

University Hospitals Bristol & Weston (UHBW) NHS Foundation Trust in the UK is testing the myQA SRS. Radiotherapy Physicist Chris Stepanek and UHBW's Head of Radiotherapy Physics, Sally Fletcher, carried out their evaluation of myQA SRS on Elekta Versa HD Linacs, using SBRT plans calculated in the RayStation v7.0 treatment planning system (TPS) for a range of beam energies and clinical indications (including spine, lung, liver and prostate).

In the clinic, the UHBW physicists integrated the detector into the cylindrical myQA SRS phantom (compatible with static and rotational delivery) or



Patient-focused QA: Chris Stepanek (above) of UHBW NHS Foundation Trust, UK, adjusts the myQA SRS set-up during a comprehensive evaluation of the detector, phantom and supporting software using SBRT plans for a range of beam energies and clinical indications. (Courtesy: UHBW NHS Foundation Trust)

in water-equivalent Scanplas. Field and plan measurements were subsequently compared to RayStation calculations using gamma analyses, also with commissioned plan verification systems (e.g., radiochromic film and IBA Dosimetry's CC04 ion chamber).

The emphasis on integrated product design is key to the combined detector–phantom assembly, minimizing uncertainties in set-up, calibration, and QA checks. "The detector comes with its own dedicated phantom and inserts for ion chambers and radiochromic film – all of which are straightforward to set up," Stepanek explains. "The myQA software is also very intuitive, enhancing ease of use and efficiency within the SRS/SBRT workflow."

Ease of use translates into a streamlined Patient QA workflow, sidestepping the lengthy and cumbersome process controls needed to get consistently accurate absolute dose data with film dosimetry. "For SRS/SBRT, QA is all about patient

Workflow efficiency: IBA Dosimetry's myQA SRS solution with the high-resolution detector (right) and advanced software (left) for streamlined SRS/SBRT patient QA measurements and plan validation.

safety and workflow efficiency," adds Fletcher. "As such, the myQA SRS detector will speed up time to treatment delivery for the patient, while providing reassurance that what your TPS has calculated is what your stereotactic treatment system is delivering. That reassurance is doubly important given the steep dose gradients implicit with SRS/SBRT modalities."

A new-look QA platform

In terms of the underlying technology, the myQA SRS detector is based on a silicon complementary metal-oxide-semiconductor (CMOS) platform. This enables a compact design, fast read-out, and high pixel density along the x and y coordinates (with each pixel representing a radiation-sensitive element comprising a photodiode, capacitor, and three transistors). Spatial resolution is 0.4 mm, with 105,000 pixels across an active area of 12×14 cm2.

Those specifications promise significant time savings for the QA of patients with several treatment volumes. There is no need for the physicist to choose which targets they want to QA when everything can fit in one irradiation session to verify the complex dose distributions required for mono-isocentric SRS plans with multiple targets.

The extreme physics of SRS/SBRT – focusing high-dose radiation very precisely on a small lesion and having it fall off as quickly as possible – remains a dosimetric and QA challenge for radiation oncology. It's not easy to confirm targeting accuracy and dose-distribution accuracy when the stereotactic treatment volume can be as small as a few millimeters in diameter.

While film provides excellent precision for dose resolution, it is cumbersome to use, time-consuming and temperamental, due to the uncertainties in handling, calibration, and development. Conversely, 2D diode arrays and ion-chamber arrays generate results rapidly but they lack the necessary spatial resolution and error-detection sensitivity for SRS/SBRT QA. "With myQA SRS, the accuracy versus efficiency trade-off no longer applies," claims Sandra Kos, product manager for Patient QA solutions at IBA Dosimetry. "It's that value proposition we set out to verify during our in-house evaluation of the detector in Q4 of last year and subsequently with the help of our clinical beta sites through 2021."

Quantitative validation

The main importance is in the dosimetric detail and the ability of the myQA SRS detector to verify dose distribution accuracy in minutes rather than hours and with the necessary spatial resolution for SRS/SBRT QA. Stepanek, Fletcher and their UHBW colleagues used ion-chamber measurements to assess myQA SRS dose linearity, dose-rate dependence, and field-size dependence. TPS calculations and radiochromic film enabled assessment of off-axis square fields and step-and-shoot off-axis stripes.

"We validated the performance of myQA SRS through the measurement of clinical plans and subsequent comparison with small-volume ion chambers, radiochromic film and TPS doses," explains Stepanek. "The project also evaluated the detector versus a variety of errors simulated within a selection of treatment plans, focusing in the main on sensitivity to single MLC position errors as well as gantry and collimator miscalibrations."

Stepanek will present full results of the UHBW study at ESTRO 2021. In summary, the detector demonstrated good dose linearity and good

dose-rate independence above 200 MU/min. Measurements of field-size dependence agreed well with small-volume ionization chambers, as did measurements of small off-axis fields versus TPS doses. Further investigations included the measurement of 6 MV and 6 MV FFF clinical plans with the detector integrated into the myQA SRS phantom. Those measurements demonstrated excellent agreement versus TPS doses, ion-chamber readings and radiochromic film.

Into the clinical workflow

Through the second half of this year, the UHBW medical physics team will continue its clinical evaluation of myQA SRS, while Kos and her colleagues are focused on collating feedback from customers and beta sites to inform the next phase of myQA SRS product development.

“Right now,” Kos adds, “the detector is validated and released for standard C-arm Linacs capable of delivering stereotactic treatments, though we already have further clinics working on operational validation of the detector with different treatment delivery machines.”

For more information about myQA SRS - visit: https://www.iba-dosimetry.com/future-of-pqa/

The University Hospitals Bristol & Weston (UHBW) NHS Foundation Trust in Bristol, UK. (Courtesy: UHBW NHS Foundation Trust)