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Evaluation of the RTI Dose Probe for Daily Superficial X-Ray Radiotherapy (SXRT) Output Constancy QA

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ABSTRACT

Purpose:
To evaluate the suitability of the RTI Dose Probe for monitoring daily output constancy of superficial X-ray radiotherapy (SXRT) units.

Methods:
The RTI Dose Probe, originally designed for radiology applications, was assessed for use in daily radiotherapy quality assurance (QA) on an Xstrahl 150 SXRT unit. The detector was housed in customised RW3 solid water, with an additional 2 mm RW3 build-up layer to provide mechanical protection. A 10 cm diameter, 15 cm source-to-surface distance (SSD) open-ended cone was positioned on top of the build-up. Measurements were acquired with a 30-second exposure. Commissioning tests were designed with the recognition that the detector's role was output constancy checks rather than absolute dosimetry. Detector response was evaluated across clinically relevant beam qualities (50–100 kVp). Performance metrics included dose linearity, short- and medium-term reproducibility, and sensitivity to output variations. Detector readings were compared with reference dosimetry measurements to establish baseline output values. Measurement uncertainty and detector stability were used to define appropriate daily QA tolerances and action levels.

Results:
The RTI Dose Probe demonstrated stable and reproducible performance suitable for daily output constancy verification of the Xstrahl 150 SXRT unit. Detected output variations showed good agreement with those measured using a reference ionisation chamber, indicating adequate sensitivity to identify early deviations in beam output.

Conclusions:
Although the RTI Dose Probe was originally developed for radiology QA, the absence of a robust, dedicated dosimetry system for daily output constancy in superficial radiotherapy motivated its evaluation for SXRT applications. The results indicate that the RTI Dose Probe is suitable for daily SXRT output constancy QA. This methodology may also be applicable to orthovoltage radiotherapy units.

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INTRODUCTION

Daily quality assurance (QA) in superficial radiotherapy (SXRT) is essential for ensuring accurate and consistent dose delivery. However, the absence of a simple, reliable, and robust dosimeter for daily constancy checks remains a challenge in routine QA, particularly for low-and medium-energy kilovoltage X-ray therapy units. This study investigated the use of the RTI Dose Probe (Figure 1), a solid-state PIN photodiode detector used in conjunction with the Cobia Sense system (RTI Group, Mölndal, Sweden), as a potential dosimeter for daily SXRT output constancy checks. Although originally designed for diagnostic X-ray dose measurements, the system was evaluated for its suitability in routine superficial radiotherapy quality assurance. Reproducibility, linearity, and sensitivity to changes in radiation output were assessed to determine its utility as a device for daily SXRT output constancy verification.

METHODS AND MATERIALS

The RTI Dose Probe (S/N: CB5-24070013) was evaluated for daily QA on an Xstrahl 150 (Xstahl LTD, Walsall, United Kingdom) SXRT unit. The detector was positioned within a custom-designed RW3 solid water slab containing a detector-conforming cavity and a 2 mm build-up layer to provide stable positioning and reproducible measurement geometry. A 10 cm diameter open-ended cone at a 20 cm source-to-surface distance (SSD) was positioned on top of the build-up (Figure 2). Detector response was evaluated across clinically relevant beam qualities with half-value layers (HVLs) ranging from 1 mm Al to 5 mm Al. The detector was irradiated perpendicular to the entrance window. Performance metrics included output, linearity, reproducibility, and sensitivity to output variations. 1% output changes were deliberately introduced to assess the detector's sensitivity. Detector readings were compared with reference dosimetry measurements to establish baseline output values. Measurement uncertainty and detector stability were used to define appropriate daily QA tolerances and action levels.

Figure 1. Cobia Sense & RTI Dose Probe

Figure 2. QA setup with 2mm buildup.

RESULTS

The RTI Dose Probe exhibited a linear response across the clinically relevant dose range, as shown in Figure 3. The detector was sensitive to introduced output variations, consistently tracking 1% changes in dose output with minimal deviation from the expected response (Table 1). Energy dependence was most pronounced for the 50 kV beam (HVL = 1 mm Al), while responses for all other clinically used beam qualities were within 3% (Table 2). Reproducibility testing under repeated setup conditions demonstrated consistent detector response (Figure 4) within 0.5%.

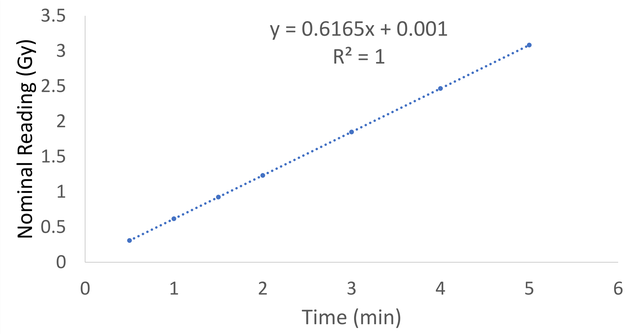

Figure 3. Linearity: detector response for exposure time from 0.5 – 5 minutes (5 mm Al filter)

Table 1. Sensitivity to output variation of 1%.

HVL (mm Al)	kV	mA	Detector response
1	50	30	1.3%
2	80	30	1.1%
3	100	30	1.2%
4	120	20	1.0%
5	120	20	1.0%

Table 2. Energy dependence of RTI Dose Probe for beam qualities between 1 mm AL and 5 mm Al.

HVL (mm Al)	kV	mA	Energy dependence
1	50	30	16.5%
2	80	30	3.2%
3	100	30	1.3%
4	120	20	1.2%
5	120	20	0.0%

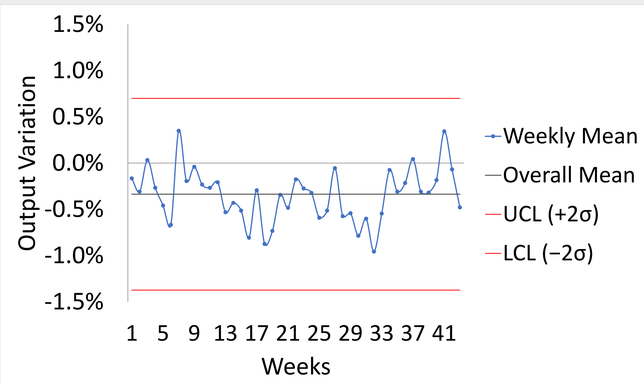

Figure 4. Reproducibility: Weekly mean output variation for a 100 MU exposure (5 mm Al filter).

DISCUSSION

The RTI dose probe was successfully commissioned for SXRT daily QA. Output measurements were consistent with the reference dosimetry system for all tested beam qualities and applicator configurations.

Measurable energy dependence was observed, with the largest deviation at 50 kV (HVL = 1 mm Al), while responses for higher-energy clinically used beams remained within 3% of the reference dosimetry system. This behaviour is consistent with the non–water equivalence of silicon and the energy dependence of photon interaction cross sections in kilovoltage beams. Although energy compensation is applied through filtration and inherent correction algorithms, residual differences persist, particularly at lower beam qualities where photoelectric interactions dominate.

The compact detector design and custom RW3 holder enabled reproducible setup geometry and reduced user-dependent positioning variability. The system provides instantaneous readout and does not require temperature or pressure corrections, reducing additional correction steps during routine use.

Baseline output values and daily QA action thresholds of 2% were established through repeated measurements.

This study was limited to output constancy QA and did not evaluate absolute dosimetry performance. Further work is required to assess long-term stability, radiation-induced response changes, and suitability for absolute dose measurements in SXRT.

CONCLUSIONS

The RTI Dose Probe demonstrated stable, reproducible performance with linear response, acceptable energy dependence, and sensitivity to output variations across clinically relevant SXRT beam qualities. These characteristics support its suitability for daily SXRT output constancy QA. The system's simplicity, rapid readout, and stable operation may facilitate routine clinical implementation. This approach has been implemented in our clinic for daily QA for nearly two a years, with no observed issues during this period. In addition, this approach may have potential applicability to orthovoltage radiotherapy QA systems.

REFERENCES

1. *Detector Data RTI Dose Probe*. Part No. 9630503-00, Version 2021.08A. Mölndal, Sweden (available at: R10https://rtigroup.com/wp-content/uploads/2021/08/9630503-00-RTI-Dose-Probe-Detector-Data-v2021.08A.pdf0 Detector Data).
2. Klein EE, Hanley J, Bayouth J, et al. Task Group 142 report: Quality assurance of medical accelerators. Med Phys. 2009;36(9):4197–4212. doi:10.1118/1.3190392.

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