Multipurpose real-time Flash IOERT dose detector

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Introduction

Currently, for the dosimetry of eFlash beams, the primary options are alanine dosimeters, Gafchromic films, and thermoluminescent detectors (delayed-read detectors with low reproducibility), specific ionization chambers (not applicable for clinical SSDs), and diamond detectors for relative dosimetry (expensive). The aim of this work is to evaluate the feasibility of using diodes as dosimeters for eFlash beams at clinical SSDs.

Materials and Methods

The study focused primarily on a 9 MeV eFlash beam (2 μs pulse at 90 Hz) at different clinical SSDs (23.3, 40, 49, and 50 cm) accessible with the IntraOp Mobetron accelerator. Beam quality was assessed using Gafchromic EBT-XD films and TLD-100 thermoluminescent detectors, calibrated with a 9 MeV electron beam from an Elekta Versa HD accelerator. The high-current transformer installed in the Mobetron head was used to control output stability.

In-vivo diodes and the Razor diode by IBA, along with their respective electrometers, the DPD3 and Dose-X, were tested. A Pico Technology oscilloscope was also used.

Results

Highly sensitive in-vivo diodes were found to be usable at SSDs of 50 and 49 cm. However, they slightly overestimated the dose by approximately 4% compared to film measurements. These diodes can be used for weekly checks of energy and dose per pulse using a simple plastic phantom equipped with inserts matching the depths described in IntraOp acceptance tests.

The Razor diode, being less sensitive, could be used at all SSDs without saturation, making it suitable for relative dosimetry (PDD, Output factor, profiles). For absolute dose measurements, the Razor diode overestimated the dose by approximately 9% compared to film at all SSDs.

Conclusion

When a correction factor is applied, diodes (direct-read, highly reproducible, and cost-effective detectors) are suitable for dose and energy control, relative dosimetry, and as in-vivo detectors for eFlash beams. Thanks to the use of different diodes and setups, critical information for eFlash dosimetry was easily observed and confirmed (e.g., PDD variation with pulse width, dose per pulse slightly dependent on pulse count, and dose per pulse also sensitive to frequency).