Feasibility study of patient-specific energy verification using a multilayer acrylic-disk radiation sensor

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Background: Obtaining an integral depth-dose (IDD) curve using a recently developed acrylic-disk radiation sensor (ADRS) is time-consuming because its single structure requires point-by-point measurements in a water phantom. The goal of this study was to verify the ability of a newly designed multilayer ADRS, composed of 20 layers, to measure the energy of proton pencil beam scanning (PBS) in patient-specific quality assurance (QA).

Materials and Methods: The multilayer ADRS consisted of a disk-type transmitter, with a diameter of 15 cm and with a thickness of 1 mm, surrounded by a thin optical fiber; this ADRS provided a higher spatial resolution than the single ADRS, which was 2 mm. The dosimetric characteristics of the multilayer ADRS were determined to accurately measure the energy delivered layer-by-layer. We selected five patients to verify the energy measured using multilayer ADRS from the actual clinical proton therapy plans. The accuracy of the results measured using the multilayer ADRS from the actual clinical proton therapy plans. The accuracy of the results measured using the multilayer ADRS was compared with that of measurements by a Bragg peak ionization chamber (IC) and that calculated by a Monte Carlo TOPAS simulation.

Results: The difference between multilayer ADRS measurements and those of the TOPAS simulation was within 1 % for all patients. The ranges, corresponding to the beam energies for each patient, measured using the multilayer ADRS were closer to those calculated using the TOPAS simulation than those measured using the Bragg peak IC.

Conclusions: The multilayer ADRS is well suited to verifying the energy of a pencil beam. The acrylic materials used in its configuration make this device easier to use and more cost-effective than conventional detectors. This device, with its high extensibility and stability, may be applicable as a new dosimetry tool for PBS.

Reference

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