A solid water pelvic and prostate phantom for imaging, volume rendering, treatment planning, and dosimetry for an RTOG multi-institutional, 3-D dose escalation study

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Abstract

Purpose: With increased interest in 3-D conformal radiation therapy and dose escalation, it is necessary to provide advanced techniques to assure quality in treatment delivery. Multi-institutional trials for these newer treatment techniques require methods of verifying the consistency of treatments between the participating institutions. For this reason, a phantom was designed to address the quality and consistency of Radiation Therapy Oncology Group (RTOG) 3-D prostate treatment protocol.

Methods and Materials: A solid water pelvic and prostate phantom for imaging, volume rendering, treatment planning, and dosimetry applications for performing comprehensive quality assurance has been designed and fabricated. Its configuration was based upon CT slices obtained from a patient study. Individual slices were machined with corresponding contours of the prostate, bladder, rectum, and the left and right femurs. Most of the phantom is made of solid water (Gammex/RMI, Middleton, WI), while the femurs are made of bone-equivalent material. The CT numbers from patient images were used to adjust the solid water composition within the organ volumes, providing image contrast from the remainder of the phantom. Cylindrical insertion grooves are machined in the phantom to allow placement of ionization chambers and thermal luminal dosimeters (TLDs) for dosimetry applications. During imaging, the cavities are filled with rods fabricated from solid water material.

Results: The phantom is being used to evaluate the consistency of a range of processes in radiation therapy simulation, planning, and delivery of 3-D-based treatments for prostate cancer.

Conclusion: The ultimate study objective is to use the phantom to evaluate the accuracy and consistency of treatments delivered by institutions participating in national collaborative clinical trials involving 3-D conformal dose escalation.

Keywords: 3-D Conformal radiotherapy, Quality assurance, Prostate phantom

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