Equivalence between Solid Water and printed ABS plates for 6 MV clinical photon beam - An assessment using thermoluminescent dosimetry

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Three dimensional models of anatomical structures produced by rapid prototyping are being adopted for medical application as hemodynamics studies and maxillofacial surgery planning. Models with geometrical accuracy can be achieved using medical images as MRI or CT and produced using polyurethane, polylactic acid and epoxy resins. Changing materials and densities is possible achieve the desired tissue-equivalence[1].

This work was developed in order to analyze the equivalence between the printed ABS and the Solid Water, by using the thermoluminescent dosimetry, in order to evaluate the viability of build a phantom for radiotherapy with a 3D printer.

The ABS plates with different thickness used in this study were printed using a 3D Printer model UP Plus 2, making use of the higher quality of impression ("Solid Honeycomb"[2]) which gives the strongest printed part. Solid water RMI-457 plates with different thickness were used as standard material. In order to analyze the results obtained by the measurements done with the TLDs it was done the planning of the irradiations using the planning treatment system Eclipse™.

The Analytical Anisotropic Algorithm (AAA) was applied to perform the calculus of absorbed dose. The comparison between the dose calculated by the AAA and the dose measured by TLD showed that the percentage between them was higher than 5%[3]. The calculus of the dose it was redone using the Acuros XB advanced dose calculation (AXB), presenting a difference less than 3% in all measured depths.

The depth dose percentage was then calculated. Comparing the depth dose for Solid Water and for ABS will be noted that the ABS seems not to have equivalence with the Solid Water since differences are higher than 5%, but it is not possible to affirm yet that ABS cannot be used to produce phantoms for clinical dosimetry. It is necessary to develop a phantom with different print qualities or using more than one printed material (e. g. printed PLA) to achieve the desired attenuation/scattering of the radiation.

Keywords: 3D print, percentage depth dose, ABS, thermoluminescence, Eclipse™, radiotherapy

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