Dosimetric response of ferrous gels in a low energy beam produced by a mini -accelerator

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Résumé

Purpose: The INTRABEAM® system is a miniature accelerator producing low energy photons (50 keV maximum). The published dosimetric characterization of the INTRABEAM system for flat and surface applicators [1, 2] was ased on detectors (radiochromic films or ionization chambers) not allowing measuring the absorbed dose in the first millimeters of the irradiated medium, where the dose is actually prescribed. This study aims at measuring the dose deposit produced with INTRABEAM surface applicators in the first millimeters by determining gel sensitivity with Magnetic Resonance Imaging (MRI).

Material and method: The irradiations at different dose levels were performed with the INTRABEAM® Carl Zeiss Surgical system (Oberkochen, Germany)]. The gel used in this study is a new " sensitis " material which is described by C. Stien et al and V. Dedieu et al [3, 4]. Gel irradiation in tin containers was carried out for twelve dose levels between 2 Gy and 50 Gy at the gel surface with a 4 cm surface applicator. In order to compare gel sensitivity at low energy with high energy, gels in tins containers were irradiated by a 18 MV photon beam produced by a Varian Clinac 2100 CD. T2 weighted multi echo MRI sequences were performed with 16 echo times and TR= 2000 ms. The response in T2 was determined on Matlab (Version 7.11, MathWorks, Natrick, MA, US).

Results: The T2 signal versus echo times can be fitted with a mono-exponential function with 95% of confidence. The calibration curve determined from experiments with tins

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at low energy is a linear function (R2=0.964) with a sensitivity of 0,0422 s-1.Gy-1. It is of the same order of magnitude as the gel sensitivity found from experiments at high energy (0.0391 s-1.Gy-1 with R2=0.924). The calibration curve at low energy was used to obtain Isodose maps from images (*Figure 1*). The PDD (Percent Depth Dose) determined in gel is similar to the one measured with an ionization chamber.

Conclusion: The dosimetric response of ferrous gels in a low energy beam produced by a mini -accelerator was determined with MRI measurements. It allowed measuring the dose distribution in particular in the first millimeters for an irradiation with the INTRABEAM® miniature accelerator equipped with a surface applicator. These results must be confirmed for the other diameters of surface applicators and for flat applicators as well.

Schneider et al., *J. Appl. Clin. Med. Phys.*, 2014

M. Goubert et al., *Physica Medica*, 2015

Stien et al., *Physica Medica,* 2015

Dedieu et al., *Physica Medica*, 2015

Mots-Clés: Gel, intrabeam, MRI, dosimetry