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In-vivo dosimetry in HDR brachytherapy with Fricke-gel catheters: preliminary results

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In-vivo dose measurements during complex conformal radiotherapy treatments are very important, in order to check the dose delivered to the patient and compare this dose with the prescribed one, improving in such a way the treatment quality. A method has been studied and developed aimed to perform in vivo dosimetry during brachytherapy treatments. The method is based on a radiochromic Fricke-gel injected in plastic catheters with length of 14 cm and external diameter of 0.3 cm. The gel is infused with a modified Fricke solution, having the following composition: ferrous sulphate solution [1mM $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$], sulphuric acid [25mM H_2SO_4] and Xylenol-Orange [0.165mM $\text{C}_{31}\text{H}_{27}\text{N}_2\text{Na}_5\text{O}_{13}\text{S}$]. The gelling agent was Agarose, in the amount of 3% of the final weight. Ionizing radiation produces a conversion of ferrous ions to ferric ions whose yield is proportional to the absorbed dose. The absorption spectrum of the chemical compound XO-Fe^{3+} has a peak around 585 nm, whereas the absorption spectrum of the non-bounded XO molecule has a peak around 430 nm. The dosimeter analysis is executed evaluating the variation in optical density, in the region of wavelengths around 585 nm, of the optical transmittance images detected by a CCD camera. Proper software was developed, to achieve light absorbance through dosimeters having cylindrical shape. After having outlined a suitable analysis protocol and developed the due software, the dose-response curve was studied. Finally, in-phantom measurements have been carried out, with a Microselectron (Nucletron, Veenendaal, The Netherlands) high dose-rate remote afterloading device. The resulting dose profiles were compared with the dose values calculated by the treatment planning system (TPS) along all the dosimeter position and the reliability of the proposed method was confirmed.

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