Comparison of dosimetry gels prepared by agar and bovine gelatine

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Abstract. Gel dosimeters are unique materials capable of showing three dimensional (3D) dose distributions of therapeutic or diagnostic exposures. Fricke gel dosimeters can be considered as chemical dosimeters that rely on a radiation-induced chemical reaction. Dose distribution of Fricke solutions containing Fe^{+2} ions determines the transformation of acidic, oxygen saturated Fe^{+2} ions to Fe^{+3} ions by the ionizing radiation in aqueous solutions. In this study we produced two different types of gel dosimeters using agar and bovine gelatin with similar fabrication methods. We compared the magnetic resonance (MR) T1 imaging responses of these two gel dosimeters to acquire a dose dependency of MR intensities. In conclusion agar gel dosimeters found to be produced easily and more consistent.

1. Introduction

Main purpose of treatment of cancer with radiation -briefly radiotherapy- is to expose previously diagnosed pathological volume of tissues with sufficient quantity of radiation dose to prevent the division or tumor cell proliferation and to realize this process with the least possible damage to normal tissues. During delivery of the prescribed dose to the patient it is critical to give radiation doses to specific organs (ie. eye, thyroid, spinal cord, adrenal glands, etc.) under standard threshold dose values for each organ.

Today, the determination of organ doses is measured during radiotherapy with point (ionization chambers, TLDs, diodes) or planar dosimeters (such as radiochromic films or 2D diode arrays). Therefore, the distribution of three-dimensional (3D) doses is needed to be measured with dosimetric systems [1].

The ferrous sulphate solution had been used for radiation dosimetry for a long time but firstly Gore [2] used magnetic resonance imaging to make possible three-dimensional radiation dosimetry. In a $FeSO_4$ doped gel the absorbed dose after exposure to ionizing radiation can be determined by optical absorption in the visible spectrum. Different reduction in the spin relaxation rates of hydrogen existing in aqueous solutions of ferrous and ferric ions can be used for the 3D determination of the absorbed dose [3].

The purpose of this study is to compare dose distribution of Fricke solutions containing Fe^{+2} ions doped in different gel matrix containing agar agar or bovine gelatin by performing MR T1 relaxation time measurements.

2. Materials and Methods

In this study we produced two different types of gel dosimeters using agar or bovine gelatin with similar fabrication method described by Gambarini et al [4] . Gelling agent added to previously heated water at 70°C. Solution was regularly stirred under an air flow at $20Lh^{-1}$ and heated to 100 °C. During the 20 min the solution was left to boil for saturation and then cooled down to 70 °C again. The acidic $FeSO_4$ solution was added and stirred for 5 minutes (Figure 1a). After that the gel was poured into the

polyethylene tubes for MR (Figure 1b). The samples were maintained at 4 °C until their analyses were done.

Figure 1. a) gel production assembly, **b)** the samples (after irradiation).

Prepared gels were irradiated with linear accelerator gamma radiation, dose rate of 300 cGy/min and energy 6MV, with doses between 50 and 350 cGy. The samples were maintained at least 30 min at room temperature before the MRI evaluations. The T1 weighted MRI signals were obtained by Siemens Symphony MR Scanner (1.5T), with quadrature head coil, using the TR= 367 ms, TI= 300ms and TE= 18 ms Inversion Recovery sequence parameters (Figure 2). Irradiation process and the MR measurements were performed within 24 hours after gel production for increasing the accuracy and sensitivity of the analysis.

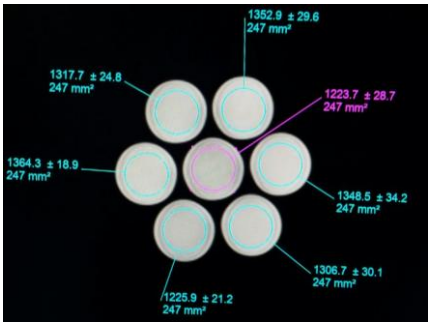

Figure 2. MR image of samples axial plane slice.

3. Results

Our initial results did not give a dose-intensity correlation with an expected linear slope. But at least there is a linear correlation for the agarose gel dosimeters we can say. A linear model can be shown between dose and MR intensity at Figure 3.

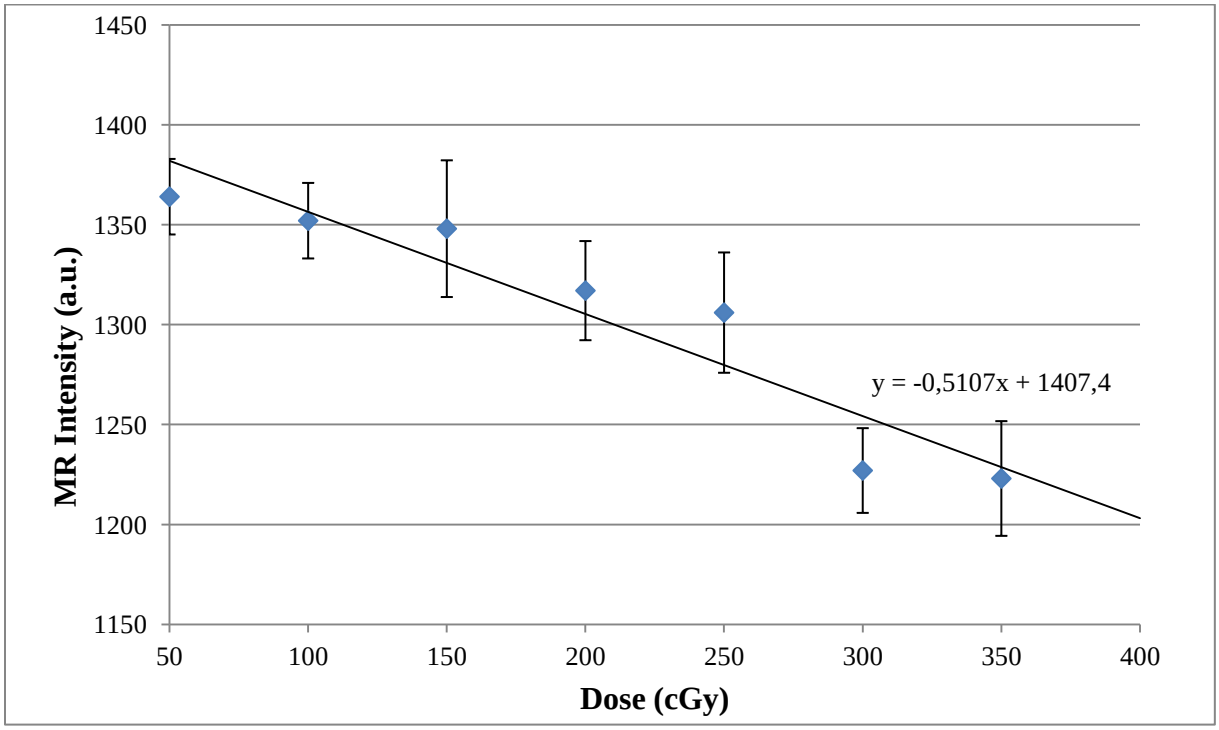

Figure 3. Dose-MR intensity response of agar gel dosimeters.

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