

# EVALUATION OF THE DOSE DISTRIBUTION GRADIENT IN THE CLOSE ENVIRONMENT OF BRACHYTHERAPY SEEDS USING ELECTRON PARAMAGNETIC RESONANCE IMAGING

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Brachytherapy uses permanently implanted radioactive sources (such as <sup>125</sup>I, <sup>103</sup>Pd or <sup>192</sup>Ir) to treat some types of tumor (prostate, eye). In this modality of cancer treatment, it is important to have a precise estimation of the dose delivered to the tumour and to the surrounding healthy tissues. Unfortunately the dose estimation in the near proximity of the radioactive source is not easy to measure. Most generally, this is performed using Monte Carlo simulations, which can give different results depending on the Monte Carlo codes used.

Experimentally, dosimetry could be achieved using thermoluminescent (TLD) dosimeters. However, it remains challenging to obtain data with a high spatial resolution due to the large gradient of dose and the very low dose rate. In this context, there is still a need for the development of experimental methods allowing the estimation of the dose deposited in the proximity of brachytherapy seeds. The present study is a first attempt to develop a new method based on the reconstruction of dose by the use of Electron Paramagnetic Resonance Imaging (EPRI).

Although alanine is the most known dosimeter material, formates (salts of formic acid) were suggested as alternative to alanine a couple of years ago. Lithium formate is about six times more sensitive than alanine, and more tissue equivalent. Its radiation-induced EPR spectrum consists of a single line, a particularly convenient property for imaging purpose using EPRI.

We used L-band EPRI as a tool to experimentally evaluate the spatial dose distribution and to apply the proof-of-concept to the reconstruction of gradient of doses surrounding brachytherapy seeds. For that purpose, we developed large cylindrical tablets of lithium formate, and holes were drilled inside the pellets to allow the insertion of brachytherapy <sup>125</sup>I seeds. EPR images were carried out on pellets irradiated by one or two seeds. Experimental data were compared to Monte Carlo simulations using MCNP version 4 code.

Experimental results showed that the dose gradient can be determined using 2D EPR images. Overall, the method offers linearity of response with increasing doses, high sensitivity, and reproducible homogeneity of signal in areas irradiated at the same doses. Quantitative data correlated with the dose profile obtained by Monte Carlo simulations, although shape differences between the curves were observed. This study provides a first proof-of-concept to estimate the gradient dose distribution in phantoms after irradiation using EPRI.