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Retrospective Dosimetry Using Fingernail EPR Response

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Abstract

Human fingernails were utilized to estimate the radiation dose via EPR measurements of radiation-induced radicals. The limiting factors in this research were mechanically induced EPR signals due to the mechanical stress during the preparation of the samples. Thus, different treatment methods of fingernails were used to reduce the mechanically induced signals. The results demonstrate that the mechanically and radiation induced signals have apparently different microwave power saturation behaviors. Also, the mechanically induced signal shows a fading evolution over time and reaches a constant value. Chemical treatment using the different reagents showed that the minimum mechanically induced signal was obtained using the dithiothreitol reagent. The dose response curves of the samples treated with dithiothreitol for 30 min demonstrated a greater linearity in comparison to those of samples treated for 5 min. Therefore, to find an unknown absorbed dose in a fingernail sample by using a calibration curve, we recommend adopting the mentioned chemical treatment procedure to reduce the uncertainty.

Keywords: EPR spectroscopy, Retrospective dosimetry, Fingernail, Radiation accident

1. Introduction

Since the second half of the twentieth century, a variety of releases of radioactive materials from industrial facilities and military program activities, or overexposure of persons by the improper use and disposal of radiation sources, has been experienced. These events resulted in a broad range of ionizing radiation exposure to a considerable number of people. Experience has proved that despite all precautions, radiation accidents occur. According to the Radiation Emergency Assistance Center/Training Site Radiation Accident Registries, in the period of 1944–2004 there were 421 major radiation accidents worldwide [1]. Therefore, the development of a non-invasive and reliable method that can produce results immediately after a radiation event is highly demanded for measuring radiation dose. Electron paramagnetic resonance (EPR) biodosimetry is a physical method based on measurement of the stable radiation induced radicals in calcified tissues of the human body [2-7]. The application of this method for future assessment of radiation risk coefficients in epidemiological cohorts is relatively recent, having started 5–7 years ago. The individual dose can best be reconstructed

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