EPR Dosimetry in Irradiated Fingernails

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Presentado en: EPR BioDose 2010.
Mandelieu, La Napoule, Francia, 10 al 14 de octubre de 2010.

EPR DOSIMETRY IN IRRADIATED FINGERNAILS

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The Electron Paramagnetic Resonance (EPR) is being transformed in a complementary tool of biologically-based methods for evaluation of dose after accidental radiation exposure. Many efforts are being carried out in laboratories to evaluate the performance of different materials for its use in EPR doses measurements and for improving the current methods for spectrum analysis and calibration curves determinations.

In our country the EPR techniques have been used in different areas with dosimetric (alanine) and non dosimetric purposes. Now we are performing the first studies to obtain properly dose response curves to be used for accidental dose assessments through irradiated fingernails. It is by now well known that the fingernails present two types of signals, a background one (BKS), originated in elastic and inelastic mechanical deformations and the radio induced one (RIS), object of interest (I). In this work we will present some of the previous studies performed to characterize the fingernail samples and we analyse the additive dose method for data obtained employing the technique of the substraction of the spectrum recorded at two different microwave powers in order to reduce the BKS signal. Fingernail samples collected from different donors were treated by soaking in water during 10 min and 5min drying on paper towel and the BKSsignals were studied previously its irradiation. The stadistical analisys (R statistics) show a distribution with a Standard Deviation of 24% respects to its media. During these studies we also conserved in freezer for more than 6 months irradiated fingernails that, were periodically measured and the statistical analysis of the peak to peak amplitude show a normal distribution through the Quantile correlation test with a SD 11% respected to its median.

(I) Reyes RA, et ál. Electron paramagnetic resonance in human fingernails: the sponge model implication. Radiat Environ Biophys.4:515-26 (2008).

Keywords: EPR/fingernails; Biophysical indicators of exposure; Post accident dosimetry

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ABSTRACT

The Electron Paramagnetic Resonance (EPR) is being transformed in a complementary tool of biologically-based methods for evaluation of dose after accidental radiation exposure. Many efforts are being carried out in laboratories to evaluate the performance of different materials for its use in EPR doses measurements and for improving the current methods for spectrum analysis and calibration curves determinations.

In our country the EPR techniques have been used in different areas with dosimetric (alanine) and non dosimetric purposes . Now we are performing the first studies to obtain properly dose response curves to be used for accidental dose assessments through irradiated fingernails. It is by now well known that the fingernails present two types of signals, a background one (BKS), originated in elastic and inelastic mechanical deformations and the radio induced one (RIS), object of interest [1]. In this work we will present some of the previous studies performed to characterize the fingernail samples and we analyse the additive dose method for data obtained employing the technique of the subtraction of the spectrum recorded at two different microwave powers in order to reduce the BKS signal . Fingernail samples collected from different donors were treated by soaking in water during 10 min and 5min drying on paper towel and the BKS signals were studied previously its irradiation. The stadistical analisys (R statistics) show a distribution with a Standard Deviation of 24% respects to its media. During these studies we also conserved in freezer for more than 6 months irradiated fingernails that, were periodically measured and the statistical analysis of the peak to peak amplitude show a normal distribution through the Quantile correlation test with a SD 11% respected to its median.

INTRODUCTION

As it is well known, ionizing radiation generates free radicals in nails and other keratin- reach materials. These species can be detected by EPR spectroscopy by the so called radiation-induced signal (RIS) that increases with the dose, thus showing its potential as biodosimeter.

Their main advantages are the requirement of non-invasive samples from individuals, simple sampling processing and enough sensitivity in the range of clinically-relevant doses.

However, one problem encountered is the presence of two non-radiation signals generated by mechanical cutting of fingernails that ov RIS spectrum.

Different strategies were proposed to preferentially remove th of these Mechanically Induced Signals (MIS1 and MIS2) from irradiated nails.

In this work we present some of the previous studies characterize the fingernail samples and we analyse the method to obtain properly dose response curves for data o samples treated by soaking in water prior irradiation and the the spectrum recorded at two different microwave powers reduce both MIS signals [1,2]

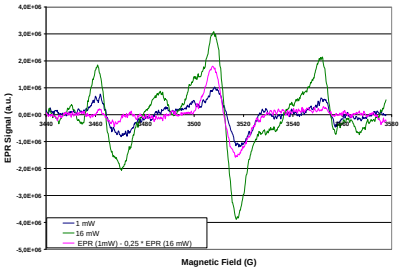

Fig 1. Subtraction of the spectrum of an irradiated sample acquired at 16mW, multiplied by (1/16)1/2, from that acquired at 1mW. Two of the six lines of the Mn^{+2} in CaO was used as standard

signals were studied previously its irradiation. The statistical statistics) show a distribution with a SD of 23% respects to

During these studies irradiated fingernails were conserved in freezer for more than 6 months and were periodically measured. The statistical analysis of the peak to peak amplitude show a normal distribution through the Quantile correlation test with a SD 11% respected to its median (Fig 2 A, B)

MATERIALS and METHODS

Fingernail samples were collected from adult volunteers at different times. Each sample consisted of 5 pieces of 1-2 x 5-6 mm, totalling 25-30 mg. Prior to irradiation, the nail clippings were soaked in distilled water for 10min and dried 5min on a paper towel.

A Co60 GammaCell 220 (AECL) irradiator with a dose rate of 0.4Gy/min was used for irradiation.

EPR spectra were obtained on a Bruker EMX 10/2,7 spectrometer, at room temperature with the following acquisition parameters: Microwave power: variable, Modulation amplitude: 5G; HF modulation: 100kHz; time constant: 81.92ms, Sweep time: 41.93s, Number of scans: 10.

EPR measurement were repeated at least three times and normalized to weight

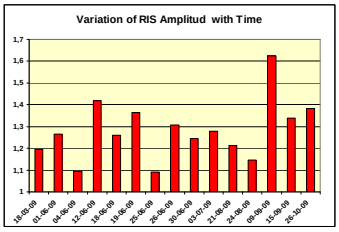

Fig 2A

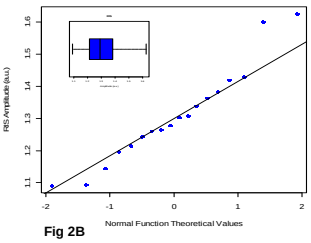

Fig 2B

RESULTS and DISCUSSION

We start trying to characterize the radio-induced signal and the overlapping non-radiation signals.

As it has been shown, the soaking of samples in water shortly after cutting, eliminates the MIS1 and significantly reduces the MIS2 (1,2)

As Proposed, in order to eliminate the contribution of the residual MIS2, the spectrum recorded at 16mW was modified by the factor $(1/16)^{1/2}$ and substracted from the spectrum recorded at 1mW (Fig 1).

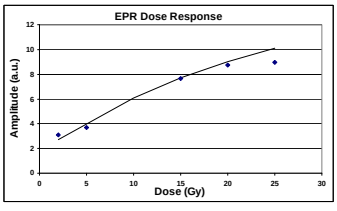

Fig 3

Taking into account these previous studies, the optimal conditions for measurement were determined and EPR spectra of samples irradiated at different doses were used for the developing of Dose-Response curves by the additive dose method (Fig 3)

REFERENCES

1- Reyes RA, et al. Electronic paramagnetic resonance in irradiated fingernails: variability of dose dependence and possibilities of initial dose assessment Radiat Environ Biophys. 48:295-310 (2009)

2- Reyes RA, et al. Electron paramagnetic resonance in human fingernails: the sponge model implication.Radiat Environ Biophys.47:515-26 (2008).

In our country the EPR techniques have been used in different areas with dosimetric (alanine) and non dosimetric purposes . Now we are performing the first studies to obtain properly dose response curves to be used for accidental dose assessments through irradiated fingernails. The benefits of the technique as a complementary tool in biodosimetry justify continuing the effort