Electron Paramagnetic Resonance dosimetry in fingernails

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Abstract

Based on the capabilities of new instrumentation and the experience gained in the use of teeth for "after-the-fact" dosimetry, we have undertaken a systematic electron paramagnetic resonance (EPR) study of irradiated fingernails. There have been only a modest number of previous studies of radiation-induced signals in fingernails. While these have given us some promising aspects, overall results have been inconsistent. The most significant problem of EPR fingernail dosimetry is the presence of two signals of non-radiation origin that overlap the radiation-induced signal (RIS), making it almost impossible to do dose measurements below 5 Gy. Historically, these two non-radiation components were named mechanically-induced signal (MIS) and background signal (BKS). In order to investigate them in detail, three different methods of MIS and BKS mutual isolation have been developed and implemented. Having applied these methods, we were able to understand that fingernail tissue, after cut, can be modeled as a deformed sponge, where the MIS and BKS are associated with the stress from elastic and plastic deformations respectively. A sponge has a unique mechanism of mechanical stress absorption, which is necessary for fingernails in order to perform its everyday function of protecting the fingertips from hits and trauma. Like a sponge, fingernails are also known to be an effective water absorber. When a sponge is saturated with water, it tends to restore to its original shape, and when it looses water, it becomes deformed again. The same happens to fingernail tissue. Our suggested interpretation of the mechanical deformation in fingernails gives also a way to distinguish between the MIS and RIS. Obtained results show that the MIS in irradiated fingernails can be almost completely eliminated without a significant change to the RIS by soaking the sample for 10 minutes in water. This is an ongoing study but even at its present state of development, it has shown that it is quite possible that it will be feasible to use fingernails as an indicator of the severity of radiation exposure in individuals. The findings in this study set the stage for understanding fingernail EPR dosimetry and doing in-vivo measurements in the future. The final goal of this work is to develop an accurate retrospective dosimetry methodology that could be used to determine if potentially exposed populations have received exposures to radiation doses that could be life threatening.

KEYWORDS: External dosimetry, accidents, fingernails, Electron Paramagnetic Resonance.

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