APPLICATION OF EXPERIMENTAL AND NUMERICAL METHODS FOR ESTIMATION OF UNCERTAINTIES IN EPR TOOTH DOSIMETRY

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Currently, Electron Paramagnetic Resonance (EPR) dosimetry of tooth enamel is practically the only method of retrospective personal dosimetry. In spite EPR tooth dosimetry is now widely applied, the problem of uncertainty analysis of the method still exists. EPR dosimetry of teeth is a multi-step procedure that includes sample preparation, instrumental measurement, spectra processing and calibration. Each step of the method influences the total uncertainty. Moreover, individual variability of radiation sensitivity and quality of a sample are those features of biological samples that also influence the uncertainty.

One of the problems in evaluation of uncertainty is that different factors that influence the total uncertainty cannot be separated. Another problem is that blank samples are absent resulting into a lack of calibration standards. Each tooth extracted for medical indications has its own age that starts from hydroxiapatite formation. Due to natural radiation exposure there are not any tooth enamel with zero dose. Therefore, each tooth accumulates some unknown dose doe to natural background.

For the reasons above, the accuracy of EPR dosimetry is not a trivial task. This study developed a new approach for estimation of the uncertainty using combination of physical and numerical (Monte Carlo simulation) experiments. The experimental basis of this work was the results of intercomparison of three EPR laboratories: GSF (Munich, Germany); ISS (Rome, Italy) and IMP (Ekaterinburg, Russia).

Results of the study show that EPR measurement uncertainty depends on both amplitude of signal and sample mass. Moreover, statistical modeling of EPR signal demonstrates the presence of not only a random error of signal evaluation but also a systematic bias of spectra processing that depend on an amplitude.

Proposed algorithm for uncertainty estimation can be applied for any method of EPR dose reconstruction and can be useful for finding ways for reduction of the uncertainty.

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