In Vivo EPR Tooth Dosimetry

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Previously, EPR spectroscopy has been applied to perform retrospective radiation biodosimetry using extracted samples of calcified tissues following radiation accidents and exposures resulting from weapon use, testing, and production. Dose estimates are based on the quantitative measurement of radiation induced free radicals produced in hard tissues such as bone and teeth, and typically involve measurements with several added doses to provide dose calibration. While this technique is well suited for use in limited populations following known exposures, its use as a tool to perform triage after an event where a large number of people have potentially been exposed to clinically relevant doses is limited by the need to extract the tissue. In order to meet the need for large-scale biodosimetry, likely in concert with complementary biologically based techniques, at Dartmouth Medical School we have developed techniques to perform EPR dosimetry using intact teeth. *In vivo* EPR tooth dosimetry has several very desirable characteristics for triage, including independence from confounding biologic factors, non-invasive measurement procedure, capability to make measurements at any time after the event with immediate estimation of the dose, and the developing ability to perform measurements with non-expert users in the field at the site of an event.

The ability of *in vivo* tooth dosimetry to provide estimates of absorbed dose has been established through a series of experiments using unirradiated volunteers with specifically irradiated teeth placed *in situ* within gaps in their dentition and in patients who have completed courses of radiation therapy for head and neck cancers. *In vivo* measurements have been performed using molar, premolar, and canine teeth. Multiple measurements in individual patients demonstrate the expected heterogeneous dose distributions. Dose response curves have been generated using both populations and, using the current methodology and instrument, the standard error of prediction is approximately 150cGy based on 4.5 min measurements. Averaging of independent measurements can reduce this error significantly. While such averaging may not be practical when deployed in the field, this result provides us with important insights as to the factors that need to be improved and that, with these improvements, the technique would be appropriate for effective triage. In summary, it seems plausible that the EPR dosimetry techniques will have an important role in retrospective dosimetry for exposures involving large numbers of individuals.

Research supported by NIH (U19AI067733) and DARPA (HR0011-08-C-0023)