GRADIENT DOSE DISTRIBUTION IN IRRADIATED BONES STUDIED BY EPR IMAGING: A FEASABILITY STUDY

Levêque, Philippe[1]; Godechal, Quentin [1]; Trompier, François[2]; Gallez, Bernard [1].

[1]Biomedical Magnetic Resonance Unit, Université catholique de Louvain, Av. Mounier 73-40, B-1200 Brussels, Belgium
[2] Institut de Radioprotection et de Sûreté Nucléaire, BP 17, F-92265 Fontenay-aux-roses, France
Corresponding author: bernard.gallez@uclouvain.be

EPR has been successfully used for retrospective biophysical dosimetry of victims exposed to ionising radiations, in the absence of a conventional dosimeter. This technique uses the stable carbonate free radical induced by radiations in hydroxyapatite, present in tooth enamel. Retrospective dosimetry is nevertheless not limited to teeth. Bones also exhibit an EPR signal[1]. Several human fingers overexposed during radiation accidents were recently studied either by X- or L-band EPR spectroscopy[2,3]. A precise knowledge of the irradiated areas that risk necrosis is of great interest because it could allow surgeons to assess which zone has to be amputated. Spectroscopy is not able to give spatial information, unless if invasive sampling is used, whereas EPR imaging can give a 2D or 3D map of the spin density distribution within a sample.

In this study, we investigate the possibility of using EPR Imaging for delineating the regional dose distribution and gradient profiles of irradiated bone samples.

Samples of human bones were irradiated by X or γ-rays, either with a continuous gradient of dose or with a stepwise gradient. Tablets of compressed synthetic hydroxyapatite were also used under the same conditions for comparison. 2D and 3D images were acquired in X-band on a Bruker E540 Elexsys system equipped with a Super High Sensitivity Probe.

Preliminary results show that the map of the spatial spin density distribution measured on 2D or 3D images correlates with the known profile of the dose gradient. In hydroxyapatite phantoms, a proportional signal is observed between the different irradiated areas under stepwise gradients. For continuous gradients, gradient profiles are somewhat smoothed, probably because of the limited resolution due to large line-width of the CO_2^- radical EPR signal.
In bones, tissue density seems to be a concern for unambiguous measurements. Best results are obtained for compact bone, and are, in first approximation, similar to those obtained with hydroxyapatite phantoms.

References

1. Swartz HM,Radiation research **24**: 579-86 (1965)
2. Zdravkova M, Vanhaelewyn G, Callens F, Gallez B, Debuyst R, Spectrochim Acta A: **61**:3131-8 (2005)
3. Zdravkova M, Crokart N, Trompier F, Beghein N, Gallez B, Debuyst R Phys. Med. Biol. **49**:2891-98 (2004)