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Airway deposition and health effects of inhaled radon progenies

I. Balásházy, Á. Farkas and I. Szőke

Health and Environmental Physics Department, Hungarian Academy of Sciences KFKI Atomic Energy Research Institute, Konkoly Thege M. út 29-33, 1121 Budapest, Hungary

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Inhaled radon progenies provide more than the half of natural radiation exposure. There is increasing evidence that the cellular distribution of radiation burden is an important factor regarding the biological response to ionisation radiation, thus, one of our tasks was the characterisation of the distribution of cellular exposure.

Histological studies of former uranium miners presented strong correlation between primer deposition hot spots and neoplastic lesions. Most of these lesions were located along the carinal regions of the large bronchial airways. In the present work, computational fluid dynamics (CFD) approaches have been applied to simulate the deposition distribution of inhaled radon progenies along central human airways. The geometry and the cellular structure of epithelial lung tissue were numerically reconstructed based on anatomical and histological data. Single and multiple alpha-hit and cellular dose distributions have been computed applying Monte Carlo modelling techniques at different breathing conditions.

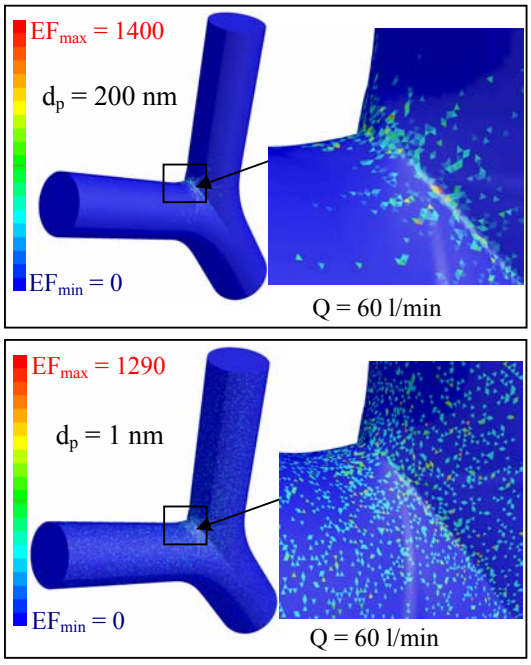

Figure 1. Deposition enhancement factor (EF) distribution of attached, 200 nm, and unattached, 1 nm, diameter inhaled radon progenies on a central airway bifurcation in airway generations 4-5 during light physical activity breathing condition. Size of scanning surface element is a 45μm side triangle.

Values of local per average deposition densities, that is, enhancement factors (Figure 1), hit probabilities (Figure 2) and doses may be up to two-three orders of magnitude higher in the deposition hot spots than the average values. Dose calculations revealed that some cell clusters may receive high doses even at low exposure conditions.

Applying the model to different radiation exposure conditions useful relations can be received regarding the linear-nonthreshold hypothesis.

Ultrafine deposition distributions can be experimentally validated by the measurement technique of Jani et al. 1999.

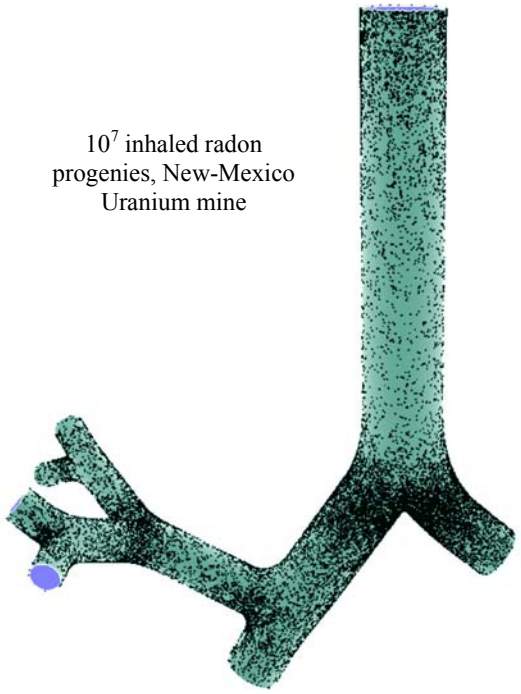

Figure 2. Distribution of cell nuclei hit with alpha particles in the epithelium of airway generations 1-5, leading to the right upper lobe.

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Jani P., Nagy A., & Czitrovszky A. (1999). *SPIE* Vol. 3749, 458-459.