A Multiscale Computational Model of the Response of Swine Epidermis after Acute Irradiation

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ABSTRACT

Radiation exposure from Solar Particle Events can lead to very high skin dose for astronauts on exploration missions outside the protection of the Earth's magnetic field [1]. Assessing the detrimental effects to human skin under such adverse conditions could be predicted by conducting territorial experiments on animal models. In this study we apply a computational approach to simulate the experimental data of the radiation response of swine epidermis, which is closely similar to human epidermis [2]. Incorporating experimentally measured histological and cell kinetic parameters into a multiscale tissue modeling framework, we obtain results of population kinetics and proliferation index comparable to unirradiated and acutely irradiated swine experiments [3]. It is noted the basal cell doubling time is 10 to 16 days in the intact population, but drops to 13.6 hr in the regenerating populations surviving irradiation. This complex 30-fold variation is proposed to be attributed to the shortening of the G_1 phase duration. We investigate this radiation induced effect by considering at the sub-cellular level the expression and signaling of TGF-β, as it is recognized as a key regulatory factor of tissue formation and wound healing [4]. This integrated model will allow us to test the validity of various basic biological rules at the cellular level and sub-cellular mechanisms by qualitatively comparing simulation results with published research, and should lead to a fuller understanding of the pathophysiological effects of ionizing radiation on the skin.

References:

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