ION TRACKS AND CELLULAR REPAIR MECHANISM OBSERVED IN RADIATION DOSE RESPONSE CURVES

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Chromosome aberrations (CA) are considered as the most sensitive and reliable indicator of radiation action with living cells and in fact remain the only valuable method in bio-dosimetry. The corresponding dose-response curves are usually described by a linear-quadratic model using the tissue specific α and β parameters. The ab initio Monte Carlo simulations can describe formation of the ion track structures but still fail in the description of the final biological effect of irradiation – the number of chromosomal aberration or the shape of survival curves. Thus, phenomenological models are necessary to include the biological effects, such as dependence of the repair mechanisms on dose and radiation quality. Especially, the low relative biological effectiveness (RBE) of fast protons remains one of the most important questions which is also important for practical application of the proton radiotherapy.

In the present work, we investigated CA in human lymphocytes induced by 150 MeV and spread out Bragg peak (SOBP) proton beams, 199 MeV/u ^{12}C and 22 MeV/u ^{11}B ions and, for comparison, by ^{60}Co γ rays.

We studied biological response based on dose effect curves and statistical distribution of chromosome aberration. The quadratic term of the dose-effect curves, assumed to result from overlapping ion tracks, was used to study an effective interaction track radius. Based on a simple analytical model, a comparison with the physical radii was possible. The experimentally determined effective track radii turned out to be larger than the physical expectations by about one order of magnitude. Thus, we can conclude that the biological effects of cellular repair processes determine the main contribution to the quadratic term of the dose-effect curves. That supports our observation of a nearly independence of the quadratic parameter of the beam quality. Additionally, the dose dependence of the efficiency of the repair mechanisms could be estimated.

Bibliography

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