Bystander effects induced by direct and scattered radiation generated during penetration of medium inside a water phantom
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ABSTRACT
Background: The biological effects of ionizing radiation have long been thought to result from direct targeting of the nucleus leading to DNA damage. Over the years, a number of non-targeted or epigenetic effects of radiation exposure have been reported where genetic damage occurs in cells that are not directly irradiated but respond to signals transmitted from irradiated cells, a phenomenon termed the “bystander effects”.
Aim: We compared the direct and bystander responses of human A 549, BEAS-2-B and NHDF cell lines exposed to both photon (6 MV) and electron (22 MeV) radiation inside a water phantom. The cultures were directly irradiated or exposed to scattered radiation 4 cm outside the field. In parallel, non-irradiated cells (termed bystander cells) were incubated in ICM (irradiation conditioned medium) collected from another pool of irradiated cells (termed donor cells).
Materials and methods: In directly irradiated cells as well as ICM-treated cells, the frequency of micronuclei and condensation of chromatin characteristic for the apoptotic process were estimated using the cytokinesis-block micronucleus test.
Results: In all tested cell lines, radiation induced apoptosis and formation of micronuclei. A549 and BEAS-2B cells cultured in ICM showed increased levels of micronuclei and apoptosis, whereas normal human fibroblasts (NHDF line) were resistant to bystander response. In A549 and BEAS-2B cells placed outside the radiation field and exposed to scattered radiation the formation of micronuclei and induction of apoptosis were similar to that after ICM-treatment.
Conclusion: Results suggest that the genetic damage in cells exposed to scattered radiation is caused by factors released by irradiated cells into the medium rather than by DNA damage induced directly by X rays. It seems that bystander effects may have important clinical implications for health risk after low level radiation exposure of cells lying outside the radiation field during clinical treatment.
Keywords: X-irradiation; Apoptosis; Micronuclei; Bystander effect; Scattered radiation