AbstractID: 2032 Title: Variation of RBE with Dose and Dose Rate for a Miniature Electronic Brachytherapy Source

A new miniature x-ray source with flexible high voltage cable allows significantly improved brachytherapy dose delivery. Changing source operating voltage varies the dose-depth characteristics of the radiation and changing beam current varies the dose rate. Because dose rate can equal or exceed that of an ^{192}Ir HDR source, questions have arisen about appropriate values of relative biological effectiveness (RBE) for radiation from the new source.

The problem is addressed using two simple modifications to the standard LQ model. First, the "1" in the formula for Relative Effectiveness, $1 + d/[\alpha/\beta]$, is replaced with the "maximum RBE at very low dose". Second, the relative duration of dose-per-fraction and repair rate-constant for radiation damage are incorporated by including the Lea-Catcheside dose-rate factor, G, in the α/β term.. With these changes, the expression for RBE for a dose, d, is simply

$$RBE = (RBE_{max} + Gd/[\alpha/\beta]) /(1 + Gd/[\alpha/\beta])_{ref}.$$

Assuming $\alpha/\beta = 3$ Gy (appropriate for late complications including breast fibrosis), $RBE_{max} = 2.0$, and that the tissue has a rapid repair component with $T_{1/2} = 0.4$ hours, then, for a 5 to 8 minute dose delivery time, G is 0.94 and the RBE for 3.4 Gy dose is 1.48. If a more realistic value of 1.5 is chosen for RBE_{max} then the RBE for 3.4 Gy dose is 1.24. Given the rapid dose fall-off for low energy sources, alterations of 10- 20% in RBE will be offset by radial distance variations of 1-2 mm from the target.

Research supported by Xoft microTube