AbstractID: 10092 Title: The Biology of 50KV EBT vs Ir-192 HDR for Vaginal Cylinder Gyn Brachytherapy

Due to the lower energy of 50kV electronic brachytherapy (EB) radiation compared with that of Ir-192, the biological effectiveness of EB is greater than that of conventional brachytherapy. This is because the average LET of the electrons released by the 50 kV x rays is higher, leading to an increase in the yield of DNA double strand breaks, which are lethal. In terms of the α and β parameters of the linear-quadratic (L-Q) model, this means an increase in the α (irreparable damage) component with EB. In contrast, the β (reparable damage) component is not affected by the LET and hence remains unchanged. The ratio of the α's for EB and Ir-192 radiations gives the relative biological effectiveness (RBE) of the EB radiation compared to that of Ir-192 *for very small doses*. This is known as the RBE_{max}. Values of RBE_{max} given in the literature are of the order of 1.4 – 1.5 but it will be shown that this grossly overemphasizes the biological effectiveness of EB radiation for doses used in clinical practice. For doses/fraction of 7 Gy, the L-Q model predicts that the RBE for cancers should be about 1.17, whereas, for late-reacting normal tissues it is only about 1.07. Hence, for a constant effect on late-reacting normal tissues, there is a potential 10% increase in biological effectiveness in terms of tumor damage. We ought to be able to exploit this "therapeutic advantage" of electronic brachytherapy. According to the L-Q model, it should be possible to reduce the dose when converting from Ir-192 based brachytherapy to EB by about 7%, yet increase the effect on tumors by about 10% without increasing the risk of late-reacting normal tissue damage. Should the dose be reduced by about 7% for these treatments, therefore? Not necessarily because, if late-reacting normal tissue tolerance is the limiting factor on the dose that can be safely delivered, the increase in *bioeffective* dose for late-reacting normal tissues if the prescribed dose were not reduced would be only about 7%, which is far less than the reduction in *physical* dose to surrounding normal tissues with the less penetrating EB radiation.

A second potential advantage of EB over Ir-192 relates to the O_2 effect. The higher the LET of the radiation the lower the protection offered by hypoxia. Since many cancers are known to contain hypoxic cells which decrease radiation sensitivity, the higher-LET EB radiation ought to exhibit an advantage for these cancers.

For the treatment of endometrial cancers using vaginal cylinders, however, both these advantages are just "theoretical" unless proven by clinical trials since the L-Q model is just an approximation, and the presence of hypoxic cells in these cancers has not yet been demonstrated or shown to effect outcome.

Educational Objectives

1. Understand why EB radiation has a higher biological effectiveness than Ir-192 gamma rays.
2. Understand how the linear-quadratic model can be used to estimate the RBE of EB at doses/fraction used clinically.
3. Understand why EB might exhibit some biological advantages over conventional brachytherapy.