A systematic comparison of dose distributions delivered in 125I-plaque brachytherapy and proton-radiation therapy for ocular melanoma

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What was your motivation for initiating this study?

Our multidisciplinary ocular melanoma programme, which brings together physicians and physicists from Massachusetts General Hospital and Massachusetts Eye and Ear, offers several treatment options to our patients, including plaque brachytherapy and proton-beam therapy. Both radiation treatments have been used successfully for several decades, and with the recent expansion in the availability of proton therapy, more hospitals are now able to offer both protons and plaques at the same location. In clinical rounds, as well as in conversation with patients, questions frequently arise regarding whether either of the radiation modalities might have a particular advantage in a specific case. As a medical physicist, I have received many requests to compare treatment plans across two popular model-based systems: EyePlan for proton therapy and Plaque Simulator for brachytherapy. During the comparison of cases and plans, I appreciated how the characteristics of dose distributions varied according to the tumour size and its location within the eye. I was also surprised that very few papers had been published on the topic. I had the idea of putting together reference tables or charts to illustrate how the doses to the optic nerve, lens, fovea, and other structures of interest varied depending on the tumour characteristics. My colleagues were particularly interested to find out whether any specific tumour presentations rendered themselves especially favourably towards either plaque or proton therapy.

What were the main challenges during the work?

My co-authors and I wanted this publication to appeal to a broad audience that would include physicists, physicians, patients and patients' families. There were several challenges in the design of this study and the interpretation of the results. One had to do with selecting "typical" cases of interest; ideally, the selection would include a wide range of clinical presentations, yet remain manageable for data interpretation and clear presentation. In collaboration with physician colleagues, we identified 111 unique scenarios of intraocular tumours that varied according to their location within the eye and their dimensions. These cases were then modelled in two treatment planning systems, and the doses to critical organs and points of interest were tabulated. The next challenge was to present these data to the reader in a way that was visually clear and easy to interpret. Our journal publication focused on the main findings of our dose comparison study. We also took advantage of the opportunity to provide the full set of results for reference, as a supplement to the paper.

What are the most important findings of your study?

The inherent advantage of proton beams is their ability to spare completely tissues posterior and lateral to the irradiated volume. One interesting finding of our study was that while protons, in a typical treatment, completely spared the centre of the eye lens, the dose delivered by plaques at the periphery of the lens was lower in most cases (with some exceptions, such as smaller temporally located tumours, or mid-size targets that extended within 6mm of the cornea, to which protons delivered lower doses than did plaques). Although the use of protons enabled the complete sparing of large sections of the retina, the areas irradiated to 50% and more of the prescription dose were more tightly conformed to the target in plaque treatments. Plaque treatments also showed dosimetric advantage in the sparing of the optic nerve and fovea in nasally located targets, especially those of larger circumference and height, while protons fared better in temporal, superior and inferior locations.

What are the implications of this research?

Our team identified several distinctions between the plaque and proton dose distributions. We hope that readers, clinicians and patients alike, will find this information useful during their consideration of individualised treatment options. Free access to the article (no sign-up, registration or fee is required) is provided until November 13, 2022, at the following link: https://authors.elsevier.com/a/1fowu1Hx52CHPc

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