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The “CLAWS” – An applicator for whole-eye radiotherapy

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Introduction:

Ophthalmic tumors are fairly rare and diverse and their diagnosis and treatment usually requires special expertise and equipment, including patient care by a multidisciplinary team. Brachytherapy is the preferred radiation treatment modality for various intraocular tumors and the most commonly used radionuclide is I-125. The “Claws” is a gold applicator that is loaded with I-125 seeds for localized whole-eye radiotherapy. It was designed at Groote Schuur Hospital. The applicator is mainly used to treat retinoblastoma, a childhood cancer of the eye.

Methods:

Under general anaesthesia, a pericorneal ring is attached to the four extra-ocular muscles, and four appendages, each loaded with I-125 seeds, are inserted beneath the conjunctiva in-between each pair of muscles and attached anteriorly to the ring. The applicator has an inside diameter of 22 mm.

Current dose calculations approximate each I-125 seed as a point source, and a project is underway to improve the dose calculations, and particularly the dose to critical structures in and around the eye, based on Monte Carlo calculations.

Spectra of the OncoSeed IMC6711 seed at different angles were measured in air using a silicon drift detector. Seed measurements in specially designed phantoms were done using thermoluminescent dosimeters and gafchromic film. A CAD model of the “Claws” was designed and used to manufacture a PVC model in a milling machine, which was then micro-CT scanned at a 20 μm resolution. The CAD model was also cut into 20 μm slices; these will be edited and used as input for Monte Carlo simulations.

Results: The applicator irradiates the eye with minimal dose to the surrounding bony orbit, extraocular optic nerve, eyelids and lacrimal gland. Certain seeds may be omitted to reduce the dose to the unaffected parts of the eye. A typical treatment prescription is 40 Gy given over four days to the centre of the eye. General anaesthesia is also required for the removal of the applicator.

Conclusion: The applicators are cost-effective because they can be re-used. The I-125 seeds are regularly used for other eye plaques and implants. The eye does not need fixation during treatment and cosmesis is excellent. The Monte Carlo simulations will take into account the gold shielding of the applicator and the anisotropic dose distribution around the I-125 seeds, which will give a better estimation of the dose to the organs at risk.

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