OUT OF FIELD DOSE DURING GAMMA KNIFE TREATMENT: A PAEDIATRIC CASE STUDY

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Introduction: It is important when delivering radiation therapy that dose outside the intended target volume is kept as low as possible to reduce unwanted side effects. This is especially true for stereotactic techniques, where large doses are delivered in hypofractionated or single fraction settings. Out-of-field dose minimisation is particularly important for paediatric patients for several reasons: increased consideration towards radiation induced malignancies due to long life expectancy, relatively limited information on paediatric radiobiology and, in the case of intracranial treatments, the generally shorter distance between the target area and radiosensitive organs.

An 11-year-old girl with an arteriovenous malformation (AVM) was referred for Gamma Knife treatment. Because of the considerations above, it was decided to conduct a full assessment into the potential delivered dose to the patient prior to proceeding with the treatment, and monitor the dose received throughout the course of the procedure.

Materials and methods: A phantom was constructed from water equivalent materials to simulate the patient (Figure 1). A target volume was defined to emulate the size and location of the AVM visible in diagnostic images, and a dose of 100 Gy to the 50% isodose, five-fold higher than the regular prescription, was planned to ensure adequate signal to the dosimeters. An ionisation chamber and EBT3 Gafchromic film were used to record absorbed dose at strategic points both on the surface and at depth within the phantom.

On the day of treatment, EBT3 Gafchromic film was used to conduct in vivo dosimetry. Separate films were used for imaging (CT, Angiography) and treatment. Film was calibrated and processed according to our regular technique (Moylan, 2013).

Results: The pre-treatment phantom measurements matched the planning system for the cranial section (the only modelled section) and no measurable dose above background was detected in the extracranial sites.

In vivo measurements of the lenses returned doses of up to 2 cGy for imaging and 8 cGy for treatment (20 Gy to 50% isodose) which was also consistent with the planned dose.

Dose to the thyroid, chest and abdomen was not measurable above background in either the phantom or in vivo measurements, even though the dose was increased above typical prescription for the phantom study.

Conclusions: The rapid drop in dose outside the field was verified and measured doses to organs at risk were very small. The study demonstrates the capability of the Gamma Knife to confine high doses to the intended volume, and the accuracy of the planning system in predicting out-of-field dose.