Case Report

Lens sparing technique using multi-leaf collimators in irradiation of the unilateral retro-orbital space for benign disease

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Abstract The authors present a case of a 30-year-old woman with pseudolymphoma of the left medial rectus muscle. A multi-field technique was planned for irradiating the unilateral retro-orbital space to 20 Gray (GY) in 15 fractions while keeping the average dose to the lens of 8 GY and the peak dose to the lens of 11 Gy using multi-leaf collimators is described.

Key words Orbit, pseudolymphoma, cataract, ionising radiation

Introduction Pseudolymphoma of the orbit is a benign disease and is a diagnosis of exclusion. Presentation is usually in the 5th decade and involves unilateral acute inflammatory symptoms including proptosis and restriction of eye movement. Imaging most commonly reveals (43%) a focal mass within the orbit. Characteristic MRI features and biopsy are the main stays of diagnosis. Treatment options include steroids and cytotoxic chemo therapeutic agents. Radiation therapy is usually reserved for salvage as irradiation of the relatively young for a benign condition means that there maybe a long survival time in which to exhibit late radiation effects including second malignancy. A common late effect of orbital irradiation is cataract and occurs when the lens is irradiated. The best way to avoid irradiating the lens when irradiation of the retro-orbital space is intended is with stereotactic radiation therapy. Lacking this capability we devised a technique of unilateral retro-orbital irradiation to treat an orbital pseudolymphoma confined to the medial rectus muscle that minimised dose to the lens using multi-leaf collimators (MLC). This technique may be an improvement on previous methods described for the treatment of this disease.

Case study A 30-year-old co-operative woman presented with onset over days of left orbital inflammation with swelling, proptosis and...
painless. The patient failed to settle on intravenous antibiotics. A computerised tomography (CT) scan of facial bones showed contrast enhancing enlargement of the left medial rectus muscle. Magnetic resonance imaging (MRI) scan (Fig. 1) revealed fusiform enlargement of the left medial rectus muscle that enhanced with gadolinium. Biopsy showed a 3 mm specimen consisting of striated muscle with abrupt transition to dense sclerotic and partly hyalinised connective tissue. There was no evidence of neoplastic infiltration. The pathological diagnosis was the sclerotic stage of orbital pseudolymphoma. A whole body gallium and CT scan showed no evidence of distant disease. Thyroid function tests were within the normal range. She was treated with high dose Prednisolone and Cyclophosphamide for two cycles. MRI scan 6 weeks post presentation and 3 weeks after chemotherapy showed progression of the lesion and she was referred for radiotherapy.

Technique
The patient was simulated supine with skull base vertical immobilised in efficast. Planning CT was performed with 2 mm axial cuts with eyes open, gazing forward in neutral position. The clinical target volume (CTV) was contoured and included the retro-orbital space including the left medial rectus muscle and its insertions. A 3 mm expansion was done to planning target volume (PTV) (Fig. 2). The left lens and other critical structures were contoured. A five-field plan was generated with one backup wedged lateral field and 4 anterior fields. The latter differed from each other in having two 5 mm MLC leaves crossing midline of the field from different directions. A dose of 20 Gray (Gy) in 15 daily fractions was prescribed to the 95% isodose which covered the PTV. In order to achieve this, a reference dose of 26.5 Gy in 15 fractions was to be delivered. The field weight breakdown of this was 15 Gy from the left lateral, 5.5 Gy from anterior field 1, and 2 Gy each from the remaining three anterior subfields. The contribution from the four anterior fields was 0.767 Gy per fraction. The dose-volume histogram (DVH) of the left lens (Fig. 4) showed a maximum dose in the lens of 10.63 Gy and the average dose to the lens of 8 Gy over 15 fractions. The volume of lens that received the maximum dose of 10.63 Gy was 1%. During treatment a focus point was placed on a shielding tray in the head of the linear accelerator. This acted to keep the patient’s lens focused throughout the treatment. Field placement was verified using amorphous silicon electronic portal imaging, with the first anterior subfield being imaged pre-treatment each day (Fig. 5). Two monitor units were required to achieve an image of acceptable quality. The dose used to acquire a pre-treatment image each fraction was incorporated into the plan, and was considered in calculating lens dose. It was in this case found to be 0.3 Gy and was considered negligible. Using this imaging method it was possible to match field placement and thus MLC lens shield placement.

The dosimetry was verified using Kodak EDR2 film (Ref CAT 809 7214). A calibration film was irradiated such that regions of the film were exposed to a set of known dose parameters. An electronic scan of this film was obtained using a Vidar VXR-16 film scanner. The grey scale values corresponding to the regions of known dose parameters were then used to create a calibration table. Another film from the same batch was placed in a solid water phantom at a depth corresponding to the depth of the area of interest. It was exposed with the four anterior beams as prescribed for one fraction. The films were developed in the same processor at approximately the same time. The film exposed in the phantom was scanned and representative grey scale values obtained for the regions of interest. These grey scale values were converted to dose in Gy using the calibration data. (Fig. 6).

It can be noted from the data that the region corresponding to the eye (Region E) has a reduced dose, 0.133 Gy per fraction (approximately 17% of the maximum, 0.775 Gy).
It should also be noted that regions B, D, F and H are on average reduced from the maximum by approximately 25%. For each of the sub-fields, these are the regions that are occluded by the ‘MLC bar’. After reviewing the technique, it may be possible to use an alternative MLC configuration that provides the required reduction in region E without the unwanted reduction in regions B, D, F and H.

Radiotherapy was ceased after 2 fractions as review by the multidisciplinary team thought that more chemotherapy should be tried first. Repeat MRI scan after 8 cycles over 5 months showed a resolving lesion.

Discussion
Cataract formation in the lens following radiotherapy can happen with as little as 2 Gy\(^6\). Tolerance doses that give a 5% to 50% of occurrence of cataract at 5 years are given as 6–12 Gy\(^7\). Fortunately, cataracts are easily treated with lens implant but to avoid this in an irradiated eye, we chose to develop the above technique. This technique is a further evolution of the technique of Austin-Seymour et al.\(^4\). They used two wedged anterior oblique fields with a back up lateral. At the level of the lens an eye bar was inserted. This measured 20.6 cm in length and 1.3 cm in diameter and was suspended in the beam by a support arm that transmitted 93% of the beam. The position of the support beam was rotated through 4 quadrants on successive days to minimise dose inhomogeneity. Six patients with unilateral benign lymphoid disease of the retro-orbit were treated with doses ranging from 20 Gy in 10 fractions to 36 Gy in 18 fractions. Their technique delivered less than 5% of the dose at Dmax to a depth of 6 mm as recorded by thermoluminescent dosimetry, 6 mm being the reputed average depth of the lens. None developed cataracts with a mean follow-up of 35 months.

Ideally, our patient would have been treated with fractionated stereotactic radiotherapy (FSRT) but experience is limited. Ahn et al.\(^3\) treated four patients with benign disease with FSRT alone to 20 Gy in 10 fractions, and one patient with malignant disease with an 8 Gy FSRT boost after 16 Gy with conventional external beam therapy in order to avoid cataractogenesis but no follow-up data is given.

Our technique with MLCs enables all fields to be treated each day, and CT planning with verification allows exact doses to the lens to be computed with DVH. Improved technology has enabled refinement of an established technique in this patient population.

References