# Visual Loss Following Cranial Irradiation For Primary Brain Tumour

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**Citation**

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**Abstract**

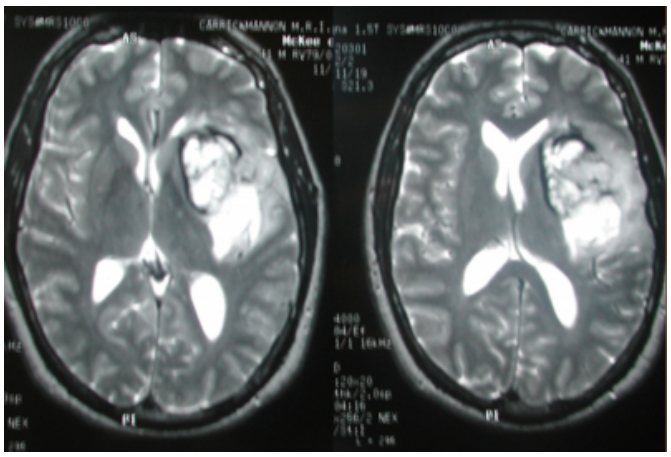
Postoperative cranial irradiation is a standard adjuvant treatment for malignant brain tumours1. Usually it is tolerated quite well, although gastrointestinal and dermatological side effects are occasionally seen. Fortunately, these are transient and reversible. The neurological side effects are uncommon, often delayed and irreversible. We report a rare case of subacute visual loss eight months following cranial irradiation for an anaplastic frontal oligodendroglioma. The mechanisms responsible for this unfortunate phenomenon are explored and issues regarding quality of life are discussed.

## CASE REPORT

A 45-year-old right handed gentleman presented with a progressive history of complex partial seizures for four years. MRI scan showed an intrinsic parenchymal lesion in the left frontal lobe. (Fig 1)

### Figure 1

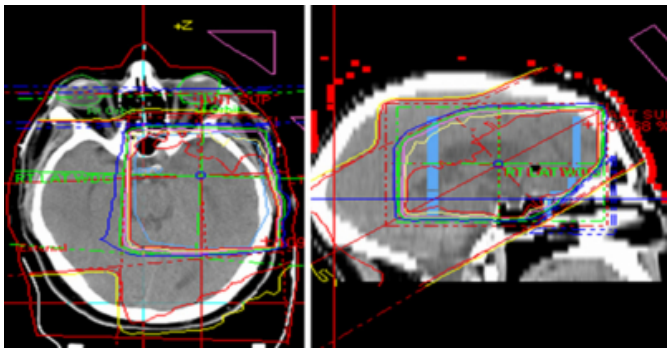
Figure 1: Pre-operative axial MRI scans showing the tumour



He underwent craniotomy and subtotal excision of this left frontal oligodendroglioma. Postoperatively he developed right hemiparesis and expressive dysphasia. This, however, improved significantly, except his right upper limb, which continued to remain severely weak. Two years following his initial surgery, he developed symptoms suggestive of raised intracranial pressure. Repeat MRI scan showed recurrent tumour with mass effect, midline shift and compression of the ventricular system. He underwent re-exploration of the craniotomy and further debulking of the tumour. The histopathology reconfirmed an oligodendroglioma but now with focal anaplastic changes. In view of the recent anaplastic change, he had postoperative adjuvant radiotherapy. He was treated supine in a beam direction shell. The planning target volume encompassed visible abnormalities in adjacent parts of the left frontal, parietal and temporal lobes with a margin. (Fig 2)

### Figure 2

Figure 2:Transverse isodose distribution of the applied radiation field. Light Blue Â– Intended Targets & Green Â– Actually applied field. Please note that the optic chiasm has been included in the target volume. It will therefore have received the full intended dose.

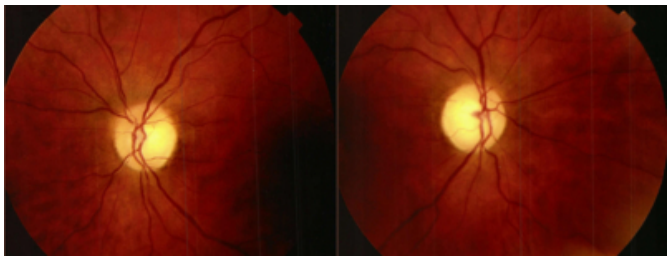


Treatment was delivered through a three field arrangement using right lateral, left lateral and supero-anterior beams. A dose of 60 Gy was delivered in 30 fractions in an overall period of 40 days. He tolerated this well without any immediate untoward effects.

Eight months following completion of his radiotherapy he noticed rapid deterioration of vision over a period of two weeks. Just prior to this deterioration, his vision, as noted by his local optician, was completely normal. On examination, he had no clinical features of raised intracranial pressure. His residual neurological deficits following initial surgery were static. Ophthalmological examination revealed visual acuity to be perception of light (PL) in the right eye (RE) and 6/24 in the left eye (LE). The fundal examination showed optic atrophy in right eye with minimal pigmentation .There was a temporal pallor in the left disc with bilateral attenuated arterioles. (Fig 3)

**Figure 3**

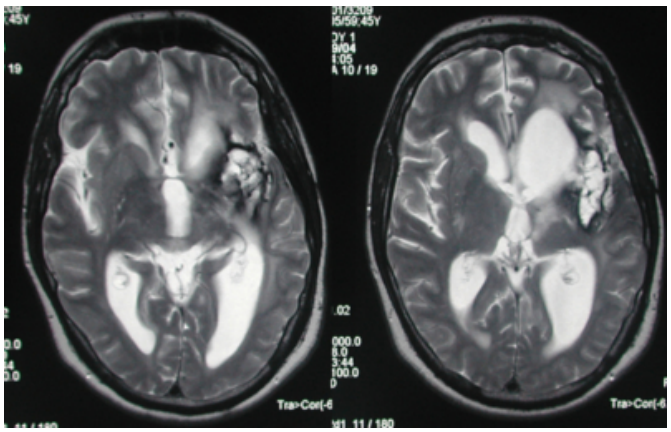
Figure 3: Fundoscopic pictures of both eyes showing optic atrophy.



A MRI brain with contrast following this visual loss showed small tumour remnant with some porencephalic dilatation of the ipsilateral frontal horn. There was no mass effect or shift. The ventricular system was slightly enlarged, but the sulcal pattern was well preserved. (Fig 4) There were no radiological features suggestive of acutely raised intracranial pressure. There was no tumour infiltration of the optic pathways which could have explained his dramatic visual loss.

**Figure 4**

Figure 4: Post operative axial MRI images showing small residual tumour without mass effect.



He was commenced on high-dose methyl prednisolone, but with no benefit. An external ventricular drain (EVD) was also inserted to drain the CSF and to simultaneously measure intracranial pressure. The opening pressure of the ventricles was low with very little drainage of the CSF on continuous drainage. The intracranial pressure was always within normal range. There was no benefit from CSF drainage. On the contrary, the deterioration continued despite steroids and decompression of the ventricles. Within three weeks following the onset of visual loss, his vision had deteriorated to complete blindness in the RE and only PL in the LE. Over next eight weeks, there was no visual improvement, although he had not developed any new neurological symptoms.

## DISCUSSION

Cranial irradiation can have neurological, cutaneous or systemic side effects. These are usually type- and dose-dependent, but can rarely be idiosyncratic.[2,3] The systemic side effects are normally gastrointestinal while burning and peeling of the skin are common dermatological aftermaths. The neurological complications can be classified as ‘early' (within one month), ‘early-delayed' (one to four months) and ‘long-term' (after four months) (Table 1). Sub-acute visual loss as a long term complication due to cranial irradiation is rare and can have devastating effects on patients whose life-span is already limited.[4,5] This radiation induced visual loss depends on the nominal standard dose (NSD) or time-dose fraction (TDF). NSD is calculated based on the total dose in rads, the number of treatment fractions and overall treatment time. TDF has more emphasis on the number of treatments and radiation dose.[2] The optic nerve and the visual pathways exhibit a much higher sensitivity to single fraction radiation compared to other cranial nerves.[3]

**Figure 5**

Table 1: Neurological Side Effects of Radiotherapy

| Type | Side effect |
|---|---|
| Early | Acute Encephalopathy |
| Early delayed | Demyelination<br>Vasogenic edema<br>Encephalopathy<br>Decline in long term memory |
| Long term | Diffuse Cerebral Atrophy<br>Gait disturbance<br>Cognitive decline<br>Personality changes |

In our case, the patient developed near-complete visual loss within four weeks from the time of onset of visual deterioration. Various reasons for this sub-acute visual loss were possible. Firstly, tumour recurrence with infiltration of the optic tracts was considered. The MRI scan, however, did not show any such tumour infiltration.(Fig 4) Secondly, tumour growth causing raised intracranial pressure with subsequent visual deterioration was thought of. However, the patient did not have any clinical or radiological features suggestive of increased intracranial pressure. Although the MRI scan also revealed mild ventriculomegaly, this was possibly due to post-radiation atrophy, monitoring of intracranial pressure being within normal range. We believe, radiation induced optic neuropathy was the only possible diagnostic explanation in our patient for such a dramatic visual loss. The intended and actually targeted areas had included the optic chiasm as well as optic tracts supporting this theory. (Fig 2) Kline and co-workers have also emphasised the need for carefully excluding all other possible aetiologies prior to labelling the visual loss as a delayed complication of irradiation. [4]

Radiation induced visual loss is usually presents subacutely with an average latency of 18 months.[5] Visual symptoms start painlessly in one eye and the second eye follows. Rarely, it is painful and can be acute.[5] The exact aetio-pathogenesis of this phenomenon is not known. Levin et al hypothesised that radiation causes endothelial cell damage resulting in blood brain barrier (BBB) breakdown. This, in turn, causes thrombotic occlusion of small arteries which demonstrate thickening, lymphocytic and macrophage infiltrates and fibrin exudates.[6] Sawaya and co workers proposed involvement of plasminogen activator inhibitor-1 in the pathogenesis of delayed radiation damage.[7]

Treatment of visual loss caused by irradiation remains unsatisfactory. Hyperbaric oxygen, anticoagulants and steroids have been tried without any proven conclusive benefit. Ashamalla and co workers used hyperbaric oxygen to conclude that its safe for radiation induced complications, both in prevention and treatment.[8] Guy and Schatz proposed that hyerbaric oxygen is promising in the management of radiation induced optic neuropathy by increasing oxygen gradient and stimulating revascularization of the capillary bed.[9] Glantz et al suggested that anticoagulation may arrest and, in fact, reverse endothelial injury which is thought to be the fundamental pathology of radiation necrosis. Unfortunately, this has not shown to be effective in radiation induced optic neuropathy.[10] Hyperbaric oxygen, according to Glantz, is effective only if given in the very early course of visual deterioration.[10]For this, however, early diagnosis by serial testing of visual evoked potentials in high risk period is necessary even before visual deterioration becomes clinically apparent.[5] Although high dose of steroids has been advocated by some workers and were tried empirically by us, there are no conclusive reports proving its efficacy, as claimed.[4]

## CONCLUSION

Postoperative radiotherapy, an invaluable adjuvant for treatment of primary malignant brain tumours, is well-known to prolong survival. It is generally tolerated well by most patients. However, delayed visual loss following apparently successful irradiation treatment, can have a devastating effect on patients' morale and their quality of life. It is an unfortunate situation where the treatment makes the patient worse than the disease itself. Until ionising radiation can be administered without any ill-effects on the surrounding normal parenchyma, all vulnerable patients need to be carefully counselled and warned about this potential complication. Careful monitoring and follow-up after administering radiotherapy is also mandatory. Sometimes, in high-risk patients, it may well be justified omitting adjuvant radiotherapy altogether, albeit at the cost of some reduction in the length of survival.

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