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Meningioma Causing Visual Impairment: Outcomes and Toxicity After Intensity Modulated Radiation Therapy

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Summary

This prospective study closely evaluated ophthalmologic outcomes after intensity modulated radiation therapy (IMRT) in patients with meningiomas in a variety of sites that compromised vision. Objective improvements in visual function were observed in 40% of patients, often in the absence of radiological change, and toxicity was minimal. These findings provide evidence for the use of IMRT to treat meningiomas affecting many sites along the visual pathway, and they support previous studies, which have mainly focused on optic nerve sheath tumors.

Purpose: To evaluate ophthalmologic outcomes and toxicity of intensity modulated radiation therapy (IMRT) in patients with meningiomas causing visual deficits.

Methods and Materials: A prospective observational study with formal ophthalmologic and clinical assessment of 30 consecutive cases of meningioma affecting vision treated with IMRT from 2007 to 2011. Prescriptions were 50.4 Gy to mean target dose in 28 daily fractions. The median follow-up time was 28 months. Twenty-six meningiomas affected the anterior visual pathway (including 3 optic nerve sheath meningiomas); 4 were posterior to the chiasm.

Results: Vision improved objectively in 12 patients (40%). Improvements were in visual field (5/16 patients), color vision (4/9 patients), acuity (1/15 patients), extraocular movements (3/11 patients), ptosis (1/5 patients), and proptosis (2/6 patients). No predictors of clinical response were found. Two patients had minor reductions in tumor dimensions on magnetic resonance imaging, 1 patient had radiological progression, and the other patients were stable. One patient experienced grade 2 keratitis, 1 patient had a minor visual field loss, and 5 patients had grade 1 dry eye.

Conclusion: IMRT is an effective method for treating meningiomas causing ophthalmologic deficits, and toxicity is minimal. Thorough ophthalmologic assessment is important because clinical responses often occur in the absence of radiological change.

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Introduction

Meningiomas are the most common nonglial brain tumor, and visual deficits are a common clinical feature. Surgery is the mainstay of treatment for most meningiomas unless there is a high risk of surgical morbidity (eg, optic nerve sheath meningioma [ONSM] for which radiation therapy is accepted as primary treatment). In other skull base sites, adjuvant radiation therapy is commonly used after subtotal resection or recurrence. The 10-year local control rates from 3-dimensional conformal radiation therapy (3D-CRT) are 77% to 93%, with late toxicity rates of 3% to 14% (1-4). However, most case series evaluating ophthalmologic outcomes after radiation therapy have been retrospective and have focused on ONSM, which account for only 1% to 2% of meningiomas.

Given that both surgery and radiation therapy have the potential to cause visual toxicity, careful assessment and comparison of the outcome of both treatments is necessary. There are many retrospective surgical series categorized by tumor location and surgical technique. Jacob et al found an improvement in vision in the ipsilateral eye in 23%, stable vision in 27%, and deterioration in 50% of patients who underwent surgery for cavernous sinus meningioma (5). Improvements in visual symptoms after surgery for suprasellar meningioma are reported in 42% to 78% of patients, with deterioration in 13% to 28% (6). Postoperative improvements in vision have been reported in 30% of cases of sphenoorbital ridge meningiomas, with a reduction in proptosis in 85% of patients but new cranial nerve deficits in 21% (7).

An improvement in symptoms was reported in 40% of patients with meningioma-related visual field disturbances after radiosurgery (RS), with no deteriorations (8). In view of the higher potential for toxicity with large single fractions, dose reductions to areas of meningioma adjacent to visual pathways are often necessary. Longer-term results and further study are required. A tumor size of >3.5 cm mean diameter, optic nerve or chiasm compression, and ONSM are cited as contraindications to single-fraction RS (9).

Intensity modulated radiation therapy (IMRT) is increasingly used to treat meningiomas. IMRT provides higher dose conformality, improved target coverage, and better sparing of critical structures compared with 3D-CRT, without the contraindications of RS. Although the prescribed dose for meningiomas is often below the tolerance of most critical structures close to the target volume, the retina is an important exception, which is often hard to exclude from the treated volume when 3D-CRT is used. We also believe that limiting high doses to normal brain is justified in these patients, who are expected to survive long enough to experience late radiation toxicity, including a risk of cognitive impairment. There is evidence that carefully planned IMRT does not increase integral dose to normal tissue compared with 3D-CRT, which was previously a concern (10).

Here we report the results of a prospective study assessing ophthalmologic outcomes and treatment-related toxicity in 30 patients treated with IMRT for meningiomas affecting several parts of the visual pathway.

Methods and Materials

Patient selection

Between November 2006 and January 2011, 30 consecutive patients with visual symptoms attributable to meningioma underwent IMRT at our institution and had serial neuro-ophthalmology assessments within a prospective observational study. Ethical approval for the conduct of this study was obtained by the Regional Ethics Committee (reference 06/Q0502/81). Inclusion criteria were as follows: age over 18, a histologic or radiological (magnetic resonance imaging [MRI]) diagnosis of meningioma (any grade), and performance status 0-2. Patients could undergo IMRT as a primary treatment or after previous surgery. Patients were excluded if they had previously received radiation therapy to the region or had any other illness that interfered with the protocol treatment plan.

Radiation therapy

Patients were immobilized with a thermoplastic shell, and computed tomography scans were made with the patient in treatment position (2.5-mm slices). Scans were fused with preoperative and postoperative T1 plus gadolinium MRI sequences. Target volumes were delineated using Oncentra Masterplan. The gross tumor volume encompassed the visible tumor, and a 1-cm margin was applied in the plane of dural enhancement, or bone/brain invasion to form the clinical target volume. A 5-mm margin was applied to create a planning treatment volume (PTV) to account for both setup and fusion inaccuracy as measured at our institution. A 3-mm margin was added to organs at risk (OARs) to create a planning organ-at-risk volume (PRV). Inasmuch as the OARs were outlined primarily on the computed tomography scan, no additional fusion uncertainty margin was required.

Treatments were planned on Eclipse, version 8.9 (Varian Medical Systems, Palo Alto, CA), using the Anisotropic Analytical Algorithm and a 2.5-mm calculation grid. Each plan was optimized for a 6-MV beam on a Varian 2100 Series Clinac and normalized to the mean target dose prescribed. A static gantry dynamic multileaf collimator technique was used with 5 to 7 nonopposing coplanar fields.

The prescribed dose was 50.4 Gy to mean target dose in 28 daily fractions. The median target doses were very similar to the mean (50.32-50.58 Gy). The PRV maximum dose objectives are specified in Table 1. Patients were moved on set to correct for systematic shifts in accordance with daily online Kv imaging.

Ophthalmic evaluation

Ophthalmic and clinical evaluations were conducted by a neuro-ophthalmologist and an oncologist before IMRT, during IMRT (oncologist only), and at 3 months, 6 months, and 12 months after treatment, then annually. Both eyes were evaluated. Visual acuity was assessed with a Snellen chart (± pinhole) and scored as shown on Table 2. A defect was defined as 6/12 vision or worse; an increase of ≥2 points was an improvement. A defect in color vision, as assessed by Ishihara plates, was defined as ≥3/17 plates not read; an increase in ≥3 plates read constituted an improvement. The test plate had to be read correctly to indicate sufficient acuity. Visual fields were assessed by Humphrey automated perimetry when vision allowed (expressed as the mean deviation in decibels) or Goldmann kinetic perimetry (expressed as mean radial degrees on the 14e isopter). In Humphrey perimetry an improvement was a decrease of ≥3 decibels; in Goldman perimetry improvement was an increase of ≥10 mean radial degrees. Improvements had to be sustained during subsequent testing.