

## Radiotherapy for Optic Nerve Sheath Meningiomas

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### ABSTRACT

**Objective:** To determine the outcome after radiotherapy for optic nerve sheath meningiomas.

**Patients and Methods:** Six patients were treated with conventional (1 patient) or stereotactic (5 patients) radiotherapy and were followed up from 3.1 to 9.9 years (mean, 6.2 years).

**Results:** Local control was obtained in 6 patients. Useful vision remained stable for 5 patients and 1 patient experienced diminished visual acuity.

**Conclusions:** Radiotherapy results in a high likelihood of local control with preservation of vision. Stereotactic radiotherapy facilitates adequate tumour coverage while minimising the dose delivered to the uninvolved visual apparatus.

**Key Words:** Meningioma, Nerve sheath tumor, Optic nerve, Radiotherapy

### INTRODUCTION

Optic nerve sheath meningiomas (ONSMs) are rare, accounting for 1% to 2% of all meningiomas.<sup>1</sup> However, ONSMs are the second most common optic nerve sheath tumour after optic glioma.<sup>1</sup> Approximately 90% of meningiomas that involve the orbit arise intracranially; the remaining 10% are primary ONSMs.<sup>2</sup> Patients with ONSM are usually middle-aged women.<sup>1-3</sup> Andrews et al reported on 30 patients treated for 33 ONSMs at the Thomas Jefferson University; 60% were women and the median age was 44 years.<sup>3</sup> Approximately 5% of ONSMs are bilateral.<sup>1</sup>

Historically, the treatment options for patients with ONSMs were observation and surgery. Patients were often observed for as long as the tumour appeared to be completely resectable and until there was no longer useful vision, when they would undergo surgery. Surgical resection is an unattractive first step for the treatment of patients with useful remaining vision because the operation often results in blindness. Another recent

addition to the therapeutic armamentarium is stereotactic radiosurgery. However, radiosurgery necessarily delivers a single high dose of radiation to the optic nerve which may result in blindness due to optic neuropathy.<sup>4</sup>

Conventionally fractionated external beam radiotherapy is an attractive alternative because the dose required to control the tumour (50.4 to 54.0 Gy at 1.8 Gy per fraction) is lower than the tolerance dose of the optic nerve. However, this dose is associated with a significant risk of radiation retinopathy.<sup>5</sup> Therefore, radiotherapy fields must be designed to adequately encompass the tumour while sparing enough of the visual apparatus to maintain useful vision. Due to the precise realignment and steep dose fall-off associated with stereotactic radiotherapy, this technique is ideal for treating patients with ONSM.

### PATIENTS AND METHODS

The results of 6 patients treated with radiotherapy at the University of Florida, USA, between 1992 and 1999 were retrospectively reviewed as part of an institutional review board-approved Radiation Oncology Outcome Tracking Project (RADTRAC) outcomes study. All 6 patients were women and the age ranged from 41 to 72 years (mean, 55 years). All were treated with fractionated radiotherapy consisting of 1.7 to 1.8 Gy per fraction, once daily, 5 days per week in a continuous

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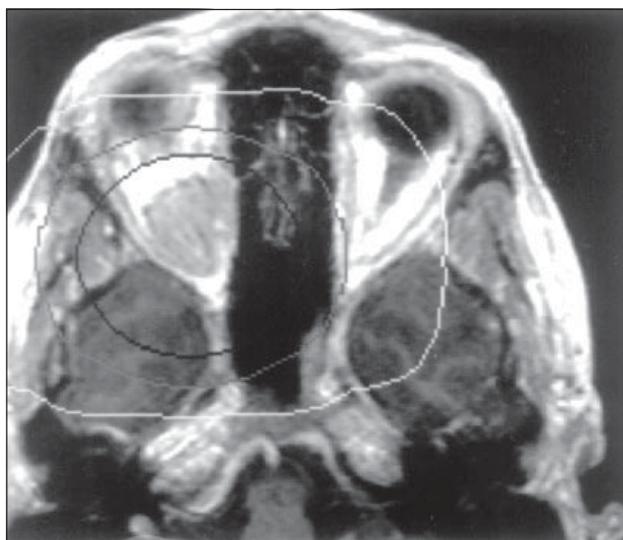
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**Table 1.** Treatment and results for optic nerve sheath meningiomas.

Maximum tumour diameter (cm)	Technique	Dose/fraction/overall treatment time	Follow-up (years)	Visual outcome	Local control
1.8	CERT	54.0 Gy/30 fractions/44 days	9.9	Preserved	Controlled
1.5	SRT	52.7 Gy/31 fractions/46 days	3.1	Preserved	Controlled
2.1	SRT	52.7 Gy/31 fractions/44 days	3.5	Preserved	Controlled
1.5	SRT	52.7 Gy/31 fractions/51 days	6.3	Diminished	Controlled
2.4	SRT	54.4 Gy/32 fractions/46 days	6.4	Preserved	Controlled
2.0	SRT	54.4 Gy/32 fractions/45 days	8.1	Preserved	Controlled

Abbreviations: CERT = conventional external beam radiotherapy; SRT = stereotactic radiotherapy.



**Figure 1.** A 41-year-old woman with an optic nerve sheath meningioma extending to the anterior aspect of the cavernous sinus. Treatment consisted of stereotactic radiotherapy using 1 isocenter, 4 arcs, and a 50 mm collimator with the dose specified at the 90% isodose line. A dose of 54.4 Gy was administered in 32 fractions over 46 days. The isodose lines depicted are the 90%, 45%, and 18% lines. The tumour was locally controlled and useful vision was stable 6.4 years after treatment.



**Figure 2.** A 51-year-old woman with a previously untreated optic nerve sheath meningioma. Treatment consisted of stereotactic radiotherapy using 1 isocenter, 4 arcs, and a 40 mm collimator with the dose specified at the 90% isodose line. A dose of 54.4 Gy was administered in 32 fractions over 45 days. The isodose lines depicted are the 99%, 90%, 45%, 18%, and 9% lines. The tumour was locally controlled, and useful vision remained stable 8.1 years after treatment.

course (Table 1). One patient was treated conventionally with a lateral field and an anterior field entering above the eye and angled inferiorly to spare part of the globe. The remaining 5 patients were treated with the University of Florida linear accelerator-based stereotactic radiotherapy system which employed 1 isocenter with the dose specified at the 90% isodose shell (Figures 1 and 2). Four patients who received stereotactic radiotherapy were treated with 4 arcs using circular collimators ranging from 40 mm to 50 mm in diameter, and the remaining patient was treated with a mini-multileaf collimator. Patients had follow-up with annual physical examinations and magnetic resonance imaging (MRI). Follow-up ranged from 3.1 to 9.9 years; no patient was lost to follow-up.

## RESULTS

The tumour remained locally controlled in all 6 patients at last follow-up. Vision remained stable in 5 patients

and deteriorated in 1 patient (Table 1). Although the latter patient had residual vision on the treated side, it was significantly diminished compared with pretreatment vision. The cause of the diminished vision was unclear. No patient experienced a significant treatment complication.

## DISCUSSION

### Local Control

The probability of local control after radiotherapy for benign meningiomas ranges from approximately 80% to 90%, and is related to length of follow-up.<sup>6,7</sup> Barring geographic miss, which should be uncommon with modern imaging and treatment planning techniques, the probability of local control is likely to be 90% or higher. All of the patients in this study remained locally controlled after radiotherapy. Liu et al reported on 5 patients treated with linear accelerator-based stereotactic radiotherapy and all remained locally controlled

from 1 to 7 years (mean, 3 years) after treatment.<sup>1</sup> Becker et al treated 15 patients with primary ONSMs with stereotactic radiotherapy (54 Gy in 28 fractions) at University Hospital (Tübingen, Germany).<sup>2</sup> All had follow-up with computed tomography (CT) and/or MRI from 10 to 73 months (median, 39 months) after treatment. No patient had evidence of tumour progression. Andrews et al reported on 30 patients with 33 ONSMs treated with linear accelerator-based stereotactic radiotherapy at Thomas Jefferson University (Philadelphia, USA) and had follow-up from 0.2 to 5.5 years (mean, 1.7 years).<sup>3</sup> Doses ranged from 50 to 54 Gy (median, 51 Gy) administered at 1.8 Gy per fraction. No patient had evidence of tumour progression. Narayan et al reported 14 patients treated with 3-dimensional conformal radiotherapy at the University of Michigan, USA and followed for a median of 51.3 months. The tumour remained locally controlled in all 14 patients.<sup>8</sup> In contrast, Turbin et al reported on 59 patients with vision greater than no light perception at diagnosis who were treated at 4 institutions with observation (13 patients), surgery (12 patients), surgery and radiotherapy (16 patients), and radiotherapy alone (18 patients).<sup>9</sup> Patients were followed up from 51 to 516 months (mean, 150 months). Radiographic evidence of tumour progression was as follows: observation, 4 of 13 patients (31%); surgery, 7 of 12 patients (58%); surgery and radiotherapy, 8 of 16 patients (50%); and radiotherapy alone, 2 of 18 patients (11%). The rate of recurrence after surgery and radiotherapy is higher than would be anticipated and could be related to long follow-up and/or geographic miss. The reason for the relatively poor local control rate in this subset of patients compared with an 89% local control rate after radiotherapy alone is unclear.

### Preservation of Vision

Five of 6 patients in this series had stable vision after treatment. Liu et al observed improved vision in 4 patients and stable vision in the remaining patient after stereotactic radiotherapy.<sup>1</sup> Becker et al observed improved vision in 6 eyes and stable vision in the remainder.<sup>2</sup> Andrews et al reported 92% preservation of vision in 22 optic nerves with useful vision before stereotactic radiotherapy compared with 16% for historical controls who were either observed or had observation combined with surgery and were followed up for a similar period of time.<sup>3</sup>

Narayan et al reported 14 patients treated with 3-dimensional conformal radiotherapy and observed

improved vision in 5 patients, stable visual acuity in 7, and decreased visual acuity in 2.<sup>8</sup> Turbin et al reported significantly decreased visual acuity after observation ( $p = 0.002$ ), surgery ( $p = 0.019$ ), and surgery combined with radiotherapy ( $p = 0.03$ ).<sup>9</sup> In contrast, vision did not deteriorate significantly for patients treated with radiotherapy alone ( $p = 0.301$ ).

### Complications

Aside from decreased vision in the treated eye of 1 patient, no other patient in this series experienced a significant treatment complication. Liu et al observed no complications in 5 patients treated with stereotactic radiotherapy.<sup>1</sup> Becker et al reported new endocrinologic deficits in 2 of 15 patients (13%) treated at the University Hospital (Tübingen, Germany); no patient experienced a severe complication.<sup>2</sup> Andrews et al reported the following complications in 4 of 30 patients (13%): decreased vision (2 patients), optic neuritis (1 patient), and transient orbital pain (1 patient).<sup>3</sup> Narayan et al treated 14 patients and observed the following complications: radiation retinopathy (1 patient), orbital pain (1 patient), dry eye (1 patient), and iritis (2 patients).<sup>8</sup>

### CONCLUSION

Conventionally fractionated radiotherapy is the best available treatment option for patients with ONSM who have useful remaining vision in order to locally control the tumour and preserve visual acuity. Since the tolerance of the retina is less than the dose required to control the tumour, techniques should be employed to limit the retinal dose to less than 40 Gy while delivering 50 to 54 Gy at 1.7 Gy to 1.8 Gy per fraction to the tumour. This can be accomplished using either stereotactic radiotherapy or intensity-modulated radiation therapy.<sup>4,5,10</sup>

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