Loss and recovery of vision with suprasellar meningiomas

F. KARL GREGORIUS, M.D., ROBERT S. HEPLER, M.D., AND W. EUGENE STERN, M.D.

Department of Surgery, Division of Neurosurgery, and the Department of Ophthalmology, University of California at Los Angeles School of Medicine, Los Angeles, California

Central visual acuity losses were documented in a group of 23 patients with surgically and histologically verified suprasellar meningiomas. The pattern demonstrated was that of acute, gradual or fluctuating loss in one eye, followed by later loss of central acuity in the other eye. Both optic nerves and chiasm were invariably involved either by stretching or compression. Neither preoperative field abnormalities nor central acuity deficits could be correlated with the anatomical location of the tumor, nor could postoperative changes in vision be correlated with tumor size. Lengthy duration of acuity loss and severe visual deficit did not preclude postoperative recovery of vision. Improvement in sight most frequently occurred within the first several weeks after operation, and further return of vision was not noted after 1 year.

KEY WORDS: meningioma □9 chiasmal syndrome □9 suprasellar tumor □9 bitemporal hemianopsia □9 optic atrophy

RECENT reviews of suprasellar meningiomas have not attempted to correlate patterns of visual symptoms with tumor position, nor have they recorded the details of postoperative visual improvement or failure.6,9,12,16 We have reviewed a series of 23 patients with surgically-removed suprasellar meningiomas to correlate patterns of visual loss with tumor growth and to estimate the prognosis for recovery of vision after tumor removal.

Analysis of Cases

The series was comprised of 21 women and two men, a sex predominance emphasized by others. The average age at the time of admission to the UCLA Hospital was 50 years; the average age at onset of symptoms was 46 years. Twenty-one of the patients had classical tuberculum sellae meningiomas, as described by Cushing and Eisenhardt.5 The tumors in the other two patients probably originated in the olfactory groove, but each extended posteriorly and adhered tenaciously to the tuberculum, distorting the visual system. All patients had histologically verified meningiomas.

Symptoms

Visual loss was the predominant initial symptom. Nine patients complained of visual blurring in part of a unilocular field, and 12 experienced a decrease of central visual acuity in one eye. The two patients with tumors of olfactory groove origin had early complaints...
other than loss of vision, but by the time of admission, visual loss was the predominant symptom in both. Bilateral visual loss, although not an early complaint in any patient, was present in all by the time of admission. In 16 patients for whom data were available, the time interval from the onset of unilateral visual loss to subjective bilateral loss was 1 year or less in seven, 3 years or greater in seven, 8 years in one, and of indeterminate duration in one patient.

Three patterns of progression from unilateral to bilateral visual involvement emerged. The first pattern, experienced in three patients in whom acuity was well documented by referring physicians prior to admission, was characterized by a fluctuating unilateral pattern of visual loss in one eye, progressing to both eyes, as exemplified by the distance visual acuity measurements shown for the patient in Fig. 1 left. The most common pattern of visual loss, noted 11 times, began with a nonfluctuating gradual or rapid progressive loss of vision in one eye followed by the gradual decrease in acuity in the contralateral eye, as illustrated by test results shown for the patient in Fig. 1 right. The third sequence, noted twice, began with an abrupt awareness of severe visual loss in one eye followed by a deficit in the contra- lateral field of vision. Simultaneous onset of visual loss in both eyes was not seen.

Onset of severe headaches or a change in previous headache patterns was noted by 15 patients. In 10, headaches were centered in the frontal or orbital regions but did not have other common features to render them of more specific diagnostic value. No patients experienced pain on extraocular movement. Endocrine symptoms were not prominent.

**Visual System Findings**

Tangent screen or Goldmann perimetric examinations revealed a variety of visual field changes. Bilateral field defects were present in 20 of the 23 patients. Three patients had unilateral field defects only; of these, only one had normal central acuity in the eye with the full field. The most common defect, observed in 16 patients, was a bitemporal field cut of varying configuration. The classical defect of symmetrical bitemporal hemianopsia was seen in only three patients. Other bitemporal variations included a partial superior temporal abnor- mality in both fields or a full temporal defect with contralateral blindness. Four patients had either a central or para-central scotoma in one field accompanied by a temporal or nasal defect in the other eye. Monocular inferior altitudinal defects, noted twice, were associated with a contralateral inferior temporal loss in one patient and with blindness in the contralateral eye in the other.
Loss and recovery of vision with suprasellar meningiomas

### TABLE 1
Comparison of preoperative and postoperative visual acuity* in 23 patients with suprasellar meningiomas

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Right Eye Preop</th>
<th>Right Eye Postop</th>
<th>Left Eye Preop</th>
<th>Left Eye Postop</th>
<th>Functional Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20/50</td>
<td>20/20</td>
<td>10/200</td>
<td>NLP</td>
<td>normal</td>
</tr>
<tr>
<td>2</td>
<td>20/20</td>
<td>20/20</td>
<td>20/100</td>
<td>20/25</td>
<td>normal</td>
</tr>
<tr>
<td>3</td>
<td>20/160</td>
<td>20/200</td>
<td>20/160</td>
<td>20/100</td>
<td>handicapped</td>
</tr>
<tr>
<td>4</td>
<td>CF</td>
<td>CF</td>
<td>20/100</td>
<td>20/20</td>
<td>normal</td>
</tr>
<tr>
<td>5</td>
<td>10/100</td>
<td>20/20</td>
<td>20/70</td>
<td>20/20</td>
<td>normal</td>
</tr>
<tr>
<td>6</td>
<td>HM</td>
<td>HM</td>
<td>20/80</td>
<td>HM</td>
<td>handicapped</td>
</tr>
<tr>
<td>7</td>
<td>NLP</td>
<td>NLP</td>
<td>20/40</td>
<td>20/25</td>
<td>normal</td>
</tr>
<tr>
<td>8</td>
<td>20/200</td>
<td>20/20</td>
<td>20/40</td>
<td>20/20</td>
<td>normal</td>
</tr>
<tr>
<td>9</td>
<td>20/20</td>
<td>20/20</td>
<td>20/80</td>
<td>20/30</td>
<td>normal</td>
</tr>
<tr>
<td>10</td>
<td>20/20</td>
<td>20/20</td>
<td>CF</td>
<td>20/40</td>
<td>normal</td>
</tr>
<tr>
<td>11</td>
<td>CF</td>
<td>20/20</td>
<td>NLP</td>
<td>NLP</td>
<td>normal</td>
</tr>
<tr>
<td>12</td>
<td>20/200</td>
<td>20/20</td>
<td>20/20</td>
<td>—</td>
<td>died</td>
</tr>
<tr>
<td>13</td>
<td>20/50</td>
<td>20/30</td>
<td>20/800</td>
<td>20/40</td>
<td>normal</td>
</tr>
<tr>
<td>14</td>
<td>20/400</td>
<td>20/20</td>
<td>HM</td>
<td>NLP</td>
<td>handicapped</td>
</tr>
<tr>
<td>15</td>
<td>20/40</td>
<td>20/20</td>
<td>20/100</td>
<td>20/20</td>
<td>normal</td>
</tr>
<tr>
<td>16</td>
<td>HM</td>
<td>NLP</td>
<td>NLP</td>
<td>NLP</td>
<td>handicapped</td>
</tr>
<tr>
<td>17</td>
<td>20/200</td>
<td>20/20</td>
<td>20/30</td>
<td>20/15</td>
<td>normal</td>
</tr>
<tr>
<td>18</td>
<td>20/50</td>
<td>20/20</td>
<td>CF</td>
<td>HM</td>
<td>normal</td>
</tr>
<tr>
<td>19</td>
<td>CF</td>
<td>20/30</td>
<td>HM</td>
<td>CF</td>
<td>normal</td>
</tr>
<tr>
<td>20</td>
<td>CF</td>
<td>20/50</td>
<td>—</td>
<td>—</td>
<td>died</td>
</tr>
<tr>
<td>21†</td>
<td>20/200</td>
<td>20/200</td>
<td>20/200</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>22†</td>
<td>HM</td>
<td>20/40</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>23</td>
<td>20/40</td>
<td>20/20</td>
<td>CF</td>
<td>CF</td>
<td>normal</td>
</tr>
</tbody>
</table>

* HM = hand movement; CF = count fingers; NLP = no light perception.
† Unavailable for follow-up.

Nasal impairment with blindness in the contralateral eye was seen once.

Visual acuity was tested with a Snellen chart at 20 feet in all patients (Table 1). Bilateral loss was present in 18 patients, and was asymmetrical in all but one. Fourteen had a loss to at least 20/200 in the more involved eye, and five of these had progressed to 20/200 or worse in both eyes. Of five patients with only unilateral decreased acuity, three had experienced a loss to worse than 20/200. All but one had field defects in the affected eye.

Optic atrophy was the predominant finding on funduscopic examination and correlated better with loss of visual acuity than with peripheral visual impairment. When the visual acuity loss was bilateral, the optic atrophy tended to be bilateral, the greater atrophy being on the side of the greater acuity deficit. Exceptions to this were the two patients whose tumors were of probable olfactory groove origin; neither had optic atrophy, while central visual acuity for distance was 20/40 and 20/20 (corrected) in one and 20/20 and 20/30 (corrected) in the other.

### Surgical Observations
A frontal, osteoplastic bone flap was used exclusively to approach these tumors. There were 13 unilateral flaps and eight bifrontal, two of which were staged. Tumor consistency varied, and the usual standard piecemeal removal was accomplished with a combination of coagulation, suction, and sharp dissection. Incomplete removal occurred in six patients because of chiasmal embarrassment, carotid artery engulfment, or adherence to the optic nerve by the tumor. Both optic nerves were surgically involved by stretching or compression in all 23 patients. In all patients except one, loss of visual acuity correlated exactly with greater involvement of the optic nerve as visualized Surgically. Direct tumor adherence to one optic nerve and severe stretching and thinning of two other optic nerves accounted for monocular absence of light perception in three patients prior to operation. Although tumor had involved the chiasm either directly or by stretching in 17 patients, it was not visualized in every instance; hence, this figure probably underestimates the true incidence of chiasmal involvement. Because of the usual compromise of optic nerves and chiasm by the time of operation, visual field defects and the surgical site of compression could not be correlated. Despite a full visual field and preserved central acuity, one patient had a tumor that had elevated the optic nerve and displaced the chiasm posteriorly. By contrast, another patient had a bitemporal field deficit but the chiasm was free of tumor when viewed surgically; in this case, chiasmal stretching may have been a factor in the field loss.

### Tumor Size
Estimation of tumor size from the weight of pathological specimens was impossible because of suction loss and piecemeal removal. Relative tumor size was estimated by measurement of the greatest cross-sectional area of the tumor in the pneumoencephalographic tomographic studies and the angiographic tumor stain or by direct surgical observation. Magnification was taken into account. Based on these measurements, tumors were divided into three groups according to approximate size. Class 3 tumors...
were those in which the greatest two-
dimensional cross-sectional plane was 11.0
cm² or greater; seven patients from this group
had an acuity of 20/200 in one eye. Class 2
tumors, of which there were eight, measured 7
to 10 cm² in the greatest two-dimensional
plane. Class 1 tumors were less than 7 cm² in
the greatest two-dimensional plane; of the
eight patients with tumors of this size, four
had a unilateral loss of acuity to 20/200 or
worse prior to operation.

Surgical Results
Two patients died in the immediate post-
operative period, an operative mortality of
9%; two patients were unavailable for follow-
up examination. The other 19 patients were
seen periodically for an average of 3.5 years,
with a range of 1 to 13 years. One of these
died 4 years postoperatively from a probable
myocardial infarction, and no postmortem
examination was obtained. The surviving 18
patients have undergone Snellen chart and
tangent screen or Goldmann perimetric ex-
aminations within the past year. There is
evidence of further growth in one patient in
whom removal was known to have been in-
complete. No other patient shows evidence of
return of tumor.

To evaluate effects of operation on vision,
visual acuity measurements obtained post-
operatively were compared to those that had
been obtained preoperatively for each eye in
each of the 19 patients. Three of the 19
patients were blind to light in one eye prior to
operation, and no visual recovery occurred in
these eyes. Thus, 35 eyes had a potential for
visual improvement by operative procedure.

Fields. Improvement in a visual field was
considered to have occurred when there had
been diminution of a preoperative field defect.
By this criterion 22 of 35 fields were im-
proved, 12 were unchanged, and one involving
an almost completely blind eye may have
been worse. Five patients had full field return
in at least one eye.

Acuity. Snellen visual acuity at 20 feet
before and after operation was compared
(Table 1, Fig. 2). Visual acuity after opera-
tion was improved in 21 of 35 eyes, un-
changed in nine, and worse in five. Although
the majority of eyes with postoperative im-
provement had better than 20/200 acuity
preoperatively, seven eyes had 20/200 or
worse initially (Table 2); all of these
recovered 20/40 vision or better. Three eyes
with only finger-counting vision preopera-
tively attained 20/40 or better vision after
operation. Three of the five eyes that became
TABLE 2

Relation of duration and tumor size to postoperative change in visual acuity

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Change in Acuity*</th>
<th>Duration Preop Visual Loss (yrs)</th>
<th>Relative Tumor Size (class)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved visual acuity:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>20/200 to 20/20</td>
<td>&lt;1</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>CF to 20/40</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>CF to 20/20</td>
<td>&lt;1</td>
<td>3</td>
</tr>
<tr>
<td>13</td>
<td>20/800 to 20/40</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>20/400 to 20/20</td>
<td>&lt;1</td>
<td>3</td>
</tr>
<tr>
<td>17</td>
<td>20/200 to 20/20</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>19</td>
<td>CF to 20/30</td>
<td>&lt;1</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>20/50 to 20/20</td>
<td>&lt;1</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>20/160 to 20/100</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>20/100 to 20/20</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>20/100 to 20/50</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>20/70 to 20/20</td>
<td>&lt;1</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>20/40 to 20/20</td>
<td>&lt;1</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>20/80 to 20/30</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>20/50 to 20/30</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>20/40 to 20/20</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>20/120 to 20/20</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>17</td>
<td>20/30 to 20/15</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>20/50 to 20/20</td>
<td>&lt;1</td>
<td>2</td>
</tr>
<tr>
<td>23</td>
<td>20/40 to 20/20</td>
<td>&lt;1</td>
<td>1</td>
</tr>
<tr>
<td>Decreased visual acuity:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>10/200 to NLP</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>HM to NLP</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>16</td>
<td>HM to NLP</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>20/160 to 20/200</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>20/80 to HM</td>
<td>&lt;1</td>
<td>1</td>
</tr>
</tbody>
</table>

* CF = count fingers; HM = hand movement; NLP = no light perception.

worse postoperatively had only 20/200 vision or less preoperatively. However, vision diminished after operation in one eye that had shown 20/80 acuity preoperatively.

**Duration of Loss.** Improvement in vision postoperatively was compared with duration of visual loss preoperatively (Fig. 2). Although greater improvement in vision appeared to occur with a shorter duration of preoperative loss, there were exceptions. Seventeen of 21 eyes in which vision improved had had a preoperative symptomatic loss of acuity of 2 years' or less duration. The remaining four improved eyes had had a loss of acuity for 3 years or longer prior to admission. One eye with a 6-year loss of vision (finger-counting only before operation) improved to 20/40 after tumor removal. By contrast, three of five eyes in which vision was worse after operation had demonstrated loss of vision for 4 years or longer; however, one such eye had shown a preoperative visual loss for only 3 months.

**Time of Improvement.** The 16 patients who experienced visual improvement were asked when maximum improvement had occurred. Four insisted it was on the first day after operation, four believed improvement occurred within the first 10 days, four within the first 2 months, and one within the first year postoperatively. Three patients who had objective improvement in visual acuity nonetheless believed no change had occurred.

**Optic Atrophy.** Disc color could not be correlated with visual improvement. Thirty-six of 38 eyes in 19 patients showed unchanged fundi postoperatively. In two patients 2 and 13 years after operation, the optic atrophy noted preoperatively was absent.

**Tumor Size.** Improvement or deterioration in vision did not appear to be related to tumor size. The majority of tumors in both the improved and unimproved groups were of the Class 2 or 3 size. Two of the patients whose vision was worse postoperatively had tumors of the Class 1 size.

**Subjective Disability.** After operation 15 patients were able to pursue normal visual activities, including driving and reading, while four patients were handicapped by serious loss of vision (Table 1); all of the latter were included in the group of five patients with worse postoperative vision (Table 2). One of these five patients was not actually handicapped because his other eye had improved to 20/20 associated with a moderately full field; he could drive, read, and conduct a normal life. In two of the handicapped patients vision in one eye improved while the other became worse. One patient's sight deteriorated in one eye to the degree of no light perception but improved in the contralateral eye from 20/400 to 20/20 in a field with a large temporal cut. She could conduct her housework and read but could not drive. The second patient improved from 20/200 to 20/100 in one eye in a retained superior nasal field. In the contralateral eye she had lost vision to 20/200. She could read with a magnifying glass but could neither drive nor perform housework. The other two handicapped patients had worse than 20/800 vision bilaterally.
Discussion

Stirling in 1897 reported the finding at autopsy of an "endothelioma" the size of a hen's egg growing from the meninges about the sella in a patient whose blindness in one eye and contralateral temporal field defect developed over a 6-year course. Since this first reported case of what has come to be called a "suprasellar meningioma," neurosurgeons from Cushing onward have noted that the initial opportunity to diagnose these benign, potentially curable tumors often belongs to the ophthalmologist. Varied combinations of central and peripheral field defects are now recognized commonly as variants of the syndrome produced by lesions that displace the optic chiasm upward and back. Newer neuroradiological techniques, including fractional pneumoencephalography and differential internal and external carotid angiography with "subtraction" processing, also assist in the diagnosis of these subfrontal lesions.

An asymmetrical loss of vision manifested by unilateral decreased acuity or constriction of a visual field was the predominant symptom in our patients. Progression to bilateral involvement was seen commonly in three sequences, some of which have been noted but not emphasized in previous reports of suprasellar meningiomas. Case 1 reported by Schlezinger, et al., exhibited a fluctuating loss of vision over a short course. Gradual loss of acuity in the ipsilateral eye, followed by a later loss in the contralateral eye, was noted frequently in Cushing and Eisenhardt's series. Sudden loss of acuity in one eye, followed by a later failure of vision in the other eye, was seen in Joy's case. Loss of vision in the contralateral eye was the crucial factor leading to admission and the appropriate neurodiagnostic studies in several instances in our group of patients.

Headache was infrequently a predominant symptom but was so variable in pattern and location as to make it of minor diagnostic help. Cushing emphasized that the absence of endocrinopathy was a useful clue in diagnosing meningiomas of the tuberculum sellae; this type of abnormality was also rare in our series.

Loss of visual acuity was the most constant finding; it was noted in at least one eye in all but one case, and this patient had bilateral field defects. Optic atrophy was a fairly constant early finding and was usually associated with a decreased visual acuity.

The incongruity and asymmetry of field defects could result from several factors. The anatomical position of the chiasm varies; 79% are positioned directly over the dorsum sellae, 12% lie on the diaphragm, and 5% are as far anterior as the tuberculum. Another factor could be that a short loop of crossing nasal retinal fibers extends into the contralateral optic nerve before coursing back through the chiasm. The combination of a central scotoma and a peripheral field deficit would be expected to result from these anatomic variations.

Vascular relationships are also important. The optic nerve is close to the ophthalmic artery at the optic foramen, and upward pressure by a growing tumor could distort this vessel and cause ischemia to the nerve. Also, the optic nerve could be directly compressed on the edge of the foramen. The studies of Bergland and Ray suggest that the central chiasm receives its vascular supply from below, while the lateral chiasm is supplied by more lateral and superior vessels. Thus, a tumor growing from below could compromise the central chiasmal blood supply. The anterior central arteries, which also supply the chiasm, may be compressed by tumor.

Finally, deformation of optic nerves and chiasm either directly or indirectly by stretching can be a factor. In our series, Cushing's classical chiasmal syndrome of optic atrophy with symmetrical bitemporal defects constituted the exception rather than the rule in patients with suprasellar meningiomas. Schlezinger et al.'s formulation of a "prechiasmal syndrome" with great field variability is closer to our usual clinical experience.

In one of three patients with unilateral full fields, the red button method of testing visual fields was positive and helpful in diagnosis. The red button test, as described by one of the authors (RSH), consists of placing a bright red button successively in the nasal and temporal fields of either eye and noting a difference in the quality of redness. The patient will perceive the button to be duller red in the temporal field if the chiasm is compressed by a mass. In our experience with chiasmal lesions, particularly pituitary
Loss and recovery of vision with suprasellar meningiomas

tumors, this sign is usually the first field alteration to be discovered and the last to resolve.

The most common pitfall in diagnosis of suprasellar meningioma is to ascribe the visual findings to retrobulbar neuritis. Although a central scotoma was found in three of our patients, a defect in the opposite field was always present, and the acuity loss was progressive, not sudden, as would be expected in a retrobulbar neuritis. The pain on ocular movement characteristically present in retrobulbar neuritis was absent from the histories of our meningioma patients.

No relationship between tumor size or severity of preoperative visual loss and visual improvement was demonstrated on follow-up examinations. This was surprising and could not be explained readily. Good postoperative visual results were obtained in patients with less than 2 years prior loss of vision. However, some patients with longstanding loss experienced a surprising return of function after decompression. A severe preoperative loss of vision to worse than 20/200 did not necessarily preclude a good result. Eight patients in our series reported early return of vision within the first 10 days after operation, four of these within the first day.

Although the majority of our patients with long-term follow-up are leading normal lives, with no sign of recurrence, four are visually handicapped (Table 2). Two of these had some postoperative improvement in visual function.

Most patients were fortunate to attain a good visual result despite loss of vision to less than 20/200 in at least one eye prior to operation. Greater awareness on the part of neurosurgeons, ophthalmologists, and primary physicians concerning the visual signs of suprasellar meningiomas should lead to earlier diagnosis and earlier surgical decompression, with consequently better visual results.

References

5. Cushing H, Eisenhardt L: Meningiomas: Their Classification, Regional Behavior, Life History and Surgical End Results. Springfield, Ill, Charles C Thomas, 1938

Address reprint requests to: F. Karl Gregorius, M.D., Department of Surgery, UCLA School of Medicine, Los Angeles, California 90024.