Surgical management of suprasellar meningioma

Part 2: Prognosis for visual function following craniotomy

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Visual outcome in 101 consecutive cases of suprasellar meningioma treated over a 35-year period has been examined. Preoperative visual loss was evaluated using a scoring system that takes both visual acuity and visual fields into account. In this way a percentage visual loss was calculated for each patient before and after surgery. The effects on visual outcome of age, preoperative visual loss, duration of visual symptoms, tumor size, status of the optic disc, and binocular versus monocular involvement was examined. For the group as a whole, vision improved in 63 patients, was unchanged in 12 patients, and was worse in 24 patients. Prognosis was favorably affected by a mean duration of symptoms of less than 2 years, a tumor size of less than 3 cm, a preoperative visual loss of less than 50%, and the presence of normal optic discs on funduscopic examination. Age had some effect on prognosis, but the presence of binocular or monocular involvement had no effect.

KEY WORDS • brain tumor • cranial nerve • meningioma • optic nerve • suprasellar tumor • visual function

SUPRASELLAR meningiomas are uncommon tumors of the central nervous system. Representing approximately 4% to 10% of all intracranial meningiomas, they often involve the anterior visual pathways and present commonly with vision failure. Despite this, few reports have dealt directly with their prognosis as regards vision. The need to consider the many variables involved, such as visual fields, visual acuity, or monocular or binocular involvement, has made analysis somewhat difficult. In some patients, vision may improve in one eye while remaining unchanged or deteriorating in the other eye.

Most investigators have approached this problem by examination of the different variables separately. Some authors have looked at only visual acuity, while others have considered both visual acuity and visual fields separately from one another. Visual improvement has usually been referenced to the eye with the best postoperative improvement, but others have found it more useful to divide each patient into two ocular units, with analysis of each eye separately and as part of a group of ocular units. We have approached the problem by using a point scoring system where both the visual field and the visual acuity of each eye are taken into account. The points are then added and a percentage of visual loss is calculated for each patient. It is therefore possible to represent all these variables with one number, the percentage visual loss. This was useful since we were interested in the overall visual function of the patient rather than any one variable.

In this communication we report our analysis of the visual outcome in 101 cases of suprasellar meningioma treated in this unit.

Clinical Material and Methods

Patient Population

The patient population is the same as that described in the accompanying paper, and consists of 101 consecutive cases of suprasellar meningioma selected from a total of 940 cases of meningiomas operated on at The National Hospital for Nervous Diseases, Queen Square, and at the Maida Vale Hospital, London. The records of these patients were carefully reviewed and an analysis was made of the clinical presentation, severity of visual involvement, and degree of postoperative recovery. Operative reports were examined and used to assess the degree of optic nerve involvement at the time of surgery. Tumor size was estimated from computerized tomography (CT) scans, angiograms,
Subjective binocular involvement was seen in 69 patients, whereas objective monocular loss of vision: 3.1 ± 4.4 years and 2.3 years, respectively. This difference, however, was much less dramatic when comparing the group with objective binocular visual loss to the group with objective monocular loss of vision: 3.1 ± 4.4 years and 2.3 ± 2.3 years, respectively. This was not a statistically significant difference. In 27 patients who noted the onset of visual symptoms in one eye, followed by symptoms in the other eye, the mean “interocular interval” (the interval of time from involvement of the first eye to involvement of the second eye) was 4.4 ± 6.2 years, with a range of 1 month to 30 years.

Headache was the second most common symptom, being present in 46 patients. Other symptoms were far less common and included mental changes in 10, hyposmia in four, epilepsy in three, and symptoms related to hypopituitarism in two. These are discussed in detail in the accompanying paper. The most common nonocular finding on examination was hyposmia, seen in 24 patients. Nine patients showed abnormalities on mental status testing, and pyramidal signs were noted in another nine cases. No patient demonstrated any clinical evidence of hypopituitarism on examination, and in only four cases were the preoperative endocrine studies abnormal.

On physical examination all 101 patients had abnormalities on visual field testing and all but one patient showed impairment of visual acuity. Ten patients were found to have monocular blindness, while one patient had binocular blindness. Approximately one-half of the patients had a moderate degree of visual impairment with a visual loss of 26% to 50%, while one-quarter had a severe degree of visual failure of 51% to 75%. Twelve patients had a very severe degree of visual impairment, with loss of vision exceeding 75%. Only 18 patients showed a mild degree of visual involvement, with a visual loss of less than 25%.

Optic atrophy was noted in 81 patients, and 14
patients had a normal funduscopic examination. In six cases this examination was not recorded. Papilledema was seen in four patients; two other patients showed signs of the Foster-Kennedy syndrome with unilateral optic disc edema and contralateral optic atrophy. Oculomotor nerve palsy was uncommon and was seen in only one case.

Operative Findings

All patients underwent craniotomy. In 92 cases, both optic nerves were found to be involved with tumor. Of these 184 optic nerves, 33 were severely displaced and flattened to a thin band, 14 were surrounded on three sides by tumor, and 17 were completely surrounded by neoplastic growth. The remaining 120 optic nerves were displaced and partially compressed in varying degrees. In nine patients, only one optic nerve was involved; four cases showed severe displacement and thinning of the optic nerve, while in the remaining five cases partial compression and displacement was seen. In all, 68 optic nerves in 46 patients showed severe involvement. These cases proved to be technically challenging as the tumor was usually adherent to the optic nerve, making dissection difficult and potentially compromising the nerve.

In the majority of patients with bilateral optic nerve involvement, the involvement was asymmetrical, with one optic nerve being affected more than the other. There was good correlation between severity of involvement and degree of preoperative visual loss. The more severe the preoperative loss of vision, the greater the incidence of severe optic nerve involvement found at craniotomy (Table 2). Seventy-five percent of patients with a preoperative visual loss of more than 75% showed severe optic nerve involvement, compared to only 23.5% of patients with a preoperative visual loss of 25% or less. In addition, the eye more severely affected on examination was always ipsilateral to the more affected optic nerve.

The most common configuration noted was that of an asymmetrical chiasmal displacement where one nerve was displaced downward and backward and the other was displaced either laterally or laterally and upward, with the chiasm lying posteriorly and obliquely between the two. An hourglass configuration was also seen where both the optic nerves and the chiasm straddled the tumor. In a few cases, both the optic nerves and chiasm were displaced downward with the tumor located on top of them. In one case, both optic nerves were displaced in the same direction by a tumor arising from the anterior clinoid process. In this case, the ipsilateral optic nerve was displaced medially and lay adjacent to the contralateral optic nerve which had been displaced laterally.

Results

There were six deaths among the 101 patients: two in the immediate postoperative period, two at 2 weeks, one at 5 weeks, and one at 2 months after craniotomy. Visual improvement was recorded in 63 patients following craniotomy. In 62 cases, improvement was rapid and occurred within 2 weeks of surgery. In 37 cases visual improvement was complete by 2 months, and in 14 cases improvement continued for an additional 4 months. Although visual improvement continued for yet another 6 months to 1 year postoperatively in 11 patients, this was marked in only three patients who experienced an average reduction in visual loss of 24%. In the remaining eight patients, visual loss was reduced by an average of only 4.8% during this period of time.

Vision was unchanged in 12 patients and was worse in 24 patients. One patient with no change in his visual function immediately after craniotomy improved over a 6-month period. Only two of 24 patients whose visual function was worse postoperatively eventually regained their preoperative degree of visual function; the remainder had some visual improvement but never reached their preoperative level.

In order to evaluate quantitatively the effects of surgery on vision, a visual improvement quotient (VIQ) was derived. The VIQ is defined by the following equation:

\[
\text{VIQ} = \frac{\text{VL preop} - \text{VL postop}}{\text{VL preop}}
\]

where VL is visual loss, and VIQ represents the degree
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TABLE 3
Effect of patient’s age on postoperative visual recovery

<table>
<thead>
<tr>
<th>Age Groups (yrs)</th>
<th>Normal</th>
<th>Improved</th>
<th>Unchanged</th>
<th>Worse</th>
<th>Improved Cases Only</th>
<th>Whole Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 40</td>
<td>23.5%</td>
<td>41.2%</td>
<td>5.9%</td>
<td>29.4%</td>
<td>0.69 ± 0.33</td>
<td>0.28 ± 0.7</td>
</tr>
<tr>
<td>40–50</td>
<td>20.7%</td>
<td>41.4%</td>
<td>17.2%</td>
<td>20.7%</td>
<td>0.59 ± 0.35</td>
<td>0.30 ± 0.5</td>
</tr>
<tr>
<td>51–60</td>
<td>18.8%</td>
<td>46.9%</td>
<td>6.3%</td>
<td>28.1%</td>
<td>0.51 ± 0.38</td>
<td>0.21 ± 0.58</td>
</tr>
<tr>
<td>&gt; 60</td>
<td>9.5%</td>
<td>53.4%</td>
<td>19%</td>
<td>19%</td>
<td>0.64 ± 0.25</td>
<td>0.35 ± 0.45</td>
</tr>
</tbody>
</table>

* VIQ = Visual improvement quotient; see text. NS = not significant.

of visual improvement or deterioration in each patient or group of patients obtained by comparing the visual loss (as defined in Table 1) both pre- and postoperatively, and relating that difference to the preoperative visual loss. Two types of assessments were performed; for the “whole group” and for the “improved patient.” The whole-group VIQ takes all of the outcomes of a particular group of patients in question and puts them into numerical terms. Patients who improve have positive VIQ values between 0 and 1, 1 being the highest possible VIQ value obtainable, representing a 100% improvement. Patients with no improvement have 0 values, while patients with visual deterioration following surgery have negative values. In this way we were able to see what surgery had done for any group of patients in question by taking into account all possible visual outcomes and averaging them together. The improved-patient VIQ takes into account only those patients whose vision improved postoperatively, and is a measure of the average degree of improvement in a group.

Using both the VIQ and the visual loss rating scale, we examined the influence on postoperative visual recovery of age, preoperative visual loss, duration of visual symptoms, binocular and monocular involvement, tumor size, and the status of the optic disc on funduscopic examination. Each will now be discussed individually.

Patient’s Age

Patients were divided into four age groups, and mean VIQ’s were calculated for each group (Table 3). No statistically significant difference could be established between the mean whole-group VIQ’s of each age group or between the mean VIQ’s of the improved patients only. Patients less than 40 years of age, however, were more likely to have their vision return to normal (23.5%) than were those patients over 60 years of age (9.5%). This difference, however, was not statistically significant.

Preoperative Visual Loss

In order to evaluate the effect of preoperative visual loss on visual prognosis, the patients were divided into four groups (Table 2). The degree of preoperative visual loss correlated well with postoperative visual improvement, as well as with the frequency of severe optic nerve involvement found at craniotomy. The greater the visual loss prior to surgery, the greater the incidence of severe optic nerve involvement seen at operation. Good correlation was also noted between the severity of visual loss preoperatively and the frequency with which vision returned to normal. No patient with a visual loss of more than 75% had a return of vision to normal, while 41.2% of patients with less than 25% visual loss had the return of normal vision.

The mean VIQ of patients whose vision improved following surgery was significantly greater in those whose preoperative visual loss was less than 50%, than in those in whom it was greater than 50% (mean VIQ’s of 0.71 ± 0.30 and 0.37 ± 0.30, respectively; p < 0.001). That is to say, the average degree of visual improvement in patients who improved was 71% in the less severely affected group (visual loss < 50%) compared to an average improvement of only 37% in the more severely affected group (visual loss > 50%).

Duration of Visual Symptoms

Duration of visual symptoms had a striking effect on prognosis of visual function (Table 4). Patients with symptoms lasting for 2 years or less did far better on the whole than patients with a longer history of visual disturbance. The mean whole-group VIQ of 0.40 ± 0.47 in the short-duration group was significantly different from that of 0.02 ± 0.58 in the long-duration group (p < 0.001). The reason for this is twofold. First, in a higher percentage of patients in the short-duration group vision either returned to normal or was improved postoperatively (74%) compared to that in the long-duration group (42.9%). Second, a higher incidence of visual deterioration was noted in the long-duration
group (42.9%) compared to the short-duration group (14.5%). The average degree of improvement in patients who did improve, however, was not significantly different in the two groups (mean improved-patient VIQ: 0.60 ± 0.33 and 0.52 ± 0.36, respectively).

**Ocular Involvement**

To evaluate the effect of monocular and binocular involvement on postoperative visual recovery, the data were examined in two ways (Table 5). In one the clinical history was used as the determinant of ocular involvement ("subjective"), and in the other the findings on physical examination ("objective") were used. This was necessary since 23 patients with subjective monocular complaints proved to have binocular visual involvement on ophthalmological examination.

On examining the subjective group, no significant difference in visual recovery could be identified between patients with monocular involvement and those with binocular involvement. Mean whole-group and improved-patient VIQ's were very similar in the two groups, as was the incidence of visual recovery and visual deterioration postoperatively. In the objective analysis, however, a difference between the monocular and binocular groups was found. The percentage of patients in whom vision returned to normal was greater in the group with objective monocular visual loss (23.3%) than in the group with objective binocular visual loss (14.5%). This, however, was offset by a higher incidence of visual deterioration in the monocular group and, therefore, the mean whole-group VIQ was lower for this group than it was for the group with binocular visual loss (mean VIQ's of 0.19 ± 0.70 and 0.33 ± 0.45, respectively). This difference, however, was not statistically significant. When the mean improved-patient VIQ was analyzed, however, patients with objective monocular visual loss who improved showed a greater degree of improvement than patients who improved in the binocular visual loss group (mean VIQ's of 0.75 ± 0.32 and 0.55 ± 0.34, respectively; p < 0.05).

**Tumor Size**

Tumor size had a definite effect on visual prognosis (Table 4). Patients with tumors 3 cm in diameter or less (small tumors) had a better visual outcome on the whole than did those with tumors larger than 3 cm (large tumors). Mean whole-group VIQ was almost twice as large in the small-tumor group (VIQ = 0.41 ± 0.54) as it was in the large-tumor group (VIQ = 0.22 ± 0.50), the difference barely missing statistical significance. In addition, patients with small tumors whose vision improved postoperatively showed a greater degree of improvement than patients with large tumors who improved (mean improved-patient VIQ's of 0.69 ± 0.31 and 0.50 ± 0.34, respectively; p < 0.025).

In nearly 28% of patients with small tumors vision returned to normal, while only 11.1% of those with large tumors showed this degree of recovery (chi-square, p < 0.01). Vision was unchanged or made worse in nearly 39% of patients with large tumors as compared to 30% of patients with small tumors.

**Optic Disc Status**

Fourteen of 95 patients in whom a funduscopic examination was recorded had normal optic discs. This group represented a clinical situation where all the previously mentioned prognostic factors were found to be favorable. In these patients, the average duration of symptoms was less than 2 years (1.8 ± 1.8 years); the mean tumor size was less than 3 cm (2.9 ± 0.7 cm); the mean preoperative visual loss was less than 50% (34.5% ± 13.3%); and the average age was 45 years. Not unexpectedly, this group of patients fared much better than any of the other groups of patients. Vision was returned to normal in 50%, improved in a further 35.7%, and worsened in only 14.3%. The average degree of visual improvement in patients who improved was a striking 84%.
Discussion

Suprasellar meningiomas have been a challenge to the neurosurgeon’s skill since they were first described in 1897.18 Their surgical removal can be fraught with hazards because of surrounding vital structures.14 Nonetheless, the goal of surgery remains the total excision of these lesions where possible, with restoration of visual function to normal. While most studies have addressed the morbidity and mortality involved in the removal of these tumors, few have directly examined the various prognostic factors involved in determining visual outcome. Grant,4,5 reported 27 cases of suprasellar meningioma but failed to discuss the visual outcome in these patients. Likewise, Fusek and Kune3 reported 47 cases but concentrated on operative mortality and morbidity. In a more recent communication, Solero, et al.,17 published their experience with these tumors. Of their 55 patients treated, 33 survived the surgery. Visual acuity was improved in 20, made worse in four, and was unchanged in nine. Prognostic parameters for visual recovery, however, were not discussed.

Jane and McKissock1 pointed out the importance of tumor size on operative mortality; however, the relationship to postoperative visual recovery was less clear. Of 32 patients with tumors larger than 3 cm, 18 survived the surgery. Of these 18 patients, vision was improved in eight, worsened in four, and unchanged in six. Of 17 patients with small tumors (< 3 cm), all survived the surgery; nine showed visual improvement and eight were unchanged. Kadas, et al.,10 reviewed 105 cases of suprasellar meningioma. Of 85 patients for whom follow-up data were available, visual acuity was improved in 56%, unchanged in 27%, and worsened in 16%. Ten patients in this series had tumors smaller than 3 cm in size. Of these, nine patients improved and one was unchanged. Ehlers and Malmros1 also found no effect of tumor size on visual recovery. Gregorius, et al.,6 reported on their experience in 23 cases operated on for suprasellar meningioma: 17 of 21 eyes in which vision improved had had a preoperative symptomatic loss of acuity of 2 years' or less duration. Perhaps surprisingly, they were unable to correlate improvement or deterioration in vision with tumor size or with optic atrophy. The influence of preoperative visual disturbance on postoperative visual outcome was also alluded to by Olivecrona15 and Ehlers and Malmros.1

In our series, duration of preoperative visual symptoms had a very strong influence on visual outcome. Patients with a symptom duration of 2 years or less had a higher incidence of postoperative visual improvement (53.2%) compared to 32.3% of patients with a history exceeding 2 years (chi-square, p < 0.025). Additionally, in 21.0% of the former patients vision returned to normal, while only 8.6% of the latter had return of normal vision. Of the patients who did improve, the average degree of improvement was for the most part greater in the group with symptoms of short duration than in patients who had been symptomatic for longer than 2 years.

Tumor size also had a strong effect on prognosis of visual function. Patients with tumors smaller than 3 cm had a better visual outcome than patients whose tumors were larger than 3 cm, and vision was restored to normal in nearly 28% of the former group, but in only 11.3% of the latter. In addition, the degree of visual improvement in patients who improved was greater in the small-tumor group, with an average improvement in visual loss of 69% compared to 50% in the large-tumor group.

The degree of preoperative visual loss had a moderate but definite effect on visual outcome. Patients with the smallest degree of visual loss preoperatively had the lowest incidence of severe optic nerve involvement found at the time of craniotomy, as well as the highest incidence of vision returning to normal. In addition, of the patients who improved postoperatively, those with a visual loss of less than 50% preoperatively showed the greatest degree of improvement (71% compared to 37% average improvement in those with a preoperative visual loss greater than 50%).

Patient's age had relatively little effect on visual outcome. Patients aged under 40 years were more likely to have vision return to normal (23.5%) than patients older than 60 years (9.5%). Otherwise, the incidence and degree of visual improvement was no different in the various age groups.

Monocular versus binocular involvement had a mixed effect on prognosis. If one considers subjective ocular involvement as defined by the clinical history, then no difference in visual outcome can be demonstrated between the two groups. If, however, ocular involvement is defined by the findings on ophthalmological examination, then a difference between the two groups may be seen. On the one hand, patients with objective monocular visual loss tended to do worse than those with binocular visual loss; 50% of the former patients showing visual deterioration or no change postoperatively as compared to 30.4% of the latter. On the other hand, patients with objective monocular visual loss whose vision improved showed a greater degree of improvement than their counterpart in the binocular group (75% and 55% average reversal of visual loss, respectively).

Of all the factors so far mentioned, the status of the optic discs at the time of admission had the strongest influence on prognosis of visual function. Of 14 patients with normal optic discs on funduscopic examination, nearly 86% showed a postoperative improvement in visual function, and in seven (50%) vision returned to normal. In this group of patients, all of the previously mentioned factors were acting in concert in a favorable manner. This further underscores the importance of early diagnosis. If diagnosis can be made early, then the prognosis for visual function in patients with suprasellar meningioma need not be as dismal as once thought. With earlier diagnosis and treatment, visual improvement should be possible in nearly 90% of cases.
Acknowledgment

We thank Ms. Julia Dunn for her secretarial help in the preparation of this manuscript.

References


Manuscript received March 7, 1984.
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