Neuro-ophthalmological function of patients with pineal region tumors approached transtentorially in the semisitting position

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To optimize orientation and operative exposure for aggressive resection, the authors approached pineal region tumors transtentorially with the patient in a semisitting position. In the current report, 12 consecutive patients were evaluated to document operative ocular morbidity referable to the brain stem as well as visual deficits secondary to occipital lobe retraction. Before craniotomy, ophthalmological findings related to dorsal midbrain dysfunction were evident in four of the 10 patients who had previously undergone ventricular shunting. The other patients developed a partial or complete Parinaud's syndrome in the early postoperative period and some suffered additional deficits such as cranial nerve palsies. These deficits improved to varying degrees in all patients. Although each had full visual fields preoperatively, an absolute or incomplete left homonymous hemianopsia developed in the immediate postoperative period. Such visual field deficits fully resolved over a variable period of time in 10 of the 12 patients. One patient has a permanent left homonymous hemianopsia, while another has a left homonymous paracentral scotoma. Eight patients were able to return to preoperative pursuits. While ocular abnormalities related to dorsal midbrain dysfunction are most probably independent of operative approach, visual field deficits attributable to occipital lobe retraction were common in patients after a occipital transtentorial approach performed in the semisitting position. Reading difficulties associated with ocular motor dysfunction due to dorsal midbrain involvement represent the principal long-term neuro-ophthalmological complaint of patients who have undergone pineal region surgery.

KEY WORDS • pineal tumor • Parinaud's syndrome • neuro-ophthalmology • occipital transtentorial approach

RECENT advances in diagnosis and therapy have significantly reduced the operative morbidity and mortality rates associated with aggressive resection of pineal area lesions. The two most commonly used surgical exposures to lesions in the pineal region are the supracerebellar, and the occipital transtentorial approaches. The latter approach provides excellent exposure of both the tumor and the deep venous system; however, it has been criticized, particularly when performed with the patient in a sitting or semisitting position, because of the risk of visual field defects secondary to occipital lobe retraction. The incidence and clinical course of these defects have not previously been documented, so we studied the pre- and postoperative visual function of a consecutive series of patients with pineal area lesions that were approached via the occipital transtentorial route at surgery in the semisitting position. In addition, since the pineal is in close proximity to brain-stem areas that control ocular motility, we also documented operative morbidity referable to the tectal region.

Clinical Material and Methods

Patient Population

From 1981 through 1989, 12 patients underwent craniotomy for pineal region lesions at the Oregon Health Sciences University by a single surgeon (E.A.N.). The clinical characteristics of these patients are summarized in Table 1. Ten patients required ventricular shunting prior to craniotomy for hydrocephalus secondary to pineal region pathology; 2 to 4 weeks after shunting, all 10 underwent definitive surgery.
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TABLE 1
Clinical course and follow-up results of 12 patients with pineal region lesions approached transtentorially

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age, Sex</th>
<th>Histological Diagnosis</th>
<th>Degree of Resection</th>
<th>Radiation Therapy</th>
<th>Chemotherapy</th>
<th>Follow-Up Period (mos‡)</th>
<th>Outcome‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21 yrs, M</td>
<td>astrocytoma grade II &amp; pineoblastoma</td>
<td>95%</td>
<td>+</td>
<td>–</td>
<td>77</td>
<td>stable (88 mos)</td>
</tr>
<tr>
<td>2</td>
<td>51 yrs, M</td>
<td>pineoblastoma</td>
<td>95%</td>
<td>+</td>
<td>–</td>
<td>68</td>
<td>stable (68 mos)</td>
</tr>
<tr>
<td>3</td>
<td>6 mos, F</td>
<td>pineoblastoma</td>
<td>gross total</td>
<td>+</td>
<td>6</td>
<td>recurrence at 4 yrs</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>17 yrs, M</td>
<td>astrocytoma grade II &amp; germinoma</td>
<td>gross total</td>
<td>+</td>
<td>14</td>
<td>died at 14 mos (metastatic disease)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>60 yrs, F</td>
<td>meningioma</td>
<td>95%</td>
<td>–</td>
<td>–</td>
<td>43</td>
<td>stable (55 mos)</td>
</tr>
<tr>
<td>6</td>
<td>61 yrs, F</td>
<td>&quot;pincitis&quot;</td>
<td>biopsy</td>
<td>–</td>
<td>–</td>
<td>30</td>
<td>no evidence of disease (41 mos)</td>
</tr>
<tr>
<td>7</td>
<td>5 yrs, M</td>
<td>astrocytoma grade II</td>
<td>biopsy</td>
<td>–</td>
<td>–</td>
<td>33</td>
<td>stable (41 mos)</td>
</tr>
<tr>
<td>8</td>
<td>20 yrs, M</td>
<td>germinoma</td>
<td>90%</td>
<td>+</td>
<td>–</td>
<td>12</td>
<td>no evidence of disease (27 mos)</td>
</tr>
<tr>
<td>9</td>
<td>24 yrs, F</td>
<td>germinoma</td>
<td>25%</td>
<td>+</td>
<td>–</td>
<td>7</td>
<td>no evidence of disease (18 mos)</td>
</tr>
<tr>
<td>10</td>
<td>50 yrs, F</td>
<td>vascular fibroglial tissue</td>
<td>90%</td>
<td>+ (preop)</td>
<td>–</td>
<td>6</td>
<td>no evidence of disease (17 mos)</td>
</tr>
<tr>
<td>11</td>
<td>12 yrs, M</td>
<td>astrocytoma grade II</td>
<td>biopsy</td>
<td>+</td>
<td>–</td>
<td>3</td>
<td>stable (14 mos)</td>
</tr>
<tr>
<td>12</td>
<td>38 yrs, F</td>
<td>pineal cyst</td>
<td>gross total</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>no evidence of disease (12 mos)</td>
</tr>
</tbody>
</table>

* All operations were performed in the semisitting position via a right occipital transtentorial approach; all patients except Cases 4 and 5 underwent ventricular shunting 2 to 4 weeks prior to surgery.
† Time from craniotomy to last formal neuro-ophthalmological evaluation.
‡ Data in parentheses represent total time postcraniotomy.

Operative Approach

All operations were performed via a right occipital transtentorial approach with the patient in the semisitting position.* In order to decrease occipital lobe retraction, a large occipital bone flap was used to expose the sagittal sinus medially and the torcular herophili and transverse sinus inferiorly; in adults, the bone flap extended approximately 10 cm rostrally from its inferior border. Full visualization of the sinuses was accomplished by the placement of Burr holes slightly to the left of the midline and inferiorly, just below the transverse sinus. Prior to dural opening, patients received mannitol, 0.15 gm/kg intravenously. The dura was opened in a stellate fashion; occipital lobe retraction was further minimized by extending the dural opening to the edges of the sinuses. Parasagittal draining veins are rarely present in the occipital area, but generally this exposure requires sacrifice of one or two veins between the inferior surface of the occipital lobe and the tentorium. The occipital lobe was gently retracted superolaterally, taking care to protect the cortex with padding, and the tentorium was incised adjacent to the straight sinus to expose the pineal region. Spinal drainage was not used in this series. The details of tumor dissection and removal have been reported previously. 25, 29, 30, 40

Neuro-Ophthalmological Evaluation

Patients underwent neuro-ophthalmological evaluation after shunting but prior to craniotomy, in the early postoperative period, and at varying intervals thereafter. All patients have had long-term neuro-ophthalmological follow-up monitoring. The purpose of this study was to document visual field deficits and ocular motility function. In most adult patients, visual fields were tested with kinetic perimetry (Goldmann type) or with automated static threshold perimetry (Humphrey Field Analyser). Several patients, particularly in the early postoperative period, were unable to tolerate this portion of the examination due to ocular deficits referable to the tectal area. In such cases, assessment of visual fields was limited to confrontation techniques.

Results

Preoperative Neuro-Ophthalmological Evaluation

Following shunting but before craniotomy, seven of the 12 patients had normal neuro-ophthalmological examinations and no complaints of disturbance in ocular function. In the other five (including Case 3 in which not all tests were performed) various combinations of ocular abnormalities were present prior to craniotomy (Table 2). Two patients (Cases 9 and 11)
were found to have pupillary light/near dissociation, up-gaze paresis, and convergence/retraction nystagmus, all of which constitute the principal elements of Parinaud's syndrome. These patients also experienced accommodation difficulty and intermittent vertical diplopia that was most often experienced while reading. Another patient (Case 6) had bilateral inter-nuclear ophthalmoparesis, bilateral ptosis, and up-gaze paresis. This patient complained of vertical and horizontal diplopia and the sensation that "words arose from the page." In another patient (Case 4), the examination was remarkable only for resolving papilledema. All patients had normal visual fields preoperatively.

Postoperative Neuro-Ophthalmological Evaluation

Visual Fields. In the early postoperative period, all patients had an absolute or partial left homonymous hemianopia. Visual fields returned to normal in 10 patients, usually within 1 or 2 months after surgery. Two patients had persistent visual field deficits, one a near-complete left homonymous hemianopsia and one a left homonymous hemianopsic paracentral scotoma (Table 3).

Ocular Motility. In the early postoperative period, all patients tested experienced worsened ocular motility (Table 2), and Parinaud's syndrome was found in 11 of the 12 patients. By contrast to the usually transient postoperative visual field deficits, most patients continued to have some abnormal ocular motility associated with tectal dysfunction on long-term follow-up study. All patients with Parinaud's syndrome in the early postoperative period continued to have varying degrees of pupillary light/near dissociation, convergence/retraction nystagmus, and limitation in up-gaze at long-term follow-up examination (Table 2). The preoperative sixth nerve palsies evident in one patient (Case 6) failed to resolve, while another patient (Case 11) demonstrated only partial improvement of bilateral ptosis. No significant postoperative changes in visual acuity were noted in any patient.

Ocular Function. Because patients exhibited varying degrees of ophthalmological abnormalities at examination soon after surgery, patient function was documented as a measure of long-term morbidity (Table 4). In the early postoperative period, all patients had varying degrees of ocular abnormalities; the most common and troubling symptom was difficulty with reading. At long-term follow-up examination, despite the use of prisms by most, several patients continued to have some difficulty with reading (Table 4). For example, a 21-year-old man who underwent aggressive resection of a mixed astrocytoma-pineoblastoma (Case 1) now experiences only occasional episodes of vertical diplopia. However, with the use of prisms, he continues to do well in college and is minimally troubled by his ocular deficit. By contrast, a 51-year-old physician (Case 2) has marked difficulty in reading despite the use of prisms and is unable to drive a motor vehicle because of symptoms referable to Parinaud's syndrome. In this series, one patient (Case 4) died due to metastatic

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**TABLE 3**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Preop</th>
<th>Early Postop</th>
<th>Late Postop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>normal</td>
<td>LHH</td>
<td>normal</td>
</tr>
<tr>
<td>2</td>
<td>normal</td>
<td>LHH</td>
<td>normal</td>
</tr>
<tr>
<td>3</td>
<td>normal</td>
<td>—</td>
<td>normal</td>
</tr>
<tr>
<td>4</td>
<td>normal</td>
<td>LHH</td>
<td>normal</td>
</tr>
<tr>
<td>5</td>
<td>normal</td>
<td>LHH</td>
<td>LHH</td>
</tr>
<tr>
<td>6</td>
<td>normal</td>
<td>LHH</td>
<td>normal</td>
</tr>
<tr>
<td>7</td>
<td>normal</td>
<td>LHH</td>
<td>normal</td>
</tr>
<tr>
<td>8</td>
<td>normal</td>
<td>LHH</td>
<td>normal</td>
</tr>
<tr>
<td>9</td>
<td>normal</td>
<td>LHH</td>
<td>normal</td>
</tr>
<tr>
<td>10</td>
<td>normal</td>
<td>LHH</td>
<td>Lp paracentral scotoma</td>
</tr>
<tr>
<td>11</td>
<td>normal</td>
<td>LHH</td>
<td>normal</td>
</tr>
<tr>
<td>12</td>
<td>normal</td>
<td>LHH</td>
<td>normal</td>
</tr>
</tbody>
</table>

* Preop = following shunting (when applicable) and prior to craniotomy; early postop = in the immediate postoperative period (1 day to 2 weeks following craniotomy); late postop = on long-term follow-up study. LHH = left homonymous hemianopsia.

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**TABLE 4**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Preop Findings</th>
<th>Long-Term Follow-Up Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>no complaints</td>
<td>episodes of vertical diplopia, particularly on lateral gaze</td>
</tr>
<tr>
<td>2</td>
<td>no complaints</td>
<td>persistent vertical diplopia with torsional component; reads slowly</td>
</tr>
<tr>
<td>3</td>
<td>—</td>
<td>normal examination prior to tumor recurrence and operation at outside institution</td>
</tr>
<tr>
<td>4</td>
<td>episodes of lines running together</td>
<td>intermittent vertical diplopia</td>
</tr>
<tr>
<td>5</td>
<td>vertical diplopia with extended reading</td>
<td>reading difficulties ascribable to dense left homonymous hemianopsia; decreased spatial perceptual ability; occipital seizures</td>
</tr>
<tr>
<td>6</td>
<td>marked reading difficulty</td>
<td>marked reading difficulty</td>
</tr>
<tr>
<td>7</td>
<td>no complaints</td>
<td>no complaints</td>
</tr>
<tr>
<td>8</td>
<td>no complaints</td>
<td>no complaints, except that occasionally lines appear at different levels with extended reading</td>
</tr>
<tr>
<td>9</td>
<td>reading difficulty</td>
<td>rare episodes of lines running together</td>
</tr>
<tr>
<td>10</td>
<td>no complaints</td>
<td>episodes of vertical and horizontal diplopia; misses first letters of words</td>
</tr>
<tr>
<td>11</td>
<td>reading difficulty</td>
<td>reading difficulty</td>
</tr>
<tr>
<td>12</td>
<td>no complaints</td>
<td>no complaints other than headache with extended reading</td>
</tr>
</tbody>
</table>

* Preop findings = findings after shunting (when applicable) and prior to craniotomy.
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disease and another underwent reoperation at an outside institution for recurrent pineoblastoma. Of the remaining 10 patients, eight have returned to school or preoperative career pursuits.

Surgical Complications. The primary morbidity was referable to the visual system. In this series, there was no clinically significant incidence of air embolism. In three cases, Doppler ultrasound monitoring detected small amounts of air; this was readily controlled in each case by central venous line aspiration, wound packing with saline-soaked gauze, re waxing of bone edges, and bipolar coagulation of soft tissues. In these cases, 0 cc, 2 cc, and 4 cc of air were aspirated, respectively. Changes in vital signs or cardiography did not occur during these episodes.

Discussion

In this series, surgical resection of pineal area lesions via a transtentorial approach with the patient in the semisitting position was associated with significant morbidity related to visual function. Postoperative dysfunction involving the visual system was of two kinds: 1) disorders of ocular motility and pupillary function; and 2) visual field defects.

Tectal Disturbances

Parnaud's syndrome and other abnormalities referable to the tectum produced persistent visual problems in these patients. From the available data it is not possible to determine the association, if any, between the surgical approach and postoperative ocular motility and pupillary dysfunction. Postoperative ophthamological morbidity referable to the tectum has been reported following the occipital transtentorial19,24,25 as well as the infratentorial33,48,55 approaches to the pineal region. Those reports, however, did not include formal neuro-ophthalmological evaluation. Thus, it may be suggested that postsurgical disorders of pupillary function and ocular motility are related to tumor removal rather than to the specific surgical approach used. This suggestion awaits further study; an association between pineal pathology and postoperative neuro-ophthalmological deficit cannot be drawn based on this limited series.

Visual Field Disturbances

All of our patients experienced a left homonymous hemianopsia during the immediate postoperative period. While this field defect resolved in the majority of patients, it was permanent in two. As expected, visual field loss compounded any postoperative ocular symptomatology referable to the brain stem. It is most probable that visual field deficits resulted from intraoperative occipital lobe retraction, although the removal of bridging veins that drain the occipital lobe may have contributed as well. No morbidity has been reported associated with the sacrifice of occipital veins that drain to the torcular herophili or the transverse sinuses.2,5,30,40

The precentral vein may also be sacrificed without morbidity;2,5,40 however, transection of multiple draining veins between the cerebellum and tentorium during an infratentorial approach may cause cerebellar edema,23,33 although this complication appears to be rare.1,41,47,48,54

When a transtentorial approach is used, visual field loss may be decreased by placing the patient in a prone, semiprone, or lateral position, possibly with the head flexed and rotated in such a way that gravity may assist in occipital lobe retraction.2,19,26,27,49,52 Such positioning, however, may complicate the surgeon's orientation. Lapras, et al.,25 suggested that, when the transtentorial approach is performed with the patient in a sitting or semisitting position, the incidence of visual field loss may be decreased by lateral rather than superolateral retraction of the occipital lobe.

Surgical Issues

In recent years, surgeons have become increasingly aggressive in the management of pineal area tumors.2,6,66

Cushing's view of the region as inaccessible, and surgery in this location performed prior to 1943 was associated with a 90% operative mortality rate.41 More recent series have documented a very low or no operative mortality.12,16,25,30,47 There were no operative deaths in the present series. A wide range of benign and malignant pathologies may be encountered in this area,12,14,16,25,41 and it is often difficult to determine the precise site of tumor origin preoperatively and whether there is intrinsic brain-stem involvement.1,12,14,25,42

Magnetic resonance (MR) imaging may provide more exact localization than previously available techniques.12,23,51 Such preoperative information may be utilized to refine intraoperative expectations and enhance the prediction of operative morbidity referable to the brain stem. Recent work utilizing high-resolution MR imaging suggested brain-stem invasion in a high percentage of malignant pineal tumors;41 thus, the ability of surgery to effect a "gross total" tumor resection remains to be determined, despite the pineal gland being well circumscribed. Several investigators feel that surgical resection provides more complete tissue for neuropathological diagnosis than that obtained via needle biopsy techniques, particularly given the mixed histology that may be present in a single lesion.2,15,16,25,51,44 and the lack of a clear correlation between radiographic findings.4,12,14,20,32,39 cerebrospinal fluid tumor markers,13,29,51 and tumor histopathology. Aggressive resection may be best accomplished using the occipital transtentorial approach by virtue of exposure of the superior aspect of the tumor and the deep venous system.26,30 It is also noteworthy that, in this series of consecutive patients, we did not encounter any significant episodes of air embolism, hypotension, or related potential complications when patients were operated on in the semisitting position.

Conclusions

Our study suggests significant visual morbidity following the surgical resection of pineal area lesions.
However, most of our patients have returned to their preoperative career pursuits, although many require the use of corrective prisms in glasses to overcome diplopia. Given the anatomical complexity of the pineal region, maintaining operative orientation is important. The transtentorial approach to the pineal area with the patient in a semisitting position facilitates orientation; however, this approach is often associated with transient visual field defects. Ocular motility and pupillary problems related to brain-stem dysfunction are most probably independent of the operative approach and are usually a more troubling impediment than the visual field defect.

Acknowledgment

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References

34. Parraud H: Paralysis of the movement of convergence of the eyes. Brain 9:330–341, 1886
37. Poppen JL: The right occipital approach to a pinealoma.
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