Surgical Approach to Posterior Third Ventricular Lesions – An Initial Experience

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ABSTRACT

Background: Posterior third ventricular lesions are uncommon deep seated, heterogeneous mass lesions. They constitute pineal gland tumors, epidermoid, choroid plexus papillomas, meningioma, metastases and vascular lesions. Surgical excision of these lesions pose a major challenge due to the complex anatomy of this region. Objective: The objective of this paper is to ascertain the management strategy of posterior third ventricular lesions with emphasis on surgical management. The advantages and disadvantages of the two main approaches and their indications are compared and discussed. Patients and Methods: Ten patients with posterior third ventricular region tumors were operated by the authors with age ranging from 21 to 36 years. All patients with obstructive hydrocephalus underwent a ventriculoperitoneal shunt and in one patient an endoscopic third ventriculostomy was performed. During the shunt CSF was obtained for tumor markers. Tumor excision was done through the infratentorial supracerbellar approach in five cases while the infracerebellar transtentorial approach was adopted in two patients. A combined two stage approach was adopted in two cases. In one patient an endoscopic biopsy was carried out after an endoscopic third ventriculostomy which revealed a germinoma. Results: Gross total excision of the tumor was performed in 07 (70%) patients. A subtotal excision was performed in 02 (20%) and an endoscopic biopsy in 01 (10%) patient. Two of the operated patients developed transient parinaud’s syndrome which resolved in the subsequent follow up and transient ataxia was observed in two of the patients. One patient developed venous hemorrhage of the occipital lobe but had no worsening of her visual deficit as the patient was already blind preoperatively. We encountered two deaths in our series - one due to postoperative hematoma and the other due to refractory brain edema. The most common tumor encountered in our study was pinealoblastoma (04) followed by meningioma (02), germinoma (02), epidermoid (01) and pilocytic astrocytoma (01). Conclusion: Despite advances in surgical techniques, surgical excision of these lesions remains challenging owing to the proximity of deep cerebral veins and dorsal midbrain structures. The surgical approach depends on the size and extent of the lesion and the vascular anatomy of the region. The learning curve in this is steep and the surgeon’s experience plays an important role in the overall morbidity and mortality.

INTRODUCTION

Posterior third ventricular lesions are rare, but they are more diverse than in any other intracranial location. Their location in the midline and centre of the brain has evoked controversy regarding treatment modalities.

The lesions in this region account for only 1% to 2% or less of primary intracranialneoplasms in Western countries, but they have a higher incidence of 4% in Japan and other countries in East Asia.

Most common lesions encountered in this region are pineal gland tumors, epidermoid, choroid plexus papilloma, meningioma, metastasis, and vascular lesions.

The anatomy of the posterior third ventricular region is complex and is difficult to access surgically.
The vascular anatomy of this region especially the deep venous system has posed a major challenge for neurosurgeons attempting removal of tumors in this region.

The two main approaches to tumors in this region are the infratentorial supracerebellar approach initially described by Krause and later popularized by Stein and the infraoccipital transtentorial approach of Jamieson and Poppen.

Each approach has its own advantages and disadvantages and has to be chosen after considerable deliberation. Adjuvant therapy with radiation and chemotherapy also plays a vital role in managing some of the tumors in this region.

**PATIENTS AND METHODS**

**Study design:**

The authors present their experience with the management of 10 patients (Table 1) with posterior third ventricular region lesions. There were 6 male and 4 female patients with age ranging from 21 to 36 years.

The mean tumor size was 4 cm in its maximum diameter.

All patients underwent appropriate imaging studies and routine preoperative investigations. All patients with obstructive hydrocephalus underwent a ventriculoperitoneal shunt and in one patient an endoscopic third ventriculostomy was performed. During the shunt CSF was obtained for tumor markers.

Tumor excision was done through the infratentorial supracerebellar (Krause’s) approach in five cases while the infraoccipital transtentorial (Poppen’s) approach was adopted in two patients.

A combined two stage approach was adopted in two cases. In one patient an endoscopic biopsy was carried out after an endoscopic third ventriculostomy which revealed a germinoma. (Fig. 1)

**Table 1: Demography, approaches and pathology of the 10 patients having Posterior Third Ventricular Lesions**

<table>
<thead>
<tr>
<th>No</th>
<th>Age/sex</th>
<th>Presentation</th>
<th>Approach</th>
<th>Immediate postop complications</th>
<th>CSF markers</th>
<th>HPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36/M</td>
<td>Headache giddiness</td>
<td>Krause</td>
<td>Death</td>
<td>Negative</td>
<td>Meningioma</td>
</tr>
<tr>
<td>2</td>
<td>22/M</td>
<td>Headache</td>
<td>Krause</td>
<td>Nil</td>
<td>Negative</td>
<td>Epidermoid</td>
</tr>
<tr>
<td>3</td>
<td>35/M</td>
<td>Headache giddiness</td>
<td>Etv &amp; biopsy</td>
<td>Nil</td>
<td>Positive</td>
<td>Germinoma</td>
</tr>
<tr>
<td>4</td>
<td>32/F</td>
<td>Headache loss of vision</td>
<td>Combined 2 staged</td>
<td>Ataxia</td>
<td>Negative</td>
<td>Meningioma</td>
</tr>
<tr>
<td>5</td>
<td>21/M</td>
<td>Giddiness diminished vn</td>
<td>Krause</td>
<td>Parinaud’s syndrome</td>
<td>Negative</td>
<td>Pineoblastoma</td>
</tr>
<tr>
<td>6</td>
<td>30/F</td>
<td>Ataxia diminished vn</td>
<td>Poppen’s</td>
<td>Parinaud’s syndrome</td>
<td>Negative</td>
<td>Pineoblastoma</td>
</tr>
<tr>
<td>7</td>
<td>34/M</td>
<td>Headache vomiting</td>
<td>Krause</td>
<td>Ataxia</td>
<td>Negative</td>
<td>Germinoma</td>
</tr>
<tr>
<td>8</td>
<td>35/M</td>
<td>Headache giddiness</td>
<td>Krause</td>
<td>Combined 2 stage</td>
<td>Nil</td>
<td>Pineoblastoma</td>
</tr>
<tr>
<td>9</td>
<td>35/F</td>
<td>Headache diminished vn</td>
<td>Combined 2 stage</td>
<td>Ataxia</td>
<td>Negative</td>
<td>Pineoblastoma</td>
</tr>
<tr>
<td>10</td>
<td>25/F</td>
<td>Headache vomiting</td>
<td>Poppen’s</td>
<td>Death</td>
<td>Negative</td>
<td>Pineoblastoma</td>
</tr>
</tbody>
</table>

**Surgical technique:**

1. **Infratentorial Supracerebellar approach (Fig. 2):**

The patient was placed in a sitting or concorde position with the operating surgeon standing to the side of the patient. The latter was preferred in four of the five cases which underwent this procedure. A large suboccipital craniectomy with extension well above the transverse sinus was performed. The dura was opened in a Y fashion with the base towards the transverse sinus. The bridging veins from the dorsal cerebellar surface to the tentorium were sacrificed in almost all the cases for a wide exposure and to allow gravity dependent descent of the cerebellum. Gentle retraction with self-retaining retractors to establish the corridor between superior vermician surface and the inferior surface of the tentorium was achieved. The dense arachnoid folds of the quadrigeminal cistern is incised vertically and cut, following which the trajectory towards the posterior third ventricle is achieved. The deeper venous structures are well exposed above the surgical field. Once the tumor was encountered, the tumor surface was coagulated and the internal decompression was done using the ultrasonic surgical aspirator. This was followed by careful dissection of the capsule from the surrounding structures. Following tumor decompression, the third ventricular cavity and the ependymal lining was well visualized right upto the foramen of Monro.

**Fig. 1:** Posterior third ventricular space occupying lesion management strategy
2. Infraoccipital transtentorial approach (Fig. 3):

The patient was placed in prone position with the head slightly tilted to the ipsilateral side to facilitate gravity dependent retraction of the occipital lobe. A parieto-occipital craniotomy was fashioned in such a way to expose the rim of the transverse sinus inferiorly, the superior sagittal sinus medially and a lateral extension for about 5-6 cms. After the dura was opened in a cruciate fashion, the occipital lobe was gently retracted supero laterally. The posterior horn of the lateral ventricle can be punctured and CSF aspirated to reduce ventricular pressure and obtain more space if required. Access to the pineal region was obtained in the angle along the straight sinus between the falx and the tentorium. When the splenium of corpus callosum was reached, the tentorial edge was coagulated parallel and lateral to the straight sinus and divided until the incisural edge, thereby bringing the superior cerebellar surface into view. A good view of the pineal region and the quadrigeminal plate was achieved without the hindering deep venous structures, which are now positioned above and lateral to the approach. The tumor removal was then carried out in a piece meal fashion.

Fig. 2 a-d: a: The Krause’s approach, cerebellum being retracted downwards with patient in concorde position and surgeon standing to the right. The dense arachnoid over the lesion can be seen. b: The arachnoid is opened in a vertical fashion. c: Tumor decompression using ultrasonic aspirator. d: Tumor capsule being excised intoto.

Fig. 3a-d: a: Through the right sided Poppen’s approach tumor being coagulated. b: The falx being cut to gain access to the tumor on the opposite side. c: Tumor (meningioma) decompression being done using ultrasonic aspirator. d: After total tumor excision.
3. Combined two stage approach (Krause and Poppen’s) this was performed in two of our cases to achieve total excision of the tumor since there was a significant residual tumor above the tentorium and was adherent to it, which couldn’t be accessed via the Krause approach initially.

Postoperative management: Eight out of ten patients were immediately extubated and shifted to the intensive care unit for postoperative care. Postoperative CT scan was taken for all the patients, (Fig. 4-7).

RESULTS

Gross total excision of the tumor was performed in 07 (70%) patients (Figure 3, 4 & 5). A subtotal excision was performed in 02 (20%) and an endoscopic biopsy in 01 (10%) patient.

Average operating time was around 160 minutes from the time of induction and the average blood loss estimated was around 450ml at the end of the surgery in the suction apparatus after subtracting the fluids from the total volume.

Two of the operated patients developed transient parinaud’s syndrome which resolved completely in the subsequent follow up and transient ataxia was observed in two of the patients. One patient developed venous hemorrhage of the occipital lobe but had no worsening of her visual deficit as the patient was already blind preoperatively (Figure 76a). We encountered two deaths in our series—one due to postoperative hematoma (Figure 7b) and the other due to refractory brain edema.

The most common tumor encountered in our study was pinealoblastoma (04) followed by meningioma (02), germinoma (02), epidermoid (01) and pilocytic astrocytoma (01).

Fig. 4a-e: a-c: Shows pre-operative MRI and d&e: post-operative CT scan of a patient with pinealoblastoma excised using the Krause’s approach
Fig. 5a-d: a&b: Pre-operative MRI and c&d: post-operative CT scan of a patient with posterior third ventricular epidermoid excised totally through the Popen’s approach.

Fig. 6a-e: a&b: Pre-operative MRI and c&e: post-operative CT scan of a patient with a large posterior third ventricular meningioma which was totally excised using combined two staged approach.
Fig. 7 a&b: a: Post-operative CT scan of a patient showing venous hemorrhage of the right occipital lobe after the Poppen’s approach. b: Post-operative CT scan showing hemorrhage in the tumor bed and intraventricular hemorrhage.

DISCUSSION

Posterior third ventricular lesions are rare and diverse. The anatomy of the posterior third ventricular region is complex and is difficult to access surgically. The major parenchymal components of this region include the pineal gland, the posterior commissure, and the habenular commissure, the superior and inferior colliculi of the tectal plate.

It is defined anteriorly by the posterior recess of the third ventricle, superiorly by the cistern of the velum interpositum and posteriorly by the quadrigeminal plate cistern. The vascular anatomy of this region poses a formidable surgical challenge. The arteries encountered are the distal parts of the posterior cerebral artery, superior cerebellar artery and its branches and the thalamogeniculate perforators. The veins constitute the internal cerebral veins, basal vein of Rosenthal on either side, the lateral occipital vein, vein of galen, inferior sagittal sinus and the straight sinus. All these veins need to be preserved through careful dissection.

These lesions present with headache, impaired vision, nausea, impaired ambulation and common clinical signs include papilledema, ataxia and Parinaud’s syndrome. MRI is the imaging modality of choice for these lesions. It shows the exact location and extent of the lesion, involvement of adjacent structures and displacement of the large veins.

The sagittal MRI also reveals the situation and plane of the tentorium in relation to the tumor and is an important factor which determines the surgical approach according to the senior author. If most of the tumor is below the tentorium the Krause's approach is preferred while the Poppen's approach is adopted if most of the tumor is above the tentorium. If only computed tomography (CT) is available, angiography is desirable prior to the surgery to identify the course of the veins. Tumor markers in the CSF and blood also aid in determining the management of the lesions of the posterior third ventricular region.

The tumors of the pineal region, because of their close association with critical vascular and brain structures are known to pose problems for neurosurgeons during surgical excision. Classically, open surgical resection is associated with a high risk of morbidity and mortality. Horsley was the first to attempt surgery for these lesions. In the earlier series, the operative mortality rate after direct surgery ranged from 30% to 70% and the morbidity rate was up to 65%.

Thus, a conservative approach was initially advised - irradiation after a CSF drainage procedure, with surgery being reserved for tumors that failed to respond. It was argued that 75% of pineal tumors were malignant and rarely amenable to surgical excision but were radiosensitive. This management was associated with an overall mortality rate of less than 5% and a 5-year survival rate of 60% to 75%. Improvements in microsurgery and anesthesia have greatly reduced mortality and morbidity rates for direct surgery. Despite the advances in microsurgical techniques, excision of pineal tumors remains difficult.

The credit for the first successful excision of tumors of this region goes to Krause in 1913, who utilized the infratentorial supracerebellar approach, an approach revived and popularized by Stein in 1971. The alternative approaches to this region are Jamieson’s and Poppen’s occipital transtentorial approach, Van
Wagenen’s posterior transventricular approach and Dandy’s posterior transcallosal approach.

A preoperative CSF diversion procedure has to be employed in the form of shunting or endoscopic third ventriculostomy which not only helps in relieving the obstruction but also makes the brain lax for retraction during surgery. It also aids in diagnosing certain tumors by CSF markers and if the tumor is radiosensitive then the definitive surgery can be avoided.

**Infratentorial Supracerebellar approach:**

The main advantage of this approach is that it provides a midline trajectory to the tumor from where it may be extended eccentrically with minimal neural damage. It also gives sufficient exposure minimizing the risk of damage to the deep venous channels as these are usually displaced superiorly by the lesion.

Disadvantage of this approach is that the lesions with a significant component extending laterally and superiorly until the trigone or the lesions involving the corpus callosum are difficult to remove completely by this access and hence require supratentorial approaches. Moreover, this approach is limited by a narrow corridor which can be distressing to the neurosurgeon especially if the lesions are vascular.

Some neurosurgeons adopt the sitting position for this procedure but it can cause serious discomfort to the surgeons due to the outstretched hands and also carries a risk of air embolism. The Concorde position negates the above disadvantages. The senior surgeon prefers this position, standing to the side of the patient thus preventing uncomfortable bending over the patient (while standing at the head end) and extreme flexion of the neck.

**Infracoccipital transtentorial approach:**

The main advantage of this approach is it gives a wider exposure and lesions involving the trigone and corpus callosum are easily accessible by cutting the falx if necessary. Cutting the tentorium also gives access to the posterior fossa. This approach is preferred especially in cases where the deep venous system is dorsally displaced as occurs in tentorial meningioma.

The disadvantages are that the deep venous system is reached initially, complete tumor removal is difficult in tumors extending eccentrically to the contralateral side and the retraction of occipital lobe results in retraction edema, venous hemorrhage and homonymous hemianopia.

**A Combined two stage approach:**

Using both the above approaches may be adopted if the lesions are large and radical excision is desirable. This not only stages the operation but also negates the risk of neurovascular injury in attempting radical excision through a single approach which may not be possible or desirable in large lesions.

**Other approaches:**

Alternative approaches utilized to access lesions in this region are posterior interhemispheric transcallosal approach and the anterior transcallosal transventricular approach. The access from the lateral to the third ventricle is gained by a subchoroidal approach. Alternatively, after the corpus callosum is divided, the transcallosal interforniceal approach permits direct entry into the third ventricle by separating the fornices in the midline. The lateral paramedian infratentorial approach in park-bench position traverses between the superior surface of cerebellar hemisphere and the lateral tentorium.

**CONCLUSION**

Posterior third ventricular region lesions remain a challenge to neurosurgeons attempting surgical excision of these lesions inspite of the advances in micro neurosurgery. The learning curve in this is steep and the surgeon's experience plays an important role in the overall morbidity and mortality. The surgical approach depends on the size and extent of the lesion and the vascular anatomy of the region. The histopathology also plays an important role in the surgical management adopted.

**REFERENCES**