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Interhemispheric Transtentorial Approach to the Pineal Region

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Abstract

Context: *Many approaches were used to remove tumors of the pineal region. None of these approaches could gain general acceptance. Consequently, the choice of the approach is always problematic.*

Aims: *To illustrate and evaluate the usefulness of using the interhemispheric occipital transtentorial approach in treating pineal tumors.*

Settings and Design: *A retrospective study of ten cases of pineal region tumor*

Materials and Methods: *Ten patients suffering from pineal region tumors were operated upon through the interhemispheric occipital transtentorial approach.*

Results: *Three tumors (30%) were easy to dissect from the surrounding and thus were totally removed. Other three tumors (30%) were found adherent to the brain stem and thus sheets of the tumor were left behind i.e. subtotal removal. Four tumors (40%) were very vascular and infiltrating the surrounding and were only debulked. In all the ten patients, the approach was never the limiting factor for tumor removal. When complete surgical excision was not achieved it was due to either a poor plane of cleavage between the tumor and the brain stem, difficulty to dissect the tumor from the deep venous system of the brain or due to invasion of the surrounding vital structures.*

Conclusion: *The interhemispheric occipital transtentorial approach is a suitable approach when treating pineal body tumors.*

Keywords: *Interhemispheric occipital transtentorial approach; Occipital transtentorial approach; Pineal region tumors; Surgery to pineal region.*

Introduction

Surgery to pineal region tumors has always been difficult. In the early days of neurosurgery shunting procedure followed by irradiation was the only possible line of treatment for these difficult lesions[1,2,3]. Although this was an acceptable approach at that time, it did not help in benign tumors of this region which are not much affected by irradiation. With the introduction of microsurgery, neurosurgeons started to explore this region. The better magnification and illumination offered by the operating microscope decreased the morbidity and mortality associated with surgery. Dandy approached the pineal region from the right side of the falx through the splenium[4].Krause tried approaching such tumors over the cerebellum and under the tent[?]..Van Wagenenused a transventricular approach [5]. Popen described approaching the pineal region by elevating the occipital lobe and incising the tent [6]. Stein populated Krause's approach.Yasargil populated the occipital transtentorial (OT) approach[7,8,9].

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Krause and Popen approaches have the advantage of avoiding damage to nervous structures in contrast to that of Dandy's and Van Wagenen's procedures.

The OT approach was further divided into interhemispheric and lateral approaches[10]. The interhemispheric OT approach isadvised for midline lesions arising from the precentral cerebellar fissure that have significant superior extension to the posterior incisural space. The interhemispheric corridor also provides midline exposure to lesions extending into the velum interpositum, third ventricle, and medial thalamus[10]. In the present article, the authors are evaluating the interhemispheric OT approach which was used to treat ten cases of pineal region tumors.

Materials and Methods

Between 2007 and 2011,ten patients suffering from pineal region tumor were operated through theinterhemispheric OT approach (Table 1). Six of them underwent CSF tumor markerstudy for human chorionic gonadotrophin (hCG) and Alpha-Fetoprotein(AFP) before surgery and the result was negative. The CSF samples were obtained during shunting. The last fourcases were operated upon without shunting. In these four cases, CSF sampleswere obtained during surgery. These samples werealso found negative. One of the ten patients hadcranial irradiation previously.

Operative procedure

In order to determine the best location for craniotomy the authors adopted a very simple method to achieve a direct access to the pineal region with the shortest operative depth. On the mid sagittal plane of the patient's MRI, a line is drawn starting from the center of the tumor backwards to intersect the occipital bone at right angle (Fig 1). This line defines the shorted distance between the surface of the skull and the pineal body tumor. The distance between the inion and the point where this line intersects the occipital bone is measured. At the beginning of surgery, this pointof intersection is marked on the patient head using its distance from the external occipital protuberance. The medial border of a rectangularbone flap is centered on this point (Fig 3). In the occasion where the previously mentioned line passes through the splenium, the surface point can be moved downward. This alleviates the need to incise the posterior part of the corpus callosum.

Surgery is done under general anesthesia. The patient is put in the three-quarter prone position. The head is fixed with three point skeletal head holder. The patient body is brought to the opposite side of the operating table toward which he will be turned. After turning the patient, the back is further moved toward the edge of the table. A roll is put in the axilla to protect the brachial plexus from the sharp edge of the table. The upper arm is supported on a hand rest. The head is rotated 60 degrees to the horizontal plane so that the face is turned towards the ground. The approach is made from the dependent side. In this position gravity helps to retract the occipital lobe away from the falx. This is also aided by the lack of bridging veins between the occipital lobe and the posterior part of the superior sagittal sinus. These two factors lessen the need for occipital lobe retraction. A U shaped occipital skin incision is reflected inferiorly. The medial limb of the incision is centered on the point of intersection of a perpendicular line from thecenter of the tumor to the occipital bone (described above)(Fig 3). A 5X4 cm rectangular bone flap is then made just lateral to the superior sagittal sinus with the long limb parallel to it. Dural tack up sutures guard against the accumulation of extradural hematoma. Ventricular taps were made in the four patients who were not shunted.

The durais opened in a C-shaped fashion hinged on the superior sagittal sinus.With the aid of the operating microscope, the straight sinus is identified. The tent is incised 1cm lateral to the straight sinus. The incision is started proximal to the surgeon and was

carried towards the quadrigeminal cistern using bipolar coagulation and scissors. This minimizes the bleeding from the intersected dural leaflets. A retractor may be placed on the falx to increase the exposure. The arachnoid covering the quadrigeminal cisterns is opened. The veins in the quadrigeminal cistern are identified and separated from the tumor. One should always try to preserve these veins. The widest area of the tumor surface devoid of veins is incised. The tumor is internally debulked using suction, tumor forceps, cautery, scissors and ultrasonic aspiration if necessary. As the tumor is decompressed, the capsule is dissected from the surrounding. At this stage, the surgeon should decide whether the tumor can be resected safely or not. The tumor capsule in most cases can be removed from superior and lateral direction. The inferior part of the capsule should be approached with caution due to its relation to the brain stem. At the end of the surgery, the third ventricle can be seen. Hemostasis should be meticulous since small clots may obstruct CSF flow causing hydrocephalus.

Fig 1. MRI scans in a 42-year-old man with a pineocytoma (a) contrast-enhanced T1-weighted sagittal MRI scans demonstrating a tumor in the pineal region. The line drawn from the center of the tumor to occipital bone defines the shortest surgical corridor.(b) postoperative contrast-enhanced T1-weighted scans revealing complete resection of the tumor

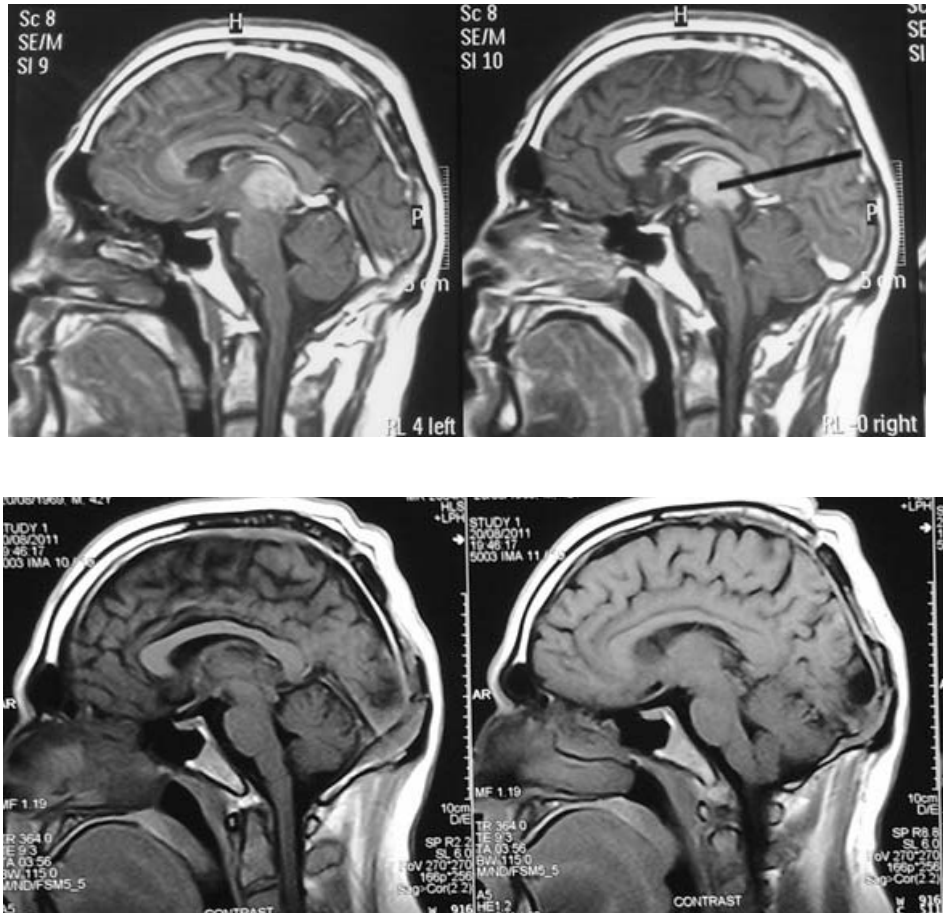


Fig 2. MRI scans in a 15-years-old boy with a dermoid tumor. (a) Contrast-enhanced T1-weighted axial MRI scans showing a pineal region tumor. He received 35 sessions of irradiation with no response. (b) Postoperative contrast-enhanced T1-weighted scans showing the extent of tumor removal. The last piece of the tumor was adherent to the vein of Galen which hindered complete surgical excision

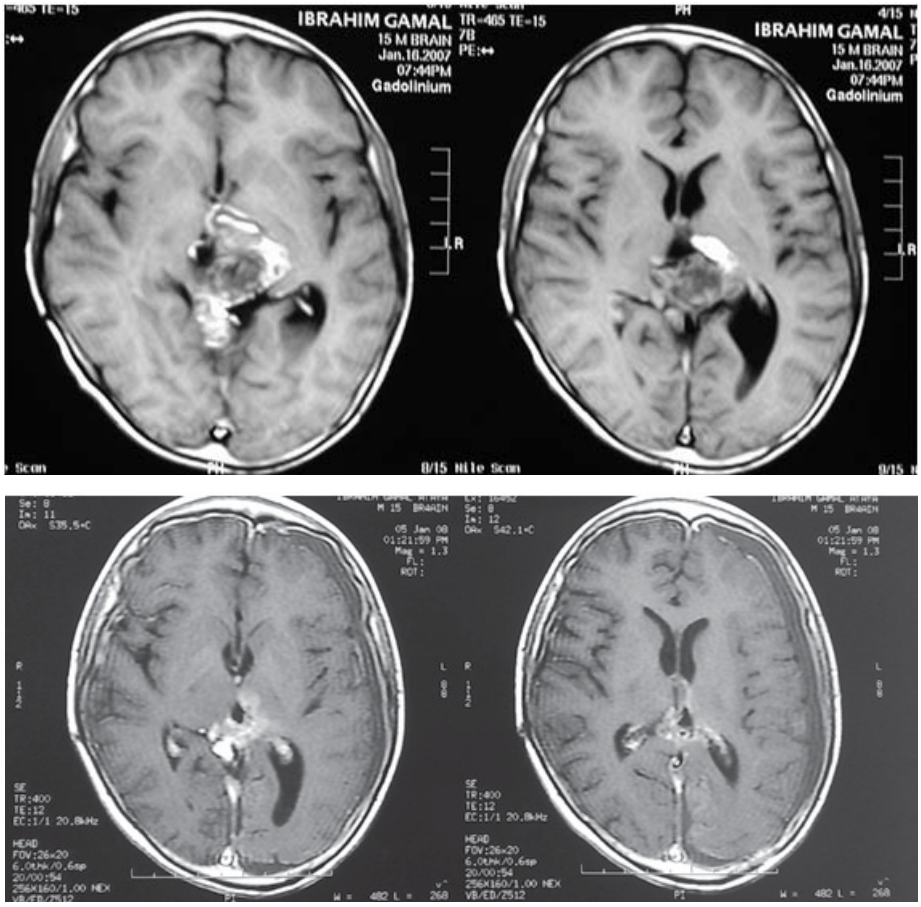
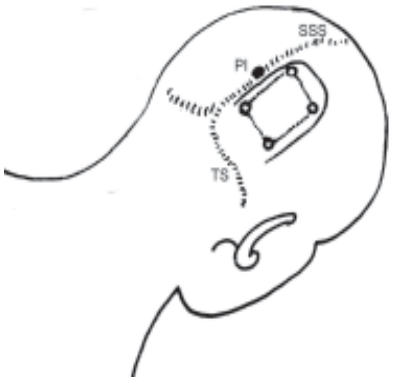


Fig 3. Skin incision and craniotomy for the interhemispheric OT approach. SSS: Superior sagittal sinus TS: Transverse sinus, PI: Point of intersection of line dropped from tumor center to occipital bone



Results

Eightpatientswere operated upon from the right and two from the left side. The right, non-dominant, side was usually preferred except in cases wherethe tumor showed left lateral extension. The presenting symptom was headache in all cases. Headache with other symptoms of increase intracranial pressure were present in five cases. Headache in association with inability to look upwards were present in two cases.

Eight cases showed hydrocephalus in their pre-operative imaging. The remaining two cases had ventriculomegaly. Of the eight patients who showed hydrocephalus six were shunted. During shunting CSF samples were

obtained and proven negative for tumor markers. The last two hydrocephalic cases were operated upon directly without shunting. In these two cases, preoperative imaging suggested a benign pathology that could be remove totally and the hydrocephalus was expected to be relieved. The pathological diagnoses of these two cases werecraniopharngioma and arachnoid cyst. After operation, hydrocephalus was relieved as expected.

During surgery, three tumors were easy to dissect from the surrounding and thus were totally removed (Fig 1). Other three tumors were found adherent to the brain stem and thus sheets of the tumor were left on iti.e. subtotal removal (Fig 2). Four tumors were very vascular and infiltrating the surrounding and were only debulked.

The pathological diagnoses of the cases were: twopineoblastoma and onedermoid cyst, pineocytoma, craniopharngioma, germinoma, pilocytic astrocytoma, arachnoid cyst, teratoma and glioblastoma.

In the post-operative period, two patients developed weakness grade I (ie motor power grade IV-) which improved after 3 months but did not return to normal (motor power grade IV+). Two patients showed inability to look upwards. In the three months follow up one of them improved. Three patients developed diabetes insipidus. Two of them improved while one did not. Early postoperative visual field loss occurred in three cases but this was temporary.

Discussion

Many approaches were described to remove tumor of the pineal body[4,5,6,10-20]. The posterior approaches are gaining much acceptance because they have the advantage of not traversing important neural structures. The posterior approaches are mainly the OT and the supracerebellar infratentorial[21]. The OT has two variants[10]; the interhemispheric and lateral. In this series, the authors found that the interhemispheric OT approach was most helpful in treating ten patients suffering from pineal body lesions.

The classic OT approach involves exposure of the posterior part of the superior sagittal sinus, the torcula and the medial part of the transverse sinus. The occipital pole is retracted in the anatomical superolaterally direction. The inferior cerebral veins draining the occipital lobe in the transverse sinus are in the operative field and have to be preserved since their interruption may produce infarction and edema of the occipital lobe[22]. In the interhemispheric OT approach, only the posterior part of the superior sagittal sinus is exposed. The occipital lobe is retracted laterally. The anterior part of the tentorium is only incised. This shortens the distance to the pineal region by adopting a more direct approach and preserves the inferior cerebral veinsbyputting them away from the operative field.

The interhemispheric OT approach providesa very good view of the medial border of occipital lobe, the quadrigeminal cistern (posterior incisural space) with the pulivinar of the thalamus laterally and sometimes the medial border of the temporal lobe of the same side [15,23-28]. From above downwards, the splenium of the corpus callosum, the velum interpositum, the deep venous system, the pineal gland, the superior and inferior colliculi down to the depth of the cerebellomesencephalic fissure can bevisualized [15].

The interhemispheric OT approach can be used for tumors in the pineal region not extending beyond the lateral border of the brain stem. This is due to the fact that the occipital lobe limits itsipsilateral extension, while the posterior part of the falx limits it contralateral extension[15]. However in certain occasions when brain dehydration is adequate exposure of structures lateral to the ipsilateral brain stem can be achieved.In this series none of the tumors had lateral extension. These limitations are important since tumors extending beyond these limits cannot be resected using this approach

One of the major disadvantages of the interhemispheric OT approach for tumor of the pineal region is that the tumor is removed working between friable veins of the deep venous system. This disadvantage has been overemphasized by critics[15,24,30-33]. In the present series, it was found that pineal tumorsstretch and displace the venous system allowing triangles to work through. Working along veins, from the beginning, was not a major concern. It carried the advantage of visualization of these delicate structures from the start. Early identification of these veins helped to protect them. It also conveyed if the tumor could be dissected from the deep venous system of the brain. Learning thisearly in the operation, affected the surgical strategy whether to try toresect the tumor totally or not. Moreover, in this series as well as other recent ones[10,20], there was no morbidity or mortality related to injury of the deep venous system.

One of the disadvantage of the interhemispheric OT approach is thathomonymous hemianopia may develop due to occipital lobe retraction. Visual field loss was reported in 19 to100% of cases according to different authors. It only persisted in 17% of the patients[34-37]. In this series, visual field loss related to surgery was noticed in three patients (33%). None showed persistence of their symptoms when they were investigated 3 months later. Visual loss, in the present cases, never amounted to a full blown picture of homonymous hemianopia (incongrous hemianopia). Many factors could have led to this favorable result. Six of the ten patients included in this study had previous shunting operation. The remaining four had ventricular tap early after elevating the bone flap. Reducing the intracranial pressure early in the operation lessens the need for forcible brain retraction. Using the three quarter prone position with the head sagittal plane rotated 60 degrees to the ground allowed the occipital lobe to fall away from the falx further decreasing the need for retraction.

In this series,the interhemispheric OT approach was always adequate to remove tumors of the pineal region. Tumors of the pineal region are mainly midline structure and they rarely extend laterally. This made the interhemispheric OT approach suitable for all of them. In all the ten patients, the approach was never the limiting factor for tumor removal. When complete surgical excision was not achieved it was due to either a poor plane of cleavage between the tumor and the brainstem or the difficulty to dissect the tumor from the deep venous system of the brain.

Conclusion

Although many approaches were described to remove tumors of the pineal body, still acontroversyexists about the best approach to adopt. In the present study, the authors found that the interhemispheric OT approach is very usefulto excise pineal body tumors and it was never the limiting factor in preventing tumor resection. The authors believe that the location of the bone flap becomes very adequate if its medial side is centered on a line which extends from the tumor to intersect the occipital bone at right angle.

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