A Review Of Anterior Interhemispheric Subfrontal Approach In Management Of Suprasellar Meningiomas With Endoscopic Assistance

A Kumar, C Deopujari, V Karmarkar

Citation

Abstract
Objective: The aim of this paper is to review the anterior interhemispheric subfrontal approach for resection of suprasellar meningiomas and to study the use of endoscope in achieving near complete resection. Methods: All cases of suprasellar meningiomas operated trans-cranially during last 13 years were analyzed retrospectively. Majority presented with visual complaints. The outcome was assessed after surgery and at follow up (ranging from 1-12 yrs) in terms of visual outcome, extent of resection and mortality & morbidity of the procedure. There were a total of 36 cases of which 15 were planum sphenoidale, 7 were tuberculum sellae, 4 were anterior clinoidal, 1 was a diaphragma sellae meningioma. In 9 cases there was a wider attachment to more than one place. 25 patients underwent anterior interhemispheric subfrontal approach, 9 were operated from pterional approach and 2 were operated from unilateral sub-frontal approach. Endoscopy was used whenever required. Results: The meningiomas were excised completely in 33 cases (Simpson grade I and II) while subtotal excision was done in 3 cases. The visual recovery was observed in 60% of the patients while it was preserved in 40% cases. One patient died after 1 month of an uneventful discharge due to a seizure episode while bilateral anosmia was seen in 2 patients. Conclusions: Anterior interhemispheric subfrontal approach for suprasellar meningiomas is one of the key surgical approaches for management of larger midline lesions. The use of endoscope can further help in achieving near total resection. Although this approach has not been amongst the preferred ones off late, meticulous technique and adequate precautions can help in achieving optimal results with little morbidity.

ABBREVIATIONS
TSH: Thyroid Stimulating Hormone
CSF: Cerebro-Spinal Fluid
MRI: Magnetic Resonance Imaging
CT: Computed Tomography
SSS: Superior Sagittal Sinus
DVT: Deep Venous Thrombosis

INTRODUCTION
In 1938 Cushing and Eisenhardt reported 28 cases of tuberculum sellae meningiomas and defined the term “Suprasellar”. It included lesions arising from planum sphenoidale, clinoidal process and dorsum sellae. These lesions pose great technical challenges to a neurosurgeon because of their close proximity to the anterior visual pathways, arteries of the anterior circulation and the hypothalamus. The “Chiasmal Syndrome”, a primary optic atrophy with bi-temporal field defect has been the classical presentation of these tumours, though other clinical presentations have also been described. Patients can present with bilateral/unilateral diminution of vision with or without field defects. Suprasellar meningiomas can be tackled in various ways. There are various trans-cranial and endonasal approaches mentioned in the literature which provide direct access to the anterior skull base for their resection.

PATIENT AND METHODS
36 patients of suprasellar meningiomas including tuberculum sellae, planum sphenoidale, anterior clinoidal and diaphragma sellae were retrospectively analyzed between 1997 and 2010 after their clinical history, imaging, endocrinological and ophthalmological findings, operative notes and discharge cards were scrutinized. All patients underwent MRI brain with contrast and plain CT scans of brain (to look for hyperostosis and anatomy of frontal sinus, Figure 1A, 1B & Figure 2).
MR Angiography was not performed routinely although it was done as and when required based on the angioarchitecture seen on MRI scans. Patients underwent routine ophthalmological (visual acuity by Snellen’s chart, visual fields by perimetry and fundoscopic evaluation) and endocrinological examinations pre-operatively which included a baseline T3, T4 and TSH levels, serum cortisol levels and serum prolactin levels.

**CLINICAL PRESENTATION**

Females were affected more commonly (F: 24, M: 12) in the middle age group (40-60 years). 60% patients presented with gradual progressive loss of vision in one or both eyes and 70% patients presented with visual field defects affecting both the eyes. 30% presented with seizures (one had focal seizures while others had generalized tonic clonic convulsions) while 10% presented with headaches. One case was detected incidentally during his routine health check up. None of the patients had pre operative endocrinological disturbances except one who had raised TSH.

**SURGERIES**

A total of 40 procedures were performed on 36 patients. 25 were operated via bifrontal craniotomy and anterior interhemispheric subfrontal approach. The endoscope was used whenever significant tumor was attached to the tuberculum obscured from direct vision. This approach was used in all those larger tumours which were in midline and
had elevated the optic apparatus and anterior cerebral arteries upwards. 9 underwent pterional craniotomy in cases where the tumour was more eccentric and had pushed the neurovascular structures medially. 2 patients underwent unilateral sub-frontal approach for excision of smaller sized lesions. 4 secondary procedures were also performed on these 36 patients. 2 patients required trans-sphenoidal surgeries for extracranial recurrences. One patient had an orbital recurrence which was removed by a different procedure. One patient had to undergo a CSF repair surgery after he developed CSF rhinorrhea after the primary surgery.

Follow up: All these patients were assessed immediately after surgery (within 24 hours), 3 months after surgery and 12 months after surgery. They underwent ophthalmological and endocrinological examinations at the follow up.

**ANTERIOR INTERHEMISPHERIC SUBFRONTAL APPROACH WITH ENDOSCOPIC ASSISTANCE: TECHNIQUE**

Lumbar drain is inserted pre-operatively for brain relaxation. Patient is placed supine with head elevated above the heart level and kept in neutral position in Mayfield clamp with extension of 20 degrees for frontal lobes to fall away from the skull base. Bicoronal skin incision is given and flap is always reflected back in 2 layers so as to harvest vascularised pericranium for skull base repair. Bifrontal craniotomy is done by making two key burr holes on either side and two in the midline (one burr hole just above the nasion and one 4 cms behind the first). Frontal sinuses whenever transgressed are exteriorized with the pericranium after removing the mucosa and packing them with muscle. Dura is opened parallel to the skull base. Anterior superior sagittal sinus is ligated and cut. Subfrontal interhemispheric dissection is done after covering the frontal lobes with gelfoam sheets and taking utmost care to preserve the frontal cortical veins (Figure 3).

Olfactory nerves are dissected beforehand to prevent their accidental avulsion and covered with gelfoam. The tumour attachments are coagulated progressively as tumour is approached along the skull base which helps in detaching the tumor and helping in devascularisation also. All the tumours arising especially from planum sphenoidale can be tackled this way as their vascularity comes from anterior and posterior ethmoidal arteries. In addition, the interhemispheric approach helps to visualize the upper extent of the tumor and the anterior cerebral arteries can be seen relatively easily. As compared to pterional approach where tumor excision under the ipsilateral optic nerve becomes slightly difficult, subfrontal approach achieves it more easily with good bilateral exposure. The tumour entering the optic canal can be removed by drilling the optic canal. Minimal handling and copious irrigation is a must to prevent thermal injury to the optic nerves during drilling. The tumour always can be separated from the neurovascular structures by way of an arachnoid plane which helps in the dissection (Figure 4).
Angled bipolar forceps may be found useful for coagulating the tumour attachments in the region of tuberculum (Figure 5).

Then, a 30 or 45 degree endoscope is used to excise the remnants attached to the tuberculum. With the help of an endoscope, a panoramic view of the pituitary fossa can be seen and remnants can be retrieved by help of forceps or curette (Figure 6).

Sometimes if it is involved, the tuberculum has to be drilled for achieving grade I excision and in those cases, the skull base has to be repaired with the vascularised pericranial flap. The closure is done in usual manner and lumbar drain is removed after surgery.

**RESULTS**

The results were analyzed in terms of visual recovery, extent of excision and morbidities due to the surgery.
EXTENT OF EXCISION
There was complete excision in 33 cases (Simpson grade I and II: 91.7%) while 3 cases were sub-totally removed (grade III or higher: 8.3%). All these 3 cases recurred extra-cranially later on during follow up. Two cases underwent trans-sphenoidal surgeries and one patient was operated trans-cranially for an orbital recurrence.

VISUAL RECOVERY
Almost 60% patients improved in the less affected eye while 40% remained the same. Vision in the more affected eye did not improve substantially on acuity assessment although some patients had marginal subjective improvement. One patient had transient deterioration in both the eyes, which improved within a week. This patient had no pre-operative visual deficit and was incidentally detected. Most of these patients had presence of pallor in optic disc on pre surgical fundoscopic examination (Figure 8).

MORBIDITIES AND MORTALITY
Two patients deteriorated post operatively due to frontal lobe edema which resulted in removal of their bone flaps. Both improved later on and had replacement of the bone flaps electively. One patient developed transient diabetes insipidus and one had an episode of hyponatremia. One patient had transient deterioration of vision which improved after a period of 1 week. Two patients developed deep venous thrombosis of calf veins which was treated with low molecular weight heparin. One patient had post operative hematoma which was evacuated surgically. Two patients had bilateral anosmia. One patient developed CSF leak following surgery which required a skull base repair. There was one death due to seizures after an uneventful discharge.

DISCUSSION
The term suprasellar is a broad terminology which contains tumours of anterior clinoid, diaphragma sellae, planum sphenoidale, medial sphenoid wing, dorsum sellae and tuberculum sellae. Sometimes, tumours of olfactory groove are also included in this, although the major difference between them and suprasellar meningiomas is the downward displacement of neurovascular structures in the former and anosmia as a clinical presentation. We have included a total of 36 cases of which 15 were planum sphenoidale, 7 were tuberculum sellae, 4 were anterior clinoidal, 1 was arising from diaphragma sellae and in 9 cases there was a wider attachment to more than one place.

Almost 65% patients had bi-temporal hemianopia also (Figure 9).

The percentage of gross tumour removal ranges from 35-100% in various series as per Nakamura et al. We achieved 91.7% Simpson grade I and grade II excision. The use of endoscope in addition helped us to remove the residual lesion in the pituitary fossa adherent to the tuberculum which may get obscured otherwise during the subfrontal trajectory. All the other 8.3% patients who had undergone subtotal resection developed recurrence in the follow up and were re-operated later. Cushing and
Eisenhardt\(^3,4\) defined the “chiasmal syndrome” with one eye having primary optic atrophy and presence of bilateral temporal field defects. Symon and Rosenstein\(^10\) reviewed 101 pts where the most common signs were visual field defects (100%), loss of acuity (99%), optic atrophy (85%). Papilloedema, Foster-Kennedy syndrome and 3\(^{rd}\) nerve palsy were other rare findings. Most of our patients presented with unilateral or bilateral loss of vision with or without loss of visual fields. The vision in the less affected eye improved immediately after surgery in 60% of patients which maintained during the follow up period. However, the vision in the worst eye remained the same and didn’t improve. One of our patients had transient deterioration probably due to spasm of perforators to the optic apparatus during tumour removal. Almefty et al.\(^1\) have enumerated numerous causes for visual deterioration in tuberculum sellae meningioma surgery. Because of the intimate relationship between the optic nerves and chiasm with the tumor, visual impairment may occur due to direct damage to the optic apparatus, hematoma, interruption of vascular supply to the optic nerve and chiasm, or compression resulting from surgically-induced material or arachnoiditis. There were two cases in which the optic canal was drilled as the tumor was encroaching the optic canal (Figure 10).

**Figure 11**

Figure 10: Tumor encroaching the left optic canal

Both the patients did not experience any visual deterioration. Internal decompression followed by outer dissection should always be done during the surgery. The tumour always remains demarcated from the surrounding neurovascular structures by way of arachnoid planes which must be respected and strict adherence to this basic methodology can avoid many neurovascular injuries. Cushing and Eisenhardt\(^3\) had a 50% visual improvement rate in their series published in 1929. Fahlbusch and Schott\(^5\) found out an improvement rate of 80% in their series of 47 cases of suprasellar meningiomas with pterional craniotomy. They proposed the preoperative duration of visual deficits less than 1 year and young age as good prognostic factors. 70 cases were retrospectively analyzed by Goel et al.\(^6\) where vision was improved in almost 70% cases. According to Andrews and Wilson\(^7\) also, the duration of visual symptoms less than 6 months was a favourable factor for recovery and the recovery is always inversely proportional to the duration of preoperative blindness. They also inferred that tuberculum meningiomas (11 out of their 38 patients) were more completely resected while medial sphenoid wing and clinoidal ones were the most difficult to remove and thus had high recurrence rates. Mortality rates in tuberculum sellae meningiomas have been varying in different case series from 0 to 67% (Jallo et al.\(^7\)). Recent studies have shown much less mortality rates with the introduction of instruments like ultrasonic aspirator and development of better microsurgical techniques. Jane and McKissock\(^8\) reported a mortality rate of 42% in 32 cases in which the tumor was larger than 3 cm. No deaths occurred in 17 patients where the tumors were smaller than 3 cm. We could not find any such association as the only mortality in our series was due to a seizure after an uneventful discharge. Although, we had our share of morbidities in form of DVT, electrolyte disturbances, wound infection, CSF leak. These can be prevented by early mobilization and rehabilitation of post operative patients. Exteriorization of frontal sinus in a meticulous manner by muscle and pericranial flap cannot be overemphasized. We had to remove bone flaps of two patients (5.5%) due to frontal lobe edema which were replaced later. This might have happened due to frontal lobe retraction and impairment of the venous drainage. Lumbar drainage of CSF can therefore help in achieving adequate space obviating the need for excessive frontal lobe retraction. We always try to preserve at least one olfactory nerve by dissecting the arachnoid beforehand and thus avoid their accidental avulsion intra-operatively.

**CONCLUSIONS**

Suprasellar meningiomas pose a tough challenge for neurosurgeons. There are many approaches available to resect them with pros and cons of each. Although we have not compared various other approaches and have not found
the statistical differences between them, the anterior interhemispheric subfrontal approach in our hands has been one of the key approaches due to excellent bilateral control on large midline tumors. The likely risk of CSF leak and anosmia can be minimized after taking adequate precautions during the surgery. In addition the use of endoscope may assist in resecting these tumours more completely by venturing into regions hidden usually by the subfrontal trajectory. A prospective randomized controlled trial involving a larger number of patients undergoing anterior interhemispheric subfrontal approach for these lesions should be done to evaluate further.

References

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Author Information

Ashish Kumar, MCh
Department of Neurosurgery, Bombay Hospital Institute of Medical Sciences, Mumbai 400020, Maharashtra, INDIA

Chandrashekhar E. Deopujari, MCh
Department of Neurosurgery, Bombay Hospital Institute of Medical Sciences, Mumbai 400020, Maharashtra, INDIA

Vikram S. Karmarkar, DNB
Department of Neurosurgery, Bombay Hospital Institute of Medical Sciences, Mumbai 400020, Maharashtra, INDIA