The Use of the Bifrontal Interhemispheric Approach with Bilateral Olfactory Tract Preservation for the Surgical Resection of Tuberculum Sella Meningiomas

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Abstract

Objective: Is to examine the details of the bifrontal interhemispheric approach with olfactory tract preservation; when the approach is used for surgical resection of tuberculum sella meningiomas.

Material and Methods: In the period between June 2009 and January 2011, 8 patients with tuberculum sella meningiomas were operated using a bifrontal interhemispheric approach with olfactory tract preservation. All patient information were prospectively collected and at the end of the study retrospectively analyzed. Patients were followed-up for a period ranging from 6 months to 2 years.

Results: Gross total resection was achieved in all cases. All cases were WHO grade 1-11 meningiothelial meningiomas. No recurrences were reported over a 2 year follow-up period. 75% of cases showed some degree of visual improvement after surgery, while 25% remained the same. 25% developed a permanent anosmia. 37.5% of cases showed variable degrees of venous infarction after surgery. However; only one case required a decompressive craniectomy.

Conclusion: Bifrontal interhemispheric approach can be considered superior to any other approach regarding anatomical exposure, midline orientation, neurovascular dissection, higher incidence of radical resection and arachnoid preservation. However, the benefits of the approach must be weighed against the high incidence of venous infarction reported with this approach.

Key Words: Tuberculum sella meningiomas — Bifrontal interhemispheric approach — Olfactory tract preservation.

Introduction

TUBERCULUM sella meningiomas arise from the tuberculum sella on one side and grow in an infrachiasmatic direction. They displace the arachnoid and neurovascular structures laterally and posteriorly [1b The early visual involvement causes them to present with a relatively small size in most cases. Accordingly, they have a good chance at radical resection and cure [2].

The pterional approach remains the approach most widely used for the resection of tuberculum sella meningiomas. A number of authors using this approach have described those tumors as formidable and challenging tumors; because of the difficulty of neurovascular dissection and midline identification through the pterional approach. It has also been stated that the main merits of this approach are; the early vascular identification, the preservation of olfaction and the lack of interference with the venous drainage of the frontal lobes [3,4,5].

Based on the pattern of arachnoid and vascular displacement in tuberculum sella meningiomas, the aim of our work is to examine the various aspects of the bifrontal interhemispheric approach as applied to tuberculum sella meningiomas.

Subjects and Methods

Eight patients with tuberculum sella meningiomas were operated using a bifrontal interhemispheric approach with olfactory nerve preservation on both sides at Cairo University Hospitals in the period between June 2009 and January 2011. The techniques used for craniotomy and olfactory nerve preservation as well as interhemispheric fissure dissection were described elsewhere [3].

After exposure, neurovascular dissection is started by detaching the tumor from the midline to attack the base of the tumor first. The tumor is then rolled medially from underneath the optic nerve, for the early identification of the carotid artery. The artery is usually found medial to the optic nerve. Knowledge of this fact is important

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to prevent carotid artery injury. The same process is repeated on the other side to have a bilateral and symmetrical step wise vascular identification. The tumor is then debulked and rolled out from its bed. Here the membrane of liliequist is identified and preserved to look for the pituitary stalk. The intact membrane of liliequist is essential to preserve the pituitary stalk and the hypothalamic structures as the surgeon curves around the tumor between the tumor and the carotid artery.

Finally, the interhemispheric part of the approach is used to identify the A2. Now having identified and dissected the carotid artery and the A2, the last part of the tumor is dissected from the AI and the optic chiasm. Preservation and dissection of the olfactory tract up to the medial and lateral olfactory stria was found to be helpful because it gives an imaginary idea about the position of the AI and the carotid bifurcation. This approach allowed us in most cases to split the Sylvain fissure bilaterally for a good exposure of the carotid bifurcation. In most of our cases, there was a good arachnoid separating the tumor from the AI. The tumor usually insinuates itself between the optic chiasm and the AI. The tumor is then finally removed. After removal through this approach there is usually a wide unobstructed exposure all the way to the basilar bifurcation. Hemostasis is performed and the wound closed in a usual fashion.

Data were prospectively collected and at the end of the study retrospectively analyzed. Patients were followed-up for a period ranging between 6 months and 2 years. Particular care was given to the pre and postoperative visual status, olfactory function, the presence or absence of infarctions related to frontal lobe vein coagulation and the presence or absence of arterial injury during surgery and particular care was given to the technique used in the dissection of the carotid and the anterior cerebral artery during surgery. All relevant patient information can be seen in Table (1).

<table>
<thead>
<tr>
<th>Patient number</th>
<th>Age</th>
<th>Sex</th>
<th>Pre-operative visual status</th>
<th>Surgical resection</th>
<th>Post-operative visual status</th>
<th>Complications</th>
<th>Pathology</th>
<th>Recurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40</td>
<td>f</td>
<td>Unilateral</td>
<td>Complete with very small optic canal extension</td>
<td>Improved</td>
<td>Anosmia</td>
<td>Meningiothelial Meningioma WHO grade I</td>
<td>Non</td>
</tr>
<tr>
<td>2</td>
<td>39</td>
<td>f</td>
<td>Unilateral</td>
<td>Complete</td>
<td>Same</td>
<td>Asymptomatic venous infarction and Diabetes incipidus</td>
<td>Meningiothelial Meningioma WHO grade II</td>
<td>Non</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>f</td>
<td>Unilateral</td>
<td>Complete</td>
<td>Improved back to normal on follow-up</td>
<td>Anosmia</td>
<td>Meningiothelial Meningioma WHO grade II</td>
<td>Non</td>
</tr>
<tr>
<td>4</td>
<td>55</td>
<td>f</td>
<td>Bilateral with an attempt at trans-sphenoidal resection</td>
<td>Complete</td>
<td>Same with completely destroyed nerve found during surgery</td>
<td>Symptomatic venous infarction that required decompressive craniotomy</td>
<td>Meningiothelial Meningioma WHO grade II</td>
<td>Non</td>
</tr>
<tr>
<td>5</td>
<td>42</td>
<td>f</td>
<td>Unilateral</td>
<td>Complete</td>
<td>Improved</td>
<td>Diabetes incipidus</td>
<td>Meningiothelial Meningioma WHO grade II</td>
<td>Non</td>
</tr>
<tr>
<td>6</td>
<td>38</td>
<td>f</td>
<td>Unilateral</td>
<td>Complete</td>
<td>Improved back to normal on follow-up</td>
<td>Asymptomatic venous infarction</td>
<td>Meningiothelial Meningioma WHO grade I</td>
<td>Non</td>
</tr>
<tr>
<td>7</td>
<td>60</td>
<td>f</td>
<td>Unilateral</td>
<td>Complete</td>
<td>Improved</td>
<td>Diabetes incipidus Meningiothelial Meningioma WHO grade II</td>
<td>Non</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>49</td>
<td>f</td>
<td>Unilateral</td>
<td>Complete</td>
<td>Improved</td>
<td>Meningiothelial Meningioma WHO grade II</td>
<td>Non</td>
<td></td>
</tr>
</tbody>
</table>

Case presentation:
This patient was a 50 year old female patient. She presented with a unilateral diminution of vision in the left eye. On examination, she had a visual acuity of counting fingers 60 centimeters and was having some degree of optic atrophy as well on fundus examination. The patient was operated through a bifrontal interhemispheric approach. During surgery one olfactory nerve was accidentally cut. The tumor was totally resected. After surgery the patient experienced an improvement of vision to 2/60. She developed anosmia as well. One and a half years later the patient came on follow-up with a remarkable improvement of vision to 6/60. The figures show a pre and a post-operative MRI of the patient.
Fig. (1A): Pre-operative sagittal MRI T1 weighted image with contrast showing tumor extensions.

Fig. (1B): Post-operative sagittal MRI T1 weighted image with contrast showing a complete tumor resection.

Results

Gross total resection was achieved in all 8 cases (100%). However, no dural or bony attachments were removed. All cases operated in this series were well devascularized, and after detachment from the skull base were avascular and easy to deal with.

On preoperative MRI it was not possible to determine which optic nerve involvement was more severe. The optic nerve with the more severe involvement was determined clinically. None of our cases showed extension into the optic canal except one (12.5%).

All cases were of the meningiothelial meningioma WHOI-II type on pathological examination. No recurrences took place during the two year follow-up period in this study.

Preoperative visual status was very characteristic in all except one (12.5%) case. All patients showed considerable discrepancy between both eyes. Only one case (12.5%) showed absence of this discrepancy and the involvement was bilateral and symmetrical. This particular case was referred to our department after an attempt had been made elsewhere at trans-sphenoidal resection, as the case was mistaken for a pituitary macro adenoma. Six cases (75%) in the series showed variable degrees of visual improvement after surgery. In two cases (25%) vision remained the same. In one of the two cases, the nerve was found to be completely destroyed by the tumor during surgery. The nerve was not salvageable. Improvement took place in the immediate postoperative period in all cases. However, only two cases (25%) went back to normal on follow-up. These were the cases with only mild visual involvement, and presented originally with only small tumors.

Discussion

Tuberculum sella meningiomas represent 5-10% of all intracranial meningiomas and are more common in middle age females [6,7]. Tuberculum sella meningiomas have a complex pathological anatomy. They grow in an infrachiasmatic manner and involve the hypothalamus, anterior cerebral arteries, pituitary stalk, optic nerves, posterior cerebral, basilar and the carotid arteries [8]. There have been many reports on their clinical presentation, surgical outcome and techniques of surgical resection. Many approaches have been used for their resection including; pterional, bifrontal, subfrontal, supraorbital and transsphenoidal approaches [1,2]. However, detailed reports on their resection through the bifrontal interhemispheric approach are sparse and confusing. This is particularly true regarding the merits of this approach in comparison to other approaches and the inherent drawbacks that can result from this approach.

Using the bifrontal interhemispheric approach gross total resection was achieved in all our patients. There were no recurrences over the 2 years of follow-up that were reported. There were also no mortalities in the present series. This coincided with the work of Choky, et al. [8] who also reported a similar outcome using the same approach.
Visual involvement was present preoperatively in all of our cases. 25% of our patients remained the same after surgery. All remaining 75% showed immediate post-operative improvement. This coincides with the work of Mahmoud, et al. and Oyama, et al. [9,10] who also reported a 74% improvement of vision. 12.5% showed a small extension into the optic canal and accordingly there was no need for optic canal unroofing or opening of the falciform ligament. Other series have reported a need to drill the optic canal [9,10,11]. However, this may be attributed to the small number of cases in the present series.

Only 12.5% developed a post-operative anosmia in the present series. This incidence is also comparable to other series using the same approach [13].

Based on our observations regarding the size of such tumors at the time of clinical presentation in our small series of 8 cases all cases did not reach a large size because of the early visual involvement. This finding is also in agreement with the observations of a number of authors [4,5,12]. Accordingly, all such tumors in our series had a very good well maintained arachnoid plane with all the neurovascular structures. An ideal approach accordingly would be one that would take advantage of the well maintained arachnoid plane, that would meanwhile be centered symmetrically on the whole tumor while exposing the tumor as well as the surrounding anatomical structures bilaterally and symmetrically while providing the surgeon with a good space for neurovascular dissection [9].

Tumor resection is started in the midline by detaching the tumor from the skull base. In all our cases we found the optic nerve lateral to the carotid artery. Accordingly, while detaching the tumor there is a risk of carotid artery injury as the artery is in a deeper plane and often obscured by the tumor. Accordingly, detachment has to be kept strictly to the midline and the artery has to be sought with great care working from thereon laterally. However, after detaching the tumor from the midline rolling the tumor medially from underneath the optic nerve helps expose the carotid artery. In all our cases even in cases which preoperatively appeared to completely encircle the carotid artery there was a well maintained arachnoid which helped in the dissection process [6,9,13].

Once the carotid artery is reached on both sides, attention is usually shifted to the anterior cerebral artery. This artery usually poses particular difficulty in dissection and this agrees with the findings of Goel, et al. [6] and Terasaka, et al. [14]. However, we have found this particularly useful in this approach to use the opened interhemispheric fissure to locate the A2 and then having previously exposed the carotid artery to work downwards from thereon 1141. In all but one case the tumor was found to grow underneath the vessel and insinuate itself between the vessel and the optic chiasm. The tumor then surrounds the circumference of the vessel. Goel, et al. [6] have advocated leaving part of the tumor in such cases. Probably because of the small number of cases in our series we did not find this necessary in any case. The arachnoid was found to be more difficult to find in this part of the surgical procedure but even when completely engulfed by the tumor the prehand knowledge of the location of the carotid and the A2 helped in the location and the dissection of the Al [14,15]. This finding is contrary to what is found in other approaches which usually find difficulty in locating and dissection of the anterior cerebral artery because of lack of the A2 exposure through a midline exposure which gives a symmetrical access to the anterior cerebral artery on both sides. Also one point that we found to be particularly helpful was that the dissection of the olfactory tract as well as the exposure of the medial and the lateral olfactory stria helped give a very good idea about the location of the carotid bifurcation. In addition, the medial aspect of the Sylvian fissure can be exposed and split bilaterally in this approach; which combines the merits of the pterional approach as if performing a bilateral pterional exposure [3,14].

Once the anterior cerebral artery is dissected the tumor is finally rolled out from its bed from underneath the optic chiasm this part was relatively simple on all cases because we have always found a very good membrane of Lillequist standing as a shield in all cases even in cases that showed a considerable and large extension in the posterior fossa and even when they appeared to involve the basilar artery. The pituitary stalk was found to be usually displaced to one side usually contralateral to the side with the most optic nerve involvement [6].

37.5% of cases in our series showed postoperative venous infarction. However, only one required decompressive craniectomy. This coincides with the findings of Terasaka [14] who reported a similar outcome regarding venous involvement. This problem remains the main drawback of this approach. However, the superior anatomical orientation, the excellent midline knowledge, the symmetrical approach to the tumor, and the use of the arachnoid shield, as the arachnoid is approached from its
medial aspect, can be considered to overweigh the venous drawbacks of the approach \[2,3,4,14,15\].

The small number of cases in this series makes it difficult to draw solid statistical guidelines as regards recommending this approach for this particular tumor. However, the pursuit of the same approach as an ongoing process will provide us in the future with more solid statistical data that would make it more possible to draw solid lines regarding the mentioned observations.

Conclusion:

Bifrontal interhemispheric approach can be considered superior to any other approach regarding anatomical exposure, midline orientation neurovascular dissection, higher incidence of radical resection and arachnoid preservation. This is mainly because the approach addresses the arachnoid from a more medial perspective. However, the benefits of the approach must be weighed against the high incidence of venous infarction reported.

References