PERITUMORAL BRAIN EDEMA IN MENINGIOMAS: CORRELATION WITH
SURGICAL FINDING AND PROGNOSIS

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Abstract

Background: Peritumoral brain edema (PTBE) in meningiomas had been a subject of interest; its occurrence in an extraaxial tumor was the reason of many studies and published data.

Objective: The goal of this study was to evaluate and to determine the exact implication of Peritumoral brain edema in meningiomas in intraoperative and short postoperative prognosis.

Subjects and Methods: During 2006 to 2011, 45 patients with supratentorial meningiomas were studied. Intraoperatively certain findings were reported including: easy or difficult resection, simpson’s grade of removal, brain tumor interface, plane of cleavage, pial vascularization of the tumor and arachnoid disruption. Morbidity and mortality were recorded; also postoperative CT and/or MRI were obtained within the first 3 months.

Results: There were 26 meningiomas (57.7%) with peritumoral edema and 19 meningiomas without (42.3%). Pial vascularization of the tumor was defined in 24 patients (53.3%), 4 patients (21%) had a pial blood supply in edema negative group compared to 20 patients (76.9%) in edema positive group. In this study, there was 1 case mortality (2.2%) in edema positive group. As regard morbidity, 8 (30.6%) patients in edema positive group suffered an early postoperative morbidity this is in comparison to 4 patients (21%) in the edema negative group. Conclusion: Our study shows that PTBE in meningiomas affects the surgical prognosis and confers a higher risk of morbidity and postoperative complications. Preoperative management of PTBE and immediate post-operative monitoring are important.

Key words: Meningioma, Brain edema

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**Introduction**

Meningioma possesses the ability to produce peritumoral brain edemas (PTBE) despite its extracerebral origin and being a benign and a slow-growing tumor.\(^1\,^2\) Peritumoral edema is present in at least half of the cases of meningioma, and it may be present in varying degrees and in an unpredictable fashion.\(^3\)

Unlike intraaxial tumors, whose physiopathology is attributed to hematoencephalic barrier disorder, the precise mechanism of peritumoral edemas is still unknown.\(^4\) Different theories have been proposed to explain its formation: mechanical factors such as tumoral compression to the adjacent parenchyma causing cerebral ischemia\(^5\,^6\) or the compression of large veins and/or sinus vein that produce vein stasis\(^6\). The secretor-excretory phenomenon with the production of edemagen substances\(^7\,^8\), as well as hydrodynamic factors that produce breakage of the hematoencephalic barrier are studied hypothesis.\(^9\,^6\) More recently, Tanaka and Colleagues\(^10\) proposed that PTBE could be related to the tumor drainage vein hypoplasia.

For some authors, management is more difficult if meningiomas are associated with PTBE\(^11\), but this is controversial.\(^12\) Overall, little is known of prognostic factors Influencing morbidity and mortality after intracranial meningioma surgery\(^13\).

**Aim of the work:** The goal was to evaluate and to determine the exact implication of peritumoral brain edema in benign meningiomas in intraoperative and short postoperative prognosis.

**Subjects and Methods**

During 2006 to 2011, 45 patients with benign supratentorial meningiomas were studied.
The clinical variables considered were the age and sex of the patient, the duration of clinical history (months), and the existence of focal deficits, seizures (focal or generalized), a psychorganic syndrome (including decreased level of consciousness), and an intracranial hypertension syndrome.

All patients underwent MRI before surgery. The size of the tumor was calculated by multiplying the maximum coronal, axial anteroposterior and axial mediolateral tumor diameters on MRI. The area of PTBE, including the tumor, was obtained using the same method. Edema Index (EI) was calculated by dividing the size of the PTBE by that of tumor, thus, if EI = 1, there is no PTBE.

**Figure 1:** T2 MRI Shows the lesion without oedema around.

The edema was identified as either a hyperintense image in MRI in T2-weighted scans or hypointense in T1 weighted scans. Presence and absence of calcifications was also evaluated.
Figure 2: T2 MRI Shows the lesion with oedema around.

Perioperative care, each case included in this study was given IV antibiotics (third generation cephalosporin in most cases) 1 hour before surgery, and continued during the operation as needed, and for 48 hours after surgery or until all drains and long lines were removed. Steroids “dexamethasone” was given as needed in cases with vasogenic edema and was started at least 48 hours before surgery, continued during surgery, and gradually tapered
over 4-5 days following surgery. All the cases were operated upon by the staff members in
the neurosurgical department.

Microscopic removal of the tumor was done whenever possible and whenever needed. Intraoperatively certain finding were reported including; easy or difficult resection, simpson’s grade of removal, brain tumor interface, plane of cleavage, pial vascularization of the tumor and arachnoid disruption.

Histopathological examination of tumor specimen were done and reported. Morbidity and mortality were recorded; also postoperative CT and/or MRI were obtained within the first 3 months and were evaluated for presence of tumor residue, resolution of edema, and secondary effect on brain parenchyma.

Statistical Analysis: Continuous data are presented as mean and standard deviation. Dichotomous or categorical data are presented as number and percent. Comparison between patients with peritumoral brain edema and patients without edema regarding categorical or dichotomous variables was done by using Chi square test or Fischer exact test. Level of significance was considered at P value ≤ 0.05. SPSS 19 was used for statistical analysis.

Results

Data of this study was collected from 45 cases of supratentorial intracranial benign meningiomas were analyzed and the results were evaluated. The study included 45 patients 30 females and 15 males whose age ranged between 29 and 69 years, mean age was 51.7 years ± 1.6. In this study headache was the prevalent symptom in the course of illness, 40 patients (88%) was presenting with headache. In this study, 20 patients (44.5%) presented with seizures in the course of illness. In this study, there were 26 meningiomas (57.7%) with peritumoral edema (Figure 2) and 19 meningiomas without edema (42.3%) (Figure 1).

According to location; tumors were classified into convexity, olfactory groove, falcine, parasagittal, sphenoid wing, tuberculum sella, and suprasellar; table 1. In this study, sphenoid
wing, falcine and olfactory groove meningiomas have the highest mean edema indices 3.48, 3.14, and 2.64 respectively.

**Table 1: Comparison between edema (-) and edema (+) as regards location**

<table>
<thead>
<tr>
<th>Location</th>
<th>Edema (-)</th>
<th>Edema (+)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Convexity</td>
<td>10</td>
<td>52.6%</td>
<td>13</td>
</tr>
<tr>
<td>Falcine</td>
<td>0</td>
<td>0%</td>
<td>3</td>
</tr>
<tr>
<td>Olfactory groove</td>
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<td>0%</td>
<td>4</td>
</tr>
<tr>
<td>Parasagittal</td>
<td>5</td>
<td>26.3%</td>
<td>3</td>
</tr>
<tr>
<td>Sphenoid wing</td>
<td>2</td>
<td>10.5%</td>
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<tr>
<td>Suprasellar</td>
<td>1</td>
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<td>0</td>
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<tr>
<td>Tuberculum sella</td>
<td>1</td>
<td>5.2%</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>19</td>
<td>100.0%</td>
<td>26</td>
</tr>
</tbody>
</table>

n: Number of patient, %: Percent

All cases had underwent surgical removal, and certain intraoperative factors were recorded and analyzed; Simpson grade of removal, brain tumor interface, crossing pial blood vessel to the tumor, and surgical plane of cleavage; table 2.

Twenty patients (44.5%) excised with Simpson grade 1, 18 patients (40%) with grade 2, and 7 (15.5%) with grade 4 removal. There was no correlation between degree of removal and incidence of edema.
Intraoperative brain tumor interface was defined in 31 patients (68.8%), 16 patients (84.2%) had a defined brain tumor interface in edema negative group compared to 15 patients (57.6%) in edema positive group ($P = 0.06$).

Intraoperative surgical plane of cleavage was defined in 30 patients (66.7%), 16 patients (84.2%) had a defined surgical plane of cleavage in edema negative group compared to 14 patients (53.8%) in edema positive group ($P = 0.03$). Surgical plane of cleavage correlated to the severity of peritumoral edema.

There was a very strong association between incidence of peritumoral edema and presence of pial blood supply. Pial vascularization of the tumor was defined in 24 patients (53.3%), 4 patients (21%) had a pial blood supply in edema negative group compared to 20 patients (76.9%) in edema positive group ($P < 0.001$).
Table (2): Comparison between edema (-) and edema (+) as regards intra-operative finding

<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
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<td>%</td>
</tr>
<tr>
<td>Simpson grade</td>
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<td>G1</td>
<td>9</td>
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<td>36.8%</td>
<td>11</td>
<td>42.3%</td>
<td>18</td>
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<td>31</td>
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</tr>
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<td>26</td>
<td>100.0%</td>
<td>45</td>
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<td>14</td>
<td>53.8%</td>
<td>30</td>
<td>66.6%</td>
</tr>
<tr>
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<td>26</td>
<td>100.0%</td>
<td>45</td>
<td>100.0%</td>
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<td>79.0%</td>
<td>6</td>
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<tr>
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<td>4</td>
<td>21.0%</td>
<td>20</td>
<td>76.9%</td>
<td>24</td>
<td>53.3%</td>
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<tr>
<td>Total</td>
<td>19</td>
<td>100.0%</td>
<td>26</td>
<td>100.0%</td>
<td>45</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

n: Number of patient, %: Percent, G: grade

Postoperatively patients were followed during the first three months, in concern with mortality, and morbidity.

In this study, there was 1 case mortality (2.2%) that died early during follow-up, in the edema positive group, death was related to intraoperative procedure during excision that was followed by extensive infarction and edema.

As regard morbidity, 8 patients (30.6%) in edema positive group suffered an early postoperative morbidity ranging from controlled fits to deep coma; this is in comparison to 4 patients (21%) in the edema negative group.
Discussion

Despite primarily extraaxial locations, slow progression rates, and usually benign histologic characteristics, meningiomas are frequently associated with PTBE.\(^3\) Peritumoral brain edema is found in approximately 50% of meningiomas.\(^14\) Clinically, perioperative mortality and morbidity in menigioma surgery may be attributed to PTBE in meningioma. Hence, significant brain edema may cause severe neurologic deficits and limit the surgical field during the approach.\(^3\)

Meningiomas are separated from the white matter by the arachnoid membrane, the subarachnoid space, the pia mater, and the cerebral cortex that are formed from a dense network of neuronal and glial processes resistant to the fluid flow.\(^5\) The arachnoid is impervious to fluid, and pia mater is less permeable to edema protein.\(^7\) Despite of that resistance, approximately 60% of meningiomas are associated with peritumoral brain edema.\(^4,6,15\)

In this study, we evaluated the surgical finding and prognosis of PTBE in meningiomas. The majority of our patients (57.7%) had PTBE on preoperative imaging, in agreement with previous findings.\(^12\) The incidence of PTBE was 57.7% in our patient population and ranges from 45% to 92% in other reports.\(^16-18\)

At present, there are no unanimous results regarding tumoral location. Most cited the following locations having a higher connection with a larger edema incidence; convexity\(^6,9,19\), parasagittal\(^9,19\), falx\(^6\), sphenoidal wing\(^20\), frontobasal\(^15,19,20\), and medium fossa.\(^15\) Other authors mention a lower edema incidence among tumors located at the posterior fossa\(^6,19\) and tentorium\(^6\) may be because these exhibit symptoms more precociously or due to a smaller amount of white matter at the posterior fossa. In this study, sphenoid wing, falcine and olfactory groove meningiomas have the highest mean edema indices 3.48, 3.14, and 2.64 respectively.
When surgical findings were evaluated, Salpietro and Colleages\textsuperscript{2} verified the existence of relationship between invasive tumors and edema extension. A study published by Tamiya and Colleages\textsuperscript{21} in 2001 analyzed 175 cases, indicating as predictive factors peritumoral edema, disappearance of tumor-brain arachnoid layer interface visible in T2 by nuclear magnetic resonance, and tumor pial vascularization pattern.

In our opinion, the easier the surgical plane is to detect, the easier the resection. On the other hand, when resection is difficult, the brain/meningioma interface is not clearly identifiable. We found Intraoperatively surgical plane of cleavage was defined in 30 patients (66.7%), 16 patients (84.2%) had a defined surgical plane of cleavage in edema negative group compared to 14 patients (53.8%) in edema positive group. Surgical plane of cleavage correlated to the severity of peritumoral edema.

The pial-cortical arterial supply of meningiomas reflects the close spatial relationship between the tumor surface and the adjacent brain parenchyma. The arachnoid, which serves as a physiological barrier between the brain and extraaxial structures such as the meningioma, is either penetrated by the cerebral vessels or infiltrated by the tumor.\textsuperscript{4} A recently published study demonstrated a strong correlation between the pial-cortical blood supply and the occurrence of edema, in agreement with our results.\textsuperscript{3} In our study There was a very strong correlation between incidence of peritumoral edema and presence of pial blood supply. Pial vascularization of the tumor was defined in 24 patients (53.3%), 4 patients (21%) had a pial blood supply in edema negative group compared to 20 patients (76.9%) in edema positive group.

Overall mortality of meningioma surgery is variable in the literature, ranging from 2\% to 23\%.\textsuperscript{12,22} In this study, there was 1 case mortality (2.2\%) that died early during follow-up, in the edema positive group, death was related to intraoperative troubles during excision that was followed by extensive infarction and edema.
Edema was related to higher morbidity in the surgical management of meningiomas. For example, PTBE was associated with a longer hospital stay, increased difficulty of surgical resection, and increased risk of postoperative intracranial hematoma and intracranial hypertension compared to meningiomas without PTBE. In our study, morbidity was 8 (30.6%) patients in edema positive group suffered an early postoperative morbidity ranging from controlled fits to deep coma; this is in comparison to 4 patients (21%) in the edema negative group.

**Conclusion**

Our study shows that PTBE in meningiomas affects the surgical prognosis and confers a higher risk of morbidity and postoperative complications. Preoperative management of PTBE and immediate post-operative monitoring are important.

**References**


الملخص阿拉伯

العلاقة ما بين الوضع المخية المصاحبة للورم السكبي والاستئصال الجراحي وحالة المريض بعد إجراء الجراحة

العكاس من هذه الدراسة تقييم أثر الوضع المخية المصاحبة للورم السكبي على مجريات الأمور أثناء الاستئصال الجراحي وكذلك على حالة المريض بعد الجراحة مباشرة وكيفية التعامل مع الورم في وجود هذا الوضع أثناء وبعد الجراحة مباشرة لتلقي المصاعبات المصاحبة لاستئصال الورم المخية السكبي.

وقد أجريت هذه الدراسة على 45 مريضاً من المصابين بالورم السكبي في مستشفى بني الجامعي في الفترة ما بين عام 2006 إلى عام 2011 مع اعتبار كل الشواهد الإكلينياتية والفحوصات وعمل أشعه بالرنين المغناطيسي على المخ مع تسجيل ورصد كل العلامات والشواهد أثناء الجراحة والصعوبات أثناء الاستئصال الجراحي وجد استئصال الورم (معامل مسمن) والحد الفاصل ما بين الورم والمخ والأوعية الدموية العابرة من الأم الحنة إلى الورم وكذلك تسجيل الآثار السلبية المتصلة على الجراحة وحالات الوفيات وكذلك عن طريق متابعة المريض وعمل أشعه مقطعية ورنين مغناطيسي على المخ خلال الشهر الأول مع تقيم وجود بقايا من الورم من عدمه ومدى شحية الوضع المخية وكذلك الآثار السلبية على المخ جراء وجود هذه الوضع.

وقد تم جمع كل هذه البيانات وتحليلها وتقييم النتائج وقد أشكلت هذه الدراسة على 45 مريضاً منهم 30 من النساء و15 من الرجال وكان معدل السن ما بين 29 إلى 69 عاماً وقد بلغ عدد من يعانون من الوضع المخية المصاحبة للورم السكبي في هذه الدراسة 26 مريضاً بنسبة (67.7%) و19 مريضاً بنسبة (42.3%) لا يوجد بهم الوضع المخية المصاحبة للورم السكبي وقد تم استئصال الورم في 20 مريضاً بنسبة (44.5%) بمعامل مسمن من الدرجة الأولى و18 مريضاً بمعامل مسمن من الدرجة الثانية بنسبة (40%) و7 مريضاً بنسبة (15.5%) بمعامل مسمن من الدرجة الرابعة.

وفي هذه الدراسة كانت هناك حالة وفاة واحدة بنسبة (2.2%) (من المجموعة التي تعاني من الوضع المخية المصاحبة) 8 مرضى عانو من مضاعفات ما بعد الجراحة (30.6%) مقارنة بعدد 4 مرضى (21%) من المجموعة التي لا تعاني من الوضع المخية.

وقد خلصت الدراسة بعد مقارنتها بما نشر في الدراسات المشابهة أن الوضع المخية المصاحبة للورم السكبي تؤثر على حالة المريض أثناء الجراحة وبعدها كذلك و أكملت الدراسة أن الوضع المخية عامل من عوامل الخطر التي تؤدي إلى مضاعفات ما بعد الجراحة للمريض المصابين بها ويجب معالجتها قبل البدء في الجراحة ولاحظة المريض ملاحظة لاصفية بعد الجراحة مباشرة لتقليل الآثار السلبية لهذه الوضع المصاحبة لمرضى ورم المخ السكبي.