Intracranial meningiomas: correlations between intraoperative consultation and histopathological diagnosis

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Abstract

Objective: To investigate the current role of intraoperative cytological consultation in the management of intracranial meningothelial tumors. Study design: The present study made a retrospective analysis of 62 consecutive patients with intracranial meningothelial tumors operated on during 01.01.2008-31.12.2009, in the Department of Neurosurgery, Emergency Clinical Hospital “Prof. dr. N. Oblu” Iaşi. Smears were prepared from the fresh biopsy samples sent to The Department of Neuropathology for immediate processing. The smears were stained by the 1% alcoholic toluidine blue method. Further, paraffin sections were prepared by the residual tissue and stained by H & E method. The tumours were classified according to the World Health Organization classification of CNS neoplasms, 2007. Smear cytologic diagnosis was correlated with histopathological findings and with demographic data of the patients. The observations were then subjected to appropriate statistical analysis methods.

Results: Of the 62 patients, 41 were females (66.13%) and 21 were males (33.87%). 16 patients (25.80%) were in the age group of 41-50 years. There was concordance between intraoperative consultation and the final diagnosis in 58 cases (93.54%). A complete correlation was achieved in 51 cases (82.25%) and a partial correlation in 7 cases (11.29%) as there were underestimations of the malignancy grade. In four cases (6.45%), intra-operative consultation was discordant with final diagnosis because of the technical errors noted on smear slides such as intense tumoral vascularity, thickness of the smears and of difficulties of smears interpretation as cell morphology of glioblastomas resembles well with those of anaplastic meningiomas.

Conclusion: Squash smear technique in neurosurgery is a rapid and inexpensive method of intraoperative diagnosis and lead to a high diagnostic concordance.

Keywords: meningiomas, cytology, smear, malignancy grade
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consider that intraoperative consultation is of great diagnostic value for intracranial meningiomas as it provides a preliminary diagnosis enabling the neurosurgeon to decide further management in the operative room (2, 3, 6, 7, 9). It is considered that this technique is more useful than frozen section examination because the last has certain limitations, particularly related to artifacts caused by ice crystals introduced into the tissue, which makes the interpretation of sections really difficult.

The present study was undertaken to evaluate the usefulness of smear technique in rapid diagnosis of neurosurgical biopsies in the Department of Pathology, Clinical Emergency Hospital "Prof. Dr. N. Oblu" Iasi. A comparative analysis between cytopathological diagnosis and clinico-pathological data of intracranial meningiomas was done with the aim to identify the possible errors, pitfalls, and limitations with the usage of smear technique.

Materials and methods

This study was based on a retrospective review of 62 patients operated on for a primary intracranial meningioma, in the Neurosurgery Clinic of Emergency Hospital "Prof. Dr. N. Oblu" Iasi over two years (January 2008 - December 2009).

Patients’ demographic data and cytological and histopathological diagnosis were taken from the registries of the Department of Pathology of the same hospital. In all cases there were made three smears on surgical specimens, by displaying a thin piece of tissue between two glass slides. Tumoral specimen, which usually had a thickness of 2-3 mm and a length of about 0.5 cm, was placed on the right end of a clean glass slide and then divided, with a very sharp scalpel, into smaller fragments, each of which was transferred by another glass slide.

A second glass slide was applied at right angle, but parallel to the first slide surface, and pressed firmly on the tissue fragment, moving across the length of the first slide, paying attention to the two surfaces which had always remained parallel. Thus, the specimen was displayed throughout the original slide. The smears were stained with 1% alcoholic toluidine blue solution (Figure 1).

![Figure 1 A: A second glass slide is applied at right angle and parallel to the first slide surface in order to display the specimen on the original glass slide.](image1a)

![Figure 1 B: Staining the smears with toluidine blue. Paraffin sections were made from the](image1b)
remaining tissue, following classical histological technique and staining them with hematoxylin and eosin. Tumors were diagnosed according to histological classification of tumors of the nervous system (World Health Organization, 2007) (5). The diagnosis of smear preparation was correlated with that of routine paraffin sections and the final data were processed by percentage or reports between two indices. The discordant cases were identified and possible reasons were analysed.

We considered as complete concordance the situation when the histopathological examination confirmed the initial intraoperative consultation. When the tumoral histology was set correctly (meningothelial tumor), but the degree of malignancy was misdiagnosed, we considered that it was a partial concordance. In cases of an erroneous histological type diagnoses, although malignancy was relatively well established, we considered to be discordance between the intra-operative consultation and histopathological diagnosis.

Results

Of the 62 patients, 41 were females (66.13%) and 21 were males (33.87%) (Figure 2).16 patients (25.80%) were in the age group of 41-50 years. Female patients predominated numerically in almost all age groups, especially in the 41-50 years age group (F: M = 4.3:1). After 71 years, the ratio F: M is reversed in favor of males (F: M = 5 / 6), and at ages above 81 years, such neoplasms were found only in males (Table I).

There was concordance between intraoperative consultation and the final diagnosis in 58 cases (93,54%). A complete correlation was achieved in 51 cases (82.25%) and a partial correlation in 7 cases (11.29%) as there were underestimations of the malignancy grade (Table II). In four cases (6.45%), intra-operative consultation was discordant with final diagnosis. The four discordant cases included three glioblastomas and a metastatic carcinoma. A final histopathological diagnosis and the possible reasons for misinterpretation on the intraoperative consultation are summarized in Table III. The technical errors noted on smear slides were intense vascularity and thick smears. There were also difficulties of smears interpretation as cell morphology of glioblastomas resembles well with those of anaplastic meningiomas.

![Figure 2 Gender distribution of the patients with intracranial meningiomas](image)

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>No. of the cases and percentage</th>
<th>Female</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11-20</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>21-30</td>
<td>3 (4.83%)</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>31-40</td>
<td>2 (3.22%)</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>41-50</td>
<td>16 (25.80%)</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>51-60</td>
<td>13 (20.96%)</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>61-70</td>
<td>15 (24.19%)</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>71-80</td>
<td>11 (17.74%)</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>81-90</td>
<td>2 (3.22%)</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>91-100</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Correlation with the histopathological diagnosticui cytopathology

<table>
<thead>
<tr>
<th>Tumoral type</th>
<th>Cyto-pathological diagnoses</th>
<th>Histopathological diagnoses</th>
<th>Cyto-histopathological concordance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meningiomas grade I</td>
<td>45</td>
<td>38</td>
<td>100%</td>
</tr>
<tr>
<td>Meningiomas grade II</td>
<td>10</td>
<td>16</td>
<td>62,5%</td>
</tr>
<tr>
<td>Meningiomas grade III</td>
<td>3</td>
<td>4</td>
<td>75%</td>
</tr>
</tbody>
</table>

Four discordant cases and limitations encountered

<table>
<thead>
<tr>
<th>Diagnosis based on intraoperative consultation</th>
<th>Final diagnosis</th>
<th>No. of cases</th>
<th>Limitations encountered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaplastic meningioma</td>
<td>Metastatic carcinoma with small cells</td>
<td>1</td>
<td>• Vascularity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• thick smear</td>
</tr>
<tr>
<td>Anaplastic meningioma</td>
<td>Glioblastoma multiforme</td>
<td>3</td>
<td>• Vascularity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• thick smear,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• resemblance of cell morphology</td>
</tr>
</tbody>
</table>

Discussion

Meningiomas are the second type of intracranial tumor in order of frequency and therefore we chose to determine the usefulness of the squash smear method in the diagnosis of such tumors.
In our study, samples were taken mostly from female patients (66.13%), aged mainly in their 5th decade of life. Diagnostic concordance between intra-operative consultation and histopathological examination was 93.54%, which is a very good percentage, similar to other studies from the literature (7, 10).

Our study showed that for grade I tumors, meningiomas cytopathological examination may be useful for diagnosis in 100% of cases, because meningothelial tumors have characteristic cytological findings. The present study revealed that the smears made from a meningioma specimen show the presence of spindle cells arranged in syncytial pattern, often with whorls centred by concentric calcification located in the walls of capillaries, observed as round dark blue formations, and called "psammoma bodies". These structures must be sought in all preparations but with patience, because meningiomas have a wide variety of architectural patterns and a variable number of psammoma bodies.

Eleven cases posed some difficulties to the intraoperative consultation. Seven of the 11 discrepancies between intra-operative and final diagnoses were related to assigning histological grades. The entities that are most subject to misinterpretation are atypical versus typical meningiomas. The neuropathologists were unable to detect frequent mitosis in what appeared to be “typical” meningiomas and the invasion of the brain wasn’t evident in the smear slides.

The malignancy degree was underestimated because there were significant variations of anaplasia from an area to another within the same tumor. The specimen taken in the operating room and used for smear may not be from the area with the highest malignancy and the neuropathologist can receive only a small piece from the benign part of the meningeal tumor. It is therefore necessary to require neurosurgeons to send several pieces especially in the case of stereotactic biopsies and so the neuropathologist can to have an overview of the whole tumor.

Ali et al. (2008) analyzed 107 cases of meningiomas examined by intra-operative crush preparation and then by histopathological examination. The authors pointed that it is difficult to establish the degree of a meningioma only by extemporaneously examination, but grade III meningiomas can be diagnosed relatively easily by this technique (1).

Four of the 11 discrepancies between intra-operative and final diagnoses were related to incorrect assigning the histogenesis of the tumors. There were three glioblastomas multiforme and a metastatic carcinoma erroneous diagnosed in intra-operative consultation as anaplastic meningiomas. An evaluation of the four discordant cases revealed some pitfalls, which led to misdiagnosis. The misinterpretation resulted from emphasis given to vascularity and to richness of the tumoral cells due to the thickness of the smear as some other authors have already shown (8). Some tumors were undergraded and misdiagnosed. The grading of malignancy should be done on a permanent section after an optimal evaluation of the entire sample as most specimens received for intraoperative consultation are small.

In the present study we also found some errors related to identification of histological tumor type, although malignancy was interpreted correctly. Final histopathological diagnosis in 4 cases (6.45%) didn’t fit with initial
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cytopathological examination, although definite malignancy was established. This may be due to either lack of tissue architecture on cytology slides or great richness of tumoral cells due to technical defects (smears have been too thick) and neuropathologist could not identify the cells morphology. Therefore it must be given proper attention to smear slides in order to obtain a uniform thickness as possible.

The presence of nuclear atypia is a good indicator for atypical or anaplastic variants. On the other hand, the cytological features identified in smears made from anaplastic meningiomas can cause diagnostic difficulties because other primary meningeal tumors, glioblastomas or metastatic carcinomas may show similar morphological aspects and in these situations it is necessary to correlate citopathological diagnostic with histopathological conclusion as some other authors have already shown (3, 9, 12).

Conclusions

Based on data obtained in this study, we can say that the squash smear technique of meningothelial tumors is a simple, fast (no more than 10 minutes to achieve), reliable (provides a very good concordance (over 90%) with histopathological diagnosis), economic method and do not requires special tools. It is a preferred method because it provides important details on cell morphology avoiding cellular distortion artifacts seen in frozen sections. Intraoperative smears can make a quick diagnosis that allows the neurosurgeon to monitor the neurosurgical approach. The Department of neuropathology with its medical staff, including the technician performing the technique, have an important role in the management and subsequent treatment of patients with meningeal tumors.

There are also some limitations of the method namely: sampling errors, the possible occurrence of artifacts due to meningeal tumoral tissue firmness, and medical staff (doctor and technician) well trained in implementing this technique because the interpretation of cytological details depends on all these factors.

References

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