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Accuracy of frozen section in determining meningioma subtype and grade

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ABSTRACT

Frozen section intraoperative consultation is a well-established means of evaluating brain tumors at the time of surgery. Limitations to the procedure are also well recognized resulting in less than perfect specificity of diagnosis. This study retrospectively reviewed 424 consecutive meningioma cases ($N = 310$ females; mean age 57.3 years) to examine concordance between frozen section evaluation of meningioma subtype and grade as compared with the final diagnosis subtype and grade. A discrepancy between frozen section diagnosis and final diagnosis was observed in 114 (26.9%) of cases. Of the WHO grade I subtypes, the most common discrepancy involved transitional meningiomas ($N = 31$) which were most commonly diagnosed at frozen section as either fibrous ($N = 18$) or meningothelial ($N = 13$) meningiomas. None of the grade I tumors were diagnosed as higher grade lesions. Of the higher grade meningiomas (WHO grade II and III) ($N = 145$) reviewed, concordance between tumor type and grade was seen in only 26.2% of cases; most commonly, 73/98 atypical meningiomas were under-graded as some subtype of WHO grade I meningioma (71/73 cases). In conclusion, discrepancies at frozen section with respect to accurately identifying higher grade meningiomas and higher grade meningioma subtypes are common and are generally due to tumor sampling and heterogeneity.

1. Introduction

Utilization of intraoperative consultation in the assessment of potential brain tumors is a well-established practice which provides information to the surgeon at the time of surgery which may guide operative management as well as provide information as to whether or not the tissue being sampled is representative of the lesion as it appears on imaging studies [1-3]. It is also well established that there is an error rate associated with the interpretation of frozen sections that is due to a variety of factors including tumor heterogeneity, surgeon operator error, pathologist interpretation error and technical artifacts i.e. cautery, crush or freeze artifacts [1,3-6].

The purpose of this study was to systematically review a series of meningioma cases to assess concordance/discordance between the diagnosis made based on the frozen section slide alone and the final diagnosis with respect to tumor subtype and grade, using the recently revised World Health Organization (WHO) tumor classification [7].

2. Methods and materials

Institutional Review Board (IRB) approval was obtained prior to commencement of the study. The departmental surgical pathology files were searched for all tumors diagnosed as “meningioma” between 2012 and 2016. A total of 523 cases were identified. Of those cases, a frozen section was performed in 424 cases (81.1%); these cases comprised the first part of the study group. The frozen section slide(s) were reviewed separately without knowledge of the final diagnosis and an attempt was made to classify and grade the tumors based solely on the frozen section slide(s) alone, using the most recent guidelines of the WHO [7]. In 399 cases, a single frozen section slide was available for review in the case. In the remaining cases, two frozen section slides were available for review in 21 cases, three slides in two cases, four slides in one case and six slides in one case. The frozen section diagnoses were then compared with the final diagnosis based on review of all slides in each case, looking for discrepancies. All available microscopic slides were reviewed in each case (range 3–28 slides; mean 7 slides).

In order to obtain a larger number of grade II and III meningioma cases, an additional four years of meningioma cases (2008–2011) were reviewed and the higher grade tumors culled out. In a similar fashion, a diagnosis was made based on the frozen section slide(s) alone, and then these results were compared with the final diagnoses, looking for discrepancies.

Clinical information in terms of patient age, gender and tumor location was tabulated from information contained in the pathology reports.

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3. Results

Of the 424 patients who formed the study group, there were 310 females (73.1%) and 114 males who ranged in age from 6 months to 89 years of age at the time of surgery (mean age 57.3 years). One hundred forty seven tumors (34.7%) were situated on the right side of the brain or spinal cord, 136 (32.1%) on the left side. Four tumors (1%) were bilateral and 2 (0.5%) intraventricular tumors were noted. In 135 cases (31.8%), laterality was not specified. The most common site of origin for the tumors studied were frontal lobes (n = 133, 31.4%), skull base (n = 112, 26.4%), parietal lobes and spinal cord (n = 25 each, 5.9%), temporal lobes (n = 21, 5.0%), convexity not further specified (n = 19, 4.5%), sella/suprasellar region (n = 18, 4.2%), and orbital or spheno-orbital region (n = 16, 3.8%).

When the frozen section slides were separately analyzed with respect to tumor type and grade, a discrepancy with the final diagnosis was observed in 114 (26.9%) cases. Among the grade I tumors (n = 47/114, 42.2%), the most frequent discrepancy arose in cases that were classified, based on the frozen section as transitional meningiomas (n = 31); based on permanent sections, 18 of these cases were diagnosed as fibrous meningiomas and the remaining 13 cases as meningothelial meningiomas. Five tumors which appeared to represent meningothelial meningiomas on frozen section turned out to be a variety of other lesions (one each of transitional, fibrous, microcystic, secretory and meningothelial meningioma and one hyperplasia on permanent sections). Five secretory meningiomas diagnosed at frozen section turned out to be all meningothelial meningiomas (Fig. 1A and B). Four tumors classified as angiomatous meningiomas at frozen section were diagnosed as meningothelial meningiomas based on permanent sections. One psammomatous meningioma on frozen section was diagnosed as a fibrous meningioma on permanent section. One microcystic meningioma at frozen section was diagnosed as a meningothelial meningioma on permanent sections.

A total of 145 cases from 2008 to 2016 were diagnosed as grade II or III meningiomas (98 atypical WHO grade II meningiomas, 26 clear cell WHO grade II meningiomas, 12 chordoid WHO grade II meningiomas, 9

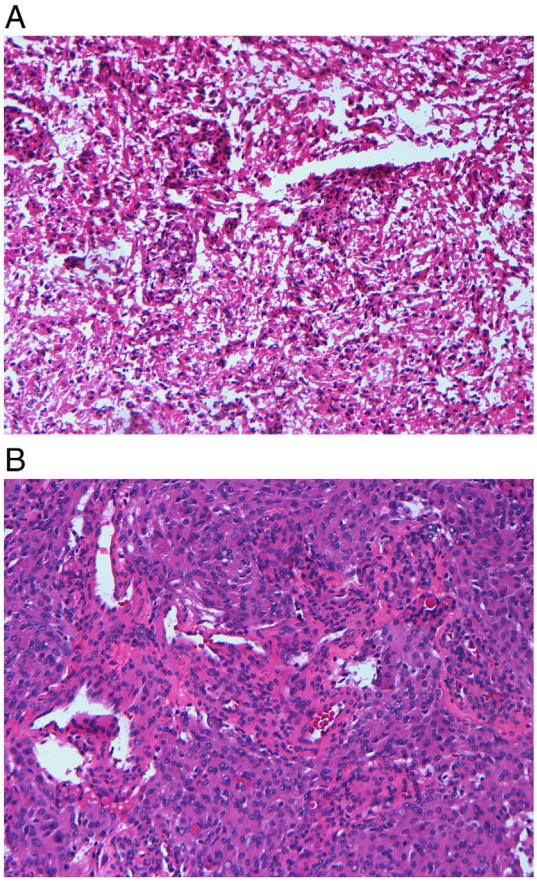

Fig. 1. A: Frozen section of a right frontal convexity mass resembling a meningothelial meningioma, WHO grade I with some freeze artifact (hematoxylin and eosin, original magnification 200×).
B: Permanent section from the case in Fig. 1A showing round eosinophilic protein accumulations consistent with a secretory meningioma, WHO grade I (hematoxylin and eosin, original magnification 200×).

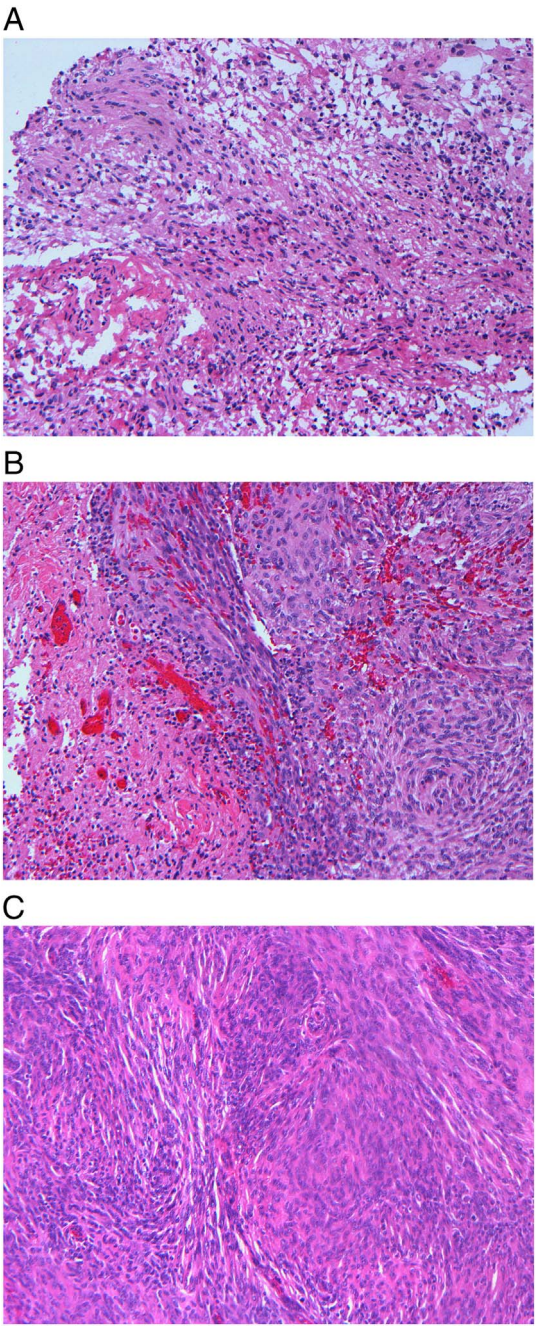

Fig. 2. A: Frozen section of a temporal lobe mass showing a spindled appearing meningioma resembling a fibrous pattern, WHO grade I (hematoxylin and eosin, original magnification 200×).
B: Permanent section from the case in Fig. 2A showing focal necrosis (hematoxylin and eosin, original magnification 200×).
C: Permanent section from the case in Fig. 2A showing hypercellularity and nucleolation. The tumor also had increased numbers of mitotic figures (5 mitotic figures/10 high power fields) and was diagnosed as an atypical meningioma, WHO grade II (hematoxylin and eosin, original magnification 200×).