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Accuracy of intraoperative pathological diagnosis using frozen sections of spinal cord lesions

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ABSTRACT

Objectives: Frozen sections are used to provide gross and rapid microscopic pathological information for guidance on intraoperative management and therapeutic decision-making. Many studies have shown the accuracy of frozen section diagnosis for intracranial lesions, but there are no studies focusing on spinal cord lesions. The purpose of this study is to evaluate the accuracy of intraoperative rapid diagnosis using frozen sections and to investigate limitations of this approach for spinal cord lesions.

Patients and methods: We performed intraoperative pathological diagnosis using frozen sections in 67 cases in which it was difficult to determine malignancy in preoperative images. The lesions were extradural (ED) in 13 cases, intradural extramedullary (IDEM) in 27 cases, and intramedullary (IM) in 27 cases. Metastatic tumors were excluded. The accuracy of intraoperative pathological diagnosis and the patterns of incorrect diagnosis were examined.

Results: Comparison of the intraoperative and final diagnoses gave an overall diagnostic sensitivity of 86.6% (58/67), with 100% (13/13) for ED lesions, 96% (26/27) for IDEM lesions, and 70% (19/27) for IM lesions. The diagnostic accuracy for IM lesions was significantly lower than those for ED and IDEM lesions ($p < 0.05$). Cases with small specimen sizes were frequently incorrectly diagnosed and inflammatory processes were common incorrect diagnoses using frozen specimens.

Conclusion: Among all spinal cord lesions, low diagnostic accuracy in intraoperative diagnosis using frozen sections is most likely for intramedullary lesions. The results of intraoperative rapid diagnosis should be interpreted with understanding of the limitations of this procedure.

1. Introduction

Frozen sections are used to provide a gross and rapid evaluation of microscopic pathology for guidance in intraoperative or perioperative management and decision-making on the therapeutic approach in surgery. Many studies have confirmed the accuracy of frozen section diagnosis for assessment of intracranial lesions [1–6]. However, there are no published data on the diagnostic accuracy and limitations in use of this technique for spinal lesions, including for extradural (ED), intradural extramedullary (IDEM), and intramedullary (IM) lesions, and for cervical, thoracic, and lumbar lesions.

Preoperative diagnosis of a spinal lesion is sometimes difficult based only on clinical symptoms and imaging findings. Therefore, intraoperative pathological diagnosis using frozen sections is important in determining the surgical approach for the tumor. In this study, we retrospectively evaluated the reliability of frozen section diagnosis for spinal lesions based on a comparison of the intraoperative and final pathological diagnoses to determine the limitations of this approach for these lesions.

2. Material and methods

A total of 329 surgeries for spinal lesions were performed at our hospital from January 2003 to December 2012. Intraoperative pathological diagnosis was not performed in 235 cases in which preoperative diagnosis was possible using imaging. After exclusion of these cases and 27 cases with metastatic tumors, 67 cases were included in the study. In these cases, it was difficult to determine malignancy preoperatively and all underwent intraoperative pathological diagnosis using frozen sections. The accuracy of intraoperative pathological diagnosis and the patterns of incorrect diagnosis were evaluated.

All pathological diagnoses were performed in the Department of

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Clinical Laboratory Medicine by four pathologists with an average of 14 years experience (range 11–28 years). A decision on a pathological diagnosis routinely requires the agreement of two pathologists, after which certification is performed and the report is completed. In this study, the diagnosis based on an intraoperative frozen section is defined as the "intraoperative rapid diagnosis", and that based on the final surgical specimen after surgical treatment is defined as the "final diagnosis". If the two diagnoses indicated the same pathology, the case was defined as a "match"; and if the two diagnoses indicated different pathology, the case was defined as a "mismatch" [7]. The mismatched biopsies were then further defined as "inaccurate", if the biopsy did not contain neoplastic cells or the neoplasm was sampled, but the pathologist was unable to make a definitive or correct diagnosis; and "nonspecific", if the intraoperative diagnosis was not precise, but still consistent with the final diagnosis. Histological diagnosis was made using criteria in pathology textbooks for histological typing of tumors and WHO recommendations [8].

For intraoperative rapid diagnosis, the frozen section was prepared by placing the tissue sample in a tissue cassette, mounting it with OCT compound medium, and then immersing the sample in liquid nitrogen. Sections of tissue of 10 μm were prepared and stained with hematoxylin and eosin (H&E). Based on clinical information and frozen section findings, additional samples were submitted for preparation of frozen or permanent sections. The procedure for permanent sections was to fix the tissue sample with 10% neutral buffered formalin, followed by routine preparation and embedding in a paraffin block. Sections of 4–6 μm were processed for light microscopy and stained with H&E and immunohistochemical stains as required.

Significance was assessed by Student *t*-test or Fisher exact test, at a level of $P < 0.05$. Data analysis was performed with SPSS ver. 22 for Windows (IBM, Chicago, IL). This study was approved by the ethical committee of our institution (IRB No. 354-3).

3. Results

The 67 patients (37 males, 30 females) ranged in age from 6 to 83 years old (mean 47 years old). The lesions were ED in 13 cases (Table 1), IDEM in 27 cases (Table 2), and IM in 27 cases (Table 3). In the final diagnosis, 7 of the ED lesions were benign and 6 were malignant, all 27 IDEM lesions were benign, and 21 IM lesions were benign and 6 were malignant.

Comparison of the intraoperative and final diagnoses gave an overall diagnostic sensitivity of 86.6% (58/67), and 100% (13/13) for ED lesions, 96% (26/27) for IDEM lesions, and 70% (19/27) for IM lesions. The accuracy for IM lesions was significantly lower than those for ED and IDEM lesions ($p < 0.05$) (Fig. 1). Summaries of the 9 cases with a mismatch (5 nonspecific, 4 inaccurate) between intraoperative and final diagnoses are given in Table 4. Among the IM lesions, biopsy only was performed in 4 cases. The accuracies of intraoperative rapid diagnosis using frozen sections did not differ significantly between the tumor resection group (16/23, 70%) and the biopsy only group (3/4, 75%). Four illustrative cases of IM lesions are described below. There were no cases in which an intraoperative procedure was not performed due to an incorrect intraoperative diagnosis.

Table 1
Pathology on final diagnosis for extradural lesions.

Benign (n = 7)	
Giant cell tumor	2
Hemangioma	2
Chondroma	1
Osteoid osteoma	1
Langerhans cell histiocytosis	1
Malignant (n = 6)	
Ewing sarcoma	2
Fibrosarcoma	1
Chondrosarcoma	1
Osteosarcoma	1
Osteoblastoma	1

Table 2
Pathology on final diagnosis for intradural extramedullary lesions.

Benign (n = 27)	
Schwannoma	12
Neurofibroma	7
Epidermoid	2
Myxopapillary ependymoma	3
Pigmented villonodular synovitis	1
Perineurinoma	1
Meningioma	1

Table 3
Pathology on final diagnosis for intramedullary lesions.

Benign (n = 21)	
Ependymoma	8
Cavernous hemangioma	8
Lipoma[a]	2
Sarcoidosis[a]	2
Hematoma	1
Malignant (n = 6)	
Astrocytoma	6
Diffuse astrocytoma WHO grade II (4)	
Pilocytic astrocytomas (1)	
Anaplastic astrocytoma WHO grade III (1)	

[a] Biopsy only.

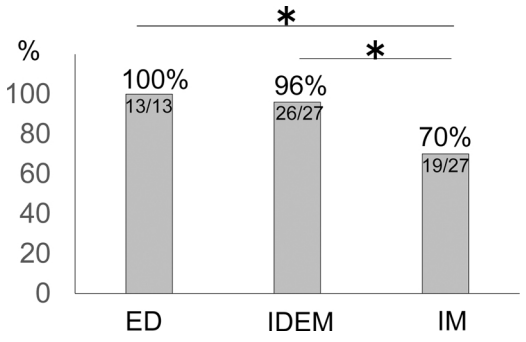

Fig. 1. Comparison of the accuracy of intraoperative rapid diagnosis using frozen sections for extradural (ED), intradural extramedullary (IDEM), and intramedullary (IM) lesions. *p < 0.05.

Table 4
Cases with a mismatch between intraoperative rapid diagnosis and final diagnosis (n = 9).

Final diagnosis	Intraoperative rapid diagnosis	Number of cases	Inaccurate/ Nonspecific
Intradural extramedullary (n = 1)			
Perineurinoma	Necrotic tissue with calcification	1	Inaccurate
Intramedullary (n = 8)			
Cavernous hemangioma	Inflammatory process	2	Nonspecific
Cavernous hemangioma	Tumoral lesion	1	Inaccurate
Astrocytoma	Glial neoplasma	1	Nonspecific
Astrocytoma	Tumoral lesion	1	Inaccurate
Ependymoma	Glial neoplasma	1	Nonspecific
Ependymoma	Tumoral lesion	1	Inaccurate
Sarcoidosis	Inflammatory process	1	Nonspecific