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Accuracy of intraoperative histological diagnosis in neurosurgery : A study of 30 cases

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Background : *Having been extensively used in general surgery in Thailand, intraoperative histological diagnosis has rarely been applied in neurosurgery.*

Objective : *To evaluate the accuracy of intraoperative histological diagnosis in Neurosurgery and its impact upon immediate operative management.*

Setting : *Neurosurgical Unit, Department of Surgery and Department of Pathology, King Chulalongkorn Memorial Hospital.*

Research design : *Prospective descriptive study.*

Materials : *Thirty patients operated at the Neurosurgery Unit, from October to December 2001.*

Methods : *Specimens were examined by smear technique with an occasional use of frozen sections. Intraoperative diagnosis was made by a neuropathologist. Final diagnosis was based upon the agreement of the neuropathologist and a pathologist, the latter was blind to the intraoperative diagnosis.*

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Results : *Compared to the final diagnosis, the accuracy of intraoperative diagnosis in this study was 97 %, consisting of 83 % completely and 14 % incompletely correct diagnoses. In 2 cases (7 %), the result of the rapid diagnosis influenced immediate intraoperative managements.*

Conclusions : *Accuracy of intraoperative histological diagnosis in neurosurgery is high. Although rarely does the result change the immediate intraoperative management, the technique was a useful adjunct to standard histological evaluation.*

Key words : *Smear technique, Frozen sections, Intraoperative diagnosis, Neurosurgery.*

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จิระพร อมรฟ้า, สมฤทัย ช่วงโชติ, วัลลภา วงษ์ทับทิม, วรรณี วัฒนเสริมกิจ, ชนพ ช่วงโชติ. ความแม่นยำของการวินิจฉัยทางพยาธิวิทยาระหว่างการผ่าตัด ในประสาทศัลยศาสตร์ : การศึกษาผู้ป่วย 30 ราย. จุฬาลงกรณ์เวชสาร 2545 พ.ค; 46(5): 383 - 90

ปัญหาของการทำวิจัย : *ในประเทศไทย การวินิจฉัยทางพยาธิวิทยาระหว่างการผ่าตัด ทำกันอย่างแพร่หลายในการผ่าตัดทั่วไป แต่ทำน้อยมากในประสาทศัลยศาสตร์*

วัตถุประสงค์ : *หน่วยประสาทศัลยศาสตร์ ภาควิชาศัลยศาสตร์ และภาควิชาพยาธิวิทยา โรงพยาบาลจุฬาลงกรณ์*

รูปแบบวิจัย : *การศึกษาไปข้างหน้าแบบพรรณนา*

วัสดุ : *ชิ้นเนื้อจากผู้ป่วย 30 รายที่ทำการผ่าตัดในหน่วยประสาทศัลยศาสตร์ ระหว่างเดือนตุลาคม ถึงเดือนธันวาคม พ.ศ. 2544*

วิธีวิจัย : *ชิ้นเนื้อจากผู้ป่วยทุกรายได้รับการตรวจด้วยวิธีสเมียร์ การตัดเนื้อเยื่อด้วยวิธีแช่แข็งพิจารณาทำในบางราย ประสาทพยาธิแพทย์ทำการวินิจฉัยระหว่างผ่าตัด ผลการวินิจฉัยขั้นสุดท้ายทำโดยประสาทพยาธิแพทย์คนเดิม และพยาธิแพทย์อีกคนหนึ่งที่ไม่ทราบผลการวินิจฉัยระหว่างผ่าตัด*

ผลการวิจัย : *เมื่อเปรียบเทียบผลการวินิจฉัยระหว่างผ่าตัดกับผลการวินิจฉัยขั้นสุดท้าย พบว่าผลการวินิจฉัยระหว่างผ่าตัดมีความแม่นยำร้อยละ 97 โดยแบ่งเป็นผลการวินิจฉัยที่ถูกต้องสมบูรณ์ร้อยละ 83 และผลการวินิจฉัยที่ถูกต้องส่วนหนึ่งร้อยละ 14 พบว่าในผู้ป่วย 2 ราย (ร้อยละ 7) ผลการวินิจฉัยระหว่างผ่าตัด มีผลทำให้เกิดการเปลี่ยนแปลงวิธีการผ่าตัดอย่างชัดเจน*

สรุป : *การวินิจฉัยทางพยาธิวิทยาระหว่างการผ่าตัดทางระบบประสาท มีความแม่นยำสูง ถึงแม้ว่าผลการวินิจฉัยจะเปลี่ยนแปลงวิธีการผ่าตัดในผู้ป่วยส่วนน้อย แต่ก็มีส่วนช่วยพยาธิแพทย์ในการให้การวินิจฉัยขั้นสุดท้าย*

Neurosurgery service is enhanced by the use of intraoperative diagnosis, particularly concerning specimens suspected of neoplasms. Techniques applied for rapid diagnosis include traditional frozen sections and smear preparation. While the former has been the mainstay for intraoperative diagnosis and is still routinely used in some neuropathology laboratories today, the latter has become increasingly accepted as adjunct or alternative approach. [1] Since first introduced by Eisenhardt and Cushing in the late 1920s, the smear technique has been modified by changing fixation or staining method, but the basic principle has remained unchanged.[1]

In Thailand, frozen sections have been widely used in general surgery, but rarely applied for neurosurgical specimens, probably related to a small number of practicing neuropathologists in the country. The smear technique for intraoperative diagnosis in neurosurgery is even less popular. The main purpose of this study is to determine the accuracy of intraoperative diagnosis by smear technique and/or frozen sections and to evaluate an impact of the diagnosis upon immediate operative managements.

Materials and Methods

Thirty-three specimens from patients operated in the Neurosurgery Unit, Department of Surgery, Chulalongkorn Hospital, from October to December 2001, were examined by smear technique and/or frozen sections for rapid intraoperative diagnosis. Prior to the operation, all the clinical data, including radiological findings and differential diagnosis, were discussed between the team of neurosurgeons and neuropathologist (Shuangshoti Sh). After surgically removed, the fresh tissue was put in normal saline solution, packed with ice, and sent immediately to the pathological laboratory. Approximately 4 representative areas per case, each measured 1-2 mm. in dimension, were selected for smear technique. Briefly, the selected sample was placed on one end of a labeled glass slide. The second slide was then placed on the tissue, perpendicularly to the first one. While applying an optimal pressure, the second slide was moved forward to make a smear towards the other end of the first slide. For cytological detail preservation, each smeared slide was immediately immerged in 95 % ethanol. All slides were stained with Hematoxylin and Eosin (H&E) by standard procedure; Toluidine Blue stain was occasionally used. Frozen sections were performed only when the smear was considered unsatisfactory, mostly due to hardness of the tissue, or it was felt that the technique would provide additional information.

All of the intraoperative diagnoses were made by a neuropathologist, based upon the World Health Organization (WHO) 2000 classification of the nervous system tumors.[2] The remaining tissue was fixed in 10% formalin, and embedded in paraffin for permanent sections. Final diagnoses were rendered by the same pathologist and were also made by another pathologist (Shuangshoti So), who at the time of reviewing permanent sections was blind to the results of intraoperative diagnosis. All final diagnoses were based upon the agreement between the two pathologists. The intraoperative and final diagnoses were compared, based on the following categories for accuracy determination (three cases were excluded from the study since the permanent section failed to provide a definitive answer).

Table 1. Summary of the demographic data, technique(s) used, intraoperative and final diagnoses, and the category of intraoperative diagnosis.

No.	Age	Sex	Location	S	F	Intraoperative Dx	Final Dx	Category
1	60	F	Rt frontal lobe	+	-	Meningioma	Meningioma	I
2	40	F	Lt parietal lobe	+	-	Meningioma	Meningioma	I
3	57	F	Lt sphenoid ridge	+	-	Meningioma	Meningioma	I
4	43	F	Rt sphenoid ridge	+	-	Meningioma	Meningioma	I
5	83	F	Foremen magnum	+	-	Meningioma	Meningioma	I
6	89	F	Spinal cord (T8-9)	+	-	Meningioma	Meningioma	I
7	31	F	Rt CPA	+	-	Neurilemmoma	Neurilemmoma	I
8	31	M	Rt CPA	+	-	Neurilemmoma	Neurilemmoma	I
9	29	F	Rt CPA	+	-	Neurilemmoma	Neurilemmoma	I
10	41	F	Spinal cord (C4-5)	+	-	Neurilemmoma	Neurilemmoma	I
11	30	F	Spinal cord (T6-10)	+	-	Neurilemmoma	Neurilemmoma	I
12	35	F	Pituitary gland	+	-	Adenoma	Adenoma	I
13	40	F	Pituitary gland	+	-	Adenoma	Adenoma	I
14	43	F	Pituitary gland	+	-	Adenoma	Adenoma	I
15	73	M	Pituitary gland	+	-	Adenoma	Adenoma	I
16	73	M	Rt frontal lobe	+	-	Metastatic adenocarcinoma	Metastatic adenocarcinoma	I
17	59	M	Lt frontal lobe	+	-	Metastatic adenocarcinoma	Metastatic adenocarcinoma	I
18	13	M	Lt lateral ventricle	+	-	Subependymal giant cell astrocytoma	Subependymalgiant cell astrocytoma	I
19	80	M	Rt temporal lobe	+	-	Astrocytoma	Astrocytoma	I
20	64	F	Lt temporal lobe	+	-	Glioblastoma	Glioblastoma	I
21	50	F	Spinal cord (L2-T1)	+	-	Ependymoma	Ependymoma	I
22	9	M	Lt caudate nucleus	+	-	Germinoma	Germinoma	I
23	52	F	Spine (C1-2)	+	-	Plasmacytoma	Plasmacytoma	I
24	49	M	Rt orbit	+	+	Cavernous hemangioma	Cavernous hemangioma	I
25	27	F	Spine (C7)	+	+	Giant cell tumor	Giant cell tumor	I
26	32	M	Rt thalamus	+	-	Oligodendroglioma	Anaplastic oligodendroglioma	II
27	33	F	Lt frontal lobe	+	-	High grade glioma	Glioblastoma	II
28	49	M	Pineal region	+	-	Pineocytoma	Pineal parenchymal tumor of intermediate differentiation	II
29	26	M	Pineal region	+	-	Germinoma	Mixed germinoma and endodermal sinus tumor	II
30	59	F	Pineal region	+	-	Positive for tumor	Gangliocytoma	III

No = Number, S = smear technique, F = frozen sections, Dx = diagnosis, Rt = right, Lt = left, CPA = cerebellopontine angle, C = cervical level, T = thoracic level, L = lumbar level, and Category = category of intraoperative Dx.

Category I.) Completely correct intraoperative diagnosis
Definition: The intraoperative and final diagnoses are exactly the same, both the histological type and grade.
Category II.) Incompletely correct intraoperative diagnosis
Definition: The intraoperative diagnosis is correct in the histological type, but failed to designate the degree of malignancy or to diagnose all histological types of mixed tumors.
Category III.) Incorrect intraoperative diagnosis:
Definition: The intraoperative diagnosis is incorrect in histological type, or offered only the presence or absence of tumor.
Category IV.) Deferred diagnosis
Definition: The intraoperative diagnosis failed to offer any information.

Results

Table 1 summarizes the clinical data of 30 cases, including the age, sex, the site of lesion, technique(s) utilized for intraoperative consultation, and intraoperative and final diagnoses. The patients consisted of nineteen women and eleven men; their ages ranged from 9 to 83 years. Smear technique was applied in all specimens as a primary method. Additional frozen sections were performed in 2 cases (case Nos. 24, 25) because the tissues were very tough, resulting in unsatisfactory smears.

In twenty-five cases (83 %), the intraoperative diagnosis fell into the category I (for definitions of categories, see materials and methods). Category II and III were observed in 4 cases (14 %) and 1 case (3 %), respectively. No category IV-intraoperative diagnoses were found in the present series.

In two examples (7 %), the rapid diagnosis dramatically influenced the intraoperative management. One was a cervical spine plasmacytoma (case No. 23) in which an intraoperative diagnosis immediately changed the primary aim of total resection into stabilizing the spine, as the lesion is known to be chemo- and radiosensitive. The other was a recurrent giant cell tumor of the cervical spine (case No. 25) in which the recurrent lesion was thought to be fibrous scar intraoperatively. The result of positive recurrent tumor rendered an attempt of total excision.

Discussion

To our knowledge, this is so far the first reported series, evaluating the accuracy of intraoperative histological diagnosis in neurosurgery performed in Thailand. We have demonstrated 97 % accuracy of the diagnosis, which can be divided into 83 % completely correct and 14 % incompletely correct diagnoses. There was only 1 case (3 %) in which the neuropathologist could only report that the tumor was present, but unable to pinpoint the neoplastic cell type. Comparing our result with others, however, it is not a straightforward matter due mainly to the different criteria applied for the accuracy determination and techniques employed. In many of the previous studies, correct intraoperative diagnosis referred roughly to that in our categories I and II (for definitions, see materials and methods), and the accuracy of cytological preparation between 88-94 % [3-8] and frozen sections between 76 - 95 %[1,9] has been noted. Torres and Collaço[10] reported a very high accuracy (92 %, n = 307 cases) of smear technique in determining both the tumor subtype and correct histological grade, intraoperatively. A study closely matched to ours would be that of Firlik et al.[7] who, in

comparison with the final diagnosis, divided the intraoperative diagnosis into complete and partial correlation, and found that 52 % and 38 % of 595 cases belonged, respectively, to their categories.

Whether to apply the smear and/or frozen sections, it basically depends on individual preference and experience. Both techniques have advantages and disadvantages, which complement each other. The former is very simple and inexpensive; it requires merely a small amount of tissue, and yet gives an excellent quality of cytological detail. Nonetheless, there is inevitably an architectural distortion, and, besides, lesions that vary histologically from place to place or mixed tumors may not be sampled thoroughly, which may result in an incomplete intraoperative diagnosis. The problem is particularly true to the glioma specimen in which the diagnosis of higher histological grade is based on the presence of some histological features. Similarly, all components of mixed tumors such as mixed germ cell tumors may not be included for examination. On the contrary, lesions that are histologically uniformed namely pituitary adenoma, meningioma and neurilemmoma pose fewer problems.

Despite an architectural preservation, frozen section technique is relatively laboratorious; it requires special equipment and a larger amount of tissue sample. Moreover, it provides poor cytological information. Indeed, if both techniques had been applied in our study, the percentage of completely correct diagnosis should have increased. However, according to the opinion of the neuropathologist, smear technique alone is quite adequate for most neurosurgical biopsies; it has a reasonably high percentage of accuracy. Frozen sections can be reserved for very tough specimens that cannot be well smeared.

As previously observed,[1] although the accuracy of intraoperative histological diagnosis is high, only rarely does the result influence the immediate operative management. From pathological standpoint, the smear technique, however, is very helpful as an adjunct to permanent section. Some of the pathological features can only be appreciated on smear. Of interest but may be overlooked, certain types of tumor have a characteristic texture, albeit not pathognomonical, Each tends to generate a reproducible smearing pattern. For example, soft lesions, such as pituitary adenoma, are easy to smear into a thin, blood film - like smear; while tough lesions such as neurilemmoma form distinct cohesive clusters. Simple method like examination of the smear with naked eyes, thus, provides useful information, especially when the differential diagnosis is taken into account. The additional data obtained form the technique may reduce the need of highly sophisticated diagnostic tools *viz.* immunohistochemistry and electronmicroscopy. Consequently, it reduces the cost of pathological work.

Additionally, a rapid diagnosis speeds up the flow of patient's care, as long as clinicians realize its limitations and discuss with the pathologist. The smear technique is, therefore, encouraged. It cannot only be done by pathologists but also, in fact, be performed by the neurosurgeon. Nevertheless, it is particularly important to emphasize the need for pathologists to know all the pertinent clinical data before interpreting the smear preparation. Failure to do so may result in erroneous diagnosis, which may be harmful to the patient.

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