

# Whole Slide Imaging and Telepathology for Intraoperative Frozen Section Examination

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## BACKGROUND

Many surgeons consider intraoperative frozen section examination as an important part of surgery, providing guidance to the surgeon about margin status and/or tumor type. Our hospital network has recently moved toward a speciality-based anatomical pathology signout. The impact of this specialization on frozen section accuracy is not well-characterized. We recently started the assessment of use of whole slide images (WSI) and telepathology for evaluation of frozen section analysis.

We reviewed the pathology records at our institution for all intraoperative consultations performed in a one year period. We compared the number and types of discrepancies between the frozen and permanent sections. All slides of frozen sections were stained with haematoxylin and eosin. Automated whole slide image capture was performed on an Aperio T2 slide scanner (Aperio Technologies, Vista, CA). The system's spatial sampling period (the area of tissue section subtended by a pixel) was approximately 0.46 microns/pixel. For telepathology, we employed a Trestle Medmicroscopy system.

The overall goal was to reduce the number of errors and deferrals. Innovations such as the use of telepathology may help reduce frozen section discrepancies by imaging the key slides which cause diagnostic difficulty and making them available for an intraoperative consult.

## METHODS

Twenty difficult cases were selected by a non-participating pathologist. All slides associated with the cases (a total of 184 slides) were scanned using the Aperio Scanscope T2. Four surgical pathologists volunteered to participate in the QA study. A survey was developed that recorded the pathologists' perceptions of diagnosis, image/slide quality, case complexity, diagnostic confidence, and time to complete case. The study design required each participant to view 10 cases via WSI and 10 cases via light microscopy. The 10 cases viewed via light microscopy were different than the cases viewed via WSI. Each participant scheduled an hour of time to complete the study, and no two pathologists participated in the study at the same time. A member of the evaluation team used a stop watch to measure the amount of time spent on each case.

**FIGURE 1:** An example of a deferred frozen section (A). This is a low power view of the margin section from a partial nephrectomy specimen. The mass was classified as renal cell carcinoma, clear cell type. The frozen section showed some epithelial area considered to be suspicious for involvement by carcinoma. The case was deferred due to extensive cautery artifact to make a definite call. On permanent glass sections, the margin was classified as positive after additional immunohistochemical stains for EMA (B) and pancytokeratin were performed.

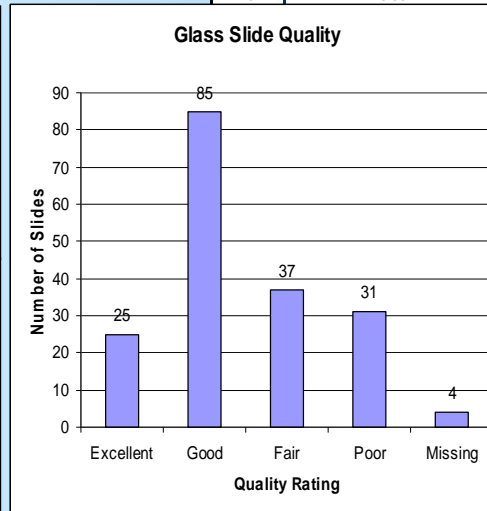
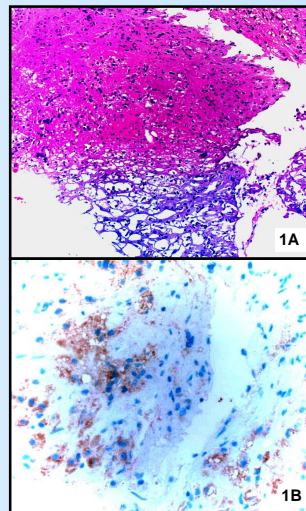
## RESULTS

**TABLE 1: Frozen Section Errors and Deferrals by SubSpeciality (2004-2005)**

Sub-Speciality	Interpretation Error (%)	Sampling Errors (%)	Deferrals (%)	Total
DermPath	1(25)	0(0)	1(25)	4
ENT	16(1.2)	22(1.6)	539(39.4)	1369
GU	7(2.3)	6(2.0)	50(16.7)	299
GI	17(1.9)	10(1.1)	143(15.8)	904
GYN	10(1.5)	10(1.5)	106(16.2)	655
HemePath	4(2.9)	1(0.7)	95(68.8)	138
Neuropath	16(1.7)	2(0.2)	191(20.1)	952
Perinatal	0(0)	0(0)	2(16.7)	12
Bone/Soft Tissue	14(3)	2(0.4)	72(15.5)	466
Thoracic	24(2.2)	9(0.8)	166(15)	1105
Transplant	6(0.9)	3(0.4)	49(7.3)	675
Breast	7(2.2)	16(5)	12(3.7)	318
<b>TOTAL</b>	<b>122(1.8)</b>	<b>81(1.2)</b>	<b>1426(20.7)</b>	<b>6897</b>

**TABLE 2: Average Number of Minutes to Completion Per Case**

Case #	Average Time (Min)
1	3.36
2	3.65
3	3.67
4	3.83
5	3.27
6	10.55
7	5.87
8	8.26
9	8.71
10	10.24
11	3.96
12	14.44
13	11.21
14	22.35
15	2.27
16	9.48
17	7.62
18	7.71
19	3.34
20	5.56



## DISCUSSION

Table 1 shows the frozen section errors and deferrals by sub-speciality for a two year period. Table 2 shows the average time per case the pathologists took to complete the glass slide portion of the Frozen Section study with an average time of 7.56 minutes per case. Case 14 took the longest to evaluate with an average time of 22.35 minutes. Case 15 had the lowest average time spent on it (2.27 minutes).

Figure 2 shows the quality ratings for all glass slides. Most glass slides were rated with a "Good" rating. There were 37 and 31 fair and poor rated slides, respectively.

The WSI portion of the project was not completed by any of the participating pathologists owing to a number of technical problems associated with WSI of frozen section slides and the pathologists' relative lack familiarity with viewing and navigation of WSI.

## CONCLUSIONS AND FUTURE DIRECTIONS

- The purpose of this study was to duplicate a "real-life" frozen section examination using glass slides and WSI.
- However, in the WSI portion of the study we encountered many problems which prevented us from completing this portion of the study.
- The number of slides within each case and/or the complexity of the cases rendered the pathologists and evaluators unable to judge how much time would need to be dedicated to finish the project.
- WSI image quality was also a large problem for this study.
- The images derived from frozen sections had too many "out of focus" areas and artifacts for the pathologist to read.
- We have now started using live robotic telepathology systems to continue this study, and preliminary results have been very encouraging.
- The live telepathology systems are dynamic and allow the remote pathologist to focus and assess areas with a depth perception, a feature not available in WSI, which we used for our studies.
- Pathologists at our institute have now completed training in the use of telepathology systems that will be useful as we move forward with evaluation of remote frozen sections using telepathology.

## REFERENCES

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