Live Telemicroscopy is Substantially Equivalent to In-person Intraoperative Frozen Section Diagnosis

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Introduction

Intraoperative diagnosis by frozen section is a mainstay of surgical pathologic practice, since the use of frozen saline in the early nineteenth century to "Orth's fluid" in 1895, methylene-blue based stains in the early 1900s, and finally the mounting-medium, H&E-based modern method codified in 1931.[1] Despite good accuracy with modern methods,[2] access to intraoperative surgical pathology with an appropriate turn-around time (TAT)[3] has been a limiting factor for small or remote surgical centers with negative impacts on cost and patient care.[4]

As a major regional referral center for pathology services, the University of Nebraska Medical Center utilizes remote telemicroscopy to provide intraoperative diagnoses to satellite hospitals. A pathology assistant or high-level technician cuts the tissue and loads the slides into the telemicroscope, and the pathologist at the main site provides the diagnoses. I sought to compare this mechanism to our standard in-person intraoperative diagnoses.

Design

All frozen section diagnoses in a four-year period were queried in our laboratory information system for surgical center, anatomic site of frozen section performed, intraoperative organ site, TAT, reading pathologist, and concordance with final (paraffin) diagnoses. Intraoperative diagnoses performed by telemicroscopy were also compared to intraoperative diagnoses on glass slides.

Telemicroscopy was performed using the SL-5 dual-slide scanner from Mikroscan®. Intraoperative reads not performed exclusively by telemicroscopy, and intraoperative reads for adequacy only, were excluded. Comparisons were performed by Kruskal-Wallis, Mann-Whitney, and Chi-square tests as appropriate. For cases with multiple frozen blocks, only the main specimen was included.

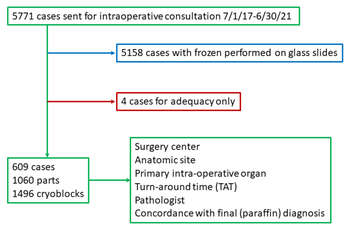

Figure 1: Analysis pipeline. Of 5771 total frozen section cases performed, 609 were performed by telemicroscopy at two regional hospitals. Of those, 576 (94.6%) had concordance data and 556 (91.3%) had TAT data available.

Results

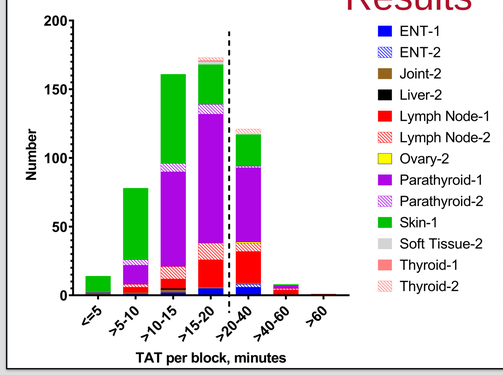

Figure 2: Turn-around time (TAT) per block for anatomic site and hospital. The TAT per block for each case (n=556) is included. The numbers in the legends indicate the surgical center. The dashed line at 20 minutes indicates the quality metric from the College of American Pathologists. Four-hundred twenty-seven (76.80%) of the 556 cases met this criterion. In two cases (0.33% of total), computer technical issues did not allow a diagnosis to be rendered. In the same timeframe, 4812/5432 in-person cases with fully available data (88.59%) met the 20-minute cutoff (p<0.0001).

Results, continued

	Hospital 1			Hospital 2			Combined		
Anatomic site	**Number**	***n* with TAT**	**mean TAT**	**Number**	***n* with TAT**	**mean TAT**	**Number**	***n* with TAT**	**mean TAT**
Parathyroid	243	234	18:01	18	18	15:07	261	252	17:49
Skin	213	182	13:08	1	0	N/A	214	182	13:08
Lymph node	66	59	23:14	31	30	19:15	97	89	21:53
ENT	15	14	20:04	2	2	24:30	17	16	20:37
Thyroid	1	1	18:00	6	5	22:00	7	6	21:20
Joint	0	0	N/A	6	6	13:02	6	6	13:02
Soft tissue	0	0	N/A	4	3	27:20	4	3	27:20
Liver	0	0	N/A	1	1	13:00	1	1	13:00
Brain	0	0	N/A	1	0	N/A	1	0	N/A
Ovary	0	0	N/A	1	1	23:00	1	1	23:00
sum/mean	538	490	16:53	71	66	18:15	609	556	17:03

Table 1: Tissue site and turnaround time (TAT) for telemicroscopic cases by hospital. For each hospital where telemicroscopic intraoperative diagnosis was performed, the site of frozen tissue with average block turnaround time was calculated for the 556 cases available. Tissue site was determined by the frozen tissue, not primary surgery; e.g., incidental parathyroids for ear, nose and throat (ENT) surgeries without another frozen diagnosis were included in "Parathyroid." For cases with multiple frozen tissues, only the main specimen (e.g. cancer resection) was included in calculations. Mean TAT was 17m03s±8m03s. In the same timeframe, glass diagnoses in our center had a mean TAT of 14m17s±7m07s (p<0.0001). No difference in mean TAT was identified between the two external hospitals (p=0.131).

Pathologist	Specialty	Total counts	Category A	Category B	Category C	totals
1	Derm	131				**0**
2	Derm	73				**0**
3	Surg	47	3		1	**4**
4	GI	42	2	1		**3**
5	B/G	41	2	2		**4**
6	GI	40	1			**1**
7	GI	40				**0**
8	GI	39		2		**2**
9	Surg	37		1		**1**
10	Neuro	23				**0**
11	GI	22		1	2	**3**
12	B/G	22				**0**
13	Surg	14				**0**
14	Neuro	8				**0**
15	Surg	6		1		**1**
16	Surg	6				**0**
17	Surg	5				**0**
18	B/G	4				**0**
19	Surg	2				**0**
20	Surg	2				**0**
21	Surg	2				**0**
22	GI	2				**0**
23	Surg	1				**0**
	Sum	609	8	8	3	**19**

Table 2: Telemicroscopy by reading pathologist and discordance. Twenty-three different pathologists performed telemicroscopic diagnoses an average of 26.5 times (range: 1-131). Of 609 cases, 576 (94.6%) had concordance data. Of those, 557 (96.7%) were concordant. Nineteen discordant cases (3.30% of available) were identified among eight pathologists. Categories A; does not change management; B: may change management; C: requires additional intervention. Derm: dermatopathology; Surg: multiple fields of surgical pathology; GI: gastrointestinal pathology; B/G: breast/gynecologic pathology; Neuro: neuropathology.

Results, continued

Category	Anatomic site	Number	Narrative	Specialty
A	Lymph node	2	Additional node positive for breast carcinoma	B/G x2
			One case already known positive	
			One case negative on frozen with isolated carcinoma cells on levels	
		1	Additional node negative for breast carcinoma	GI
	Skin	1	Focal positive margin > negative margin	Surg
		1	Possible tumor > negative	GI
	Parathyroid	1	Misreport weight/more parathyroid in fat	Surg
		1	No parathyroid > small parathyroid	GI
		1	Parathyroid > thyroid	GI
B	Skin	3	Focal positive margin (BCC or SCC) > negative margin	GI x2, B/G
		1	Actinic keratosis > in situ squamous cell carcinoma	GI
		1	Negative margin > focal positive margin	GI
	Lymph node	2	Negative for breast carcinoma > positive	Surg, B/G
	ENT	1	Negative for squamous cell carcinoma > positive	Surg
C	Thyroid	1	Lymphocytic thyroiditis with focal papillary change > follicular thyroid carcinoma	Surg
	Parathyroid	1	Endocrine tissue, favor parathyroid > thyroid	GI
	Skin	1	Negative margin > positive margin	GI

Table 3: Discordance by anatomic site. The specific discordant scenarios for the nineteen cases are outlined. Eight of 23 reading pathologists had any discordant read. The subspecialty of the reading pathologist for these nineteen cases is included. B/G: breast/gynecologic pathology; GI: gastrointestinal pathology; Surg: multiple fields of surgical pathology.

Table 4: Discordance by method of intraoperative diagnosis. There is no difference in concordance between in-person and telemicroscopic diagnosis at either site (p=0.375).

	Glass	Hospital 1	Hospital 2
Concordant	6539	494	63
Discordant	262	16	3
A	90	7	1
B	140	7	1
C	32	2	1

Discussion

Diagnoses by telemicroscopy did not meaningfully differ from on-glass on TAT and concordance; although in-person diagnoses were statistically faster, the great majority of telemicroscopic diagnoses were returned in <20 minutes. This remained true through numerous pathologists, pathology assistants and/or technicians, two different hospitals, and over four years. The concentration of discordant diagnoses among relatively few pathologists suggests a level of individual comfort with telemicroscopy and/or frozen section. Rare cases of technological issues prevented telemicroscopic diagnosis. Overall, this provides further justification for continued use and expansion of telemicroscopic services in primary intraoperative diagnoses.

References

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3. Novis DA, Zarbo RJ. Interinstitutional comparison of frozen section turnaround time. A College of American Pathologists Q-Probes study of 32868 frozen sections in 700 hospitals. *Arch Pathol Lab Med*. 1997 Jun;121(6):559-67.
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