Telepathology for Frozen Section Analysis: A Validation of Remote Meeting Technologies (RMT)™ Software

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ABSTRACT

Background:

The University of Wisconsin Hospital and Clinics is supporting frozen section (FS) capability at a partner institution over 40 miles away. The Department of Pathology was tasked with finding the most efficient solution providing this service. Cost effectiveness and accuracy were our most pressing concerns. After review of many techniques, including virtual scanning, real time imaging was chosen. To prove this method was just as effective as direct microscopy, a validation/correlation study was performed. This also functioned as a training/competency assessment for participating pathologists allowing them to become familiar with making diagnoses from digital images.

Design:

Six pathologists were given a set of 20 FS slides and asked to interpret them via our chosen telepathology system, Remote Meeting Technologies (RMT). The slides were chosen after a review of common FS slides seen in the partner institution. The more difficult cases were favored to show that the RMT system could accurately display diagnostic features in a digitized image. After 3 months or more of lag time, the slides were reordered and presented to the same pathologists for direct microscopy examination. The answers from each exam were then correlated to determine if any difference existed between the two methods of diagnosis.

Results:

The Cochran-Mantel-Haenszel (CMH) test found outstanding correlation between telepathology and direct microscopy with a p value of <0.0001. The null hypothesis in this analysis was that there was no correlation between the two methods. The exceedingly low p value gives extremely strong evidence against that null hypothesis.

Conclusions:

The RMT system provides 1920 x 1080 pixels of resolution which is the equivalent to high definition. This provides the diagnosing pathologist with an exceptionally sharp view of diagnostic features. Our study shows that our telepathology system is valid for interpreting FS. The collected data provides excellent evidence of a high degree of correlation between the two methods. More studies of this type need to be performed on other systems being developed to prove their validity in FS diagnosis and the pathologists' competency in using them.

INTRO

Telepathology can expand laboratory efficiency in a time of tightening budgets and simultaneous need to expand services. Telepathology was considered after the University of Wisconsin Hospital and Clinics (UWHC) formed a strategic partnership with the Watertown Regional Medical Center (WRMC) to extend specialty medical care, surgical services, neurologic care, and pathology within the region. As part of medical services extended to the WRMC, UWHC needed to find a way to serve the intraoperative consultation needs of this hospital. However, the intraoperative consultation volume was not sufficient to justify travel of over an hour (one way) for an anatomic faculty member.[1] A telepathology solution utilizing dynamic imaging would allow a surgical pathologist to conduct remote consultation alongside daily signout activities. Telepathology allows pathologists to evaluate specimens and make diagnoses in geographically disparate areas without the logistical complications of travel. Telepathology has been used by pathologists in the Veterans Health Administration system in this region for more than 15 years.[2] Also, the UWHC cytopathology section has been using telepathology since 2005 to allow cytopathologists the ability to remotely evaluate fine needle aspirate specimens for adequacy. UWHC now sought to use dynamic imaging telepathology for intraoperative frozen section consults.

Because technical staffing was needed at the remote site for preparation of the tissue, sectioning, and staining of the slide, a pathology assistant(PA) was needed to scan the frozen section slide under the microscope at the remote location or show gross specimens that needed dissection. With technical staff available at the remote location, a dynamic, real-time, imaging system from Remote Meeting Technologies (RMT), was chosen, as opposed to whole slide imaging, for simplicity of implementation and lower capital expenditures.

Figure 1: Pathologist at Main Surgical Pathology Sign Out Facility

Figure 2: Camera at Remote Site; Grossing Station

Figure 3: Camera at Remote Site; Microscopy Station

A pathologist at the main laboratory is in contact with the PA at all points in the intraoperative consultation (Fig. 1) process via phone. High definition grossing cameras are used to allow for pathologist input into the tissue dissection (Fig. 2). This allows for issues related to tissue sampling (in a large specimen) or tissue orientation to be discussed as these may be critical in margin assessment. When the slide is ready, it is scanned manually by the PA via a full 1080p microscopic camera (Fig. 3) with instruction by the pathologist to assure all aspects of the slide are examined.

As with all newly implemented laboratory methods, validation was necessary. Validation goals were to conform to Clinical Laboratory Improvement Amendment act of 1988 and College of American Pathology regulations, to train staff, and to test technology.

MATERIALS AND METHODS

Validation was performed through competency assessments of frozen section slides viewed on telepathology and by light microscopy. The competency assessments on each method were then compared for accuracy between the methods. Acceptable accuracy was determined to be 90% of cases receiving the correct diagnosis for both light microscopy and telepathology.

A selection of 20 FS slides was chosen based on the type of specimens seen at WRMC. Specimens were chosen such that they represented the most diagnostically challenging material, including cases of lobular breast carcinoma in a sentinel lymph node. The more difficult cases were favored to show that the RMT system could accurately display diagnostic features in a digitized image.

Six pathologists were given the same set of slides and asked to interpret them via the RMT system. After a period of 3 months or more of lag time, the slides were reordered and presented to the same pathologists for direct microscopy examination. The answers from each exam were then correlated to determine if any difference existed between the two methods of diagnosis.

The RMT system transmitted via a leased line from Charter Communications with bandwidth of 10 Mbps from the WRMC to the UWHC which allowed safe and reliable transmission through a private network (rather than the public internet). IT staff from both UWHC and WRMC had detailed communication with each other to allow the system to pass the visual data through hospital firewalls securely in compliance with the Health Information Portability and Accountability Act (HIPAA) regulations.

RESULTS

All pathologists had acceptable accuracy with both methods; microscopy and telepathology. There is no difference detected between telepathology diagnoses and microscopic diagnoses. The Cochran-Mantel-Haenszel (CMH) test (Table 1) found outstanding correlation between telepathology and direct microscopy with a p value of <0.0001. The null hypothesis in this analysis was that there was no correlation between the two methods. The exceedingly low p value gives extremely strong evidence against that null hypothesis.

TABLE 1. CMH Test to Compare Telepath with Direct Microscopy Controlling for Pathologists

Cochran-Mantel-Haenszel test		Comments
For hypothesis that correlation=0.	P-value<.0001	There is a significant correlation between telepathology and direct microscopy.

TABLE 2. Overall Kappa coefficients and test of equal Kappa coefficients

Overall Kappa Coefficient		Comment
Kappa=.73		There is an excellent agreement.
95% CI (.60, .85)		
Test of equal Kappa coefficients among all pathologists		
Chi-square test	P-value=.98	All kappa coefficients are equal.

TABLE 3. McNemar's test for each pathologist

Pathologist	p_value from McNemar's test	Comment
D	1	Telepath and direct agree.
F	.083	Telepath and direct agree.
G	.083	Telepath and direct agree.
H	1	Telepath and direct agree.
I	.083	Telepath and direct agree.
J	.16	Telepath and direct agree.

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CONCLUSIONS

In pathology informatics, there are many products of variable utility. The product studied here has been effective and also simple to use, implement, and support. Given institutional support of the technology and network infrastructure required for transmission of images, RMT real-time imaging product has great potential to expand a pathologist's efficiency. RMT software product provides diagnostic quality video streaming capabilities which require little training and minimal technical support following implementation.

No difference between diagnostic capability using telepathology and direct microscopy could be detected in our study. Similar studies in other institutions have also found dynamic real-time telepathology to be diagnostically equivalent to light microscopy.[2-6] Therefore, telepathology can be judged as an effective and efficient method of extending pathology services to cover wide geographic areas.

Without full remote control of the slide for the pathologists in the main laboratory, an experienced PA or other technical staff is needed at the remote site. This staff should be able to scan the frozen section slide through the imaging system and show the entire slide to the pathologist. At the same time, there must be excellent communication between the two areas in telepathology. The pathologist needs to be certain that if there are unusual features with a given case that the PA can communicate and show those features. The PA needs to be comfortable with histology and basic dissection, and be able to understand any concerns that a pathologist might have regarding a given case. Future plans include developing human resources at the remote site to train qualified staff or hire more qualified staff for the PA portion of the process. Also, there are plans for implementation of a remote robotic system for slide control if and when developed. This would allow for greater control of the slide by the surgical pathologist at the main laboratory, but a trained PA or staff would still be needed for dissection and histologic sectioning.

Although there was an initial reluctance to work with the telepathology system, faculty soon recognized the productivity benefits. All faculty involved in frozen sections from March 2012 thru Dec 2012 requested at the remote location used the telepathology and found it to be adequate for rendering a diagnosis. No faculty involved in frozen section diagnoses were needed at the remote location. When a frozen section is necessary, PAs and lab techs begin the connection from the remote camera stations to the viewing station in the reading room at the UW, and the pathologist routinely assigned to frozen section services makes the diagnosis.

Many systems have resolution that is better at lower power and worse at higher power. Paradoxically, the RMT system has resolution noted to be superior at 10x rather than at 4x by several of the pathologists participating in the study. We are unable to pinpoint the technical component of the system to alter resolution. Though surgical pathologists tend to use the 4x objective heavily, resolution was overall excellent and entirely adequate for diagnostic need.

A private Wide Area Network connection is needed to transmit data between geographically divided organizations. Telepathology fits well with the organizational plan to provide telemedicine services including telestroke, remote telemetry monitors, and cytologic specimen adequacy evaluation. Without institutional investment in technology infrastructure, this system would not be possible.

Developing and troubleshooting new computer systems is a challenge, even more so when two disparate organizations with different IT staff hierarchies seek integration. Excellent communication between IT staff within partnering organizations is essential for the long term maintenance of a telepathology system. Even with excellent communication, weekly "system checks" are performed to assure images can be transmitted between hospitals and through firewalls. The system checks allow changes to network security that would halt image transmission to be detected prior to an urgent intraoperative consultation or FNA procedure.

Although there was some concern about system reliability, we have not had any technical issues at time of frozen section. Each person involved in this implementation was asked to comment on an issue with the system they had noted since its first usage in March of 2012. There were two user errors noted. In the first case, the PA at the remote site had not started the image broadcast. In the second case, the faculty member at the university had not started the imaging client software. Technical support staff had five issues to resolve; four of these issues were fixed by rebooting the telepathology server at the remote site. One technical issue was related to changes in the firewall at the WRMC without awareness of the need for the telepathology system to be permitted to transmit. These issues were all detected during system checks or during use of the system during procedures other than intraoperative consultation.

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