Telecytology in the diagnosis of pleural effusion smears

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Abstract

Objective
Telecytologic diagnosis of pleural effusion smears is potentially useful because it could allow more efficient use of cytopathologist resources and expertise. The purpose of our investigation was to evaluate how well this type of review correlates with a review in which the entire slide is available for examination by the pathologist.

Materials and Methods
35 pleural effusion smears with different diagnosis were selected retrospectively. They include 16 benign, 5 suspicious for malignancy and 14 malignant which were confirmed with two expert cytopathologists. For each slide number 3 to 11 fields containing abnormal cells were digitally imaged. Pathologists reviewed all glass slides and digitized images individually. Diagnoses based on selected digitized images were compared with those based on conventional review. The kappa statistic, a measure of chance-corrected agreement (reproducibility), was calculated in each setting.

Results
The interobserver kappa value for the 3 observers for the glass slides was 76%. The interobserver kappa value for the digital images was 67%.

Conclusion
The disagreement between a pathologist’s glass slide and digital diagnose (mean intraobserver kappa value = 73%) is greater than that for different pathologists reviewing glass slides (mean slide interobserver kappa value= 76%). Overall, intraobserver and interobserver reproducibility of pleural effusion slides (consists of direct smear after centrifugation and cytospin preparation) diagnoses is good to excellent.

Keywords: Telecytology, Diagnostic reproducibility, Pleural effusion smears.
Introduction

Most published studies have been considered surgical pathology specimens; only handfuls have been considered telecytologic diagnosis. Most of these studies have found a high (90% to 95%) concordance between telecytologic diagnoses and glass slide diagnoses but are restricted to a small subset of cytologic specimen types (1, 2, 3). Telecytology has been proposed as a means of initial off-site diagnosis or expert consultation. Additionally, use of telecytology could be considered for the administration of proficiency testing.

A study examining (1) intraobserver variability of 3 pathologists for the telecytologic diagnosis of breast fine-needle aspiration biopsy specimens found 80% to 96% diagnostic concordance between telecytologic diagnosis and glass slide diagnosis.

The present study was undertaken to evaluate the diagnostic reproducibility of pleural effusion smears (consist of direct smear after centrifugation and cytospin preparation smear) among 3 pathologists using digitally captured images and a light microscope.

Materials and Methods

35 pleural effusion smear (direct smear after centrifugation and cytospin preparation), with different diagnosis were retrospectively and randomizely selected from year of 2002 to 2005, from archive of department of pathology in Ghaem hospital, Mashhad, Iran. This was done through the resident of pathology (BA. J.). Each pleural effusion smear consisted of two direct smear after centrifugation slide and one cytospin preparation slide which stained with H&E.

These slides had been screened by an experienced resident of pathology; the diagnoses of the case included 16 benign, 5 suspicious for malignancy and 14 malignant, that confirm with two expert cytopathologists.

Each of three pathologists (A. H, T. A., S. H.) reviewed all 35 pleural effusion smears once by light microscopy and once by computer monitor. The delay between viewing of the digitized images and off the glass slides was approximately 2 weeks for each pathologist, and the observers did not consult each other regarding the study cases. Images were captured using an Olympus DP-12 Digital camera mounted on an Olympus microscope (Model U-MDOB3- Japan). The camera was connected via SCSI interface to micron 2.6 GHZ Pentium CPU windows XP.

One resident of pathology (BA. J.) imaged the fields. The fields selected provided information routinely used in cytologic diagnosis, such as cellularity and background, reference cell, such as normal mesothelial cell, neutrophil, monocyte and red cells, and representative fields showing abnormal features. Each area of interest was imaged at 100× and 400×. Images were captured at 787 × 787 resolutions at 24-bit color depth and 200 dpi and imported directly into Adobe Photoshop 7.0. Within Adobe Photoshop, image resolution was reduced to 72 dpi, and JPG compression of 10:1 was applied.

Images from each slide were sent by E-mail for three pathologists. Conventional light microscopy was performed individually on an Olympus (MODEL: CH30RF200-Japan). Objective lenses were provided to each pathologist. The data supplied by the contributors varied by case, but all included patient age and sex.

After reviewing the slides, the pathologists rendered diagnosis on each case. All pathologists were board certified in anatomical and clinical pathology by the Iranian Board of Pathology.

To evaluate the diagnosis and the glass slide diagnosis, the diagnoses were divided into 3 groups: 1. benign, 2. suspicious for Malignancy, 3. Malignant. Intraobserver and
interobserver reproducibility were calculated using Cohen's Kappa statistic (4), using SPSS version 10. Intraobserver reproducibility between glass slide diagnoses and digital image diagnoses were calculated among all pathologists. Finally, interobserver reproducibility for both glass slide diagnoses were considered semiquantitatively (5). The results were aggregated into 3 categories, with each diagnosis corresponding to a step from benign to malignant.

The ordering of these 3 diagnostic categories was benign, suspicious for malignancy and malignant. Any difference in diagnostic category between glass slide and digitalized images was considered a diagnostic disagreement. Therefore, telecytologic and light microscopic diagnoses that fell into the same category were considered concordant, and diagnoses that fell into different categories were considered discordant by 1 or 2 steps. Mean intraobserver reproducibility was calculated as the weighted average of the individual kappa values (6).

**Results**

The intraobserver kappa value between the digital images and glass slides for each of the 3 observers are shown in Table1.

Although there are no formal criteria by which to qualitatively describe kappa value, many observers consider a kappa > 0.75 to indicate excellent, kappa of 0.58 to 0.74 good, kappa of 0.4 to 0.57 fair, and kappa of 0.2 to 0.39 poor reproducibility (7). By these criteria our results show good to excellent intraobserver diagnostic reproducibility.

The mean interobserver kappa value for the 3 observers for the glass slides was 0.76. The mean interobserver kappa value for the digital images was 0.67. Although the diagnostic reproducibility was higher for glass slide than for digital images, kappa value in these two groups was in the good to excellent range. 1-step disagreement between 3 observers were found in 3 cases in glass slides (figure 1) and 1 case in digital images and 2-step disagreement between 3 observers were found in 6 cases in glass slides and 7 cases in digital images.

The disagreement between a pathologist's glass slide and digital diagnoses (mean intra observer kappa value = 0.73) was greater than that for different pathologists reviewing glass slides (mean slide interobserver kappa value = 0.76). Overall, diagnostic reproducibility was slightly higher for glass slides than for digital images.

**Figure 1**

Typical images drawn from a single case in which 10 digital fields were presented to the pathologists. When viewing the glass slides, two of the pathologists favored a diagnosis of malignancy; the third preferred a diagnosis of being suspicious (one step discordant), and when viewing the digital images, each of the pathologists agreed with malignancy. Image acquired with 10x objective lens. Image acquired with 40x objective lens.
Table 1: Intraobserver reproducibility between digital images and glass slides.

<table>
<thead>
<tr>
<th>Observer</th>
<th>Kappa value</th>
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<tbody>
<tr>
<td>1</td>
<td>0.89</td>
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<tr>
<td>2</td>
<td>0.71</td>
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<tr>
<td>3</td>
<td>0.60</td>
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<tr>
<td>mean</td>
<td>0.73</td>
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Discussion

Two different methodologic approaches have been advocated for telepathologic diagnosis.

In dynamic system, images are viewed live and real time as the receiving viewer directly controls specimen orientation, field selection, and fine focus of the microscope via robotic controls (7).

In static system, images captured in a digital format on an image frame grabber board and then transmitted individually as still images to the receiving viewer. The receiving viewer usually has little or no direct control over microscope function (8).

Although dynamic imaging is unquestionably the more powerful technologic approach, the substantially lower cost favors the use of static imaging methods for review of pleural effusion smears. When evaluating the reproducibility of diagnoses mode via 2 or more different viewing modalities, the overall percentage or proportional agreement appears to be a simple and intuitively correct measure of reproducibility.

Given the limited number of diagnostic possibilities it is important to correct for chance agreement.

Agreement is the overall or proportional number of cases given the same diagnosis between or within observers, including that part of the agreement, which may be attributable to chance.

Reproducibility, that part of the agreement that may not be explained purely by chance, is appropriately measured by the kappa static (4).

Reproducibility may be evaluated at the level of 2 or more observers examining the same specimen (Interobserver reproducibility) or at the level of the same observer examining a specimen via 2 or more modalities or on 2 or more occasions (Intraobserver and reproducibility).

We found that the intraobserver and interobserver diagnostic reproducibility for both digital image and the light microscope was good to excellent, which kappa value ranging from 0.6 to 0.89 (mean, 0.73) for intraobserver reproducibility and from 0.6 to 0.83 for interobserver reproducibility.

The disagreement between a pathologist's glass slide and digital diagnoses (mean intra observer kappa value=0.73) that for different pathologists this is greater than more likely to disagree on the interpretation of digital images (mean digital image inter observer kappa value=0.67) rather than on the interpretation of glass slides.

Overall, diagnostic reproducibility was slightly higher for glass slide than for digital images. It seems likely that the major factors underlying the better reproducibility of glass slide diagnoses among pathologists is the ability to review the entire pathologic specimen slide before a diagnosis is rendered.

Other factors, such as initial selection of slide fields for imaging and transmission, technical factors (digitalization, transmission and display) and review expertise and comfort with viewing and interpreting computer images would seem to play a greater role in determining intra pathologist disagreements in interpretation of glass slides and video images.

As instrumentation improves and pathologists gain more experience in sending, receiving, and interpreting digital images, the diagnostic reproducibility of digital images, will likely improve. In two study examining the diagnostic accuracy of
video microscopy versus conventional examination of cervical-vaginal smears, Ziol et al. (9), Particia et al. (10) and Lee et al. (11) found an intraobserver kappa of 0.47 to 0.81, 0.47 to 0.77 and 0.68 to 0.76 respectively.

In another study in telecytodiagnosis of routine cases Yamashiro et al. found that telecytology is very useful for primary cytodiagnosis in regional medicine and that it may raise the accuracy of cytodiagnosis in future (12).

Our finding generally supports the viability of remote pathologist review of selected abnormal fields of cytologic specimens in the context of a well-designed program in which pleural effusion smears.

In summary, the intraobserver and interobserver diagnostic reproducibility of pleural effusion smears using digital images and light microscope is good to excellent. These finding indicate that the use of telecytology for pathologist review of pleural effusion smears holds much promise as a useful and reliable diagnostic tool.

References