Original Article

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Perceptions of First-Year Medical Students on the Use of Whole Slide Imaging in Learning Histology

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Abstract

Background: Traditional practice in histology teaching is to use the optical microscope for examination of the slides. Whole slide imaging (WSI) or virtual microscopy is an innovation that uses the scanned images of the histology slides that can be seen in any device that can be connected to the internet. WSI allows the user to pan and zooms the slide just like in a microscope, and the quality of the image is also reported to be superior to an optical microscope. The aim of the study was to assess the first-year medical students' perceptions on the use of whole slide imaging in learning histology slides. Settings and Design is Cross-sectional, questionnaire-based survey. **Subjects and Methods**: Students of phase I MBBS were the study participants. Practical sessions on the histology of the gastrointestinal tract were conducted using the whole slide imaging. Using a 10 item questionnaire, feedback was obtained at the end of the teaching sessions. Statistical analysis used Descriptive statistics were used to explain the data. **Results:** The students showed a positive response in embracing this new mode of histology teaching. There was uniform support to the fact that the image quality and ease of use of the pan and zoom feature were useful in identifying details of the tissues. **Conclusions:** WSI was accepted with enthusiasm as a much-needed innovation in histology learning. If not a supplant, WSI can be used as an adjunct to traditional glass slide teaching using an optical microscope

Keywords: Microscopy, Feedback, Perception, Survey, Whole Slide Imaging.

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Introduction

Histology or microscopic anatomy is one of the core components of the anatomy curriculum and is the foundation for recognizing the morphological features of many pathological conditions. The traditional practice in image-based laboratories such as histology and even pathology are to use the optical microscope (OM) for examining the glass slides.[1] Conventional light microscopy(CLM) remains one of the basic and time-tested tools in histology learning.

Recent advances in technology have led to the use of innovative practices in medical education. Over the last two decades, innovative technologies like digitized images, web-based animations, and whole slide imaging (WSI), or virtual microscopy (VM) have gained popularity.[2] WSI is a technological innovation that involves the use of a slide scanner to scan the glass slides to generate the digitized images of the tissues in the histology or the pathology glass slides.[3] The images obtained can then be made accessible remotely to multiple users at the same time using any internet-enabled device.[4] Navigating through the digitized images simulates the use of a microscope and hence is also referred to as VM.[5]

WSI/VM has many advantages over the CLM.[3] WSI can be used by multiple users simultaneously, anywhere, anytime using an internet-enabled device. WSI neither requires the presence of the conventional OM for learning histology slides, nor students need to physically present in a laboratory.[6–8] The CLM requires changing objectives and even eyepieces to obtain a panoramic view or magnified view. The WSI viewers can see the image at the lowest possible magnification to the highest possible magnification by quickly navigating the slide over a computer screen or any internet-enabled handheld device. WSI allows for marking annotations on the screen by the teacher, and hence it becomes a lot easier for the students to identify the key features in a slide.[9–11] With the digitized images, there are no worries of slide break, loss, fading of stains, and storage space.

WSI has disadvantages too. The initial cost of procuring the scanning device with software is relatively expensive and requires a high-speed internet connection.[12,13] Another disadvantage is that students may not learn how to use a microscope with increased use of WSI. There is also fear of loss of personal connection between the teacher and the student.

Literature review suggests that the benefits of WSI overweigh the weakness and hence has been adopted by many medical institutions as a part of their curriculum.[14–16] Previous research also reports the effectiveness of WSI in improving the learning experience and also performance in the assessment of undergraduate and postgraduate students in medicine and also dentistry.[2,17,18]

Existing literature reports research involving pathology residents, second-year and third-year medical undergraduates. Data on perceptions of WSI in histology learning is scant. To make an informed decision in adopting WSI in the curriculum for the first-year medical students, it is critical to gather a full view of the implications of WSI in comparison to OM, for different levels of learners. The current research aims to assess first-year medical students' perceptions regarding the use of VM or WSI in histology teaching.

Subjects and Methods

Study design: This cross-sectional, questionnaire-based survey was approved by the institutional ethical committee.

Setting: This research was conducted in the department of anatomy of Adichunchanagiri Institute of Medical Sciences, a constituent college of Adichunchanagiri University, Karnataka.

Study participants: Participants were all 150 first-year medical students of Adichunchanagiri Institute of Medical Sciences. Prior to the beginning of the research, the students were ensured that their participation in study was entirely voluntary and non-participation had no impact on their formative or summative assessment.

Data collection: After obtaining the approval of the institutional ethical committee, the authors came to a consensus to choose nine hematoxylin and eosin-stained slides of the gastrointestinal tract for the study. The slides selected were esophagus, cardiac and pyloric part of stomach, duodenum, jejunum, ileum, vermiform, and appendix and colon. Each of the demonstration sessions was planned for 30-45 minutes and was scheduled as follows; week 1-esophagus, week 2-cardiac and pyloric part of the stomach, week 3- duodenum jejunum and ileum, week 4- vermiform appendix and colon.

Before each demonstration session, the slides were scanned using the Morphle Whole Slide Scanner [Figure 1] and were uploaded in the cloud space [https://cloud.morphlelabs.com/dashboard/] provided by the manufacturer [Figure 2]. The actual screen with various tools (including case info, slide info, zoom button, preview, annotation tools, grid view, settings, screen shot and screen share) and magnification adjustment is shown in [Figure 3]. The uploaded slides were used for demonstration by the primary author using an iPad connected to a high-definition projector through an apple TV. The purpose of using the iPad was the portability of the device that would allow the author to magnify the image using the touch screen feature while moving around the demonstration room. Even a normal laptop or a desktop connected to a high-definition projector is good enough to run the demonstration just with click of a mouse. The slides were magnified from the lowest possible magnification of 0.7x to 80x [Figure 4] with a simple touch and enabling all 50 students to get the feel of observing the slide under the CLM with shifting of the objective.

Figure 1: Morphle whole slide scanner

At the end of the 4^{th} week of demonstration, a questionnaire was administered to gather perceptions of the students regarding the use of VM as a tool to learn histology slides. The questionnaire had 10 items with a 5 point Likert scale 1 of 5 (5 = strongly agree, 4 = agree, 3 = not sure, 2 = disagree, and 1 = strongly disagree) and two open-ended questions.

Statistical analysis: The data collected were entered in a Microsoft Excel sheet for windows 10 and was summarised using descriptive statistics.

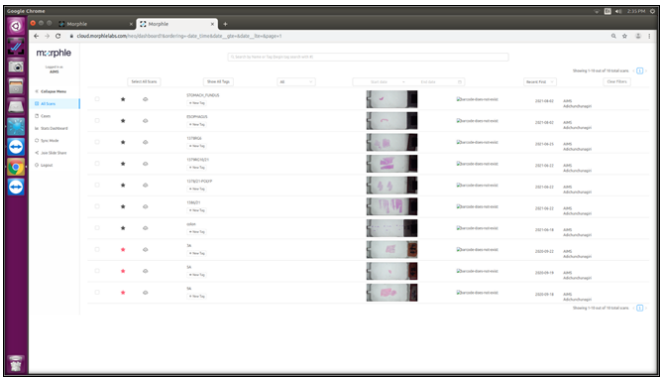

Figure 2: Morphle cloud access url and dashboard.

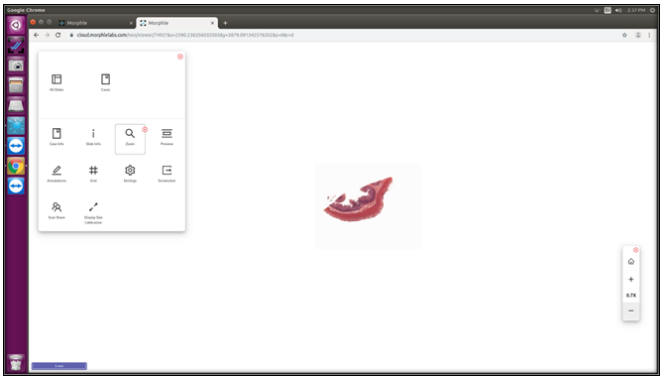

Figure 3: Scanned image with author tools.

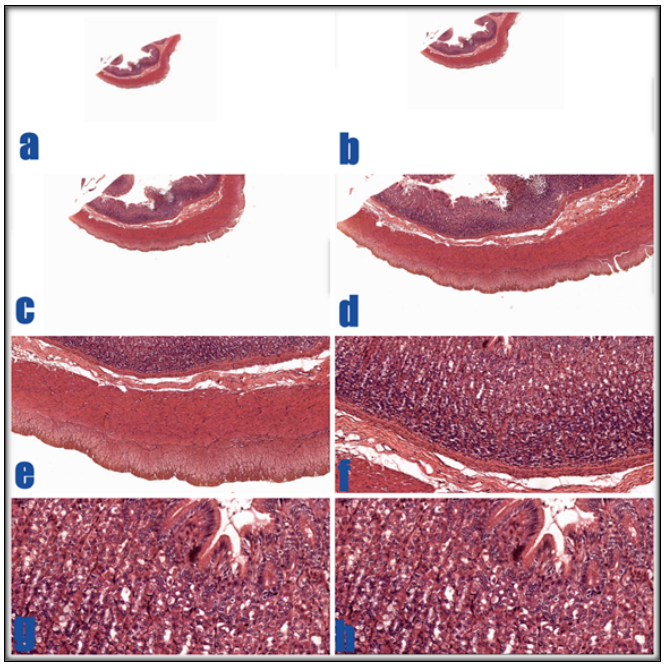

Figure 4: Scanned image of heamatoxylin and eosin stained slide of stomach at various magniifcation. a. 1.3x b. 2.5x c.5x d.10x e.20x f.40x, g and h. 80x.

Results

A total of 118 students (out of 150) responded to the questionnaire (response rate of 78.67%). This included 51.7% (n=61) female students and 41.3% (n=57) male students. None of these 118 students had a prior experience of VM or WSI, but all of them had CLM experience for examination of histological slides. The data shown in table.1 are presented as the percentage of responses of the participants to a specific statement.

Not all students responded to the open-ended questions. In the first open-ended question, the students were asked, what were the significant advantages of the WSI over CLM? Their responses were narrowed down into five broad themes as follows,

- WSI is a lot easier to use than the CLM
- The ease of change of magnification in WSI is a lot easier than CLM
- The quality of images in WSI looked a lot better than in a CLM
- The annotations in WSI helped us appreciate the structure or details the teacher wanted us to see.
- Better suited to avoid crowding around a CLM where a teacher is demonstrating the slide to multiple students and hence could be a valuable tool in the time of the pandemic.

In the second open-ended question, the students pointed out some of the peculiar disadvantages or concerns regarding WSI use. These responses were again narrowed down into the following themes,

- WSI deprives us (students) of the practice of actual use of CLM
- What if we are trained using WSI and in exams given CLM for examination of slides?
- We may lose the opportunity of exploring the slide if only the instructor is using WSI for demonstration
- We are not sure about the data consumption by the cloud/internet-based software that is used for WSI.

Discussion

The traditional use of CLM in histology and histopathology has been recently challenged by the increasing use of VM/WSI. Some authors describe this as the third revolution

Table 1: Percentage of responses of study participants to survey questions

Survey question	Strongly agree	Agree	Can't say	Disagree	Strongly dis-agree	Total
Scanning the whole slide is easy using the WSI	43.6%	48.2%	8.2%	0%	0%	100 %
Changing the magnification is easy using the WSI	44.7%	51.8%	3.5%	0%	0%	100 %
The quality of images using the WSI in low magnification was superior to CLM	75.3%	22.4%	2.4%	0%	0%	100 %
The quality of images using the WSI in high magnification was superior to CLM	80%	16.5%	1.2%	2.4%	0%	100%
Appreciation of features of cellular details in WSI was superior to CLM	83.5%	15.3%	1.2%	0%	0%	100 %
The markings and annotations used during demonstrations were allowed better learning	63.5%	19.5%	10.2	7.8%	0%	100%
The concept of using whole slide imaging (WSI) is the way forward in histology teaching	57.6%	38.8%	2.4%	1.2%	0%	100%
I would prefer learning histology using only WSI compared to learning histology using the CLM	18.8%	36.5%	18.8%	3.5%	18.8%	100%

in pathology after immunohistochemistry and mutational assays.[17,19] With this context, the current study was to planned assess the perceptions of the first-year medical students regarding the use of VM/WSI for histology learning. Our study shows that WSI/VM is a useful tool in histology training but needs to be used as an adjunct to CLM but not as supplant.

Our histology laboratory's traditional practice was that the students would take the slides from the department collection and observe them using a CLM. They would be guided by a tutor/ demonstrator/ teacher using a slide that would be used for exam purposes only or demonstration purposes only but rarely given to students because of the fear of breakage and loss due to improper handling. A single teacher would demonstrate to tens of students using a single slide and a single microscope, which would take a lot of time for each student to see the details demonstrated by the teacher. Even though time-consuming, this was one of the popular methods followed by us. But the COVID-19 pandemic changed the way of practical and skill training. This challenge led us to explore the utility of WSI in histology practical training.

With WSI, a single teacher demonstrated the features of a particular slide to a batch of 50 or 100 or any number of students with ease in both online and offline mode. The ease of use, change of magnification, appreciation of cellular details was much better to CLM as perceived by the students. The responses were the same as reported by some of the authors.[2,17,20]

As perceived by students, one more advantage of WSI was that the students themselves could magnify the image and appreciate the details starting from the lowest possible to the highest possible magnification offered by the device (in our device, the lowest possible magnification as 2x and the maximum magnification was 80x). Many students often perceived this navigation as a troublesome experience.

With WSI, the students' appreciation of cellular details in higher magnification was perceived as superior to traditional CLM. Marking and annotations used during WSI demonstration was feature that the students well appreciated.

WSI also allowed us to store the images (in the cloud/ a storage device/ a computer or a laptop) lot more easily than glass slides

and alleviated the fear wear and tear and fading associated with repeated use of the glass slides. The images could be easily accessed by the teaching faculty and the students and hence providing access to these images beyond the closure of the histology laboratory. Reports of earlier research reinforce these findings.[3,21]

Despite the advantages mentioned above, the student surprisingly still perceived that WSI alone may not serve as a learning tool in histology. Their main concern was that they would be deprived of the skills of using a CLM and the art of focussing slides under different magnification. Students also felt that with WSI, self-directed learning might also get affected.

Apart from the concerns raised by the students, one more disadvantage of WSI is the initial cost of procuring a scanner device and the software. WSI requires an active, high-speed internet connection, mainly when a cloud-based storage device is used for demonstration. Some researchers have also reported that the quality of the images in WSI may not be suitable for learning compared to CLM.[22] But in our study, the students strongly felt that the quality of images was much more superior in WSI than CLM.

Previous research points towards the utility of the WSI as a useful tool in histology learning. Alotaibi et al. in 2015 suggested that VM/WSI can be a useful substitute to CLM.[2] Laohawetwanit T in 2017 highlighted the importance of the potential role of VM/WSI in undergraduate teaching.[17] McBride and Drake in 2018 reported that, in the US the use of virtual microscopy in histology teaching has increased by 129% from 2014 to 2017.[23] The use of WSI/VM for histology training in India is yet to take off and this research further reiterates the need for further research in this field.

One limitation of the current study was that only the perception of the students was assessed. Since this was more of study of perceptions of the students after the first experience of WSI/VM, the performance of the students after the use of WSI was not done and hence utility of WSI/VM was not assessed. The teachers' perceptions regarding the use of WSI was also not assessed. We intend to further our research by assessing the performance of the students after use of WSI.

Conclusion

The results of our study show that VM/WSI is perceived by the first-year medical students as a promising tool for histology learning but needs to be judiciously used, tested and validated before it replaces and if it replaces the CLM in the future.

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