IMPLEMENTATION OF VIRTUAL MICROSCOPY IN MEDICAL UNDERGRADUATE TEACHING OF PATHOLOGY; FIRST EXPERIENCE OF LIBYA IN MISURATA UNIVERSITY

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ABSTRACT

Pathology education includes an important visual part supporting a wide range of theoretical knowledge. However, the use of traditional microscopes in pathology education has declined over the last decade and there is a lack of interest for microscopy. Virtual microscopy, which was first described in 1985 and has experienced a revolution since 2000, is an alternative technique to conventional microscopy, in which microscopic slides are scanned to form digital images and stored in the web. The aim of this study was to evaluate the use of virtual microscopy in practical pathology sessions and its effects on our students and undergraduate education at our faculty. Forty third year medical students who were used to conventional microscopes were included in the study. The practical sessions were carried out via virtual slides and the effect of the new technique was investigated by a scale at the end of the general pathology module. Academic staff from the pathology department joined sessions to promote discussion and respond to questions. Student ratings were analysed statistically. The evaluation of the ratings showed that the students were easily adapted to the use of virtual microscopy. They found it user-friendly and thought that the opportunity of viewing slides at home was advantageous. Collaboration between students and interactive discussions was also improved with this technique. It was concluded that the use of virtual microscopy could contribute to the pathology education of our students.

KEY WORDS: Virtual microscopy, Digital, Pathology, Microscope, Medical education.

INTRODUCTION

Pathology education, which is a highly visual subject, is partly based on histological examination of diseased tissues. This practical part is important because it helps students understand the basic concepts as well as the mechanisms of diseases. Analysing tissue and searching for clues of diagnosis improve the students' approach to the disease, simulating clinical examination of a patient[1]. Additionally, the students can imagine how the tissue is processed and what the daily work of a pathologist looks like[2,3]. The microscope has been the most widely used instrument in pathology education. However, some recent studies have demonstrated a decrease in the use of traditional microscopes in medical schools, mainly as a result of current developments in the curriculum as well as some disadvantages of the technique itself [4]. The quality of educational microscopes used in many faculties is often poor and the cost of the new technology microscopes is quite high. Thus, adapting the laboratory to evolving technology and increasing the number of medical school students is costly. Maintenance of an adequate slide collection is also difficult and creates a huge increase in laboratory work as hundreds of slides are selected, cut, stained and sorted. Moreover, the slides have to be changed regularly because of fading of the dye or slide damage. Variability between sections in the slide collection often cause confusion among students and affects the success of teaching process. In addition, a large reserve of tissue is needed while preparing a slide set for the whole class. Cytological samples, small biopsies and special areas in biopsies such as transition of dysplastic epithelium to invasive cancer are generally difficult to reproduce in large numbers of consecutive slides and therefore difficult to demonstrate to all students[3,4]. To standardize sections and the representative areas that the students are supposed to see is not possible with light microscopy sections. Finding sufficient laboratory time for slide review during a busy curriculum is also a problem. The use of the microscopes is often limited to the working hours of the faculty, requiring the students to be physically at school for self study[5]. Medical students frequently complain about difficulties in finding lesions while examining histologic slides by microscopes. These difficulties mainly originate from lack of orientation of the organ and the lesion that they need to learn. Since very low power magnification that makes an overview easier is not available in student microscopes, getting oriented to the whole slide is quite difficult. Thus, there is usually need for demonstration on a projection screen in a classroom setting. Even after demonstration, students may hardly correlate what they see on the microscope with the demonstrated lesion. Unfortunately, being unable to put annotations on each slide other than crude dotting, limits students' proper orientation to the lesion[6]. There has been a change towards using microphotographs in practical sessions because of the mentioned difficulties. However, this has not been a satisfactory solution especially for the orientation problem. Virtual microscopy or digital

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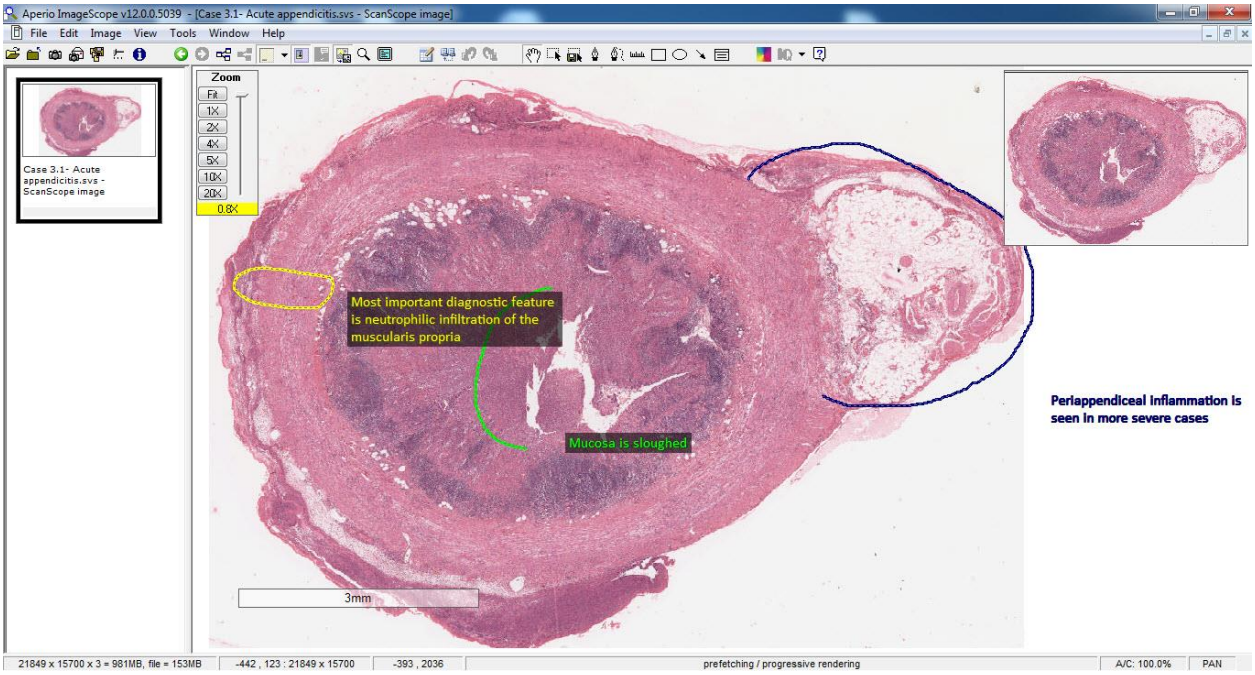
slide technology, which serves as a simulator of microscopy, provides an effective solution for this problem. The experience of the medical schools that partially or completely integrated the virtual microscope technology into their histology and pathology curricula has previously been reported[6-16]. Learning with this technique was accepted by students at a high rate in most of these studies[6-16]. Experience with the integration of this technology to active learning curricula is more limited[17]. Virtual microscopy has not only been reported to improve the student learning process, but it has also been shown in several studies to improve their collaboration skills, communication abilities and self-confidence[12]. Due to the mentioned reasons, we have decided that implementation of virtual microscopy is needed in our curriculum and have planned this study.

MATERIALS AND METHODS

This study was set up to assess the students attitude to implementation of virtual microscopy in pathology teaching. This project was carried out with undergraduate medical students who were in their third year of medical education at Faculty of Medicine at Misurata University. Forty third year students, who had already become adapted to individual single headed monocular microscopes (since they had practical histology sessions in their first and second years) participated in the study.

In the third year medical curriculum, pathology is taught as two main blocks; general and systemic pathology. General pathology block is taught over a period of eight weeks. Virtual microscopy was integrated in teaching of general pathology practical. The topics covered in this module include: Cell injury, Inflammation and repair, Hemodynamic disturbances, Neoplasia, and infectious diseases. Every week a new practical session was conducted. During each session, the tutor presents a powerpoint presentation supported by digital slide images, with average of 6 digital slides per session. The digital slides that were intended to be taught in these practical sessions were freely downloaded from the web. Digital slides of normal tissues were also downloaded in order to remind students of the normal histology of the related organ. Annotations including squares, arrows or shapes with numbers, pointing to the microscopic features, were placed on each tissue. The slides were viewed with ImageScope software downloaded for free from the web. The students were given information about the virtual microscopy technique and how they would use the ImageScope program at the first practical class.

All students had free access to the digital slides (Figure 1). In the class, the digital slides were operated offline by the tutor using the lab computer and projected over a large screen to be viewed by all students. At the end of each session, the digital slide set were distributed to all students as an electronic format stored on their own external hard drives to be viewed at home.



(Figure 1) A virtual slide of acute appendicitis, with annotations.

A tutor guide was prepared and given to all students before the practical session, describing how to view the digital slides and how to interpret the sections. Scientific knowledge about the disease, description of annotations, and the learning objectives were also included in these guides. At the end of the general

pathology module; Scales with 10 questions were distributed to students to evaluate their satisfaction with virtual microscopy. The scale included ratings of the virtual slide sessions, from 1 to 5 (5: Strongly agree, 4: agree, 3: have no idea, 2: disagree, 1: strongly disagree). In the scale used in this study, some questions allowed the students to make comparisons between traditional microscopes and virtual slides, as they had experience previously on how to use traditional microscopes in their histology sessions. Unfortunately, both techniques could not be used at the same time for the purpose of comparison because of the laboratory conditions and timing issues. A total of 40 students responded to the survey (out of 100 third year students who were called to participate in this study). The student ratings were analysed statistically by SPSS version 22. The scale used in this study is given in (table 1).

(Table 1) Scale used to evaluate the students' satisfaction. (5: Strongly agree, 4: agree, 3: have no idea, 2: disagree, 1: strongly disagree)

Digital microscopy is more practical and easier to use than conventional microscopy
The Imagescope software used in viewing digital slides is user-friendly.
Digital microscopy is less time consuming than conventional microscopy
The image quality is better than conventional microscopy
I can discuss the microscopic findings with my friends and ask my questions to the tutors easier when compared with conventional microscopy.
I find it advantageous to be able to look at the digital slides at home as well
Digital microscopy can replace conventional microscopy in pathology education
Digital microscopy should be used in combination with conventional microscopy in pathology education
We should only use conventional microscopy in pathology education, and Digital microscopy should NOT be used.
It is fun to use Digital microscopy in pathology education.
Please write any additional feedback related to the contribution of Digital microscopy to pathology Education

RESULTS

The results of the students ratings are given in (table 2). The reliability analysis of the scale used in this study showed that the mean Cronbach Alpha value was 0.97.

(Table 2) Student ratings as percentage. (5: Strongly agree, 4: agree, 3: have no idea, 2: disagree, 1: strongly disagree)

Questions	Student ratings as percentage (Total: 40 students)				
	5	4	3	2	1
practical and easier to use	37	54	2	5	0
The Imagescope software is user-friendly	20	50	5	17	7
less time consuming	37	37	5	15	5
The image quality is better	62	32	2	2	0
Interactive discussion advantage	35	50	7	7	0
Accessibility at home	48	43	0	5	2
Can replace microscope	30	37	17	10	5
should be used in combination	15	28	17	20	17
Digital microscopy should not be used.	5	7	5	41	41
It's fun	40	47	7	2	2

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.974	.979	10

The students were well adapted to the virtual microscopy technique. They found it user-friendly, practical, easier to use and also found the opportunity to view slides at home advantageous. They appreciated the image quality. Most of them agreed that virtual slides could replace or be used in combination with traditional microscopes. They liked viewing slides in collaboration with their friends and this improved their understanding of the histopathology. Being able to view the normal histologic slides as well as the pathologic samples for comparison also contributed to their learning. Most of them believed that this technique added more fun to the study of pathology.

DISCUSSION

Advances in virtual microscopy and web-based technologies have revolutionized the e-learning of several biomedical disciplines, including pathology, overcoming barriers of space, equipment and time. Web-based educational systems based on digital imaging and virtual microscopy could effectively augment traditional light microscopy in teaching and learning of human pathology. First strides of this approach began with the introduction of a method for panning and zooming of digital images with the aid of a microscope equipped with a precision scanning stage[11]. This was followed by the design of virtual microscopes that combine computer hardware and a software system as an emulation of a real microscope[12]. The integration of web-based digital technologies with conventional microscopy has then boosted the introduction of virtual microscopy to view high-resolution digitized 'virtual' slides online[13]. The four functions of a light microscope, that is displaying, panning, zooming and focusing, are simulated in a virtual or digital microscope, in which real slides are substituted with 'virtual slides' over a computer network, which can be viewed offline from

electronic storage devices or online via the Internet[14]. This becomes feasible after the capacity to digitize virtual slides into images with high resolution, where thousands of images can be captured at high magnification from a single slide and then digitally stitched together to represent the whole glass-mounted slide.

The role of virtual microscopy in medical education and training is increasingly growing. This is attributed, in part, to the fact that it overcomes the difficulties encountered with the use of conventional microscopy, including the increasing numbers of students in laboratory sessions, difficulty in maintaining and archiving slides and increased cost of microscope maintenance[15]. Ease of access and simultaneous viewing, annotating and universal sharing of digital slides via web-accessible interfaces enhance their utility as interactive educational tools even from remote locations[16], broadening the scope of use of virtual microscopy in biomedical research and education. Virtual slides provide a better platform for interactive instruction and independent self-study than still computerized images by allowing the change of magnification properties[17].Virtual microscopy promotes teamwork collaboration, skills transfer to students and problem solving, which are required in biomedical education[18,19]. Computer screen allows student collaboration and group discussions, and these have been confirmed by our own students as well.

CONCLUSION

The improvement of learning while practicing specific skills by the use of simulation-based tools such as phlebotomy or resuscitation models is the main purpose in medical education. Similar to these simulation-based techniques used in medical education, virtual slides have already taken their place within the learning process in pathology. For the first time in Libya, we experienced an improvement in pathology education in our institution with this technique.

Therefore, we think that this technology is applicable to medical school curricula, which will otherwise turn out to be completely theoretical and devoid of visuality while teaching basic aspects of medicine.

CONFLICT OF INTEREST

The authors declare no conflict of interests.

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REFERENCES

1- Braun MW, Kearns KD. Improved learning efficiency and increased student collaboration through use of virtual microscopy in the teaching of human pathology. Anat Sci Educ. 2008;1:240-6.

2- Coleman R. Can histology and pathology be taught without microscopes? The advantages and disadvantages of virtual histology. Acta Histochemica. 2009;111:1-4.

3- Merk M, Knuechel R, Perez-Bouza A. Web-based virtual microscopy at the RWTH Aachen University: Didactic concept, methods and analysis of acceptance by the students. Ann Anat. 2010;192:383-7.

4- Dee FR. Virtual microscopy in pathology education. Hum Pathol. 2009;40:1112-21.

5- Foster K. Medical education in the digital age: Digital whole slide imaging as a learning tool. J Pathol Inform. 2010;1. pii: 14.

6- Kumar KR, Velan GM, Korell SO, Kandara M, Dee FR, Wake D. Virtual microscopy for learning and assessment in pathology. J Pathol. 2004;204:613-8.

7- Heidger PM, Dee FR, Consoer D, Leaven T, Duncan J, Kreiter C. Integrated approach to teaching and testing in histology with real and virtual imaging. Anat Rec. 2002;269:107-12.

8- Blake C, Lavoie HA, Millette CF. Teaching medical histology at the University of South Carolina School of Medicine: Transition to virtual slides and virtual microscopes. Anat Rec B New Anat. 2003;275:196-206.

9- Krippendorf BB, Lough J. Complete and rapid switch from light microscopy to virtual microscopy for teaching medical histology. Anat Rec B New Anat. 2005;285:19-25.

10- Kim MH, Park Y, Seo D, Lim YJ, Kim D, Kim CW, Kim WH. Virtual microscopy as a practical alternative to conventional microscopy in pathology education. Basic Appl Pathol. 2008;1: 46-8.

11- Silage DA & Gil J Digital image tiles: a method for the processing of large sections. Journal of Microscopy, 1985; 138, 221–227.

12- Ferreira R, Moon B, Humphries J et al. The virtual microscope. Proceedings of the American Medical Informatics Association Annual Fall Symposium, 1997; 44, 9–443.

13- Mikula S, Trotts I, Stone J & Jones E Internet-enabled high-resolution brain mapping and virtual microscopy. Neuro-Image, 2007; 35, 9–15.

14- Lee S-H Virtual microscopy: applications to hematology education and training. Hematology, 2005; 1, 151–153.

15- Felten CL, Strauss JS, Okada DH & Marchevsky AM Virtual microscopy: high resolution digital photomicrography as a tool for light microscopy simulation. Human Pathology, 1999; 30, 477–783.

16- Harris T, Leaven T, Heidger P, Kreiter C, Duncan J & Dick F Comparison of a virtual microscope laboratory to a regular microscope laboratory for teaching histology. The Anatomical Record, 2001; 265, 10–14.

17- Alcala-Canto Y, Ibarra-Velarde F, Vera-Montenegro Y & Alberti-Navarro A Virtual microscopy for studying veterinary parasitology. Comparative Parasitology, 2012; 79, 138–142.

18- Lundin M, Lundin J, Helin H & Isola J A digital atlas of breast histopathology: an application of web based virtual microscopy. Journal of Clinical Pathology. 2004; 57, 1288–1291.

19- Burthem J, Brereton M, Ardern J et al. The use of digital 'virtual slides' in the quality assessment of haematological morphology: results of a pilot exercise involving UK NEQAS (H) participants. British Journal of Haematology, 2005; 130, 293– 296.