

Use of Digital Microscopy as Compared to Conventional Microscopy for Undergraduate Oral Pathology Training

Lisans Düzeyinde Oral Patoloji Eğitiminde Dijital Mikroskobinin Konvansiyonel Mikroskope Karşılaştırılması

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ABSTRACT

Objective: Conventional light microscopy (CLM) is the foundation for histology and pathology. Various medical organizations in different countries have begun to adapt Digital Microscopy (DM) into their general pathology program. However, there is a dearth of literature describing the viewpoint of dental students in India regarding implementation of Digital microscopy in teaching oral pathology. The study aimed to assess the ease, acceptance, benefits and disadvantages of digital V/s conventional microscopy via questionnaire and to assess the performance of students after digital microscopy intervention as compared to conventional microscopy for undergraduate oral pathology training.

Methods: The study included 48 Students currently in the 3rd year B.D.S training in subject of Oral pathology. The students were trained using CLM as a routine. Further they were also trained with DM by using digital slides prepared using whole slide scanners and made available for access through a cloud-based software. A questionnaire of 26 items was given to gauge student opinions regarding use of DM in comparison to CLM. Assessment in the form of spotter examination was conducted to evaluate the performance of the students.

Results: There were significantly higher ratings given to efficiency of digital microscopy as compared to CLM as per our questionnaire and the students obtained substantially higher scores with digital microscopy teaching.

Conclusion: In conclusion, digital microscopy is a highly favoured replacement /adjunct for CLM for dentistry students for oral pathology practical training.

Keywords: Digital Microscopy, whole slide scanners, digital slides, oral pathology training, undergraduate program

ÖZ

Amaç: Konvansiyonel ışık mikroskobisi (KIM) histoloji ve patolojinin temelidir. Farklı ülkelerdeki çeşitli tıbbi kuruluşlar, Dijital Mikroskobiyi (DM) genel patoloji programlarına uyarlamaya başladılar ancak Hindistan'daki diş hekimliği öğrencilerinin oral patoloji öğretiminde DM'nin uygulanmasına ilişkin bakış açısını açıklayan literatürde eksiklikler vardır. Çalışmanın amacı, anket yoluyla DM'nin KIM'a kıyasla kolaylığını, kabul edilebilirliğini, faydalarını ve dezavantajlarını değerlendirmeyi ve lisans düzeyinde oral patoloji eğitimi için DM müdahalesinden sonra öğrencilerin performansını KIM'a kıyasla değerlendirmeyi amaçlamaktadır.

Yöntem: Çalışmada, Oral Patoloji konusundaki 3. yıl B.D.S eğitiminde bulunan 48 öğrenci yer aldı. Öğrenciler rutin olarak KIM kullanma eğitimi aldılar. Ayrıca, tüm slayt tarayıcıları kullanılarak hazırlanan ve bulut tabanlı bir yazılım aracılığıyla erişilebilir hale getirilmiş dijital slaytlar kullanarak DM ile de eğitildiler. Öğrencilerin KIM ile karşılaştırıldığında DM kullanımına ilişkin görüşlerini ölçmek için 26 adet anket verildi. Öğrencilerin performansını değerlendirmek için spotter sınavı şeklinde değerlendirme yapıldı.

Bulgular: Anketimize göre DM'nin verimliliği KIM ile karşılaştırıldığında önemli ölçüde daha yüksek puanlar aldı ve öğrenciler DM öğretiminde çok daha yüksek puanı elde ettiler.

Sonuç: Sonuç olarak, diş hekimliği öğrencileri için DM oral patoloji pratik eğitiminde KIM'ın tercih edilen bir alternatifi olabilir.

Anahtar Kelimeler: Dijital Mikroskopi, tüm slayt tarayıcıları, Dijital slaytlar, Ağız Patolojisi Eğitimi, Lisans programı

INTRODUCTION

Nearly 200 years ago, Conventional light microscopy (CLM) was developed as a diagnostic and educational apparatus, and later has served as the foundation for histology and pathology teaching. Oral pathology classes often involve in-person teaching as well as the light microscopic study of tissue sections on glass slides. Nevertheless, it has several limitations which include, lack of possibility for numerous pupils to see the slides in tandem and use of many microscopes is expensive and need constant upkeep. Furthermore, glass slides must be produced and stored, which have a considerable financial impact as after a certain amount of time, the stained tissue sections on the glass slides may begin to fade in colour, thus making the identification challenging and it is also necessary to displace the outdated and deteriorating glass slides.¹

Recently, a variety of technological advances have been applied to improve students' learning experiences with histology slides. These methods include use of digital photos and online animations and whole slide imaging or virtual microscopy.^{2,3}

Virtual microscopy also referred to as digital microscopy, has greatly expanded the field of pathological teaching and training. Histology and pathology courses are currently using digital microscopy more frequently, and it may eventually substitute for or possibly replace current classic glass slides for their learning needs. Besides its academic purposes in medical and dental institutes, the digital microscope with digitised slides has been employed in many training programmes as well as clinically in daily utilization for disease diagnosis in pathological labs.^{2,3}

Digital microscopy is based on a technique called Whole slide imaging (WSI). This technology is composed of Robotic microscopes with whole-slide image (WSI) scanners which digitally capture the complete glass slide, and thus generates the digital image of the slide. With today's scanners, you can scan the entire slide or only a specific area of the tissue depending on your needs.^{4,4} A specific software enables online viewing of digital slides from computer of mobile devices by zooming in at various magnifications. Additionally, comprehensive perspective of the cases can be got using a variety of tools for measurements including annotations on the images. They can also provide supplementary patient details.^{1,5}

WSI is a very helpful teaching tool, it enables the viewing of the histology slides on a computer screen and addresses several CLM issues. As a supplement to or a replacement for CLM, this technology is quickly becoming more popular as a teaching tool.¹

Therefore, various medical organizations have begun to integrate Digital Microscopy (DM) into their syllabus. In a few papers, people have discussed their experience with implementing digital microscopy in dental education.^{6,7} However, there are no detailed comparisons between DM and CLM concerning dental student preferences. Additionally, there is no literature describing the perspectives of dental students in India regarding implementation of Digital microscopy in educating oral pathology. Thus, the present study aimed to assess the use of digital microscopy as compared to conventional light microscopy for undergraduate oral pathology training.

METHODS

The present study was carried out at KLE institute of Dental sciences, Belagavi, India. After obtaining study approval from the Institutional ethical committee, informed consent was taken from each participant. All undergraduate students (48 students) currently in their 3rd year of Bachelor of Dental Surgery training in the subject of Oral pathology were enrolled in the study.

Digital Slides were created through WSI (Company-Optimus6x, Software- Morphle) which is an Artificial Intelligence- enabled robotic Plug and Play whole slide scanner (<https://www.morphlelabs.com>). The digital slides were scanned at 40x objective and uploaded on the centralized server through software Morphle. The slides created were for the chapter of Odontogenic tumours which is the part of the Oral Pathology Curriculum. All the students were able to view the digital slides independently using the Morphle software interface by applying the username and password provided to them. The slides could be opened and zoomed at varying magnifications without need of changing the objective. The area of interest can be clicked and then it can go be zoomed from 0.25X up to 40x (Figure 1).

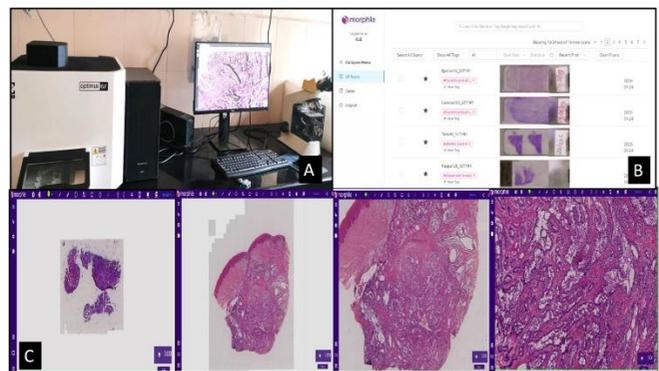


Figure 1. A: Virtual Slides were created through AI enabled Whole slide imaging scanner (Company- Software- Morphle) Optimus6x. B: All the students were able to view the digital slides independently using the morphle software by applying the username and password provided to them. C: The slides could be opened and zoomed at varying magnifications from 0.25X upto 40X

The slides of odontogenic tumors were first taught using the conventional microscopy and subsequently, the same slides were also explained using the digital microscopy (Figure 2). The students were instructed via projector by Professor in Oral Pathology (PVA) regarding use of digital slides that were accessible from the cloud via their computers as well as their smartphones. Assessment in the form of spotter examination was conducted to evaluate the performance of the students after conventional teaching session and subsequently after intervention with digital microscopy. The questionnaire was then handed out among the students at the end of teaching course for evaluating the perspectives related to digital microscopy V/s Conventional light Microscopy. The Questionnaire included twenty-four questions with regards to instructions, operation method, navigation, clarity and ease in identification, stimulation of interest in learning, discussion and cooperative learning, slide revision, access of slides outside the class time and preference for the teaching modality among both the microscopy methods. Additionally, there were two questions that were open ended to know the student's insight about both digital and conventional microscopy. The responses were assessed on five (5)-point Likert scale, wherein Point 1 signified "Strongly disagree" and Point 5 signified "Strongly agree".



Figure 2. A & B : Orientation of students for viewing slides using the conventional microscopy C and D: Orientation of the same slides using the digital microscopy.

Statistical analysis

Evaluation of the responses of the questionnaire was done by frequency, percentage and Descriptive statistics and comparison of performance of the students in the assessment was done using independent t test. If the P-value was less than 0.05, the outcome was deemed significant.

RESULTS

Digital slides for the chapter Odontogenic tumors were created.

We evaluated the students' mean acceptability of the digital microscopy by comparing them to those of the conventional microscopy. Our classroom observations show that, on the whole, students responded positively and were very accepting of the digital microscopy instruction using digital slides.

The questionnaire survey's findings are displayed in Table 1.

Table 1. Student scores for the questions regarding conventional light microscopy and. digital microscopy.

Questions	Conventional Light microscopy			Digital microscopy		
	Mean	Mode	S. D	Mean	Mode	S. D
The instructions to use microscopy were clear to me	4.3	4.0	0.8	4.6	5.0	0.5
The operation method and navigation are user friendly and convenient	3.7	4.0	0.8	4.6	5.0	0.6
The teaching method using is fun and stimulated my interest in learning oral pathology	3.4	4.0	1.0	4.5	5.0	0.6
The magnification of the histopathological image allowed me to examine the tissues in detail	3.1	3.0	1.1	4.5	4.5	0.6
Allows for easier identification of the pathology	3.0	3.0	1.1	4.4	5.0	0.8
Allows for cooperation and discussion with classmates	2.6	2.0	1.3	4.5	5.0	0.6
Allows for cooperation and discussion with classmates	2.6	2.0	1.3	4.5	5.0	0.6
Allows asking questions about the microscopic findings and discuss with the tutor	3.3	4.0	1.2	4.4	4.5	0.6
Allowed simultaneous viewing by multiple students	2.4	2.0	1.4	4.3	5.0	1.1
Slide revision and access to the slides outside the scheduled class time.	2.4	2.0	1.3	4.5	5.0	0.9
Technical Issue while using the microscopy	2.8	3.0	1.3	3.9	4.0	1.1

When we compare the mean of responses for questionnaires, it was found that most of the students favored the digital microscopy because the mean scores were higher in digital microscopy as compared to conventional microscopy.

Almost 90% of the students agreed that the instructions to use digital microscopy was clear to them. 64.58% students strongly agreed and 31.25% students agreed that operation method and navigation of digital microscopy is user friendly and convenient while only 14.58% strongly agreed that conventional microscopy is user friendly. There were 56.25% students strongly agreed and 39.58% agreed that teaching method using digital microscopy is fun and stimulated their interest in learning oral pathology. Almost 97.92% students felt that the magnification in DM allowed them to examine the tissues in detail while around only 40% were comfortable regarding this aspect using CLM. Among students 54.17% strongly agreed and 35.42% agreed that Digital microscopy is easier for identification of the pathology (Figure 3).

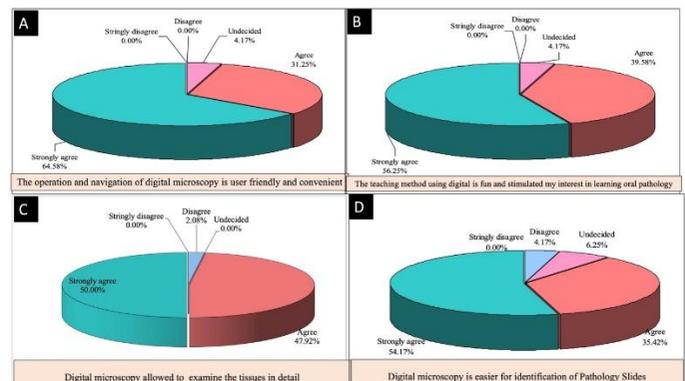


Figure 3. Pie charts showing the responses of the regarding digital microscopy A: Operation and Navigation B: Teaching method is fun and stimulated learning C: Allowed examination of tissues in detail D: Easier identification of slides.

54.17% students strongly agreed and 41.67% student agreed that Use of digital microscopy allows cooperation and discussion with classmates and 66.67% students strongly agreed and 22.92% of students agreed that use of digital microscopy allowed Slide revision and access to the digital slides outside the designated class period.

Further 54.17% of students strongly agreed and 35.42% students agreed that use of Digital microscopy allowed simultaneous viewing by multiple students. And again 50 % of students strongly agreed and 29.17% of students agreed with the statement that they did not face any technical issue while using a digital microscopy.

When asked regarding the preference of teaching modality, around 85% of students felt that combination of conventional light microscopy and Digital Microscopy should be used in teaching oral pathology and 68% of students felt that conventional light microscopy can be replaced by digital microscopy in teaching oral pathology. Almost 80% said that they preferred of digital microscopy over light microscopy for learning oral pathology.

To the open ended questions, the frequent answers received included from the students were that they prefer digital microscopy, it enabled "understanding clearly each cells", "it is accessible, can be magnified to more extent and can be repeatedly studied", "we can zoom in and out the slides without any difficulties and come prepared for

exams better”, “same slide can be viewed simultaneously by multiple people and get more time to observe and discuss”, “ more clarity in magnification, easy to discuss and view” and finally “ more understanding and more convenience source of education”

These findings were evident by the spotter assessment (out of 10 marks) that was taken, the result of which are Table 2. The mean test scores were higher for digital microscopy and also students obtained significantly higher scores after digital microscopy method of teaching as compared to conventional microscopy method of teaching.

Table 2. Comparison of Conventional microscopy and Digital microscopy with mean marks scores by independent t test

Methods	Mean	SD	SE	95% CI for mean		t-value	P-value
				Lower	Upper		
Conventional light microscopy	3.98	1.58	0.23	3.52	4.44	6.9215	.0001*
Digital microscopy	6.51	1.98	0.29	5.94	7.08		

* $p < 0.05$

DISCUSSION

In this study, during the Covid-19 pandemic period; parents' This is the first research to assess the efficiency of digital pathology slides (WSI)/digital microscopy in teaching oral pathology to undergraduate dental students from the Indian population.

The benefit of WSI is that it enables any computer to function as microscope, which minimises or eliminates the requirement for traditional microscopes. Students are more comfortable using WSI since the current generation is computer savvy. WSI also has the benefit of always having the slides in focus.^{1,8,9,6,7,10,12} Hence, the pupils acquire accustomed to the device very fast and can focus better on the histological characteristics of the slides without having to get to know the microscope or adjust the settings. It may be used in any classroom, because all that is needed for WSI is a personal computer (PC) with connection to the Internet.^{1,12} Furthermore, WSI enables usage on any device, both within and beyond the institution's walls. This implies that students can access the histology slides and analyse them wherever they are and whenever they choose, which will help them with their studies and remove the access constraints.^{1,9,12,13,14,15}

Digital microscopy is selected by our students as a tool to enhance learning, according to the authentic evaluation conducted in this study. The pupils' ratings of the digital microscopy vs conventional light microscopy elements were much higher, which is consistent with other research by Felipe-paiva Fonseca et al in Brazilian students.⁷

Safina Ahmed et al, reported that digital microscopy can produce microscopic practical knowledge that are on level with or superior than those produced by CLM.¹⁶ It was consistent according to our survey, the effectiveness of digital microscopy received significantly higher evaluations. Students who received instruction in digital microscopy scored significantly higher.

Kumar et al. reported that both students and teachers become accustomed to using Digital microscopy. The authors discovered that digital slides provided good to exceptional image quality while resolving a number of issues with student learning.¹⁷

Ohoud Alotaibi et al.2016 reported that educational experiences of students are improved by the use of digital microscopy as a teaching apparatus.¹⁸ Study conducted by Krippendorf BB et al, 2005 revealed that students' achievement and educational efficiency were improved when light microscopy was quickly and completely replaced by digital

microscopy in medical histology.¹⁹ In this study also students performed well after digital method of teaching

In the current study also, students accepted and appreciated the digital microscopy because of many reasons, instructions and navigation method of digital microscopy was clear to them because due to their earlier computer experience, students have greater comfort at using WSI. In contrast to CLM's fixed focus, the pupils can examine the complete slide in a digital slide at varied magnifications (from 1x to 40X) and thus this helps the students in easy identification which helps them to perform better in exams. They accepted with statement that digital microscopy stimulating their interest in learning oral pathology because specific notations and markings can be made on certain fields, allowing for easy doubt clearing and specific enquiries to the teacher. Digital microscopy improved their discussion and cooperative learning because in front of a computer screen, it can be used by an infinite number of people at once and seeing the same subject being addressed helps teachers and students interact more effectively. Students strongly agreed that digital microscopy helps them in slide revision and access of slide outside the scheduled class time because it is accessible whenever and wherever, it enables several revisions of the slides well before exam.

The superiority of using digital microscopy over CLM was evident by the significantly higher mean score evident in test after DM instruction. Thus, in this study we found that the digital microscopy was considered a better option than the CLM for teaching because students felt that light microscopy is an outdated and laborious technique, courses must take place on the college's premises, there is hardly any interaction, all fields are challenging to navigate below a light microscope and markers have a hard time highlighting the subject matter of interest.

Most of the students believe that combination of conventional light microscopy and Digital Microscopy should be used in teaching oral pathology because it enables collaborative learning and simple synthesis of theoretical understanding with practical expertise.

Digital microscopy offers numerous unparalleled opportunities for updating pathology instruction, yet higher expense required for buying a slide scanner limits its wide spread use. upkeep of laboratories with many microscopes.^{1,7} However, the adoption of this new technology may overcome the many issues like storage expenses, picture calibre, navigation of slides, opens up remote access.¹⁶ Thus, the advantages of digital microscope out way the disadvantages.

CONCLUSION

In conclusion, digital microscopy is a highly favoured replacement for CLM for educating dentistry students about oral histology and pathology. Digital Microscopy is an effective teaching tool that should be recommended in the teaching of oral pathology to dentistry students in their undergraduate years. This methodology can be incorporated in the undergraduate curriculum. In future, it can be implemented in post graduate teaching also.

Ethics Committee Approval: The study has been approved by the Institutional Ethical Committee, KLE VK Institute of Dental Sciences, Belagavi with the Date: Date: 11/2/2023 and Number 1452.

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