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Comparison of light microscopy and digital microscopy for learning oral pathology practicals among second year dental students

Sofia Ali Syed [a*], Syeda Sadia Zafar [a], Faryal Ali Syed [b], Asifa Iqbal [c], Saira Atif [d]

[a] Department of Oral Pathology, Dr. Ishrat-ul-Ebad Khan Institute of Oral Health Sciences, Dow University of Health Sciences, Karachi, Pakistan
[b] Department of Orthodontics, Baqai Dental College, Baqai Medical University, Karachi, Pakistan
[c] Department of Oral Pathology, Avicenna Dental College, University of Health Sciences, Lahore, Pakistan
[d] Department of Oral Biology, Combined Military Hospital Lahore Medical College & Institute of Dentistry, National University of Medical Sciences, Lahore, Pakistan

Abstract *Background/purpose:* Previous studies have shown that digital microscopy is an indispensable tool for teaching oral pathology laboratory course. Despite this, our institute relies solely on recommended/reference book images for oral pathology practicals, neglecting both light and digital microscopy methods. Gathering students' feedback on these methods is essential before considering digital microscopy as part of the oral pathology curriculum. Therefore, this study aimed to compare the usefulness of light and digital microscopy among second-year dental students.

Materials and methods: The study was conducted from December 6 to December 7, 2023, in the Department of Oral Pathology, Dr. Ishrat-ul-Ibad Khan Institute of Oral Health Sciences, Dow University of Health Sciences. The study involved the selection of five cases from the oral pathology course, followed by feedback on students' diagnostic skills, learning impact and acceptance rate of light and digital microscopy using an online questionnaire. Mann—Whitney U test was used to compare students' responses and P-value < 0.05 was set as statistically significant.

Results: There was a statistically significant difference in diagnostic scores between light microscopy and digital microscopy ($P < 0.05$). Statistically significant differences favoring digital

* Corresponding author. Department of Oral Pathology, Dr. Ishrat-ul-Ebad Khan Institute of Oral Health Sciences, Dow University of Health Sciences, Gulzar-e-Hijri Scheme-33, Karachi 75300, Pakistan.
E-mail address: sofia.ali@duhs.edu.pk (S.A. Syed).

microscopy were observed in various aspects, including interpreting variations, diagnosis, time efficiency, and image clarity.

Conclusion: Although diagnostic scores were lower, digital microscopy was perceived as a useful method for enhancing diagnostic skills among dental students. Both light microscopy and digital microscopy are viable options for oral pathology practicals, however, digital microscopy was preferred by students due to its time efficiency and clear image quality.

Introduction

In dental education, oral pathology assumes a pivotal role within the curriculum. Aspiring dental professionals require extensive knowledge of oral conditions and their underlying pathology, highlighting the need for innovative solutions to enhance learning experiences in this field.[1] Globally, oral pathology laboratory course is taught by using glass slides or light microscopy. However, the light microscope, despite its historical significance, presents challenges such as difficulty in operation, suboptimal image quality, and logistical issues with slide storage and accessibility.[2] Over the past two decades, advancements in technology, have transformed medical and dental education.

Previous studies have shown that digital microscopy is an indispensable tool for teaching oral pathology laboratory course and could be used as an alternative form of light microscopic glass slides.[3,4] Furthermore, with the recent COVID-19 pandemic, the use of digital technology has been substantially increased across the globe. This has further limited the use of glass slides in teaching laboratory or practical course.[5] Digital microscopy plays a significant role in providing an interactive and accessible learning process, affording students the convenience of examining and analyzing the pathological cases with the ease. The advantages of digital images extend beyond mere convenience — they can be easily preserved, shared, and accessed remotely, thereby overcoming spatial limitations and fostering a more collaborative learning environment. The digital medium further elevates the learning experience by offering a suite of features including annotation, magnification, and visual modifications. These capabilities not only enhance students' engagement but also considerably contribute to their proficiency in personalized and adaptive learning, pathological analysis, and the interpretation. Nonetheless, concerns persist about the comparability of digital photographs to the rich detail and color accuracy of microscopic glass slides. There are also potential problems related to the availability as well as appropriate presentation of digital photographic images.[4,5]

Our institute relies solely on recommended/reference book images for oral pathology practicals, neglecting both light and digital microscopy methods. Recognizing the need for modernization and enhanced learning experiences, it is essential to introduce students to light and digital microscopy. This will provide them with a broader exposure to histopathological images and prepare them for advancements in the field. Gathering students' feedback on these methods is essential before considering digital microscopy as part of the oral pathology curriculum. This study aimed to compare the usefulness of light microscopy and digital microscopic images for learning oral pathology practicals among second-year dental students.

Materials and methods

Study design

This cross-sectional study was conducted from December 6, 2023 to December 7, 2023 in the Department of Oral Pathology, Dr. Ishrat-ul-Ibad Khan Institute of Oral Health Sciences, Dow University of Health Sciences. The approval was taken from Institutional Review Board of Dow University of Health Sciences (Ref: IRB-3158/DUHSApproval/2023/337). Written informed consent was obtained from participants.

Sample size

Using OpenEpi online software, the calculated sample size was found to be 76 students with a desired 95% level of confidence and an 80% level of power and 37.22% and 85.71% acceptance rate by conventional glass slide and digital slides respectively, as reported in previous study.[6] Therefore, in a class size of 98, a total of 79 second-year dental students who attended all lectures and tutorials of selected topics and were willing to participate in the study were included.

Data collection

Five cases from the oral pathology course including odontogenic cysts, odontogenic tumors, epithelial pathology, verrucal-papillary lesions were selected. The selected cases were in line with dental curriculum of University and students had prior knowledge/understanding of clinico-pathologic features of the topics through lectures, tutorials and class tests. The study was conducted over a two-day period at the end of academic year. Students were also taught and trained on light microscope (Nikon, Tokyo, Japan). For light microscopy, students were exposed to light microscope (Nikon) wherein they were provided with brief history, clinical/radiographic features and representative histopathological glass slides of the cases. Students were then instructed to examine histopathological slides

under microscope and diagnose the lesions. For digital microscopy, histopathological glass slides were scanned at 4×, 10× and 40× magnifications and converted into digital images using camera (Motic, Hongkong, China) mounted on microscope (Motic) and software (Motic). Following this, case scenarios were prepared, each including history, clinical, and radiographic features. Subsequently, digital images were incorporated into the case scenarios and shared with students via Google Forms. In both light microscopy and digital microscopy, each student received a diagnostic score of 1 for every correct diagnosis. Thus, the total diagnostic score for all cases in each method was 5. Students' diagnostic and learning abilities were assessed through an online questionnaire administered via Google Forms. The questionnaire included sections on diagnostic skills, learning impact, and acceptance rate of light or digital microscopy. Responses were recorded on a 5-point Likert scale, ranging from "strongly agree" to "strongly disagree."

Statistical analysis

The data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Descriptive statistics were computed for demographics and questionnaire responses to reflect participants' experiences. To assess the normality of data distribution, the Shapiro—Wilk test was applied. As the Shapiro—Wilk test yielded a significance level $P < 0.05$, indicating non-normal distribution of the data, non-parametric tests were considered for analysis. The comparison of mean diagnostic scores and between the two teaching methods (light microscopy and digital microscopy) was conducted using the Mann—Whitney U test. A significance level of $P < 0.05$ was set for statistical significance.

Results

Out of the 79 dental students, 71 (89.9%) were females and only 8 (10.1%) were males. The mean age of the participants in the study was 20.22 ± 0.81 years. Table 1 presents the students' diagnostic scores obtained using both light and digital microscopy. There was a statistically significant difference in diagnostic scores between light microscopy and digital microscopy ($P = 0.001$).

Tables 2 and 3 present students' perceptions of the usefulness of digital and light microscopy in diagnostic skills, impact on learning and acceptance rate. In digital microscopy, over 60% of students found it beneficial for interpreting variations (68.35%), identifying histopathological features (67.08%), and diagnosing oral lesions (63.29%), while agreement rates for light microscopy were lower, with only 54.43% finding it helpful for identifying

histopathological features, 48.10% for interpreting variations, and 46.83% for diagnosis.

Regarding the impact on learning and acceptance rates, the majority of students (>65%) favored digital microscopy with increased willingness to learn (67.08%), concentration (69.62%), time efficiency (67.08%), clear images (72.15%), and recommending it for oral pathology practicals (72.15%) and incorporation in oral pathology curriculum (74.68%), whereas light microscopy showed lower ratings, with willingness to learn (56.96%), concentration (62.02%), time efficiency (34.17%), clear images (49.36%), and recommendation for learning (55.69%) and incorporation in oral pathology curriculum (55.49%).

Table 4 reveals statistically significant differences between light microscopy and digital microscopy in various aspects. Students showed preference for digital microscopy over light microscopy particularly for interpreting variations in histopathology of oral lesions ($P = 0.015$), making diagnosis ($P = 0.048$), as well as for its clear images ($P = 0.000$) and time efficiency ($P = 0.013$). There was no statistically significant difference in learning impact between the two microscopy techniques ($P > 0.05$).

Discussion

This study aimed to compare the usefulness of light microscopy and digital microscopy in learning oral pathology practicals among second-year dental students. The findings suggest that while light microscopy yielded higher diagnostic scores, students preferred digital microscopy compared to light microscopy for diagnostic skills, specifically in interpreting variations and making diagnoses. Interestingly, our study found no significant difference in the identification of histological features between light and digital microscopy methods. Moreover, there was no statistically significant difference in the learning impact, as measured by increased willingness and concentration among students, suggesting both methods are comparably effective in engaging students and facilitating learning in the context of oral pathology practicals. However, acceptance rates were notably higher for digital microscopy, with students valuing its time efficiency and clear image quality. Regarding the recommendation and incorporation of digital and light microscopy respectively in oral pathology practicals and curriculum, our findings suggest no significant difference between light microscopy and digital microscopy, indicating that both methods are equally viable options.

Previous studies on diagnostic scores among dental students showed variable results. Some studies reported higher scores with digital compared to light microscopy, while others found similar scores between digital and light microscopy.[6—8] Factors such as study design, duration of

Table 1 Students' diagnostic scores in light microscopy and digital microscopy.

	Microscopy type	N	Mean	Standard deviation	P-value
Diagnostic scores	Light microscopy	79	3.72	1.38	0.001*
	Digital microscopy	79	3.05	1.03	

*$P < 0.05$. Mann—Whitney U test.

Table 2 Students' perception on usefulness of digital microscopy.

Questions: I think digital microscopy	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total agreement (%)
Diagnostic skills						
1. Helped me to interpret variations in histopathology of oral lesions	5	9	11	47	7	68.35
2. Helped me in diagnosis	6	8	15	44	6	63.29
3. Helped in identification of histopathological features	4	7	15	46	7	67.08
Impact on learning						
4. Increased my willingness	2	6	18	45	8	67.08
5. Made me more concentrated	3	7	14	45	10	69.62
Acceptance rate						
6. Very time-efficient	3	7	16	46	7	67.08
7. Very clear	4	5	13	48	9	72.15
8. Recommend for learning oral pathology practicals	5	5	12	46	11	72.15
9. Recommend incorporating it in curriculum	5	3	12	45	14	74.68

Table 3 Students' perception on usefulness of light microscopy.

Questions: I think light microscopy	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total agreement (%)
Diagnostic skills						
1. Helped me to interpret variations in histopathology of oral lesions	8	17	16	33	5	48.10
2. Helped me in diagnosis	9	14	19	32	5	46.83
3. Helped in identification of histopathological features	9	7	20	37	6	54.43
Impact on learning						
4. Increased my willingness	7	6	21	37	8	56.96
5. Made me more concentrated	7	6	17	40	9	62.02
Acceptance rate						
6. Very time-efficient	7	11	34	22	5	34.17
7. Very clear	7	10	23	31	8	49.36
8. Recommend for learning oral pathology practicals	6	11	18	34	10	55.69
9. Recommend incorporating it in curriculum	9	7	16	33	14	59.49

exposure to microscopy, participant characteristics, educational approaches employed and challenges associated with microscopy may contribute to these discrepancies.

Our study also showed that students perceived digital microscopy as helpful for interpreting histopathological variations and making diagnoses. These findings are consistent with a previous systematic review.[1,9] Recent studies have also emphasized the feasibility and efficiency of digital microscopy compared to light microscopy, further highlighting the growing preference for digital microscopy in oral pathology instruction.[6–12]

Furthermore, our findings regarding recommendations for the incorporation of microscopy methods into oral pathology practicals and curriculum are in contrast with recent studies.[9–12] However dental instructors can make

informed decisions regarding the incorporation of microscopy methods into oral pathology practicals and curriculum by considering students' preferences and learning outcomes. This approach allows the importance of tailoring educational methods to meet students' needs while ensuring the effectiveness of the learning process.

Our findings may not be generalizable due to small sample size, limited number of cases and single-institution based study. Furthermore, other potential factors that could impact on students' learning including learning styles, pre-test scores as well as retention of knowledge attained through light and digital microscopy were not investigated.

Future research should aim to address these limitations by considering a range of cases and potential factors influencing students' preferences for digital microscopy

Table 4 Comparison of students' feedback post-exposure to light and digital microscopy.

Questions: I think digital/light microscopy	Mean ± standard deviation		P-value
	Light	Digital	
Diagnostic skills			
1. Helped me to interpret variations in histopathology of oral lesions	3.12 ± 1.13	3.53 ± 1.02	0.015*
2. Helped me in diagnosis	3.12 ± 1.13	3.45 ± 1.03	0.048*
3. Helped me in identification of histopathological features	3.30 ± 1.11	3.56 ± 0.95	0.117
Impact on learning			
4. Increased my willingness	3.41 ± 1.06	3.64 ± 0.86	0.209
5. Made me more concentrated	3.48 ± 1.08	3.65 ± 0.94	0.330
Acceptance rate			
6. Very time efficient	3.08 ± 1.01	3.59 ± 0.91	0.000*
7. Very clear	3.29 ± 1.09	3.67 ± 0.94	0.013*
8. Recommend for learning oral pathology practicals	3.39 ± 1.11	3.67 ± 1.00	0.078
9. Recommend incorporating it in curriculum	3.45 ± 1.21	3.75 ± 1.00	0.119

*$P < 0.05$. Mann—Whitney U test.

over light microscopy in oral pathology education. Additionally, longitudinal studies assessing the long-term retention of knowledge and skills acquired through both microscopy methods would provide valuable insights into their lasting effectiveness in dental education. Moreover, investigating the impact of integrating emerging technologies, such as artificial intelligence or virtual reality, with digital microscopy could further enhance diagnostic accuracy and student engagement in oral pathology practicals.

In conclusion, both light microscopy and digital microscopy were equally perceived by second-year dental students for learning oral pathology practicals, however, digital microscopy was accepted by students due to its time efficiency and clear image quality. Furthermore, despite higher diagnostic scores in light microscopy, digital microscopy was perceived as a valuable tool for interpreting histopathological variations and diagnosis of oral lesions.

Declaration of competing interest

The authors have no conflict of interest relevant to this article.

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