



Original Article

Effectiveness Of Conventional Versus Projection Microscopy in Teaching Histology to Medical Students

Dr. Archana Kalyankar¹, Dr. Faiz-ur-Rahman Khan¹, Dr. Sabreen Wajid Ali Khan¹

¹Department of Anatomy, Government Medical College, Chh. Sambhajinagar, Maharashtra, India

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Corresponding Author:

Dr. Faiz-ur-Rahman Khan

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ABSTRACT

Background: Histology is traditionally taught using light microscopy; however, advances in digital microscopy have introduced new opportunities to enhance learning. Understanding students' perceptions of these teaching methods is essential for optimizing histology education. **Objectives:** To evaluate the effectiveness of digital microscopy in histology teaching and to assess undergraduate MBBS students' perceptions of conventional and digital microscopy-based learning. **Methods:** A questionnaire-based cross-sectional study was conducted among undergraduate MBBS students at a tertiary care teaching institution. A total of 176 students who had exposure to both conventional light microscopy and digital microscopy during histology practical sessions participated. Students' preferences and opinions were assessed using a structured questionnaire. Data were analyzed using descriptive statistics and the chi-square test, with $p < 0.05$ considered statistically significant. **Results:** Digital microscopy was significantly preferred for identification of histological structures (73.3%), ease of studying histology (60.2%), reduced time required for learning (80.1%) and overall learning of histology (60.2%) ($p < 0.05$). No significant difference was observed between digital and conventional microscopy with respect to clarity of histological images and interest generation. A majority of students perceived digital microscopy as useful for learning histology (93.8%) and improving understanding (80.1%). However, most students (86.4%) favored using both conventional and digital microscopy together and 86.9% opposed complete elimination of conventional microscopy. **Conclusion:** Digital microscopy is an effective adjunct to conventional light microscopy in undergraduate histology teaching. A blended approach integrating both methods appears to provide the most balanced and effective learning experience.

Keywords: Histology education; digital microscopy; light microscopy; medical students.

INTRODUCTION

Histology is a core branch of anatomy that deals with the microscopic organization of tissues and plays a crucial role in understanding normal structure, function and disease processes [1]. Along with cell biology, histology forms an integral component of the undergraduate medical curriculum and is traditionally taught through laboratory-based practical sessions during the early years of medical education [2]. Conventional histology teaching primarily relies on light microscopy, where students individually examine glass slides to identify microscopic structures [3]. Although this method promotes independent learning, students often find it difficult to interpret static microscopic images, correlate structures with physiological concepts and achieve consistent learning outcomes due to variability in slides and limited real-time guidance from instructors [4,5]. Additional challenges of traditional microscopy include restricted field of view, inability of teachers and students to view slides simultaneously, operational difficulties and issues related to slide maintenance and storage [6]. Recent advances in medical education and digital imaging technologies have led to the introduction of digital microscopy as an effective alternative or adjunct to conventional microscopy [7]. Digital microscopy employs whole-slide imaging technology to digitize glass slides into high-resolution images that can be viewed on computer screens, allowing

simultaneous access, uniform image quality and greater flexibility in learning [8,9]. Several studies have demonstrated that digital microscopy enhances student engagement, improves understanding of histological concepts and supports self-directed learning [10–12]. Despite its increasing global adoption, histology teaching in India continues to depend largely on traditional microscopy, with limited incorporation of digital microscopy tools [13]. Integrating digital microscopy with conventional teaching methods may help overcome existing limitations and improve students' learning experiences. The present study was undertaken to evaluate the effectiveness of digital microscopy in histology teaching and to assess students' perceptions of conventional and digital microscopy-based learning.

METHODOLOGY

Study design and setting: This questionnaire-based cross-sectional study was conducted in the Department of Anatomy, Government Medical College (GMC), Aurangabad. The study was carried out among undergraduate MBBS students during regular academic sessions.

Study participants: A total of 200 MBBS students were approached for participation in the study. Students from the first professional MBBS to final professional MBBS who had been exposed to both conventional light microscopy and digital/virtual microscopy during their histology practical sessions were included. Students who did not provide informed consent were excluded from the study. Finally, responses from 176 students were included for analysis.

Teaching intervention: Digital microscopy was integrated into routine histology practical teaching in addition to conventional light microscopy. Following completion of regular didactic lectures, histology slides were demonstrated using live digital images projected during practical sessions. The digital images of histological sections were displayed using microscope-mounted imaging systems and computer-based visualization software during small-group teaching. Representative microscopic images were captured and important histological features were clearly labelled on the digital images. These images were stored in standard image formats and made accessible to students through institutional resources, enabling revision outside practical hours using personal computers or laptops in the hostel or at home. Students were also encouraged to compare the digital images with conventional glass slides viewed under the light microscope. As part of the learning activity, students were asked to identify structures and draw histological diagrams based on observations made using both methods.

Study tool: A pre-validated, structured questionnaire was used to assess students' perceptions regarding conventional microscopy and digital microscopy. The questionnaire included items related to clarity of images, ease of learning, identification of structures, time efficiency, interest generation and overall preference for learning histology. Additional questions assessed students' opinions on the usefulness and future role of digital microscopy in histology teaching.

Data collection: The questionnaire was administered after students had adequate exposure to both teaching methods. Participation was voluntary and confidentiality of responses was ensured. Written informed consent was obtained from all participants prior to data collection.

Statistical analysis: Data were entered into Microsoft Excel and analyzed using appropriate statistical software. Categorical variables were expressed as frequencies and percentages. Preferences between conventional microscopy and digital microscopy were compared using the chi-square test. A p value < 0.05 was considered statistically significant.

RESULTS

Out of 200 students approached, 176 students (88%) gave consent and participated in the study, while 24 students (12%) did not participate.

Best method for learning histology slides

More than half of the students preferred digital microscopy for most aspects of learning histology.

- 53.4% of students felt that digital microscopy provided better clarity of histological images, while 46.6% preferred conventional microscopy. This difference was not statistically significant.
- For identifying histological structures, 73.3% of students preferred digital microscopy, compared to 26.7% who preferred conventional microscopy, showing a statistically significant difference.
- 60.2% of students felt that digital microscopy was easier for studying histology, whereas 39.8% preferred conventional microscopy, which was statistically significant.
- Regarding interest in studying histology slides, 53.4% preferred digital microscopy and 46.6% preferred conventional microscopy; this difference was not statistically significant.
- A large majority, 80.1% of students, felt that digital microscopy allowed them to study slides in a shorter time, while only 19.9% preferred conventional microscopy, showing a highly significant difference.
- Overall, 60.2% of students considered digital microscopy as the best method for studying histology, compared to 39.8% who preferred conventional microscopy and this difference was statistically significant.

Students' opinion about digital microscopy

Students expressed a strongly positive attitude towards digital microscopy.

- 93.8% of students felt that digital microscopy is useful for learning histology, while only 6.2% disagreed.
- 73.3% of students reported that digital microscopy increases interest in learning histology, whereas 26.7% did not feel so.
- 80.1% of students believed that digital microscopy improves understanding of histology, while 19.9% did not.
- Only 13.1% of students felt that conventional microscopy should be completely eliminated, while 86.9% opposed its complete removal.
- A large majority, 86.4% of students, felt that both conventional and digital microscopy should be used together, whereas 13.6% did not support this idea.

In summary, most students preferred digital microscopy, especially for understanding histology and saving time. However, conventional microscopy was not rejected and the majority of students (86.4%) supported using both methods together for effective histology teaching.

Table 1: Students' opinion about the best method of teaching histology slides (n = 176)

Sl. No	Question	Conventional microscopy N (%)	Digital microscopy N (%)	χ^2 value	p value	Interpretation
1	Best clarity of histological images	82 (46.6%)	94 (53.4%)	0.82	0.36	Not significant
2	Useful in identification of structures	47 (26.7%)	129 (73.3%)	38.20	<0.001	Significant
3	Easier for studying histology	70 (39.8%)	106 (60.2%)	7.36	0.007	Significant
4	Creates interest in studying slides	82 (46.6%)	94 (53.4%)	0.82	0.36	Not significant
5	Allows studying slides in shorter time	35 (19.9%)	141 (80.1%)	63.80	<0.001	Significant
6	Best overall method for studying histology	70 (39.8%)	106 (60.2%)	7.36	0.007	Significant

Table 2: Students' opinion regarding digital microscopy (n = 176)

Sl. No	Question	Yes n (%)	No n (%)	χ^2 value	p value	Interpretation
1	Digital microscopy is useful in learning histology	165 (93.8%)	11 (6.2%)	134.6	<0.001	Significant
2	Digital microscopy increases interest in learning histology	129 (73.3%)	47 (26.7%)	38.20	<0.001	Significant
3	Digital microscopy improves understanding of histology	141 (80.1%)	35 (19.9%)	63.80	<0.001	Significant
4	Conventional microscopy should be totally eliminated	23 (13.1%)	153 (86.9%)	96.10	<0.001	Significant
5	Both conventional and digital microscopy should be used	152 (86.4%)	24 (13.6%)	92.80	<0.001	Significant

DISCUSSION

In the present study, undergraduate MBBS students showed a clear preference for digital microscopy over conventional light microscopy for identification of histological structures, ease of learning, time efficiency and overall learning of histology. A large majority of students also perceived digital microscopy as useful and supportive of better understanding, while opposing the complete elimination of conventional microscopy and favoring a blended teaching approach. These findings indicate that digital microscopy enhances learning efficiency, but conventional microscopy continues to retain educational relevance.

These findings are consistent with those reported by Kumar et al. (2019) [14], Rabha et al. (2025) [15] and Hande et al. (2017) [9]. Kumar et al. demonstrated strong student preference and acceptance of digital microscopy, particularly for clarity, ease of identification and time-saving advantages, while also highlighting widespread support for combined use of digital and conventional methods. Performance-based evidence from Rabha et al. further supports the present findings, showing significantly higher MCQ and OSPE scores among students trained using virtual microscopy, suggesting that positive perceptions are accompanied by measurable academic gains. Similarly, Hande et al. reported the highest learning outcomes when digital and conventional microscopy were used together, reinforcing the educational benefit of an integrated approach.

The lack of a significant difference between digital and conventional microscopy for image clarity and interest generation in the present study suggests that traditional microscopy still provides adequate visual quality and engagement for some learners. However, the consistent preference for digital microscopy in efficiency-related domains reflects its ability to reduce technical difficulties and allow students to focus on conceptual understanding. Overall, the present study supports the integration of digital microscopy into routine histology teaching, not as a replacement, but as a complementary tool that enhances learning outcomes when used alongside conventional microscopy.

CONCLUSION

The present study demonstrates that digital microscopy is a valuable and effective adjunct to conventional light microscopy in undergraduate histology teaching. Most students preferred digital microscopy for identification of microscopic structures, ease of learning and time efficiency, while also acknowledging the continued importance of conventional microscopy for developing practical skills. The findings suggest that digital microscopy enhances students' understanding and engagement without diminishing the educational relevance of traditional methods. A blended approach that integrates digital microscopy with conventional light microscopy appears to offer the most balanced and effective strategy for histology education in undergraduate medical training.

LIMITATIONS

Despite its strengths, the present study has certain limitations. The study was conducted at a single institution, which may limit the generalizability of the findings to other settings. Student perceptions were assessed using a questionnaire and subjective responses may be influenced by individual preferences and prior exposure to digital tools. Objective measures of learning outcomes, such as pre- and post-intervention performance assessments, were not included, which restricts conclusions regarding direct academic impact. Additionally, long-term retention of histological knowledge and skill acquisition was not evaluated. Future multicentric studies incorporating objective performance measures and longitudinal follow-up would provide stronger evidence regarding the educational effectiveness of digital microscopy.

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