

Dermoscopy in Clinical Dermatology Education: Current Applications and Future Perspectives

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Abstract: Dermoscopy serves as the dermatologist's stethoscope, with extensive applications in pigmented skin disorders, skin tumors, and inflammatory dermatoses. It enhances early detection rates of skin malignancies and aids in the differential diagnosis of inflammatory conditions, constituting an essential competency for dermatologists. However, the integration of dermoscopy into clinical education lacks standardized protocols. This review synthesizes the current status and pedagogical models of dermoscopy education across undergraduate medical curricula and residency training programs in various countries, revealing a notable mismatch between curricular offerings and clinical practice demands. Analysis indicates that dermoscopy teaching hours remain insufficient, instructional methods predominantly rely on theoretical lectures, and students have limited opportunities for hands-on practice and direct patient-based learning. We further explore the potential for expanded dermoscopy applications in medical education, aiming to provide a reference framework for optimizing its role in clinical dermatology training.

Keywords: Dermoscopy; Medical education; Undergraduate teaching; Clinical clerkship; Standardized residency training; Teaching models

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1. Introduction

Dermatology is a clinical discipline characterized by a broad spectrum of diseases, wherein different conditions may present with identical cutaneous manifestations, while the same disease may exhibit variable morphology across different stages of progression. Cultivating the ability for rapid clinical recognition of skin lesions presents a considerable educational challenge. Dermoscopy is an emerging, non-invasive, adjunctive diagnostic imaging technique that offers advantages of portability and real-time visualization, enabling observation of the lower epidermis, dermo-epidermal junction (DEJ), and the papillary dermis through polarized light—an indispensable “diagnostic assistant” for dermatologists. The first polarized-light

dermoscope was manufactured in the United States in 2001, followed by the publication of the International Dermoscopy Society's consensus on the dermoscopic diagnosis of pigmented lesions in 2003. In China, clinical adoption of dermoscopy commenced in 2003. Over the past two decades, the role of dermoscopy in routine dermatological practice has evolved from a supplementary tool to a clinical skill that dermatologists are expected to master.

Nevertheless, the application of dermoscopy in clinical teaching remains in an exploratory phase. A 2002 survey in the United States revealed that only 38% of dermatology residents received formal dermoscopy training during residency^[1]. In 2022, the University Hospital Augsburg in Germany implemented a structured dermoscopy training curriculum for residents, demonstrating improvement in both therapeutic decision-making accuracy (74.0% vs. 89.4%) and dermoscopic diagnostic accuracy (65.0% vs. 85.6%) compared with baseline assessments^[2]. Concurrently, dermoscopy has begun to emerge in Chinese dermatology clinical education, with exploration into its integration with traditional lectures, problem-based learning (PBL), case-based learning (CBL), and other multimodal teaching approaches^[3].

A retrospective study at the Mayo Clinic reviewed melanoma cases from 2005 and 2019, revealing a significant increase in the proportion of pigmented malignancies over the 14-year interval, potentially attributable to enhanced dermoscopy training, clinical experience, and utilization, with dermoscopy serving as a supportive criterion for biopsy decisions. Consequently, the authors advocated for the incorporation of dermoscopy into dermatology residency curricula, and recommended that dermatologists who completed residency without formal dermoscopy training receive appropriate instruction^[4].

This review systematically examines the current state of dermoscopy education across undergraduate and residency training phases, analyzes the applicability and limitations of various pedagogical approaches, and proposes directions for future improvement, with the goal of informing the optimization of dermoscopy's role in clinical dermatology education.

2. Dermoscopy education in undergraduate and clinical clerkship phases

The majority of medical schools globally allocate limited curricular time to dermatology at the undergraduate level, despite dermatological conditions accounting for up to 25% of primary care consultations—creating a substantial gap between educational exposure and clinical competency requirements^[5,6]. In China, undergraduate curricula have yet to incorporate practical diagnostic modalities such as dermoscopy. Many medical students lack a systematic understanding of the tripartite correlation among “clinical presentation—dermoscopic features—histopathological correlates.”

Dermatology, as a morphology-based clinical discipline, places emphasis on guiding students to observe lesion morphology and master disease-specific cutaneous manifestations as a core teaching focus and challenge. Multimodal visual stimulation represents a critical strategy for facilitating disease recognition^[7]. Dermoscopy enables clear, real-time observation of pigmentary, vascular, and other structural features, and allows for subsequent image analysis. For example, plantar warts—hyperkeratotic lesions of the palms and soles—exhibit dermoscopic features including whitish or yellowish papillomatous structures, hemorrhagic puncta, and interruption of dermatoglyphics, which correspond histopathologically to epidermal papillomatosis, enabling students to recognize the characteristic architecture of viral warts. Furthermore, dermoscopy is of paramount importance in the differentiation of benign versus malignant skin tumors.

Educational studies involving medical students demonstrate that brief dermoscopy training can significantly improve skin cancer recognition skills. For instance, following instruction in the three-point rule, medical students achieved sensitivity and specificity in distinguishing melanoma from benign pigmented lesions comparable to those of general practitioners. Existing curriculum evidence confirms that dermoscopy instruction at the undergraduate level is feasible and produces positive educational outcomes ^[8,9]. A randomized controlled trial demonstrated that, within an ultra-short training period, computer-assisted self-learning using dermoscopic images was non-inferior to classroom-style lectures for medical students ^[10].

Multiple teaching practices in China have reported high satisfaction with a combined dermoscopy and clinical clerkship teaching model among undergraduate students during dermatology rotations, suggesting that this approach stimulates student interest and enhances comprehension of theoretical knowledge. The authors recommended broader implementation of dermoscopy in undergraduate clinical clerkships ^[11–15]. Scoping reviews similarly indicate that basic dermoscopy instruction can be effectively integrated into undergraduate medical education, enabling early exposure to skin cancer discrimination and acquisition of foundational skills ^[16].

Undergraduate dermoscopy instruction is primarily delivered through the following formats: In theoretical teaching, core content encompasses the basic principles of dermoscopic imaging, equipment operation, characteristic dermoscopic features of common dermatoses, and fundamental diagnostic algorithms including the ABCD rule and pattern analysis. Practical teaching incorporates dermoscopic image review sessions, during which students observe classic cases and document dermoscopic structures under faculty supervision. At the bedside, instructors perform live demonstrations in outpatient settings, allowing students to simultaneously observe macroscopic lesions and their dermoscopic correlates. Establishment of a digital image library of classic dermoscopic cases enables students to review materials independently after class ^[17]; this model demands a high level of self-directed learning and is best suited for highly motivated intern groups. Integrated teaching models combine histopathological slide review, dermoscopic image interpretation, and clinical observation—presenting clinical manifestations, dermoscopic findings, and histopathological sections of the same case sequentially for comparative learning.

Case-based learning employs clinical case materials provided by instructors, with students engaging in discussion of diagnosis, diagnostic rationale, and management strategies. Problem-based learning is a student-centered, inquiry-driven approach wherein small groups actively research materials, analyze dermoscopic images, and formulate their own conclusions in response to a clinical problem, with instructors guiding the analytical process through questioning rather than providing direct answers ^[18]. Online image repositories provide a foundation for web-based dermoscopy instruction, while remote case discussions transcend geographic constraints to facilitate learning.

3. Dermoscopy education in standardized residency training

3.1. Application in dermatology residency training

Standardized dermatology residency training constitutes the core pathway for developing competent specialist dermatologists. Dermoscopy should be regarded as an essential clinical skill that residents must acquire, encompassing the abilities to visualize, diagnose, and make clinical decisions. However, the penetration of dermoscopy education in residency programs varies considerably across countries.

A 2002 US survey indicated that 38% of dermatology residents received formal dermoscopy training

during residency; by 2016, this proportion had risen to 84% ^[1]. Additional studies demonstrate that dermoscopy utilization in US dermatology residency programs is increasing, with over 94% of chief residents reporting dermoscopy use in 2013, reaching 100% by 2017 ^[19,20]. Nonetheless, dermoscopy training has been identified as the area of lowest satisfaction among US dermatology residents ^[21]. A 2014 survey revealed that nearly 98% of dermatologists with ≤ 5 years of practice employ dermoscopy in clinical diagnosis, with 100% having received formal training ^[22]. In China, clinical adoption of dermoscopy began in 2003, with substantial development over the past decade, and it is currently among the most commonly utilized skin imaging modalities in dermatology practice.

Similar to undergraduate education, the most frequently employed instructional modality in residency is lecture-based teaching, followed by clinical mentorship under dermoscopy experts in outpatient settings—the latter being perceived as most effective. The majority of dermatology residents receive dermoscopy lectures and clinical training covering differentiation of benign nevi from melanoma, detection of basal cell carcinoma, and recognition of seborrheic keratosis. However, despite demonstrated value in inflammatory dermatoses and cutaneous infections, few residents receive systematic dermoscopy training specifically focused on inflammatory skin conditions ^[20].

A 2017 German survey of 880 dermatologists examining training history, utilization patterns, and perceived benefits of dermoscopy concluded that dermoscopy curricula should be incorporated into future residency training and continuing medical education programs to enhance skin oncology care and expand diagnostic applications in inflammatory dermatoses ^[23]. A questionnaire-based survey across multiple Latin American countries (Argentina, Brazil, Colombia, Costa Rica, Chile, Ecuador, Guatemala, Mexico, Panama, and Uruguay) involving 81 residents revealed that only 72% had completed dermoscopy training courses, with substantial variation in training hours. The most commonly taught methods included pattern analysis (74.1%), the two-step algorithm (61.7%), and the ABCD rule (59.3%). Nearly all respondents expressed interest in additional training during residency and considered dermoscopy training should be a graduation requirement ^[24].

3.2. Dermoscopy training in other specialty residency programs

Dermoscopy training has also been integrated into residency programs in other specialties, including family medicine and plastic surgery. The American Academy of Family Physicians now requires family medicine residents to complete dermoscopy coursework. Studies have investigated multi-modal approaches combining 120-minute brief training sessions with spaced reinforcement and blended learning strategies to improve long-term retention and enhance family physicians' ability to differentiate benign from malignant lesions ^[25].

A 2024 Italian study evaluated 41 plastic surgeons' diagnostic performance following a short-term intensive dermoscopy course, demonstrating improvement in diagnostic accuracy regardless of baseline proficiency ^[26]. A 2021 Canadian study using online questionnaires surveyed plastic surgeons and residents at two universities regarding dermoscopy awareness and utilization; although 96% were familiar with dermoscopy, only one reported clinical use, with lack of training and equipment cited as primary barriers. Respondents demonstrated low scores on dermoscopic feature recognition and showed a tendency toward diagnostic or excisional biopsy, potentially inflating benign-to-malignant surgical ratios. Nonetheless, 89% expressed willingness to receive formal dermoscopy training during residency, leading the authors to conclude that dermoscopy utilization in plastic surgery training is currently minimal but that trainee interest

is strong, supporting its inclusion in residency curricula ^[27].

3.3. Current challenges

In summary, the primary challenge in dermoscopy clinical education is the mismatch between limited curricular time allocation and the growing clinical competency requirements. The majority of published studies are single-center, small-sample observational reports, with a paucity of large-scale randomized controlled trials. Most investigations report only short-term post-intervention performance changes without control groups to account for confounding from accumulated clinical clerkship experience. Existing curricular frameworks exhibit considerable heterogeneity in content, time allocation, and assessment methods, lacking reproducible instructional templates, which complicates cross-institutional comparisons. Furthermore, most studies evaluate outcomes within weeks of course completion, without long-term follow-up to assess knowledge retention after students enter clinical practice.

4. Innovative explorations in dermoscopy education

4.1. Theory-based pedagogical approaches

Anhui University of Chinese Medicine investigated the efficacy of a combined PBL+CBL model leveraging dermoscopy and the WeChat teaching platform in dermatology residency training, finding that this approach enhanced residents' competency-based educational outcomes ^[28]. In dermatology residency training, utilizing dermoscopy to correlate macroscopic skin lesions with microscopic structural features not only facilitates teaching but also integrates with multiple pedagogical models—including LBL, PBL, CBL, and RBL—enabling students to deepen their diagnostic understanding, while simultaneously enhancing initiative, clinical reasoning, and innovative thinking, thereby improving training quality ^[3]. Chinese scholars have innovatively incorporated classic dermoscopic imaging materials into traditional PBL frameworks, rendering standardized cases more vivid and engaging in clinical teaching practice, and rapidly improving medical students' clinical competence in non-invasive skin diagnostics ^[29].

Chinese diagnostic dermatology teaching models have adopted multi-method approaches incorporating outpatient mentorship, mini-lectures, classic case teaching rounds, and difficult case discussions, emphasizing the integration of dermoscopic findings with clinical and histopathological correlates. CBL combined with dermoscopy in a dual-track model demonstrated significantly superior assessment performance and learning capacity in the intervention group compared to controls ^[12]. Multi-modal image review integrated with the WeChat platform combines clinical lesion observation, dermoscopic image analysis, and histopathological interpretation, leveraging WeChat's convenience for resource sharing and collaborative learning. The flipped classroom model, when combined with dermoscopic image databases, offers inherent advantages. Other integrated models include PBL, RBL, and other pedagogical approaches combined with dermoscopy.

Gamification represents an innovative approach. Survey findings indicate that game-based learning strategies are perceived positively in dermoscopy education, facilitating skill acquisition ^[30]. The Dermoscopy Bowl, initiated in the United States in 2018, employs gamification to enhance resident engagement in dermoscopy education; competition-based identification of knowledge gaps in image analysis has informed curricular improvements. Educational gamification remains a relatively underexplored concept in dermoscopy teaching and may serve as a valuable supplement to traditional instruction ^[31].

4.2. Integration of teaching materials and tools

Leveraging technological advances, incorporating novel tools into teaching can enhance dermoscopy educational outcomes. In 2019, the University of Texas MD Anderson Cancer Center Department of Dermatology, in collaboration with surgical oncology, cancer biology, and the Melanoma and Skin Center, established a cooperative educational partnership involving eight academic dermatology residency programs across Texas and Missouri. This initiative provided monthly dermoscopy lectures via the Project ECHO (Extension for Community Health Outcomes) tele-mentoring platform with real-time videoconferencing, supplemented by web- and smartphone-based assessment tools for educational evaluation. Assessment measures included: (1) monthly content-specific pre- and post-tests; (2) quarterly comprehensive dermoscopy knowledge assessments; and (3) quarterly trainee self-efficacy evaluations. These smartphone-based assessment tools enhanced learner engagement with educational content while providing individual performance data, institutional benchmarking, and additional information on the pedagogical value of specific lesion images. This performance metric-based tele-mentoring collaborative model offers new opportunities for scalable dermatology education across broader geographic regions^[32].

In 2021, the University of North Carolina at Chapel Hill Department of Dermatology developed an online learning tool providing a self-directed, accessible method for teaching basic dermoscopy concepts and diagnosis. Evaluation of first-year dermatology residents' self-reported confidence and quiz performance pre- and post-module completion: among 447 first-year residents, 50 (11.2%) participated. Self-reported confidence on a 5-point Likert scale improved from predominantly "poor" or "fair" to "fair" or "moderate" ($P < 0.001$). The median correct response rate for distinguishing benign from malignant lesions increased from 80% to 95% ($P < 0.001$)^[33].

In 2019, Taiwanese investigators designed smartphone wallpapers featuring benign nevi and malignant melanoma for supplementary training of first-year postgraduate trainees and junior residents, demonstrating that this intervention improved dermoscopy learning outcomes as a convenient and effective adjunctive training tool^[34].

5. Challenges and future directions

The dissemination of dermoscopy in clinical education faces multiple practical obstacles. The total curricular time allocated to dermatology within the broader medical curriculum is limited, constraining opportunities for dermoscopy instruction. Access to dermoscopy equipment varies across regions, with some training centers unable to provide individual residents with available devices.

To address these challenges, judicious use of artificial intelligence-assisted dermoscopic image recognition technology holds promise. AI can serve as a pedagogical tool, providing reference diagnoses and feature annotations after learners complete image interpretation, helping them identify overlooked structures. Establishment of regional dermoscopy teaching collaboratives would enable participating institutions to share classic case images and teaching materials, reducing the cost of independent curriculum development. Such collaboratives could conduct multi-center educational research using standardized assessment tools to measure the effectiveness of different teaching methods, informing evidence-based curricular improvements. Online platforms and web-based teaching modalities can further expand dermoscopy's application in clinical education.

6. Conclusion

The educational value of dermoscopy in clinical teaching is progressively gaining recognition. With ongoing technological advances, dermoscopy is poised to play an increasingly significant role across undergraduate education, standardized residency training, and continuing medical education for dermatologists. Developing robust curricular frameworks, establishing phased competency-based learning objectives, and expanding hands-on practice opportunities represent key pathways to enhancing dermoscopy teaching quality. As digital teaching tools and artificial intelligence technologies mature, dermoscopy education has the potential to achieve substantive improvements in the near term, and may serve as a catalyst for broader reform in dermatology education.

Disclosure statement

The authors declare no conflict of interest.

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