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The Role of Dermoscopy in Diagnosing STI-Associated Genital Lesions

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ABSTRACT

Dermoscopy is a non-invasive tool commonly used in dermatology to examine and diagnose various skin lesions. Traditional methods of diagnosing sexually transmitted infection (STI)-related genital lesions often rely on laboratory tests like PCR, serology, and histopathology, which can be costly, time-consuming, and impractical in sensitive areas or resource-limited settings. Dermoscopy offers a faster, more accessible way to visualize lesions in real-time, making it a promising tool to help differentiate STI-associated genital lesions with overlapping clinical presentations, such as syphilitic chancres, genital warts from human papillomavirus (HPV), and herpes simplex virus (HSV) lesions. Studies have identified distinct dermoscopic patterns for these lesions, with HPV-induced genital warts often showing fingerlike, mosaic, or knoblike patterns, while HSV lesions appear as clustered vesicles on an erythematous base, and primary syphilis chancres display a reddish central erosion with whitish borders. These features allow for differentiation from other similar-appearing lesions. Dermoscopy can potentially improve clinical suspicion, reducing reliance on laboratory testing, especially in settings where such tests may not be available. Although promising, further research is needed to validate dermoscopy's effectiveness, standardize diagnostic criteria, and assess its practical use in clinical practice. Ultimately, dermoscopy has the potential to improve patient care by facilitating faster, more accurate diagnoses, reducing delays in treatment, and enhancing the overall management of STI-related genital lesions. This review aims to explore common

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dermoscopic patterns of these lesions, evaluate the diagnostic accuracy of dermoscopy, and examine its feasibility in clinical practice, especially when laboratory tests are unavailable.

Keywords: Dermoscopy, STI-Associated Genital Lesions, Human Papillomavirus (HPV), Herpes Simplex Virus (HSV), Syphilis Chancres

INTRODUCTION

Dermoscopy, also known as dermatoscopy or epiluminescence microscopy, is a non-invasive diagnostic technique that enhances the visualization of skin features that are not typically visible to the naked eye [1]. Although traditionally used to assess pigmented lesions, dermoscopy has become an increasingly valuable tool for evaluating inflammatory, infectious, and neoplastic skin conditions, overall improving diagnostic accuracy and reducing the need for unnecessary biopsies and laboratory tests [2]. More recently, its use has extended to include the evaluation of genital lesions, including those caused by sexually transmitted infections (STIs) [3].

Typically, STI-associated genital lesions are diagnosed through clinical evaluation followed by confirmatory tests such as polymerase chain reaction (PCR), serologic assays, or histopathologic analysis [4]. While these methods remain the gold standard, they have some limitations. PCR and serology can be costly, time-consuming, and difficult to access in low-resource settings [5]. Histopathology requires tissue sampling, which may be invasive and uncomfortable, particularly in sensitive areas like the genital region. Additionally, social stigma and patient discomfort may lead to delays in diagnosis or avoidance of care altogether [6]. Given these challenges, dermoscopy may offer a promising alternative, as it allows for real-time, non-invasive, and relatively low-cost assessment of genital lesions.

In general dermatology, key dermoscopic criteria include the morphology and arrangement of vascular structures, scaling patterns, color variations, follicular abnormalities, and other diagnostic features [1]. When applied to STIs such as syphilis, human papillomavirus (HPV)-related genital warts, and herpes simplex virus (HSV) infections, dermoscopy can reveal distinctive vascular and pigmentary patterns that support clinical diagnosis and guide management [7-9]. This is particularly beneficial when lab testing is delayed, unavailable, or unaffordable. Additionally, dermoscopy can assist in triaging and expediting referrals or treatment decisions in busy clinical environments, such as emergency departments or high-volume STI clinics [10]. Beyond its diagnostic utility, dermoscopy may help address healthcare disparities by expanding access to care, particularly in underserved and stigmatized populations [5,6].

This review aims to highlight the dermoscopic features of three common STI-associated genital lesions: syphilitic chancres, HPV-induced genital warts, and HSV-related lesions. Additionally, it seeks to examine the diagnostic accuracy of dermoscopy and explore its potential for integration into routine clinical practice, especially in low-resource or high-stigma care settings.

Dermoscopic Patterns of Syphilitic Genital Lesions

Syphilis is a sexually, blood-contracted, or congenitally transmitted disease caused by the bacterium Treponema pallidum. Syphilis, if left untreated, can progress through four stages: primary, secondary, latent, and tertiary. In the primary phase, patients will generally develop a single, indurated, painless ulcer on their genitals, referred to as a "chancre." The chancre evolves from a macule to a papule, eventually progressing into a pink, red, or greyish erosion that is round or oval with sharp, indurated margins [11]. It will most commonly appear on either the glans penis or foreskin in men, or on the cervix or labia majora in women, but can appear anywhere on the skin that was in contact with an infectious lesion. Due to their painless nature, chancres may often go unnoticed. The secondary phase follows 3-12 weeks after resolution of the chancre and includes cutaneous manifestations of alopecia, described as a "moth-eaten" pattern, which is considered to be pathognomonic. Additionally, the presence of a local or diffuse macular exanthem rash on the soles of the hands and feet is a diagnostic criterion for syphilis [12]. In the latent phase, patients are asymptomatic, and the syphilis infection can only be detected on serology. If left untreated for years, syphilis can progress to a tertiary phase, which is a systemic infection that can affect multiple organ systems, varying from neurosyphilis, cardiovascular syphilis, or gummatous syphilis. Understanding the clinical stages of syphilis lays the foundation for interpreting its dermoscopic presentation.

Dermoscopy can be a valuable, non-invasive tool to support the diagnosis of syphilis in its different stages, especially in distinguishing primary chancres from other genital ulcerative conditions. Multiple papers have discussed cutaneous manifestations during the secondary phase of syphilis,

emphasizing their dermoscopic appearance, including lesions on the genitals, but do not analyze the dermatoscopic presentation of genital chancres in primary syphilis [13,14]. Ankad BS, et al. [7] describe the dermoscopy evaluation of a chancre present on the ventral aspect of the penis, displaying a central red area surrounded by a white border. These lesions contain dotted, glomerular, and linear looped vessels; however, it was noted that the morphology and arrangement of vessels may vary depending on the chancre's location [7]. Chauhan P, et al. [15] discovered similarities noted in the dermatoscopic view of the syphilitic chancres as a multicolored background with hues ranging from orange and red to purple, as well as white to yellow-white tones. These lesions also demonstrated polymorphic vascular patterns, findings attributed to the underlying histopathology [15]. Several studies have recognized an orange-to-yellow-red background with dotted and glomerular vessels in secondary syphilis as the key dermoscopic finding, emphasizing its diagnostic significance in clinical evaluation and highlighting the link between findings in primary syphilis genital lesions and secondary syphilis cutaneous manifestations [7,13,15,16].

As mentioned before, dermatoscopic evaluation of syphilitic lesions can vary based on anatomical location and skin tone. While most studies focus on secondary syphilis, findings may extend to primary lesions. For example, in secondary syphilis, differences in cutaneous manifestations across differing skin types have been observed with Biette's collarette, a characteristic dermoscopic feature [13]. In lighter skin types, it is seen as a whitish circle of outwardly oriented scales over a yellow-red background, with vessels. On the other hand, in darker skin types, vascular structures, including erythema may be less evident, and yellow or orange structures appear as brownish-yellow structures [7]. Further research is needed to examine the variations in dermoscopic findings in syphilitic chancres across different skin types.

Although dark-field microscopy and serological testing remain the gold standards for diagnosing syphilis, dermatoscopy is a promising additional diagnostic tool [17]. Primary syphilis chancres exhibit consistent dermoscopic features of dotted, glomerular, and linear looped vessels and orange, red-purple backgrounds [7,15]. These differentiating features can distinguish syphilis from other ulcerative genital lesions, reducing the risk of misdiagnosing patients. Incorporating dermoscopy into routine assessment can facilitate the early detection and diagnosis of syphilis, improving clinical outcomes through earlier intervention.

Dermoscopic Patterns of Genital Warts

Papillomaviruses often infect the stratified squamous epithelium of the body, particularly in the skin, oral cavity, and anogenital tract. The significant risk factors for HPV infection are due to sexual activity. Other risk factors include oral contraceptive use, black or Hispanic ethnicity, and a history of chlamydia infections. Genital warts are contagious and can develop within 2-3 months of direct infection. HPV is more frequently easily detected when there are high-grade dysplastic lesions, but is mistakenly undiagnosed because there are no direct symptoms that patients report as concerning. The primary form of protection against HPV includes the vaccine, and second-line protection is the screening and routine checking of cervical cancer [18].

The physical appearance of HPV infections can be asymptomatic, but oftentimes includes various warty lesions that possess a cauliflower-like texture and appearance in the genital area. These lesions can also be flat, papular, or appear like a keratosis. Oftentimes, there can be burning, pain, and pruritus associated with the genital lesions that come with HPV. Additionally, these lesions often grow in number and can grow more prominently over time. As the lesions enlarge, they can affect other areas, such as the urethra, vagina, or rectum, leading to an obstruction that can be dangerous. Additionally, the color of the genital lesions oftentimes ranges from flesh-colored to brownish or purple. When comparing men and women, it is interesting to consider that genital warts are more common around the coronal sulcus and glans of the penis and the shaft, while in women, they are around the external genitalia. Though these lesions are most common in the genital area, it is important to note that lesions can occur elsewhere. Ultimately, they can lead to an increased likelihood of cervical cancer in women and penile cancer in men. Management of the lesions includes surgical and in-office procedures, such as cryotherapy, podophyllin, surgical excision, or a CO2 laser. Additionally, biopsies are encouraged for atypical lesions and for patients who do not respond to treatment. Further research is needed to explore the recurrence rate and what factors play into the recurrence of genital lesions in different populations [19].

Dermoscopic Patterns of Genital Herpes

Herpes genitalis, caused by herpes simplex virus type 1 or 2

(HSV-1, HSV-2), is among the most common STIs; however, it continues to be underdiagnosed due to its nonspecific presentation of symptoms. HSV-1 is primarily known to cause lesions in the perioral region, but it can cause some genital lesions as well. The initial presentation of symptoms of HSV-2 includes genital itching, painful irritation, and erythema. In addition, the primary infection may present with painful genital ulcers, sores, crusts, tender lymphadenopathy, and dysuria [20]. The classical features include macular or papular skin and mucous membrane lesions progressing to vesicles and pustules that last up to three weeks and can spontaneously regress. The lesions associated with HSV-2 are most often painful, which can progress to swelling of the vulva in women, burning pain, and dysuria [20]. The presentation of HSV-2 genital lesions, unfortunately, is not atypical, and therefore, diagnosis based on clinical presentation alone can be unsatisfactory. Especially with the various overlaps of clinical features among STIs, dermoscopy can become a very useful diagnostic tool.

It is important to identify the unique characteristics of HSV under dermoscopy because of its clinical resemblance to other conditions. However, there is minimal literature on the dermatoscopic features of HSV genital lesions. One study found that 80% of patients showed three zones with central brown pigmentation surrounded by white color, representing ballooning degeneration and peripheral edema, and 20% of patients showed an erythematous background, erosions, and brown dots [9]. The HSV-1 perioral vesicular eruptions can be used as a solid foundation for the dermatoscopic characterization of HSV-2 genital lesions because the main difference between lesions is the route of transmission and not the actual dermatologic manifestations themselves. Thus, it can be hypothesized that HSV-2 genital lesions will also have the central brown pigmentation with a surrounding white border, an erythematous background, and brown dots.

The clinical presentation of HSV is very similar to that of pemphigus vulgaris and bullous pemphigoid. These vesiculobullous disorders are often described on dermoscopy as erythema on base, well-defined/ill-defined border, brown dots/patches, and erosions [21]. It has been identified that in herpes zoster lesions, there are multiple confluent, round, cloudy white polylobular structures with central brown dots and surrounding erythema [21]. These structures have been suggested to correspond to the ballooning of keratinocytes and the brown dots that are associated with the multinucleated giant cells of herpetic lesions. While vesicles were present in most of the vesiculobullous disorders and herpetic lesions, the presence of multiple confluent polylobular structures appears to be a distinguishing factor for herpes infections. Therefore, an assumption may be made that HSV genital lesions will have a similar appearance.

One factor to consider is the timing of when herpetic lesions are evaluated with dermoscopy. One study found that the characteristics of herpes zoster lesions differed between an early and late course of infection. Both lesions consisted of polylobular gray and brown globules; however, the early lesions had a bright pink background and a grayish veil-like structure with a gray rim. Whereas the later lesions were surrounded by an erythematous zone resembling a solar eclipse pattern with multiple dots [7]. In addition, the later lesions had a 'crumpled fabric' appearance, depicting the folding of the roof of the flaccid bullae [7]. These findings suggest that due to the natural course of infection, herpetic lesions will vary in appearance on dermoscopy, and it is important to understand the possible variance in presentation.

Diagnostic Accuracy of Dermoscopy

Dermoscopy has become an essential tool in a dermatologist's practice, providing a valuable noninvasive complement to clinical examinations for both pigmented and nonpigmented skin conditions. When diagnosing melanoma, the use of a dermatoscope has been shown to improve diagnostic accuracy by 15.6 times compared to visual inspection alone [23]. Previous studies have also demonstrated high sensitivity for the diagnosis of scabies and folliculitis [24]. Dermoscopy showed good diagnostic accuracy for Demodex (88.1%), scabietic (89.7%), and dermatophytic folliculitis (100%), as well as for pseudofolliculitis (92.8%) [25]. There have also been studies demonstrating dermoscopy use for the diagnosis of genital lesions. A study by Erritchetti et al. found that dermoscopy can serve as a valuable adjunct in the clinical evaluation of patients presenting with erythematous lesions on the glans penis, aiding in the accurate differentiation between erythroplasia of Queyrat (EQ) and chronic balanitis. Erritchetti et al. found that EQ and chronic balanitis exhibit distinct dermoscopic patterns, highlighting dermoscopy's utility as a supportive non-invasive tool for distinguishing between these conditions.

Dermoscopy has emerged as a valuable non-invasive tool to aid diagnosis of STIs by allowing for detailed visualization of

skin lesions. Its application aids in differentiating STI-related lesions from other dermatological conditions, thereby improving diagnostic accuracy. Dermoscopy reveals specific patterns in secondary syphilis lesions, such as scaling within skin furrows and central darker areas with ill-defined borders. These features assist in distinguishing syphilitic lesions from other dermatological conditions [26]. Moreover, it has also been shown to aid in the diagnosis of genital warts, allowing it to distinguish small papular lesions with a mosaic pattern from HPV-associated cauliflower-like lesions revealing multiple, irregular projections. For molluscum contagiosum, it has shown polylobular, white-yellowish, amorphous structures with a pore or orifice that can either have a central or eccentric pattern [27]. Incorporating dermoscopy into routine clinical practice significantly bolsters the diagnostic process for STI-related skin lesions. It offers a non-invasive means to observe and differentiate lesion characteristics, thereby supporting accurate diagnoses and facilitating timely and appropriate interventions.

Feasibility of Incorporating Dermoscopy into Clinical Practice

Dermoscopy integration into clinical practice offers several advantages for the clinical assessment of STI-associated genital lesions, particularly in diagnostic efficiency and accessibility. While confirmatory tests remain the gold standard for various STI diagnoses, the utilization of dermoscopy as an initial, non-invasive tool may guide targeted testing and reduce unnecessary or broad-spectrum laboratory evaluations [27]. Handheld dermoscopes are relatively inexpensive, with costs comparable to otoscopes and ophthalmoscopes. The ability to visualize distinct dermoscopic patterns in real-time may also enhance clinical suspicion and improve diagnostic confidence, allowing physicians to communicate sooner with patients regarding their potential diagnosis and treatment expectations.

Dermoscopic examination may be beneficial in environments where traditional diagnostic testing methods are limited or impractical. In resource-limited or underserved settings, many healthcare facilities lack access to advanced laboratory testing like serologic assays, polymerase chain reaction (PCR), or histopathology. As a result, healthcare professionals must rely on symptoms for diagnosis, which can be unreliable and lead to misdiagnosis. In these scenarios, dermoscopy provides an alternative diagnostic tool that does not require costly laboratory infrastructure and provides immediate visual information to aid in clinical decision-making. For clinicians that are unfamiliar with dermoscopic pattern recognition, dermoscopes can be connected via smartphone to capture high-resolution images and send them to dermatologists or infectious disease specialists for remote consultation. This practice is already occurring to diagnose skin cancer lesions through the Teledermatology in Rural Georgia program, where primary care providers transmit dermoscopic images to specialists for expert diagnostic and therapeutic recommendations [28]. By incorporating dermoscopy into genital lesion evaluations, especially in resource-limited settings, healthcare providers can minimize dependence on laboratory testing, enable timely treatment, and ultimately improve patient outcomes and access to specialized care.

Dermoscopy can prevent unnecessary delays associated with laboratory processing times, and promote early detection and intervention. This is especially important for highly contagious infections like herpes simplex virus (HSV) and syphilis, ultimately contributing to improved patient care and disease management. Additionally, dermoscopic examination may reduce the need for empirical treatments, which are often used while awaiting laboratory confirmation. By allowing for early targeted therapies, dermoscopy may play a role in reducing broad-spectrum antibiotic and antiviral overuse, promoting antibiotic stewardship. Lastly, dermoscopy is a suitable option for diagnosing genital lesions in situations where biopsy or testing is unfeasible. Ultimately, dermoscopy can be utilized as a relatively inexpensive point-of-care diagnostic tool for STI-associated genital lesions to reduce delays in diagnostic testing, improve clinical decision-making, and support more targeted therapeutic approaches.

Challenges and Barriers to Adoption

As dermatoscopy continues to establish itself as an essential diagnostic instrument in both dermatology clinics and primary care environments, several obstacles impede its wider implementation. It was noted that inexperienced providers may overlook critical signs or misinterpret normal variations as pathological findings, which emphasizes the necessity for extensive training in dermoscopy. A comprehensive cross-sectional survey conducted among dermatology fellows across the United States revealed that a striking 39.7% of respondents who do not engage in dermatoscopy attribute their lack of use to inadequate training [29]. This lack of

familiarity can inhibit practitioners' confidence in utilizing the tool, resulting in a reliance on traditional diagnostic methods, which may not yield the most accurate results. Moreover, only a quarter of those surveyed (25%) consider dermatoscopy a regular part of their clinical practice [29]. This indicates a significant gap in the integration of a valuable diagnostic technique that could improve patient care and outcomes.

Research underscores the positive impact of formal training, indicating that participation in a dedicated dermatoscopy training course considerably increases the likelihood of the technique being integrated into everyday medical practice [1]. Encouragingly, the landscape is evolving: recent data shows a notable shift in dermatology residency programs, with an impressive 84% now incorporating specialized dermoscopy training into their curricula as of 2016 [30]. This trend suggests a growing recognition of the importance of dermatoscopy and a commitment to equipping future practitioners with the necessary skills to utilize this valuable diagnostic tool effectively.

The challenge of obtaining critical diagnostic equipment is particularly evident in healthcare settings with limited resources. Research reveals that teaching hospitals, which function as academic medical centers, are significantly more likely to have access to dermatoscopy equipment than their counterparts, specifically non-academic and government-funded facilities [31,32]. This disparity can be attributed to the fact that academic centers frequently handle a higher volume of complex clinical cases, which raises the need for state-of-the-art diagnostic tools like dermatoscopes. In contrast, more commonplace conditions, such as sexually transmitted infections, often do not present the level of clinical intricacy necessary to warrant the use of dermatoscopy in these educational institutions. This results in a cycle where non-academic institutions may overlook the potential benefits of advanced diagnostic technology due to both a lack of resources and a limited clinical emphasis on complex cases that typically require dermatoscopy for accurate assessment and treatment. As a result, without significant advancements in the distribution and modernization of diagnostic technology, non-academic healthcare facilities are at risk of missing out on the valuable opportunities that dermatoscopy could bring to their diagnostic protocols. This could ultimately hinder their ability to provide comprehensive patient care and accurately diagnose skin-related conditions that may benefit from such an advanced tool [32]. Creating strategies to improve access to dermatoscopy in diverse healthcare settings is critical, as it could lead to earlier detection and treatment of STIs and other dermatologic conditions, ultimately improving public health outcomes.

The examination of genital lesions through dermatoscopy presents a multifaceted challenge, particularly in relation to patients' willingness to participate in such evaluations. A significant barrier is the prevalence of harmful stereotypes surrounding sexually transmitted infections, which can contribute to feelings of shame and embarrassment in patients presenting with genital lesions [33]. These stereotypes are often rooted in societal stigma, which inaccurately associates genital lesions exclusively with promiscuity or moral failing, thereby alienating individuals who may actually be experiencing benign conditions [33]. Despite the fact that not all genital lesions are indicative of STIs, the fear of judgment and the potential for social repercussions may discourage patients from being forthcoming about their symptoms. This hesitance can lead to diagnostic delays and worsened conditions, ultimately compromising patient outcomes. In clinical practice, this stigma often translates into a reluctance to undergo comprehensive examinations, including those utilizing dermatoscopy [34]. Many patients may perceive such procedures as invasive or excessively medicalized, particularly in a context that already involves sensitive discussions about sexual health.

The physical exposure associated with a dermatoscopic examination can intensify feelings of vulnerability and may be construed as disrespectful or threatening, particularly for individuals who struggle to communicate about their sexual health concerns. Consequently, patients may express a preference for a more conversational approach, seeking to describe their symptoms verbally rather than undergo a physical examination [33,34]. This preference highlights the necessity for healthcare providers to cultivate an environment of trust and security, in which patients feel empowered to disclose their concerns without fear of judgment. To address these issues, it is imperative for healthcare professionals to adopt a trauma-informed approach that recognizes the psychological impacts of stigma. This approach not only prioritizes patient comfort but also actively works to dismantle the stereotypes that contribute to shame [34]. By employing empathetic communication strategies and providing education about the nature of various lesions, clinicians can help alleviate patients' anxieties and promote their willingness

to participate in necessary examinations. Ultimately, fostering an open and nonjudgmental dialogue is essential for improving patient engagement and health outcomes in the context of genital lesions and sexual health.

Limitations of Current Literature/Future Directions

Despite many advantages, dermoscopy also has several limitations that hinder its application for the diagnosis of STI-associated genital lesions. First, diagnostic accuracy is very dependent on user expertise. Clinicians without formal training may misinterpret findings or overlook key features [1]. Additionally, interpretation of dermoscopy remains subjective and can vary between physicians, contributing to inconsistent clinical diagnoses and outcomes [29]. Dermoscopic presentations also differ based on anatomical site and skin type. Most existing studies focus on lighter skin tones, leaving a knowledge gap for darker skin tones [7,13]. Furthermore, the genital region presents some challenges due to its sensitivity and various mucosal surfaces, which may alter the appearance of lesions [27]. Literature gaps also exist on this subject. While syphilitic and HPV lesions have been moderately well-characterized, herpes simplex virus (HSV) lesions remain understudied, with less standardized criteria or large-scale studies available [9,15]. These limitations highlight the need for broader research efforts, including more diverse patient populations and studies, to enhance dermoscopy's utility in sexual health diagnostics.

CONCLUSION

Dermoscopy is a valuable, non-invasive clinical aid that can be used in the diagnosis of STI-associated genital lesions by enabling the rapid visual differentiation of conditions such as syphilis, HPV, and HSV. Characteristic patterns, such as dotted and glomerular vessels with an orange-red base in syphilis, or mosaic and fingerlike projections in HPV-induced warts, enhance clinical suspicion and may reduce reliance on laboratory testing or invasive procedures [7,8]. This is particularly beneficial in low-resource settings where traditional diagnostics are inaccessible or delayed [27]. Furthermore, dermoscopy can support early intervention and promote antibiotic stewardship by reducing empirical treatment. However, to fully integrate dermoscopy into sexual health care, future research should aim to standardize diagnostic criteria, improve provider training, and expand representation of diverse skin types and care environments [15,29]. With further research, dermoscopy holds the potential to significantly improve the accuracy, efficiency, and equity of STI diagnosis and management.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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