Dermatoscopy: Physics and Principles

Balakrishnan Nirmal
Department of Dermatology, Velammal Medical College and Research Institute, Madurai, Tamil Nadu, India

Abstract

Dermatoscopy is an in vivo noninvasive technique used to examine pigmented and amelanotic skin lesions. The technique is performed using a hand-held self-illuminating device called dermatoscope that visualizes features present under the skin surface that are not normally visible to unaided eye. The images from the dermatoscope can be digitally photographed or recorded for future reference. Nonpolarized dermatoscopy requires contact with the skin surface and interface fluid between glass and skin surface. Polarized light penetrates deeper than the nonpolarized light and does not require contact fluids.

Keywords: Dermatoscopy, nonpolarized, polarized

INTRODUCTION

Skin surface microscopy was first performed in the early 20th century by Johann Saphier (1920) using a binocular microscope having an inbuilt light source. Leon Goldman (1951), also known as father of dermatoscopy, used the technique for the evaluation of pigmented lesions. MacKie (1971) used the technique for the assessment of pigmented lesions before surgery. From then, dermatoscopy was recognized as a noninvasive technology used to visualize subsurface features including epidermis, dermoepidermal junction, and superficial dermis that are not visible to the naked eye.[1]

TERMINOLOGY

Dermatoscopy is also known as dermoscopy, skin surface microscopy, epiluminescence microscopy, and incident light microscopy.[2] However, the consensus with regard to the correct terminology for the technology is still debatable. While the term “dermoscopy” is popular, “dermatoscopy” is more traditional and correct.[3] The specialty is correctly termed as dermatology not dermology.[4] Hence, it is always better to use the correct terminology rather than using shorter popular terms.

COMPONENTS OF DERMATOSCOPE

The essential components of a dermatoscope include as follows:

1. Illumination system
2. Achromatic lens
3. Contact plate
4. Power supply.

Older dermatoscopes used halogen lamp illumination system which rendered a yellowish hue to the images. The present dermatoscopes utilize white-light-emitting diodes as light source which consumes less power when compared to the halogen lamps. Power source is rechargeable lithium battery, AA battery, and lithium-ion battery. The achromatic lens usually provides a magnification of ×10 in most standard dermatoscopes. Contact plates are multicoated silicone glass and either graduated or nongraduated. Graduated plates have a scale inscribed to measure the dimensions of the lesion examined.[5]

MAgnIFIED LIGHT

Natural light when incident on objects is reflected, absorbed, or scattered. Light incident on the skin surface normally is reflected back. This phenomenon is called glare or specular reflectance [Figure 1]. Light is reflected back because the stratum corneum has a higher refractive index of 1.55 as compared to 1.0 of air. Thus, most of the light...
incident on the skin surface is reflected when visualized with a magnifying glass, and hence, dermatoscope is not a magnifying glass.

**Nonpolarized Dermatoscopy**

To visualize deeper skin structures, this specular reflectance has to be reduced. This can be achieved when a glass plate with a refractive index of 1.52 comes in contact with the stratum corneum (1.55) with an interface fluid in between both the surfaces [Figure 2]. The refractive index of the fluid interface should ideally be equal to that of the skin to match it optically and minimize glare, allowing more light to penetrate through the stratum corneum.[6]

**Polarized Dermatoscopy**

Specular reflectance reduction is also achieved by a technology called polarized dermatoscopy which utilizes two filters held orthogonally at 90°. Polarizers are widely used in the field of photography to reduce glare.[7] Polarized light incident on the stratum corneum is partly reflected from the surface and the rest enters the skin. The part which is reflected from the skin surface maintains its polarization and is blocked by the second filter. The part which penetrates the skin surface loses its polarization and hence is allowed to pass the second filter. The polarized light penetrates 60–100 µm deep into the skin surface [Figure 3]. This technology which allows the light which has lost its polarization to pass through the second filter.
Nirmal: Dermatoscopy – Physics and principles

Figure 4: Dermatoscopy of acanthosis nigricans (×10): Crypts and fissures are more prominent in nonpolarized dermatoscopy (a) when compared to polarized dermatoscopy (b). (Image courtesy: Department of Dermatology, CMC, Vellore)

whereas blocking the light which maintains its polarization is known as cross-polarization.[8]

Figure 5: Dermatoscopy of psoriasis (×10): When compared to nonpolarized dermatoscopy (a) regular red dots are clearly visualized in polarized dermatoscopy. (Image courtesy: Department of Dermatology, CMC, Vellore)

Figure 6: Dermatoscopy of melasma (×10): When compared to nonpolarized dermatoscopy (a) accentuated reticular pattern seen more darker with polarized dermatoscopy (b). (Image courtesy: Department of Dermatology, CMC, Vellore)

Figure 7: Nailfold capillaroscopy of systemic sclerosis (×10) with ultrasound gel as interface fluid. (Image courtesy: Department of Dermatology, CMC, Vellore)

whereas blocking the light which maintains its polarization is known as cross-polarization.[8]

**Nonpolarized versus Polarized Dermatoscopy**

Nonpolarized dermatoscopy requires contact with the skin surface and interface fluid, whereas polarized dermatoscopy neither requires contact nor fluid. Nonpolarized dermatoscopy helps in better visualization of superficial structures such as
Comedo-like openings, milia-like cyst, crypts, fissures, and scales [Figure 4]. Deeper structures such as white, shiny streaks, vessels [Figure 5], and pigment network [Figure 6] are more conspicuous with polarized dermatoscopy.\[9\] Hence, nonpolarized and polarized dermatoscopy techniques are complementary to each other, with structures more apparent with one mode not being clearly visible in the other mode. These structures blink when toggled between both these modes in hybrid dermatoscopes possessing both these modes.\[10\]

**Interface Fluids**

The penetration of light from a dermatoscope is increased by the application of clear interface fluids. Few early studies have reported the use of immersion oil as contact fluid and have fallen out of favor subsequently due to carcinogenic and fetotoxic properties of chlorinated paraffin and dibutyl phthalate.\[11\] The various interface fluids used currently in dermatoscopy include alcoholic disinfectant, aqueous disinfectant, 70% ethanol, 90% isopropanol, liquid paraffin, water, and ultrasound gel.\[12\] Air inclusions are an issue when contact fluids are used and the number of inclusions is the highest for liquid paraffin. Ultrasound gel though slightly blurry is the fluid of choice in nails [Figure 7], mucosa, and periorbital region where other fluids will flow off. Alcohols have good clarity, low viscosity, and disinfectant properties. Nosocomial infection is a matter of concern with contact dermatoscopy. It has decreased significantly with the use of disposable covers for contact plates and disinfection with 70% isopropyl alcohol.\[13\]

**Colors**

Melanin is the most important chromophore in pigmented lesions, and the color of melanin under dermatoscopy depends on its depth of location in the skin and its concentration. Melanin is black under dermatoscopy when present in the stratum corneum or upper epidermis, brown at the dermoepidermal junction, gray at papillary dermis, and blue when present in the reticular dermis [Figure 8].

**Concluding Remarks**

Histopathologic examination is the gold standard of diagnosis in dermatology. Dermatoscopy is never an alternative or competitive method to histopathology, but a complementary tool that adds important clues to the diagnosis.\[14\] However, proper knowledge about the physics of the device and dermatoscopic patterns is extremely important to use this technique efficiently. Diagnostic accuracy of dermatoscopy correlates with the experience of the physician, and those not formally trained have decreased diagnostic performance.\[15\]

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Paech V, Schulz H, Argenyi Z, Gambichler T, Altmeyer P, editors. Introduction. Compendium of Surface Microscopic and Dermoscopic Features. Berlin: Springer; 2008. p. VII-IV.
2. Kalitrayan F. The scope of the dermoscope. Indian Dermatol Online J 2016;7:359-63.
3. Kittler H, Marghoob AA, Argenziano G, Carrera C, Curiel-Lewandrowski C, Hofmann-Wellenhof R, et al. Standardization of terminology in dermoscopy/dermatoscopy: Results of the third consensus conference of the international society of dermoscopy. J Am Acad Dermatol 2016;74:1093-106.
4. Ackerman AB. Dermatoscopy, not dermoscopy! J Am Acad Dermatol 2006;55:728.
5. Nischal KC, Khopkar U. Dermoscope. Indian J Dermatol Venereol Leprol 2005;71:300-3.
6. Wang SQ, Dusza SW, Scope A, Braun RP, Kopf AW, Marghoob AA, et al. Differences in dermoscopic images from nonpolarized dermatoscope and polarized dermoscope influence the diagnostic accuracy and confidence level: A pilot study. Dermatol Surg 2008;34:1389-95.
7. Pan Y, Gareau DS, Scope A, Rajadhyaksha M, Mullanli NA, Marghoob AA, et al. Polarized and nonpolarized dermatoscopy: The explanation for the observed differences. Arch Dermatol 2008;144:828-9.
8. Anderson RR. Polarized light examination and photography of the skin. Arch Dermatol 1991;127:1000-5.
9. Benvenuto-Andrade C, Dusza SW, Agero AL, Scope A, Rajadhyaksha M, Halpern AC, et al. Differences between polarized light dermatoscopy and immersion contact dermoscopy for the evaluation of skin lesions. Arch Dermatol 2007;143:329-38.
10. Braun RP, Scope A, Marghoob AA. The “blink sign” in dermoscopy. Arch Dermatol 2011;147:520.
11. Binder M, Kittler H, Pehamberger H, Wolff K. Possible hazard to patients from immersion oil used for epiluminescence microscopy. J Am Acad Dermatol 1999;40:499.
12. Gewirtzman AJ, Saurat JH, Braun RP. An evaluation of dermoscopy fluids and application techniques. Br J Dermatol 2003;149:59-63.
13. Stauffer F, Kittler H, Forstinger C, Binder M. The dermatoscope: A potential source of nosocomial infection? Melanoma Res 2001;11:153-6.
14. Lallas A, Argenziano G. Dermatoscope – The dermatologist’s stethoscope. Indian J Dermatol Venereol Leprol 2014;80:493-4.
15. Yucel A, Gunasti S, Aksungur VL. The influence of training on the recognition of gross features of dermoscopy images. Indian J Dermatol Venereol Leprol 2010;76:132-7.