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PEDIATRIC Dermoscopy Trichoscopy & Onychoscopy

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CHAPTER 2

Instrument

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DERMOSCOPE

INTRODUCTION

Rightly called as a dermatologist's stethoscope, a dermatoscope (a.k.a. dermoscope, skin surface microscope, epiluminescence microscope, episcope) is a noninvasive device which helps in visualization of the minute clinical details of not only the lesions on surface of the skin but also of the subsurface structures up to the superficial dermis. Basically dermoscope is a handheld microscope along with a magnification lens and an inbuilt illumination system.

ADVANTAGES OF DERMOSCOPE OVER A SIMPLE MAGNIFICATION LENS

Now, it is essential that a dermoscope should not be viewed as any other magnification device. Although the fundamental function of a dermoscope is magnification, it has several additional features:

- Self-built illumination system
- Image capturing and recording ability
- Allowing visualization of deeper dermal structures
- Analytical capacity (for follow-up of melanoma especially in western countries, e.g. DermoGenius MoleMap and FotoFinder dermoscope).

BASIC MODEL OF A DERMOSCOPE

The following integral components are assembled into a dermoscope:[1]

- *Achromatic lens*: The basic purpose of a lens is magnification. Majority of the dermoscope models provide magnification in the range of 10× – 20×. But higher magnification up to 1000× for better results can be attained with special lenses in modern videodermoscopes.

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- *Inbuilt illuminating system*: Currently, light-emitting diodes (LEDs) are the standard sources of light providing high intensity white light with less power consumption than the traditionally used halogen lamps. The illumination and the color (hence the wavelength) of light can be controlled which in turn determines the depth of penetration into the skin by the incident light. Structures under the surface of skin are made visible by the use of polarized light sources.
- *Power source*: Batteries like rechargeable battery (DermLite MSO), AA battery (mini 2000 dermoscope), lithium ion battery (DermLite DL1000), and rechargeable handles (DELTA 200) power the device.
- *Display system*: This can be the dermoscope itself (handheld dermoscopes) having a see-through viewing window, or having the ability to be connected to mobiles and using mobile screen as display, or the videodermoscopes that can be connected to the computer or other devices with their own display screen.
- *Inbuilt image capturing system*: Dermoscopes can be grouped on the basis of this feature as:[2]
  - Instruments without image capturing facility, e.g. dermatoscope
  - Instruments with image capturing facility, e.g. Dermaphot
  - Instruments with image capturing facility and analytical capability, e.g. DermoGenius Molemap.

Devices without image capturing facility: In these models, an adapter can be used for attaching cameras to some of these devices. Some examples of this type of dermoscope are DermoGenius Basic, DermaliteMSO, DELTA 10, and Mini 2000 Dermatoscope.

Devices with image capturing facility: Dermoscopes under this category have either an inbuilt image recording system or an attached camera. An apparatus like Mole Max I is also capable of whole body photography (body mapping). Video dermatoscopes (Video dermoscope, Videocap100) come under this category that can record small videos in addition to high resolution pictures, which can be seen on the computer screen. Delta20, Dermaphot, DermLite Foto, etc. are some of the models of this type.

Dermoscopes with image capturing facility and analytical capability: These devices have the additional feature of interpreting the images taken and are mostly used for follow-up of melanoma in western countries. New images of the patient are compared with the recorded ones and different color signals are generated in case of any significant change. Similarly, the benignness of a melanocytic nevus is decided by an artificial neural network mechanism. Some examples of this type are DermoGenius MoleMap, Fotofinder dermoscope, etc.

OPTICS IN DERMOSCOPY[3,4]

Optical Properties of Light without the Use of Dermoscopy

Any light ray incident on the skin undergoes reflection, refraction, diffraction, and absorption governed by the optical properties of two different media—skin and air. Refractive index of skin is 1.55 which is higher than that of air 1.00. Whenever light travels from skin to air, it follows Snell's law of refraction which states that when light travels from a denser medium

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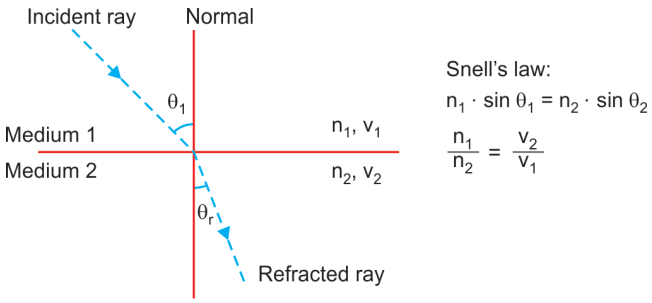

Fig. 1: Snell's law.

(higher refractive index) to a lighter medium (lower refractive index) it speeds up and bends away from the normal (Fig. 1).

Hence, most of the incident light reflected back from the stratum corneum known as *Surface glare* blinds the retina and prevents the observer from visualizing the light reflected from the deeper layers of skin.

Optical Properties of Light with Dermoscopy

There are two types of dermoscopy:[5]

1. Nonpolarized
2. Polarized.

Nonpolarized Dermoscopy

These dermoscopes require a liquid interface with refractive index equal to or closely matching that of the skin. The use of a liquid interface converts the skin-air interface to skin-liquid-glass (of the dermoscope) interface. Since the refractive indices of glass (1.52) and the liquid medium are almost similar to that of skin (1.55), the incident light reflected back from the surface of the skin undergoes minimal reflection and the observer is able to visualize the epidermis. Nonpolarized dermoscopy (NPD) can visualize structures up to the dermoepidermal junction. This is because incident light ray penetrating the superficial layers of skin [up to the dermal-epidermal junction (DEJ)] undergoes minimal scattering but there occur multiple scattering events, decay of light and decrease in reflected back light with increase in depth of penetrating light.

Various immersion liquids that can be used are 70% alcohol, ultrasound gel, water, liquid paraffin, or mineral oil. One should be particular to avoid formation of air bubbles in between the skin-liquid-glass interface as this would create a skin-air interface which causes back-scatter of light and the visualization of structures below the stratum corneum is prevented. 70% alcohol and water cause fewer air bubbles but come with the drawback of rapid evaporation. Ultrasound gels are best suited for onychoscopy and periorbital areas. Mineral oils are better avoided because they are fetotoxic, carcinogenic, and teratogenic.[6] Multicoated silicone glass is used to manufacture the glass plates of dermoscope. Graduated scales are inscribed into the glass plates for measuring the lesion.

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Polarized Dermoscopy

This type of dermoscopes uses two polarizers in orthogonal axes to achieve cross polarization. Light emitted from the polarized dermoscopy (PD) passes through the polarizer and becomes unidirectional (polarized) light. The reflected light must first pass through the second polarizer that is orthogonal (perpendicular) to the first. For this to happen, the original polarized light must undergo sufficient scattering events in the skin (randomization of polarization) that changes its direction by 90°.

Light reflected from the stratum corneum maintains its original polarization, cannot pass through the cross-polarized filter, hence PD is "blind" to surface glare.

Incident light penetrating the superficial layers of skin is not subjected to enough scattering events resulting in its direction change by 90° and pass through the cross-polarizer. Therefore, epidermal structures cannot be visualized with a PD.

Whereas the light penetrating deeply down the DEJ, through the superficial dermis encounters multiple scattering events leading to "randomization of polarization". Thus, reflected light from the deeper layers passes through the cross-polarized filter and enters observer's eyes permitting the visualization of structures below the DEJ up to the superficial dermis.

PDs do not need contact with skin or any immersion medium. This noncontact technique prevents nosocomial infections. Some PDs have the option of both noncontact and contact dermoscopy.

Difference between PD and NPD

Superficial structures (epidermis up to DEJ) are better seen in NPD whereas PD is better for visualizing deeper structures (DEJ to superficial dermis). Blood vessels and vascular blush are better seen with PD as blood vessels are located in deeper dermis, also due to the lack of pressure effect since PD uses noncontact technique.

Nonpolarized dermoscopy can specifically diagnose seborrheic keratosis by identifying milia-like cysts and comedo openings which are epidermal structures.[7]

Hybrid Demoscopes

Dermoscopes like DermLite DL 3N have PD and NPD modes which can be toggled by a switch. These devices improve dermoscopic diagnosis because one mode complements the other. These devices use contact technique with a liquid interface, or else dermoscopic features will be seen only in PD mode.

TYPES OF DERMOSCOPE[5]

There are two main types of dermatoscopes:

1. Handheld dermoscope
2. Video dermoscope.

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Handheld Dermoscopes

These are portable, cheaper and easier to maintain but the major limitation that comes with these kinds of devices are their limited magnification, limited area of visualization at a time, and difficulty screening larger areas in a limited span of time. The various handheld dermoscopes are:

- DermLite (3 gen)
- Delta 20 (Heine)
- Veos (Canfield).

DermLite Dermoscopes

DermLite line of dermoscopes are the often the first choice among dermatologists because of their portability, bright light source, good optics, and facility for being connected with mobile phones and tablets (iPhone, iPad, Samsung Galaxy). The latest DermLite dermoscope is DermLite DL4 among the many varieties of this line of dermoscopes. DL4 dermoscopes come with many advantages over the previous models like larger field of view, improved imaging of the deeper pigmentation, two levels of color spectrum control (PigmentBoost Plus), and all this in a smaller size. Along with this, they (DL4 dermoscopes) come with a unique facility for infection control with their Ice Cap (Infection Control and Epidemiology system) technology. These disposable caps can be attached with the spacer and greatly reduce the risk of contamination. Most of the dermoscopes of this series are hybrid with few only PD (DL 100, DL 200HR) models also available.

Heine Dermoscopes

Durability and high-resolution dermoscopic image capturing ability are the essential features of this series of devices. These sturdy dermoscopes are good option for academic institutions with multiple users. The dermoscopic images achieved with these devices are of high quality suitable for publication purpose. These devices are also hybrid and can be toggled between polarized and nonpolarized. But Heine dermoscopes need to be connected with a DSLR camera and adapter for DSLR for image capturing. Thus, even though the device is portable, it is impractical to carry the entire image capturing facility from one place to another.

Veos Dermoscopes

Veos dermoscopes are smart, flexible, and versatile. Veos HD1 is polarized and Veos HD2 is hybrid model. Both the devices come with an optional sleeve attachment for Iphone-enabling high-quality dermoscopic image capture and storage facility. Canfield has come up with whole body imaging systems like VECTRA WB 180 and VECTRA WB 360 which instantaneously capture the patient's skin surface and body shape of entire body in a single high-resolution 3D image. The Veos dermoscopes can be integrated with the DermaGraphix software, so that the dermoscopic images captured can be linked with their corresponding tagged lesions in the 3D body map. This has additional applications like the accurate body area assessment in case of psoriasis (PASI calculation), vitiligo, etc.

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Video Dermoscopes

Video dermoscopes require a computer or any other screen for output of images and thus they provide options for recording of small videos. Video dermoscopes range from simple models with only NPD mode to complex models (marketed by DermaIndia TLS Ultracam) having multiple light sources (visible light, polarized light, and ultraviolet light). Ultraviolet light can be used as a Wood's lamp to differentiate pigmented lesions (e.g. vitiligo from other depigmented lesions). Video dermoscopes are very good for teaching purpose where exact structure can be shown to students.

Handheld Video Dermoscopes

These are small pocket-sized instruments having a screen like mobile to enable viewing of the dermoscopic images. These devices are inexpensive, high magnification, portable, do not need to be attached to a computer but have lower resolution. They also have an inbuilt camera for image capturing and storage (Figs. 2 to 6).



Figs. 2A and B: DermLite DL3.

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Fig. 3: DermLite DL4.



Fig. 4: DermLite with smart phone attachment.

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Figs. 5A and B: DermLite Photo II Pro.

CONCLUSION

In the current scenario, dermoscopes are like the bridge between clinical dermatology and dermatopathology. With increasing awareness about dermoscopy and development of specific dermoscopic signs, this noninvasive device has become an integral addition to the existing diagnostic armamentarium for dermatologists.

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Fig. 6: Fotofinder.

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Subrata Malakar MD (Dermatology) DCH is an accomplished clinician and astute academician par excellence, heading Rita Skin Foundation, one of the premier dermatology centers in Kolkata, West Bengal, India. Having passed Dermatology in 1985, he has also completed diploma in child health from one of the top institutes in Kolkata. His passion for Dermatology, vision in innovation and commitment to the subject has rendered him the status of a teacher and doctor par excellence. He has authored two books Trichoscopy: A Text and Atlas and Dermoscopy: Text and Atlas, over 90 papers in various international and national journals, many chapters in various textbooks and over 76 presentations in international and national conferences. Dr Malakar has received several prestigious honors and awards in his career. He is known amongst his peers as a visionary, always striving for excellence and his passion for innovation distinguishes him in the field of dermatology.

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