Polarized and Nonpolarized Dermoscopy

The Explanation for the Observed Differences

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DIFFERENCES IN OBSERVED STRUCTURES, colors, and patterns present in lesions imaged with nonpolarized dermoscopes (NPDs) and polarized dermoscopes (PDs) have been previously noted.[1,2] Herein we address the science behind the differences observed and present representative lesions in which these differences can be appreciated. Under normal conditions, most of the light that impinges on the skin surface will be reflected (ie, specular reflectance or glare) due to the higher refractive index of the stratum corneum (1.55) compared with that of air (1.0). An NPD reduces this reflection by using a liquid interface that optically matches the refractive index of the glass plate of the dermoscope (approximately 1.52) with the stratum corneum.[1] Elimination of the air interface reduces the amount of light reflected off the stratum corneum (**Figure 1**, blue line) and allows for increased light penetration into the skin (Figure 1, red and black lines). Light that is being scattered from below the corneal layer (Figure 1, red dashed and black lines) allows for the direct observation of underlying dermoscopic structures. A PD reduces the visualization of surface-reflected light through the use of 2 polarizers with orthogonal axes (intersecting at 90°). Light passing through the source polarizer is unidirectional and will be rejected by the detector polarizer unless it changes its direction of polarization. Since polarized light reflected from the superficial layers of the skin (Figure 1, blue and red lines) maintains its original polarization, it is completely rejected by the detector polarizer. Polarized light scatters as it penetrates the skin and, on average, undergoes 10

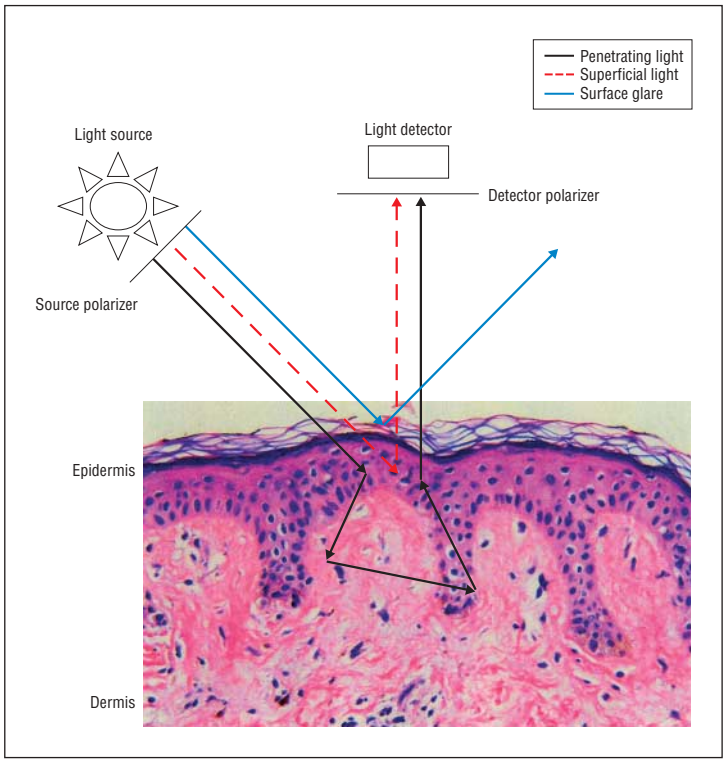

Figure 1. Penetrating light is multiply backscattered light; superficial light is singly backscattered light; surface glare is specular reflectance.

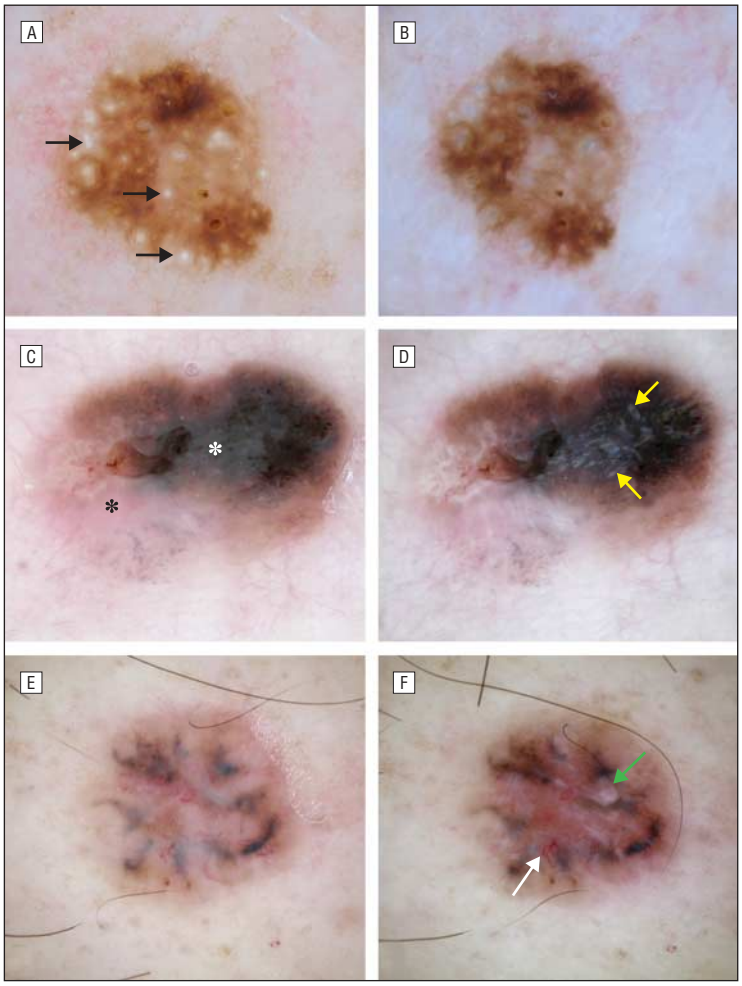

Figure 2. Appearance of seborrheic keratosis (A and B), melanoma (C and D), and basal cell carcinoma (E and F) under nonpolarized dermoscopy (NPD) (A, C, and E) and polarized dermoscopy (PD) (B, D, and F). A, seborrheic keratosis under NPD exhibits many bright superficial milia cysts (black arrows); B, under PD, these milia cysts are not apparent. C, Prominent blue-white veil of melanoma, which in this case is due to compact orthokeratosis, is seen clearly in the NPD image (asterisks); D, veil is hard to appreciate under PD. However, PD allows the observer to visualize deeper structures such as white shiny streaks, representing collagen/fibrosis in the superficial dermis (yellow arrows), which are not seen in the NPD image. E and F, The blood vessels of basal cell carcinoma are less prominent and less numerous when seen with NPD (E) than with PD (F, white arrow). Furthermore, white, shiny, streaklike areas are better appreciated under PD (F, green arrow) than under NPD (E).

scattering events before its polarization is randomized (Figure 1, black line).[3,4] The depth that polarized light penetrates before undergoing 10 scattering events is approximately 60 to 100 µm. In other words, most of the light returned is from deeper layers (Figure 1, black line) and not singly backscattered light (Figure 1, red line) or surface-reflected polarized light (Figure 1, blue line). These physics explain the differences between PD and NPD observations and account for the depth of the skin each device can visualize. An NPD is better able to visualize the superficial layers of the skin, thus allowing for the easy identification of structures such as milialike cysts and the blue-white veil associated with orthokeratosis (**Figure 2**A and C). In contrast, a PD is essentially "blind" to the superficial layer and thus will not allow the observer to appreciate these structures, which may be important diagnostic cues for some lesions such as seborrheic keratosis (Figure 2B and D). However, by eliminating the superficial glare, PD allows for better appreciation of deeper structures such as the vasculature and collagen (Figure 2D and F), which may be helpful in identifying some malignant neoplasms.[1]

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1. Benvenuto-Andrade C, Dusza SW, Agero AL, et al. Differences between polarized light dermoscopy and immersion contact dermoscopy for the evaluation of skin lesions. *Arch Dermatol*. 2007;143(3):329-338.
2. Agero AL, Taliercio S, Dusza SW, et al. Conventional and polarized dermoscopy features of dermatofibroma. *Arch Dermatol*. 2006;142(11):1431-1437.
3. Jacques SL, Roman JR, Lee K. Imaging superficial tissues with polarized light. *Lasers Surg Med*. 2000;26(2):119-129.
4. Anderson RR. Polarized light examination and photography of the skin. *Arch Dermatol*. 1991;127(7):1000-1005.