Comparison of visual effects of immersion fluids for dermoscopic examination of acral volar melanocytic lesions

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Abstract

Background: Acral volar melanocytic lesions have a high potential for malignancy. Dermoscopy is a useful, noninvasive tool for the diagnosis of such malignancies. The use of immersion fluids can provide better visual effects and improve the diagnostic accuracy of dermoscopic examinations.

Methods: Fifteen volar melanocytic lesions, including two palmar and 13 plantar lesions, were included in our study. We compared the visual effects of two different immersion fluids as an interface for dermoscopy. Four combinations of immersion fluid (ultrasound jelly or mineral oil) and observation mode (polarized or nonpolarized light) were compared for visual effects during the dermoscopic examination of lesions based on air bubble inclusion and microstructure visibility.

Results: Both the mineral oil and the ultrasound jelly allowed at least one microstructure to be clearly visible in each image of the acral volar melanocytic lesions examined. All modes of observation achieved acceptable visual effects. The use of mineral oil and the polarized light mode resulted in the formation of fewer bubbles than the use of mineral oil and the nonpolarized light mode ($p < 0.05$). The use of ultrasound jelly and the polarized light mode resulted in significantly better visual effects ($p < 0.05$) than that of ultrasound jelly or mineral oil and the nonpolarized light mode.

Conclusion: The use of either mineral oil or ultrasound jelly as an interface provides acceptable visual effects for the dermoscopic examination of acral volar melanocytic lesions. The use of the polarized light mode reduced the reflection and scattering of light, resulting in better visual effect than that achieved using the nonpolarized light mode. In the early diagnosis of acral melanoma, choosing the appropriate application of immersion fluid and observation mode yields the optimal visual effect.

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Introduction

Acral volar skin is the most prevalent site of malignant melanoma in Asian populations. The palmar and plantar melanomas are usually diagnosed at an advanced tumor stage, conferring a poor prognosis. Early acral melanoma is seen as a brownish macule, which is clinically similar to acral nevus. Screening techniques include skin self-examination, clinical skin examination, and biopsy. Dermoscopy can increase both specificity and sensitivity in the diagnosis of melanoma.

The use of conventional contact nonpolarized light dermoscopy (NPD), contact, or noncontact polarized light dermoscopy (PD) impact clinical diagnosis differently. Currently, contact and noncontact PD are widely used. In contact PD and NPD, choosing an appropriate immersion fluid as an interface provides better visual effects during the dermoscopic examination of lesions.

The purpose of our study was to compare the use of polarized and nonpolarized light observation modes using mineral oil and ultrasound jelly for the dermoscopic examination of acral volar melanocytic lesions.

Methods

PD is currently widely used. In PD, the polarized light is obtained using filters that achieve a cross polarization. In both contact and noncontact PD, the scattering of light by the deep tissues is selectively limited, which reduces the reflectivity of the skin surface.
Either PD or NPD with the contact mode uses an immersion fluid that functions as a liquid interface between the skin and the instrument. The immersion fluid has a refraction index that is approximately equal to that of the skin, which reduces the reflectivity of the skin and enhances the transparency of the stratum corneum, allowing the observation of the subsurface structures and the location and distribution of the melanin. To aid clinicians in the efficient diagnosis of acral volar pigmented lesions, immersion fluids with specific viscosities and optical characteristics are used to optimize the visualization of structures beneath the stratum corneum. Various types of immersion fluids, such as alcohols, ultrasound gel, water, and mineral oil, have been evaluated for the visualization of a range of different types of lesions. Ultrasound jelly and mineral (paraffin) oil were used as the immersion fluids (Figure 1B) in our study due to the adequate viscosity and low volatility for acral volar skin applications.

Two palmar and 13 plantar melanocytic lesions were included in our study. Thirteen patients (2 men and 11 women) were enrolled in our study. A dermatoscope (DermLite II hybrid; 3Gen LLC, California, USA) with polarized and nonpolarized observation functions was used for visualization in our study (Figure 1A). The images were recorded using a digital camera with 1360 megapixels image resolution (DSC-W300; SONY, Tokyo, Japan) that was attached to the dermatoscope using an adaptor ring (VAD-WP; SONY).

The immersion fluid was applied over the lesion covered by a plastic wrap (Figure 1C), which was used to maintain hygiene and ease of clean-up, and the dermatoscope lens was placed on the lesion at a 90° angle (Figure 1D). The plastic wrap was stretched with slight tension to ensure contact with the skin surface. To obtain the best visual effect by dermoscopy, the following observation mode/immersion fluid combinations were evaluated: Group 1, ultrasound jelly with nonpolarized light; Group 2, ultrasound jelly with polarized light; Group 3, mineral oil with nonpolarized light; and Group 4, mineral oil with polarized light. Four digital images of each lesion at 10× magnification were recorded. A blinded dermoscopic expert evaluated the visual effects using a pattern analysis that is unique to acral volar surfaces.4

Evaluation of air bubble inclusion

Because air bubbles can be introduced into the immersion fluids during image acquisition, the numbers of air bubbles were evaluated as a parameter for image quality assessment. The images collected were classified into three categories based on the number of bubbles as follows: Category 1, no air bubbles; Category 2, one to 15 bubbles; and Category 3, more than 15 bubbles.

Evaluation of microstructures and pattern analysis

The structural analysis parameters included parallel ridge, irregular diffuse pigmentation, parallel furrow, lattice-like patterns, fibrillar patterns, blotch with regular or irregular distribution, regression, regular network, dots, blue-whitish veil, and unclassified patterns because they are widely used for the diagnosis of melanocytic lesions.5–9 Based on the number of structural components, the collected images were classified into three categories as follows: Category 1, no distinct structural components; Category 2, one distinct structural component; and Category 3, more than one distinct structural component.

Statistical analysis

The frequencies and percentages of the categorical variables were determined, and the Chi-square test was used to evaluate the statistical relationship between the visual effects for each combination. The level of statistical significance was defined as p < 0.05. The MedCalc for Microsoft Windows, version 10.2.0.0 (MedCalc Software, Meriaerde, Belgium) computer software was used for the statistical analysis.

Results

Two palmar lesions and 13 plantar lesions, including two toe lesions and one heel lesion, were included in our study. A representative image of the types of bubbles observed is shown in Figure 2 (white arrow). Air bubbles were observed in most of the
images, regardless of the observation mode used (Table 1). Although bubbles in ultrasound jelly are thought to be generated during the dispensing of the mixture by squeezing it from the bottle, no significant difference in bubble numbers was observed between the jelly and oil groups. Fewer bubbles were observed using the oil and polarized light observation mode (Group 4) than the oil and nonpolarized light mode (Group 3), whereas no significant differences in the number of bubbles were observed between the ultrasound jelly groups.

Representative images of an acral melanoma case with the typical parallel ridge pattern (Figure 2, blue arrow), blue-whitish veil pattern (Figure 2, yellow arrow), and asymmetric blotch pattern (Figure 2, red arrow) are shown in four observation modes in Figure 3. A case of acral vular nevus showing parallel furrow, lattice-like, and fibrillar patterns under the four observation conditions is presented in Figure 4. The fibrillar pattern is an artifact resulting from shearing forces. Most of the observation modes yielded one distinct structural component including parallel furrow, lattice-like, fibrillar, regression, regular network, and dots pattern, with few images displaying more than one structure, that is, one lesion showed parallel ridge and blotch patterns and two lesions showed parallel furrow and fibrillar patterns. Some reflection was caused by the wrinkled surface of plastic wrap (Figure 4B).

The numbers of distinguishable dermoscopic structures are shown in Table 2. The use of ultrasound jelly and the polarized light mode produced better structural observation than that of the jelly and the nonpolarized light mode (p < 0.05). The use of the ultrasound jelly and the polarized light mode provided better structural observation than that achieved using the mineral oil and the nonpolarized light mode (p < 0.05).

**Discussion**

Acral vular melanocytic lesions are well known for their high potential for malignancy, especially for the development of melanoma. Acral lentiginous melanoma is considered to be more aggressive, and carries a poorer prognosis than other subtypes of melanoma. An early difference in the biological nature of the tumor may be associated with a better outcome than a delayed diagnosis. The area chosen for biopsy may not contain the most histopathologically advanced cells because the hyperpigmented lesions that are often suspected of malignancy usually present with a mottled, rather than homogenous, appearance. In an uneven acral vular surface, it can be very difficult to obtain a biopsy specimen with sufficient width and depth for accurate diagnosis. Dermoscopy, also known as epiluminescence microscopy, plays an important role in assisting clinicians in the diagnosis of pigmented lesions because it can be used to analyze the entire skin lesion noninvasively. Accurate evaluations of the microstructures and colors of the skin are essential for the in vivo diagnosis of early acral melanomas. Various local dermoscopic features of melanocytic lesions on acral vular skin have been described. Saida et al examined acral vular pigmented lesions in an Asian population, and described the dermoscopic features of those lesions. The typical patterns of early acral melanoma are the parallel ridge pattern and diffuse irregular pigmentation. Besides, melanocytic nevi located at sites that directly bear the body’s weight tend to have fibrillar patterns, whereas other types of nevi located on the arch areas usually have lattice-like patterns. Some acral nevi may undergo temporal changes in dermoscopic features, but the transition from benign dermoscopic patterns to the parallel ridge pattern has not been reported, implying that the de novo development of primary melanoma may be possible in the absence of a pre-existing nevus.

The accuracy of melanoma diagnosis by dermoscopy is approximately 30% greater than that of clinical visual inspection. Recent research showed that the use of immersion fluids in polarized light contact dermoscopy improves the diagnosis of acral melanocytic lesions. The optimal characteristics of immersion fluids include high microstructure visibility (known as high effect), the maintenance of color, nonstaining, noncrystallizing (on the dermatoscope), low volatility, adequate viscosity, low air bubble inclusion, economical, and easy clean-up. We compared the use of ultrasound jelly and mineral oil in the dermoscopic analysis of acral vular melanocytic lesions. Two important parameters, air bubble inclusion and microstructure visibility, were evaluated because the presence of air bubbles can impact image definition and structural features are critical for good image assessment.

**Assessment of air bubbles**

The light-emitting diode (LED) light used in dermoscopy influences the temperature of adjacent materials. Thus, the viscosity and surface tension of immersion fluids decrease as their temperature increases, which reduces air bubble formation. Ultrasound jellies, which are primarily aqueous polyacrylamide solutions, have a higher viscosity and surface tension than pure water. Mineral oil has a lower surface tension, which may result in less bubble formation in dermoscopic applications. However, our results showed that the use of mineral oil as an immersion fluid for the observation

<table>
<thead>
<tr>
<th>Category</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (%)</td>
<td>3 (20.0)</td>
<td>9 (60.0)</td>
<td>3 (20.0)</td>
<td></td>
</tr>
<tr>
<td>N (%)</td>
<td>3 (20.0)</td>
<td>6 (40.0)</td>
<td>6 (40.0)</td>
<td></td>
</tr>
<tr>
<td>N (%)</td>
<td>4 (26.7)</td>
<td>9 (60.0)</td>
<td>2 (13.3)</td>
<td></td>
</tr>
<tr>
<td>N (%)</td>
<td>3 (20.0)</td>
<td>11 (73.3)</td>
<td>1 (6.7)</td>
<td></td>
</tr>
</tbody>
</table>

Category 1: no air bubbles; Category 2: up to 15 bubbles; Category 3: more than 15 bubbles.

a The total number of air bubbles regardless of size in each image were evaluated.
of melanocytic lesions on acral volar skin does not result in less bubble formation than the use of ultrasound jelly, with the two different types of immersion fluids providing equal visual effects in dermoscopy. Thus, ultrasound jelly may represent a better choice as an immersion fluid because it can be more easily removed from both the skin and the lens of the instrument. The easy clean-up of ultrasound jelly may also allow examination without the use of plastic wrap, which produces interference during dermoscopic observation.

Our results also showed that fewer numbers of air bubbles were introduced during the use of the polarized light mode with mineral oil obtained better visual effect (i.e., less visible bubbles) than the use of the nonpolarized light mode with mineral oil ($p < 0.05$), whereas no significant difference in the number of bubbles was observed between the polarized and nonpolarized light modes when ultrasound jelly was used. The larger-sized bubbles generated in the ultrasound jelly as it is squeezed from the bottle may increase light scattering and reflection more than the smaller bubbles introduced as the mineral oil is dispensed, and may thus interfere more with dermoscopic observation. Preheating the bottle of the ultrasound jelly in a warm water bath may reduce the surface tension of the jelly, resulting in a reduction in the size of the bubbles introduced when dispensing it. Further study is required to provide corroborative evidence that the polarized light mode produces less visible bubbles when ultrasound jelly is used as an immersion interface.

**Structural analysis**

The nonpolarized light device used in our study contained 24 LEDs. Its use is considered to cause more reflection and scattering of light, making more bubbles visible during dermoscopic observations, compared with the use of the polarized light device, which contained eight LEDs. The optimal image was obtained while placing the dermatoscope on the skin at an angle of $90^\circ$, and spreading the immersion fluid to the periphery with circular movements. The results of our structural analysis revealed that the use of either mineral oil or ultrasound jelly allowed at least one microstructure to be clearly visible in each image. All modes of observation provided acceptable visualization of the plantar melanocytic lesions. Our results also suggest that the polarized light mode provides better visual effects with more visible dermoscopic structures than the nonpolarized light mode, regardless of the type of immersion fluid used.

Herein, we demonstrate some typical features of acral volar melanocytic lesions. Dermoscopy was used to aid the diagnosis in an 84-year-old woman who had a 5-year-history of two blackish patches over her right heel. Three types of microstructures were noted, including blue-whitish veil pattern, parallel ridge pattern, and some blotches with dark-brown or black structureless area and asymmetric distribution, which are all characteristic of melanomas (Figure 2). The parallel ridge pattern, a pattern typical of benign acral nevus, was clearly visible in all four modes of observation (Figure 3). However, the dermoscopic features of the same type of melanocytic lesions also showed deviations from the furrow and fibrillar patterns using different modes of observation of another plantar lesion (Figure 4). The fibrillar pattern is an artifact resulting from the slanted arrangement of the cornified layer, which does not represent proliferating melanocytes within the epidermis. Keeping the dermatoscope pressed firmly against the lesion while moving the dermatoscope horizontally on the skin surface (known as the wobble test) may cause a parallel furrow pattern to appear as a fibrillar pattern. However, both the furrow and fibrillar patterns are characteristic of benign tumors.

Our results differ somewhat from those of Levent et al, who found that oil performed better as an immersion fluid than ultrasound jelly for the identification of the pigment network in lesions. However, another finding in the same study reported that there was no difference in the accuracy of diagnosis between the

![Figure 3](image-url) Parallel ridge pattern from the heel using four observation modes. (A) Ultrasound jelly with nonpolarized light. (B) Ultrasound jelly with polarized light. (C) Mineral oil with nonpolarized light. (D) Mineral oil with polarized light.
use of ultrasound jelly or mineral oil as an immersion fluid for the examination of nevo-melanocytic or nonmelanocytic lesions of the skin, mucosa, or nail beds. In addition, our results are partially consistent with those of Benvenuto-Andrade et al who concluded that melanin appeared darker and blue nevi exhibited more shades of blue in polarized light dermoscopy images, compared with nonpolarized light dermoscopy images.23 We propose that the light mode, rather than the immersion material, has the greatest impact on visual effects in dermoscopy because both the mineral oil and the ultrasound jelly provided acceptable visual effects in our study.

**Study limitations**

Our current findings should be interpreted with caution because of the following limitations of our study. First, plastic wrap was used as a shield between the lens of the dermatoscope and the skin to allow more rapid switching between the observation modes, and the lens was easily cleaned. However, some reflection was caused by the wrinkled surface of the plastic wrap. This systemic error might be minimized if the plastic wrap surface was substituted with one’s own dermoscopy lens surface. Second, it was difficult to apply the same amount of immersion fluid to each lesion for all the observation modes, which may have affected bubble formation. Third, the experience of the photographer may play an important role in the quality of dermoscopy images. The collection of photos can be difficult for tumors on acral surfaces with bi-axial curvature, such as toes or nail beds. Small lens or noncontact mode dermoscopy may provide additional diagnostic information for such tumors. Further studies are required for dermoscopic examination of the more delicate parts of the distal extremities.

**Conclusion**

We found that the use of either mineral oil or ultrasound jelly as an immersion fluid provided acceptable visual effects for dermoscopy. No statistical difference of visual effects between the use of ultrasound jelly or mineral oil as an immersion fluid for dermoscopic examination of acral volar melanocytic lesions. Mineral oil provided neither fewer air bubbles nor more visible microstructures than ultrasound jelly did in this study. Although the polarized light mode reduced the reflection and scattering of light, providing better visual effects than those obtained using the nonpolarized light mode. Achieving optimal visualization using PD, especially noncontact PD, for the assessment of acral pigmented lesions remains challenging because of the extremely thick corneal layer, the bi-axial curvature of acral surfaces (especially the digits), and a large amount of cleavage lines in acral regions. In the early diagnosis of acral melanoma, choosing the appropriate application of immersion fluids and observation modes yield optimal visual effects.

**Table 2**

Evaluation of distinguishable dermoscopic microstructures in all observation modes (N = 15).

<table>
<thead>
<tr>
<th>Group</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
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<tbody>
<tr>
<td>Group 1</td>
<td>0 (0.0)</td>
<td>13 (86.7)</td>
<td>2 (13.3)</td>
</tr>
<tr>
<td>Group 2</td>
<td>0 (0.0)</td>
<td>12 (80.0)</td>
<td>3 (20.0)</td>
</tr>
<tr>
<td>Group 3</td>
<td>0 (0.0)</td>
<td>13 (86.7)</td>
<td>2 (13.3)</td>
</tr>
<tr>
<td>Group 4</td>
<td>14 (93.3)</td>
<td>1 (6.7)</td>
<td></td>
</tr>
</tbody>
</table>

Category 1 – no distinct structural components; Category 2 – one distinct structural component; Category 3 – more than one distinct structural component.

Group 1 – jelly as immersion fluid with nonpolarized light mode; Group 2 – jelly as immersion fluid with polarized light mode; Group 3 – oil as immersion fluid with nonpolarized light mode; Group 4 – oil as immersion fluid with polarized light mode.
Acknowledgments

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References