Comparison of Photographic Methods

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ABSTRACT

Background: Photo documentation has become increasing important in medicine, especially given the demand for cosmetic procedures. Standard photography is not always adequate; newer techniques exploring the use of polarized, cross and ultraviolet photography can give detailed information on subtle skin lesions including skin pigmentation and skin surface characteristics.

Objective: To use various methods of photography including standard photography, cross polarized light, parallel polarized light and ultraviolet passing photography to assess which method most effectively captures skin features such as texture, pigment, and/ or vascularity.

Methods: A prospective analysis comparing advanced photographic techniques including standard photography, polarized light photography, cross-polarized light photography and ultraviolet light passing photography. The photos were then evaluated and scored by two experts and a blinded observer to characterize the differences visualized in each type of photography compared to standard photography in terms of subsurface skin features, hypopigmentation, hyperpigmentation, and rhytids.

Results: 9 subjects completed the study. Overall, of the 3 photographic methods compared to standard photography, UV passing most enhanced the visualization of subsurface features and hypopigmentation, with increased hyperpigmentation as well. Enhancement of these features made UV passing best for capturing photodamage. Cross-polarized photography was best for visualizing hyperpigmentation, but also heightened visualization of hypopigmentation and subsurface features such as vascularity. Parallel-polarized photography enhanced visualization of skin texture.

Conclusions: These methods of photography show a quantifiable and reproducible selective ability to evaluate and document elements such as skin texture, vascularity, and pigmentation. Each of these techniques has unique properties that can add to the precision of the clinical evaluation and can be of particular value to providers of cosmetic procedures where photo documentation has become increasingly important in providing an objective means of evaluating outcomes.

J Drugs Dermatol. 2015;14(2):134-139.

INTRODUCTION

Photography has become increasing utilized in the regular practice of medicine. Aesthetic and reconstructive surgeons have depended on photography for the past 50 years for documentation, assessment of operative results, education, and communication among peers.[1] Today it has become an increasing integral piece of medical documentation, in some fashion, for most specialties. Cosmetic procedures continue to increase in popularity and accurate documentation with pre and postoperative photographs is essential. Standardized photography provides an objective way of evaluating outcomes after aesthetic and reconstructive procedures and for documentation of pathology and medical conditions being treated.

Patient satisfaction is a significant consideration when determining treatment outcomes. It is not uncommon at a return visit for a patient to not fully appreciate the results of a cosmetic procedure. "Is it better? Can you show me?" Providing patients with an opportunity to study their before and after photos may give them the reassurance they are seeking. Photographs can also be used pre-treatment to discuss realistic goals and expectations for particular treatments. This is even more important as noninvasive cosmetic procedures become increasing popular since the outcomes are often very subtle and may be difficult to appreciate. However, plain photography may not adequately capture these subtle changes. Changes in skin color such as erythema and pigmentation or changes in skin texture such as improvement in fine lines or scarring may be difficult to appreciate and evaluate using traditional standard photography. Glare, lighting, and perspective can all alter a photograph to selectively portray or enhance what we visualize with the naked eye. This is a technique that has been taken advantage of by professional photographers who attempt to highlight their subject's favorable features and minimize less desirable attributes.

As physicians attempting to alter patient characteristics such as texture, pigment, vascularity, and contour, there may be certain methods of photography that, if used appropriately, will more accurately document these selective characteristics. The objective of this study is to use various methods of photography including standard photography, cross polarized light, parallel polarized light and ultraviolet light passing photography to assess which method most effectively captures skin features such as texture, pigment, and/ or vascularity. Ultimately, the goal of this study is to provide the reader with confidence in duplicating the photographic setup and implementing this technique for selective and accurate documentation of patients undergoing procedures of an aesthetic or reconstructive nature or of pathologic processes that are reflected by these features.

METHODS

This is a prospective study evaluating the efficacy of various photographic methods for a variety of specific patient skin characteristics including, skin texture, pigment, and/ or vascularity. Multiple dermatologic processes such as basal cell lesions, vitiligo and hypopigmentation, melasma, or photoaging were examined using each of the methods of photography including standard color flash photography, parallel polarized light photography, cross polarized light, ultraviolet light passing photography and black and white standard photography. Approval for this study was obtained from Wake Forest School of Medicine Institutional Review Board.

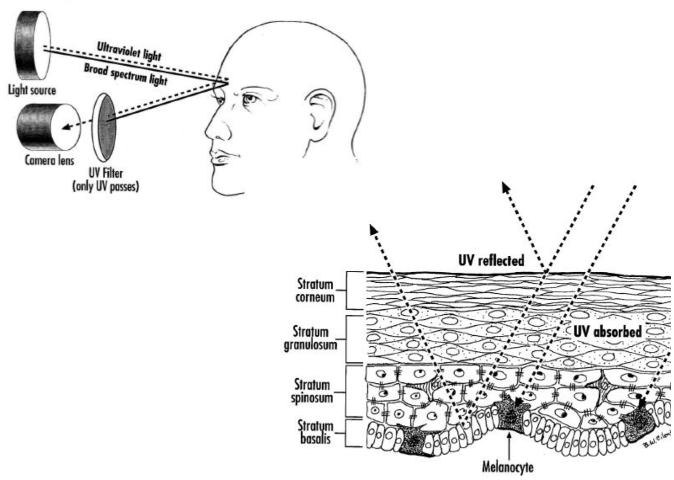
Subjects 18 years of age and older were recruited from The Wake Forest School of Medicine, Department of Otolaryngology clinic (ENT) and the Facial Plastic & Reconstructive Surgery Clinic. Written informed consent was obtained from subjects that agreed to participate. Subjects were asked to complete a data collection form, which included gender, date of birth, race, Fitzpatrick score, history of skin cancer, history of sunscreen use, and history of facial surgery. Subjects were instructed to cleanse facial skin in order to remove any ultraviolet protecting makeup or sunscreen, as well as camouflage. Patients were photographed using standard color and black and white photography, parallel-polarized light photography, cross-polarized light photography, and ultraviolet passing light. An otolaryngologist, a fellowship trained board-certified facial plastic surgeon, and a blinded non-physician observer evaluated the photographs with an objective numerical scale to characterize the differences visualized by with type of photography.

All patients were photographed with all photographic techniques including plain film, UV passing, parallel polarized, and cross-polarized photography. First the patients were positioned in a sitting position on a standardized chair in a standardized position.

Standard black and white photography: A standard gray scale background and standard fixed chair positions were used for all views. Photographs were obtained with the Nikon N70 camera using a Nikkor AF 105 mm D series lens with Black and White Tmax 400 film. Overhead lighting was from a Paul C. Buff White Lightning flash. Light was projected a length of 2 feet in front of the subject—set to a height at face level. The baseline photograph is taken with the flash settings at low power in order to provide as similar exposure as possible to the ultraviolet passing photography, which blocks significant portions of the light spectrum and is therefore darker at the same flash output.

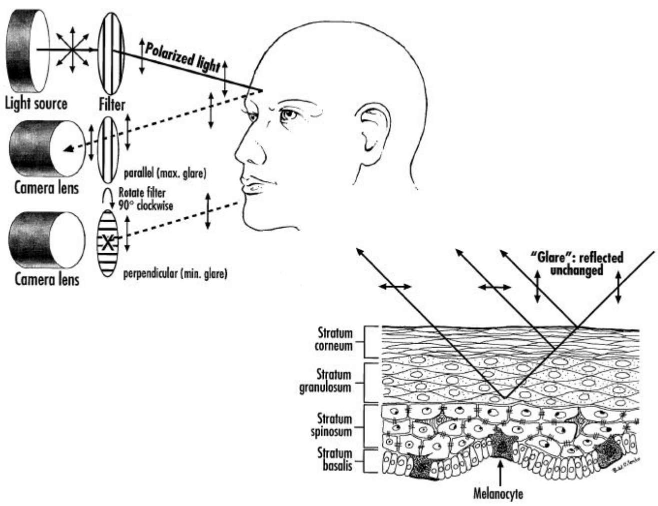
Ultraviolet passing photography: A Kodak 18 A ultraviolet passing filter only allows ultraviolet light to penetrate and blocks the visible spectrum. This filter is placed in front of the lens of the camera. A Nikon N 70 camera is used, set to manual mode with black and white Tmax 400 film using a Nikkor AF 105 mm D series lens. The Paul C Buff White Lighting flash is set to maximal output and the bulb had no ultraviolet protective coating as many standard flashes do. Without a broad spectrum light source with ultraviolet light reflecting off the patient, no ultraviolet light can be captured by the camera and film. All visible light is being blocked from reaching the camera sensor and film by the ultraviolet (only) passing filter. Focusing must be done with the patient in a stable position, and the camera on a tripod prior to replacing the filter in front of the camera lens. Once the focus is set, the UV filter is placed in front of the camera and the photograph is taken. The camera will then record only ultraviolet light (Figure 1).

FIGURE 1. Ultraviolet passing photography. As UV light penetrates the epidermis, it is absorbed by the epidermal melanin. This type of light source is essentially a method for highlighting the epidermis and makes UV light examination very useful in the diagnosis of pigmentary disorders.



Parallel polarized and cross-polarized photography: A Fuji S3 digital camera using a Nikon D-series AF 55mm lens is now set to manual mode at F11 for all photographs. The overhead mounted flash is now turned off. The Paul C. Buff White Lightning flash is used on a tripod mount with a polarizing filter held in front of the light source and between the light source and the subject. A second polarizing filter is placed in front of the camera lens between the subject and the camera sensor. The polarizing filters are then examined for polarity. If parallel po-

FIGURE 2. Polarized photography. Polarized light photography can separate the information carried by the light that is reflected by the stratum corneum-air interface and the light, which is remitted after traversing the epidermis and the papillary dermis.



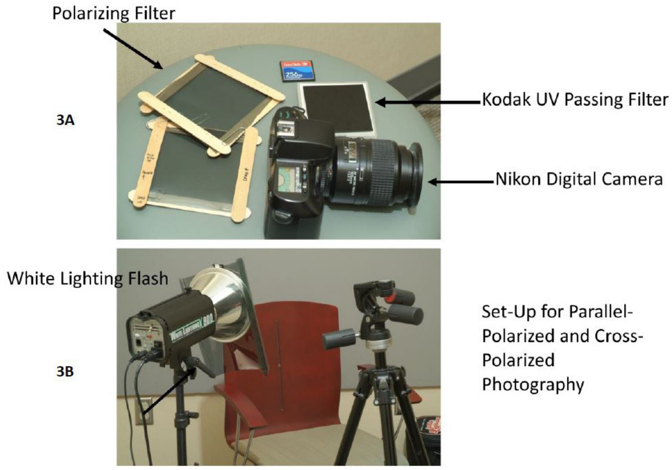
larized, when two filters are superimposed, an image should be 'see through' (Figure 2). In this orientation, the polarizing filters are aligned similarly allowing light of the same polarity to pass through both filters. If the second filter is rotated 90 degrees, the image is then opaque/obstructed and no light penetrates. For cross-polarized photography one of the filters should be arranged 90 degrees to the other. In this orientation, light that travels through the first filter, but will not pass through the second filter unless it changes polarity before reaching the second filter, thus giving an opaque appearance when the 2 filters are held close together. The only difference between parallel and cross-polarized photography, is the orientation of the filter in front of the light source in comparison to the orientation of the filter in front of the camera. Holding the filter in the appropriate direction, a photograph is taken with one filter firmly clipped to the flash, and one filter turned in the appropriate direction held just in front of the camera lens (Figure 3).

With the completion of the photography session, the photographs were processed and evaluated by an otolaryngologist, a fellowship trained board-certified facial plastic surgeon, and a blinded observer. The evaluation form scored how well subsurface skin features, hypopigmentation, hyperpigmentation, and rhytids were visualized on a scale of 1 to 5 (1= least visualized, 3=visualized, 5=most visualized) using parallel polarized light, cross polarized light, and UV passing photography compared to standard black and white and color photography.

RESULTS

A total of 9 subjects completed the study including completing the questionnaire, posing for photographs and meeting inclu-

FIGURE 3. Set-up for photographic methods. Polarized and UV filters are pictured (3A). Set-up for polarized photography is portrayed (3B).



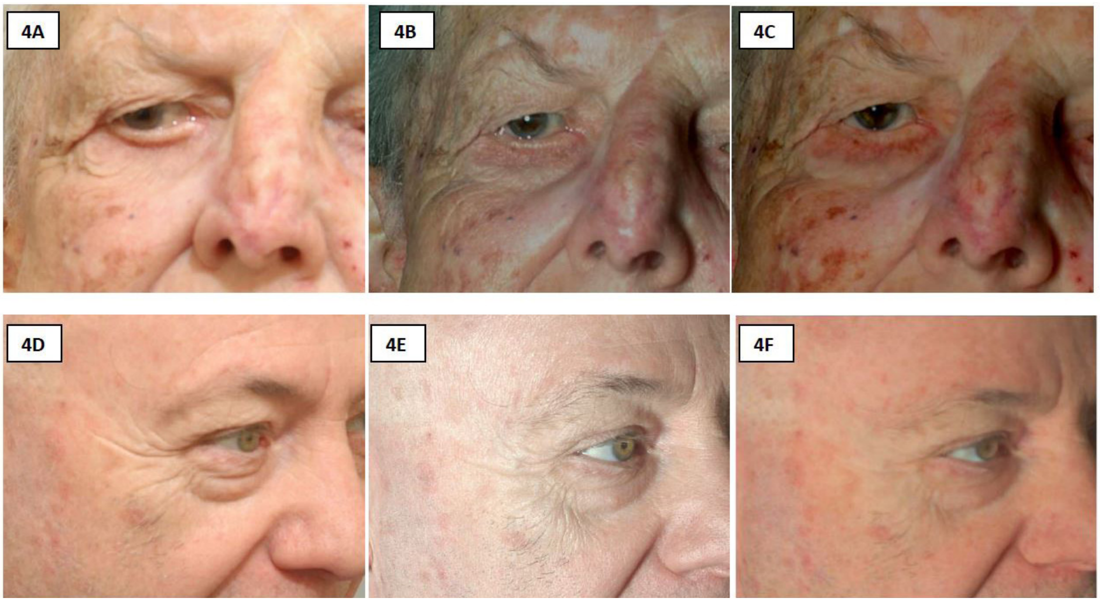
sion criteria. Included in the study were 5 females and 4 males; all were Caucasian except one African American. The ages ranged from 26 to 81 years old (median age 60). All Fitzpatrick skin types were represented except type V, with the greatest percentage of type II (44.4%). Poorly focused or poorly lighted images were removed and therefore, not all photographs were evaluated. Results from the data collection form were averaged between the 3 observers and the difference between the averages was calculated and reported (Table 1).

When evaluating the parallel polarizing light photographs, a decrease in the visibility of subsurface features and hyperpigmentation was noted in all subjects compared to standard photography (Table 1). There was no difference in visualization of rhytids and hypopigmentation, however when excluding the blinded observer who is not in the medical field, parallel polarizing light could reveal increased rhytids in all cases. We suspect the reason for this is the blinded observer was looking at laxity as well as texture as compared to the otolaryngologist and facial plastic surgeon. The fine lines are visibly highlighted with this photographic method, and the uneven surface texture is more evident (Figure 4).

> "Melanin will absorb light and will selectively darken in photographs to document pigment changes to a greater degree than standard photography."

The cross-polarized photographs enhanced hyperpigmentation compared to standard photography, but subsurface features such as erythema and inflammation, and hypopigmentation were also more visible (Table 1). In 67% of the subjects, sub-

FIGURE 4. Parallel polarized and cross polarized photographs. In the parallel polarized photos (4B, 4E), the fine lines around the eyes and glabella are highlighted and the uneven surface texture is more evident compared to standard photographs (4A, 4D). In the cross polarized photos, erythema is pronounced. The blood vessels are highlighted, particularly of the lower eyelid and nose (4C), and photodamage is more appreciable (4C, 4F).

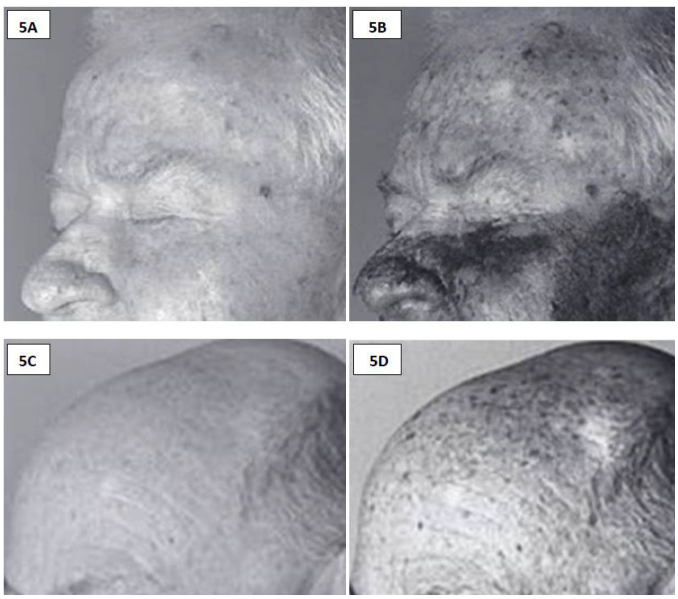


surface features appeared more prominent to the observers, however 80% of the subjects had hypopigmentation enhanced by the cross polarizing light and 100% of the subjects were noted to have increased hyperpigmentation. Visibility of rhytids was reduced compared to standard photography (Table 1).

The use of UV passing photography most enhanced subsurface features compared to standard black and white photography, followed by increased hypopigmentation and hyperpigmentation, respectively (Table 1). Subsurface features and hypopigmentation were better visualized in 100% of subjects, and hyperpigmentation in 67% of subjects. Enhancement of these features overall make UV passing photography best for capturing photodamage (Figure 5). The ease of visualizing sun damage with this method was striking. Enhancement of rhytids was negligible compared to standard photography (Table 1).

Overall, of the 3 photographic methods compared to standard photography, UV passing most enhanced the visualization of subsurface features and hypopigmentation. Cross-polarized photography was best for enhancing hyperpigmentation. None of the methods increased visualization of rhytids compared to standard photography, however as noted above, when scored only by the experts, the use of parallel-polarized photography enhanced skin texture.

FIGURE 5. Black and white and UV passing photographs. In the UV passing photo (5B), the sun-spared forehead from wearing a baseball cap for many years is highlighted compared to the standard black and white photo (5A). Similarly, photodamage from a sun-exposed scalp is highlighted in the UV passing photo (5D) compared to the black and white photo (5C). Subsurface features and hypopigmentation (scars left forehead (5B) and left scalp (5D) are increased in the UV passing photos.



DISCUSSION

There is an increasing need to use photography in medicine, especially in the field of cosmetic procedures. An initial consultation for cosmetic procedures is generally comprised of a physical exam to evaluate the skin or area to be treated, and often includes flash photography for photo documentation. Newer techniques however exploring the use of polarized light,

TABLE 1.

The Average of the Difference for Parallel, Cross-Polarized, and UV Passing Photography Compared to Standard Photography. A positive value correlates with an increase in visualization compared to standard photography and a negative value correlates with a decrease in visualization.

	Subsurface Features	Hypopigmentation	Hyperpigmentation	Rhytids
Parallel	-0.556	0	-1.222	0
Cross-polarized	0.4	0.2	0.667	-1.134
UV passing	1.667	0.889	0.333	0.111

cross and parallel, and ultraviolet photography can give detailed information on subtle skin lesions including skin pigmentation and skin surface characteristics. These multiple photographic methods will provide a basis for objective, non-invasive data collection, which is superior to the standard subjective evaluation of skin if used effectively to monitor specific characteristics.

According to our results, parallel-polarized light photographs enhance visualization of skin surface features such as skin texture. For documentation of resurfacing techniques, this may be more objective and useful. Similar findings have previously been reported where skin surface details are enhanced with parallel planes of polarization.[2-4] In contrast, rotation of the polarized filter to produce cross-polarized light photography better portrayed pigment changes, especially hyperpigmentation, and subsurface features such as erythema and inflammation. These results correspond to Muccini et al's findings that polarized light oriented perpendicular results in enhancement of telangiectasias and erythema.[4] This would be less useful to use for resurfacing patients but would be better documentation for treatment of vascular lesions, and dermal pigmentation. Polarized light photography can separate the information carried by the light that is reflected by the stratum corneum-air interface and the light which is remitted after traversing the epidermis and the papillary dermis[4] (Figure 1). Polarized light photography relies on the fact that light reflected from the skin has two components, regular reflectance light which is in the same plane as incident light, and glare which is depolarized scattered light. The regular reflectance contains the visual information relating to the skin surface texture including structure and contours of the stratum corneum, whereas the backscattered light contains the information relating to intracutaneous structures (eg, pigmentation, erythema, vascularity).[2] The polarization of the light can be exploited to separate surface and intracutaneous detail by using polarizing filters that are parallel or perpendicular in orientation to each other. If the second filter covering the camera lens is parallel to that of the filter covering the flash, only the reflected polarized light passes through the lens filter and consequently surface details of the skin (texture, elevation, scaling) are enhanced and pigmentation, vascularity, and color are diminished, as seen in our results. Conversely, if the lens filter is perpendicular to the flash filter, cross-polarized photography is captured. The regular reflectance is blocked and only the back-scattered light from the tissues reaches the lens. In this way, all surface detail is lost, but telangiectasia, tattoos, and inflammatory lesions are enhanced and pigmented lesions are more easily seen. Thus polarized light photography allows information on surface features to be recorded separately from that of subsurface features by a rotation of the lens-mounted polarizer. These techniques have been shown to be clinically valuable as an objective measure of outcomes in clinical trials, for example the use of cross-polarized light photography to assess erythema in patients with rosacea.[5,6]

Ultraviolet light through the use of a Wood's lamp has long been a useful tool in the diagnosis of many skin disorders and has been known to enhance pigmentation compared to visible light.[7] In our study, subsurface features, hyperpigmentation, and hypopigmentation were all better visualized using UV photography; thus overall best capturing photodamage. Usually photography is limited to the visible spectrum of light, which ranges from approximately 400 to 700nm. The shorter wavelengths of Ultraviolet (UV)-emitting lamps emit light at wavelengths of 300 to 400 nm. As UV light penetrates the epidermis, it is absorbed by the epidermal melanin (Figure 2). This type of light source is essentially a method for highlighting the epidermis and makes UV light examination very useful in the diagnosis of pigmentary disorders. In particular, it can be used to distinguish between skin color changes that are related to pigmentation and changes that result from other causes, such as collagen deposition, scarring, or vascularity. When taking photographs under a black light or Wood's light, the UV light that comes out of the flash that is absorbed by the skin appears darker on the film, and the light that is reflected shows up lighter on film. Melanin will absorb light and will selectively darken in photographs to document pigment changes to a greater degree than standard photography. Areas of skin that appear to be whitened in natural light because of the presence of scarring or collagen deposition do not highlight under Wood's light examination as their epidermal melanin content is no different from the surrounding skin. Similarly, areas where a color change results from an increase or decrease in vascularity, do not appear different from surrounding skin. UV photography has proven to be useful for both medical and cosmetic purposes and its uses continue to expand; UV photography has been useful in photodynamic diagnosis of basal cell carcinoma, where fluorescence demarcates tumor extension.[8]

As noted by Rizova, although standard photographic evaluation of skin is a step towards proper objective collection of data, there are many variables that can cause the data to be as subjective as clinical observation.[9] For instance, the quality of the camera, lighting, varying angles and the experience of the photo taker can all influence the final outcome of the photograph. Surgeons and healthcare providers rely extensively on photographic communication for documentation of patient conditions, surgical outcomes, teaching, education, research, and marketing and therefore there is a significant value in having adequate photographs.[10]

Understanding pre-operative patient deformities can be enhanced with proper photography. Photographs can assist the surgeon in determining the patient's expectations from the operative procedure and aid the surgeon in accomplishing these outcomes. In the pre-operative discussion, it is important to bring to the patient's attention asymmetries that may exist, which may be more apparent to the patient in a photograph. Patients may become aware of asymmetries or imperfections after a procedure that were not previously appreciated; documentation that they existed prior to the procedure will support a positive outcome. In addition, it may be difficult for physicians to remember a patient's baseline condition at a subsequent appointment weeks or months later and photographs can be invaluable in such instances.

Today modern camera systems are available that produce images similar to those produced by polarizing light and UV light through digital processing of a visible light photograph. However, as Draelos et al points out in her study assessing photodamage using an UV pass glass filter to generate UV images, these "UV like" computer generated digital images are not true UV images and are not an accurate tool for research purposes.[11] Whether one chooses to use a camera system that digitally processes photos or implements the photographs techniques as illustrated in this study, ultimately it is important for the provider to have an understanding of the various methods and when, how, and why they should be utilized. The possible use in melanoma screening and monitoring is an exciting opportunity for further exploration.

Limitations to this study included small sample study. In additional, a significant number of photos could not be evaluated due to poor quality. The importance of a consistent and goal directed photographic plan for medical photo documentation is highlighted by the variability in results that might be represented with each of these different techniques.

CONCLUSION

With a better understanding of how photo documentation can be optimized using various photographic methods, it is clear that standard photography alone may no longer be adequate. When a large portion of the practice involves evaluation of skin pigmentation, texture, or small skin lesions, more effective methods of skin evaluation are possible. By utilizing a simple technique that can be duplicated in any physician's office, it is possible to explore subsurface skin features and visualize photodamage. The parallel polarizing light photography is most effective for surface skin features, which may include rhytids or uneven skin texture. Cross polarizing light photography highlights subsurface features such as vascularity and pigmentation. Finally, ultraviolet passing photography is extremely effective at identifying photodamage before it is even visible to the unaided eye. Each of these techniques has unique properties that can add to the precision of the clinical evaluation. These methods of photography can allow providers to better provide information for charts, researchers, insurance companies, and our patients.

DISCLOSURES

Drs. Marcum, Goldman, and Sandoval have no conflicts to disclose.

ACKNOWLEDGMENT

Special thank-you to Artist Ben Cilento MD.

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