TECHNICAL NOTE

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Use of Alternative Light Source Illumination in Bite Mark Photography

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ABSTRACT: Recent investigation regarding the optical properties of human skin has lead to studies measuring autofluorescence, absorption, and reflectance of monochromatic light during exposure both in vitro and in vivo environments. The Stokes Shift deviation in absorbed and reflected light energy that occurs when skin is illuminated by 450 nanometer visible blue light can produce an augmentation in the appearance of pattern injuries when viewed through colored blocking filters. This paper demonstates a comparison between photographic appearances of several bitemarks inflicted on living and deceased persons to determine the corroborability and usefulness of fluorescent versus full spectrum visibility of bitemark pattern injuries.

KEYWORDS: odontology, bite marks, alternative light source, fluorescence, photography, pattern injuries

The optical properties of human epithelium have been studied primarily by two methods. The first is in vitro, wherein excised tissue sections have been transilluminated and measured for reflectance and penetration of varying wavelengths of light [*1–3*]. The second method of study is in vivo, wherein reflective measurements of light have been taken directly from the epidermis of the living subject [*4–6*].

Regarding the optical properties of skin, much information has been discovered about the photobiological mechanics of certain organic components comprising the tissue matrix [*3*]. Well established is the fact that melanin absorbs light throughout the ultraviolet and visible wavelength spectra. In fact, melanin's relative absorption coefficient varies inversely to the wavelength [*1,7*].

The role of melanin pigment in reflective ultraviolet (UVA) photography has been well documented in the field of dermatology [*15,16*]. More recently, investigation into the fluorescent properties of the organic components of human tissue has been discussed [*9*].

Studies in absorption and fluorescence in human tissue have been aided by the application of monochromatic (laser and narrow-band) light. This technique has been popu-

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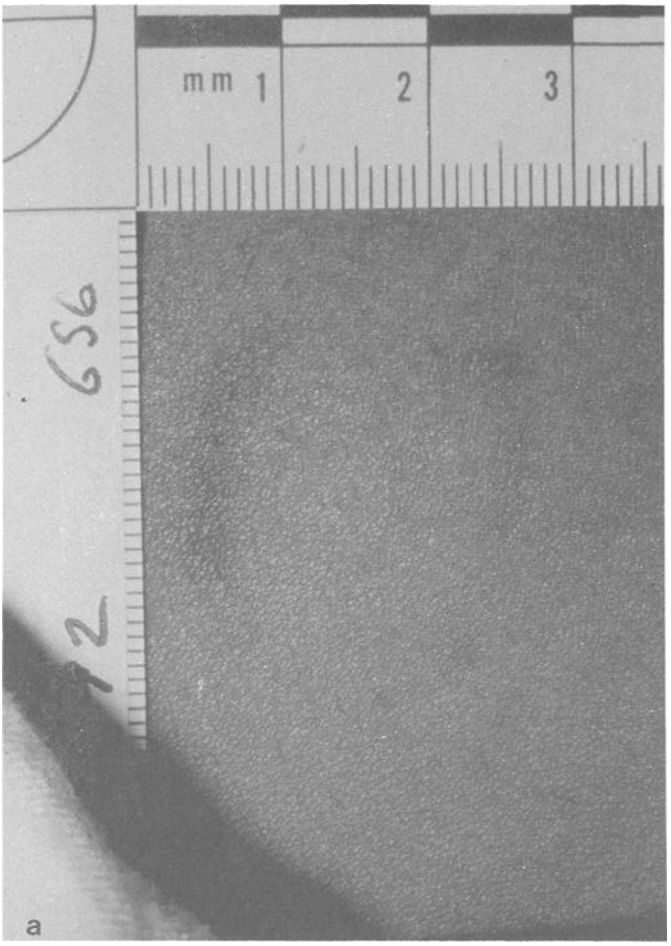

FIG. 1—*Photographs of bitemark in Case 1 with* (a) *normal flash illumination, and* (b) *alternate light source illumination.*

larized by its tremendous value to forensic investigation when used in document examination [*10*], latent fingerprint processing [*11*], and locating serological trace evidence [*12,13*]. Additionally, the application of alternative light source (ALS) illumination to document trace wound pattern injury has been demonstrated [*14*]. The technique uses long-wave, (450 nanometer) ultraviolet blue light as an excitatory source of illumination. The fluorescent image emitted as a result of the excitation of the tissue components can be visualized and photographed through a yellow-blocking filter. The net effect of this process is an observable visual enhancement of the pattern injury; detail and subtle features of the bruise frequently become more discernable as a result of absorption of light by melanocytes and hematologic components [*8*], and fluorescence of surrounding dermal components [*3,9*]. The phenomenon of the change in frequency of the light remitted from the subject is known as Stokes' Law.

In view of the aforementioned, a logical extension of wound-pattern injury documentation would be to apply fluorescent image analysis to bitemarks. A comparison of the

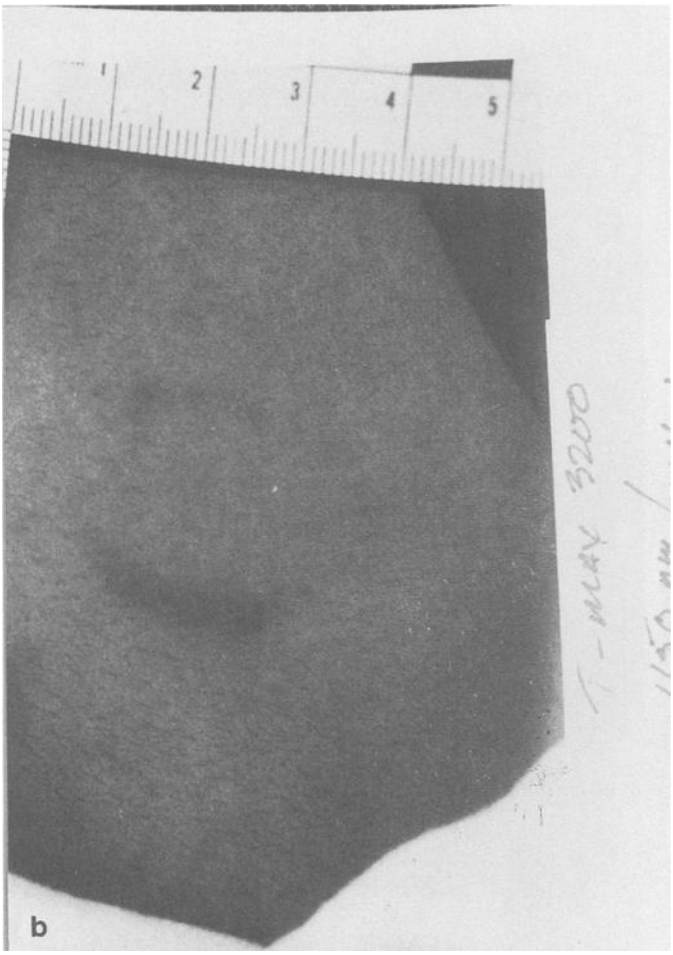

FIG. 1—*(Continued).*

photographic differences in appearance of cutaneous and subcutaneous changes in bitemark pattern injuries under normal and ALS conditions was performed in each case.

Methods

Several bitemark injuries were photographed under normal (full-spectrum) lighting conditions and were compared to photographs of the same bitemarks under 450 nm light. An Omniprint 1000® ALS unit, manufactured by the Omnichrome Corporation, Chino, California, was used. The unit is a portable, multiband-selection light generator originally designed for forensic investigation. The wavelength setting of 450-nm was selected for illumination of each fluorescent photograph. A yellow Plexiglas® filter supplied with the Omniprint® unit was placed in front of the lens of a tripod-mounted Nikon® FE camera, equipped with a Vivitar® 90 mm macro lens. The shutter speed was set for automatic through-the-lens metering. Exposure times were set at the 0, +1, and +2 overexposure factors on the camera. The f-stop aperture was set at f 4 for all fluorescent photos. Since

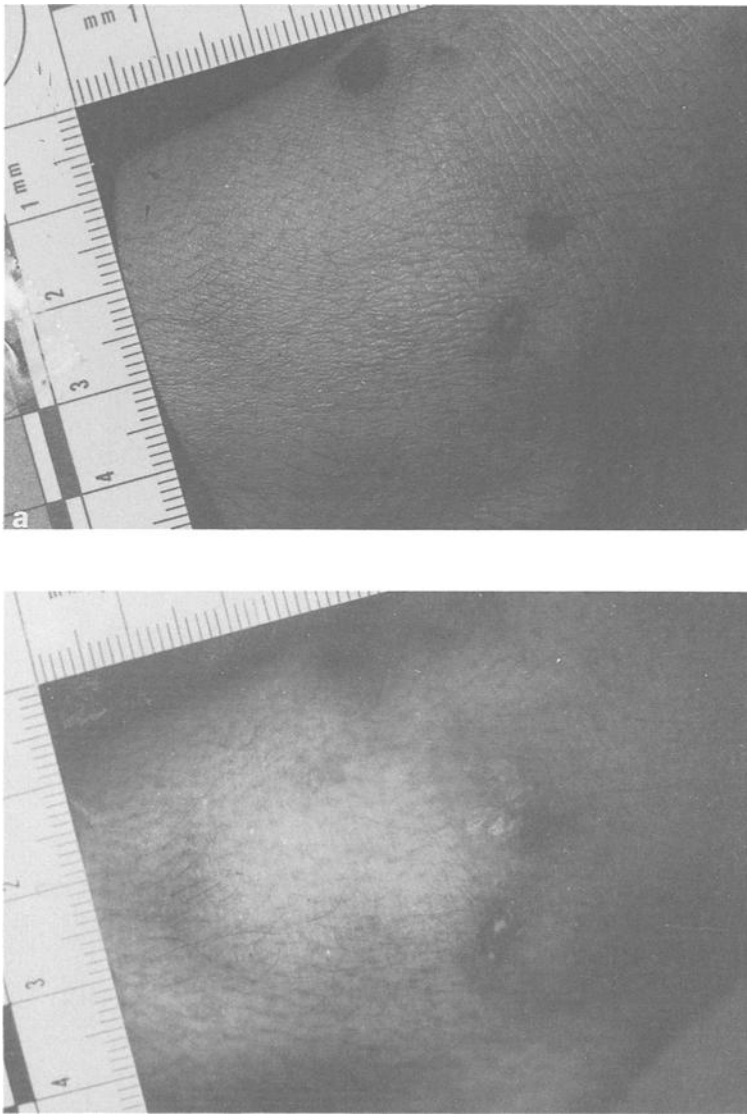

FIG. 2—*Photographs of bitemark in Case 2 with* (a) *normal flash illuminations, and* (b) *alternate light source illumination.*

no prior research data existed to guide the author on which particular film type produced the best visual results for this new photographic method, various types and speeds of color slide, color print, and black and white films were exposed and noted for each figure. In some cases the color films produced better photographic results; in others, the black and white films captured the enhanced fluorescent image much better than the color film. The fiber-optic cable carrying the emitted light from the source was continuously painted around the field of view at a distance of about 18 to twenty inches during exposure. Care was taken not to leave the light in any one position for an extended

FIG. 3—*Photographs of the bitemark in Case 3 with* (a) *normal flash illumination, and* (b) *alternate light source illumination.*

period of time so that overexposed areas would be minimized. Slow, even panning of the light was attempted for each exposure.

For full-spectrum photography the same camera, lens, and films were used. The light source was a Sunpak® model #120 point flash mounted at the front of the macro lens. Shutter speed was set at $^{1}/_{60}$th second at f 22. No filters were used.

Case 1

A bite mark was produced on the left scapular area of an adult black female during an altercation that occurred 120 days prior to photographic documentation. This woman was alive and verified the timing of the incident. A comparison can be seen between normal flash illumination (a) and the fluorescent image (b) taken during alternative light exposure using Kodak® T-Max 3200 ISO black and white film pushed to 6400 ISO during processing. (Fig. 1)

Case 2

A Hispanic male homicide victim was recovered from an open field in rural southern California. At postmortem examination, (time of death unknown), a possible bite mark pattern injury was observed on the dorsum of the right wrist. The top photo was exposed

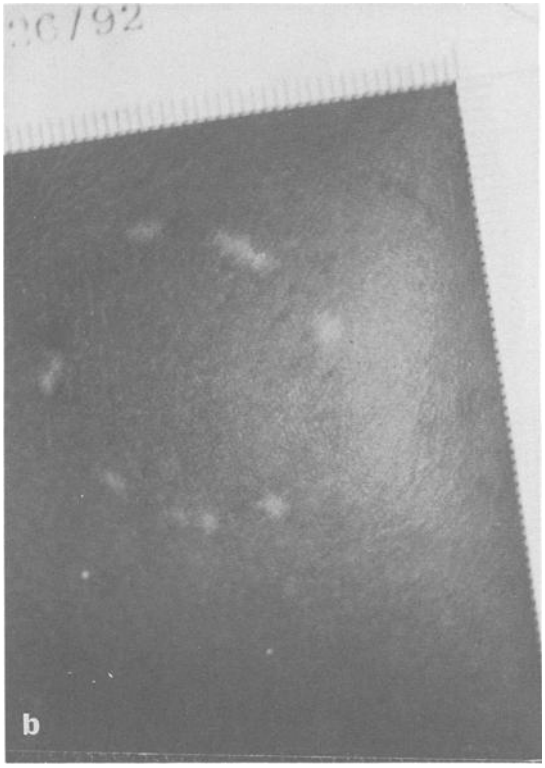

FIG. 3—*(Continued).*

during normal flash illumination; the bottom photo is the fluorescent image. Fujicolor® print film, 100 ISO was used in both exposures. (Fig. 2)

Case 3

A 14-year-old black female was a victim (and survived) of assault and sustained multiple bitemarks. The bite to the right cheek was photographed with normal flash (a), and under ALS (b). The photographs were taken seven days after the assault. Note the points where penetration of the skin occurred and the resultant fluorescence of melanin-free healing tissue versus the surrounding uninjured melanin-rich light-absorbing tissue. Prints are from color slides, (Fugichrome® E6 100 ISO) (Fig. 3).

Case 4

A female Hispanic homicide victim sustained a bitemark to the lateral aspect of the right forearm. Figure 4 shows photographs taken under normal flash (top) and 450 nm ALS (bottom). This series was collected approximately 12 hours postmortem and prior to embalming. She was then embalmed after autopsy. The second set of photographs, (Figure 5) was collected 6 days postmortem. Figure 4 was Fugicolor® print film, 100 ISO. Figure 5 was Fugichrome® color slide film, 100 ISO.

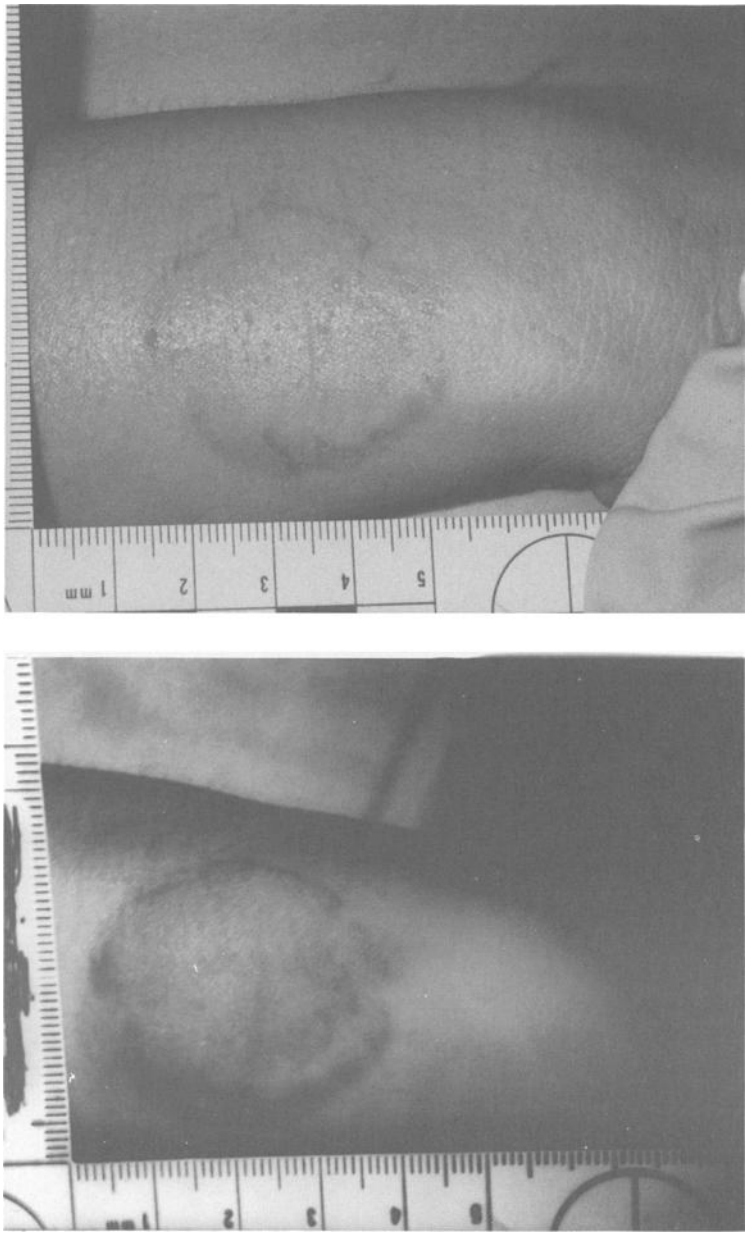

FIG. 4—*Photographs of the bitemark in Case 4 with* (a) *normal flash illumination, and* (b) *alternate light source illumination, approximately 12 hours postmortem and prior to embalming.*

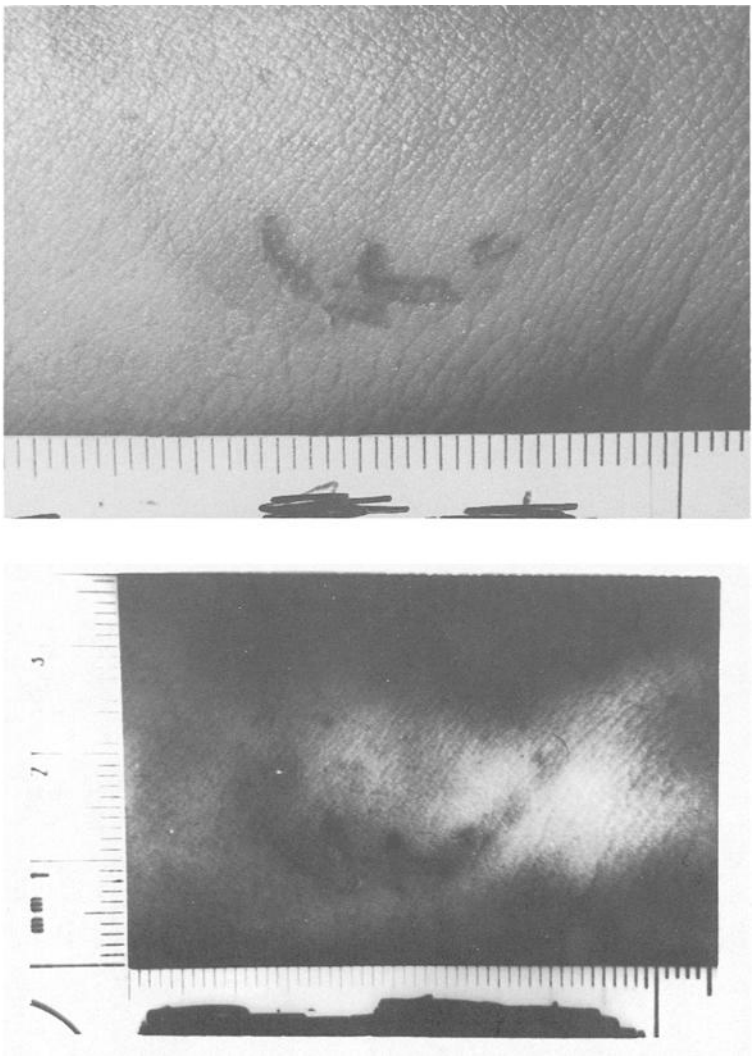

FIG. 5—*Photographs of the bitemark in Case 4, as in Fig. 4, except taken 6 days postmortem, after embalming.*

Discussion

This data is from a sample of bitemark victims, living and deceased, who sustained bites in various locations on their bodies. The crimes committed against these persons were under investigation through the City of Upland, CA. Police Department and the San Bernardino County Sheriff during the months of July to October, 1992. The data shows the enhancement of the reflective and absorptive images of the injured tissue when photographed using long-wave (450 nm) visible blue light as compared to the full spectrum of light. This enhancement enables the observer to better distinguish changes in the dermal and epidermal tissues as a result of injuries such as bite marks. The effect

is most important for forensic purposes when surface markings are vague or completely obliterated by time, healing, or the embalming process.

Conclusions

In each of the cases described there was an observable enhancement in photographic appearance of a bitemark injury taken with the aid of 450 nm alternate monochromatic light when compared to those taken under full spectrum lighting conditions. This noticeable difference lends support to the findings of previous investigators and basic research concerning the fluorescent properties of human skin. Further study to establish standardized parameters and techniques for optimum light source and filtration, together with the ideal photographic protocol, should prove useful in future investigative efforts of bitemarks and similar pattern injuries.

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