A Portable Digital Microphotography Unit for Rapid Documentation of Periungual Nailfold Capillary Changes in Autoimmune Connective Tissue Diseases

RICHARD D. SONTHEIMER

ABSTRACT. ***Objective.*** While employing a DermLite dermoscopy unit to assess pigment pattern networks in melanocytic skin lesions, it was observed that this compact, portable dermoscopy unit can also be used to quickly detect nailfold capillary changes when entertaining a diagnosis of autoimmune connective tissue diseases (CTD) such as dermatomyositis (DM), scleroderma/systemic sclerosis (SSc), or systemic lupus erythematosus. Aware that the suppliers of the DermLite dermoscopy unit also market a portable digital microphotography unit based on the DermLite optical principles for efficiently documenting cutaneous pigment network patterns, we investigated whether this unit (DermLite Foto flash unit attached to a Nikon Coolpix digital camera) might be used to photographically document nailfold capillary changes in patients with autoimmune CTD.

Methods. A DermLite Foto flash unit attached to a Nikon Coolpix digital camera was used in a controlled observational study to obtain digital photographs of nailfold capillaries in a small sequential sample of patients with autoimmune CTD attending a rheumatic skin disease subspecialty clinic in an academic department of dermatology.

Results. The digital microphotography system proved to be highly useful in documenting the nailfold vascular changes observed in a small sample of patients with DM. We observed that the nailfold capillary changes seen in patients with clinically amyopathic DM were qualitatively and quantitatively similar to those seen in patients with classical DM.

Conclusion. Digital microphotography systems designed for examining pigmented skin lesions can be used easily to document nailfold capillary changes often observed in DM and SSc. Nailfold capillary changes documented in this manner appear to be indistinguishable in clinically amyopathic DM and classical DM. (J Rheumatol 2004;31:539–44)

Key Indexing Terms:
DERMOSCOPY DIGITAL MICROPHOTOGRAPHY NAILFOLD CAPILLARY CHANGES
AUTOIMMUNE CONNECTIVE TISSUE DISEASES DERMATOMYOSITIS

It has been almost 30 years since the detection of *in vivo* (vital) periungual nailfold capillary changes (dilated, tortuous capillary loops; microhemorrhage from incompetent capillaries; capillary dropout resulting in avascular areas) by widefield capillary microscopy was associated with autoimmune connective tissue diseases (CTD)[1]. While most attention in this area has been to the association of visible capillary abnormalities in Raynaud's disease/Raynaud's phenomenon and scleroderma/systemic sclerosis (SSc), a similar association exists in dermatomyositis (DM) and to a lesser extent in systemic lupus erythematosus (SLE). It has been the author's experience as well as that of others[2] that nailfold capillary changes are as prevalent and as prominent in DM (both classical DM and clinically amyopathic DM) as in the scleroderma/SSc spectrum of clinical disorders. The author has also had the impression that the nailfold capillary changes observed in patients with clinically amyopathic DM are virtually indistinguishable from those seen in patients with classical DM.

The negative predictive value of such capillary changes for the diagnosis of SSc and DM is much higher than the positive predictive value, since similar but less dramatic nailfold capillary changes have been observed in SLE and more recently in other clinical settings (e.g., Henoch-Schönlein purpura[3], ankylosing spondylitis[4], familial Mediterranean fever[5]). In addition to assisting in the diagnosis of autoimmune CTD, morphological and quantitative changes in nailfold capillaries have also been suggested to parallel systemic disease activity/severity and signal response to treatment[6]. The newer technique of video capil-

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laroscopy with intravital dye has provided a research tool for more systematically documenting nailfold capillary variables and their relationships to clinical disease[7].

Despite this progress, the routine use of widefield, *in vivo* nailfold capillaroscopy at the bedside has yet to become fully integrated into routine clinical rheumatological and dermatological practice as a diagnostic and disease activity assessment tool. One reason for this has been the difficulty of integrating into routine clinical practice the cumbersome equipment necessary for photographically documenting nailfold capillary images (i.e., epi-illuminescent stereo microscope with attached camera). While nailfold capillary changes can be visualized at the bedside using an ordinary ophthalmoscope or portable hobby microscope through a thin layer of mineral oil or immersion oil, documenting such changes photographically until now has been cumbersome and time-consuming. We describe a portable digital microphotography system (DermLite Foto flash unit attached to a digital camera) originally designed to capture magnified *in vivo* images of pigment patterns within melanocytic skin lesions that we have found useful for efficiently capturing digital images of nailfold capillary abnormalities in a high-volume outpatient practice setting.

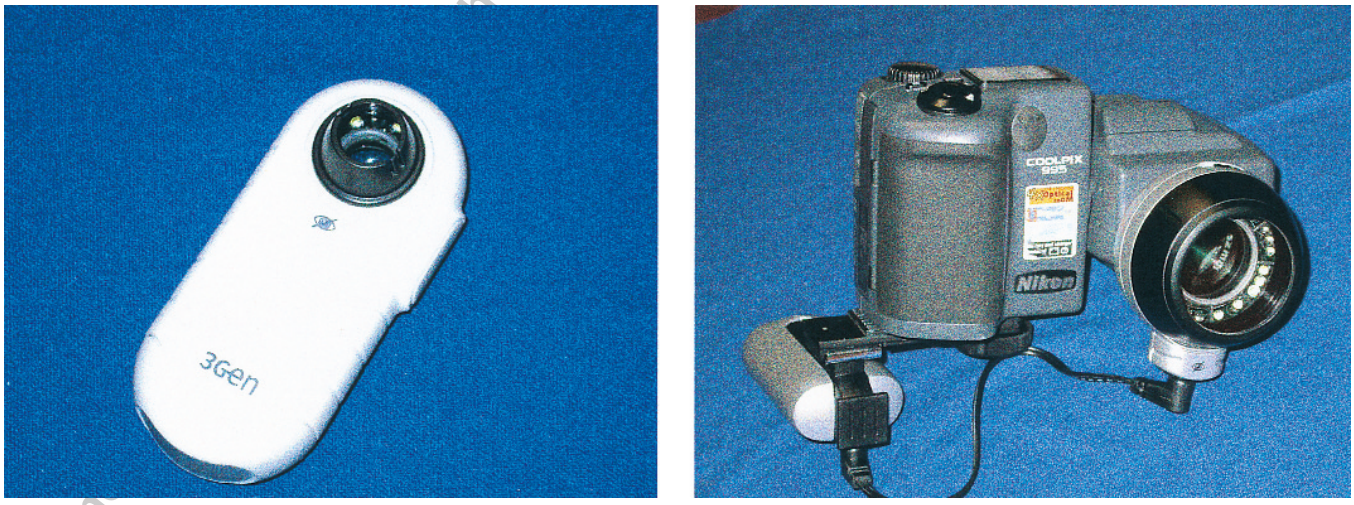
While using a DermLite dermoscopy 10× fixed magnification unit (Figure 1A) (3Gen LLC, Delasco <http://www.delasco.com/>) in an academic outpatient dermatology practice setting to assess pigmented skin lesions, we observed that the DermLite can also be used to quickly examine nailfold capillary changes when entertaining a diagnosis of autoimmune CTD such as DM, SSc, or SLE. Aware that the suppliers of the DermLite dermoscopy unit also market a portable microphotography unit based on the DermLite optical principles for efficiently capturing at the bedside digital images of the pigment network in pigmented skin lesions (DermLite Foto, http://www.dermlite.com/foto.html), we questioned whether this unit might also be used to efficiently document photographically nailfold capillary changes in patients with autoimmune CTD.

MATERIALS AND METHODS

A DermLite Foto flash unit and Nikon Coolpix 995 digital camera were supplied by the manufacturer (3 Gen LLC) without cost for this project. [The digital camera and flash unit used in this study were sold at the time of the preparation of this manuscript (May 2003) for a retail price of US$1950. The DermLite Foto flash unit is available separately for US$1150. The current retail price of a standard DermLite Dermoscopy unit is US$375. It should be noted that other portable digital microphotography units are available, e.g., DermoGenius Ultra (Linos Photonics), available through Canfield Imaging Systems [http://www.canfieldsci.com/index.html]; however, the author has no personal experience with them. The DermoGenius Ultra requires the use of oil applied to the skin prior to viewing/photography, whereas the DermLite Foto unit does not. The Heine Dermatoscope is a similar product to the DermLite Dermoscope; however, the Heine Dermatoscope also requires the use of oil. The DermLite Foto flash unit easily attaches through a threaded mounting mechanism to the lens housing of the Nikon Coolpix 995 digital camera as well as other Nikon Coolpix digital camera models. The DermLite Foto flash unit consists of a polarized ring flash powered by a rechargeable battery pack that attaches to the bottom of the camera with a mounting bracket. The DermLite Foto flash unit can be quickly unscrewed from the camera lens housing so the camera can be used for conventional digital clinical photography. The DermLite and DermLite Foto dermoscopy equipment employed in this study does not require prior application of oil to the area of skin being examined since the polarized light source eliminates the obscuring backscatter of light that is seen with nonpolarized light sources.

RESULTS

Following instructions provided by the supplier, the author began to collect digital images of nailfold capillary changes in consecutive patients with autoimmune CTD encountered



A B

Figure 1. A. DermLite dermoscopy unit. B. DermLite Foto flash-equipped Nikon Coolpix 995 digital camera.

in the University of Iowa Rheumatic Skin Disease Clinic. With only an amateur level of familiarity with digital photography techniques, the author found it easy from the outset to obtain high quality color images of nailfold capillary changes.

Figures 2–4 show a series of digital photographic images of nailfold capillaries taken at 3 ranges of magnification in Caucasian female patients with classical DM or clinically amyopathic DM[8-11] and, for comparison, randomly selected healthy adult Caucasian women of similar age. Photographs were taken at varying magnifications using the optical zoom feature of the camera. The digital images were downloaded via a USB connection to a personal computer using Nikon View 5 software supplied with Nikon Coolpix digital cameras.

No attempt was made to standardize the distance between the camera lens and nailfold capillaries when obtaining photographic images. The author wanted to simulate a freehand technique that might be most useful to busy practitioners. Attempts were made to obtain 3 different views of nailfold capillaries on each subject (low, intermediate, and high magnification) by observing the degree of magnification of images displayed in the camera's digital image monitor.

It was found that the autofocus feature of the camera for these type images was more efficient using the macro exposure mode. It was also noted that if the glass lens cover on the DermLite Foto flash unit is pressed against the skin while taking photographs, blanching of the blood present in nailfold capillaries can occur, obscuring the appearance of the capillaries. The glass lens cover can be easily removed from the flash to eliminate this problem.

It was possible to obtain even higher magnification nailfold capillary images than those displayed in Figure 4 by using the digital zoom feature of the camera. However, it

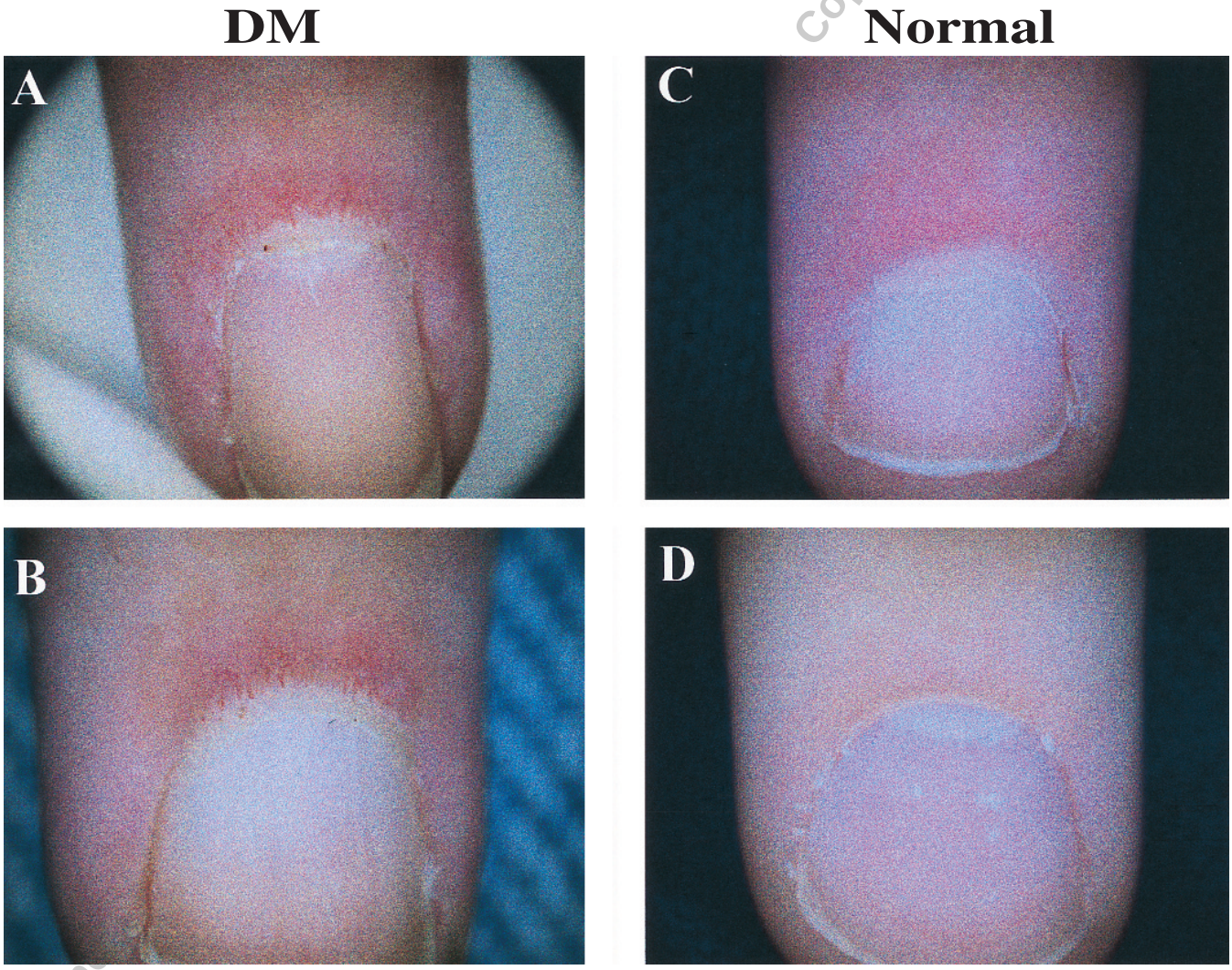


Figure 2. Low magnification appearance of nailfold capillaries on 4th finger of female patients with DM and healthy female volunteers photographed with the DermLite Foto flash-equipped digital camera combination. A. Patient CDM-1, with classical DM. B. Patient CADM-1, with clinically amyopathic DM. C and D. Different healthy adult female volunteers. No attempt was made to standardize the distance between the camera lens and nailfold, to simulate the freehand technique that might be common in clinic.

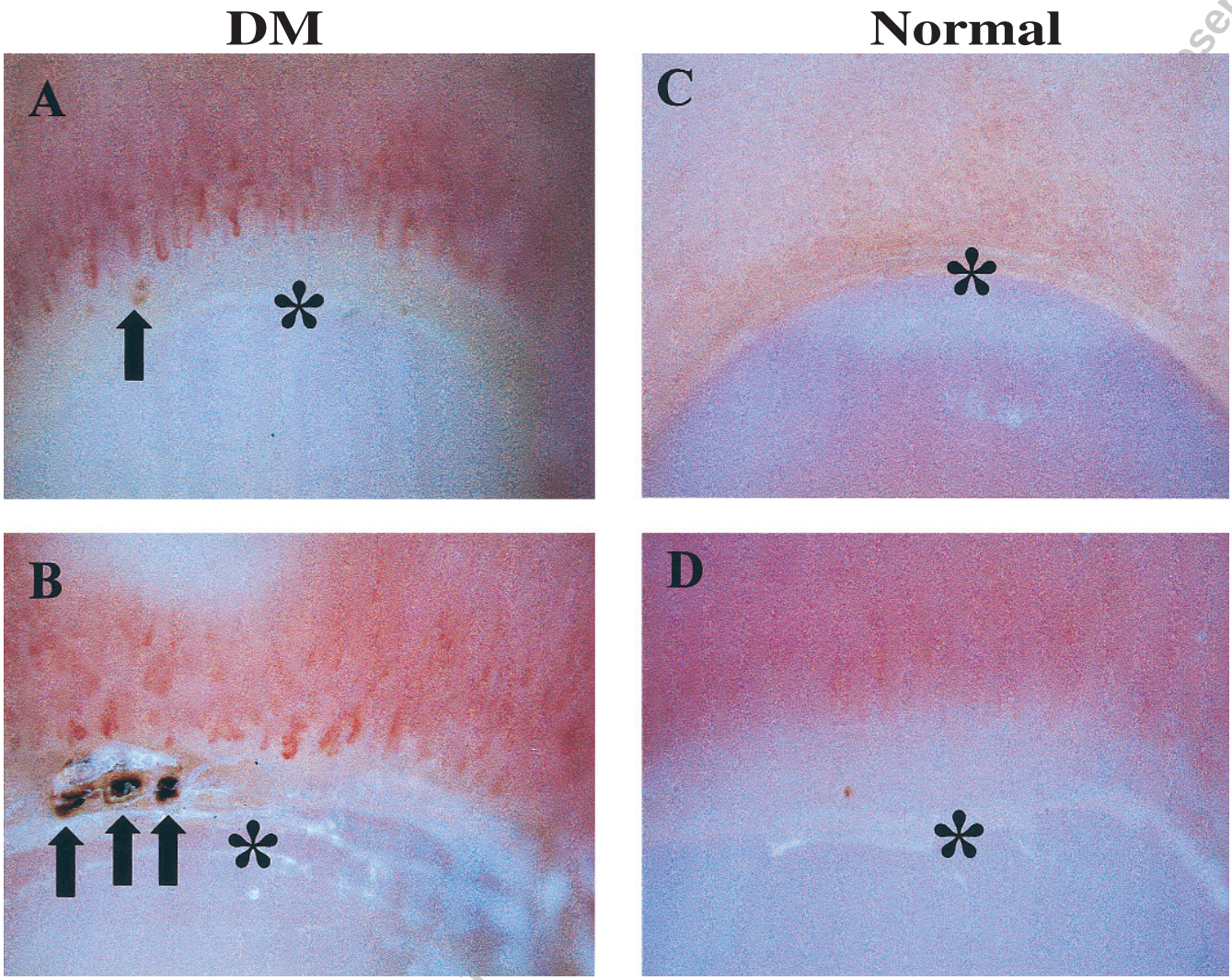


Figure 3. Intermediate magnification appearance of nailfold capillaries of 4th finger of female patients with DM and healthy volunteers. A. Patient CADM-1, with clinically amyopathic DM. B. Patient CADM-2 with clinically amyopathic DM. C and D. Different healthy adult female volunteers. *Junction of the cuticle and the nail plate. Arrows indicate heme deposits within the cuticle resulting from microhemorrhage from incompetent nailfold capillaries.

was difficult to keep the capillaries in sharp focus at such magnification while holding the camera in one's hands.

It would be possible to enhance the appearance of nailfold capillary changes after the digital images have been obtained by adjusting the lighting intensity, contrast, and color saturation using standard digital photography software packages. However, only minimal degrees of such adjustments were made in the images displayed in Figures 2–4 for the sake of optimizing the published images. Thus, the images presented here represent a realistic depiction of the images that were observed through the DermLite dermatoscope.

DISCUSSION

Dermoscopy is a noninvasive method that allows for magnified *in vivo* visualization of various anatomical elements within human skin. Dermoscopy has become an increasingly valuable tool to dermatologists for noninvasively assessing malignancy risk of pigmented skin lesions at the bedside[12] [http://www.dermoscopy.org/]. Computer-assisted analysis of dermoscopy images is being used with increasing frequency to more objectively and reproducibly assess malignancy risk of melanocytic skin lesions[13,14]. While originally developed as a technique for *in vivo* examination of pigmented skin lesions, dermoscopy has proven to be of diagnostic value in examining other cutaneous elements such a microvasculature and microcystic change[15].

The more recent availability of hand-held, battery-powered dermoscopy units employing a polarized light source to eliminate reflection from the skin surface, thereby eliminating the need for applying mineral oil/immersion to the skin surface, has made dermoscopy much more practical in a high volume outpatient setting such as a dermatology

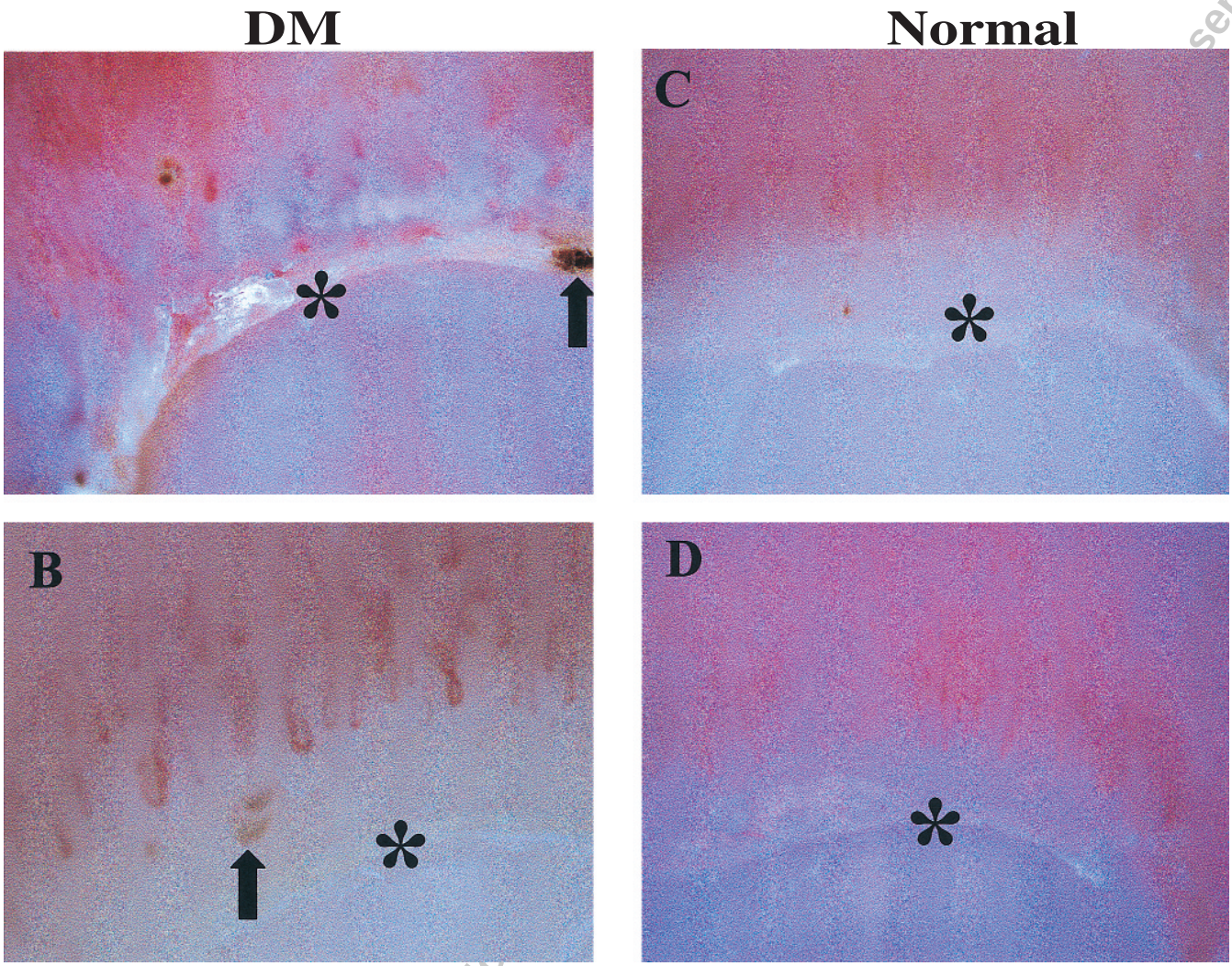


Figure 4. High magnification appearance of nailfold capillaries of 4th finger of female patients with DM and healthy female volunteers. A. Patient CADM-2, with classical DM. B. Patient CADM-1, with clinically amyopathic DM. C and D. Different healthy adult female volunteers. *Junction of the cuticle and the nail plate. Arrows indicate heme deposits within the cuticle resulting from microhemorrhage from incompetent nailfold capillaries.

practice. One such commercially available dermoscopy unit is the DermLite. The DermLite is an epi-illuminated microscope that features white LED technology, a 10× Hastings Triplet lens, cross-polarization, a longlife battery, and a very compact size (3.5 oz/99 g). The experience of the author confirmed the value of this high quality tool in a general/medical dermatology practice.

By chance, the patients encountered in our clinic during the study period having nailfold capillary abnormalities on screening examination with a DermLite dermoscopy unit were limited to DM. However, published data suggest that the qualitative and quantitative changes observed in nailfold capillaries in patients with DM are very similar to those that are encountered in scleroderma/SSc. In general, such nailfold capillary changes are less frequent and less conspicuous in SLE. While no formal data currently exist, it has been our impression that the nailfold capillary changes seen in patients with classic DM and clinically amyopathic DM are virtually identical. The preliminary results presented here would tend to support this hypothesis.

The author has found that detection of nailfold capillary changes can be of special value in several clinical settings. One is a patient presenting during the early, incompletely expressed phase of an autoimmune CTD. An example would include the appearance of isolated Raynaud's phenomenon in a patient destined to later develop SSc. Another example would be the appearance of the early, clinically indeterminate inflammatory skin changes of DM in a patient shortly before the development of muscle weakness (i.e., premyopathic DM) or a patient destined never to develop muscle weakness or develop muscle weakness after prolonged periods of time (6 mo–10 yrs) (i.e., clinically amyopathic DM)[10,11]. Another setting where recognition of nailfold capillary changes can be of clinical value is when evaluating

a patient experiencing overlapping elements of several different autoimmune CTD. We found the DermLite dermoscopy unit to be a very useful clinical tool for efficiently detecting such nailfold changes at the bedside and the DermLite Foto flash-equipped digital camera system an efficient and relatively economical tool for photographically documenting such changes.

REFERENCES

1. Maricq HR, LeRoy EC. Patterns of finger capillary abnormalities in connective tissue disease by "wide-field" microscopy. Arthritis Rheum 1973;16:619-28.
2. Blockmans D, Beyens G, Verhaeghe R. Predictive value of nailfold capillaroscopy in the diagnosis of connective tissue diseases. Clin Rheumatol 1996;15:148-53.
3. Martino F, Agolini D, Tsalikova E, et al. Nailfold capillaroscopy in Henoch-Schonlein purpura: a follow-up study of 31 cases. J Pediatr 2002;141:145.
4. Wendling D, Risold JC. Nailfold capillaroscopy and ankylosing spondylarthritis: incidence of anomalies, but absence of diagnostic and prognostic value. Rev Med Interne 1994;15:448-51.
5. Dinc A, Melikoglu M, Korkmaz C, Fresko I, Ozdogan H, Yazici H. Nailfold capillary abnormalities in patients with familial Mediterranean fever. Clin Exp Rheumatol 2001;19 Suppl 24:S42-4.
6. Silver RM, Maricq HR. Childhood dermatomyositis: serial microvascular studies. Pediatrics 1989;83:278-83.
7. Hern S, Mortimer PS. Visualization of dermal blood vessels — capillaroscopy. Clin Exp Dermatol 1999;24:473-8.
8. el-Azhary R, Pakzad SY. Amyopathic dermatomyositis: retrospective review of 37 cases. J Am Acad Dermatol 2002;46:560-5.
9. Caproni M, Cardinali C, Parodi A, et al. Amyopathic dermatomyositis — A review by the Italian group of immunodermatology. Arch Dermatol 2002;138:23-7.
10. Sontheimer RD. Dermatomyositis: An overview of issues of interest to dermatologists [review]. Dermatol Clin 2002;20:387-408.
11. Sontheimer RD. Would a new name hasten the acceptance of amyopathic dermatomyositis (dermatomyositis sine myositis) as a distinctive subset within the idiopathic inflammatory dermatomyopathies spectrum of clinical illness? J Am Acad Dermatol 2002;46:626-36.
12. Argenziano G, Soyer HP, Chimenti S, Argenziano G, Ruocco V. Impact of dermoscopy on the clinical management of pigmented skin lesions. Clin Dermatol 2002;20:200-2.
13. Fleming MG. Digital dermoscopy. Dermatol Clin 2001;19: 359-67,ix.
14. Rubegni P, Burroni M, Dell'eva G, Andreassi L. Digital dermoscopy analysis for automated diagnosis of pigmented skin lesions. Clin Dermatol 2002;20:309-12.
15. Stolz W, Braun-Falco O, Bilek P, Landthaler ML, Cognetta AB. Color atlas of dermoscopy. Oxford: Blackwell Science Ltd.; 1993.