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Dermoscopic insight into skin microcirculation – Burn depth assessment

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ABSTRACT

To investigate the effectiveness of dermoscopic observation of skin microcirculation, the dermal capillary integrity of burn wounds was evaluated by dermoscopy according to a proposed algorithm that is designed to distinguish burn wounds between superficial dermal burns: SDB, and deep dermal burns: DDB. As the gold standard for comparison, two widely accepted endpoints of primary healing within 21 days (SDB) or over 21 days after injury (DDB) were used. A number of dermatologists conducted diagnostic imaging by dermoscopy. Comparison among polarized noncontact dermoscopy (PNCD), polarized contact dermoscopy (PCD) and nonpolarized contact dermoscopy (NPD) was also conducted. Images from the three modalities were evaluated for color, pattern and qualitative differences among them. The results of dermoscopy measurements according to the proposed algorithm showed accuracy of 96.7%, sensitivity of 100.0% and specificity of 94.4%. Dermoscopy measurements were significantly more accurate than clinical assessment ($p < 0.05$). The recognition of dots increased for NPD, vessels were most clearly observed under PCD and colours tended to be more distinctly recognized under polarized light. Dermoscopy is a useful and simple tool to evaluate not only epidermal and superficial dermal skin components but also the skin microcirculation.

1. Introduction

Skin microcirculation is vital to the functioning not only of skin but also of the whole body. Many approaches have been conducted to investigate skin microcirculation from various points of views [1–4]. However, they have not become familiar technology because of their cost, cumbersome procedure, training requirements and so on.

Dermoscopy is now thought to be an essential tool in daily clinical practice for dermatologists. At first, melanin chromospheres in pigmented skin lesions (PSL) were the main interest of dermoscopy studies [5–9]. A spate of reports followed on various skin tumors, and then vascular structures of skin

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tumors such as amelanotic melanoma [10], pyogenic granuloma [11], Kaposi's sarcoma [12], dermatofibrosarcoma protuberans [13], common inflammatory skin diseases [14], psoriasis, seborrheic dermatitis, [15,16] and pityriasis rosea [17], as well as connective tissue diseases [18] were reported to be evaluated effectively by dermoscopy. Dermoscopy has been proved to be an effective tool to evaluate the vascular structure of the superficial dermis.

In both skin tumors and inflammatory skin diseases, the epidermis is normally located above the superficial dermis. Therefore, it is unavoidable that dermoscopic images of such conditions are interfered with by the existence of the epidermal layer. In skin ulcers, such as in intermediate-depth burns, the epidermal layer is injured and lacking, so the vascular structure of the superficial dermis can be observed without the interference by the epidermal layer.

The burn healing potential is reported to be a function of blood flow to the wound. In the daily medical practice of burn care, burn wound depth is critically important because it determines not only therapeutic strategy but also a patient's prognosis, including morbidity. Burn depth is effectively assessed by evaluating the dermal capillary integrity [19–24].

Nonpolarized contact (fluid immersion) dermoscopy (NPD) has been a conventional approach and many investigations on dermoscopy have been reported using NPD. Fluid immersion decreases the amount of light reflected at the stratum corneum and visualizes deeper epidermal and dermal structures. Subsequently, advanced techniques enable new dermoscopic observation, such as polarized dermoscopy (PD), which enables dermoscopic observation of a deeper layer than NPD without fluid immersion. Therefore, contact and noncontact dermoscopy with polarization is now available. Deeper structures such as the vasculature can be better observed by PD. Some studies reported the differences in observation by NPD, polarized noncontact dermoscopy (PNCD) and polarized contact dermoscopy (PCD) [25–29]. Additionally, dermoscopy is proved to be useful in the assessment of burn wounds and scars [30,31].

The aim of this study was to evaluate the usefulness of dermoscopy in the evaluation of dermal capillary integrity through burn depth assessment, and to examine the differences in the observation of the vasculature without interference of the epidermis by NPD, PCD and PNCD.

2. Materials and methods

2.1. Subjects

This investigation was conducted at the Burns Unit, Nagasaki Hospital. The hospital's ethical committee approved this study. Patients who presented at the Burns Unit of Nagasaki Hospital with intermediate-depth burns, the depth of which was difficult to assess with the naked eye, were prospectively assessed clinically and dermoscopically. The identification of intermediate-depth burns was conducted by the first author (KM), who was an experienced dermatologist with more than 15 years' experience of burn care. Patients with burn wounds of a size greater than or equal to 1% and less than 10% of the total body surface area (TBSA), older than 15 years old and who gave written informed consent were included in the study. Patients with a concomitant illness such as diabetes and other known vascular problems, as well as psychiatric disease, were excluded from the study.

2.2. Dermoscopy

A handheld dermoscope, ONDEKO DERMOSCOPE EPILITEx8 (Ondeko Corporation, Tokyo, Japan), with a slide switch between non-polarization and polarization was used to conduct dermoscopy measurement over the entire wound because of its simplicity and convenience. Derma9500 (Derma Medical, Inc., Tokyo, Japan), which can be used both with and without a polarization filter, composed of a close-up adapter unit mounted on a Canon Powershot G11 digital camera (Canon, Inc., Tokyo, Japan), was used to take dermoscopic images.

At first, the wound was cleaned well under running water, photographed clinically and assessed for its depth clinically, and then covered with thin transparent polyvinylidene chloride film, Kurewrap (Kureha Corporation, Tokyo, Japan). The film was laid on the wound with care not to compress it to avoid the possibility of transmitting infection through the dermoscopy and to alleviate the patients' haphalgesia by the procedure.

The first author (KM), who is experienced in clinical burn practice and burn depth assessment clinically and dermoscopically, took clinical digital photos of burn wounds with a digital camera (Nikon D40; Nikon, Inc., Tokyo, Japan) mounted with a micro-lens (AF-s Micro NIKKOR 60 mm f/2.8G ED; Nikon, Inc., Tokyo, Japan) and an electric flash (Sigma EM-140DG; Sigma Corporation, Kanagawa, Japan), and assessed their depth clinically according to the classification of burns by ISBI/WHO [32]. After that, KM conducted dermoscopy measurement over the entire wound through investigation of the dermal capillary integrity. KM carefully investigated the area that was thought to indicate the overall burn depth and took digital photos of the dermoscopic image. At first, the close-up adapter unit with a polarization filter was mounted on a Canon Powershot. Two digital photos were taken while avoiding contacting the wound (PNCD) using an automatic focus. The second or later photos were taken with a dot marked on the polyvinylidene chloride films above the wounds with an oil-based marker pen (MO-120-MC-BK; Zebra Co., Ltd., Tokyo, Japan) to fix the area used in the investigation. The first photo (PNCD) without a marked dot was used for burn depth assessment. The second or later photos (PNCD, PCD, and NPD) with a marked dot were used to evaluate the difference between the images with or without polarization and contact between glass plate and wounds. PCD and NPD images were taken using programmed focus, which was associated with the glass faceplate of the adapter (Fig. 1).

After the assessment, each patient received conservative treatment for 21 days after injury. Conservative treatment provided in this study was as follows: after thorough cleaning under running water, topical administration of 0.25% tretinoin tocoferil cream (KYORIN Rimedio Co., Ltd., Ishikawa, Japan), white petrolatum-impregnated gauze and dry gauze.

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