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A validation study of scar vascularity and pigmentation assessment using dermoscopy

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ABSTRACT

Introduction: Vascularity and pigmentation are two important indicators of the maturing status of hypertrophic scars. We used the dermoscope to measure vascularity and pigmentation of hypertrophic scars to examine its validity and reliability.

Materials and method: Eighteen subjects were assessed using the Vancouver Scar Scale (VSS), spectrocolorimeter and dermoscope. Correlations between the measurements by these tools and reliability parameters were examined.

Results: A strong correlation was found between the redness measured by spectrocolorimeter and the RGB redness values of dermoscope pictures ($r = 0.890$). A correlation was found between the lightness measured by spectrocolorimeter and the lightness of dermoscope pictures ($r = 0.536$), and between the lightness by spectrocolorimeter and the blanched dermoscope pictures ($r = 0.448$). The calculated RGB values of redness of the dermoscope correlated with the VSS vascularity score ($r = 0.625$); the transformed VSS pigmentation score correlated with the lightness of the blanched dermoscope pictures ($r = 0.783$). The intra-class correlation coefficient (3, 1) of the dermoscope was 0.980 for the redness measurement and 0.965 for the lightness measurement, while the intra-class correlation coefficient (2, 2) was 0.930 for the dermoscope redness measurement and 0.871 for the dermoscope lightness.

Conclusion: The dermoscope is a promising objective tool for vascularity and pigmentation assessments of hypertrophic scars with good validity and reliability.

1. Introduction

The assessment of hypertrophic scars has always been an important issue in evaluating the effects of various kinds of scar management strategies. Over the years, clinical practitioners and researchers have developed many scales and instruments to examine the characteristics and condition of hypertrophic scars. One of the most commonly used scales is the Vancouver Scar Scale (VSS) which assess the scar with four specific parameters including pigmentation, pliability, vascularity and

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height (i.e., thickness). Among them, vascularity is a main feature that indicates the proliferative status of the scar and reflects the degree of scar maturation [1,2]. The more active the scar is, the more blood supply is observed [3]. However, VSS has been considered subjective and with poor sensitivity and inter-rater reliability, and the scores are not sensitive to minor changes of colours [4,5].

Over the years, with the development in electronics and information technology, efforts in exploring more objective and accurate assessment tools for scar measurement have never stopped. One worldwide accepted objective measurement approach for scar colour is spectrophotometry, which interprets the colour of the scar in terms of redness, lightness and yellowness [6,7]. There are many types and models of instruments based on this approach, and many have been proved to be useful and reliable in measuring skin or scar colour in clinical and research settings [8,9]. One type of such instruments—the spectrocolorimeter, has also been validated in our previous study in the measurement of scar colour, which included information for pigmentation and vascularity [5]. It has been proved useful and reliable in our clinical practice and research regarding hypertrophic scar treatment. However, this kind of instrument is usually extremely expensive and difficult to be carried around, thus it is not a convenient tool to be widely used for many burn and rehabilitation institutes in developing and undeveloped countries. Also, the data collected from the spectrocolorimeter is a mixture of skin colour information, which includes information of both vascularity and pigmentation. Although the vascularity and pigmentation status can be reflected objectively through the readings of redness, yellowness and lightness [5], the system would be less sensitive if the two factors cannot be analyzed separately. It would be desirable to differentiate the vascularity and pigmentation information from the colour data and analyze them respectively.

Laser Doppler has been proved useful in measuring blood perfusion of scars which is also an important indicator of vascularity of scars [3,6,10]. However, pigmentation characteristics cannot be measured with Laser Doppler, and the borders of the scar cannot be seen from the Doppler image. Digital photography is a relatively simple, convenient and inexpensive method to capture the visual characteristics of a scar. It can be readily adopted by clinicians and therapists in daily work. With standardized documentation methods, photographs do have certain usefulness in objectively recording the skin colour during treatment. However, environmental lighting conditions and camera settings, as well as human factors (e.g., skills of the photographer), can affect the accuracy of the measurement [7,11]. Recently, several studies have been carried out based on polarized light photography, which involved combinations of polarized light, spectral modelling, digital photography and image analysis [3,7,12–14]. Polarized light has the advantage of blocking the reflectance from the skin surface, such that the characteristics of the epidermal and superficial dermal layers can be observed more clearly [12]. Some devices can even analyze the haemoglobin and melanin distributions in the skin separately, which are good indicators of vascularity and pigmentation for scars. However, the overall capturing process and the devices are complicated with expensive costs [13,14]. In addition, digital photography only analyze the overall pattern of haemoglobin and melanin distributions, but not able to reflect the micro-details regarding vascularity or pigmentation [12,15].

Dermoscopy is widely used among dermatologists in diagnosing various kinds of dermatosis, especially melanoma. Its efficacy has been proved over many years of clinical practice and is also considered to be a better instrument than spectrophotometric intracutaneous analysis in dealing with pigmented skin lesions [16]. However, no study has reported the use of dermoscopy in quantitatively assessing hypertrophic scars previously. The dermoscopy uses light source of its own, and enables the observer to visualize the structures in the epidermis and superficial dermis [17]. Moreover, polarized dermoscopy, which also adopted the principles of polarized photography, is able to filter the reflected light from the surface of the skin and capture the backscattered light from the deeper layers of the skin, thus allowing the observer to see deeper and clearer [17]. The dermoscopy is able to visualize dilated capillaries and pigments in the dermal and epidermal layers of hypertrophic scar very clearly, which offers a big advantage in assessing the vascularity and pigmentation accurately. Modern dermoscopy can be easily connected to a digital camera, which makes it a very convenient tool for obtaining and analysing the captured features [17]. Since the dermoscopy uses its own light source, the measurement results are not likely to be affected by the environmental lighting condition. As a pilot test of the present study, we have tested the dermoscope in different environmental lighting conditions and found that the captured pictures were in the same colour as they supposed to be. Also, the dermoscope is able to discriminate vascularity and pigmentation from pure colour of the scar, by placing a glass plate and contacting the surface of scar with pressure (the same concept as VSS assessment) [2]. The visible capillaries and vascular structures would all be blanched out with the application of pressure, leaving only the pigmentation information (Fig. 1). Furthermore, with the polarized dermoscope, collagen structures which are otherwise not apparent can be observed easily [18] and thus can help the clinician and the researcher to monitor the inner changes of hypertrophic scar conveniently.

Dermoscopy can be a promising method for objective and accurate assessment of scar vascularity and pigmentation, if given rigorous validation for its reliability and usefulness. In the present study, we explored the application of dermoscope in the assessment of scar vascularity and pigmentation, and evaluated its validity and usefulness in clinical practice.

2. Materials and method

2.1. *Subjects*

Eighteen patients with hypertrophic scars were recruited from the Rehabilitation Clinic of The Hong Kong Polytechnic University and the Burns Clinic of Prince of Wales Hospital in Hong Kong using convenience sampling. All subjects had hypertrophic scars previously diagnosed by burn surgeons. Subjects with scar sites of size less than 1×1 cm^2 or scar sites with open wound or infections were excluded. Subjects who

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