Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/burns

Transepidermal water loss measured with the Tewameter TM300 in burn scars

Kim L.M. Gardien [a,b,c], Dominique C. Baas [b,c,*], Henrica C.W. de Vet [d,e], Esther Middelkoop [a,b]

[a] Dept Plastic, Reconstructive and Hand Surgery, VU University Medical Center, MOVE Research Institute, 1007 MB Amsterdam, The Netherlands
[b] Association of Dutch Burn Centers, 1940 EA Beverwijk, The Netherlands
[c] Burn Center, Red Cross Hospital, 1942 LE Beverwijk, The Netherlands
[d] EMGO Institute for Health and Care Research, VU University Medical Center, 1007 MB Amsterdam, The Netherlands
[e] Department of Epidemiology and Biostatistics, VU University Medical Center, 1007 MB Amsterdam, The Netherlands

ARTICLE INFO

Article history:
Accepted 28 April 2016

Keywords:
Burn scar
Reliability
Scar quality
Tewameter
Transepidermal water loss

ABSTRACT

Transepidermal water loss (TEWL) is a physiological characteristic to measure the efficiency of the skin barrier. The aim was to investigate the reliability of the Tewameter TM300 for the assessment of TEWL (g/m^2/h) in burn scars. Also the relation between TEWL scar values and scar quality parameters was investigated. Three different study areas (scar, healthy adjacent and contralateral skin) were assessed in 55 adult patients. The intra- and inter-observer reliability were tested using the intra-class correlation coefficient (ICC) and the standard error of measurement (SEM). The inter-observer reliability for the three areas was excellent with ICC values between 0.85 and 0.94. SEM values were between 1.76 and 3.97 g/m^2/h. Bland–Altman plots showed relatively wide LoA values for scar and healthy skin. Mean TEWL scar values were significantly higher than healthy skin ($p < 0.001$). Significant correlations were found between TEWL hypertrophic scar values and erythema ($r = 0.60$, $p = 0.001$) and a negative correlation for weeks after burn ($r = -0.61$, $p = 0.001$). TEWL values were significantly different between 3 and 6 months and 3 and 12 months old scars (respectively $p = 0.021$ and $p = 0.002$). To evaluate the skin barrier function over time as a measure for scar maturation, Tewameter TM300 measurements have to be performed according to strict and standardized protocols.

1. Introduction

Quantitative and qualitative analysis of clinical conditions is becoming more and more important in health care. Also for wound healing research, patient related outcome measures, as well as objective and subjective scar evaluation are of paramount importance for monitoring scar evolution and to evaluate the effectiveness of therapeutic treatments or compare research interventions. Scar severity, resulting from burn wounds depends on many factors, one of them being the initial depth of the burn wound [1]. Functional and esthetical abnormalities of the skin are most severe in excessive hypertrophic scars and keloids [2]. The skin of each patient

* *Corresponding author at*: Rode Kruis Ziekenhuis, Brandwondencentrum, Vondellaan 13, 1942 LE Beverwijk, The Netherlands. Tel.: +31 251265220; fax: +31 251216059.
E-mail address: dbaas@rkz.nl (D.C. Baas).

http://dx.doi.org/10.1016/j.burns.2016.04.018
0305-4179/

has its own variable characteristics, healing parameters and displays a diversity in scar maturation. The unaffected skin, comparable to the anatomical position of the scar tissue, is therefore the most common reference area to evaluate scar tissue in patients. An accurate scar evaluation can be reached by objectively measuring various morphological characteristics.

During long term scar follow-up, scar quality is mainly assessed by determining the morphological characteristics (e.g. vascularity, pigmentation, thickness, relief and pliability) with the POSAS questionnaire (Patient and Observer Scar Assessment Scale), a color measurement using the DSM II ColorMeter (Cortex Technology, Hadsund, Denmark) and an elasticity measurement using the Cutometer® (Courage & Khazaka GmbH, Cologne, Germany) [3–5]. Besides morphological characteristics, also physiological characteristics of healthy skin and scar tissue are of great importance, such as transepidermal water loss (TEWL) [6–8]. Recovering from partial or full thickness burn wounds, the function of the stratum corneum is damaged, resulting in deviating TEWL in scar tissue compared to normal skin [8,9]. TEWL is measured by estimating the flux density of evaporated water from the skin surface [10]. TEWL is considered to be the most important non-invasive physiological characteristic to assess the function of the skin barrier [6,9,11–13]. Studies concerning skin barrier function are important for the cosmetic industry and dermatological research (e.g. neonatal care, (burn) scars).

One of the commercially available systems to measure TEWL values is the Tewameter® TM300 (Courage & Khazaka GmbH, Cologne, Germany). This device uses a non-invasive method which measures through an open-chamber system. It is well-studied and already widely used in the field of dermatology and cosmetology and its applicability has been reviewed in several papers [6,7,14–17]. To assess the appropriateness of a measurement device, clinimetrical properties (e.g. reliability, measurement error and validity) are of critical importance. This study focusses on the reliability of the Tewameter® TM300 for the assessment of TEWL values in patients with burn scars in a clinical setting. Furthermore, we aimed to determine the relation between the TEWL scar values and different scar quality parameters of 3,6 and 12 months old burn scars.

2. Methods

2.1. Study design and population

In this cross-sectional study 55 adult patients with a burn scar, after partial thickness and/or full thickness burns, 3, 6 or 12 months after burn were recruited from October 2014 until June 2015 in the scar outpatient clinic of the Burn Center of the Red Cross Hospital in Beverwijk, The Netherlands. All patients gave written informed consent and the patients and data were anonymized using codes. The study followed the tenets of the Declaration of Helsinki and the study protocol was approved by the Medical Ethics Committee Noord-Holland, The Netherlands (M014-021).

2.2. Tewameter® TM300 and other instruments

The Tewameter® TM300 probe (Courage & Khazaka GmbH, Cologne, Germany) is used for the evaluation of skin barrier function by measuring TEWL (Fig. 1). The probe is connected to the MPA 580 system of the same manufacturer. The physical basis for the measuring principle is Fick's diffusion law. The probe measures the density gradient of the water evaporation from the skin by two pairs of sensors located at different heights, a temperature and humidity sensor. These sensors are placed in an open hollow cylinder, in order to minimize influences of air turbulence inside the cylinder. A microprocessor measures the values. The flux density of water is expressed in grams per square meter per hour ($g/m^2/h$).

In addition to the TEWL values obtained from the Tewameter, patient and treatment characteristics were collected and documented. To monitor scar quality, the morphological characteristics of the scar were assessed by a validated questionnaire, the POSAS, and an objective color measurement by means of the DSM II ColorMeter.

The POSAS consists of an observer and a patient scale and includes scar characteristics that are considered clinically relevant [3]. The observer scores the six items vascularization, pigmentation, thickness, surface roughness, pliability and surface area of the scar. The patient scores the six items pain, pruritus, color, pliability, thickness and relief of the scar. In addition, the patient and observer give their overall opinion on the scar quality. All items are scored on a 10-point rating scale, in which a score of 1 represents normal skin and a score of 10 reflects the worst imaginable scar. Both subscales, the patient and observer scale, are summed over the characteristics and provide separate total scores (range 6–60). The overall opinion, of both the patient and the observer, is not included in the total score. Lower (total) scores represent better scar quality [3].

The DSM II ColorMeter (Cortex Technology, Hadsund, Denmark) is a reliable and valid small handheld measurement device which objectively measures the erythema and melanin index [4]. The DSM II ColorMeter combines narrow-band spectrophotometry and tristimulus reflectance colorimetry in one single measurement [4]. van der Wal et al. describe that

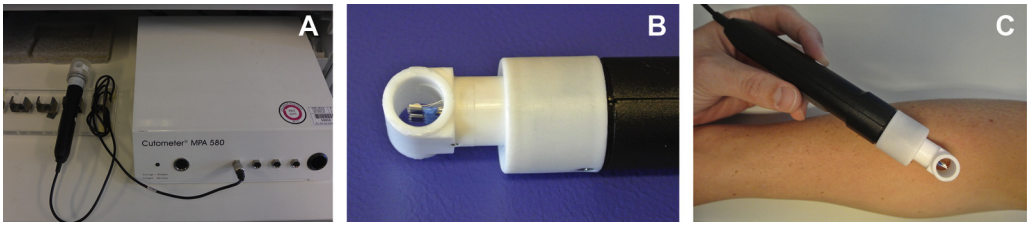

Fig. 1 – (A) Tewameter TM300 probe as part of the Cutometer® MPA 580 (Courage & Khazaka GmbH, Cologne, Germany). (B) Tewameter sensors in probe head. (C) Probe positioning on the right lower arm.