CHAPTER 5

In Vivo Evaluation of the Hydration State of the Skin: Measurements and Methods for Claim Support

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Introduction

The presence of an adequate amount of water in the stratum corneum is important for the following properties of the skin: general appearance of a soft, smooth, flexible and healthy skin and presence of an intact barrier function allowing a slow rate of transepidermal water loss (TEWL) under dry external conditions, which are often encountered [1-4].

Clinically, dry skin is defined as a dry, less flexible, scaly and rough aspect of the upper layers of the epidermis [1, 4, 5]. Itch may accompany these symptoms. In more severe cases of dryness (a condition described by dermatologists as xerosis) and in pathological conditions fissuring, scaling and cracking may occur [6-9]. There is no universally accepted definition of the concept of dry skin [10]. Some authors consider dry skin as being more related to disorders of corneocyte adhesion (rough and scaly surface), to a deficiency in epidermal lipids, or to disorders of the water retaining properties of the horny layer [3,4]. The perception of a dry skin state by the patient himself also may be different from the diagnosis of the clinician.

There is currently no data confirming or infirming that dry skin is actually linked to a diminution of the water content of the horny layer. Only the positive pharmacological effect of moisture applied to the skin surface to relieve the conditions of dry skin has been repeatedly confirmed. This does not prove a water deficiency. Nevertheless, given the fact that the presence of an adequate amount of water is an essential prerequisite for the maintenance of the normal structure and function of the stratum corneum, research has been directed at the evaluation of the water content of this tissue. This water content is influenced by several factors:

- Water diffusing from the deeper viable layers of the epidermis. This water is normally retained by the barrier function of the lipid bilayers in the stratum corneum.
- Water present in the horny layer. This water is fixed among other elements by the natural moisturizing factors (NMF) containing amino acids, lactic acid, pyrrolidone carboxylic acid, urea and various other components.
- Equilibrium between water in the upper layers of the horny layer and the external ambient humidity of air. Depending on the value of the external relative humidity, the upper layers of the stratum corneum may take over or release water.
- Treatment of the skin surface with a moisturizer. Moisturizers are hydrating products used to combat the signs and symptoms of dry skin [11]. They may hydrate the skin along different manners either by reducing the loss of water due to the occlusive effect of oils and fats contained in the formulation on the skin surface, by adding water to the stratum corneum and fixing it with the help of humectants, or by a combination of both [1-4, 12].
As a consequence, the in vivo determination of the degree of hydration of the horny layer is important for the characterization of normal and pathological skin conditions, such an actinically aged or irritated skin, and, finally, for the assessment of the effectiveness of various moisturizing products.

The use of such dermato-cosmetic products in order to restore softness, smoothness and moisture to dry skin is widely practised. Clinically, moisturizers are also considered to be extremely important treatment adjuncts [13]. This chapter is concerned with the clinical evaluation and with the non-invasive bioengineering measurements of the hydration state of the skin. A critical overview of the different available bioengineering methods will be given in order to carry out hydration measurements on normal, well hydrated skin and on (very) dry skin, and to quantitatively assess the efficacy of moisturizers.

As has been described earlier, reliable and reproducible hydration measurements are only obtained if the in vivo experiments on humans are carried out under well controlled standardized conditions [2–4, 14–18]. A description of the influence of intrinsic and extrinsic factors which could influence the hydration measurements will be given. Some general recommendations will be made in order to substantiate the claims of cosmetic products manufacturers. Finally, some typical applications of the assessment of skin hydration will be described and discussed.

Methods for Evaluating the Hydration State of the Skin Surface

Clinical Evaluations

The clinical assessment of symptoms of dryness can be performed either by an expert evaluator or by the subject him(her)self [8, 19–21].

The appearance and feeling of a dry skin surface can be clinically evaluated by trained experienced researchers (physician, dermatologist or other persons) based on well defined objective criteria. For example, visual evaluations of dryness and roughness may be carried out using numerical scales for rating (a score of 0–10 or 0–4). The participation of several independent examiners is usually advantageous. This procedure is called objective clinical rating. The absolute rating of dryness and roughness may differ for each examiner but the relative comparative ratings are accurate, reproducible and sensitive. Generally good correlations are found between the visual clinical evaluations of dryness and the bioengineering methods [8, 19, 20].

This is not true for the subjective perception of the subjects themself about their skin condition (feeling of discomfort, stiffening and itching). Using the same numerical scales for dryness of the skin as in the objective ratings, some interesting comparisons can be obtained. The correlations of the subjective perceptions with the clinical ratings and bioengineering measurements are variable: sometimes very good or sometimes very poor since great discrepancies may be observed [8, 19–21].

Bioengineering Methods

The clinical symptoms of dryness are numerous: dryness, scaling, roughness and diminution of flexibility. A large variety of bioengineering methods are available to