

## ***In vivo measurement of dynamics of water movement across the stratum corneum after barrier disruption\****

### **Introduction**

Barrier disruption by tape stripping is known to initiate a response that results in a rapid restoration of the barrier function. The detailed kinetics of trans-epidermal water loss (TEWL) after barrier disruption are well-known, with barrier function being restored to a partial but functional level within a few hours. Full recovery requires complete renewal of the stratum corneum (SC), taking about two weeks [1]. Prior to the availability of in vivo Raman spectroscopy, the rate and extent with which SC hydration level (water content) recovers following barrier disruption was not measurable, and was therefore unknown. This is important information, since key biochemical processes such as enzyme activation are dependent on hydration level. The advent of practical in vivo Raman spectroscopy now makes this information accessible. In vivo confocal Raman spectroscopy is a non-invasive technique for obtaining detailed information about the molecular composition of the skin as a function of distance to the skin surface. The only instrument capable of making such measurements on a routine basis is the River Diagnostics Model 3510 Skin Composition Analyzer (SCA). This note describes the use of the SCA to make the first determination of the water content of skin following barrier disruption.



**Figure 1.** Disrupting the barrier, using D-squame® tape strips (CuDerm corporation).

### **Experimental**

Five healthy volunteers (27-47 years old) were evaluated by confocal Raman spectroscopy as described by Caspers [2], using the SCA on the cheekbone of the face and on the ventral forearm.



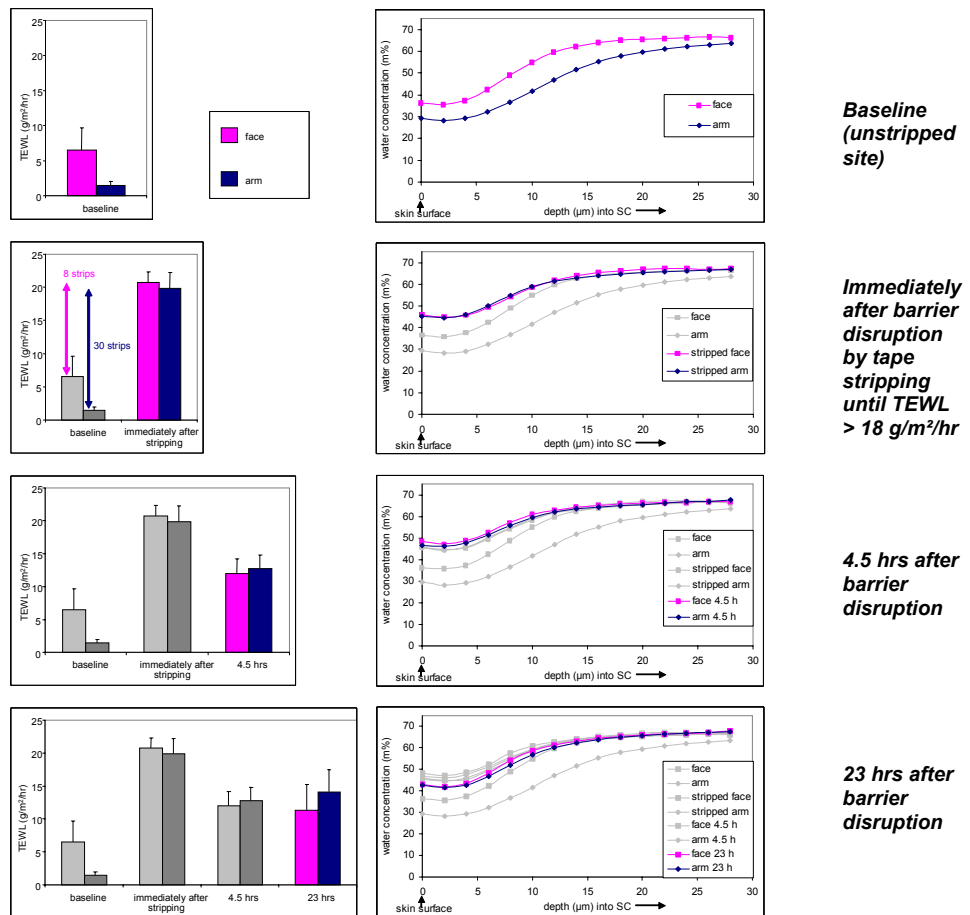
**Figure 2.** A cheek.

Measurements were made before, at 4.5 hrs and at 23 hrs after disruption by tape stripping. Stripping was done until TEWL > 18 g/m<sup>2</sup>/hr was reached, indicative of barrier disruption by removal of most of the SC.

### **Results**

Inspection of the data (see figure 3) shows that TEWL recovers quickly (4.5 hours) to about 60% of the disrupted value. However, there is no measurable further recovery one day (23 hours) later. The Raman-measured in vivo water profiles initially show increased water content near the stratum corneum surface, with the face and arm showing virtually identical profiles, consistent with the TEWL result. In contrast, however, after 23 hours barrier recovery is clearly discernable in profiles as reduced water content of the outer layer of the recovering stratum corneum.

\* Adapted from a poster presentation at the 35th annual ESDR meeting, September 22-24, Tübingen, Germany, coauthored by L. Hellemans, L. Van Overloop, L. Declercq and D. Maes of the Estee Lauder Companies, with A. van der Pol and W.M. Riggs of River Diagnostics.



**Figure 3.** TEWL at skin surface (left, Evaporimeter, Servomed) and water content as a function of depth into SC (right, from Raman spectroscopy).





**Conclusions**

These results reveal a difference in the dynamics of the recovery response after tape stripping between the external water flux, determined with TEWL, and the internal water content of the stratum corneum. The fast initial recovery of the TEWL may be explained by the release of the lipid content of the

lamellar bodies immediately after barrier disruption [3]. We speculate that this “film of lipids” might keep the internal water content of the stratum corneum elevated, which in turn may facilitate the enzymatic processing required for the barrier recovery response.

**References**

- [1] Fore-Pfliger J, *Advances in Skin and Wound Care*, October, 2004.
- [2] Caspers PJ, Lucassen GW, Bruining HA, Puppels GJ, *J. Raman Spectrosc.* 31, 813-818, 2000.
- [3] Rassner U, Feingold KR, Crumrine DA, Elias PM, *Tissue Cell.*, Oct, 31(5), 489-498, 1999.

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