In-vivo Skin Hydration - A Comparison Study of Different Measurement Techniques

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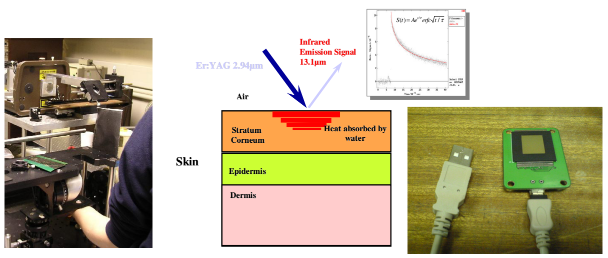
Introduction

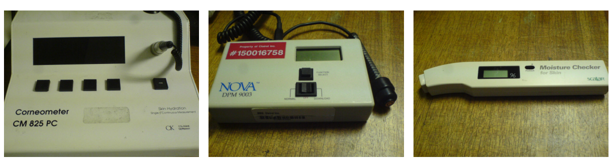
Water in Stratum Corneum plays a key role in skin's barrier functions as well as its cosmetic properties [1]. To date, there are several commercial devices available for such measurements [2]. Previous studies show that opto-thermal transient emission radiometry (OTTER) [3-6] and capacitance based Fingerprint card sensors [7-9] can also be used for skin hydration measurements. Comparing with existing technologies, OTTER is an novel infrared remote sensing technology that offers benefits of non-contact evaluation, whilst Fingerprint sensors can generate 2D skin hydration images. In this paper, we will investigate the correlations between different skin hydration measurement techniques and to understand the repeatability of each technique.

Apparatus

Five skin hydration measurement instruments - opto-thermal transient emission radiometry (OTTER), Fingerprint sensors (MBF200, Fijistu), Corneometer (CM825, C+K Electronic) , Nova (DPM 9003, DermLab) and Moisture Checker (Scalar)- are used to measure in-vivo skin hydration of different skin sites from different volunteers and at different hydration levels.



Opto-thermal Transient Emission Radiometry (OTTER) | Fingerprint sensor



Corneometer | DermLab | Moisture Checker

Figure 1. Skin hydration measurement technologies.

Results and Discussions

All the measurements are performed under normal ambient laboratory conditions, i.e. 20~21℃, and 40~50% relative humidity (RH), and all the volunteers are acclimatized in the laboratory for 20 minutes prior to the measurements. The skin sites used for the measurements are untreated, but were wiped clean with ETOH/H_2O (95/5) solution.

The repeatability measurements is done by measuring the same skin site repeatedly 30 times using different measurement instruments. Total seven different skin sites was studied. Table 1 shows the repeatability study results. The variability in measurement results can be caused by many factors, among them skin site variability and instrument variability are the two most significant ones. From Table 1 results, by averaging the coefficient of variation (CV) of different instruments on the same skin site, we can get the information of skin site variability; whilst by averaging coefficient of different skin sites using the same instrument, we can get the information of instrument variability. Skin sites from palm and volar forearm are the least variable sites, and OTTER and moisture checker gave the most repeatable results. The high variability in Fingerprint sensor results is likely due to in-consistent contact pressure. Work is in progress to develop a new measurement case which will maintain a constant contact pressure during measurements.

Table 1 The average, standard deviation (StDev), and coefficient of variation (CV) results of different skin sites using different measurement instruments.

	Fingerprint			OTTER			Corneometer			Moist Checker			Nova			**Skin Sites**
	Average:	StDev:	CV:	Average:	StDev:	CV:	Average:	StDev:	CV:	Average:	StDev:	CV:	Average:	StDev:	CV:	**Variability**
Palm	78.4	4.4	5.6%	24.2	0.3	1.3%	33.5	1.7	4.9%	30.2	1.1	3.5%	167.5	7.8	4.6%	**4.0%**
Thumb	129.4	9.9	7.7%	25.2	0.4	1.4%	40.9	2.6	6.4%	33.9	1.0	2.9%	501.3	21.4	4.3%	**4.5%**
Volar Forearm	75.8	5.4	7.1%	25.2	1.2	4.7%	37.1	1.5	4.2%	30.3	0.8	2.7%	178.0	4.7	2.6%	**4.3%**
Forehead	74.6	8.5	11.4%	26.7	1.0	3.9%	47.3	4.4	9.2%	31.7	1.4	4.4%	147.5	4.8	3.2%	**6.4%**
Neck	80.9	11.1	13.8%	31.3	1.9	6.0%	53.6	3.8	7.1%	30.5	1.7	5.6%	170.3	14.0	8.2%	**8.2%**
Cheek	52.3	5.8	11.1%	32.3	1.1	3.3%	39.4	3.2	8.1%	22.2	2.4	10.9%	126.3	14.7	11.6%	**9.0%**
Back of Hand	70.1	2.6	3.7%	27.7	0.8	2.9%	40.2	4.5	11.1%	31.4	0.8	2.4%	203.4	4.8	2.3%	**4.5%**
Instrument Variability			**8.6%**			**3.3%**			**7.3%**			**4.6%**			**5.3%**	

Figure 2 shows Table 1's coefficient of variation (CV) results and correlations of between Fingerprint sensor and other measurement instruments. Apparently the correlations between each measurement instrument are poor, which is likely due to that the measurements results are dominated by skin sites variability and instrument variability.

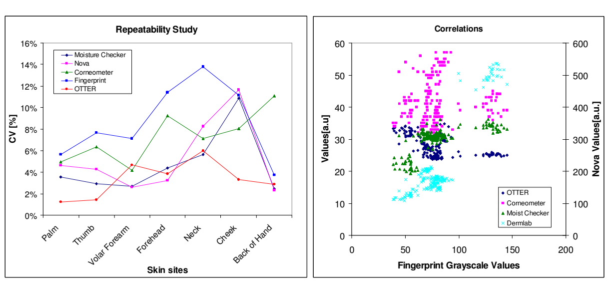


Figure 2. Coefficient of variation (CV) results of different skin sites using different measurement instruments (left) and correlations of different measurement instruments (right).

In order to better understand the correlations of the different measurement instruments, we need to measure at different skin hydration levels. The different skin hydration levels in this study are achieved through skin occlusion by applying a wet tissue patch on test skin sites for 5 minutes. The measurements were performed both before and after the occlusions.

Figure 3 shows the wet tissue patch hydration measurement results of four different skin sites by using five different measurement instruments. For all five measurement instruments, the skin hydration level increased immediately after the 5 minutes wet tissue patch occlusions, and gradually recovered back to the normal levels after about 20 minutes.

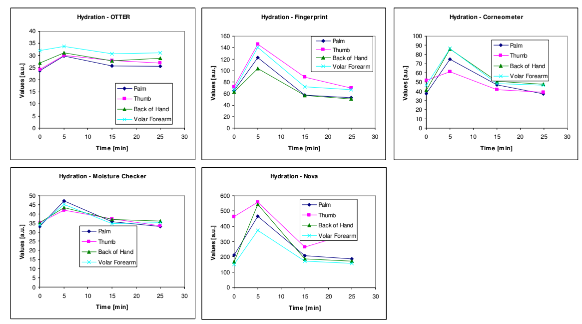


Figure 3. The wet tissue patch hydration measurement results of five different measurement instruments on four different skin sites.

Figure 4 shows the correlation between different measurement instruments. In this case, there is a general good correlation between Fingerprint sensor and all other measurement instruments.

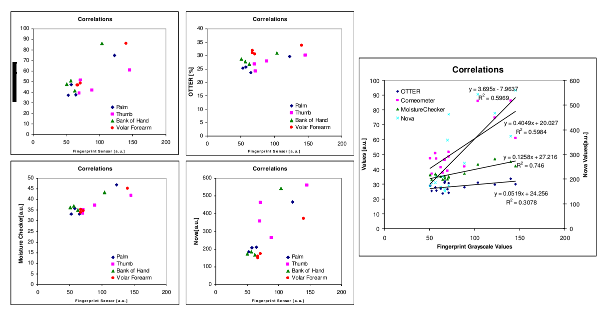


Figure 4. The correlations between different measurement instruments.

Conclusions

The study shows that by repeatedly measuring different skin sites using different measurement instruments, we can study the skin site variability and the instrument variability. By measuring different skin hydration levels using different measurement instruments, we can study the correlations between each measurement instrument. The results show that there is a general good correlation between Fingerprint sensor and all other measurement instruments.

Acknowledgement

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