Skin Water Changes Induced by Local Heating
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Abstract

Background: Skin water content and distribution are affected by dermatological and cardiovascular conditions. It is suggested that localized heat-induced vasodilation increases capillary filtration causing increased interstitial fluid that is measurable as an increase in skin water. Thus, we hypothesized that there should be a significant correlation between skin water parameters and the magnitude of hyperemic blood flow.

Objective: Our goal was to test this hypothesis by assessing skin water changes subsequent to localized hyperemia.

Methods: Skin water was assessed by stratum corneum capacitance and by tissue dielectric constant measurements (TDC) at 300 MHz to skin depths of 1.5 mm (TDC15) and 2.5 mm (TDC25) on forearm skin of 32 healthy subjects before and after localized skin heating from a baseline of 29.5 ± 1.2°C to 39.0 ± 2.7°C for 12 minutes. Skin water loss was assessed via transepidermal water loss (TEWL) and skin temperature (TSK) was assessed via IR. Hyperemia was assessed by laser Doppler blood perfusion (LDP) in perfusion units (pu) before and during heating. All subjects signed IRB approved consents.

Results

Immediate post-heat peak perfusion assessed via LDP measurements increased from a baseline (35°C) value of 2.8 ± 1.6 pu to 23.6 ± 9.7 pu. The hyperemia ratio (10.5 ± 6.3) was accompanied by significant (p<0.001) increases in all measured skin parameters with the following post-heat/pre-heat ratios: TEWL (4.3 ± 2.4), SC (9.0 ± 11.0), and TSK (1.18 ± 0.67). Regression analysis showed significant correlations between SC and TSK (r=0.536, p<0.001), LDP and TSK (r=0.585, p<0.001). No other significant relationship between the hyperemic response magnitude and any other skin water parameter was found.

Conclusions: Although the present results show major changes in skin water parameters accompanying heat induced hyperemia and a small correlation between the hyperemia and the 2.5 mm depth TDC value, the absence of a significant correlation between skin water parameters and the other skin water parameters suggests that our initial hypothesis and concludes that processes associated with altering skin water parameters are not importantly dependent on heat induced vasodilation in young skin.

Methods

Figure 1: Stratum Corneum Measurement
Figure 2: Transepidermal Water Loss Measurement
Figure 3: Tissue Dielectric Constant Measurement (TDC using 1.5 and 2.5 mm probes).
Figure 4: Heating device with laser Doppler probe applied to measurement site.
Figure 5: Summary of protocol describing baseline skin measurements to be taken for 4 mins @ 35 degrees C, measurement of blood flow during heating phase for 12 minutes, and post heat measurements taken afterwards.

Figure 6: TDC at 1.5 and 2.5 mm after heating skin to 39 degrees C on average.
Figure 7: SC, skin temperature and TEWL after heating skin to 39 degrees C on average.

References


This study was approved by the Institutional Review Board at Nova Southeastern University.