Potential Physiological Impacts of Eccrine Glands on Skin Tissue Dielectric Constant (TDC)

Benjamin Eisenman OMS-II and Harvey N Mayrovitz PhD
Nova Southeastern University, Dr. Kiran C. Patel College of Osteopathic Medicine and College of Medical Sciences

Background

Tissue Dielectric Constant (TDC) values largely depend on tissue water and are used to assess edema and lymphedema. The effect of eccrine glands and their activation on TDC values is unknown. It is known that the whole body has about 4 x 10^6 eccrine sweat glands with the forehead containing 360 ± 50 /cm² and forearm 225 ± 25 /cm². Eccrine gland tube length and diameter are on average 5 mm and 0.02-0.05 mm respectively. Sweat is composed of 99.0-99.5% water with about 75 Mn Na+ and Cl- thus likely to affect TDC values in a pore-density and activation state dependent manner.

Objectives

The specific aim of this research was to take first steps to investigate and clarify the physiological basis of potential eccrine gland impacts on TDC values.

Methods

Two initial experimental approaches were formulated for evaluation. In both, skin water changes were assessed via TDC measurements. These are done by touching the skin with a device (MoistureMeter) that measures TDC via the open-ended transmission line method. The approaches, described below, were tested in a single subject as pilot work.

In TEST 1, TDC and skin temperature measurements were taken on the forehead and anterior forearm before, immediately after, and six-minutes after removal of heat that was applied by two standard heating pads. At each time point TDC was measured six times in rapid succession.

TEST 2 used Methyl Nicotinate (MN) applied to the anterior forearm (ArthArrest, 0.5% MN = 35mM). TDC measurements were made before and after MN application. In addition, skin blood flow at the application site was measured before (baseline) and during MN using the method laser Doppler flowmetry. The response to MN application was monitored for about six minutes (Figure 3 and 4).

Results

In TEST 1, with only heat applied, TDC values increased on forehead (Figure 1) and on forearm (Figure 2) as determined immediately after removal of the heat source and TDC continued to increase during the cool down process. This was attributed in part to the sweating increase. In TEST 2, with MN application, skin blood flow (Figure 3) increased without inducing any detectible sweat increase in the area (Figure 4). As illustrated in figure 5 there was also a concomitant increase in measured TDC values as compared to the baseline measurements.

Conclusions

The initial limited specific aim of the research was to determine the immediate effects of eccrine activation vs. the possible effects of blood flow per se on TDC values. The present results indicate that both sweat and skin blood flow when increased cause an increase in TDC values. As a consequence of these new findings a strategy that might separate the relative magnitudes of these effects is presently being formulated. Despite the ambiguity of the pilot results, it is clear that activation of the eccrine glands does impact the TDC value thereby indicating the need to further evaluate the magnitude of this effect.