



Elimination of spurious absent sweat response in QSWEAT recordings

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ABSTRACT

Introduction: Forearm QSWEAT recordings are occasionally absent in females, likely due to high skin resistance. **Methods:** We identified consecutive subjects with no sudomotor abnormalities but absent/markedly reduced QSWEAT forearm volume, and repeated QSWEAT at the same site after gentle abrasion. **Results:** QSWEAT volumes were absent for 4 subjects and markedly reduced for the other 4 (median 0.01, IQR 0–0.03). After gentle skin abrasion, repeat volumes were significantly higher for all subjects and became normal in 7 of 8 subjects. **Discussion:** Skin abrasion restores QSWEAT volumes in previously absent/markedly reduced site suggesting that skin preparation using abrasion is more effective.

1. Introduction

The quantitative sudomotor axon reflex test (QSWEAT) is a test of postganglionic sudomotor function (Low et al., 1983). Sympathetic sudomotor axon terminals are activated by iontophoresis of acetylcholine, resulting in an axon reflex with a nicotinic sweat response recorded in a different site (Low et al., 1983). The tests are sensitive and reproducible in control subjects and in patients with neuropathy. The coefficient of variation was checked in two ways. In a group of individuals checked on two occasions, the value was 14.7%. For three subjects (with low, moderate, and high sweat volumes recorded on multiple occasions), the mean coefficient of variation was 8% (Low et al., 1983). Extensive control data are available from QSWEAT responses in 139 normal subjects (74 females and 65 males) between 10 and 83 years old. Mean sweat output was 3.01 $\mu\text{L}/\text{cm}^2$ and 1.15 $\mu\text{L}/\text{cm}^2$ for the forearm of males and females, respectively. This difference was significant ($p < 0.001$). In a prospective study, Thaisetthawatkul et al. (2013) demonstrated that the test will diagnose distal small fiber neuropathy with sensitivity, specificity, and positive predictive value all $> 80\%$.

In spite of these highly favorable reports, two observations led to the following study. First, we observed that shaving a site resulted sometimes in spontaneous resting sweat activity. Shaving or skin abrasion did not cause spontaneous sweating in neuropathic sites with corresponding anhidrosis on thermoregulatory sweat test. Second, we

observed that the medial forearm site, almost exclusively in women will sometimes have absent or very low sweat volume in spite of a robust flare response. A senior technician (JC) made the observation that a key factor affecting QSWEAT responses might be skin preparation. Standard preparation, where the skin is gently wiped with acetone then alcohol then water, is mainly designed to remove applied oils. Gentle skin abrasion, in contrast, may be more effective in reducing skin resistance and enhancing efficacy of acetylcholine iontophoresis.

2. Methods

The study was approved by the Mayo Clinic Institutional Review Board, and written informed consent was obtained from all participants.

We identified consecutive subjects who had normal autonomic function except for forearm sweat response. Selection was made on the basis of: 1. Absence of an autonomic disorder or neuropathy; 2. Normal autonomic function testing except for absent or low volume forearm response; 3. Presence of a robust flare response, indicative of normal “C” fiber function. Eligible subjects were invited to repeat the study, at which time the only preparation was to gently abrade the skin using 3 M Red Dot Trace Prep fine sandpaper. The skin is stroked with minimal pressure 20 times, insufficient to cause erythema. The forearm QSWEAT response was repeated under identical conditions of testing in the Autonomic Reflex Laboratory.

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Table 1
Sweat volumes on standard recording and following gentle abrasion.

Subject	Age (years)	Sex (m/f)	Diagnosis	QSWEAT volume 1 ($\mu\text{l}/\text{cm}^2$)	QSWEAT volume 2 ($\mu\text{l}/\text{cm}^2$)
1	20	f	POTS	0.00	0.36
2	27	f	Normal	0.00	0.05
3	48	f	Anxiety disorder	0.00	0.43
4	34	f	POTS	0.02	0.19
5	15	f	OI	0.13	0.55
6	28	f	Reflex syncope	0.03	0.15
7	34	f	OI	0.06	0.44
8	35	f	OI	0.00	0.10

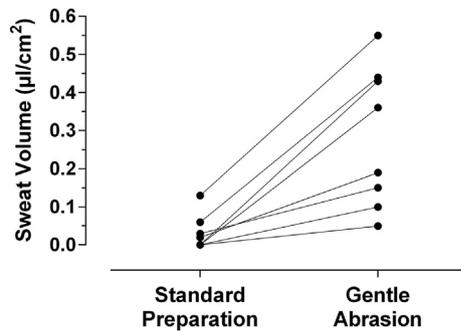


Fig. 1. Forearm sweat volume with standard preparation and following gentle abrasion.

3. Results

We identified 8 patients with absent or low QSWEAT volumes over the forearm site on skin prepared by standard protocol. Using standard skin preparation (acetone/alcohol/water/no abrasion) 7 of 8 subjects had absent or reduced responses. The remaining subject had low-normal value. In each case, a repeat study following gentle skin abrasion resulted in a significant increase in sweat volume ($p = 0.008$, Wilcoxon Signed rank; Table 1, Fig. 1). Post-abrasion QSWEAT volumes were normal in 7 of 8 subjects.

4. Discussion

The main finding of the current preliminary study is that, in normal subjects with spuriously low sweat volumes at the forearm site, gentle skin abrasion results in a significantly higher sweat response in all cases, and restores the response to normal in most subjects (6 out of 7) with reduced or absent responses; the subject with low-normal value had an increased sweat volume. This approach is simple, efficient, and

may be preferable to the current skin preparation technique. We selected female subjects since they are most prone to having spuriously absent forearm sweat response.

There are limitations to this study. The findings are preliminary. Other sites were not studied, and since spuriously low volumes are less commonly seen at other sites, there is some uncertainty about extrapolating these findings to other sites. There is some uncertainty as to how much abrasion is acceptable. Vigorous abrasion could itself stimulate spontaneous sweating, masking the acetylcholine-induced sweat response (Low and Sletten, 2008). A more definitive study might be to compare QSWEAT with electrical stimulated QSWEAT (Namer et al., 2004), where the sympathetic terminal is directly stimulated electrically. This latter approach is too painful for routine use but might be applicable in a specific set of circumstances. A study of the same subjects, comparing current method with skin abrasion, for all 4 sites should also be done in the future. Our current position is that gentle skin abrasion might be reasonable if a response is low or absent despite a robust flare response (Namer et al., 2004).

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