ONLINE FIRST

RESEARCH LETTER

Immediate Reduction in Sweat Secretion With Electric Current Application in Primary Palmar Hyperhidrosis

We present herein data showing for the first time to our knowledge that dry iontophoresis rapidly induces anhidrosis during current application in individuals with hyperhidrosis. This finding provides a novel experimental model for evaluating treatments of hyperhidrosis and determining their mechanism of action. Tap water iontophoresis, during which the patient's hands are soaked in shallow pans of tap water, sometimes with drugs added (usually anticholinergic agents), has been in wide use for several decades, although little is known about its mechanism of action.[1,2] While studying iontophoretic delivery of botulinum toxin to the palms of patients with hyperhidrosis, we noted that dry current alone induced relative palmar anhidrosis.[3]

Methods. To investigate the observed anhidrotic effect of dry iontophoresis, we recruited 6 patients (4 women and 2 men) with primary palmar hyperhidrosis and no clinically significant comorbid conditions or current medications. Ethical approval and written informed consent were obtained, and the study was conducted in accordance with the Declaration of Helsinki protocols.

The iontophoresis unit (Phoresor II; Iomed Inc, Salt Lake City, Utah) comprises a battery-operated base with twin lead cables attached to 2 conductive gel electrode pads, which were attached to the right and left upper limbs of subjects. We first assessed their baseline sweating by Minor starch-iodine test: iodine solution (2 g of iodine in 10 mL castor oil and ethanol to total 100 mL) applied to the palms followed by starch powder, which turned hyperhidrotic areas dark blue. Patients' palms were digitally photographed 2 minutes after application of starch powder.[4] Their hands were then washed and carefully dried to enable further assessment. All patients were also asked to self-rate their baseline sweating using a 100-point visual analog scale (VAS) (0, no sweating; 100, extreme sweating).

During the study treatment period, a 4-mA current was applied to the patients' wrists via the conductive pads, and the Minor starch-iodine test was reapplied 1 minute after the start of current application. Two minutes later, the hands were photographed, with the current still switched on. The current was then switched off immediately, and the hands photographed again 2 minutes later. To quantify any change in sweating during current application, all patients were then asked to rate their level of sweating during the procedure on the 100-point VAS.

Results. Starch-iodine testing revealed a rapid and substantial reduction in sweating for the duration of the current application. It also showed that sweating returned rapidly to baseline within seconds to minutes after current cessation (**Figure 1**). Subjectively, the procedure led to a significant reduction in sweating during the time of current application, from a mean (SEM) VAS of 66.2 (6.9) before current application to 19.2 (6.2) during current application ($P<.001$ by t test) (**Figure 2**). This change corresponds to a mean (SEM) fold change of 0.31 (0.09) ($P<.01$ by t test).

Comment. The application of dry current provides a unique insight into sweating patterns during iontophoresis, and we document for the first time to our knowledge that sweating in primary palmar hyperhidrosis significantly diminishes during cutaneous current application and rapidly returns on removal of current. The electrochemical forces that drive sweat production and the

Figure 1. Application of dry current alone induces rapid anhidrosis. A, Minor starch-iodine was applied to hands at baseline; hyperhidrotic areas stained dark blue. B, Hands were washed, and 4-mA current was applied through gel pads at the wrist; minor starch-iodine was reapplied after 1 minute, and the hands were photographed after a further 2 minutes, showing relative anhidrosis. C, Current was turned off, and the hands were photographed 2 minutes later, showing a return of hyperhidrosis.

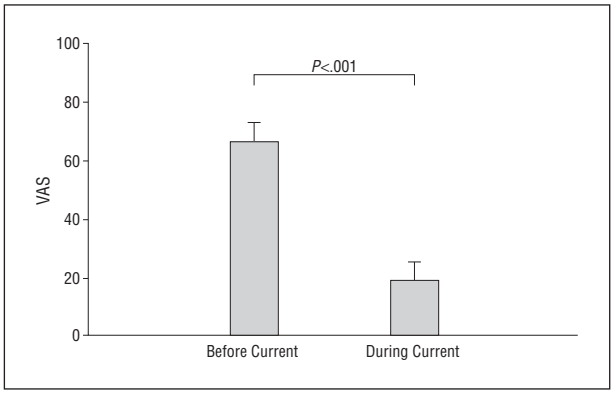

Figure 2. Electric current reduces severity of palmar sweating. Patients were asked to quantify the severity of sweating on a visual analog scale (VAS) (0, no sweating; 100, extreme sweating) before and after treatment. Error bars represent SEM ($P<.001$ by t test).

mechanism of iontophoresis are not understood. Our data support a rapid temporary interference with ion pumps and/or the innervation of eccrine sweat glands as at least partly explaining the mode of action of iontophoresis in hyperhidrosis.

Our results complement those of another study[5] in which the repeated use of dry iontophoresis reduced sweating over time, although direct comparisons with tap-water iontophoresis are thus far lacking. These results imply that tap water, in traditional iontophoresis, may play no part other than acting as a conductor for current. This suggests that far less bulky iontophoresis machines requiring less space and resources could also be effective, although further studies are required to verify this proposition.

Kave Shams, MBChB, MRCP
Gina M. Kavanagh, MBChB, MRCP

Accepted for Publication: August 8, 2010.
Author Affiliations: Departments of Dermatology, Monklands Hospital, Airdrie (Dr Shams), and Royal Infirmary of Edinburgh, Edinburgh (Dr Kavanagh), Scotland.
Published Online: October 18, 2010. doi:10.1001/archdermatol.2010.300
Correspondence: Dr Shams, Department of Dermatology, Monklands Hospital, Monkscourt Avenue, Airdrie ML6 0JS, Scotland (kave_shams@hotmail.com).
Author Contributions: Both authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Shams and Kavanagh. *Acquisition of data:* Shams. *Analysis and interpretation of data:* Shams and Kavanagh. *Drafting of the manuscript:* Shams and Kavanagh. *Critical revision of the manuscript for important intellectual content:* Shams and Kavanagh. *Statistical analysis:* Shams. *Study supervision:* Kavanagh.
Financial Disclosure: None reported.
Additional Contributions: Richard Weller, MD, FRCP, and Jonathan Rees, MedSci, FRCP, provided valuable advice on the manuscript preparation.

1. Dolianitis C, Scarff CE, Kelly J, Sinclair R. Iontophoresis with glycopyrrolate for the treatment of palmoplantar hyperhidrosis. *Australas J Dermatol*. 2004; 45(4):208-212.
2. Hill AC, Baker GF, Jansen GT. Mechanism of action of iontophoresis in the treatment of palmar hyperhidrosis. *Cutis*. 1981;28(1):69-72.
3. Kavanagh GM, Shams K. Botulinum toxin type A by iontophoresis for primary palmar hyperhidrosis. *J Am Acad Dermatol*. 2006;55(5)(suppl):S115-S117.
4. Lowe NJ, Yamauchi PS, Lask GP, Patnaik R, Iyer S. Efficacy and safety of botulinum toxin type a in the treatment of palmar hyperhidrosis: a double-blind, randomized, placebo-controlled study. *Dermatol Surg*. 2002;28(9):822-827.
5. Na GY, Park BC, Lee WJ, Park DJ, Kim W, Kim MN. Control of palmar hyperhidrosis with a new "dry-type" iontophoretic device. *Dermatol Surg*. 2007; 33(1):57-61.