

Reduction of Skin pH during Treatment for Palmoplantar Hyperhidrosis: A Conjecture on the Role of pH-Regulated Water Channel, i.e. Aquaporin

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Key Words

Skin pH · Palmoplantar hyperhidrosis · Water iontophoresis · Topical aluminum chloride

Abstract

Primary palmoplantar hyperhidrosis (PPH) is a disorder that involves excessive sweating on the palms and soles. Although the pathophysiology of PPH remains unknown, some treatments, including topical aluminum chloride (AC) and tap water iontophoresis (TWI), are effective at suppressing the perspiration. Herein, we report the kinetics of the skin pH of two cases of PPH treated with AC and TWI. We found that the skin pH decreased in accordance with the reduction in sweating. This finding indicates that the reduction in sweating may be attributed to the reduction of skin pH in AC and TWI. Whether or not the pH-regulated function of aquaporin can explain this finding remains unknown.

Introduction

Primary focal hyperhidrosis is a disorder that involves excessive, bilateral, and relatively symmetric sweating in the axillae, palms, soles, or craniofacial region. The condition, particularly in palmoplantar hyperhidrosis, can result in psychological and physical impairment and can also result in social stigmatization. At present, the pathophysiology of primary palmoplantar hyperhidrosis (PPH) remains unknown. As such, the therapy is not based on the cause. Treatment options include topical aluminum chloride (AC), tap water iontophoresis (TWI), botulinum toxin A, oral anticholinergics, and endoscopic sympathectomy.

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tomy. Among them, TWI and AC are routinely performed and are often effective [1, 2]. The accumulation of H⁺ within the sweat ducts as a result of the anodal current is suggested to be the mechanism of the TWI-induced inhibition of sweating [3]. In contrast, topical AC is considered to induce an aluminum salt blockage of the distal acrosyringium and structural changes of the eccrine glands [4]. The effect of AC on skin pH has not yet been addressed.

Aquaporin (AQP) is a water-transporting protein that has a variety of physiological functions in the skin [5–7]. AQP-5 is expressed in mammalian sweat glands and has been reported to play a role in sweating in mice, rats, and horses. Although the role of AQP-5 remains unclear in humans [8, 9], AQP members may regulate sweating by controlling the water transport. Of note, it has been suggested that the water permeability of AQP is regulated by pH [10]. Therefore, we evaluated the skin pH before and after antihidrotic therapy, based on the hypothesis that the skin pH might be related to sweating.

Case Presentation

A 45-year-old woman (case 1) and a 27-year-old woman (case 2) suffered from PPH since childhood. Case 1 was initially treated by topical AC application. Three weeks later, she underwent weekly TWI with a direct current at 12 mA for 20 min. The sweating was slightly reduced in 4 weeks and was markedly reduced in 8 weeks. Case 2 was treated with a daily application of 20% AC solution. The sweating was slightly reduced in 2 weeks and was markedly reduced in 4 weeks.

Skin surface pH was measured using a skin pH meter (D-51, Horiba, Ltd., Tokyo, Japan) according to the manufacturer's protocol. The design was validated in a pilot study. The experiment was performed in a room with a temperature of 24°C and humidity below 65%. The patients were kept at rest and the measurement was conducted after the skin was slightly wiped with tissues. The mean pH values were calculated in four sites on both the palms and soles. Twelve healthy volunteers (7 males and 5 females, mean ± SD age 33.6 ± 5.5 years, range 24–46) were also enrolled in the study.

The pH of patients with PPH before treatment tended to be high compared to that of healthy subjects (pH of healthy subjects, 5.23 ± 0.22; pH of PPH, 6.17 in case 1 and 6.65 in case 2). The comparison of pH before and after the antihidrotic therapy was analyzed by the paired t test (fig. 1). In both cases, the skin pH was significantly decreased following the treatment and was accompanied by reduced sweating.

Discussion

The first-line therapy for PPH is the topical application of AC solution or TWI [1]. The widely accepted underlying mechanism of these treatments is the blockage of the distal acrosyringium and structural changes of the eccrine glands by AC salts as well as the impaired perspiration caused by H⁺ movement into sweat ducts by TWI [3, 4]. In this report, however, we observed a reduction in skin pH with both AC and TWI treatment. At present, it remains unclear if the reduction in skin pH after AC and TWI treatment is the cause or the result of decreased sweating. Our finding calls the role of the anatomical changes observed in AC-treated skin into question and focuses on the importance of reduced pH in the inhibition of sweating. A low pH condition has been shown to inhibit water transfer by AQP. As such, it is intriguing to examine the functions of AQP-5 before and after treatment for PPH.

Funding Sources

This work was supported in part by Grants-in-Aid for Scientific Research from the Ministries of Education, Culture, Sports, Science and Technology, and Health, Labor and Welfare of Japan.

Disclosure Statement

The authors declare no conflict of interest.

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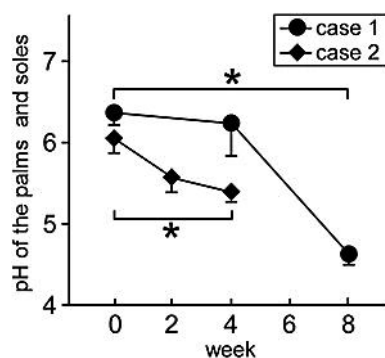


Fig. 1. Kinetics of skin pH in cases of PPH during treatment. Case 1 was treated by topical AC and TWI and case 2 was treated by topical AC. The mean pH values and standard deviations were calculated from the measurements of four sites on both the palms and soles. * $p < 0.05$ (paired t test).