Scanning Electron Microscopic Study of the Eccrine Ostia of Mouse Foot Pads After Application of Antiperspirant

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Recently, a topical preparation of 5% propantheline bromide and 10% aluminum hydroxychloride in an emulsion ground substance was introduced as an effective antiperspirant. According to the literature, aluminum salts may produce functional closure of sweat ducts. Nevertheless, histologic study has as yet failed to reveal a solid anatomic basis for occlusion.

In this study, the scanning electron microscope (SEM) was used to demonstrate eccrine gland ostial occlusion due to topical 5% propantheline bromide and 10% aluminum hydroxychloride.

Key Words: SEM, Antiperspirant, Eccrine Ostia

There have been many attempts using many approaches to control hyperhidrosis. Systemic agents have been largely abandoned due to their adverse systemic reactions. Topical antiperspirants also have limitations because of side effects such as skin irritation or allergic contact dermatitis. Recently, a topical preparation of 5% propantheline bromide and 10% aluminum hydroxychloride in an emulsion ground substance was introduced as an effective antiperspirant and was shown to have a relatively good clinical response (Aulepp, 1975; Weigtasser, 1975).

The significant antiperspirant effect of the above preparation on the arm of a healthy non-hyperhidrotic man (Lee et al., 1980) and in the mouse foot pad was reported (Chin and Lee, 1977). In this paper the anatomic basis of this preparation's antiperspirant activity was investigated using SEM.

MATERIALS AND METHODS

Hybrid, male, albino mice weighing 20-30 gm were used. The topical antiperspirant* used in this study was composed of:

- propantheline bromide 5.0 gm
- aluminum hydroxychloride 10.0 gm
- emulsion ground substance ad 100.0 gm

The mice were placed in a prone position on the board and the hind feet were extended

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through the openings (Fig. 1). One foot of the mouse was immersed in the antiperspirant solution and the other foot in saline solution as a control. This was done twice daily for 20 minutes for 10 days. The mouse was then anesthetized by injecting 0.2 ml of 250mg/ml solution of ethyl carbamate intraperitoneally and a full thickness slice of the foot pad was taken. The tissue taken from the foot pad was immediately cut into a small piece approximately 0.5x0.7cm in size and fixed in 3% glutaraldehyde in phosphate buffer (PH 7.4) overnight and subsequently dipped in isoamyl acetate. The tissues were further fixed in 1% OsO4 in phosphate buffer for 1 hour and dehydrated in a graded ethanol series. After critical point drying, the tissue surfaces were uniformly coated with about 400 Angstrom of gold in a vacuum evaporator to ensure good electrical conductivity and then observed under a Hitachi S-450 field emission scanning electron microscope. The accelerating voltage was 15 KV.

**RESULTS**

In the saline treated foot pads, the skin surface surrounding the eccrine ostia was smooth, the funnel shaped ostia were patent, and the terminal spiral of the ducts was clearly seen (Fig. 2). In the antiperspirant treated foot pads, the skin surface was rough and markedly superimposed with corneocytes. The ostia were narrowed and occluded with a non-cellular, amorphous material. The terminal spiral of the ducts was not seen (Fig. 3).

**DISCUSSION**

Topical propanetheline bromide, a component of the studied antiperspirant, is a parasympathetic blocker which is absorbed through the apopilosebaceous apparatus and enters the dermis to block the cholinergic impulses from the neural network which activate the eccrine gland (MacMillan et al., 1964). There are no atropine-like systemic side reactions. In addi-
tion, there are no disadvantages such as instability, contact allergenicity, or staining of the skin following topical application of 5% propantheline bromide (Frankland and Seville, 1971; Knudsen and Meier, 1963), in contrast to scopolamine and glutaraldehyde.

Aluminum hydroxychloride discovered in the 1940s is a less acidic salt of aluminum that could be substituted for aluminum chloride which irritates the skin and damages clothing (Shelley and Hurley, 1975). The action mechanism of aluminum salts on perspiration is still obscure (Aulepp, 1975; Weitgasser, 1975; Chin and Lee, 1977). Papa and Kligman (Papa and Kligman, 1967) postulated that aluminum salts readily penetrate the epidermal portion of the sweat duct and increase the permeability of the duct resulting in complete dermal resorption of the sweat. According to Shelly and Hurley (Shelley and Hurley, 1975), aluminum salts produce functional closure of the duct which is followed by shut-down of sweat gland secretion. It could be properly assigned to a 'high level blockade', which is an obstruction, functional or structural, in the terminal portion of the sweat duct (Papa and Kligman, 1966; 1967) but histopathologic study has as yet failed to reveal a solid anatomic basis for occlusion (Papa and Kligman, 1972; Rees-Jones and Jenkinson, 1978).

In this study, antiperspirant treatment was shown to produce occlusion of eccrine gland ostia. The eccrine ostia were narrowed and occluded with a non-cellular, amorphous material and the skin surface surrounding the ostia was rough and markedly superimposed with cornocytes. But the eccrine ostia of the saline treated foot pads were patent and the terminal spiral of the ducts was clearly seen.

Further studies to characterize the effect of topical antiperspirant on the deep portion of the sweat duct utilizing a transmission electron microscope are underway. In addition, the fate of the sweat within the occluded sweat gland will be studied.

REFERENCES


