Topical Glutaraldehyde for Plantar Hyperhidrosis

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Glutaraldehyde is a tanning agent with strong bactericidal and fungicidal properties. Topical application of a 10% solution was used with good effect against hyperhidrosis of the feet. No cross reaction was found in patients sensitized to formaldehyde.

FORMALDEHYDE, formerly widely employed to stop hyperhidrosis of the feet, is actually a tanning agent, and the exact mechanism by which it produces anhidrosis is not known.[1] Its use has been almost abandoned since it was found that patients easily become sensitized to it. However, in initial patch tests, we found that patients sensitive to formaldehyde did not react to glutaraldehyde (pentanedial = HOC-CH_2-CH_2-CH_2-CHO), another tanning agent, which is known from the leather industry.[2,3] It is also used as a fixative for electron microscopy and as a chemical sterilizer for instruments. In a 2% solution buffered to pH 7.5[4] it has a high bactericidal, sporocidal, fungicidal, and virucidal activity. In solution, glutaraldehyde is colorless and smells like apples. Its effect upon localized hyperhidrosis is reported here.

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Materials and Methods

Preparation of Glutaraldehyde.—Aqueous solutions were prepared from a 25% stock solution. Sodium bicarbonate was added to pH 7.5; thus 16.5 gm bicarbonate/100 ml was added to a 10% solution of glutaraldehyde.

Measurement of Sweating with OPT Technique.—One drop of a 5% solution of orthophthaldialdehyde (OPT) in xylene was applied to the skin. After ten minutes, the functioning sweat gland orifices appeared as black dots.[5] The number of sweat glands within a defined area 0.9 cm in diameter was counted under magnification (× 16) at room temperature (22 to 25 C).

Starch Paper-Iodine Imprint Technique.—The soles were dried and painted with an iodine solution (iodine, 3%; potassium iodide, 3% in 95% ethyl alcohol). Immediately after the skin had been fanned dry, imprints were made for two minutes on a sheet of ordinary writing paper. The amount of sweat produced was estimated on the basis of appreciable differences in the intensity of brown color appearing on the paper.

Patch Tests.—The testing was done as recommended by Magnusson et al.[6] A circular patch (diameter, 10 mm) of filter paper (Whatman No. 3 MM) on aluminum foil was impregnated with a 1% solution of glutaraldehyde and then applied to the patient's back. The test patch remained in place for 48 hours. In 160 patients routinely tested for contact dermatitis, no toxic or allergic reactions to glutaraldehyde

were seen. Eight of the patients tested were sensitive to formaldehyde.

Sweat Inhibition.—Ten volunteer medical students with symptoms of sweating from soles and palms were treated with 1%, 2%, 5%, and 10% solutions of glutaraldehyde on test areas 2 to 4 sq cm in size on soles, palms, and forearms. On the forearm, sweating was stimulated by an intracutaneous injection of methacholine iodide (0.1 mg/ml) before estimation of the number of functioning sweat glands with the OPT technique.

Patients.—The patients were between 12 and 40 years old. Twenty-five of them suffered from localized hyperhidrosis of the soles. Maceration between the toes was seen in two and a mycotic infection was found in three patients. Three of them also complained of increased sweating in the palms. Five patients were treated for excessive sweating only in the palms. One was a 12-year-old girl who sweated continuously, producing 10 ml from her palms during ten minutes in our surgery. Glutaraldehyde has also been tried in six women and two men with axillary hyperhidrosis.

Treatment of the Soles.—The 25 patients with localized hyperhidrosis of the soles were given a 10% solution of glutaraldehyde. The solution was applied with a cotton swab on one foot three times a week. After two weeks the degree of sweating in both feet was measured simultaneously by using the starch paper-iodine imprint technique. During the following two weeks the glutaraldehyde solution was applied to both feet, whereupon another sweat estimation was made. The patients were then asked to stop using glutaraldehyde on the foot they had been treating for four weeks, but to continue on the other. Two weeks later the sweating on the soles was again checked with starch paper-iodine imprints.

Treatment of Axillae and Palms.—The 10% glutaraldehyde solution was applied daily with a cotton swab to the hairy part of the axillae. Care was taken to avoid touching adjacent skin to minimize a cosmetically undesirable brown discoloration. On the palms, this staining was so disturbing that daily soaking in a 2% solution was preferred.

Results

The average effects of different concentrations of glutaraldehyde on the number of functioning sweat pores of the soles, palms, and arms of the ten volunteer subjects are shown in the Table. Inhibition of sweating was often obtained in the soles and palms 24 hours after the application of solutions with concentrations between 5% and 10%. A 2% solution was sufficient on the arms. There were great individual variations depending on the degree of hyperhidrosis and thickness of the skin. In some subjects, with a severe hyperhidrosis of the soles, functioning sweat pores could still be seen 24 hours after application of a 10% solution of glutaraldehyde. However, judging by the starch paper-iodine imprint technique, the amount of sweat produced decreased markedly. No irritation was seen, but a brown discoloration appeared at concentrations above 2%.

A good clinical effect was obtained in patients with hyperhidrosis of the soles. Three applications a week of a 10% solution was sufficient to keep the feet free from excessive sweating. A typical effect after 14 days' treatment with glutaraldehyde on one foot is illustrated in the Figure. The dark imprint is made by the untreated foot, where sweating is excessive. The treated foot looks much lighter, indicating that there is a marked inhibition of sweating. After cessation of treatment, increased sweating gradually reappeared after five to seven days.

The treatment caused no irritation in the patients with a concomitant mycotic infection and in two patients with inflammatory maceration between the toes. In these five patients, the lesions healed completely within two to four weeks.

On the palms, the patients disliked prolonged treatment for cosmetic reasons. Soaking the hands in a 2% glutaraldehyde solution was preferred since it caused only a slightly visible discoloration. The effect of soaking, as measured by the starch paper-iodine technique, was evident only in the 12-year-old girl with excessive sweating.

Mean Number of Functioning Sweat Pores

	Concentration of Glutaraldehyde*				
	0%	1%	2%	5%	10%
Palms	260	266	164	160	54
Soles	300	255	120	50	22
Arms after injection of Methacholine	110	78	54	36	32

*In ten subjects 24 hours after treatment with 0% to 10% glutaraldehyde.

Glutaraldehyde in a 10% solution was without clinical effect on axillary hyperhidrosis.

Comment

Glutaraldehyde in a 10% solution was of valuable help in hyperhidrosis of the soles and its accompanying odor. Concomitant maceration between the toes and mycotic infection healed during the treatment and were no contraindication. Glutaraldehyde is said to irritate the skin but we have had no complaints when using it on the soles. We have not seen any allergic reaction to glutaraldehyde, not even in patients sensitive to formaldehyde. Although several of our patients have been using it on the soles for

Starch paper-iodine foot imprint. Left foot has been treated with 10% glutaraldehyde solution for 14 days and shows marked reduction in sweating as compared with untreated right foot.

over a year without complications, our material is still too small to evaluate the sensitizing properties of the agent.

The bactericidal effect of a buffered 2% solution decreases after two weeks, but the tanning properties and the antihidrotic effects last at least four months.

The mechanism by which glutaraldehyde decreases sweating is not known. Shelley[7] used the glycogen levels of the tubular secretory cells as an index of secretory activity and found that the sweat glands showed minimal activity in the presence of keratotic plugging of the pores. This need not imply, however, that glutaraldehyde acts in exactly the same way, for sweating decreased in some of our patients even though a normal amount of functioning sweat pores could still be seen. The mechanism might therefore be only a partial occlusion of the sweat duct, increasing the intraluminal pressure and thereby diminishing sweat formation. A direct effect of glutaraldehyde on the sweat gland acini is the other possible explanation of its inhibitory effect on sweating.

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