Amelioration of Body Odor After Intracutaneous Axillary Injection of Botulinum Toxin A

Marc Heckmann, MD; Bianca Teichmann, MD; Bettina M. Pause, PhD; Gerd Plewig, MD

Background: Body odor is a ubiquitous phenomenon. It is commonly attributed to sweating and noted explicitly in the axillary area. Botulinum toxin A has recently been shown to be effective for axillary hyperhidrosis. Its effect on axillary odor, however, is unknown.

Observations: Sixteen healthy volunteers were injected with botulinum toxin A (Dysport, 100 U dissolved in 0.9% sodium chloride solution) in one axilla and 0.9% sodium chloride solution in the other axilla in a randomized, double-blinded fashion. After 7 days, body odor was assessed by a T-shirt sniff test. A significant reduction of odor intensity was observed for the botulinum toxin A–treated side. The smell was also rated significantly less unpleasant.

Conclusions: These findings suggest that botulinum toxin A can ameliorate or even improve body odor. The underlying mechanisms may include interference with skin microbes and denervation of apoeccrine sweat glands, but this remains to be further investigated.

Arch Dermatol. 2003;139:57-59

BODY ODOR can be an awkward problem for those affected by it as well as those being exposed to it. Because it is particularly noted in the armpits, it is commonly associated with axillary sweat secretion. However, patients with axillary hyperhidrosis (excessive sweating) rarely have excessive body odor.

Botulinum toxin A has recently been shown to be effective for axillary hyperhidrosis. It denervates eccrine sweat glands by inhibition of acetylcholine (see Huang et al for review), which is the mediator of sympathetic fibers innervating these glands. Its effect on other axillary glands such as apocrine and apoeccrine glands is unknown. Persistence of body odor after botulinum toxin A treatment for axillary hyperhidrosis was previously reported in a small series of patients; however, no investigation of this issue in hyperhidrotic or in normhidrotic individuals has been performed. We therefore wished to determine whether botulinum toxin A can measurably affect body odor irrespective of hyperhidrosis.

METHODS

From the Department of Dermatology, Ludwig-Maximilian-University, Munich (Drs Heckmann, Teichmann, and Plewig); and the Department of Psychology, Christian-Albrecht-University, Kiel (Dr Pause), Germany.

After written informed consent, 16 healthy volunteers (6 men and 10 women; ages 18-51 years [mean age, 27 years]) participated in this study. None of the subjects had a history of bromhidrosis. Prior to treatment, subjects were instructed to wear T-shirts for 1 day from noon until noon. All shirts were white 100% cotton shirts, newly bought from the same manufacturer. They were machine washed (90°C) for 1 hour without any additional washing powder. No wearing of deodorant or perfume; eating of asparagus, onions, or garlic; or close physical contact to partners was allowed 2 days before and during the time when the shirts were worn. Afterwards, the armpit areas of the shirts were cut out and stored in glass bottles. Volunteers had to sniff all samples, including their own. The identity of the samples was blinded to the volunteers as well as to the assistant conducting the sniff test.

Each volunteer was asked to rate odor intensity and emotional valence (unpleasant vs pleasant) after sniffing each of the samples. Each volunteer then received botulinum toxin A (Dysport [Speywood Biopharm Limited, Wrexham, Wales], 100 U dissolved in 0.9% sodium chloride solution, injected intradermally) in one axilla and 0.9% sodium chloride solution in the other axilla in a randomized, double-blinded fashion. The final concentration of botulinum toxin A was 100 U/mL. Ten aliquots of 0.1 mL were distributed evenly within the axillary area as reported previously. After 7 days, the T-shirt sniff test was repeated in the same manner. Ratings for intensity (0 [no odor] to 6 [most intense odor]) and emotional valence (−3 [most unpleasant] to +3 [most pleasant]) were recorded on
7-point numeric scales. Statistical analysis was carried out using the Wilcoxon test and the t test pairs; the level of significance was defined as $P<.05$.

### RESULTS

Prior to treatment (day 0), the mean (SD) rating for intensity of body odor was 2.69 (1.22) with individual ratings for different individuals ranging from 0 to 6. Each volunteer was given a bottle with a piece of cloth that had not been worn as zero reference. The mean (SD) rating for emotional valence was −0.64 (1.06) with individual ratings ranging from −3 to +2. Ratings for samples of the same person (left vs right axilla prior to treatment) did not differ significantly in intensity ($P=.54$) or emotional valence ($P=.56$).

One week after treatment (day 7), the botulinum toxin–treated axilla was markedly dry as reported by the volunteers and measured by gravimetry, which was consistently below 10-mg/min sweat production. The odor of the treated axilla received significantly lower ratings for odor intensity (1.83 vs 2.9; $P=.02$ [Figure 1]) and higher ratings for emotional valence (0.46 vs −1.14; $P=.01$ [Figure 2]) compared with the control side.

### COMMENT

Herein, we report that side-controlled axillary botulinum toxin A injections in healthy volunteers resulted in reduced odor intensity and improved odor quality. Previously, we have reported side-controlled axillary injections of botulinum toxin A in hyperhidrotic individuals. We chose the dose of 100 U of Dysport per axilla because it had been found equally effective as higher doses. It should be noted that 1 mouse unit of Dysport does not equal 1 mouse unit of Botox (Allergan, Inc, Irvine, Calif) in clinical settings. For hyperhidrosis, there is no data comparing the efficacy of the 2 products. However, for dystonic muscular diseases, ratios of 3:1 or 4:1 units of Dysport to Botox have been reported.8–10

While sweat secretion can be quantified by gravimetry,11 body odor is difficult to define in objective measures. Some studies on body odor in the field of pheromone research have repeatedly used the T-shirt sniff test as an established procedure to demonstrate how humans respond to odors of the opposite sex. This method, for example, revealed that females preferred the odor of males who differed in their major histocompatibility complex over that of males who had a similar major histocompatibility complex.12,13 Men found the odor of T-shirts from women during their follicular phase more attractive than of women during their luteal phase.14

Our study was not designed to explore pheromonal activity in axillary sweat, but simply to determine if chemodenervation of cholinergic glands that occurs after botulinum toxin A injections7 has any influence on axillary odor. We have adopted the T-shirt test to allow for multiple and anonymous ratings of all volunteers. Accidental effects of other odors from perfumes, foods, or contacts with other people were minimized by explicit instructions for the volunteers wearing the T-shirts as specified previously.12

Although the volunteers had no history of bromhidrosis, the axillary odor was clearly rated as unpleasant prior to treatment. The pungent smell frequently associated with body odor is caused by variable odoriferous compounds that are generated by microbial degradation of skin surface precursors.15,16 The turbid secretion of apocrine axillary sweat glands is thought to provide such precursors. However, apocrine sweat is difficult to analyze as it is mixed with sebum before reaching the skin surface. The neurologic control of apocrine secretion has not been completely elucidated, but there is some evidence that the surrounding nerve fibers are adrenergic rather than cholinergic.17 In contrast, eccrine sweat glands are predominately cholinergic.17 Therefore, chemodenervation by botulinum toxin A is likely to act primarily on eccrine sweat glands, which produce only clear and odorless sweat. Nevertheless, eccrine sweat may contribute to body odor indirectly by creating a moist environment that fosters bac-
terial growth. Recently, a case of Hailey-Hailey disease presenting with eroded, moist, and malodorous plaques in both axillae that was dramatically improved after botulinum toxin A treatment was discussed as a direct consequence of decreased sweat production.\textsuperscript{18}

Yet, eccrine sweat appears to play an ambiguous role in the production of body odor. Hyperhidrotic individuals, who by definition experience excessive sweating, rarely complain about body odor.\textsuperscript{1} Sato et al\textsuperscript{1} speculated that functional differences of axillary gland types between hyperhidrotics and normhidrotics may account for this enigma. They also described a third type of axillary glands, the apoeccrine gland, which displays mixed features of apocrine and eccrine glands.\textsuperscript{19} The number of these apoeccrine glands increases substantially during puberty,\textsuperscript{16} a time when axillary odor becomes distinctly noticeable. In young adults, up to 45% of total axillary glands are apoeccrine.\textsuperscript{19} As apoeccrine glands are responsive to cholinergic stimulation,\textsuperscript{20} they could be a primary target of botulinum toxin A–induced chemodenervation.

Apart from reduced odor intensity, axillae treated with botulinum toxin A were also rated as smelling less unpleasant or literally more pleasant, which means an improvement in the quality of body odor. Presently, any explanation for this phenomenon can only be highly speculative. However, there is accumulating evidence for the presence of human pheromones in axillary secretion,\textsuperscript{21-27} which can potentially affect emotional valence toward different odors.\textsuperscript{28} In this regard, botulinum toxin A may foster favorable odorous substances by rebalancing apocrine and apoeccrine secretion patterns and/or preventing unpleasant smells of microbial degradation, resulting in an overall improvement of body odor. Clearly, further exploration of this and studies with larger populations are warranted. It should be noted, however, that even with the limited number of subjects studied here, we found a significant effect (\textit{P}<.001) on the emotional valence of body odor.

We conclude that axillary injection of botulinum toxin A can significantly ameliorate the intensity and improve the quality of body odor.

Accepted for publication June 18, 2002.

Corresponding author and reprints: Marc Heckmann, MD, Department of Dermatology, Frauenlobstrasse, 9-11, D-80337 Munich, Germany.

REFERENCES


