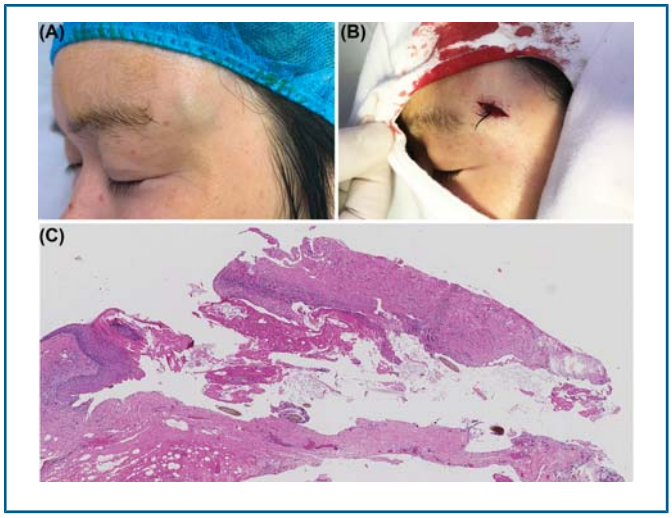

Figure 1. Clinicopathological observation: (A) A 1-cm diameter, bluish, soft, subcutaneous cyst on the left forehead. (B) The tufted hairs protrude from the wound. (C) Histopathology shows a sinus lined with stratified squamous epithelium and hair fragments in the sinus tract and granulation tissue (hematoxylin and eosin, ×40).

skin, scalp, penis, and face.[1,2] Of 12 reported cases of facial PNS, the nose (5 cases) is most commonly affected, followed by the cheek (2), chin (1), mandible (1), buccal area (1), forehead (1), and preauricular area (1).[1–4]

The etiology of PNS remains debatable. Although the predisposing factors include male gender, young age, hypertrichosis, and poor hygiene,[2] they are absent in our patient. Doll and colleagues argue against the crucial role of previous trauma in PNS.[1] However, facial PNS predominantly occur in men, possibly because of repeated shaving.[3] O'Sullivan and Kirwan[5] reported a case of mandible PNS after a facial blow, whereas our case developed frontal PNS after a nonhemorrhagic contusion. These observations suggest that trauma may contribute to the pathogenesis of PNS.

The frontal PNS should be differentiated from the dermoid cyst. Generally, the dermoid cyst occurs in infants, whereas PNS emerges in adults.[2] Histopathologically, the dermoid cyst is characterized by a true squamous epithelium–lined cyst with skin appendages attached, whereas PNS by a squamous epithelium–lined sinus with hair fragments.

The total excision with primary closure is the standard management of facial PNS and is preferred with no signs of inflammation.[1,4] No relapse of facial PNS has been reported so far.[1] Our patient also achieved a successful short-term efficacy under local anesthesia.

In conclusion, the present case may represent the first case, to the best of our knowledge, of post-traumatic frontal PNS in a middle-aged woman.

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Ni Liang, MM*
Feng-Jiao Meng, MM†
Chen Li, MM*
*Departments of *Dermatology, and*
†Pathology, Zhongshan City People's Hospital
Zhongshan, Guangdong, China

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N. Liang and F.-J. Meng contributed equally to this work.

Elimination of Sweat Glands Using the Follicular Unit Excision Technique: A Pilot Study Showing Its Potential Use for Axillary Hyperhidrosis

A method for isolating sweat glands from the scalp using the hair transplant technique of follicular unit excision (FUE) has been recently described.[1] In brief, FUE uses ≤1.00 mm punches to harvest FUs and is currently the most common harvesting technique used in hair transplantation. Interestingly, most scalp FUs contain eccrine glands because, anatomically, the eccrine coils appear to be located adjacent to the inferior portion of the anagen follicles.[2] Based on this observation, we hypothesized that if axillary sweat glands are also anatomically related with the hair follicles, FUE could be used to eliminate sweat glands with a subsequent reduction in sweat secretion. Thus, we designed this pilot study to investigate the feasibility of eliminating axillary sweat glands using the FUE technique and the extent to which it would reduce sweat secretion so that it could be used for axillary hyperhidrosis.

TABLE 1. Number of Follicular Units Removed in the Treated Axilla and Percentage of FUs Removed That Contained Eccrine Coils

Patients	Number of FUs in the Treated Axillae	Number and Percentage (%) of FUs Removed	Number and Percentage (%) of FUs Removed with Eccrine Coils
Patient 1	612	430 (70.26%)	407 (94.65%)
Patient 2	480	350 (72.92)	321 (91.71)
Patient 3	544	400 (73.53)	387 (96.75)
Patient 4	336	250 (74.40)	209 (83.6)
Patient 5	572	400 (69.93)	377 (94.25)
Patient 6	589	420 (71.31)	399 (95)
Average	522	375 (72%)	350 (93%)

Method

Six volunteer patients (2 males and 4 females) complaining of excessive axillary sweating were recruited at a private hair transplant clinic (Schambach Hair Clinic) in Guatemala. The study was conducted in accordance with the ethical requirements of the Declaration of Helsinki, and all patients gave their informed consent before inclusion in the study. In addition to the hyperhidrosis, 3 of the 6 patients complained of bromhidrosis (foul-smelling sweat).

The Minor starch–iodine test was used to assess the size of the surface area involved with sweating. The test was performed before the procedure on the day of the surgery after shaving both axillae and was repeated under the same conditions, at 3 and 6 months postoperative. The Hyperhidrosis Disease Severity Scale (HDSS) was chosen to estimate the severity of the hyperhidrosis.[3] Each patient filled in an HDSS score card per axilla preoperatively and at 3 and 6 months postoperatively. A 1-point improvement in the HDSS score is associated with a 50% reduction in sweat production and a 2-point improvement with an 80% reduction.[3] The Student-*t* statistic was used to compare the means of the pretreatment and post-treatment scores.

The surgical procedure was performed by a hair transplant surgeon experienced in FUE (MS). Only one randomly selected axilla was treated, whereas the other was used as control. Local anesthesia (lidocaine 2% with epinephrine 1:80,000) was infiltrated with blunt 21 G, 10-cm long microcannulas. A 0.9-mm hybrid punch (Devroye Instruments, Brussels, Belgium) attached to a motorized device (Multiphasic Trivellini, Asunción, Paraguay) was used (See **Supplemental Digital Contents**, Figure 1 and Video, http://links.lww.com/DSS/A928 and http://links.lww.com/DSS/A930).

To calculate the number of FUs present in the area of sweating, the area stained with the Minor test was multiplied by the FU density (average number 16.8 FUs/cm^2). Since removing around 70% of FUs per axillae was considered by the authors to be the minimum amount needed to obtain a significant reduction in sweating, the mean number of FUs extracted per axilla was estimated to be 375 (Table1).

To visualize the sweat glands, all FUs removed were stained with methylene blue and examined under the stereomicroscope as previously reported. In addition, 25 FUs were saved for histological analysis.

The surgical wounds were left to heal by secondary intention as in any standard FUE procedure. An antibiotic/anti-inflammatory spray was prescribed, and indications on daily washing with antimicrobial soap were given.

Results

The FUs removed presented prominent lumps of fatty tissue attached to the inferior portion of the follicles (Figure 1). After staining the FUs with methylene blue, it was evident that these fatty protuberances were basically sweat gland coils embedded in adipocytes (Figure 2) and that 93% of harvested FUs contained sweat glands (Table 1). The histology confirmed the presence of sweat glands (Figure 3).

A significant reduction in sweating was found 3 and 6 months after surgery. The mean preoperative axillary

Figure 1. After the incision has been made with the FUE punch, a follicular unit is pulled gently with forceps revealing the typical fatty tissue protuberance at its deepest part. This fatty tissue contains the sweat gland coil. FUE, follicular unit excision.

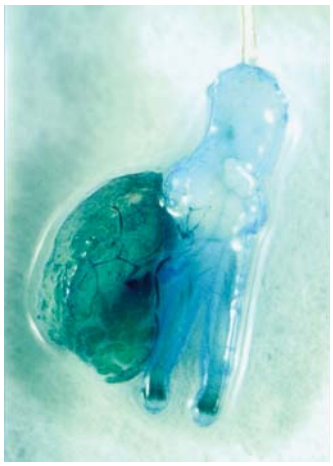

Figure 2. A 2 hair follicular unit stained with methylene blue showing the sweat gland coil within the fatty tissue protuberance at the inferior portion of the follicular unit.

sweating area of 31.16 cm^2 according to the Minor test decreased at 3 and 6 months postoperative to 7.3 cm^2 (mean difference of −23.83, with $t = -19.94$ and $p = .00001$) (Figure 4) (See **Supplemental Digital Content**, Table 1, http://links.lww.com/DSS/A948).

According to the HDSS scale, an average reduction in sweating of 80% was obtained. At 3 months postoperative, there was a mean reduction of −2.3 ($t = -2.17$ and $p = .00617$), and at 6 months postoperative, the mean reduction was −2.17 ($t = -7.05$ and $p = .00089$) (See **Supplemental Digital Content**, Table 2, http://links.lww.com/DSS/A948). 2 patients with bromhidrosis reported complete disappearance of the bad odor and 1 partial reduction. This sample was too small for biostatistical significance.

A mild erythema was seen postoperative during 3 days, which completely resolved after 10 days (See **Supplemental Digital Content**, Figure 2, http://links.lww.com/DSS/A929). Neither hypopigmented dots nor visible signs of scars were seen at 3 and 6 months postoperative. One patient had folliculitis that resolved with oral antibiotics, and another presented 2 epidermal cysts which were removed surgically.

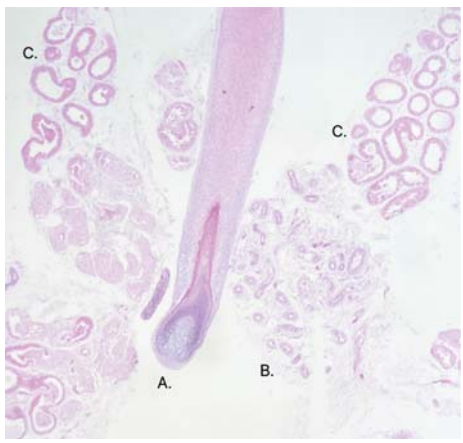

Figure 3. Histologic section showing sweat gland coils at the level of the inferior portion of the hair follicle. (A) Hair Follicle; (B) Eccrine gland: (C) Apocrine gland.

Figure 4. In this patient, the Minor iodine–starch test at 6 months postoperative shows a significant decrease in the darkened skin area and amount of sweat in the treated axilla (left) compared with the untreated one (right).

Discussion

This study shows the feasibility of removing sweat glands from the axillae using FUE. The high percentage of FUs harvested that contained sweat glands (93%) confirms the anatomic relationship between the secretory portion of the sweat glands and the hair follicles.[2]

We found that the removal of around 70% of the axillary FUs in one session achieved a very significant clinical response in sweat reduction (80% sweat reduction in average), results comparable in efficacy with other surgical therapies for axillary hyperhidrosis such as tumescent suction curettage (71% sweat reduction)[4] and the Shelley procedure (69% reduction).[5] However, a significant advantage of the axillary FUE technique is that the wounds left heal by second intention with nonvisible scarring at naked-eye examination. Another additional advantage that should not be overlooked is the permanent elimination of unwanted axillary hair which can be achieved at the same time as sweat reduction. It should be noted that all 3 patients with bromhidrosis reported either the complete disappearance or partial reduction of the foul-smelling odor.

Despite the small number of patients and limited follow-up time, this pilot study shows that FUE could be a promising new therapy for axillary hyperhidrosis while removing unwanted axillary hair at the same time. Further studies need to be performed in larger number of patients and longer follow-up periods to assess the long-term efficacy of this therapy.

Acknowledgments

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Marie-Andre Schambach, MD*
Francisco Jimenez, MD†‡
Schambach Hair Clinic, Guatemala, Guatemala
†Mediteknia Dermatology and Hair Transplant Clinic
Gran Canaria, Spain
‡Universidad Fernando Pessoa Canarias
Gran Canaria, Spain

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Commentary on Elimination of Sweat Glands Using the Follicular Unit Excision Technique

Hyperhidrosis is defined as excessive sweat production. It has been reported to affect up to 4.8% of the population, but many speculate this may be an underestimation. It can cause considerable psychosocial morbidity for affected patients. Axillary hyperhidrosis has been estimated to make up over 50% of cases.[1]

Three types of sweat glands exist: eccrine, apocrine, and apoeccrine. It is the eccrine glands, which are innervated by sympathetic cholinergic nerve fibers, that are responsible for excessive sweat production. Patients who are affected by hyperhidrosis do not have an increased number or size of eccrine glands. Rather, it is an increased or aberrant sympathetic stimulation of the eccrine sweat glands that causes hyperhidrosis.[2] Apocrine glands are under the control of adrenergic nerve fibers and release sweat into the infundibulum of the hair follicle rather than the skin surface. They are not believed to play a major role in hyperhidrosis.

Genetics have been reported to cause 35% to 56% of cases of primary hyperhidrosis. There are variable degrees of severity, and an autosomal dominant transmission has been suggested. Secondary causes include malignancy, infection, endocrine/metabolic, cardiovascular, neurologic, and medications. Complications of untreated hyperhidrosis can include body odor (bromhidrosis) and poor posture to conceal perspiration.

Current treatments include topical aluminum chloride solution, oral glycopyrronium (prescribed as 1–2 mg doses, administered 1–2x daily), topical glycopyrronium (administered as a cloth with 2.4% solution), and botulinum toxin injections.[1–3] Each of these require ongoing treatment, and insurance coverage varies. A newer microwave-based thermal treatment offers a more permanent noninvasive solution; however, the device is expensive and not available in all parts of the world.[4] Thoracic sympathectomy is another more invasive treatment but can result in compensatory sweating in other areas later on.[1] None of these therapies address the added annoyance of unwanted axillary hair growth.

In this article by Drs. Schambach and Jimenez,[5] they brilliantly address both conditions of hyperhidrosis and unwanted axillary hair growth by follicular unit excision (FUE) of hair groupings along with their associated sweat glands. Although this technique is more invasive than existing treatment options, in that it requires infiltration with local anesthesia, followed by surgical extraction of the hairs with attached sweat glands, it is more permanent and solves both issues. The authors found that 93% of the extracted follicles contained sweat glands and that by extracting approximately 70% to 75% of follicular units they were able to reduce patient's sweat production by about 80% by 3 and 6 months after surgery. Two patients with bromhidrosis reported improvement or resolution of their odor.

Although this was a small pilot study of just 6 patients, their experience showed that FUE can be a promising new treatment for hyperhidrosis with the added benefit of permanent hair removal and improvement or resolution of bromhidrosis.

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Nicole Rogers, MD, FAAD, FISHRS
Hair Restoration of the South
Metairie, Louisiana

The author has indicated no significant interest with commercial supporters.