

Clinical analysis of tumescent anesthesia technique combined with superficial fascia rotational atherectomy in axillary bromhidrosis

YONG-PING SHI^{1*}, JU-HONG LI^{2*}, YU WANG¹ and YANFEI WU³

¹Department of Burn and Plastic Surgery, Affiliated Hospital of Jiaying University, The First Hospital of Jiaying;

²120' Dispatching Center, Jiaying Emergency Medical Center; ³Foreign Language Department, College of International Studies, Jiaying University, Jiaying, Zhejiang 314001, P.R. China

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Abstract. Axillary bromhidrosis, which involves the apocrine sweat glands, severely affects adolescents. The present study aimed to evaluate the effect of tumescent anesthesia technique combined with superficial fascia rotational atherectomy treatment for axillary bromhidrosis. The present retrospective study included a total of 60 patients with axillary bromhidrosis. These patients were divided into experimental and control groups. Patients in the control group were treated using the tumescent anesthesia technique combined with conventional surgery, while patients in the experimental group were treated using the anesthesia technique combined with superficial fascia rotational atherectomy. The intraoperative blood loss, operation time, histopathological examination and dermatology life quality index (DLQI) score were used to assess the treatment effect. The intraoperative blood loss and operation time were significantly lower in the experimental group compared with the control group. The histopathological results revealed that the sweat gland tissues in experiment group significantly decreased compared with that in control group. Furthermore, there was a significant improvement in axillary odor degree for postoperative patients, and the DLQI scores in experiment group were significantly lower compared with those in control group. The tumescent anesthesia technique combined

with superficial fascia rotational atherectomy is a promising approach to treating patients with axillary bromhidrosis.

Introduction

Axillary bromhidrosis is a disease that involves the apocrine sweat glands and it is characterized as a combination of wet earwax, hyperhidrosis and bromhidrosis (1,2). The bacteria decomposition on the armpit surface skin of patients with axillary bromhidrosis produces a spicy and pungent odor. This odor severely affects interactions between individuals and negatively impacts life quality. Therefore, patients with axillary bromhidrosis usually carry a significant psychosocial burden and axillary bromhidrosis can lead to a severe sense of inferiority (3,4). Furthermore, surgical strategies require expensive treatment fees and the sweat gland tissue cannot be cleanly removed. Meanwhile, the recurrence rate for postoperative patients remains high. In addition, nodules that form in the armpits easily cause pain and adverse reactions. Furthermore, surgical strategies easily cause noticeable scars affecting the physical appearance of the patients. The serious psychological damage to patients with axillary bromhidrosis has become a prominent social problem (5-7). However, the pathogenesis of axillary bromhidrosis remains unclear. Therefore, there is an urgent need to identify effective methods to treat patients with axillary bromhidrosis (8,9). Various surgical strategies, including subcutaneous tissue resection, simultaneous removal of subcutaneous tissues and axillary skin, minimally invasive surgery and partial axillary skin resection with subsequent ablation of subcutaneous tissue, have been utilized to treat this disease; however, surgical therapy for patients with severe axillary bromhidrosis can easily cause scar formation, delayed wound healing, hemorrhage and axillary nerve damage or infection (10-12). At present, the tumescent anesthesia technique combined with superficial fascia rotational atherectomy has been reported as an effective method for treating patients with axillary bromhidrosis (13).

The tumescent anesthesia technique combined with superficial fascia rotational atherectomy, which is a rapidly developing technology for treating axillary bromhidrosis, has been widely used for the treatment of patients with axillary bromhidrosis in the clinic and the therapy results for axillary bromhidrosis have gained the attention of physicians and

Correspondence to: Dr Yu Wang, Department of Burn and Plastic Surgery, Affiliated Hospital of Jiaying University, The First Hospital of Jiaying, 1882 Zhonghuan South Road, Jiaying, Zhejiang 314001, P.R. China
E-mail: wang_y@tom.com

Dr Yanfei Wu, Foreign Language Department, College of International Studies, Jiaying University, 899 Guangqiong Road, Jiaying, Zhejiang 314001, P.R. China
E-mail: n10oelx@163.com

*Contributed equally

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patients (13,14). The tumescent anesthesia technique, which is a variant form of local anesthesia, has been used in clinical anesthesia for several years and involves local anesthetic and epinephrine injected into the tissue (15). The tumescent anesthesia technique has been successful in various surgical procedures, including superficial fascia atherectomy surgery, liposuction and varicose vein treatment. In addition, the tumescent anesthesia technique has advantages of being less invasive and more cost-effective and presenting good clinical outcomes in treating patients with axillary bromhidrosis (16). Superficial fascia rotational atherectomy destroys the axillary apocrine sweat gland tissue using rotational atherectomy to decrease sweat gland secretion and scar tissue at the damaged sweat gland and duct tissue and prevent the secretion of axillary apocrine sweat gland tissue to the skin (17). Rotational atherectomy has advantages in treating axillary apocrine sweat glands compared with other surgical procedures, such as simpler operation procedure and greater control, high efficiency, shorter operation time, reduced discomfort during the operation, wide scraping and suction range, suitability for large areas of axillary apocrine sweat gland and low postoperative recurrence rate (18). Rotational atherectomy has been widely used for the treatment of patients with axillary bromhidrosis to decrease the adverse effect (13,17,19). Therefore, rotational atherectomy on patients with axillary bromhidrosis serves a key role in treating and preventing disease progression.

The tumescent anesthesia technique and rotational atherectomy have been considered effective therapies for patients with axillary bromhidrosis, according to previous clinical studies (13,16,19). However, to the best of our knowledge, clinical studies for the tumescent anesthesia technique combined with superficial fascia rotational atherectomy treatment for axillary bromhidrosis remain limited (11,17). The present study investigated the clinical characteristics of the anesthesia technique combined with superficial fascia rotational atherectomy treatment in patients with axillary bromhidrosis.

Materials and methods

Patients. A total of 60 patients (female, $n=41$; male, $n=19$) aged 16~27 with axillary bromhidrosis, who were treated in the First Hospital of Jiaxing, Jiaxing, China from January 2017 to December 2020, were included in the present retrospective clinical study. All patients had a history of axillary bromhidrosis. All protocols used for the present study were prospectively reviewed and approved by the Use Committee of the First Hospital of Jiaxing (approval no. LS-2018-117) and written informed consent was obtained from all patients.

The study inclusion criteria were: i) History of axillary bromhidrosis; ii) meeting the Park's diagnostic criteria for axillary bromhidrosis (20); iii) symptoms that disturbed the patient quality of life; iv) absence of infection on the axillary skin or other disease that could affect the operation; v) no axillary bromhidrosis surgery within 3-6 months prior to the start of the study; vi) absence of active or progressive heart, lung, liver or kidney disease; vii) patients on a long-term hormones and aspirin therapy who were advised to stop taking these at one week preoperative; viii) patients who were able to communicate effectively to give consent.

The study exclusion criteria were: i) Very high expectation of treatment for axillary bromhidrosis; ii) severe psychological disorder; iii) anticoagulant or antiplatelet drug therapy increasing the risk of bleeding; iv) history of surgery ≥ 3 times in the axillary 3-6 months before surgery; v) active or progressive heart, lung, liver or kidney disease; vi) menstruating patients; vii) breastfeeding patients; viii) allergy to anesthesia and ix) participation in other clinical trials.

Trial design. The present study was retrospective. Study participants were equally distributed between the experimental and control groups ($n=30$ /group). The tumescent anesthesia technique combined with conventional surgery was performed on the patients in the control group, while the anesthesia technique combined with superficial fascia rotational atherectomy was performed for patients in the experimental group. A set of negative-pressure suction devices was used to collect peeled tissue.

Preoperative preparation. The rotational atherectomy system (Terumo Corporation), which comprises the host, perfusion lighting rod, planer head, power output line and pressurized infusion devices, was used to treat patients in the experimental group. Anesthesia perfusion solution (100 ml), which consisted of 0.5% lidocaine and 0.1% u-epinephrine, was prepared for local infiltration anesthesia. The blood routine for the two groups of patients was checked and four items of blood coagulation including platelet, prothrombin and thrombin time and fibrinogen were obtained. The presence of symptoms such as redness, swelling, ulceration and furuncle on the underarm skin was monitored. The scribe area on the axillary was 0.5 cm larger than the axillary hair area. The surgery aimed to completely remove the axillary bromhidrosis.

Surgical method. The patient was instructed to lie on their back, with both upper limbs abducted and raised, elbows bent and hands placed at the side of their head with palms facing up to fully expose the axillary skin. Subsequently, 40-50 ml anesthesia perfusion solution was injected above the scribe area. The incision was performed at the midpoint of the armpit. A flap was formed using vascular forceps on the subcutaneous fat layer of the incision. For patients in the experimental group, the rotational atherectomy cutter head was extended from the incision into the axillary hair area to conduct a saw-style suction. For patients in the control group, a conventional cutter head was used. A pressure suction force of 0.3-0.4 kPa was set on the negative pressure suction device, and a speed of 1,000-1,200 revolutions/min was set on the rotational atherectomy cutter head. Subsequently, subcutaneous fat, dermal apocrine sweat glands and hair follicles in the scribe area were destroyed and sucked. Finally, the thickness of the remaining flap was ~ 0.5 cm. The plucking was used to test the degree of destruction on the apocrine sweat glands.

Clinical data. Clinical data from all pretreatment patients with axillary bromhidrosis in the present study were collected, including age, sex, degree of axillary bromhidrosis odor (21), family and surgical history, skin quality, surgery time, intraoperative blood loss, axillary odor degree and quality of

Table I. Contents and scores for DLQI.

DLQI item	No effect score	Little effect score	Effect score	Severe effect score
Itching, soreness, pain or tingling of the skin	0	1	2	3
Embarrassment or embarrassment caused by skin problems	0	1	2	3
Impact of skin problems on your life	0	1	2	3
Effect of your skin problems on choice of clothes	0	1	2	3
Impact of your skin problems on your social or leisure activities	0	1	2	3
Difficulties on skin caused by exercise	0	1	2	3
Does the skin problem hinder your work or study?	0	1	2	3
Does the skin problem cause problems with spouse, or good friends or relatives?	0	1	2	3
Does your skin problem cause sexual problems?	0	1	2	3
How big is the problem caused by skin problem treatment?	0	1	2	3

DLQI, dermatology life quality index.

life score (21). These were recorded through WeChat, text messages, phone calls and follow-up visits.

Axillary skin histology. After obtaining informed consent from patients, ~5 mm full-thickness tissue was cut from the preoperative and postoperative axillary incision skin and the excised tissues were fixed with 4% paraformaldehyde at 4°C for 12 h. Subsequently, the axillary tissue was embedded in paraffin blocks, cut into 5- μ m sections for conventional hematoxylin at room temperature for 5 min and eosin staining at room temperature for 5 min and tested by YS, who was blinded to the control and experimental groups. Finally, the structural components of the tissue were observed using an optical microscope (light, 200x).

Evaluation of surgical effect. The therapeutic efficacy of tumescent anesthesia technique combined with superficial fascia rotational atherectomy for patients with axillary bromhidrosis was evaluated at 6-month follow-up. The surgery was considered curative, effective and ineffective based on postoperative axillary odor scores as follows: i) Curative, the axillary odor score was grade 0 or 1 and was significantly improved compared with that in the control group; ii) effective, axillary odor score for postoperative patients significantly improved compared with that in the control group but the effect did not reach the curative standard; and iii) ineffective, axillary odor score of the experimental group was not significantly improved compared with that in the control group and the grade for postoperative patients remained at grade 2 or 3.

Evaluation of patient satisfaction. The dermatology life quality index (DLQI) was used to evaluate patient satisfaction. DLQI, which is a questionnaire survey, has been widely used as an evaluation for the health-related life quality of patients with skin diseases (21). DLQI score system was used to evaluate the clinical effect of surgery and patient satisfaction (Table I). According to the total DLQI score, the satisfaction of these two groups of patients with axillary bromhidrosis was evaluated and compared (Table II).

Table II. Total DLQI scoring system.

DLQI total score	Effect of axillary bromhidrosis on life quality
0-1	None
2-5	Little
6-10	Moderate
11-20	Relatively large
21-30	Severe

DLQI, dermatology life quality index.

Statistical analysis. SPSS 19.0 software (IBM Corp.) was used for statistical analysis. Continuous data are presented as mean \pm standard deviation of independent experimental repeats three times, while descriptive data are presented as percentages. Measurement data and count data, were analyzed by paired t and χ^2 test, respectively. If the expected count in <20% of cells of the analyzed contingency table was >5, χ^2 test was used. If the expected count in <20% of the cells of the analyzed contingency table was \leq , Fisher's exact test was used to analyze the data changes between the experimental and control group. P<0.05 was considered to indicate a statistically significant difference.

Results

Clinical data obtained from the two groups of patients with axillary bromhidrosis. The baseline characteristics of the two groups including age, sex, family and preoperative surgery history, preoperative odor degree and DLQI were not statistically different, indicating baseline material between the two groups were relatively balanced (Table III). In addition, the odor degree in postoperative patients were significantly lower than that in control group and some postoperative patients experienced hematoma complication.

Table III. Clinical data.

Characteristic	Experimental group	Control group	P-value
Mean age, years	23.5±3.9	23.1±3.4	>0.05
Sex			>0.05
Male, n	8	11	
Female, n	22	19	
Family history of axillary bromhidrosis			>0.05
Yes	14	12	
No	16	18	
Preoperative surgery history			>0.05
Yes	2	1	
No	28	29	
Preoperative odor degree			>0.05
Grade 0/1	0	0	
Grade 2	8	13	
Grade 3	22	17	
Preoperative dermatology life quality index score			>0.05
0-1	0	0	
2-5	0	0	
6-10	3	4	
11-20	22	23	
21-30	5	3	

Table IV. Intraoperative blood loss and operation time.

Group	Number of patients	Mean intraoperative blood loss, ml	Mean operation time, min
Experimental	30	9.2±0.91 ^a	78.2±3.3 ^a
Control	30	39.1±1.1	95.6±7.8

^aP<0.05 vs. control.

Comparison of intraoperative blood loss and operation time. For 30 patients in the experimental group and control group, the intraoperative blood loss was 7.5-11.5 and 36.5-41.0 ml, respectively; mean blood loss was 9.20±0.91 and 39.10±1.10 ml, respectively (Table IV). The difference was statistically significant. These results suggested that the intraoperative blood loss was significantly less in the experimental group compared with that in the control group. Furthermore, for the experimental and control groups, the operation time was 70-85 and 80-115 min, respectively, and the mean operation time was 78.20±3.30 and 95.60±7.80 min, respectively. The difference was statistically significant. This indicated that the operation time was shorter in the experimental group compared with that in the control group.

Histopathological examination. The pre- and postoperative images for patients who underwent anesthesia technique combined with superficial fascia rotational atherectomy for the removal of apocrine sweat glands are presented in Fig. 1. Hypertrophic sweat gland and hair follicle tissue were

compared between preoperative (control group) and postoperative groups (experimental group). The histopathological results revealed that preoperative skin samples contained a large amount of hypertrophic sweat glands and hair follicle tissue. However, no sweat gland tissue was observed in postoperative skin tissue. The removed tissues were mainly sweat gland tissues and hair follicles. The histopathological results revealed that the anesthesia technique combined with superficial fascia rotational atherectomy treatment was effective in patients with axillary bromhidrosis.

Comparison of axillary odor degrees at ≥6 months postoperative. The comparison of axillary odor degrees at ≥6 months postoperative between the two groups is presented in Table V. Of the 30 preoperative patients in the experimental group, eight patients were grade 2 and 22 were grade 3. Of the 30 postoperative patients in the experimental group, 28, 2 and 0 patients were grades 0/1, 2 and 3, respectively. Among the 30 preoperative patients in the control group, 13 and 17 patients were grade 2 and 3, respectively. Of the postoperative patients in



Figure 1. Pre- and postoperative images of a patient who underwent the anesthesia technique combined with superficial fascia rotational atherectomy for the removal of apocrine sweat glands. Magnification, x200. Arrows indicate sweat gland.

the control group, 22, 7 and 1 patients were grade 0/1, 2 and 3, respectively. The difference between the postoperative patients in the two groups was statistically significant and indicated that both the tumescent anesthesia technique combined with conventional surgery. The tumescent anesthesia technique combined with superficial fascia rotational atherectomy have a good treatment effect.

Comparison of life quality of patients. The comparison of the life quality of postoperative patients is presented in Table VI. In the experimental group, 28, 2 and 0 postoperative patients had total DLQI scores of 0-1, 2-5, 6-10, 11-20 and 21-30, respectively. In the control group, 22, 8 and 0 postoperative patients had total DLQI scores of 0-1, 2-5, 6-10, 11-20 and 21-30, respectively. The difference in postoperative total DLQI score between these two groups was statistically significant. These results indicated that superficial fascia rotational atherectomy surgery could improve the life quality of patients.

Discussion

Axillary bromhidrosis, which is a common and bothersome odor, affects individuals worldwide, especially in Asia. Various types of surgery are performed to eliminate axillary bromhidrosis, but none of these has achieved satisfactory results (6,8). The present study used the rotational atherectomy technology to treat axillary bromhidrosis according to rotational atherectomy instruction and experienced technician advice. Secretions from the axillary apocrine sweat glands are converted into unsaturated fatty acids, causing a particular odor via microbial breakdown (22). A previous study showed that the apocrine sweat glands of patients with axillary bromhidrosis exhibit both hyperplasia and hypertrophy (9).

At present, axillary bromhidrosis treatment by surgery is the most effective method. Surgical treatment for axillary bromhidrosis can achieve long-term good efficacy by removing or decreasing apocrine sweat gland tissue (23). In the present study, this surgical method was modified; tumescent anesthesia technique combined with superficial fascia rotational atherectomy was performed to treat the axillary bromhidrosis. The apocrine sweat glands were removed, while the superficial axillary fascia tissue was preserved. Furthermore, the surgery time was significantly shortened, the intraoperative blood loss was decreased and the treatment result was satisfactory for these patients. Moreover, this surgical approach led to fewer complications.

A recent study showed that non-surgical modern modalities such as microwave-based therapy exhibit promising therapy efficacy (24). Axillary bromhidrosis and bromhidrosis have serious social, emotional and professional consequences. There are several treatments for axillary hyperhidrosis. Studies evaluated the efficacy and safety of microwave devices for axillary hyperhidrosis and bromhidrosis (1,25) and suggested that microwave-based therapy could relieve hematoma and pain.

In the present study, the family history, preoperative surgery history, preoperative odor degree and total DLQI score of patients with axillary bromhidrosis were statistically analyzed and the results were consistent with the results reported by previous studies (2,26). The tumescent anesthesia technique combined with superficial fascia rotational atherectomy has been widely used to treat dermatological disease because this approach is safe and easy to control (13,27). During surgical operations, the use of the tumescent anesthesia technique alleviates pain and decreases bleeding. In addition, clinicians can easily separate the skin flap from the superficial fascia

Table V. Axillary bromhidrosis degree >6 months after surgery.

Group	Grade		
	0/1	2	3
Experimental	28	2 ^a	0
Control	22	7	1

^aP<0.05 vs. control.

Table VI. DLQI score at >6 months after surgery.

Group	DLQI score				
	0-1	2-5	6-10	11-20	21-30
Experimental	26	2	2 ^a	0	0
Control	19	3	7	1	0

^aP<0.05 vs. control. DLQI, dermatology life quality index.

layer using the tumescent anesthesia technique. The tumescent anesthesia technique has advantages of the effectiveness of local anesthesia because of low invasiveness, cost-effectiveness and good clinical outcomes in treating patients with axillary bromhidrosis (2). Therefore, in the present study, the tumescent anesthesia technique combined with superficial fascia rotational atherectomy was performed to treat axillary bromhidrosis.

Intraoperative blood loss and operation time are used to evaluate the effect of the tumescent anesthesia technique combined with superficial fascia rotational atherectomy on patients with axillary bromhidrosis (28). Therefore, in the present study, intraoperative blood loss and operation time were used to compare the clinical effect. The intraoperative blood loss for patients in the experimental and control groups was 9.20 ± 0.91 and 39.10 ± 1.10 ml, respectively. The operation time for patients in the experimental and control groups was 78.20 ± 3.30 and 95.60 ± 7.80 min, respectively. These results were similar to the results of Fang *et al* (29), in which intraoperative blood loss was 41.0 ml and operation time was 99.0 min when the tumescent anesthesia technique combined with conventional surgery was performed. Furthermore, the intraoperative blood loss and operation time for patients in the control group were similar to those reported in a previous study (5). However, the intraoperative blood loss and operation time in the experimental group were less than those reported by a previous study (30). This suggested that the tumescent anesthesia technique combined with superficial fascia rotational atherectomy is a promising method for treating axillary bromhidrosis.

In the present study, the axillary odor degree and DLQI score were used to assess the effect of the tumescent anesthesia technique combined with superficial fascia rotational atherectomy. In a previous study conducted in 2019 by Van *et al* (2), the quality of life of patients with axillary

bromhidrosis was assessed using the DLQI score. The mean DLQI score for preoperative patients was 16.10, whereas for postoperative patients it decreased to 3.30. In the present study, the DLQI scores for postoperative patients in the two groups were significantly decreased compared with the scores for preoperative patients in the two groups and these results were consistent with the results reported by a previous study (31), and the removal of sweat gland and hair follicle tissue is more complete in the experimental group. However, the present results showed recurrence in some patients who still had a grade 2/3 odor degree 6 months after surgery and indicated some protective effect for patients. In addition, 28, 2 and 0 postoperative patients in the experimental group were grade 0/1, grade 2 and grade 3, respectively. Compared with the preoperative patients in the experimental group, postoperative patients in the experimental group achieved a significant improvement in axillary odor degree and this result was consistent with the results of Wu *et al* (22).

Rotational atherectomy using smaller size burrs and lower rotational speeds is a conservative approach that provided improved immediate results, with increased safety and improved long-term outcomes. The present clinical study showed that the tumescent anesthesia technique combined with superficial fascia rotational atherectomy decreased bleeding, surgery time and DLQI score. Overall, the tumescent anesthesia technique combined with superficial fascia rotational atherectomy showed a good effect on patients with axillary bromhidrosis.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

YPS conceived the study. YPS, JHL, YWa and YWu analyzed and interpreted data. YPS and JHL confirm the authenticity of all the raw data. All authors have read and approved the final manuscript.

Ethics approval and consent to participate

The present study was approved by the Ethics Committee of the Affiliated Hospital of Jiaying University (approval Number: LS2018-117), The First Hospital of Jiaying.

Patient consent for publication

Written informed consent was obtained from all patients.

Competing interests

The authors declare that they have no competing interests.

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