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The Clinical Evaluation of Minimally Invasive Treatment for Axillary Osmidrosis

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Abstract

Background: Traditional treatment of axillary odour is the surgical removal of skin and subcutaneous tissue along the edge of the axillary hair in a fusiform shape, which requires the restriction of upper limb activity, has large scars and a high recurrence rate. Minimally invasive methods have developed in recent years. The subcutaneous trimming method with small incision reduces the incision compared to traditional incision, but still requires skin incision, which does not achieve true, minimally invasive treatment. Simple negative pressure suction is difficult to destroy the sweat glands and sebaceous glands in the dermis layer. Thus, we hypothesized that combination of three minimally invasive methods might be more effective. **Objective:** To explore the clinical effect of combined treatment of axillary osmidrosis by three minimally invasive methods of microwave, scraping & suction and scratching. **Methods:** From October 2015 to October 2020, 80 patients with underarm odor were enrolled and lacal swelling anesthetic was applied. Microwave was used to treat sweat glands and sebaceous glands in the dermis following the pores. The curettage-aspiration was used to scrape and suck the apocrine sweat glands in the subcutaneous fat layer and the junction between the subcutaneous fat and dermis. To achieve the purpose of minimally invasive and thorough treatment of underarm odor, the spoon scraped the remaining sweat gland tissue. **Results**: Among 80 patients on 160 sides, all cases (100.00%) were cured on 160 sides at 1 month post-operative follow-up, 75 cases (93.75%) were cured on 150 sides, 5 cases (6.25%) on 5 sides were ineffective at 6-month post-operative follow-up, 74 cases (92.50%) were cured on 148 sides, 6 cases (7.50%) on 5 sides were ineffective at 1-year post-operative follow-up. Complications occurred in 5 cases (6.25%) after operation: 2 cases

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(2.50%) with skin necrosis on 3 sides, 1 case (1.25%) with uneven skin on 2 sides, 1 case (1.25%) with axillary abscess on 2 sides, and 1 case (1.25%) with keloids on 2 sides. **Conclusion:** The combination of three minimally invasive methods of microwave, scraping & suction and scratching to treat underarm odor is simple operation, has high cure rate, quick postoperative recovery, and few complications. It is an effective method for minimally invasive and thorough treatment of underarm odor in clinic.

Keywords

Microwave, Curettage-Aspiration, Scraping, Combining Minimally Invasive Operation, Axillary Osmidrosis

1. Introduction

Axillary odour is often referred to as "fox odour", which is the general name for hyperhidrosis and oedema, a common clinical condition that generally develops after the age of 12 and reaches its maximum odour level at the age of 18 when the sweat glands are mature. Traditional treatment of axillary odour is the surgical removal of skin and subcutaneous tissue along the edge of the axillary hair in a fusiform shape, which requires restriction of upper limb activity, has large scars and a high recurrence rate. Minimally invasive methods developed in recent years include microwave therapy, electrocautery, laser therapy, subcutaneous trimming, scratching, negative pressure suction and high frequency electrocautery [1] [2]. Subcutaneous trimming reduces the incision compared to traditional method, but still requires skin incision surgery, which does not achieve true minimally invasive treatment, and simple negative pressure suction is difficult to extract the sweat glands at the junction between dermis and subcutaneous [2] [3]. In recent years the two procedures have been combined, such as trimming combined with scratching, negative pressure suction combined with subcutaneous trimming and negative pressure suction combined with scratching. The subcutaneous trimming requires an incision and negative pressure suction combined with scratching does not destroy the sweat and sebaceous glands in the dermis. It is difficult to achieve a radical cure for axillary odour with any either procedure or two minimally invasive combined. We hypothesized that combination of three minimally invasive methods might be more effective. Eighty cases of axillary odour were treated with a combination of three minimally invasive procedures: microwave, scraping & suction and scratching from October 2015 to October 2020, with positive results, which are reported below.

2. Clinical Information and Methods

2.1. General Information

Among the 80 patients, 28 were male and 52 female; age range: 14 - 42 years (24.9 ± 5.7), all patients were first-time patients. Severity: mild in 2 cases, mod-

erate in 40 cases and severe in 38 cases.

The severity of axillary odour was rated according to a scale [4] (**Table 1**). Patients' self-assessment, 0 point as no odour, 1 point as odour that could be smelt occasionally by the nose near the armpit after strenuous activity and did not affect social activities, 2 points as odour that could be smelt by the nose not near the armpit and was considered by themselves to affect social activities, 3 points as odour that could be smelt at all times and was considered by themselves to seriously affect social activities.

Doctor's assessment: assessed by two regular doctors, 0 point as no odour, 1 point as odour is only occasionally present on the gauze after wiping the armpit with gauze, 2 points as odour can be smelt when the armpit is exposed during the examination, 3 points as odour can be smelt when the armpit is not exposed, next to the patient or at a greater distance.

2.2. Selection Criteria

Patients over 14 years of age with underarm odor were included in this study if they have an odor level of 3 points or more after evaluation by themselves and doctor according to the **OLRS** scale [4], have not received other treatments before, have no infections and scars around the operation area, and can tolerate surgery.

2.3. Surgical Approach

1) Pre-operative routine preparation: Mark the fusiform treatment area extended to 1 cm outward from the edge of the axillary hair (**Figure 1**). 2) The patient was placed in a lying position, with both upper limbs outreached, raised and the head held at the elbows bend position. The axilla was fully exposed, the treatment area was routinely disinfected and a local swelling anesthetic was applied with 2% lidocaine 50 ml + 1:1000 epinephrine hydrochloride 0.3 ml + saline 300 ml. 3) Microwave treatment: ERBE VIO100C gentle microwave mode with an output of 15 W and a 3 mm long needle-like head (marked 3 in **Figure 2**) into the skin to a depth of 3mm treated the sweat glands and sebaceous glands in the dermis pore by pore, until there is a tissue bursting sound at the treatment site, for a duration of 2 to 3 seconds. 4) Curettage-aspiration: Open two 3 mm-incision at the most distal end of the forearm side of the pike mark line (marked A in **Figure 1**) and at the midpoint of the upper axillary wall (marked B in **Figure 1**). liposuction device (XYQ-2 liposuction device, Beijing Koyi True Yanshan Medical Technology Co., Ltd.), with negative pressure 0.04 Kpa connect to 2.5 mm diameter scraping needle whose head end was ground and processed into the concave double side hole (mark 1 in **Figure 2**). The lateral double holes are directed towards the dermis and the subcutaneous fat layer and the junction between subcutaneous fat and dermis layer were scraped back and forth in a fan shape, until the skin appeared scattered purple and the odour disappeared. 5) Scratching: Scratch the junction between the subcutaneous fat layer and the dermis with the spatula (marked 2 in **Figure 2**) following the scraping and suc-

tion direction until there is no fatty fibrous tissue in the spatula scoop. 6) The 5-0 absorbable sutures were used to close the small incision. After surgery, comfrey oil gauze was applied tightly to the wound and then covered with conventional excipients and "8" pressure bandaged in 48 hours. 7) Before and after surgery, the whole skin layer of 3 mm - 5 mm in size was taken within the marker line and sent to pathology for observation of sweat glands, and the fatty fibrous tissue was randomly taken from the scraping fluid and sent to pathology for observation of sweat glands.

Table 1. Odour Level Rating Score (OLRS).

Rating	0	1	2	3
Self-assessment	☐	☐	☐	☐
Doctor-assessment				
Doctor A	☐	☐	☐	☐
Doctor B	☐	☐	☐	☐
Total Score				

Normal: Score 0; Mild Score 1 - 3; Moderate: Score 4 - 6; Severe: Score 7 - 9.

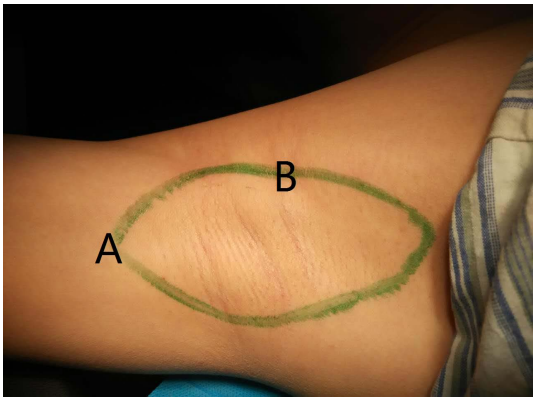

Figure 1. The operative area and the scraping and aspiration site.

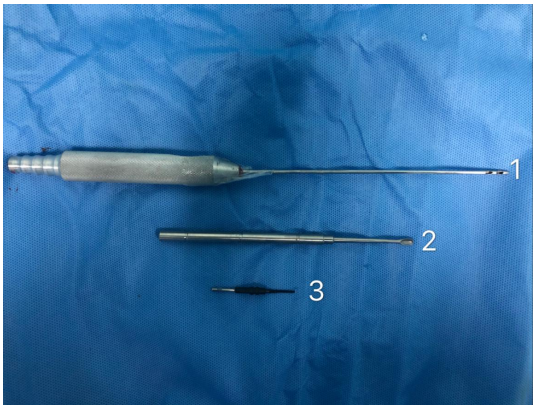

Figure 2. Scraping needle, spatula, and microwave electrode head.

2.4. Study Site

Eighty procedures were completed in clean operating room of Department of Plastic and Reconstructive Surgery, Second People's Hospital of Gansu Province, China.

2.5. Assessment of Efficacy

The Odour Level Rating Score **(OLRS)** are used to assess the efficacy as the variables. The point of the **OLRS** after surgery was used as the criterion for assessing the efficacy (Cured: normal, **OLRS** 0; ineffective: mild, moderate, and severe, **OLRS** 1 - 9). The results of the pathological examination of axillary skin before and after surgery were used as the basis for laboratory examination.

2.6. Post-Operative Follow-Up

Complication follow-up: patients were followed up within two weeks after surgery for trauma infection, skin necrosis, skin unevenness, axillary abscess, and scar growth; Efficacy follow-up: efficacy assessment at 1 month, 6 months and 12 months after surgery.

2.7. Statistical Analysis

Statistical analysis was performed using SPSS 24.0 software, and the statistical method was paired t-test, expressed as mean ± standard deviation. A difference was considered statistically significant at $p < 0.05$.

3. Results

3.1. The Socio-Demographic and Clinical Characteristics

Among the 80 patients, 2 cases were mild, 40 cases were moderate and 38 cases were severe according to OLRS pre-operative.age range: 14 - 42 years (24.9 ± 5.7), 11 cases were under 18 years old, and 69 cases were 18 yeras old or more. 28 cases were male and 52 female. There were 80 normal cases one month post-operative, were 75 normal cases, 4 moderate cases and 1 severe case six months postoperative and 74 normal cases, 4 moderate cases and 2 severe case one year postoperative (Table 2).

3.2. Post-Operative Complications

Among 80 patients, the operative area skin was infected and necrotic in 2 cases (2.50%) on 3 sides after 5 days post-operative and received dressing change treatment 3 weeks, of which 1 case 2 sides had severe scar after secondary debridement and suturing and 1 case 1 side also had large scar after dressing change. One case (1.25%) had skin striae superfluous-like unevenness on 2 sides after 1 week and didn't recover with one year follow up period. One case (1.25%) had axillary abscess on 2 sides after 1 month, with operating area scar after puncture and drainage. One case (1.25%) 2 sides has thin-betty keloid on the upper axillary wall at the 3 mm-incision site after 6 months, which healed by

surgical excision after 1 year.

The rest 75 patients had no complications only small scar (**Figure 3**) of scraping needle at 3 mm incision site and flat skin in the axilla in 1 month post-operative follow-up. The small scar disappeared (**Figure 4**) in 1 year post-operative follow-up.

Table 2. The socio-demographic and clinical characteristics.

	Normal	Mild	Moderate	Severe	*p*-value
Pre-operative	0	2	40	38	<0.05
Age (mean ± SD)					
<18	0	0	2	9	
≥18	0	2	38	29	
Gender					
Male	0	1	13	15	
Female	0	1	27	23	
Post-operative Follow up					
1 month	80	0	0	0	
6 months	75	0	4	1	
12 months	74	0	4	2	

Figure 3. One-month post-operative follow-up with a flat wound.

Figure 4. The scar disappeared in 1-year post-operative follow-up.

3.3. Pathological Examination

The 80 patients were examined for sweat glands by taking full skin tissue at the center of the preoperative and the treatment area of postoperative and random fibro fatty tissue from the aspirated tissue. Pre-operative pathological examination of 80 cases (100%) showed sebaceous glands around the hair follicles in the dermis, small sweat glands mainly at the junction between the dermis and subcutaneous fat, large sweat glands mainly in the subcutaneous fat layer, and scattered large and small sweat glands in the dermis (**Figure 5**). The sweat glands were not found in the postoperative subcutaneous fat layer in 76 cases (95.00%) (**Figure 6**), and were find scattered glands in 4 cases (5.0%).The sweat glands were not find at the junction between the dermal and subcutaneous fat in 68 postoperative cases (85.00%), 12 cases (15.00%) had scattered sweat glands but they were significantly reduced. The 40 cases (50.00%) had small sweat glands in the postoperative dermis and 42 cases (52.50%) had sebaceous glands. A large number of large and small sweat glands were visible in randomly sampling aspirated and scraped tissue of 80 (100.0%) cases (**Figure 7**).

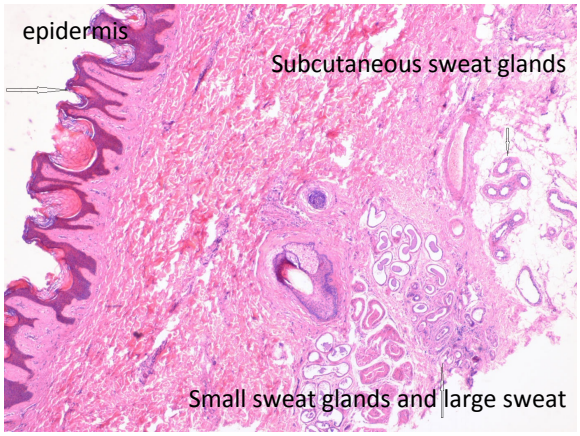

Figure 5. Distribution of large and small sweat glands on preoperative pathological examination.

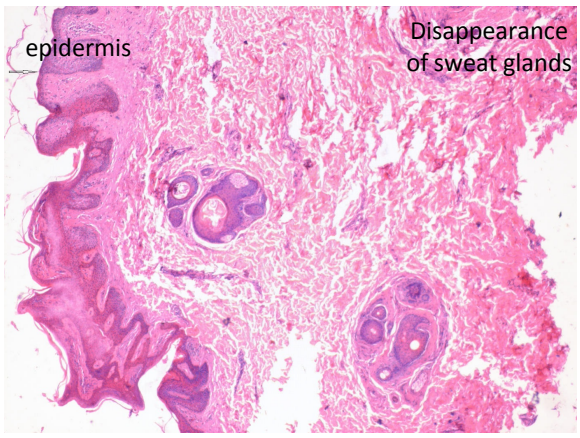

Figure 6. Disappearance of sweat glands pathological examination after combined surgery.

Figure 7. Pathological examination of large and small sweat glands in scraped and aspirated tissue.

3.4. Efficacy Follow-Up

The efficacy of the 80 patients was assessed at one month, six months and one year after surgery according to the postoperative OLRS [4].

Follow-up one month after surgery: Among 80 patients on 160 sides, 80 (100.00%) cases on 160 sides postoperative OLRS were normal.

Follow-up six months after surgery: Among 80 patients on 160 sides, 75 cases (93.75%) on 150 sides postoperative OLRS were normal, 5 cases (6.25%) on 8 sides were moderate and 2 sides were severe, of which 4 cases were severe and 1 case was moderate patients according to pre-operative OLRS.

Follow-up one year after surgery: Among 80 patients on 160 sides, 74 cases (92.50%) on 148 sides Postoperative OLRS were normal, 6 cases (7.50%) on 8 sides were morderate and 4 sides were severe, of which 5 cases were severe and 1 case was moderate patients according to pre-operative OLRS.

4. Discussion

The pathogenesis of axillary odour has not yet been elucidated, but most scholars believe that it is mainly related to the sweat glands in the axilla, while others believe that the secretions of axillary sweat glands, small sweat glands and sebaceous glands are decomposed by bacteria in the axilla, thus producing the odour [3]. In addition, there is no consensus on the range of distribution of axillary sweat glands [5] [6]. Beer [7] found that the sweat glands were located in the subcutaneous fat layer rather than in the dermis by immunohistochemical methods. Jumei Li [8] reported that the distribution of sweat glands in some patients can extend 2 - 3 cm beyond the axillary hair edge, suggesting that the sweat glands associated with axillary odour are within at least 1 cm out of the axillary hair edge and this are the main cause of recurrence of axillary by surgical removal of skin and subcutaneous tissue along the hair edge in a fusiform shape. Weiwei Li [9] compared small incisional excision, scrapie aspiration and botulinum toxin injection procedures, considering that the three treatments of axillary odour were effective, and recommended the scrapie aspiration mothod for se-

vere cases.

Axillary odour in the axillary is area associated with inconsistent understanding of the causes of axillary odour, the distribution of large and small sweat glands in the skin layer, and the extent of sweat glands. The traditional surgical excision along the edge of the axillary hair restricts the movement of the upper limbs and results in a slow recovery, large scars and a high recurrence rate. Minimally invasive methods of treatment for sweat sebaceous glands in the dermis include microwave therapy, electrocautery and laser treatment. Minimally invasive procedures targeting the deep dermal, subcutaneous fat layer and the junction between of subcutaneous fat and dermis include trimming, peeling, scratching and minimally invasive negative pressure aspiration [1] [4]. Trimming and stripping are invasive method than traditional incisions, but still require skin incision surgery and do not achieve real minimally invasive treatment, and negative pressure aspiration along is difficult to extract sweat glands from the junction between the subcutaneous fat and dermis [4]. Therefore it is difficult to achieve a radical cure for axillary odour with any one surgical procedure alone. In recent years the combined procedures have been applied, such as trimming combined with scratching, negative pressure suction combined with trimming and negative pressure suction combined with scratching. Trimming requires an incision and negative pressure suction combined with scratching does not treat the sweat and sebaceous glands in the dermis [10]. The traditional shuttle excision, a minimally invasive surgical treatment, or two minimally invasive combined treatments cannot completely cure axillary odor. We hypothesized that the combination of three or even more minimally invasive treatments can remove sweat glands completely and achieve the radical treatment of axillary odor without increasing complications.

We combined the three minimally invasive methods of microwave, scraping & suction and scratching. Firstly, ERBE VIO100C microwave with a 3 mm long needle-like head into the skin to a depth of 3 mm treated the sebaceous glands around the hair follicle and the sweat glands in the dermis pore by pore, until there is a tissue bursting sound at the treatment site, for a duration of 2 to 3 seconds. Secondly, Open two 3 mm-incision at the most distal end of the forearm side of the mark line, the needle with the concave double side hole connect to negative pressure 0.04 Kpa device inserted into the 3 mm-incision. The lateral double holes are directed towards the dermis and the subcutaneous fat layer and the junction of subcutaneous fat and dermis layer were scraped back and forth in a fan shape, until the skin appears scattered purple and the odour disappears. Finally, a spatula scratched the residual sweat glands at the junction between the dermis and subcutaneous fat layer. The treatment area is extended to 1cm outward from the edge of the axillary hair, so that the area around the hair follicle, the dermis, the junction between the dermis and subcutaneous fat layer, and the subcutaneous fat layer of large and small sweat glands are treated simultaneously by three minimally invasive means in layers of skin, while expanding the skin area. The histopathological examination of the distribution of

small and large sweat glands of pre-operative skin, post-operative skin and the fatty tissue from the aspirated liquid showed that the small sweat glands are mainly located at the junction between the dermis and subcutaneous fat, while the large sweat glands are mainly locates in the subcutaneous fat layer, also small and large sweat glands are occasionally scattered in the dermis. The sweat glands were not find in postoerative skin of 76 cases in the subcutaneous fat layer after microwave, scraping and scratching minimally invasive treatment, and were not find in the postoperative junction between dermis and subcutaneous fat of 60 cases, and a large number of sweat glands of all sizes were visible in the aspirated and scraped tissue randomly sent for examination after surgery. This showed that the combination of three minimally invasive procedures can destroy and extract the sweat glands and sebaceous glands in dermal layer, subcutaneous fat layer and the junction between the subcutaneous fat and dermis. The microwave treatment of each pore can destroy the sebaceous glands and sweat glands around the hair follicle in the dermis, further, the sweat glands in the subcutaneous fat layer and the junction between the subcutaneous fat and dermis can be removed by extracting and scraping. Jumei Li [10] concluded that the sweat glands associated with axillary odour are at least extended to 1 cm outwards from the edge of the axillary hair. This method avoided the disadvantages related to the large skin excision, postoperative wound tension, wound infection of the traditional excision method, and allowed us to treat sweat glands that are extended outward 1 cm around the axillary hair.

A total of 5 patients (6.25%) had postoperative complications in 80 patients. the operative area skin was infected and necrotic in 2 cases after 5 days post-operative and received dressing change treatment 3 weeks, of which 1 case 2 sides had severe scar after secondary debridement and suturing and 1 case 1 side also had big scar healing but only received dressing change. One case had skin striae superfluous-like unevenness on 2 sides after 1 week and didn't recover in 1 year follow up period. One case had axillary abscess on 2 sides after 1 month, and was treated by puncture and drainage. One case 2 sides has thin-betty keloid on the upper axillary wall at 3 mm-incision after 6 months, which healed by surgical excision after 1 year. Five complications were treated and the wound scars healed without affecting the outcome of the axillary odour treatment.

The efficacy of the 80 patients was followed up at 1 month, 6 months and 12 months after surgery. Odour disappeared in all patients on both sides at the 1 month follow-up, Among 80 patients on 160 sides, 75 cases (93.75%) were cured on 150 sides, 5 cases (6.25%) on 5 sides were ineffective at 6 month post-operative follow-up, 74 cases (92.50%) were cured on 148 sides, 6 cases (7.50%) on 5 sides were ineffective at 1 year post-operative follow-up. There were 5 recrudescence cases from 1 month to 6 months after surgery and increased a new recrudescence case from 6 months to 12 months after surgery, indicating that recurrence occurred within 6 months after surgery. The 6 recrudescence cases were all severe patients by the pre-operative odour level rating

scale, this indicates that the more severe preoperative odour, the more likely postoperative recurrence.

This study has only completed the treatment of 80 patients so far, and the follow-up period was only 1 year. A larger number of cases and a longer follow-up period need to be completed further, especially for patients under 18 years of age, who need to be followed up until at least after 18 years old.

5. Conclusion

This study demonstrated that the combination of three minimally invasive methods of microwave, scraping & suction and scratching treats a wide range of sweat glands in the dermis, at the junction between the dermis and subcutaneous fat and in the subcutaneous fat layer, and beyond 1 cm of the axillary hair margin, compensating for the disadvantages of a single procedure and the combination of the two minimally invasive procedures in treating sweat glands in distribution and scope. It has a high postoperative cure rate, does not require restriction of upper limb activity or interfere with daily life and has low immediate and long-term complications. It is significant to promote its clinical application.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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