Comparison of Long-Term Effectiveness and Safety of Microwave and Surgery in the Treatment of Axillary Osmidrosis: A Single-Center Retrospective Study

Si-Qi Chen, MD, Ting-Ting Wang, EdD, Yuan Zhou, PhD, Wei Li, PhD, and Xiao-Yong Man, PhD*

BACKGROUND A microwave-based device is a newly developed method for treating axillary osmidrosis. Few studies have compared the difference between microwave therapy and subcutaneous curettage for axillary osmidrosis.

OBJECTIVE To compare the long-term effectiveness, complications, and recurrence of osmidrosis after microwave therapy and subcutaneous curettage.

METHODS AND MATERIALS Medical records of 155 patients with osmidrosis treated with microwave therapy or subcutaneous curettage were reviewed retrospectively. Demographic data, visual analog scale for odor, hyperhidrosis disease scale, complications, and recurrence were analyzed.

RESULTS Osmidrosis improved significantly in both treatment groups at 6 months. Effective improvement was observed in 90% and 23% of the patients in the surgery and microwave groups, respectively, after 3 years postoperatively. The recurrence rates were 39% and 21% in the microwave and surgery groups, respectively. The transient complication rate was higher in the microwave group, and long-term complications only occurred in the surgery group.

CONCLUSION Subcutaneous curettage is a more effective approach for axillary osmidrosis. However, microwave therapy is recommended for patients with cosmetic concerns.

Axillary osmidrosis is characterized by excessive axillary malodor originating from the bacterial decomposition of apocrine hypersecretion, which produces ammonia and short-chain fatty acids.[1] Microorganisms and genetics reportedly play a crucial role in the pathogenesis of axillary osmidrosis.[2] Owing to the offensive odor and displeasing sweat stains on clothes, osmidrosis is often accompanied by diminished self-esteem and frustrating social withdrawal, particularly in East Asians.[1] Various treatments, including hair shaving and deodorants, have been developed since the 1950s.[3,4] Surgical treatment for osmidrosis was first introduced by Skoog and Thyresson in 1962.[5] The traditional surgical excision of subcutaneous apocrine glands is not only considered the most effective and satisfactory treatment but is also limited by its postoperative complications. Recently, minimally invasive surgical techniques and noninvasive devices, such as microwave therapy, have also been used. A microwave-based device (miraDry; Miramar Labs Incorporated, Santa Clara, CA) selectively heats the water-rich dermis and apocrine by physical rotation of high dipole molecules.[6] Only a few studies have compared the long-term effectiveness, as well as safety between microwave therapy and subcutaneous curettage through a small linear incision. Therefore, this study aimed to compare the improvement, recurrence rate, and complications between these 2 treatment methods for axillary osmidrosis.

Methods

Patients

This was a single-center retrospective study evaluating cases of axillary osmidrosis treated with a microwave device or surgical method. Osmidrosis was defined as bilateral axillary odor that can be detected more than 30 cm away from the armpit. The inclusion criteria included clinically defined bilateral osmidrosis in patients aged ≥16 years. The exclusion criteria were other treatments for axillary osmidrosis within 12 months, surgical history, women during their menstrual period, severe internal diseases, or coagulation dysfunction. We enrolled 155 patients with axillary osmidrosis who received microwave or surgical treatment at the Department of Dermatology, Second Affiliated Hospital Zhejiang University School of Medicine from January 2016 to October 2019. All patients and/or their guardians were informed about the advantages and disadvantages of the 2 therapies. The patients themselves then chose one therapeutic method. The same dermatologist performed microwave treatment in 107 patients and surgical subcutaneous tissue excision in 48 patients. Data, including age, sex, body mass index (BMI), and family history, were collected before each treatment. This study was approved by the local institutional review board, and informed consent was obtained from all patients.

*From the *All authors are affiliated with the Department of Dermatology, Second Affiliated Hospital, Zhejiang University School of Medicine, Hangzhou, China*

The authors have indicated no significant interest with commercial supporters.

Address correspondence and reprint requests to: Xiao-Yong Man, PhD, Department of Dermatology, Second Affiliated Hospital, Zhejiang University School of Medicine, 88th Jiefang Road, Hangzhou, 310009, China, or e-mail: manxy@zju.edu.cn

http://dx.doi.org/10.1097/DSS.0000000000003276

Treatment Procedure

Preoperative preparations were similar in both the microwave and surgery groups. Before treatment, patients were requested to shave their axillary hair. They were then placed in a supine position with arms abducted at an angle >100° for exposure. An extension of 1 cm beyond the hair-bearing range was marked as a subcutaneous undermining area. For tumescent anesthesia, the marked area of each axilla received a 50 mL subcutaneous injection composed of 40 mL normal saline, 10 mL 2% lidocaine, and 0.25 mg epinephrine.

Subcutaneous Curettage

A 3 to 5 cm linear transverse skin incision was cut open along the central axillary crease. The incision length was decided by the hair-bearing range. A pair of blunt-tip scissors was advanced through the incision to separate the superficial skin flap subtly and sharply from the subcutaneous tissue in the axillary apocrine distribution area while preserving fascial integrity. The skin was turned over with fingertips, and under direct vision, the subcutaneous sweat glands, hair follicles, and fat particles were thoroughly snipped off using a pair of curved scissors. After complete curettage, the subcutaneous space was repeatedly washed with normal saline to remove free-tissue fragments. The linear incision was intermittently sutured with 5-0 nylon sutures and subsequently covered with a sterile gauze and sterile cotton pad. A figure-eight wrap was used around both arms for immobilization and limitation for 3 days. Sutures were removed 10 days after surgery.

Microwave Therapy

An oval template with handpiece alignment lines was chosen depending on the size of the operating area. The template was marked with a lineate temporary tattoo as a positional marker. After the administration of tumescent anesthesia, the handpiece was applied to the positional marker for vacuum action and energy heating. The energy level was fixed at five. Treatment in each zone was approximately 45 seconds. Ice packs wrapped in gauze were placed under the axillae for 3 to 5 hours. Patients were advised to curb upper-limb movement and cool the treatment area with ice packs twice daily for at least 3 days.

Assessment

Patients were questioned about the improvement in axillary odor, sweat secretion, complications, and recurrence by telephone at baseline, 6 months, 1 year, 2 years, and 3 years after treatment. The Visual Analog Scale (VAS) ranging from 0 (no unpleasant odor) to 10 (most offensive malodor) was used for the subjective evaluation of axillary odor by patients. Effective improvement of malodor was defined as a VAS grade ≤2. The effectiveness of the treatment was calculated as follows: effectiveness rate of osmidrosis treatment = number of patients who showed effective improvement/number of all follow-up patients. The Hyperhidrosis Disease Severity Scale (HDSS) was used in patients with hyperhidrosis.[7] The date of occurrence and the duration of postoperative complications, including seroma, pain, pigmentation, paresthesia, scar, and infection, were collected. Recurrence was defined as the recurrence of malodor reported by patients subjectively.

Statistical Analysis

All statistical analyses were performed with GraphPad Prism software, version 8 (GraphPad Software, San Diego, CA). Measurement data are presented as mean ± SD. For patient characteristics, the independent sample *t*-test was used to compare the age and BMI of the 2 groups. Sex, family history, hyperhidrosis, and follow-up year were analyzed using the Pearson chi-square test. The Visual Analog Scale for odor and HDSS was compared using a *t*-test. The efficacy rate, complications, and recurrence were assessed using the chi-square test. Data are presented as frequencies (percentages). A p value $< .05$ was considered to be statistically significant.

Results

A total of 155 patients with axillary osmidrosis (98 women and 57 men) with a mean age of 27 years were included (Table 1). Microwave treatment was administered to 37 male and 70 female patients. Subcutaneous curettage was performed on 20 male and 28 female patients. The average BMI of patients in the microwave and surgery groups was 21.16 ± 2.99 and 21.79 ± 3.08, respectively. No statistical differences were found in the demographic data between the 2 groups, including sex, age, BMI, and family history of osmidrosis ($p > .05$). Fifty percent of the patients in both groups was also diagnosed with hyperhidrosis, which was defined by an HDSS score of 3 or 4. The follow-up periods were 3 years in 36 patients (23%), 2 years in 60 patients (39%), and 1 year in 59 patients (38%), depending on when the treatment was performed. The distribution of follow-up years was also similar between the 2 groups ($p > .05$).

All patients were followed to evaluate effectiveness and complications for at least 1 year. At baseline, the average VAS grade for odor assessed by patients themselves was not significantly different between the 2 groups (Table 2). Six months after treatment, 40 patients (83%) showed effective elimination of malodor (VAS grade ≤2) in the surgery group, whereas only 72 patients (67%) showed effective improvement in the microwave group with a mean VAS grade of 2.18 ± 2.13, which was statistically higher than that of the surgery group ($p < .05$). With the extension of postoperative time, the VAS grade in the microwave group increased gradually, and the differences between the 2 groups became more apparent ($p < .01$). Three years postoperatively, the VAS grades were 4.05 ± 2.01 and 1.36 ± 1.34 in the microwave and surgery groups, respectively ($p < .0001$). Most patients (91%) who were followed for 3 years in the surgery group still had a VAS grade <2. However, only 5 patients (23%) in the microwave group showed effective improvement. For hyperhidrosis, HDSS in the microwave group was significantly higher than that in the surgery group 1 and 2 years after treatment ($p < .01$).

TABLE 1. Demographics and Follow-Up Data of Patients

Variable	All Patients (*N** = 155)	Microwave (*N* = 107)	Surgery (*N* = 48)	*p*
Gender, *n* (%)				.49
Male	57 (37%)	37 (35%)	20 (42%)	
Female	98 (63%)	70 (65%)	28 (58%)	
Age at treatment, y				.48
Mean (SD)	26.57 (6.55)	25.94 (6.05)	26.75 (6.76)	
Min, max	16, 57	16, 57	16, 40	
Family history, *n* (%)	125 (81%)	88 (82%)	37 (77%)	.45
Hyperhidrosis, *n* (%)	77 (50%)	53 (50%)	24 (50%)	.96
Follow-up yr, *n* (%)				.47
3	36 (23%)	22 (20%)	14 (30%)	
2	60 (39%)	42 (40%)	18 (37%)	
1	59 (38%)	43 (40%)	16 (33%)	

* *N*, number of patients.

The recurrence rate of malodor in the microwave group (39%) was significantly higher than that in the surgery group (21%) ($p < .05$). The recurrence durations in the microwave and surgery groups were 9.5 and 14.6 months, respectively, which were not statistically different.

In the microwave group, seroma was the most common complication, occurring in 73 patients (68%) who recovered spontaneously after a median of 2 weeks (Table 3). No patients reported seroma in the surgery group. In addition, the swelling was usually accompanied by painful sensation; it was present in 45 patients (42%) in the microwave group, and the median duration was 2 weeks. Four (8%) patients in the surgery group experienced postoperative pain that lasted for over a year, which was significantly different from the microwave treatment group ($p < .0001$). Complications including pigmentation, paresthesia, scar, and infection occurred infrequently. The prevalence of pigmentation and paresthesia were 6% and 8% in the microwave group and 0% and 6% in the surgery group; no statistical differences were noted between the 2 groups. Scars were evident on the armpits of the 7 patients (15%) in the surgery group, including 3 unilateral cases. Moreover, 4 patients (8%) experienced transient infection after surgery. As microwave treatment is a noninvasive method, no cases of scarring or infection were observed in this group. The difference in the rates of scarring and infection between the 2 groups was statistically significant ($p < .01$). The prevalence of complications was 79% in the microwave group, which was significantly higher than that in the surgery group (38%) ($p < .0001$).

Discussion

In this study, we probed into the long-term efficacy, postoperative complications, and recurrence rate between subcutaneous curettage and microwave therapy for the treatment of osmidrosis. Surgery through a small linear incision showed a stable efficacy rate (80%–90%) over a long period in our study, which was consistent with

TABLE 2. Outcomes After Microwave Therapy and Subcutaneous Curettage

	All Patients	Microwave	Surgery	*p*
VAS grade, mean (SD)				
Before treatment	6.61 (2.08)	6.58 (2.22)	6.69 (1.75)	.77
6 mo	1.95 (1.97)	2.18 (2.13)	1.46 (1.46)	<.05
1 yr	2.43 (2.09)	2.74 (2.22)	1.73 (1.58)	<.01
2 yrs	2.54 (1.96)	3.05 (2.02)	1.53 (1.39)	<.001
3 yrs	3.00 (2.20)	4.05 (2.01)	1.36 (1.34)	<.0001
Efficacy rate, *n*/*N** (%)				
6 mo	112/155 (72%)	72/107 (67%)	40/48 (83%)	<.05
1 yr	96/155 (62%)	57/107 (55%)	39/48 (81%)	<.001
2 yrs	56/96 (58%)	27/64 (42%)	29/32 (91%)	<.0001
3 yrs	18/36 (50%)	5/22 (23%)	13/14 (93%)	<.0001

* *n*, number of patients who achieved effective improvement; *N*, number of all follow-up patients.

TABLE 3. Postoperative Complications			
	Microwave (*N* = 107)	**Surgery (*N* = 48)**	***p***
Complications, *n* (%)			
Seroma	73 (68%)	0 (0%)	<.0001
Pain	45 (42%)	4 (8%)	<.0001
Pigmentation	6 (6%)	0 (0%)	.09
Paresthesia	9 (8%)	3 (6%)	.64
Scar	0 (0%)	7 (15%)	<.0001
Infection	0 (0%)	4 (8%)	<.01
Patients with complications, *n* (%)	84 (79%)	18 (38%)	<.0001

previously published data.[8–11] The efficacy rate of microwave treatment 1 year after the procedure in our study was (72%), which is similar to that reported in previous studies[8,12] except for one retrospective study that reported a clinical improvement over 90%.[13] The subjective evaluation of effectiveness was higher in the surgery group than in the microwave group, and the gap in the VAS grade increased with the extension of postoperative time. Hyperhidrosis and osmidrosis usually accompany each other and share parallel treatment methods. Along with the destruction of apocrine glands, the mechanical surgery and microwave heating can also remove eccrine glands that are responsible for hyperhidrosis.[6,14] Thus, together with osmidrosis, hyperhidrosis was also improved in our study, with surgery achieving better improvement than microwave therapy.[9,14]

Although noninvasive procedures often facilitate excellent esthetic results for axillary osmidrosis and hyperhidrosis, the high recurrence rates of malodor and excessive sweating limit its extensive application.[15] A recent retrospective study on 19 patients who underwent microwave therapy demonstrated a recurrence rate of 26.3% after 6 months postoperatively.[8] The long-term rate of recurrence was rarely reported in the microwave treatment of osmidrosis. In our study, the mean duration of recurrence was 9.5 months after microwave treatment and occurred in 39% of patients. Significant differences were observed between the microwave and surgery groups.

According to the VAS grade in the long-term follow-up, surgery was more effective than a single course of microwave therapy, with a lower recurrence rate in the treatment of axillary osmidrosis. Previous studies on hyperhidrosis reported that microwave therapy with 2 or 3 procedure sessions can show good-to-excellent effectiveness after a 12-month follow-up.[6] Thus, to improve the curative effect of microwave therapy and lower the recurrence rate, a second or even third treatment session with an interval of 3 months should be considered.

For complications, subcutaneous curettage and microwave therapy differed significantly from each other. As a noninvasive treatment, microwave therapy is mainly followed by temporary complications, such as seroma and pain. Despite the higher prevalence of these complications in the microwave group compared with that in the surgery group, seroma and pain usually were resolved within 2 months, with no sequela.[12,16] The indistinctive high energy of microwave therapy is responsible for the overheating of thinner skin and underlying nerve structures, which may account for the higher prevalence of paresthesia in some studies.[6,13,17] However, we did not observe any significant differences in paresthesia between the 2 groups. No evident swelling was reported, and only 8% of the patients complained of painful sensations. One impetus to develop new noninvasive treatments is the long-term or permanent complications after traditional surgery, such as infection and scars.[18] Fifteen percent of the patients in the surgery group had bilateral or unilateral axillary scars and complained about poor scars. Thus, microwave therapy rather than surgery should be recommended to patients concerned with aesthetic outcomes.

Conclusion

Compared with microwave therapy, the long-term observations in our study indicated that subcutaneous curettage through a small linear incision was more effective in the treatment of axillary osmidrosis with greater improvement, lower prevalence of short-time complications, and lower recurrence rate. However, without long-term sequela, microwave treatment might be suitable for patients with osmidrosis with cosmetic concerns.

References

1. Morioka D, Nomura M, Lan L, Tanaka R, et al. Axillary osmidrosis: past, present, and future. *Ann Plast Surg* 2020;84:722–8.
2. Ren Y, Liu W, Chen J, Wang J, et al. A missense variant of the ABCC11 gene is associated with Axillary Osmidrosis susceptibility and clinical phenotypes in the Chinese Han Population. *Sci Rep* 2017;7:46335.
3. Shelley WB, Hurley HJ, Nichols AC. Axillary odor; experimental study of the role of bacteria, apocrine sweat, and deodorants. *AMA Arch Derm Syphilol* 1953;68:430–46.
4. Beer GM, Baumüller S, Zech N, Wyss P, et al. Immunohistochemical differentiation and localization analysis of sweat glands in the adult human axilla. *Plast Reconstr Surg* 2006;117:2043–9.
5. Skoog T, Thyresson N. Hyperhidrosis of the axillae: a method of surgical treatment. *Acta Chir Scand* 1962;124:531–8.
6. Hsu TH, Chen YT, Tu YK, Li CN. A systematic review of microwave-based therapy for axillary hyperhidrosis. *J Cosmet Laser Ther* 2017; 19:275–82.

7. Lecouflet M, Leux C, Fenot M, Célerier P, et al. Duration of efficacy increases with the repetition of botulinum toxin A injections in primary axillary hyperhidrosis: a study in 83 patients. *J Am Acad Dermatol* 2013;69:960–4.
8. Li Y, Huang Z, Ran L, Wang W, et al. A retrospective study on comparing the surgery and microneedles radiofrequency and microwaves treatment in axillary osmidrosis. *J Dermatolog Treat* 2020:1–7. Epub ahead of print.
9. Heidemann E, Licht PB. A comparative study of thoracoscopic sympathicotomy versus local surgical treatment for axillary hyperhidrosis. *Ann Thorac Surg* 2013;95:264–8.
10. Chen YT, Shih PY, Chen HJ, Chen TJ. Treatment of axillary osmidrosis: a comparison between subcutaneous laser and superficial liposuction curettage. *J Eur Acad Dermatol Venereol* 2015;29:2019–23.
11. Ding Z, Zheng J. A comparison of two different sub-dermal trimming techniques for the treatment of axillary osmidrosis. *J Plast Reconstr Aesthet Surg* 2013;66:1569–74.
12. Glaser DA, Coleman WP, Fan LK, Kaminer MS, et al. A randomized, blinded clinical evaluation of a novel microwave device for treating axillary hyperhidrosis: the dermatologic reduction in underarm perspiration study. *Dermatol Surg* 2012;38:185–91.
13. Yang HH, Miao Y, Chen YT, Hu ZQ, et al. Minimally invasive approaches to axillary osmidrosis treatment: a comparison between superficial liposuction with automatic shaver curettage, subcutaneous laser treatment, and microwave-based therapy with a modified technique. *J Cosmet Dermatol* 2019;18:594–601.
14. Kaminaka C, Mikita N, Inaba Y, Kunimoto K, et al. Clinical and histological evaluation of a single high energy microwave treatment for primary axillary hyperhidrosis in Asians: a prospective, randomized, controlled, split-area comparative trial. *Lasers Surg Med* 2019; 51:592–9.
15. Shin JY, Roh SG, Lee NH, Yang KM. Osmidrosis treatment approaches: a systematic review and meta-analysis. *Ann Plast Surg* 2017;78:354–9.
16. Hong HC, Lupin M, O'Shaughnessy KF. Clinical evaluation of a microwave device for treating axillary hyperhidrosis. *Dermatol Surg* 2012;38:728–35.
17. Puffer RC, Bishop AT, Spinner RJ, Shin AY, et al. Bilateral Brachial Plexus Injury after MiraDry® Procedure for Axillary Hyperhidrosis: a Case Report. *World Neurosurg* 2019;124:370–372.
18. Wu M, Dai H, Zhu J, Xu J, et al. An innovative technique of hydrosurgery in the treatment of osmidrosis. *J Dermatolog Treat* 2019;32: 328–33.