Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Clinical efficacy comparison of modified radiofrequency micro-needle and small incision surgery in the treatment of Axillary osmidrosis

Pengyu Zhao
Chengdu Second People's Hospital
Mingzi Zhang
Peking Union Medical College Hospital
Bolin Chen
Chengdu Second People's Hospital
Wei Chen
Chengdu Second People's Hospital
Lixia Xie
Chengdu Second People's Hospital
Qingbiao Wa
Chengdu Second People's Hospital
Hong Li
lihong408@163.com

Chengdu Second People's Hospital

Research Article

Keywords: axillary osmidrosis, axillary hyperhidrosis, modified radiofrequency micro-needle, small incision surgery

Posted Date: May 14th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9192105/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Objective

Comparing the clinical efficacy of modified microneedle radiofrequency (MMR) and small incision surgery in the treatment of axillary osmidrosis.

Method

A total of 80 patients diagnosed with axillary osmidrosis who sought medical consultation at the hospital between January 2024 and December 2024 were included in this study. These patients were divided into two treatment groups: the Modified Microneedle Radiofrequency (MMR) group (n = 40) and the small incision surgery group (n = 40). Six months after the intervention, several outcome measures were evaluated and compared between the two groups, with the primary outcome being the improvement in axillary odor assessed using the Odor-10 scale, and the secondary outcome being the impact of associated axillary sweating on daily life measured by the Hyperhidrosis Disease Severity Scale (HDSS) score. Other measures included the duration of the procedure, length of the time off work, pain perception measured via the Visual Analogue Scale (VAS) score, and the incidence of postoperative complications.

Result

During the 1-month, 3-month, and 6-month follow-ups after treatment, both the MMR group and the Surgery group exhibited a decreasing trend in HDSS scores and odor scores. At the 6-month follow-up, no statistically significant difference was observed between the two groups ($p > 0.05$). During the 3-day post-treatment follow-up period, the MMR group demonstrated better pain control, as indicated by lower VAS scores, compared to the Surgery group ($p < 0.05$). Additionally, the MMR group showed shorter recovery duration and treatment time than the Surgery group ($p < 0.05$). The MMR group also had a significantly lower incidence of complications compared to the Surgery group ($p < 0.05$).

Conclusion

The MMR treatment therapy demonstrates definite efficacy in treating axillary osmidrosis, with outcomes comparable to those of surgery. Meanwhile, it enables patients to experience a comfortable recovery period, reduces the incidence of complications, and shortens the time off work.

1. Background

Axillary osmidrosis is primarily characterized by an unpleasant odor originating from the underarm area, which can lead to considerable social difficulties and psychological distress for affected individuals. This

condition is often attributed to the excessive secretion of sweat by apocrine glands, which, when broken down by bacteria on the skin surface, produces malodorous compounds such as ammonia, short-chain fatty acids, and sulfides [1]. Axillary osmidrosis is prevalent among Asian populations and exhibits a strong genetic predisposition, potentially linked to chromosome 16 [2]. Research has also indicated a positive correlation between the number of apocrine glands and the volume of sweat secreted [3]. Furthermore, a neutral pH environment in the axillary region may facilitate the overgrowth of bacteria, including Staphylococcus, Corynebacterium, and Fusobacterium [4].

Currently, the primary treatment approaches for axillary osmidrosis can be categorized into surgical and non-surgical interventions [5]. Common surgical techniques include minimally invasive small incision excision [6], as well as excision combined with liposuction technology [7][8]. These procedures aim to reduce odor by removing or destroying the apocrine glands in the axillary region through surgical means. Although these methods demonstrate notable efficacy, they are often associated with complications such as hematoma formation, skin necrosis, and limitations in shoulder joint mobility. Non-surgical treatment options include botulinum toxin injections [9], microwave treatment [10], pharmacological therapy [11], and fractional microneedle radiofrequency [12]. Compared to surgical interventions, non-surgical methods offer advantages such as reduced invasiveness and fewer adverse effects, although their therapeutic effectiveness may be somewhat lower, often necessitating repeated sessions. Due to the shorter recovery time and relatively lower risk of complications, non-surgical treatments are increasingly preferred among patients with axillary osmidrosis.

The fractional microneedling radiofrequency accurately deliver radiofrequency energy into the deep dermal layer, inducing localized thermal damage. This process effectively destroys apocrine sweat glands and the associated microbial flora, thereby reducing body odor. However, due to the mechanism involving negative pressure and deep thermal injury, various potential complications may still arise [12]. Compared with negative pressure fractional radiofrequency microneedles, the modified microneedle radiofrequency technology offers a more optimal integration of microneedling and radiofrequency techniques. By employing fine, insulated microneedles that penetrate the epidermis, radiofrequency energy can be precisely targeted to the deeper dermal sweat glands. This leads to thermal coagulation and denaturation of the sweat glands, thereby decreasing secretion and achieving the desired clinical therapeutic outcome. The device head is illustrated in Fig. 1.

This study aims to compare the efficacy of modified radiofrequency microneedle treatment and small incision surgery in managing axillary osmidrosis, with a focus on therapeutic outcomes, associated complications, and patient treatment experience.

2. Method

2.1 Clinical Data

This study was a single-center retrospective analysis conducted on cases of axillary osmidrosis treated using either a modified radiofrequency microneedle technique or a small incision trimming procedure. A total of 80 patients diagnosed with axillary osmidrosis who sought medical consultation at the hospital between January 2024 and December 2024 were included in this study.These patients were divided into two groups: 40 received treatment via the modified radiofrequency microneedle method (MMR), and 40 underwent small incision surgery (Surgery group). The inclusion criteria were as follows: individuals aged 16–50 years with a clinical diagnosis of bilateral bromhidrosis, no underlying systemic diseases such as cardiac, hepatic, or renal disorders, no contraindications to the procedures, willingness to participate in the study, and provision of written informed consent. Exclusion criteria included refusal to participate, prior history of similar surgical interventions, presence of systemic diseases, pregnancy, coagulation disorders, axillary skin infections, other dermatological conditions, or a history of keloid formation. All participants were fully informed of the benefits and risks associated with both treatment modalities, and all procedures were performed by the same physician.

2.2 Treatment Methods

The preoperative preparations were identical for both patient groups. Prior to the procedure, all patients were instructed to shave their axillary hair. Subsequently, the patients were positioned supine with their arms abducted to an angle of approximately 100° to ensure adequate exposure. A treatment area extending 1 cm beyond the region covered by axillary hair was delineated. Following standard disinfection and sterile draping, each marked axillary area received an injection of 80–100 ml of subcutaneous tumescent anesthetic solution, consisting of 90 ml normal saline, 10 ml of 2% lidocaine, and 0.25 mg of epinephrine.

Surgery group: Make an incision measuring approximately 1 to 2 cm in length, parallel to the central axillary fold; the exact length may be adjusted according to the required treatment area. Insert a blunt-tipped scissors through the incision and carefully dissect the superficial skin flap from the underlying subcutaneous tissue in the region containing the apocrine sweat glands, ensuring the integrity of the fascia is preserved. Gently evert the skin flap using fingers, and under direct visualization, meticulously excise the subcutaneous apocrine sweat glands, hair follicles, and adipose tissue using a curved scissors. Following complete excision, irrigate the subcutaneous space repeatedly with normal saline to remove any residual tissue debris. Finally, close the incision with sutures and apply compression dressing.

MMR group:the axillary osmidrosis treatment device (a high-frequency electrocautery device), model United III, manufactured by Peninsula Medical Co., Ltd., China, was used. The treatment head was vertically inserted into the skin, with the insertion angle adjusted according to the thickness of the tissue to ensure full placement of the needle within the skin. The foot pedal was gently pressed to activate the system, which automatically delivered energy at parameters of 10–15 W and 200–300 ms. The device was then moved to the next treatment spot, maintaining an interval of approximately 1.5 mm between each point. Skin reactions were continuously monitored throughout the procedure, and energy

parameters were adjusted accordingly. Immediate cooling was applied during the treatment and continued for 20 minutes post-treatment, followed by the application of antibiotic ointment.

2.3Efficacy Evaluation

The severity of axillary odor and its improvement were assessed through structured questionnaires or telephone interviews conducted at four time points: pre-treatment, one month post-treatment, three months post-treatment, and six months post-treatment. The primary outcome measure for this study was the improvement in axillary odor, self-assessed by patients using a 10-point Odor Scale (Odor-10), with 0 representing no odor and 10 indicating an extremely strong odor. The Hyperhidrosis Disease Severity Scale (HDSS) was used as a secondary outcome measure to evaluate the impact of associated axillary sweating on daily life; this is a 4-point scale ranging from 1 to 4, where 1 indicates no impact on daily life, 2 indicates tolerable symptoms that occasionally affect daily activities, 3 indicates symptoms that are difficult to tolerate and frequently interfere with life, and 4 indicates unbearable symptoms that constantly impair quality of life.

All scale assessments were standardized with unified guidance provided to all patients prior to questionnaire completion to ensure consistent understanding of each scoring item. Pain levels (a secondary subjective measure) were assessed using the Visual Analogue Scale (VAS), which ranges from 0 to 10, with 0 indicating no pain and 10 indicating the worst imaginable pain. Pain assessments were conducted on the night of treatment, one day post-treatment, and three days post-treatment by two trained attending physicians from the Medical Aesthetic Center who were blinded to the patients' treatment grouping; All investigators were trained uniformly on the VAS scoring criteria prior to the study to ensure the reliability of the assessment.

The duration of treatment and the time required for work absence were recorded and analyzed statistically as objective secondary outcomes. The treatment duration was defined as the time from the initiation of tumescent anesthesia to the completion of the procedure, while the work absence duration referred to the period from the end of treatment to the point at which patients could resume normal work activities without restriction. The incidence of postoperative complications, including subcutaneous hematoma, delayed wound healing, subcutaneous asymptomatic nodules, hypertrophic scarring, and paresthesia, was also recorded and analyzed for both treatment groups as a key safety outcome measure.

2.4 Statistical Analysis

Data analysis was performed using SPSS version 26.0 statistical software. Prior to formal statistical analysis, normality testing (Shapiro-Wilk test) and homogeneity of variance testing (Levene test) were conducted for all continuous variables. Continuous variables conforming to a normal distribution and meeting the homogeneity of variance assumption were presented as mean ± standard deviation (SD) and compared using the independent samples t-test.Count data were expressed as percentages and analyzed using the chi-square (χ^2) test. A two-sided P value < 0.05 was considered statistically significant, and statistical significance was marked with * in all tables and figures.

3. Results

All continuous variables in this study were confirmed to be normally distributed (Shapiro-Wilk test, $p > 0.05$) and met the assumption of homogeneity of variance, thus supporting the use of parametric tests for subsequent comparisons.No statistically significant differences were observed in demographic characteristics, including gender, age, family history, and history of oily ears, between the two groups ($p > 0.05$). Detailed information is presented in Table 1.

Table 1
Demographics Data of Patients

Characteristics	**MMR(n = 40)**	**Surgery(n = 40)**	**Statistical value**	***P* value**
Sex				
Male	12	14		
Female	28	26		
			$\chi2 = 0.228$	0.633
Age,year(SD)				
	27.75 ± 9.79	27.55 ± 7.96	t = 0.10	0.92
Family history				
yes	36	37		
no	4	3		
			$\chi2 = 0.16$	0.69
Oily ears				
yes	39	40		
no	1	0		
			$\chi2 = 0.49$	0.48

In terms of the primary outcome of axillary odor improvement, the Odor-10 scores in both treatment groups demonstrated a significant decreasing trend at all post-intervention follow-up time points when compared with the pre-treatment baseline ($p < 0.05$). In the MMR group, the odor score decreased from 7.21 ± 1.07 pre-treatment to 2.02 ± 0.73 at the 1-month follow-up, 2.72 ± 0.56 at the 3-month follow-up, and finally to 1.82 ± 0.39 at the 6-month follow-up ($p < 0.05$). In the Surgery group, the Odor-10 score decreased from 7.29 ± 1.01 pre-treatment to 1.97 ± 0.73 at the 1-month follow-up, 2.17 ± 0.59 at the 3-month follow-up, and 1.75 ± 0.44 at the 6-month follow-up ($p < 0.05$). At the 3-month post-treatment assessment, the Odor-10 score in the Surgery group was significantly lower than that in the MMR group ($p < 0.05$). However, no statistically significant difference in the degree of odor improvement was observed between the two groups at the 6-month follow-up ($p > 0.05$), indicating comparable long-term

efficacy in relieving the core symptom of axillary osmidrosis.Detailed data are presented in Table 2 and Fig. 2.

Table 2
Odor-10 scale(0–10

MMR(n = 40)	**Before treatment**	**1 month followup**	**3 month followup**	**6 month followup**
	7.21 ± 1.07	**2.02 ± 0.73**	**2.72 ± 0.56**	**1.82 ± 0.39**
Surgery(n = 40)	7.29 ± 1.01	1.97 ± 0.73	2.17 ± 0.59	1.75 ± 0.44
t value	0.43	0.305	4.28	0.81
P value	0.67	0.76	0.01*	0.42

For the secondary outcome of sweat-related life impact assessed by the Hyperhidrosis Disease Severity Scale (HDSS), the scores in both groups also showed a significant decreasing trend after treatment when compared with the pre-treatment levels ($p < 0.05$). In the MMR group, the HDSS score decreased from 3.30 ± 0.72 pre-treatment to 1.33 ± 0.47 at the 1-month follow-up, 1.85 ± 0.36 at the 3-month follow-up, and 1.83 ± 0.38 at the 6-month follow-up ($p < 0.05$). In the Surgery group, the HDSS score decreased from 3.40 ± 0.71 pre-treatment to 1.28 ± 0.45 at the 1-month follow-up, 1.45 ± 0.50 at the 3-month follow-up, and 1.75 ± 0.44 at the 6-month follow-up ($p < 0.05$). Consistent with the Odor-10 results, the HDSS score in the Surgery group was significantly lower than that in the MMR group at the 3-month follow-up ($p < 0.05$), while no statistically significant difference was found between the two groups at the 6-month follow-up ($p > 0.05$).Detailed data are presented in Table 3 and Fig. 3.

Table 3
Hyperhidrosis Disease Severity Scale, Hdss(1–4)

MMR(n = 40)	**Before treatment**	**1 month followup**	**3 month followup**	**6 month followup**
	3.30 ± 0.72	**1.33 ± 0.47**	**1.85 ± 0.36**	**1.83 ± 0.38**
Surgery(n = 40)	3.40 ± 0.71	1.28 ± 0.45	1.45 ± 0.50	1.75 ± 0.44
t value	0.62	0.48	4.08	0.81
P value	0.54	0.63	0.01*	0.42

In the analysis of treatment experience-related objective indicators, the total treatment duration in the MMR group was significantly shorter than that in the Surgery group ($p < 0.05$). Moreover, the MMR group exhibited a notably shorter work absence duration after treatment for axillary osmidrosis, demonstrating a distinct clinical advantage in terms of recovery efficiency ($p < 0.05$).Detailed data are presented in Table 4.

Table 4
The Time Off Work And The Duration Of Treatment

MMR(n = 40)	Time off work(day)	Duration of treatment(minutes)
	2.93 ± 0.76	**59.50 ± 3.92**
Surgery(n = 40)	10.35 ± 2.35	90.51 ± 3.91
t value	19.01	35.41
P value	0.01*	0.01*

In terms of pain perception assessed by the Visual Analogue Scale (VAS), during follow-up evaluations conducted on the night after treatment, one day post-treatment, and three days post-treatment, patients in the MMR group reported significantly lower pain levels compared to those in the surgical group ($p < 0.05$). Notably, by the third day after treatment, patients in the MMR group experienced minimal to no pain, with a VAS score of only 0.95 ± 0.78 ($p < 0.05$).Detailed data are presented in Table 5 and Fig. 4.

Table 5
Pain Score,VAS (0–10)

MMR(n = 40)	On the day of treatment	1 day followup	3 day followup
	3.82 ± 1.29	**3.03 ± 0.92**	**0.95 ± 0.78**
Surgery(n = 40)	5.85 ± 0.83	5.56 ± 1.01	3.23 ± 0.98
t value	8.23	11.68	11.51
P value	0.01*	0.01*	0.01*

All treatment-related complications included subcutaneous hematoma, delayed wound healing, asymptomatic subcutaneous nodules, scar hyperplasia, and paresthesia. In this study, no cases of subcutaneous hematoma or delayed healing were observed in the MMR group; only a small number of patients developed asymptomatic nodules and scar hyperplasia. The primary complications in the Surgery group were scar hyperplasia, with occasional occurrences of subcutaneous hematoma and delayed wound healing. No paresthesia were reported in either group. Overall, the MMR group exhibited a significantly lower incidence of complications compared to the surgical group ($p < 0.05$).Detailed complication data are provided in Table 6, and two cases are illustrated in Figs. 5 and 6.

Table 6
Treatment-Related Adverse Events

MMR(n = 40)	Seroma	Delayed healing	Asymptomatic nodules	scar	Paresthesia	Total
	0	**0**	**1**	**2**	**0**	**3**
Surgery(n = 40)	2	2	0	6	0	10
Statistical value						$\chi 2 = 4.51$
P value						*P* = 0.03*

4. Discussion

The core pathogenesis of axillary osmidrosis involves the decomposition of excessive sweat secreted by apocrine glands by surface bacteria, resulting in the production of odorous compounds[13]. Therefore, current mainstream treatment strategies focus on the removal or suppression of apocrine gland secretion, and the elimination of underarm odor is the primary clinical goal for treating this condition. Existing studies have demonstrated that various surgical techniques for excising apocrine glands are effective in significantly improving axillary odor [14][15]; however, these procedures are often associated with complications such as hematoma formation, delayed wound healing, and scar formation [16], which may negatively impact patient satisfaction. Among non-surgical options, botulinum toxin injection serves as a rapid and effective treatment modality, particularly suitable for patients who are not candidates for surgery or prefer non-invasive management. Nevertheless, its therapeutic effect is typically transient, necessitating repeated injections to sustain clinical benefits [17]. Given that axillary odor may be associated with autosomal inheritance and often presents with a clear familial pattern [2], the patient population is substantial. The development of safe, effective, and well-tolerated treatment approaches remains a key direction for future research and clinical practice.

In this study, we compared the clinical efficacy of the modified microneedle radiofrequency (MMR) group and small incision surgery in the treatment of axillary osmidrosis, and optimized the outcome evaluation system to align with the core clinical characteristics of the disease. Considering the close clinical correlation between axillary osmidrosis and axillary hyperhidrosis—most patients with osmidrosis are accompanied by excessive apocrine sweat secretion—we initially included the Hyperhidrosis Disease Severity Scale (HDSS) in the assessment system. However, it is critical to clarify that the HDSS primarily reflects the impact of sweating symptoms on daily life in hyperhidrosis patients and cannot directly and specifically quantify the severity and improvement of underarm odor, the core symptom of axillary osmidrosis. To address this and take the primary clinical endpoint of osmidrosis treatment as the core, we designated the Odor-10 scale as the primary outcome measure for targeted assessment of patients' subjective perception of underarm odor improvement, and the HDSS as a secondary outcome measure

to evaluate the improvement of associated sweating symptoms and their impact on daily life, forming a comprehensive evaluation system of "core odor symptom + associated sweating symptom".

The Odor-10 scale (primary outcome) and HDSS (secondary outcome) both served as key tools for assessing treatment efficacy in this study, and our results indicated that both treatment modalities effectively alleviated the core and associated symptoms of axillary osmidrosis, as reflected by the significant decrease in both scores compared with baseline ($p < 0.05$). Starting one month post-treatment, both the Odor-10 and HDSS scores exhibited a slight upward trend, which may be associated with compensatory activity or regeneration of residual apocrine glands [18]. At the three-month follow-up after treatment, both the Odor-10 and HDSS scores in the Surgery group were significantly lower than those in the MMR group ($p < 0.05$), which may be attributed to the direct surgical excision of apocrine glands leading to a more rapid reduction in glandular secretion in the short term, while MMR exerts a gradual therapeutic effect through thermal coagulation and denaturation of sweat glands. However, no statistically significant difference was observed between the two groups in either the primary Odor-10 score or the secondary HDSS score at the six-month follow-up ($p > 0.05$), indicating comparable long-term efficacy in both relieving the core odor symptom and improving associated sweating symptoms. Axillary odor, which significantly impacts the quality of social life in affected individuals, results from the interaction between apocrine gland secretions and epidermal bacteria. In our study, the improvement trend of the Odor-10 score was highly consistent with that of the HDSS score, further verifying the reliability of the evaluation results and the close correlation between odor and sweating in axillary osmidrosis patients.

As surgical treatment for bromhidrosis typically involves compression bandaging, which is often associated with postoperative pain[19], it becomes one of the key factors influencing patients' preference for conservative management. Our study demonstrates that during the three-day post-treatment follow-up period, the MMR group exhibited significantly lower pain perception compared to the Surgery group ($p < 0.05$). By the third day, patients in the MMR group reported nearly no pain. In contrast, patients in the Surgery group usually required compression bandaging for 6–7 days or longer, resulting in prolonged pain and discomfort.

Complications associated with the treatment of axillary osmidrosis represent a major concern for patients. As summarized in the study by Zhang J et al., various surgical approaches for treating axillary osmidrosis have been reported, with a prolonged postoperative recovery period and procedure-specific complications identified as key limitations [20]. Subcutaneous hematoma is a frequently observed complication following surgical intervention. In early surgical techniques, the incidence of hematoma could reach as high as 57% [21], potentially leading to delayed wound healing and extended patient downtime. In this follow-up study, two cases of hematoma were observed in the Surgery group, resulting in prolonged treatment duration. These occurrences were often attributed to inadequate postoperative bandaging and premature physical activity. One patient admitted to not strictly immobilizing the shoulder joint on the second postoperative day. Therefore, strict postoperative immobilization of the shoulder is of critical importance, particularly within the first 24 to 72 hours following surgery, which likely contributes

to the higher Visual Analog Scale (VAS) pain scores observed in the Surgery group. As a radiofrequency micro-needle device, MMR delivers targeted energy to the deep dermal layer, minimizing subcutaneous bleeding while effectively targeting the primary location of apocrine sweat glands [22]. In this follow-up, no cases of hematoma or delayed wound healing were reported in the MMR group. Although the surgical technique employed in this study was minimally invasive with small incisions, many patients still reported significant disruptions to sleep and daily activities prior to the removal of compression dressings. The MMR group demonstrated a significantly shorter downtime (2.93 ± 0.76 days) compared to the Surgery group (10.35 ± 2.35 days) ($p < 0.05$). Additionally, the MMR group exhibited a shorter overall treatment duration (59.50 ± 3.92 minutes) compared to the surgical group (90.51 ± 3.91 minutes) ($p < 0.05$).

Traditional fractional microneedling radiofrequency (FMR) is a negative pressure-assisted radiofrequency microneedling technique that demonstrates effective treatment outcomes for axillary osmidrosis and provides a less invasive alternative to surgical intervention. However, it may occasionally induce transient abnormal sensations in the axillary region. This phenomenon is potentially attributed to the strong negative pressure applied during treatment, combined with the relatively thin subcutaneous fat layer in the armpit, which may lead to stimulation of the superficial branches of the brachial plexus by the microneedles or thermal energy. Fortunately, such discomfort typically resolves spontaneously within several months [23]. Modified microneedle radiofrequency (MMR) eliminates the use of negative pressure and instead employs a direct skin-penetration technique. The needle depth can be adjusted between 3.5 and 4.5 mm, targeting specifically the layer containing the apocrine sweat glands, while the epidermal end is insulated to minimize thermal damage to the superficial skin layers. During the procedure, the needle angle is adjusted according to anatomical variations to further reduce the risk of injury to the brachial plexus. Additionally, the volume of tumescent fluid administered is customized based on the patient's body weight and the thickness of the axillary skin. A recommended volume of 80–100 mL per side is typically used, with adjustments up to 120 mL when necessary to achieve hydrodissection, thereby reducing the likelihood of nerve injury. In this follow-up study, no patients in either group reported abnormal sensory changes, indicating a notable advantage of MMR over traditional FMR. In terms of scar hyperplasia, the MMR group demonstrated a significant advantage over the Surgery group. Occasional scarring and asymptomatic nodules may be attributed to procedural factors. Overall, regarding the incidence of complications, the MMR group (3/40) exhibited a statistically significant improvement compared to the Surgery group (10/40) ($p < 0.05$).

The primary limitation of this study is the absence of an objective and reliable quantitative method for assessing improvements in odor and axillary osmidrosis. Research conducted by Shinaoka Akira et al. has demonstrated that 33 MHz ultrasound exhibits significant potential in accurately detecting the number of apocrine sweat glands in the axillary region [24]. In future studies, the incorporation of such imaging techniques may enhance the objectivity of outcome assessments. Furthermore, axillary sweating and odor intensity may be influenced by environmental factors such as temperature and

humidity during evaluation. To mitigate these potential confounding variables, temperature and humidity will be standardized and documented during subsequent assessments.

5. Conclusion

This study demonstrates that Modified Microneedle Radiofrequency (MMR) treatment is effective in alleviating the core symptom of axillary osmidrosis—axillary odor, yielding clinical outcomes comparable to those of surgical intervention. Additionally, it offers patients a more comfortable recovery experience, with reduced pain, a lower incidence of complications, and a shorter time off work. Therefore, MMR represents a promising therapeutic approach suitable for broader clinical application. Further investigation into its underlying mechanisms is warranted in future studies.

Declarations

Author Contribution

P.Z. and H.L. designed the study and conceived the research idea; P.Z., B.C., W.C. and L.X. collected and analyzed the clinical data; P.Z. drafted the original manuscript; M.Z. and Q.W. revised the manuscript for important intellectual content and provided clinical methodological guidance; H.L. supervised the entire research process and approved the final version for submission. All authors read and agreed to the published version of the manuscript.

References

1. Morioka, D., Nomura, M., Lan, L., Tanaka, R., & Kadomatsu, K. (2020). Axillary Osmidrosis: Past, Present, and Future. Annals of plastic surgery, 84(6), 722–728. https://doi.org/10.1097/SAP.0000000000002111
2. Ren, Y., Liu, W., Chen, J., Wang, J., Wang, K., Zhou, J., Cai, S., Zheng, M., Liu, J., Liu, L., & Xue, D. (2017). A missense variant of the ABCC11 gene is associated with Axillary Osmidrosis susceptibility and clinical phenotypes in the Chinese Han Population. Scientific reports, 7, 46335. https://doi.org/10.1038/srep46335
3. Shinaoka, A., Nakahara, R., & Saeki, M. (2021). The use of 33 MHz ultra-high-frequency ultrasonography for the evaluation of sweat glands in the axilla with osmidrosis. PloS one, 16(5), e0251600. https://doi.org/10.1371/journal.pone.0251600
4. Kubomura, K., Ogawa, R., Sasaki, N., Ichinose, S., Akaishi, S., & Kuwahara, H. (2022). Objective Odor Assessment in Patients with Osmidrosis. Plastic and reconstructive surgery. Global open, 10(10), e4622. https://doi.org/10.1097/GOX.0000000000004622
5. Malik, A. S., Porter, C. L., & Feldman, S. R. (2023). Bromhidrosis treatment modalities: A literature review. Journal of the American Academy of Dermatology, 89(1), 81–89. https://doi.org/10.1016/j.jaad.2021.01.030

6. Yao, Z., Zhu, J., Peng, M., Lei, B., Li, M., Yang, J., Tang, J., & Chang, D. (2025). Blunt Dissection of the Axillary Flap through Double Mini-Incisions on Both Sides of the Axilla to Prevent Postoperative Hematoma. Plastic and reconstructive surgery, 155(5), 923e–927e. https://doi.org/10.1097/PRS.0000000000011731
7. Lin, Y., He, Y., Woo, D. M., Chen, B., Zhu, X., Liu, J., & Chen, X. (2020). Tumescent Liposuction Combined with Power-Assisted Dermal Curettage Through Small Incisions for Axillary Osmidrosis. Aesthetic plastic surgery, 44(3), 849–854. https://doi.org/10.1007/s00266-020-01659-5
8. Hu, X., Chen, B., & Yang, D. (2018). Liposuction-assisted circumferential trimming in treatment of axillary osmidrosis (AO). The Journal of dermatological treatment, 29(7), 709–714. https://doi.org/10.1080/09546634.2018.1441486
9. Jihwaprani, M. C., Ismirahmadani, T. D., Sun, Y., Sayekti, A. W., Sula, I., & Saquib, N. (2024). Tolerability and efficacy of botulinum toxin injection in the treatment of bromhidrosis: a systematic review and meta-analysis of clinical trials. Acta dermatovenerologica Alpina, Pannonica, et Adriatica, 33(4), 179–187.
10. Chen, S. Q., Wang, T. T., Zhou, Y., Li, W., & Man, X. Y. (2022). Comparison of Long-Term Effectiveness and Safety of Microwave and Surgery in the Treatment of Axillary Osmidrosis: A Single-Center Retrospective Study. Dermatologic surgery : official publication for American Society for Dermatologic Surgery [et al.], 48(1), 126–130. https://doi.org/10.1097/DSS.0000000000003276
11. Zeng, J., Du, H., Zhang, Y., Tong, X., Gao, L., Xiang, Y., Tan, W., Zhou, L., Ding, S., & Lu, J. (2021). Efficacy of topical acidified aliphatic ester for treatment of axillary osmidrosis by rebalancing skin microecology. Dermatologic therapy, 34(2), e14844. https://doi.org/10.1111/dth.14844
12. Zhang, Y., Li, Y., Li, C., & Tian, J. (2024). Experience of negative pressure fractional microneedle radiofrequency therapy for axillary osmidrosis: a case study. Archives of dermatological research, 317(1), 66. https://doi.org/10.1007/s00403-024-03560-6
13. Xu, S., Shi, Y., Li, X., Yao, P., Zhang, Q., Xian, J., Liu, K., Liao, S., & Wu, Z. (2024). Negative pressure assisted rubbing suction technique for the treatment of axillary osmidrosis based on minimally invasive principle. Asian journal of surgery, S1015-9584(24)02419-9. Advance online publication. https://doi.org/10.1016/j.asjsur.2024.10.146
14. Han, J. H., Kim, J. K., Yoon, K. C., & Shin, H. W. (2018). Versajet-Assisted Hydraulic Epilation Through Small Incisions for Axillary Osmidrosis. Aesthetic plastic surgery, 42(3), 617–624. https://doi.org/10.1007/s00266-018-1097-y
15. Xia, L., He, M., Liu, X., Zhang, J., Chen, Y., & Zhang, J. (2025). A Retrospective Cohort Study Comparing the Clinical Outcomes of the Hydrosurgery System and Traditional Single-Incision Surgery for Axillary Osmidrosis. Journal of cosmetic dermatology, 24(1), e16755. https://doi.org/10.1111/jocd.16755
16. Liu, Q., Li, W., Wang, Z., Cao, R., Mao, J., & Zhao, Y. (2025). A Comparison of 3 Minimally Invasive Surgeries for Treating Axillary Osmidrosis. Annals of plastic surgery, 95(1), 29–32. https://doi.org/10.1097/SAP.0000000000004342

17. Wu, C. J., Chang, C. K., Wang, C. Y., Liao, Y. S., & Chen, S. G. (2019). Efficacy and Safety of Botulinum Toxin A in Axillary Bromhidrosis and Associated Histological Changes in Sweat Glands: A Prospective Randomized Double-Blind Side-by-Side Comparison Clinical Study. Dermatologic surgery : official publication for American Society for Dermatologic Surgery [et al.], 45(12), 1605–1609. https://doi.org/10.1097/DSS.0000000000001906
18. Lan, S., Zhao, Z., Wu, D., Zheng, C., Dong, X., & Zhang, K. (2022). Impact of Apocrine Gland Residue on Bromhidrosis Clinical Efficacy: A Self-controlled Case Series Study. Plastic and reconstructive surgery. Global open, 10(5), e4320. https://doi.org/10.1097/GOX.0000000000004320
19. Wang, Y., Sun, P., Leng, X., Dong, Z., Bi, M., & Chen, Z. (2019). A new type of surgery for the treatment of bromhidrosis. Medicine, 98(22), e15865. https://doi.org/10.1097/MD.0000000000015865
20. Zhang J, Han P, Yang F, Jiang B. Advances in the treatment of axillary bromhidrosis. Skin Res Technol. 2024 Aug;30(8):e13895. doi: 10.1111/srt.13895. PMID: 39096181; PMCID: PMC11297419.
21. Bechara FG, Sand M, Sand D, et al. Surgical treatment of axillary hyperhidrosis: a study comparing liposuction cannulas with a suction-curettage cannula. Ann Plast Surg. 2006;56:654-657
22. Wang, Y., & Xie, S. (2024). Intraoperative Hypertonic Saline Irrigation Preventing Seroma Formation in the Treatment of Axillary Bromhidrosis. Aesthetic plastic surgery, 48(17), 3216–3221. https://doi.org/10.1007/s00266-024-03987-2.
23. Wang, Y. H., Cheng, C. Y., Chang, S. L., Hu, S., & Huang, Y. L. (2023). A single session of high-energy microwave axillary hyperhidrosis and osmidrosis therapy: Key pretherapeutic assessment and outcome analysis. Lasers in surgery and medicine, 55(4), 372–377. https://doi.org/10.1002/lsm.23656
24. Shinaoka, A., Nakahara, R., & Saeki, M. (2021). The use of 33 MHz ultra-high-frequency ultrasonography for the evaluation of sweat glands in the axilla with osmidrosis. PloS one, 16(5), e0251600. https://doi.org/10.1371/journal.pone.0251600

Figures

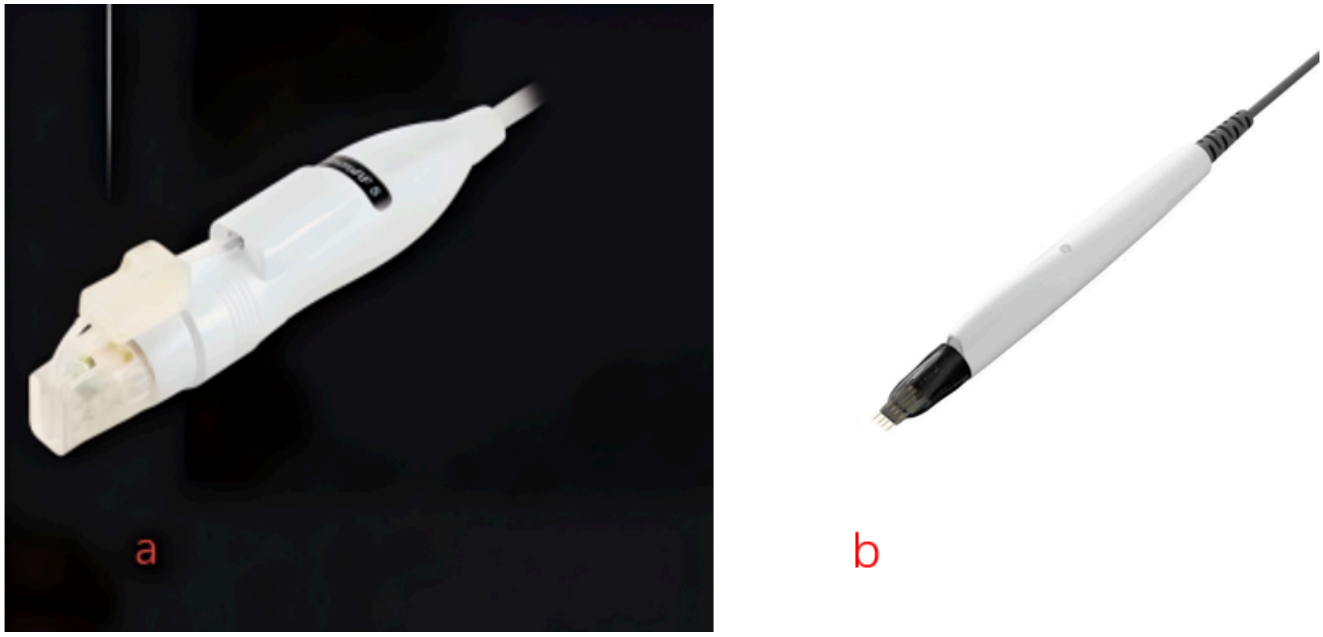


Figure 1

a,Negative Pressure Fractional Microneedling Radiofrequency,FMR；b,Modified Microneedle Radiofrequency；MMR

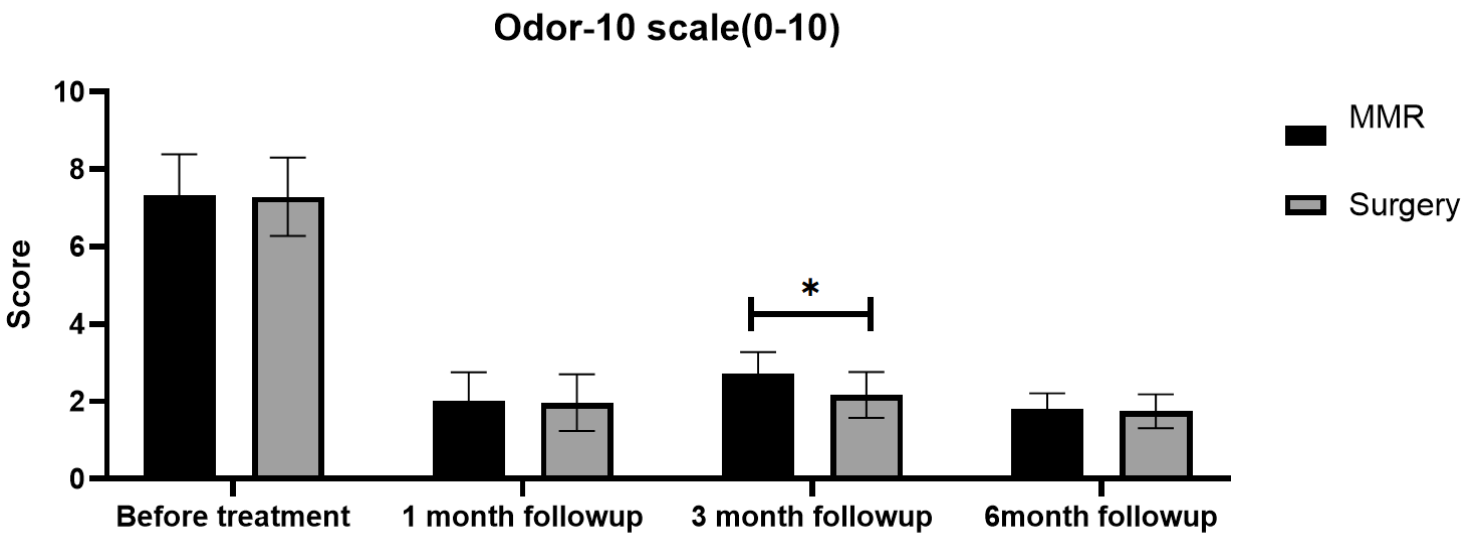


Figure 2

Odor-10 scale(0-10)

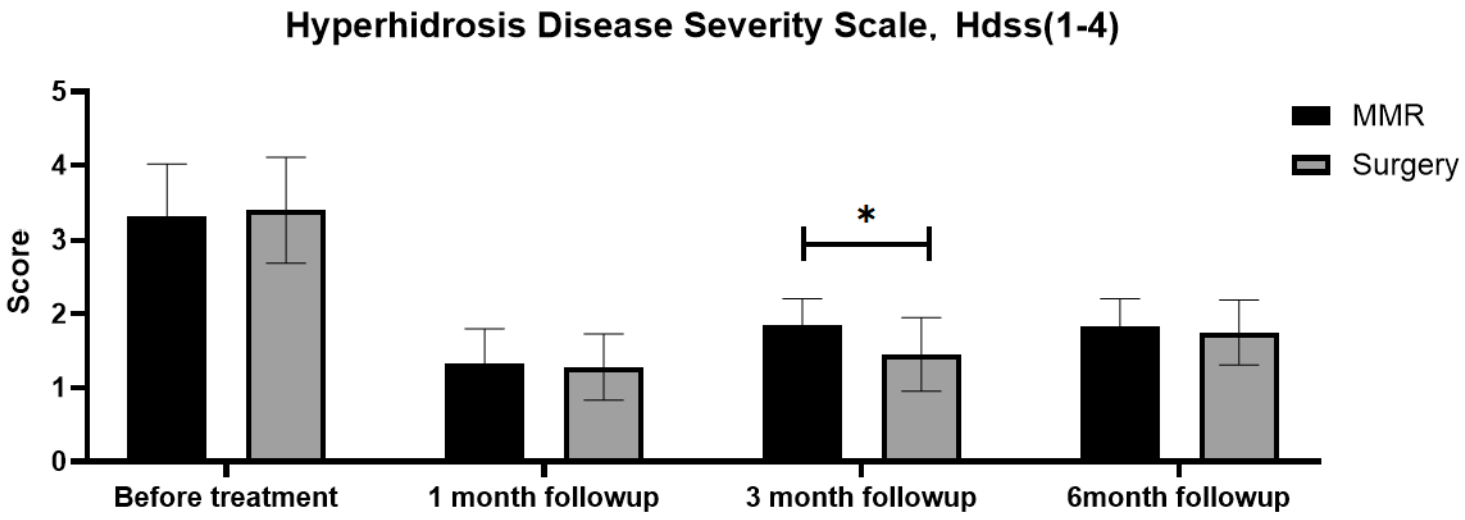


Figure 3

Hyperhidrosis Disease Severity Scale，Hdss(1-4)

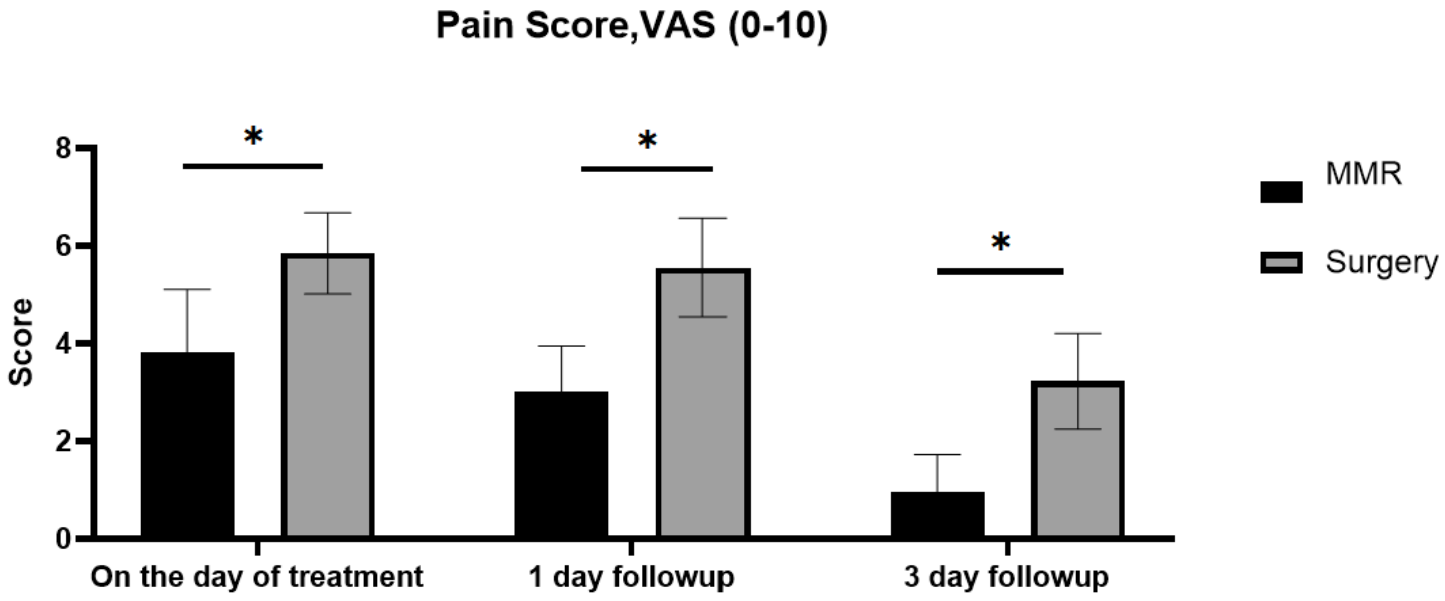


Figure 4

Pain Score,VAS (0-10)

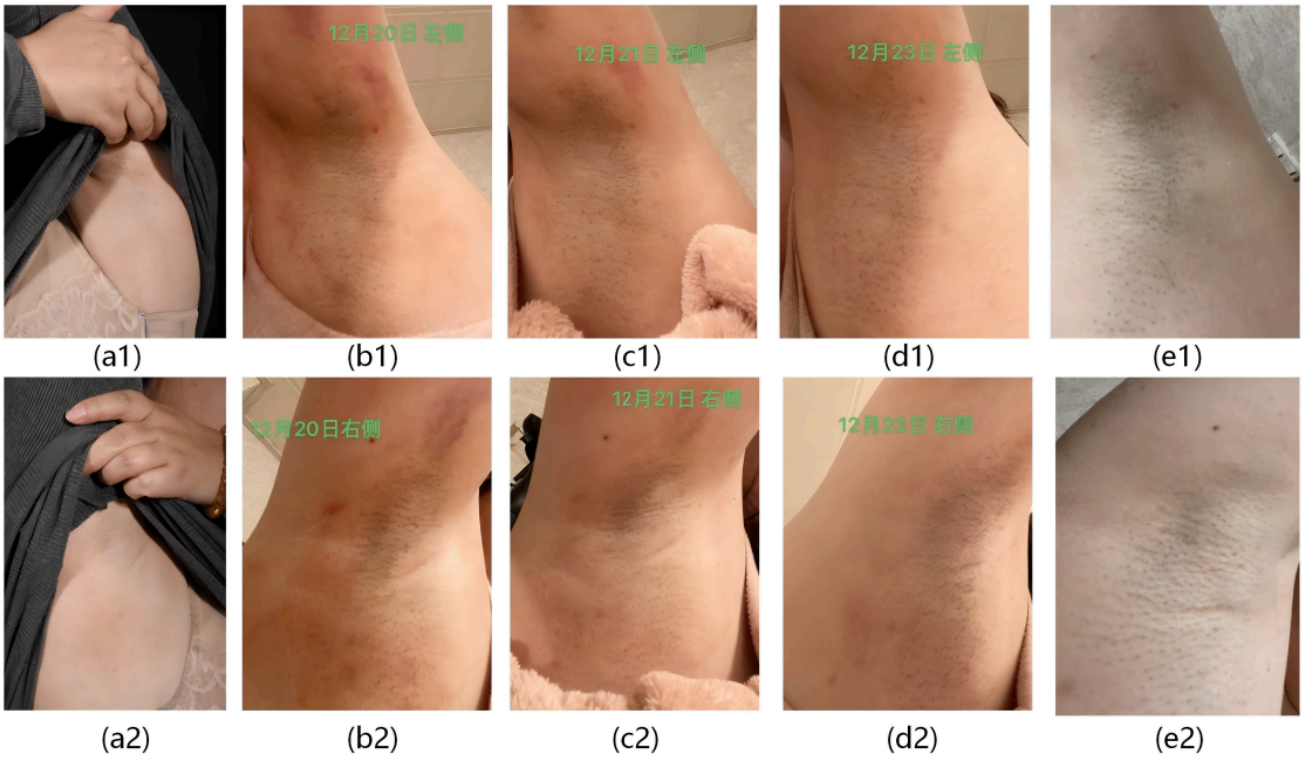


Figure 5

Case 1.(a1)(a2), The condition of both armpits before MMR treatment.(b1)(b2)The condition of both armpits on the night after MMR treatment.(c1)(c2),The condition of both armpits on the first day after MMR treatment.(d1)(d2),The condition of both armpits on the third day after MMR treatment.(e1)(e2),The condition of both armpits six months after MMR treatment.

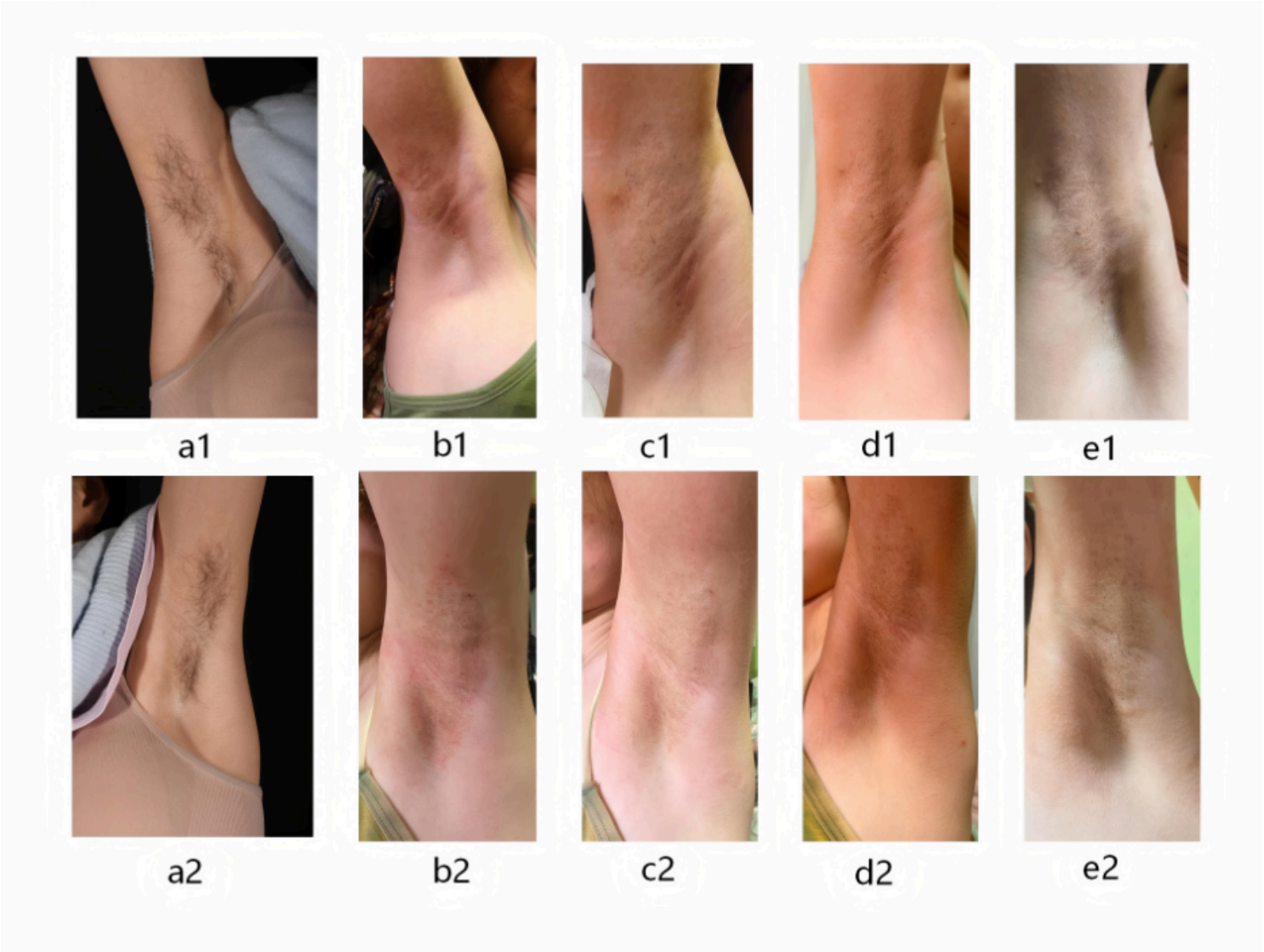


Figure 6

Case 2.(a1)(a2),The condition of both armpits before MMR treatment..(b1)(b2)The condition of both armpits on the night after MMR treatment.(c1)(c2),The condition of both armpits on the second day after MMR treatment.(d1)(d2),The condition of both armpits on the third day after MMR treatment.(e1)(e2),The condition of both armpits six months after MMR treatment.