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An Objective Assessment of Long-term Postoperative Hyperpigmentation in Patients With Apocrine Gland-eliminated Osmidrosis Surgery

Wen-Tsao Ho, MD

Background: Radical surgery is the best treatment for axillary osmidrosis to eliminate the apocrine glands. However, marked postoperative hyperpigmentation may occur. Clinicians need an objective skin pigmentation examination to identify and treat hyperpigmentation. In this study, we aimed to use the Taylor Hyperpigmentation Scale (an objective visual scale) for evaluating long-term hyperpigmentation after osmidrosis surgery.
Methods: Twenty female patients with Fitzpatrick skin type III–IV who had undergone osmidrosis surgery were included in this study.
Results: The findings demonstrated that although there is an initial variation in the intensity of hyperpigmentation, in the majority of patients, there is a peak in hyperpigmentation between the third and sixth months after surgery. This is then followed by a gradual decline over the ensuing months. Some patients resolve hyperpigmentation completely, suggesting reversibility.
Conclusions: These results can help guide patient expectations and provide suitable postoperative management, thereby improving patient satisfaction and overall quality of life. *(Plast Reconstr Surg Glob Open 2025; 13:e6424; doi: 10.1097/GOX.0000000000006424; Published online 10 January 2025.)*

INTRODUCTION

Axillary osmidrosis is characterized by a persistent, offensive odor resulting from bacterial decomposition of apocrine secretions in the axillae. The condition can markedly affect a person's quality of life.[1] Surgical procedures are the definitive treatment, with the goal of the complete removal of the glandular structures of the subcutaneous tissue and deep dermis.[2] However, a disadvantage is the potential for postoperative hyperpigmentation,[3,4] which can affect both physical appearance and psychological health.[5]

In Taiwan, the majority of people have Fitzpatrick skin type III–IV,[6] and thus, the distinct characteristics of postoperative hyperpigmentation require close observation and effective management. Importantly, postoperative hyperpigmentation is a particular concern among women,[7] emphasizing the need for comprehensive information on pigment changes. Obtaining objective evaluations of skin color and skin pigmentation is necessary for physicians diagnosing and treating patients with hyperpigmentation.[8] In this regard, an established visual scale, the Taylor Hyperpigmentation Scale, has been created to provide an inexpensive and convenient method to assess skin color and monitor changes of hyperpigmentation after treatment.[9] This standardized scoring system minimizes subjective bias, offers a precise evaluation of skin conditions, and provides an objective reference point.

In our practice, our surgical approach to osmidrosis surgery is to use manual scissors and, thus, prioritize skin health and aesthetics. To enhance postoperative care and patient satisfaction, the purpose of this study was to objectively assess postoperative hyperpigmentation using the Taylor Hyperpigmentation Scale in Taiwanese patients who underwent osmidrosis surgery.

METHODS

Study Design and Patients

We conducted a prospective, observational study at a single center involving 25 female patients with Fitzpatrick skin type III–IV who had undergone osmidrosis surgery between January 2022 and December 2022. Patients who developed complications such as scar tissue formation (n = 1) or chronic wound issues (n = 4) during the

From the Department of Dermatology, Ho Wen Tsao Skin Clinic, New Taipei City, Taiwan.

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observation period were excluded from the study. After exclusion, 20 patients were analyzed for postoperative pigmentation after 2 years. Assessments using the Taylor Hyperpigmentation Scale to evaluate pigment deposition were performed as baseline before surgery and at 2, 3, 6, 9, 12, 15, 18, 21, and 24 months postoperatively. All patients were instructed to refrain from using any oral or topical skin-lightening products or undergoing laser-based skin-lightening procedures during the 24-month follow-up period.

Ethical Statement

The institutional review board of the Chang Gung Medical Foundation approved the protocol of this study (approval no. 202200098B0), which adhered to the tenets of the 1975 Declaration of Helsinki, and signed informed consent was obtained from each included patient.

Surgical Procedure

All patients received a surgical procedure with manual scissors to eliminate apocrine glands. A detailed surgical procedure with 3 maneuvers was described in our previous study.[10]

Assessment of the Taylor Hyperpigmentation Scale

The Taylor Hyperpigmentation Scale ranges from 0 (no visible pigment deposition, similar to the patient's original skin tone) to 10 (severe pigment deposition). To facilitate the assessment, the scale was designed with a circular aperture in each hyperpigmentation band through which the skin can be viewed and thus compared with the scale.

To minimize interrater variability in appearance assessment, the same physician performed all evaluations using the Taylor Hyperpigmentation Scale. These methodological choices ensured rigorous and standardized assessments of postoperative pigment changes in patients who received osmidrosis surgery, thus contributing to the reliability and validity of the results.

Statistical Analysis

Comparisons of the Taylor Hyperpigmentation Scale score between 2 timepoints was performed with the Wilcoxon matched-pairs signed-rank test. A value of P less than 0.05 was considered to indicate a statistically significant difference. SPSS version 25.0 software (IBM Corp, NY) was used for all statistical analysis.

RESULTS

All 20 patients were women, with a median age of 27 years (range, 20–36 y) (Table 1). The pigmentation scores at different postoperative timepoints were assessed according to the Taylor Hyperpigmentation Scale (Fig. 1). Before surgery, they had a median pigmentation score of 0 (0–1) (Table 1; Fig. 2). As shown in Figure 2, a significant increase in pigmentation score emerged between the second and sixth months after surgery when compared with baseline (all $P < 0.05$), with median pigmentation scores of 0, 3, 3, and 2.5 at baseline, month 2, month 3, and month 6, respectively. During this period, the majority of patients experienced a peak in pigment deposition, resulting in scores ranging between 2 and 6, suggesting that a peak hyperpigmentation occurs between months 3 and 6 after surgery.

Takeaways

Question: Making very small incisions may sacrifice the clarity of view for surgeons, and minimally invasive incisions may not have the stretchability required to clear large areas.

Findings: The Taylor Hyperpigmentation Scale may be a potential option for evaluating long-term changes in postoperative scarring in patients with axillary osmidrosis after receiving a minimally invasive surgical procedure. Especially, male patients or those with high axial length of the operating plane are associated with a greater improvement in long-term postoperative scarring.

Meaning: This may help guide patient expectations before surgery and serve as a reference for screening patients.

Beyond the sixth month, a gradual reduction in pigment deposition scores was observed, with a median pigmentation score of 2.5 and 2 at months 6 and 9, respectively ($P = 0.020$). By the 12th month, most patients had achieved scores below 2 (the median pigmentation score at months 9 and 12 was 2 and 1; $P = 0.001$), indicating a more significant decline in hyperpigmentation. This gradual improvement over the course of a year suggests that postoperative hyperpigmentation tends to gradually decrease with time.

Subsequent follow-up visits provided further insights into the trajectory of hyperpigmentation changes. Pigment deposition scores continued to gradually decline, eventually reaching a median score of 0 at month 24. By 24 months after surgery, some patients achieved complete

Table 1. Patient Ages and Baseline Taylor Hyperpigmentation Scale Scores

Patient	Age, y	Taylor Hyperpigmentation Scale Score
1	26	0
2	35	0
3	28	1
4	36	0
5	21	0
6	29	0
7	26	0
8	24	0
9	21	0
10	21	0
11	30	0
12	20	0
13	21	0
14	32	1
15	31	1
16	26	0
17	27	0
18	27	0
19	33	0
20	31	0

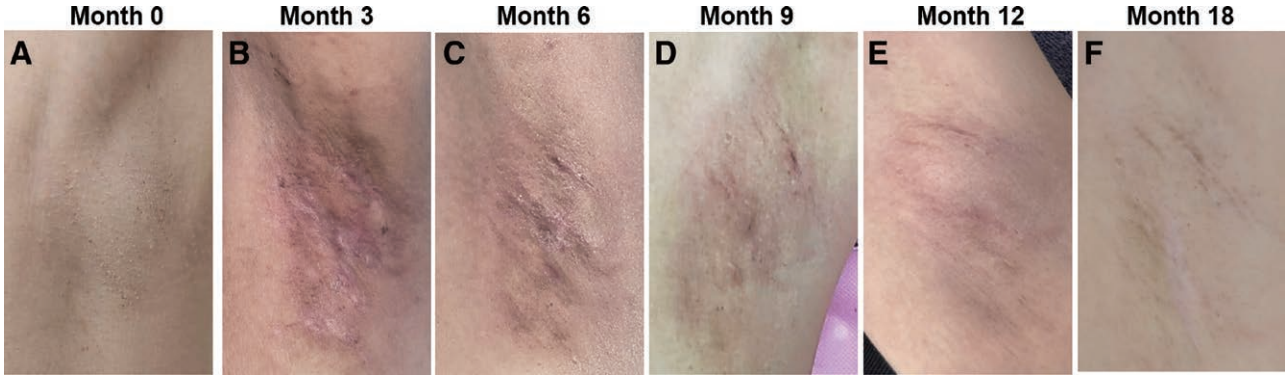

Fig. 1. Clinical photographs of patient 2. A, Baseline. B, Three months postoperative. C, Six months postoperative. D, Nine months postoperative. E, Twelve months postoperative. F, Eighteen months postoperative. At 3 or 6 months postoperative, a significant pigmentation in the skin flap was observed as compared with baseline, with the pigmentation score of 0, 4, and 3 at baseline, 3, and 6 months, respectively. At 9, 12, and 18 months postoperative, a gradual improvement in the pigmentation of the skin flap can be observed, with a pigmentation score of 2, 1, and 0, respectively.

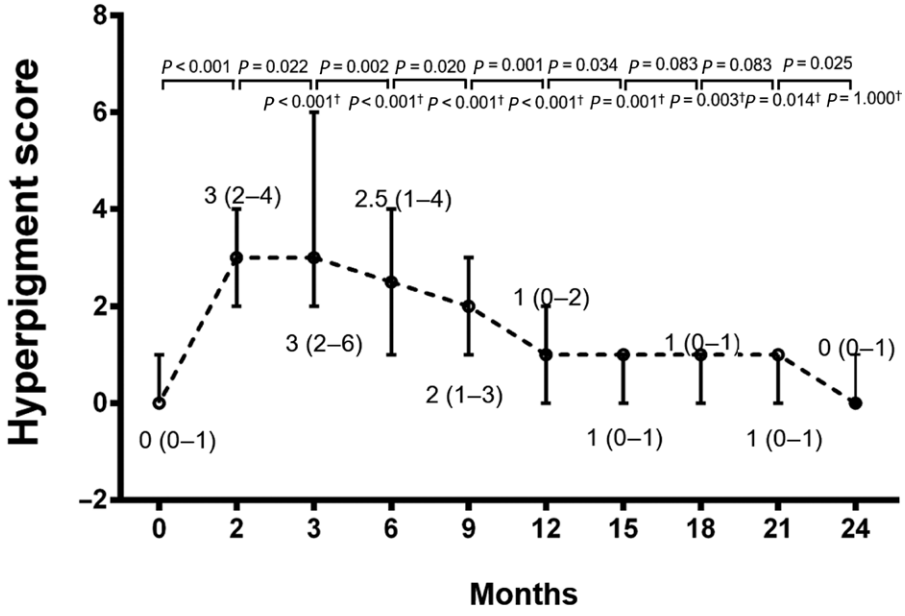

Fig. 2. A plot of the Taylor Hyperpigmentation Scale scores before and after surgery. †*P* value as compared with baseline.

recovery with no discernible hyperpigmentation. This finding underscores the potential that postoperative hyperpigmentation can be reversible, with continued decline and complete recovery.

One notable observation was the variability in hyperpigmentation severity among patients. The highest recorded pigment deposition score was 6, an outlier observed in a single patient during the third month after surgery. This emphasizes the wide range of hyperpigmentation among different patients.

DISCUSSION

The findings of this study provide valuable insights into the dynamics of postoperative hyperpigmentation after osmidrosis surgery. The results showed that there is a distinct temporal pattern in postoperative hyperpigmentation after osmidrosis surgery. Although variability exists in initial severity, most patients experience a peak in hyperpigmentation between the third and sixth months after surgery, followed by a gradual reduction up to 24 months. Ultimately, some patients achieve complete recovery, indicating that the hyperpigmentation is reversible. These findings are important for managing patient concerns and misconceptions and providing appropriate care in the postoperative period, which can enhance their satisfaction and quality of life.

Hyperpigmentation commonly affects dark-skinned individuals and is often challenging to treat. Disorders of hyperpigmentation have been demonstrated to have a negative effect on quality of life[11] and physical and psychological health.[5] The observed variability in

hyperpigmentation severity in this study underscores the importance of patient education. It is crucial to communicate to patients that postoperative hyperpigmentation is a common occurrence and typically follows a discernible pattern. The Taylor Hyperpigmentation Scale has been used in studies of patients with facial pigmentary disorders[12] and the repair of burn wounds,[13] and in patients who undergo osmidrosis surgery, it provides an objective and quantifiable measure to aid patients in understanding the expected progression of hyperpigmentation after surgery. To our knowledge, this is the first study to determine the progression of hyperpigmentation after osmidrosis surgery. Patients can take solace in the knowledge that pigment changes are a part of the healing process, and need not cause undue distress.

Although our study focused on a homogenous group of patients, it is important to acknowledge that individual characteristics may influence the course of hyperpigmentation. Patients with pre-existing conditions such as vitiligo or psoriasis, which exhibit the Koebner phenomenon, may experience unique challenges, as the Koebner phenomenon results in the formation of new psoriatic lesions.[14] Recently, the association between vitiligo and metabolic syndrome has attracted the attention of researchers, and it has been shown that vitiligo has systemic manifestations in addition to affecting the skin.[15] In addition, vitiligo greatly affects psychosocial well-being and is associated with depression[16] and anxiety.[17]

The use of lasers or skin-whitening products to treat hyperpigmentation is a topic of debate.[18] Although such interventions may have a role in managing hyperpigmentation, they must be used with caution. The risk of creating mottled pigmentation patterns should be considered, and the energy levels of lasers should be kept low to minimize dermal damage.[19] The potential benefits of oral supplements such as tranexamic acid and vitamin C in managing postoperative hyperpigmentation are promising.[18,20] Although further clinical evidence is needed to definitively establish their effectiveness, their safety profile suggests they can be used as part of postoperative care.

A previous study highlighted the potential influence of wound care and surgical techniques on postoperative hyperpigmentation.[21] Infections and chronic wounds can exacerbate hyperpigmentation,[22] emphasizing the importance of rigorous wound care.[23] In particular, our surgical approach, which uses manual scissors, seems to yield favorable outcomes with respect to postoperative hyperpigmentation and reduced dermal damage during 24 months follow-up. This warrants further investigation and comparison with other surgical approaches (eg, rotary cutters) in future research.

The study's major limitation is that it was a retrospective study at a single center with a relatively small sample size. Therefore, it still remains necessary to carry out large-scale, multicenter, and prospective studies to confirm the results of the present study. This study included 20 patients and offers valuable insights into postoperative hyperpigmentation. Nevertheless, a further investigation including case studies that track pigmentation changes over more than 24 months may be a benefit to determine this association in the present study.

CONCLUSIONS

The results of this study underscore the importance of patient education, individualized care, and cautious intervention for managing postoperative hyperpigmentation in the future after osmidrosis surgery. The use of the Taylor Hyperpigmentation Scale aids in setting realistic patient expectations and provides a framework for discussing the evolution of hyperpigmentation and helping patients understand the postoperative changes. Future research with larger numbers of patients and studies comparing surgical techniques will further enhance our understanding and refinement of postoperative care protocols for patients with osmidrosis.

Wen-Tsao Ho, MD
Department of Dermatology
Ho Wen Tsao Skin Clinic
179 F, Sector 2, Wenhua 3rd Road, Linkou District
New Taipei City 244, Taiwan
E-mail: derm.administration@gmail.com;
varec.clinic@gmail.com

DISCLOSURE

The author has no financial interest to declare in relation to the content of this article.

REFERENCES

1. Zhang L, Chen F, Kong J, et al. The curative effect of liposuction curettage in the treatment of bromhidrosis: a meta-analysis. *Medicine (Baltim).* 2017;96:e7844.
2. Bechara FG, Sand M, Hoffmann K, et al. Histological and clinical findings in different surgical strategies for focal axillary hyperhidrosis. *Dermatol Surg.* 2008;34:1001–1009; discussion 1009.
3. Lee ET. Shortening of incision by "pinch and turn-over technique" in the treatment of axillary osmidrosis. *Aesthetic Plast Surg.* 2019;43:267–277.
4. Wu M, Dai H, Zhu J, et al. An innovative technique of hydrosurgery in the treatment of osmidrosis. *J Dermatolog Treat.* 2021;32:328–333.
5. Dabas G, Vinay K, Parsad D, et al. Psychological disturbances in patients with pigmentary disorders: a cross-sectional study. *J Eur Acad Dermatol Venereol.* 2020;34:392–399.
6. Chen YA, Lee JY. Clinicopathologic study of solar dermatitis, a pinpoint papular variant of polymorphous light eruption in Taiwan, and review of the literature. *J Formos Med Assoc.* 2013;112:125–130.
7. Dijkema SJ, van der Lei B. Long-term results of upper lips treated for rhytides with carbon dioxide laser. *Plast Reconstr Surg.* 2005;115:1731–1735.
8. Stulberg DL, Clark N, Tovey D. Common hyperpigmentation disorders in adults: Part I. Diagnostic approach, cafe au lait macules, diffuse hyperpigmentation, sun exposure, and phototoxic reactions. *Am Fam Physician.* 2003;68:1955–1960.
9. Taylor SC, Arsonnaud S, Czernielewski J; Hyperpigmentation Scale Study Group. The Taylor Hyperpigmentation Scale: a new visual assessment tool for the evaluation of skin color and pigmentation. *Cutis.* 2005;76:270–274.
10. Ho WT. Minimally invasive removal of apocrine glands: a study of 100 cases using three maneuvers with blunt scissors. *J Surg Case Rep.* 2023;2023:rjad337.

11. Stratigos AJ, Katsambas AD. Optimal management of recalcitrant disorders of hyperpigmentation in dark-skinned patients. *Am J Clin Dermatol*. 2004;5:161–168.
12. Molinar VE, Taylor SC, Pandya AG. What's new in objective assessment and treatment of facial hyperpigmentation? *Dermatol Clin*. 2014;32:123–135.
13. Zhong C, Liang G, Li P, et al. Inflammatory response: the target for treating hyperpigmentation during the repair of a burn wound. *Front Immunol*. 2023;14:1009137.
14. Ji YZ, Liu SR. Koebner phenomenon leading to the formation of new psoriatic lesions: evidences and mechanisms. *Biosci Rep*. 2019;39:BSR20193266.
15. Sharma YK, Bansal P, Menon S, et al. Metabolic syndrome in vitiligo patients among a semi-urban Maharashtrian population: a case control study. *Diabetes Metab Syndr*. 2017;11: S77–S80.
16. Wang G, Qiu D, Yang H, et al. The prevalence and odds of depression in patients with vitiligo: a meta-analysis. *J Eur Acad Dermatol Venereol*. 2018;32:1343–1351.
17. Kussainova A, Kassym L, Akhmetova A, et al. Vitiligo and anxiety: a systematic review and meta-analysis. *PLoS One*. 2020;15:e0241445.
18. Nautiyal A, Wairkar S. Management of hyperpigmentation: current treatments and emerging therapies. *Pigment Cell Melanoma Res*. 2021;34:1000–1014.
19. Arora P, Sarkar R, Garg VK, et al. Lasers for treatment of melasma and post-inflammatory hyperpigmentation. *J Cutan Aesthet Surg*. 2012;5:93–103.
20. Ravetti S, Clemente C, Brignone S, et al. Ascorbic acid in skin health. *Cosmetics*. 2019;6:58.
21. Li D, Lin SB, Cheng B. Complications and posttreatment care following invasive laser skin resurfacing: a review. *J Cosmet Laser Ther*. 2018;20:168–178.
22. Shi C, Wang C, Liu H, et al. Selection of appropriate wound dressing for various wounds. *Front Bioeng Biotechnol*. 2020;8:182.
23. Johnson J, Johnson AR, Jr, Andersen CA, et al. Skin pigmentation impacts the clinical diagnosis of wound infection: imaging of bacterial burden to overcome diagnostic limitations. *J Racial Ethn Health Disparities*. 2024;11:1045–1055.