Journal of Lasers in Medical Sciences

J Lasers Med Sci 2023;14:e71

Original Article

http://journals.sbmu.ac.ir/jlms

doi 10.34172/jlms.2023.71

The Efficacy of Long-Pulsed, 1064-nm Nd:YAG Laser Versus Aluminum Chloride 20% Solution in the Treatment of Axillary Hyperhidrosis

Mehdi Gheisari[1,2], Reza M Robati[1,2], Zahra Hassanzadeh Tabatabaei[3], Tara Barat[4*]

[1]Skin Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2]Departement of Dermatology, Loghman Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[3]Laser Application in Medical Sciences Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[4]Proteomics Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran

***Correspondence to**
Tara Barat,
Email: Dr_t_barat@yahoo.com

Received: October 19, 2023
Accepted: December 10, 2023
ePublished: December 29, 2023

Abstract

Introduction: Hyperhidrosis (HH) refers to uncontrollable excessive sweating that has a significant negative impact on the quality of life. The aim of this study was to compare the efficacy and safety of the long-pulsed, 1064-nm Nd:YAG laser and aluminum chloride ($ALCL_3$) 20% solution in axillary HH treatment.

Methods: In this single-center, within-patient comparison clinical trial, 12 patients with axillary HH were treated monthly for 3 to 4 consecutive sessions with the long-pulsed, 1064-nm Nd:YAG laser system on one axilla, while the contralateral axilla was treated with $ALCL_3$ 20 % by the patient. Treatment response was evaluated by comparing the area of sweating at the end of each session and 6 months after treatment termination using the iodine starch test.

Results: Both treatments led to the reduction of HH from baseline with the mean area of sweating reduced from 109.3 ± 36.6 to 38.3 ± 19.8 and from 92.5 ± 31.6 to 35.6 ± 17.1 in laser- and $ALCL_3$-treated axilla respectively (Both $P<0.001$). In the 6-month follow-up, the area of sweating was 60.6 ± 29.2 in the laser-treated armpit and 78.3 ± 23.6 in the $ALCL_3$-treated side, which were 45% and 14.4% lower compared to the baseline respectively. Adverse events were temporary, and none caused each of the treatments to be discontinued.

Conclusion: The long-pulsed, 1064-nm Nd:YAG laser with hair reduction setting can stand as a potential therapeutic option for axillary HH since it is as effective as $ALCL_3$. The therapeutic effect is superior in the long term for the laser; nevertheless, the beneficial effect of both treatments may lessen the following treatment cessation.

Keywords: Nd:YAG laser; Aluminum chloride; Axillary hyperhidrosis.

Introduction

Sweating is an essential process for regulating normal body temperature. A healthy person produces an average of about 0.5 L of sweat per day.[1] Hyperhidrosis (HH) refers to the excessive production of sweat that is not justified in the field of body temperature regulation process, and it disrupts a person's daily activities and impairs his typical function.[2]

The most affected areas in primary HH are those with a higher density of eccrine glands, such as the armpits, palms, soles, and face.[3] The current first-line standard treatment for HH is topical aluminum chloride ($ALCL_3$) hexahydrate antiperspirant (10%-20%).[4] However, in case of shortcomings, other treatments are available, such as anticholinergics,[5] attenuated botulinum toxin injections,[6] microwave technology,[6] and surgery.[7] Nevertheless, current treatments are frequently unsatisfactory as they may be transient, have partial efficacy or systemic side effects, or in the case of surgery, may be associated with significant morbidity. This has created an increasing need for the development of new and effective therapies for controlling excessive sweating.[4]

Laser therapy is a more recent method that has been investigated for the treatment of HH. To date, little research has been done on the specific effect of hair removal lasers on the eccrine gland function and sweating process, and the results are divergent.[8] While some studies have reported HH following laser hair removal,[9] others have indicated a reduction in sweating following hair epilation.[8]

The long-pulsed Nd:YAG laser has been utilized to treat various skin diseases such as vascular lesions,[10] scars,[11] skin rejuvenation,[12] and infections including acral warts[13] or onychomycosis,[14] although it is commonly used for hair

Please cite this article as follows: Gheisari M, Robati RM, Hassanzadeh Tabatabaei Z, Barat T. The efficacy of long-pulsed, 1064-nm Nd:YAG laser versus aluminum chloride 20% solution in the treatment of axillary hyperhidrosis. *J Lasers Med Sci*. 2023;14:e71. doi:10.34172/jlms.2023.71.

removal as it targets the melanin chromophore within the hair follicle. The long-pulsed Nd:YAG lasers have recently been utilized to treat HH due to the potentially damaging effect of heat generated in hair follicles on adjacent germinative structures such as surrounding sweat glands.[8]

In this study, we compare the treatment consequences of the long-pulsed Nd:YAG laser and topical $ALCL_3$ on primary axillary HH to provide an overview of the welfare and adverse events of both treatment modalities.

Methods

Participants

The study was designed as a single-center, within-patient comparison clinical trial, in which 12 patients above 18 years old were enrolled. Key inclusion criteria were at least 6 months of visible, detectable, focal, exaggerated axillary sweating without any apparent explanation, with a bilateral and rather symmetrical distribution, that interferes with daily activities. Patients should never have undergone any surgical or sweat gland destructive treatment for their HH or any injection or medication in the past six months. Participants signed an informed consent form to clarify their understanding of the requirements and consequences of participation in the study. The main exclusion criteria included current or planned pregnancy, lactation, having any concomitant disease (e.g., hyperthyroidism, Parkinson's disease, and lymphoma), or using medication (e.g., adrenomimetic agents and cholinesterase inhibitors) that would be associated with HH.

Pre-treatment Proceedings and Treatment Protocol

The patients were evaluated by a dermatologist and their demographic data was recorded. Then, one armpit was randomly assigned to the laser treatment and the other to the $ALCL_3$ 20% solution.

The patients were treated monthly for 3 to 4 consecutive sessions with the long-pulsed, 1064-nm Nd:YAG laser system (Hyperion; Laseroptek Co., Korea) on one axilla. The laser parameters were adjusted for hair reduction, which included power of 30 J/cm^2, pulse duration of 30 ms, spot size of 18 mm, and frequency of 1 Hz, along with air cooling. The contralateral axilla was treated with $ALCL_3$ 20% as follows: The patients were given a pre-prepared $ALCL_3$ 20% solution and instructed to wash and dry the area before application. The medicine was applied to the area with a cotton ball at bedtime and was left for 6 to 8 hours. The area was washed thoroughly upon waking up. The procedure was repeated every night for about 2 weeks (until clinical improvement) and then 3 times a week.

Treatment Evaluation

The iodine starch test was used to map the areas of perspiration, and the painted areas were photographed. Before the examination, the patients were instructed to rest for 15 minutes. The skin area was thoroughly cleaned with soaked gauze and then dried. Both axillary regions were painted with a 2% iodine alcohol solution. The area was left to be dyed for 5 minutes and then a starch powder was lightly dusted on the skin area using a cosmetic brush. After 15 minutes, transparent graph paper was placed over the painted area, and the area of sweating was marked and measured. This test was performed before, at the end of, and 6 months after the last laser session. Treatment response was categorized as mild (decrease in sweating by 0-25%), moderate (decrease in sweating by 25-50%), good (decrease in sweating by 50-70%), and excellent (decrease in sweating by 75-100%). The participants were asked about their satisfaction with each treatment and possible side effects at each monthly laser session and 6 months after the end of the treatment.

Statistical Analysis

Statistical analysis was performed using SPSS version 24, and the *P* value less than 0.05 was considered statistically significant. The normality test was done with Shapiro-Wilks. The continuous variables were described with mean ± standard deviation (SD) and the categorical variables with frequency (percentage).

The independent sample t-test, paired t-test and chi-square test were done for comparing variables.

Results

Twelve primary axillary HH patients with a mean age of 36.6 ± 9.5 (23-52) years were enrolled in the study. Seven (58.3%) of the patients were women and 5 (41.7%) of them were men. The skin type in 7 (58.3%) patients was III; it was IV in 3 (33.3%) patients, and it was V in 1 (8.3%) patient. Treatment results are shown in Table 1. Both treatments led to a reduction in HH from baseline with the mean area of sweating reduced from 109.3 ± 36.6 to 38.3 ± 19.8 and from 92.5 ± 31.6 to 35.6 ± 17.1 in laser and $ALCL_3$-treated axilla respectively (Both $P < 0.001$).

The mean reductions of the sweating area from baseline in the laser-treated axilla and in the $ALCL_3$-treated armpit were 71.1 ± 29.7 and 56.9 ± 34.3 respectively, but this difference was not statistically significant between the treatment groups. In a 6-month follow-up, the areas of sweating were 60.6 ± 29.2 in the laser-treated armpit and 78.3 ± 23.6 in the $ALCL_3$-treated site, which were 45% and 14.4% lower compared to the baseline respectively (*P* value = 0.11).

Treatment response in the laser-treated area was excellent in 4 (33%), good in 6 (50%), and moderate in 2 (17%) cases, while the response rate for the $ALCL_3$-treated armpit was excellent in 3 (25%), good in 5 (42%), moderate in 3 (25%) and mild in 1 (8%) patient (*P* value = 0.698). All participants were satisfied with both

Table 1. Comparisons of the Average Surface of the Axillary Sweating and Response Rate Based on the Iodine Starch Test at Baseline, End of the Treatment, and 6-Month Follow-up

		$ALCL_3$-Treated Axilla	Laser-Treated Axilla	*P* value
Average surface of axillary sweating (Mean ± SD)	Baseline	92.5 ± 31.6	109.3 ± 36.6	0.241
	End of the treatment	35.6 ± 17.1	38.3 ± 19.8	0.733
	6-month Follow-up	78.3 ± 23.6	60.6 ± 29.2	0.118
	P value	< 0.001	< 0.001	

treatments. Adverse events reported by the patients were temporary and mild, and none of the adverse events caused the discontinuation of each of the treatments (Table 2). However, two patients in the $ALCL_3$-treated site needed short-term use of topical corticosteroids to alleviate the irritation symptoms.

Table 2. Adverse Events After the use of $ALCL_3$ and Long-Pulsed Nd:YAG Laser for Axillary Hyperhidrosis

	$ALCL_3$	Long-Pulsed Nd:YAG Laser
Pain during application	2 (16.6%)	11 (91.6%)
Irritation	7 (58.3%)	3 (25%)
Itching	8 (66.7%)	2 (16.6%)
Hair reduction	0 (0)	12 (100%)

Discussion

Topical solutions comprising $ALCL_3$ are well-known to be the first-line treatment for HH. The mechanism suggested for their therapeutic effect is the mechanical obstruction of the opening of sweat glands.[15] However, widening of acinar lumina along with atrophy and other structural changes of the eccrine gland secretory cells are other possible mechanisms.[16] In a survey done by Glent-Madsen and Dahl, 64 out of 65 patients achieved excellent control of axillary HH with the application of 20% $ALCL_3$ in ethanol. [17] In another study by Flanagan and Glaser, 21 out of 29 (72%) patients with moderate to severe primary axillary HH achieved a Hyperhidrosis Disease Severity Score < 2 and were designated as responders following the application of 15% $ALCL_3$ in 2% salicylic acid gel base.[18] In line with these findings, $ALCL_3$ was proved to be an effective treatment for axillary HH in our study. Three patients (25%) had an excellent response by more than 75% reduction in axillary sweating, and another five (42%) experienced more than 50% decrease in perspiration (Table 1).

Despite the effectiveness of $ALCL_3$ preparations, recurrence following the cessation of the treatment and irritation are two important drawbacks. In one study, 36% of the patients reported moderate irritation and 14% experienced severe irritation.[19] In our study, seven (58%) patients reported mild to moderate stinging following its application, although only two (16%) patients needed topical corticosteroids to relieve their symptoms. Nevertheless, the reappearance of sweating following treatment termination was a remarkable point with the area of sweating increasing from 35.6 ± 17.1 to 78.3 ± 23.6 after a 6-month follow-up. This is compatible with previous studies that expressed the fact that although $ALCL_3$ is an effective treatment, there is a need for repeated use to maintain the therapeutic effect. Although not statistically significant, the long-pulsed Nd:YAG laser had a greater and more durable therapeutic effect than $ALCL_3$ on axillary HH. Ten patients (88%) experienced a good to excellent response by more than 50% reduction in sweating from baseline in the laser-treated site, and the mean area of perspiration decreased from 109.3 ± 36.6 to 38.27 ± 19.8 by the end of the treatment. Although the therapeutic effect diminished after 6 months, it was still superior to $ALCL_3$ with the area of sweating reduced by 45% and 14.4% from baseline for laser- and $ALCL_3$-treated sites, respectively (Figures 1 and 2). Overall, the participants were satisfied with the outcome of both treatments. The most common adverse effect following long-pulsed Nd:YAG laser treatment was pain experienced by almost all patients during the laser procedure. Although all patients continued the treatment, four of them (33.3%) described it to be severe and hard to bear. Other adverse events were transient and tolerated well by the patients. Evidence for the laser treatment of axillary HH is scarce in the literature and has been derived from a few studies with small sample sizes and power.[8] There are theories regarding the effect of hair removal lasers on sweating, although the actual mechanism of action remains ambiguous. The fact that the apocrine glands in the armpit are placed close to the hair follicles and might be partially damaged by hair removal laser treatment led to the theory of their use for the treatment of HH.[20] The long-pulsed, 1064-nm Nd:YAG laser has been of particular interest among laser-assisted hair removal systems due to its high safety profile and acceptable efficacy. Data regarding the effect of hair removal laser on sweating is controversial. In a study conducted by Aydin et al,[9] persistent axillary HH occurred following hair removal with the long-pulsed, 1064-nm Nd:YAG laser. In their survey, two mechanisms claimed to be responsible for the hyperfunction of sweat gland, decreasing melanocyte-stimulating hormone and stimulation of nerve fibers due to the thermal effect of the long-pulsed Nd:YAG laser.

On the contrary, in a study by Goldman and Wollina,[21] the subdermal use of long-pulsed, 1064-nm Nd:YAG laser in axillary HH resulted in a significant clinical

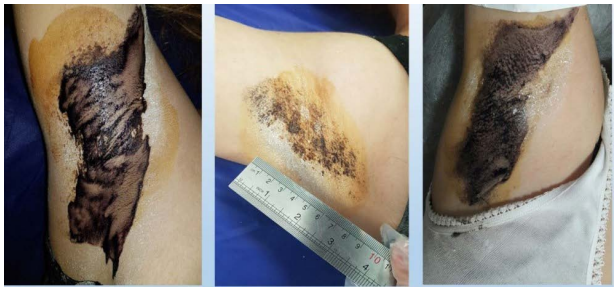

Figure 1. Area of Sweating at Baseline (a), After 4-Month Use of ALCL3 (b) and After 6-Month Follow-up (c) Based on the Iodine Starch Test

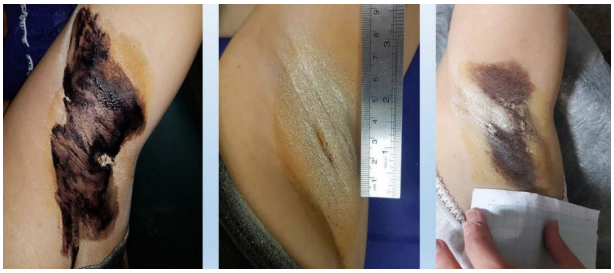

Figure 2. Area of Sweating at Baseline (a), at the End of the Treatment With the Nd:YAG Laser (b) and After 6-Month Follow-up (c) Based on the Iodine Starch Test

improvement, and histological examination revealed a variety of structural changes from mild microvesiculation to the destruction of the eccrine glands. Goldman and Wollina claimed that induction of plasma formation and thermal heating are two main modes of action.

In another prospective case-control study of the long-pulsed Nd:YAG 1064-nm laser, utilizing a modified starch iodine test showed an improvement at 9 months; however, no histologic changes were seen before and after laser treatment.[22] This led to the conclusion that the mechanism of action is impaired sympathetic cholinergic transmission in the axilla prompted by laser heating.[22]

There were some limitations to our study. None of the patients volunteered to perform a biopsy in order to compare the microscopic effects of each treatment on axillary sweat glands. In addition, the lack of statistically significant differences between treatments may be due to the small number of participants in this study, so further studies with a greater number of cases might be needed to evaluate the clinical relevance of these findings.

Conclusion

Our findings may assist in the recognition of potential alternative therapeutic options for axillary HH. This study indicates that the long-pulsed, 1064-nm Nd:YAG laser with a hair reduction setting is as effective as $ALCL_3$ in the treatment of axillary HH, with even superior results in the long term. The therapeutic effect may lessen following treatment cessation; nevertheless, along with hair removal, patients still benefit from an overall reduction in sweating from the baseline.

Acknowledgements

Financial and material support for this survey was provided by the Skin Research Center, Shahid Beheshti University of Medical Sciences.

Authors' Contribution

Conceptualization: Mehdi Gheisari.
Data curation: Tara Barat, Zahra Hassanzadeh Tabatabaei.
Funding acquisition: Reza M Robati.
Investigation: Mehdi Gheisari, Tara Barat, Zahra Hassanzadeh Tabatabaei.
Methodology: Mehdi Gheisari, Reza M Robati.
Project administration: Mehdi Gheisari, Reza M Robati.
Supervision: Mehdi Gheisari, Reza M Robati.
Writing–original draft: Tara Barat.
Writing–review & editing: Mehdi Gheisari, Reza M Robati.

Competing Interests

None.

Ethical Approval

The protocol of this trial was approved by the ethics committee of Shahid Beheshti University of Medical Sciences (Ethical Approval Code IR.SBMU.SRC.REC.1397.018)

The protocol of this trial was approved by the ethics committee of Shahid Beheshti University of Medical Sciences (Ethical Approval Code IR.SBMU.SRC.REC.1397.018) and was registered at the Iranian Registry of Clinical Trials. identifier: IRCT20190212042683N2. (https://www.irct.ir/search/result?query=IRCT20190212042683N2).

Funding

None.

References

1. Hurley HJ. The eccrine sweat glands: structure and function. In: Freinkel RK, Woodley DT, eds. The Biology of the Skin. New York: Parthenon Publishing; 2001. p. 47-76.
2. Doolittle J, Walker P, Mills T, Thurston J. Hyperhidrosis: an update on prevalence and severity in the United States. Arch Dermatol Res. 2016;308(10):743-749. doi:10.1007/s00403-016-1697-9
3. Altman RS, Schwartz RA. Emotionally induced hyperhidrosis. Cutis. 2002;69(5):336-338.
4. Singh S, Davis H, Wilson P. Axillary hyperhidrosis: a review of the extent of the problem and treatment modalities. Surgeon. 2015;13(5):279-285. doi:10.1016/j.surge.2015.03.003
5. Cruddas L, Baker DM. Treatment of primary hyperhidrosis with oral anticholinergic medications: a systematic review. J Eur Acad Dermatol Venereol. 2017;31(6):952-963. doi:10.1111/jdv.14081
6. Vergilis-Kalner IJ. Same-patient prospective comparison of Botox versus Dysport for the treatment of primary axillary hyperhidrosis and review of literature. J Drugs Dermatol. 2011;10(9):1013-1015.
7. Nasr MW, Jabbour SF, Haber RN, Kechichian EG, El Hachem L. Comparison of microwave ablation, botulinum toxin injection, and liposuction-curettage in the treatment of axillary hyperhidrosis: a systematic review. J Cosmet Laser Ther. 2017;19(1):36-42. doi:10.1080/14764172.2016.1248438
8. Cervantes J, Perper M, Eber AE, Fertig RM, Tsatalis JP, Nouri K. Laser treatment of primary axillary hyperhidrosis: a review of the literature. Lasers Med Sci. 2018;33(3):675-681. doi:10.1007/s10103-017-2434-0
9. Aydin F, Pancar GS, Senturk N, et al. Axillary hair removal with 1064-nm Nd:YAG laser increases sweat production.

Clin Exp Dermatol. 2010;35(6):588-592. doi:10.1111/j.1365-2230.2009.03638.x
10. Groot D, Rao J, Johnston P, Nakatsui T. Algorithm for using a long-pulsed Nd:YAG laser in the treatment of deep cutaneous vascular lesions. Dermatol Surg. 2003;29(1):35-42. doi:10.1046/j.1524-4725.2003.29016.x
11. Akaishi S, Koike S, Dohi T, Kobe K, Hyakusoku H, Ogawa R. Nd:YAG laser treatment of keloids and hypertrophic scars. Eplasty. 2012;12:e1.
12. Chiba C, Usui A, Hara H, Ishi Y. Clinical experience in skin rejuvenation treatment in Asians using a long-pulse Nd:YAG laser. J Cosmet Laser Ther. 2009;11(3):134-138. doi:10.1080/14764170903137634
13. Gheisari M, Iranmanesh B, Nobari NN, Amani M. Comparison of long-pulsed Nd: YAG laser with cryotherapy in treatment of acral warts. Lasers Med Sci. 2019;34(2):397-403. doi:10.1007/s10103-018-2613-7
14. Zhang RN, Wang DK, Zhuo FL, Duan XH, Zhang XY, Zhao JY. Long-pulse Nd:YAG 1064-nm laser treatment for onychomycosis. Chin Med J (Engl). 2012;125(18):3288-3291.
15. Goh CL. Aluminum chloride hexahydrate versus palmar hyperhidrosis. Evaporimeter assessment. Int J Dermatol. 1990;29(5):368-370. doi:10.1111/j.1365-4362.1990.tb04766.x
16. Holzle E, Kligman AM. Mechanism of antiperspirant action of aluminum salts. J Soc Cosmet Chem. 1979;30(5):279-295.
17. Glent-Madsen L, Dahl JC. Axillary hyperhidrosis. Local treatment with aluminium-chloride hexahydrate 25% in absolute ethanol with and without supplementary treatment with triethanolamine. Acta Derm Venereol. 1988;68(1):87-89.
18. Flanagan KH, Glaser DA. An open-label trial of the efficacy of 15% aluminum chloride in 2% salicylic acid gel base in the treatment of moderate-to-severe primary axillary hyperhidrosis. J Drugs Dermatol. 2009;8(5):477-480.
19. Rayner CR, Ritchie ID, Stark GP. Axillary hyperhidrosis, 20% aluminum chloride hexahydrate, and surgery. Br Med J. 1980;280(6224):1168. doi:10.1136/bmj.280.6224.1168
20. Caplin D, Austin J. Clinical evaluation and quantitative analysis of axillary hyperhidrosis treated with a unique targeted laser energy delivery method with 1-year follow up. J Drugs Dermatol. 2014;13(4):449-456.
21. Goldman A, Wollina U. Subdermal Nd-YAG laser for axillary hyperhidrosis. Dermatol Surg. 2008;34(6):756-762. doi:10.1111/j.1524-4725.2008.34143.x
22. Letada PR, Landers JT, Uebelhoer NS, Shumaker PR. Treatment of focal axillary hyperhidrosis using a long-pulsed Nd:YAG 1064 nm laser at hair reduction settings. J Drugs Dermatol. 2012;11(1):59-63.