Subdermal Nd-YAG Laser for Axillary Hyperhidrosis

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BACKGROUND Axillary hyperhidrosis is a common but difficult-to-treat condition with major social, labor, and emotional consequences.

OBJECTIVE The aim of this study is to present the Nd-YAG laser as a safe and effective option for the treatment of axillary hyperhidrosis.

MATERIALS AND METHODS From January 2002 to April 2007, 17 patients (15 women and 2 men) with axillary hyperhidrosis were treated using a subdermal 1,064-nm Nd-YAG laser. The results were evaluated by the patients as well as by the physician. The objective evaluation was realized by Minor's iodine starch test combined with planimetry. Histology was performed in axillary skin after the laser treatment.

RESULTS The subdermal laser-assisted axillary hyperhidrosis treatment using a 1,064-nm Nd-YAG laser resulted in significant clinical improvement.

CONCLUSIONS The treatment of axillary hyperhidrosis using the 1,064-nm Nd-YAG laser has the advantage of a minor invasive procedure without leaving large scars and causing temporary impairment. The laser proved to be effective and safe. Although the laser treatment has shown promising results in this pilot trial, further studies are necessary for final conclusions.

The authors have indicated no significant interest with commercial supporters.

Axillary hyperhidrosis is the consequence of a sudomotoric dysregulation. Recent statistics show that the prevalence of axillary hyperhidrosis in the U.S. population is 1.4%, representing more than 4 million individuals. This condition affects approximately 50% of the individuals with hyperhidrosis. One-third of the patients suffering from this condition indicate that their sweating is difficult to tolerate and frequently interferes in their daily activities or is intolerable and always interferes in their daily activities. Axillary hyperhidrosis has a strong negative impact on different domains of quality of life. It often interferes with patient's daily activities with occupational, emotional, social, and physical implications.[1,2]

Different treatments have been described to improve this condition. Topical antiperspirants such as acids, aldehydes, and metal salts; iontophoresis; botulinum toxin injections; anticholinergic and other drugs; surgeries; curettage; liposuction; and open or endoscopic sympathectomy represent some of the main treatment options. Each treatment presents advantages and limitations and, so far, there is no ideal option. Among the surgical methods, minimal skin excision combined with subcutaneous curettage is the gold standard in many countries, yet a major disadvantage of this method is the formation of scars and other adverse effects. Suction curettage in tumescent anesthesia is a less invasive method although the number of recurrences is higher.[3] Sympathectomy has been reported to cause compensatory hyperhidrosis in up to 90% of patients.[4,5] This highlights the need for further improvement of surgical treatments for the more severe cases.

There are only a few publications on laser therapy of glandular axillary disorders. Recently, Klöpper and coworkers[6] published their experience in laser-assisted suction of axillary sweat glands. Kim and colleagues[7] showed the use of the CO_2 laser in axillary osmidrosis, and Park and colleagues[8] reported good

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results in osmidrosis treatment with the use of the carbon dioxide laser to vaporize sweat glands while in direct contact with the dermis, using an inverted flap. Kunachak and coworkers[9] related their experience with a frequency-double Q-switched Nd-YAG laser in the treatment of bromidrosis in an engaging article where the laser is described to have acted directly on the skin. Ichikawa and coworkers[10] also recently published an article using the same device to treat osmidrosis. The treatment of bromidrosis (osmidrosis) using the 1,064-nm Nd-YAG laser is effectively another interesting indication because this condition has a strong relationship with the bacterial population usually present in hypersecretion.[11,12] The decrease in the bacterial population will lead to the consequent decrease in malodor.

Material and Methods

Seventeen patients with axillary hyperhidrosis (15 women and 2 men) aged between 17 and 54 years were treated with a 1,064-nm Nd-YAG laser at Clinica Goldman de Cirurgia Plastica, in Porto Alegre, Brazil (Table 1). Axillary hyperhidrosis has been defined as visible, excessive, bilateral sweating in the axillary region, which has lasted for at least 6 months without a secondary cause. Impairment of daily activities, cessation of sweating during sleep, and a positive Minor starch test were additional criteria.

Patients with previous surgical treatment such as axillary gland excision, liposuction, sympathectomy, or subcutaneous curettage were excluded from the study. All underwent a preoperative assessment to determine their general medical condition and provided informed consent. In every patient, Minor's iodine starch test[13] was performed immediately before the procedure to determine the area to be treated as well as to verify asymmetries and in the follow-up at least 8 weeks later. This test represents a semiquantitative measure and defines the extent of the hyperhidrosis area. A 5% iodine solution is applied to the axilla and allowed to dry, and then starch is brushed on the area. The starch–iodine combination turns a dark blue color wherever there is excess sweat. All tests were photographed.

TABLE 1. Demographics of Patients

Number of subjects	17
Average age (range), years	29.2 (17–54)
Males	2
Females	15
Follow-up	12 to 43 months

The laser system used in this study was a pulsed 1,064-nm Nd-YAG system (Smartlipo, DEKA, Florence, Italy). In this procedure, the laser energy is conducted to the subcutaneous tissue through a 300-μm fiber optic delivered through an 18-gauge Tuohy disposable epidural needle (Perican 18 gauge × 3.25 in., B. Braun, Sao Gonçalo, Brazil). A 100-μs pulsed laser at 40 Hz of frequency and 15 mJ of energy (working at 6 W) was used for all patients. The total accumulated energy used in each axilla ranged from 7,000 to 20,000 J/cm^2 depending on skin phototype, sweating intensity, and dimension of the treated area. The most relevant parameter that could represent the end point to the laser action seems to be the overcoming of resistance of the needle in its movement against the tissue. Other important parameters are the dimension of the affected area, intensity of the sweating, and the total accumulated energy. These parameters showed the best results in the author's experience and must be adjusted according to each situation.

The tip of the fiber optic is extended 2 mm beyond the end of the needle. This epidural needle has a smooth curve in its extremity to guide the laser beam in an angle of approximately 30°, aiming at reaching the dermal/subdermal junction where the sweat glands are located. For visualization purposes, a Helium-Neon laser source is combined into the beam path providing an exact view of where the laser is working because the positioning of the cannula is highlighted via transillumination by a red guiding beam. A crisscross manner probably optimizes the complete laser action in the affected area.

Patients were placed in a supine position with the arms abducted approximately 90°. All procedures were performed on an ambulatory basis under local anesthesia and with or without sedation according to patient desire and tolerance to the treatment. In practically all cases an anesthesiologist was present in the surgical room. Preoperative sedation (midazolam) was used for anxious patients, although the procedure is usually well tolerated and results in little discomfort. The procedure was performed with a subcutaneous infiltration of Klein's solution (0.05%–0.1% lidocaine, 1:1,000 epinephrine, 10 mEq/L sodium bicarbonate are added to each liter of normal saline). The total volume injected per axilla ranged from 30 to 200 cm^3. The injection may be delivered using syringes or infusion pumps. The procedure was initiated following a 20-minute delay, allowing diffusion of the infiltrate and appropriate vasoconstriction. One or more 1-mm incisions were made in the axillary crease, whenever possible 3 cm from the treated area. After assuring adequate eye protection for the patient and the entire team, the needle was inserted through the incision and consequently subcutaneous tunnels were created. The needle with the 1,064-nm Nd-YAG laser moved in the tissue with its curvature in direct contact with the dermis (Figures 1 and 2). Furthermore, the tip of the needle is to be elevated, thereby acting against the subdermal layer and reaching the sweat glands. It is important to move the needle slowly (approximately 1–2 cm/second). The treated area is usually extended 3 cm from the area determined by the test to affect some extra sweat glands located around the demarcated region.

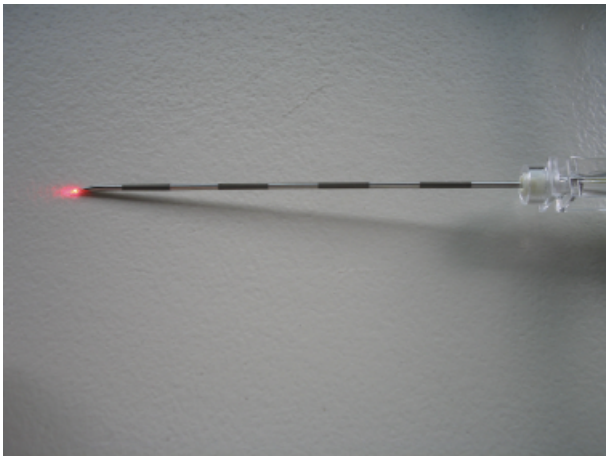

Figure 1. 1-mm needle (Touhy) containing fiber optic extended approximately 2 mm from the distal end and emitting laser energy.

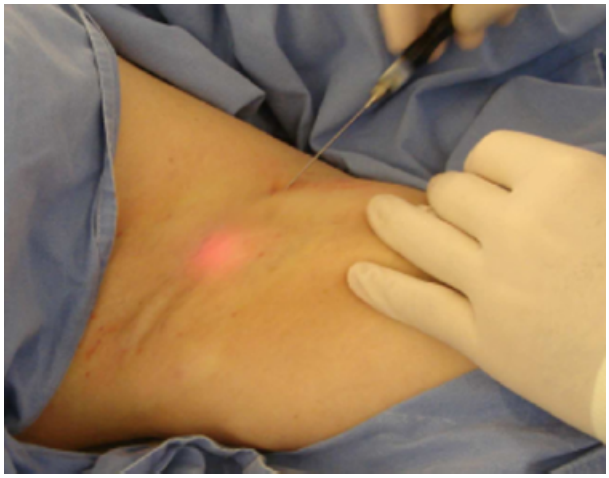

Figure 2. Subdermal laser acting on the axillary region and the transillumination effect due to the red helium–neon laser. The incision was placed in a natural axillary fold.

The procedure was then repeated on the other side. The entire procedure took about 30 minutes. Before, during, and immediately after the treatment, a cold gel dressing or air cooling system was applied so as to minimize the postoperative edema or discomfort and to decrease the possibility of damage or skin burning. With the consent of the patients, biopsies were taken from some subjects before and after the surgery. A small nonadherent and noncompressive dressing was applied for 24 hours postprocedure.

Patient's global assessment classified the outcome in four categories: poor (limited or with no improvement), fair (marked improvement in the sweating but occasionally noticeable and intolerable to the patient), good (significant improvement of the symptoms, minimal sweating, well tolerated by the patient), and excellent (no sweating).

Physicians classified the results by means of pre- and postsurgery photographs. A grid pattern was applied

over the photos and used to quantify improvement. The classification was based on the percentage of hyperhidrosis area reduction: poor—improvement from 0% to 25%, fair—from 26% to 50%, good—from 51% to 75%, and excellent—over 75%. The follow-up was made by physical exam on a regular basis for a period ranging from 12 to 43 months. Patients were evaluated every 3 months.

The results were analyzed using paired Student's *t*-test. A p value of $<5\%$ was considered to be statistically significant.

Results

The major outcome was the reduction of hyperhidrotic activity. The mean area of sweating could be reduced from 63 ± 15 to $15 \pm 18\,cm^2$. Table 2 provides a summary of the results. Histologic examination of specimens from some treated areas showed microvesiculation, decapitation and dilatation of eccrine glands after laser treatment (Figures 3–6).

Patient's global assessment showed an excellent result in 12 cases (70.6%) and a good result in 3 cases (17.6%), and 2 patients reported fair results (11.8%). No patient reported poor results.

Physician's global assessment was excellent in 10 patients (58.8%), good in 4 patients (23.5%), and fair in 3 patients (17.6%) resulting in 82.3% of good or better outcome (Tables 2 and 3).

Adverse effects were limited, transient, and mild (Table 3). The postoperative period was well tolerated in all patients, without significant discomfort or pain. Edema lasted up to 1 week in some subjects. In one case there was a small burn on the skin incision probably corresponding to a technical error due to the fact that the footswitch was not released when the cannula was removed from the skin. With the use of an antibiotic ointment, the lesion healed completely in 1 week. One patient presented with small bilateral seroma treated by an aspiration using an 18-gauge needle. No serious complications such as bleeding, damage to axillary plexus, or deeper structures were noted.

TABLE 2. Improvement of Axillary Hyperhidrosis According to Minor's Iodine Starch Test

Poor	0 (0%)
Fair	3 (17.64%)
Good	4 (23.52%)
Excellent	10 (58.82%)

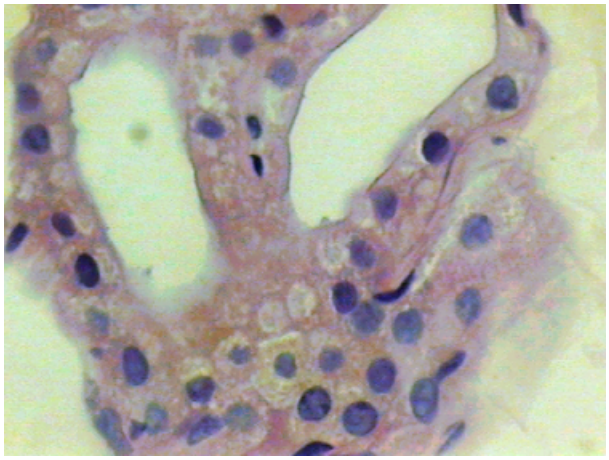

Figure 3. Histology showing ectoplasmatic microvesiculations (hematoxylin–eosin, × 300).

Of the 17 patients treated, 1 relapsed with axillary hyperhidrosis and required an additional laser treatment to the same area. All other subjects

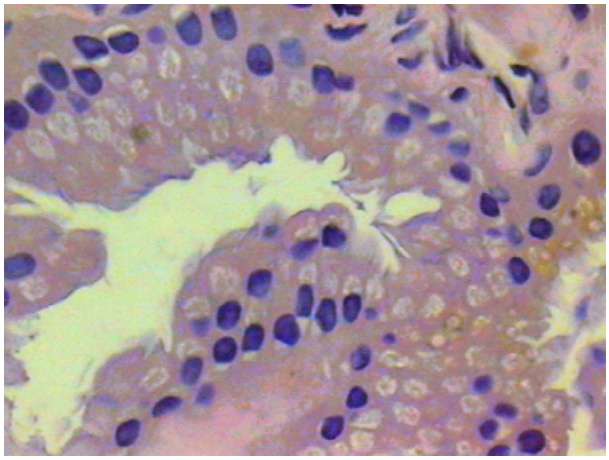

Figure 4. Histology showing ectoplasmatic microvesiculations (hematoxylin–eosin, × 300).

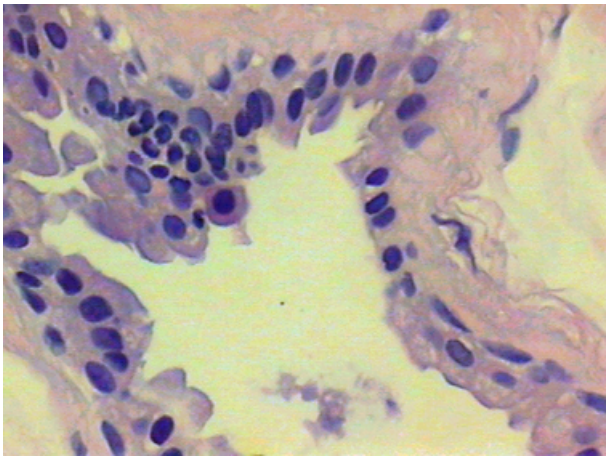

Figure 5. Sweat gland cellular decapitation and dilatation (hematoxylin–eosin, ×300).

remained asymptomatic during the follow-up period (Figures 7 and 8 and Table 4). Postoperative scarring was inconspicuous and usually located in a natural crease.

During follow-up a temporary decline in the sensitivity of the treated area was reported by all patients. The decreased sensitivity lasted about 3 to 5 weeks and gradually returned to normal parameters. No nerve injuries, bruises, or other major skin complications were reported by the patients or observed by the physicians. Temporary hair reduction was observed in eight patients (47.0%).

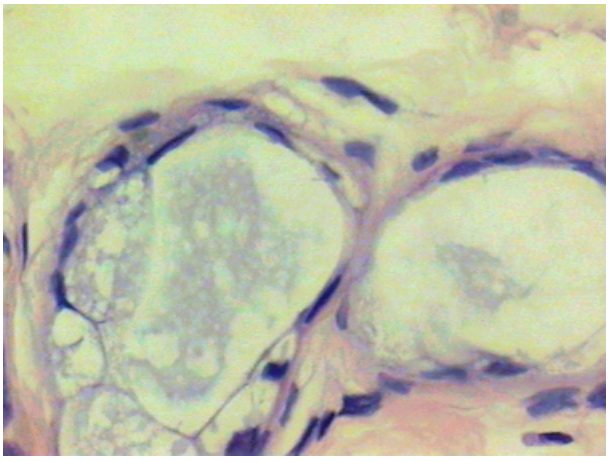

Figure 6. Histologic examination of specimens showed necrosis and the collapse of eccrine glands after the use of the laser (hematoxylin–eosin, ×300).

TABLE 3. Adverse Effects

Burns	1 (5.88%)
Seroma	1 (5.88%)
Relapse	1 (5.88%)
Temporary hair reduction after one session	8 (47.05%)

Discussion

Axillary hyperhidrosis is a common and distressing problem involving the increased production of sweat. Surgical options of treatment include the removal of axillary tissue by minor skin excision and subcutaneous curettage, liposuction curettage, and endoscopic sympathectomy. The potential risks of complication and side effects are common to all surgical procedures.

The technique described in this study uses the physical principle of the laser–tissue interaction. Unlike other techniques, the luminous energy acts directly on the anatomical location of the sudoriparous glands. Acting subdermally and not transcutaneously, the laser reaches its target directly, without the necessity of transdermal energy conduction. The way in which the energy is transmitted to the tissue, i.e., through a micro–spinal needle, offers the surgeon a direct and complete knowledge of where the laser beam is acting and thus decreases the possibility of cutaneous lesions. The laser light is conveyed through a disposable Tuohy epidural needle with a

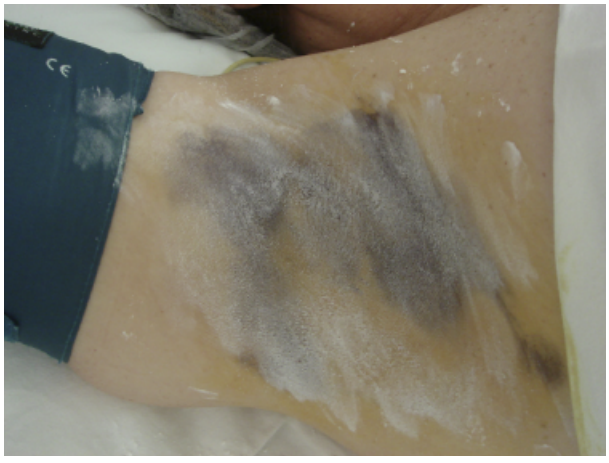

Figure 7. Minor iodine starch test before treatment.

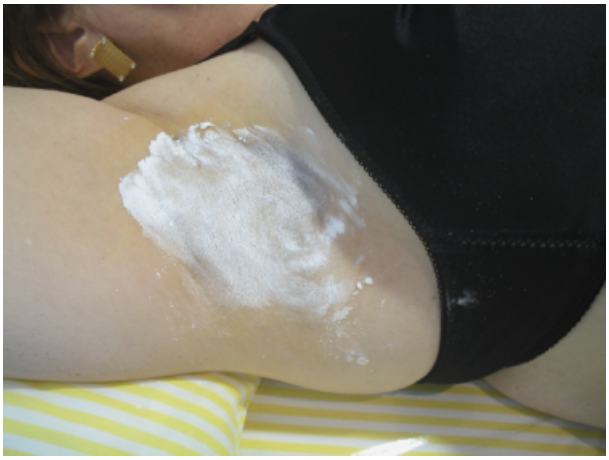

Figure 8. Minor iodine starch test 10 months after a single treatment session using a 1,064-nm Nd-YAG laser.

diameter of 1.3 mm into which an optical fiber of only 300 μm is inserted. Several studies have shown lipolytic activities, coagulation, and neocollagen formation in subcutaneous and dermal tissue.[14–22]

The pulsed 1,064-nm Nd-YAG laser offers two modes of action that might be of relevance in hyperhidrosis treatment, i.e., thermal heating and optomechanical effects by induction of plasma formation. Conducted by a flexible fiber optic delivered through a small needle, the laser energy beam comes very close to the target structures, the eccrine coils. Histologic examination shows a variety of mild to more pronounced alterations of the eccrine glands, from microvesiculation and decapitation to complete vaporization (Figures 3–6). By heating, the surrounding nerve fibers will be altered as well, also contributing to the clinical effect. With a cooling system throughout the procedure, collateral damage is limited.

TABLE 4. Follow-up

Patient	*Asymptomatic Period (in Months)*
1	5*
2	18
3	24
4	15
5	12
6	43
7	18
8	33
9	20
10	18
11	14
12	18
13	12
14	12
15	27
16	18
17	36

*Relapse.

The outcome was promising in this pilot trial with 82.3% of results scored good or better by Physician's Global Assessment (PGA). The adverse effects were mild and temporary. Scarring, which is a major concern in the traditional surgical techniques, was no problem. Compensatory hyperhidrosis was not observed and the relapse rate was low compared to suction curettage.

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