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Editor's Choice

Microwave Thermolysis Reduces Generalized and Social Anxiety in Young Adults With Axillary Hyperhidrosis

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Background and Objective: Hyperhidrosis (HH) is associated with impairments in quality of life (QOL) and elevated anxiety. Microwave thermolysis is a newer treatment that reduces sweating, yet effects on QOL and emotional symptoms have not been examined. Two treatment sessions are recommended to achieve 80% amelioration of clinical HH. We hypothesized that microwave thermolysis would reduce sweat severity, improve QOL, and reduce anxiety in young adults suffering from axillary HH in a prospective clinical trial.

Study Design/Materials and Methods: We enrolled 24 young adults (mean age = 23.57 years, 54% female) with elevated scores on the Hyperhidrosis Disease Severity Scale. All participants received one session of microwave thermolysis, and 83% received two sessions. Participants completed measures of sweat severity, QOL, generalized anxiety, social anxiety, social avoidance, and anxious/depressive mood symptoms at baseline; post-first treatment; and following second treatment.

Results: At baseline, all participants had severe sweating; 87.5% had impaired QOL, 75% had elevated social anxiety, 50% with generalized anxiety, 48% with social avoidance, and 38% with anxious/depressed mood. Paired samples t tests indicated significant improvements from baseline to first procedure, including decreased sweating ($t(21) = 5.68$, $P < 0.001$), improved QOL ($t(23) = 4.97$, $P < 0.001$), and decreased generalized anxiety ($t(23) = 8.11$, $P < 0.001$), social anxiety ($t(22) = 4.55$, $P < 0.001$), mood symptoms ($t(21) = 3.81$, $P = 0.001$), and social avoidance ($t(22) = 3.12$, $P = 0.005$). After second treatment, further improvements were noted in sweating ($t(18) = 3.28$, $P = 0.004$) and QOL ($t(18) = 3.83$, $P = 0.003$), and a marginal trend for generalized anxiety ($t(19) = 1.96$, $P = 0.064$).

Conclusion: There were significant improvements in sweat severity, skin-specific QOL, generalized anxiety, social anxiety, anxious/depressive symptoms, and social avoidance. The majority of the psychosocial benefit appears to emerge after one treatment of microwave thermolysis, whereas the level of sweat severity and QOL continued to show further improvements after a second treatment. Results would suggest that although two microwave thermolysis sessions are needed for maximal treatment optimization of axillary HH, patients may experience significant benefits in improving psychosocial functioning after just one session. Lasers Surg. Med.

Key words: microwave thermolysis; social anxiety; hyperhidrosis; psychosocial; generalized anxiety

INTRODUCTION

Hyperhidrosis is a physical condition of sweat production that exceeds physiological regulatory needs [1]. Prevalence has been recently estimated at nearly 9% among young adults ages 18–39 years old, with an overall prevalence of 4.8% in the United States [2]. Underarms are the most commonly reported site of bothersome hyperhidrosis, with 65% of patients in one study who reported axillary hyperhidrosis either in isolation or in combination with other common sites of excessive sweating (e.g., hands, feet, head/face, chest/breasts, back) [2]. The majority of individuals with hyperhidrosis report

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impairments in quality of life (QOL), with feelings of embarrassment and anxiety being the prominent negative features that contribute to social disruption.

Due to the preponderance of social anxiety and negative emotional states among individuals with hyperhidrosis, several studies have examined the effects of treatments to reduce sweat production on psychosocial functioning. Sympathectomy has been associated with improved QOL [3-6], reduced social stress and anxiety [6-9], reduced psychiatric medication prescriptions [10], and decreased depressive symptoms [6,8]. Botulinum toxin treatment has likewise been shown to improve QOL [11], reduce social anxiety [12], and decrease negative mood states of anxiety and depression [11,13].

Microwave thermolysis represents a newer approach to reducing axillary sweating [14]. Microwave thermolysis works by using a handheld device to emit microwave energy that targets the dermal–hypodermal interface of the axillary skin where both the eccrine and apocrine glands reside. The dermal/epidermal layer of the skin has a higher velocity and absorption of microwaves than the deeper adipose layer, so that much of the microwave energy when it reaches the adipose tissue is reflected at the dermal–hypodermal interface. This creates a zone of constructive interference that maximizes thermal damage in that area and promotes cellular thermolysis of the sweat glands. This process seems to be independent of skin thickness, and the sweat glands do not regenerate [15]. There is a small but growing literature, which has documented the efficacy in reducing sweat production in the axilla following thermolysis with an early, prospective randomized trial showing approximately 80% self-reported sweat reduction on the Hyperhidrosis Disease Severity Scale (HDSS) after two treatments [15]. This treatment paradigm of two microwave thermolysis sessions has now become the gold standard with other studies validating this approach [16,17], with one study even finding decreased impairments in QOL [16]. However, no known studies have examined the effects of thermolysis on psychosocial outcomes, including generalized anxiety, social anxiety, and social isolation.

In a prospective, single cohort study, we examined the effects of microwave thermolysis, as a treatment for axillary hyperhidrosis, on the psychosocial functioning of young adults. We hypothesized that microwave treatment would produce reductions in patient-reported sweat symptoms, and in turn, this may lead to decreases in skin-specific QOL impairments, and to reductions in patient-reported psychological functioning. In particular, we hypothesized that indices of social anxiety, generalized anxiety, and social isolation would reflect significant improvements after microwave thermolysis treatment for axillary hyperhidrosis.

MATERIALS AND METHODS

Inclusion criteria included age between 18 and 29 years old at the time of enrollment, clinical exam by a physician to diagnose axillary hyperhidrosis, and self-reported hyperhidrosis severity denoted by a score of 3 or 4 on the HDSS [18]. Subjects were recruited using web-based advertisements, and the clinical trial was listed on Clinicaltrial.gov website (NCT02295891). The study was approved by the Johns Hopkins Internal Review Board. There were 24 participants diagnosed with axillary hyperhidrosis who satisfied the inclusion criteria. All participants signed informed consent. Participants completed questionnaires prior to first microwave treatment (baseline), after first treatment (Time 1), and approximately 6–12 months follow-up after the first treatment (Time 2).

Microwave thermolysis was delivered using the Miramar MiraDry© device (Miramar Labs, Santa Clara, CA) [14]. One physician (M.B.) performed all procedures. Each participant was placed supine on an exam table with bilateral axilla exposed by placing arms behind the head. A starch iodine test was performed and the area of sweating was outlined and measured for all patients receiving second treatments. Templates were used to direct each treatment procedure with the device after measuring surface area and hair-bearing areas. Antiseptic skin cleanser was applied prior to injection of anesthetic. Axilla was prepared with a local anesthetic injected into each axilla. Participants received 5–20 placements at energy level 1 and 14–25 placements at energy level 5 for each axilla.

Following procedures, ice packs were wrapped in paper towels, and participants applied these to their axillae bilaterally. Participants were given home care instructions (e.g., use of ice packs, skin cleaning, avoidance of shaving and antiperspirants for 5–7 days, use of loose clothing to prevent irritation for 5–7 days, use of nonprescription antibiotic to prevent infection, and recommendation to use nonprescription anti-inflammatory medication to manage pain and reduce swelling).

Validated Measures

The HDSS [18] assesses self-reported sweating severity. Participants indicate how much sweating interferes with daily life on a 4-point scale. Scores of 3 (“my sweating is barely tolerable and frequently interferes with my daily activities”) or 4 (“my sweating is intolerable and always interferes with my daily activities”) denote severe symptoms. The validity and reliability of the HDSS have been established in prior studies; the HDSS shows strong to moderate correlations with the Hyperhidrosis Impact Questionnaire (HHIQ), Dermatology Quality of Life Index (DLQI), and gravimetric sweat production measurements [19].

The DLQI [20] is a 10-item well-validated measure of dermatology-specific QOL impairments across domains using a 4-point scale ranging from 0 to 3, and total scores ranging 0–30 [20]. Scores above 6 denote worse impairments, ranging from moderate to extremely large.

The Zung Self-Rating Anxiety Scale [21] (SAS) is a 20-item measure of generalized anxiety symptoms rated on a 4-point scale, with anxiety index scores ranging 25–100; scores on the anxiety index above 45 denote moderate to extreme anxiety [21].

The Social Phobia Inventory (SPIN) is a 17-item questionnaire to measure the severity of social anxiety disorder on a 5-point scale, ranging from "not at all" to "extremely" and total score range of 0–68. A SPIN score of 19 has been shown to distinguish between social phobia subjects and controls [22].

Achenbach Self-Report (ASR) [23] is a broadband measure of psychological functioning; standardized scores are generated in relation to norms for each gender at ages 18–35, based on national probability samples. The following subscales were used for the current study: anxious/depressed and avoidant personality (i.e., socially anxious and isolated). *T*-scores were used in the current analyses, with *T*-scores above 60 indicating elevated scores at or above the 85th percentile.

Statistics

Descriptive analyses were calculated by measure for each total score and for each time point, including mean, standard deviation (SD), and range, and the percent of participants with elevated scores, as defined for each measure. Paired samples *t* tests were used to examine changes from baseline to Time 1, and from Time 1 to Time 2 using SPSS version 23 (IBM SPSS, Armonk, NY).

RESULTS

Participants' mean age was 23.57 years (SD = 3.07 years) and median age was 23.00 years; 54% of participants were female, and participant ethnicity was predominantly White (79% White, 12.5% Black, 8.3% Asian; Table 1). All participants received one procedure, and 83% received a second treatment. All participants completed baseline questionnaires, 96% completed questionnaires post-first procedure and 96% completed the final follow-up. One questionnaire had lower total completion rates (88%, 83%, and 71%, respectively, across the three time points), likely due to length of the measure (approximately 150 questions).

Sweat Severity (HDSS)

All participants rated their sweating as severe at baseline with 54.2% denoting their sweating as barely tolerable (score of 3) and 45.8% as intolerable (score of 4), for a mean score of 3.46. Paired samples *t* test demonstrated that sweat severity significantly improved after one procedure ($P < 0.001$), with Time 1 having a mean score of 2.50. For participants ($n = 20$) who received a second treatment, there was a further significant drop in sweat severity from Time 1 to Time 2 ($P < 0.01$), with a Time 2 mean score of 1.95 (Fig. 1).

Quality of Life (DLQI)

Most participants (87.5%) endorsed quality of life impairments that were elevated at baseline (mean = 12.92), ranging from moderate to extremely large range. Paired samples *t* test indicated a significant reduction in quality

TABLE 1. Distribution of Test Results

	Baseline	Time 1	Time 2
HDSS			
Mean (SD)	3.46 (0.51)	2.50 (0.964)	2.05 (0.826)
Range	3–4	1–4	1–4
% of participants w/elevated scores	100	25	12.5
DLQI			
Mean (SD)	12.92 (5.47)	6.25 (5.74)	3.68 (4.31)
Range	4–21	0–20	0–13
% of participants w/elevated scores	87.5	41.8	12.5
SAS general anxiety			
Mean (SD)	45.67 (10.22)	30.96 (7.64)	27.50 (11.87)
Range	25–66	21–52	2–52
% of participants w/elevated scores	50	4	5
SPIN social anxiety			
Mean (SD)	28.83 (12.04)	17.91 (14.34)	15.90 (11.87)
Range	7–57	0–54	2–54
% of participants w/elevated scores	75	38.9	30
Anxiety/Depression ASR			
Mean (SD)	59.43 (9.43)	53.55 (5.50)	52.94 (4.83)
Range	50–79	50–70	50–67
% of participants w/elevated scores	38.1	20	11.8
Avoidant personality ASR			
Mean (SD)	61.38 (12.68)	53.75 (5.43)	53.35 (4.29)
Range	50–87	50–66	50–64
% of participants w/elevated scores	47.6	15	11.8

ASR, Achenbach Self-Report; DLQI, Dermatology Quality of Life Index; HDSS, Hyperhidrosis Disease Severity Scale; SD, standard deviation; SPIN, Social Phobia Inventory.

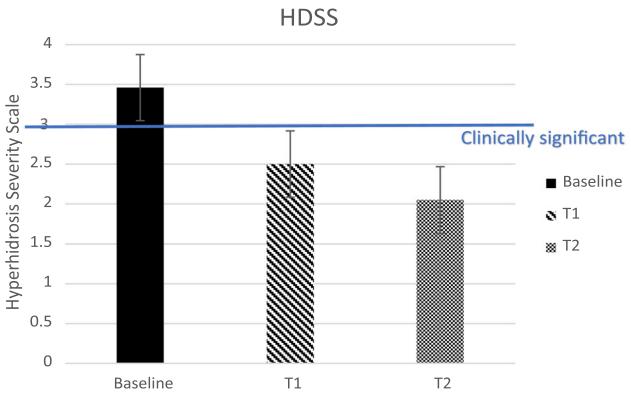

Fig. 1. Average Hyperhidrosis Disease Severity Scale (HDSS) data comparison at baseline, T1, and T2.

of life impairments following one procedure ($P < 0.001$), with Time 1 mean of 6.25, and after a second procedure, there was a further improvement from Time 1 to Time 2 ($P = 0.003$), with Time 2 mean of 3.68 indicating small impairments (Fig. 2).

Generalized Anxiety Symptoms (SAS)

Half of the participants (50%) demonstrated elevated generalized anxiety symptoms at baseline (mean = 45.67). Paired samples t test revealed significant reduction of anxiety symptoms from baseline to nonclinical levels at Time 1 ($P < 0.001$; Time 1 mean score = 30.96), with a marginal trend suggestive of further improvements from Time 1 to Time 2 ($P = 0.064$; Time 2 mean score = 27.50).

Social Anxiety Symptoms (SPIN)

Using a clinical cutoff score of 19, most of the participants (75%) endorsed clinically elevated social anxiety at baseline (mean = 28.61). Paired samples t test showed significant reduction in social anxiety from baseline to below the clinical cutoff at Time 1 ($P < 0.001$; Time 1 mean = 17.91), resulting in only 30% of participants continuing to demonstrate elevated scores. There was not a

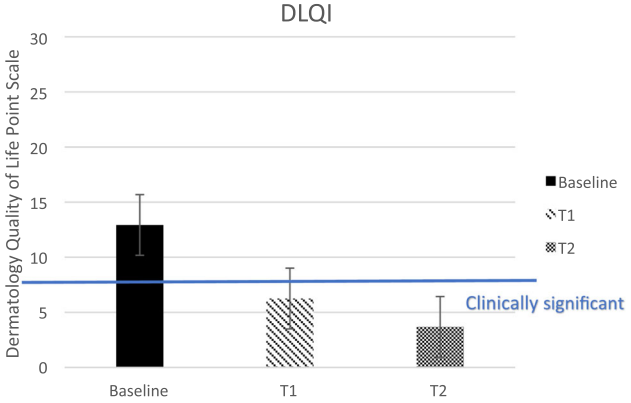

Fig. 2. Average Dermatology Quality of Life Index (DLQI) data comparison at baseline, T1, and T2.

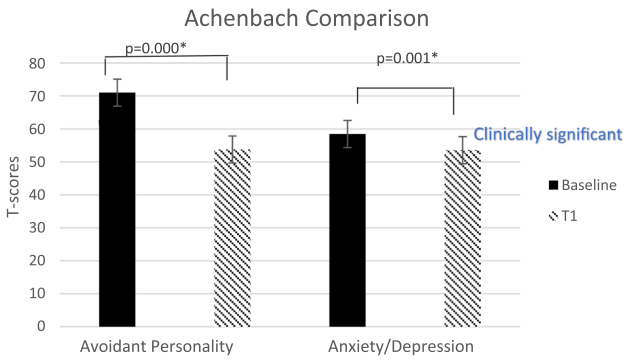

Fig. 3. Achenbach test result comparison for baseline and T1.

significant improvement found from Time 1 to Time 2 (Time 2 mean = 15.42).

Anxiety/Depressive Symptoms (ASR)

Using a norm-referenced test, 38% of participants rated their anxiety/depressive symptoms as falling above the 85th percentile at baseline (T score mean = 58.45), which falls just below the clinical threshold. These symptoms significantly improved after one procedure ($P < 0.01$; Time 1 mean = 53.55) and continued to fall in the nonclinical range. There was not a significant improvement found from Time 1 to Time 2 (mean = 52.06) (Fig. 3).

Avoidant Personality (ASR)

On the norm-referenced measure of social isolation, 47.6% of participants rated their symptoms as falling above the 85th percentile at baseline, with the mean score falling above the clinical threshold (T score mean = 60.60). These symptoms significantly improved after one procedure ($P < 0.01$; Time 1 mean = 53.75) and fell in the nonclinical range. There was not a significant improvement found for Time 1 to Time 2 (mean = 52.94) (Fig. 3).

DISCUSSION

It is well-established in the literature that individuals with hyperhidrosis experience significant psychosocial difficulties [15,24,25]. Even though two microwave thermolysis treatments are needed for full clinical benefit, after only one microwave treatment, there were significant improvements in sweat severity, skin-specific QOL, generalized anxiety, social anxiety, anxious/depressive symptoms, and social isolation. Baseline assessment reflected clinically elevated scores across most measures, with subsequent scores falling into the nonclinical range for both sweat symptoms and psychosocial functioning. Intervention studies have found improvements in psychosocial functioning with sympathectomy [6-9] and botox [11-13].

The improvements on the QOL measure (DLQI) in our study are comparable with other published studies evaluating various treatments for hyperhidrosis. In an evaluation of the QOL after thoracic sympathectomies for palmar hyperhidrosis in 36 patients, Hartmann et al.

found that the mean preoperative DLQI baseline was similar to our patients 12.7 (12.92 baseline in our cohort) improving to 4.3 measured 2.5 years postoperatively (3.68 after two treatments and 1 year later in our cohort) [2]. Using Botulinum toxin type A (BTX-A) for axillary hyperhidrosis in 24 patients, D'Epiro et al. found that the median DLQI baseline of 21.8 improved dramatically to 1.8 after treatment although the effects of BTX-A in the axillae only lasted 4–9 months on average [3]. In a more recent randomized study of the topical anticholinergic glycopyrronium tosylate (GT) of over 400 patients, the mean DLQI baseline score of 11.9 decreased to 3.3 at 4 weeks after treatment [4]. Compared with BTX-A and GT, our low QOL at one year may reflect the longer durable treatment effect of microwave thermolysis.

The current study is the first to examine whether microwave thermolysis improves psychosocial functioning among young adults with axillary hyperhidrosis. The majority of the psychosocial benefit appears to emerge after only one treatment of microwave thermolysis but did not continue to improve with a second treatment, whereas the level of sweat severity and QOL continued to show further improvements after a second treatment. These results in our sample would suggest that even though two sessions of microwave thermolysis are needed for maximal symptomatic relief of axillary hyperhidrosis, young adults with axillary hyperhidrosis are likely to experience significant benefits in improved psychosocial functioning after just one treatment session.

Results from our preliminary data would suggest that the majority of individuals with hyperhidrosis will derive benefit from microwave thermolysis. Despite the statistically and clinically significant improvements observed, it should be noted that a substantial proportion continued to experience social difficulties, with approximately 30% continuing to have elevated symptoms on a screening measure of social anxiety and nearly 12% having significant social isolation on a norm-referenced measure. This pattern of results may indicate that while microwave thermolysis is an effective medical treatment for hyperhidrosis, a subgroup of patients may benefit from evidence-based psychological treatments to provide further relief from social anxiety and isolation. Thus, although it could be inferred that reduced sweating would naturally result in improved anxiety, our results indicate that the interplay between hyperhidrosis and emotional functioning is more complex. Cognitive-behavioral therapy is a well-established treatment, which targets maladaptive behavioral and cognitive patterns associated with social anxiety and has been found to decrease social anxiety symptoms as well as or better than psychiatric medications [26-28].

Consistent with other recent studies demonstrating the effectiveness of microwave thermolysis [29], applications of the current results would suggest that microwave thermolysis is an effective treatment for axillary hyperhidrosis in young adults, which also provides psychological symptom relief. In light of the significant psychosocial burdens experienced by adults with hyperhidrosis, it is recommended that national and international guidelines for effective treatment of hyperhidrosis include routine psychological screening and consideration of referral to clinical psychologists for adjunctive psychological treatment for co-occurring anxiety symptoms and social difficulties.

Limitations of our study include small sample size, restricted age range, and lack of randomization or control condition to account for the effects of time or participant treatment expectations. Other limitations are procedure quality heterogeneity, and unrelated psychological risk factors such as past trauma. Patient self-reporting may also obscure results that do not encompass the entire axillary hyperhidrosis population as there is no standardized characterization of this disorder and its symptoms. The results of this study are profound; longitudinal replication of these data is certainly warranted.

In summary, this initial examination demonstrates that young adults with axillary hyperhidrosis experience significant improvements in sweat severity and psychosocial functioning following microwave thermolysis. The current study shows that a significant portion of the axillary hyperhidrosis population is afflicted with negative psychosocial symptoms that disrupt daily life and that the microwave thermolysis treatment can provide potential relief for these symptoms.

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