European Journal of Cardio-Thoracic Surgery 54 (2018) 904–911
doi:10.1093/ejcts/ezy211 Advance Access publication 30 May 2018

ORIGINAL ARTICLE

Cite this article as: Li DC, Hulbert A, Waldbaum B, Ober C, Hooker CM, Huang P *et al.* Endoscopic thoracic sympathectomy for primary focal hyperhidrosis: impact on psycho-social symptomatology and psychotropic medication use. Eur J Cardiothorac Surg 2018;54:904–11.

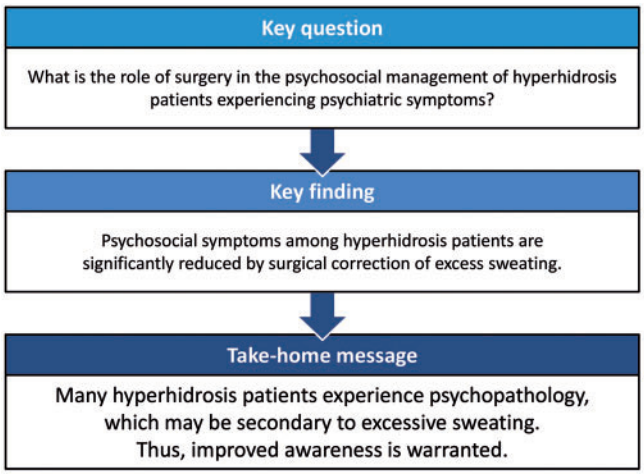
Endoscopic thoracic sympathectomy for primary focal hyperhidrosis: impact on psycho-social symptomatology and psychotropic medication use

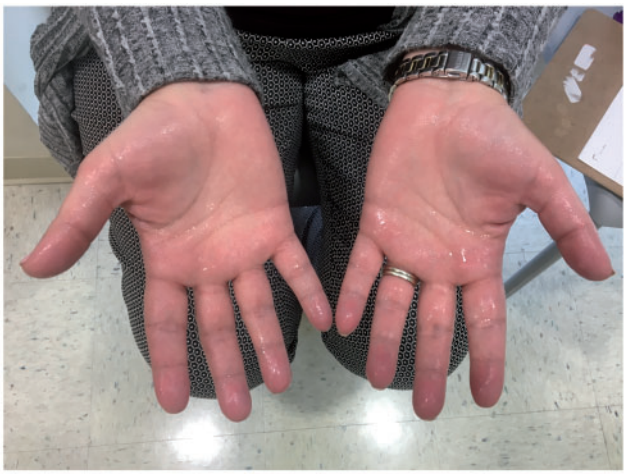
Dan C. Li[a,*], Alicia Hulbert[b], Benjamin Waldbaum[c], Cecily Ober[a], Craig M. Hooker[a], Peng Huang[b], Daniela Molena[a], Stephen C. Yang[a,b], Tomoaki Ito[a], Carisa Perry-Parrish[d] and Malcolm V. Brock[a,b]

[a] Division of Thoracic Surgery, Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, MD, USA
[b] Department of Oncology, Johns Hopkins University School of Medicine, Baltimore, MD, USA
[c] Department of Anesthesiology and Critical Care Medicine, Johns Hopkins University School of Medicine, Baltimore, MD, USA
[d] Department of Child and Adolescent Psychiatry, Johns Hopkins University School of Medicine, Baltimore, MD, USA

* Corresponding Author. 747 Ralph McGill Blvd NE Unit 1215, Atlanta, GA 30312, USA. Tel: +1-410-5644229; e-mail: dan.li2@emory.edu (D.C. Li).

Received 7 February 2018; received in revised form 16 April 2018; accepted 1 May 2018





Abstract

OBJECTIVES: The tendency for patients with primary focal hyperhidrosis (PFH), characterized by excessive sweating, to experience psycho-social deficits is well documented. In addition, although endoscopic thoracic sympathectomy (ETS) effectively corrects PFH, its role in the psycho-social management of these patients remains unclear. Here, we examined changes in psychiatric symptomatology and psychotropic medication usage in PFH patients following ETS.

METHODS: In total, 106 PFH patients underwent ETS and were compared against 213 matched controls. Information on psychiatric diagnosis and prescription was obtained through a retrospective chart review. Prospectively, PFH patients completed Hyperhidrosis Impact Questionnaires, Leibowitz Social Anxiety Scales and Center for Epidemiological Studies Depression Scales to evaluate pre- and postoperative quality-of-life and psycho-social impairment.

RESULTS: A significantly greater proportion of PFH patients had been prescribed psychotropic medication (37.7%) compared to controls (14.1%) despite no differences in the proportion of psychiatric diagnoses. Following ETS, 52.5% of the PFH patients who were using psychotropic medications reduced their prescription regimen, compared to only 10% of control patients ($P < 0.01$). Additionally, scores improved dramatically in each Hyperhidrosis Impact Questionnaires category, and in both the Leibowitz Social Anxiety Scales and Center for Epidemiological Studies Depression Scales ($P < 0.01$).

CONCLUSIONS: We demonstrate that in over half of PFH patients, psychotropic medication usage was discontinued after ETS, which is consistent with our findings on postoperative improvements in Hyperhidrosis Impact Questionnaires, Leibowitz Social Anxiety Scales and Center for Epidemiological Studies Depression Scales scores. Furthermore, our findings suggest that a considerable proportion of PFH patients who experience psychopathology may be doing so secondary to excessive sweating. Thus, improved awareness or recognition of these associations in the diagnosis and management of PFH patients is warranted.

Keywords: Hyperhidrosis • Sympathectomy • Psycho-social • Psychotropic medication

INTRODUCTION

Primary focal hyperhidrosis (PFH) is an idiopathic condition characterized by the excessive secretion of sweat well beyond physiological demand [1]. This is typically localized to regions of high eccrine gland density, namely the axillae, palms, soles and face [2]. PFH typically arises during adolescence and does not usually improve with age [3]. Recent estimates suggest that PFH may affect up to 5% of the US population, representing more than 15 million individuals, with the highest prevalence in 18–39 year olds [4].

Excessive sweating can be profoundly impactful in terms of emotional and psycho-social functioning. Hyperhidrosis patients often suffer impairments in both physical and psycho-social quality of life (QOL), commonly reporting significant levels of functional disability that negatively impact work, daily activities, social situations, personal relationships and sexual activities [5]. Patients seeking treatment for hyperhidrosis also frequently report elevated levels of anxiety, social phobia and depression compared to the general population [6, 7]. A substantial proportion of hyperhidrosis patients have a concurrent diagnosis of social anxiety disorder (SAD) [8]. In fact, the hallmarks of social anxiety, including discomfort in social situations and reduction of social contacts, have been widely observed among PFH patients in the clinical setting [2, 8, 9].

Endoscopic thoracic sympathectomy (ETS), in which the thoracic sympathetic chain is disrupted thereby abolishing eccrine gland innervation, is a definitive treatment for PFH [10]. Patients who seek surgical intervention for PFH represent the most severely affected individuals, with considerable disruptions to daily life [11] and those who have failed to demonstrate a benefit from conservative, non-invasive treatment options. Survey-based evaluations of patients undergoing ETS have demonstrated the procedure to be safe and efficacious and have proved to be a durable solution for PFH and its associated disabilities [12–15]. Moreover, multiple studies have reported the therapeutic potential of ETS in addressing the psychological difficulties associated with PFH, demonstrating improvements in QOL and reduction of anxiety and social phobia [16–19].

These findings are promising, but the question of what role ETS may play in the integrated, comprehensive treatment strategy for the considerable number of PFH patients who experience concomitant psychopathology, or the implications for the long-term postoperative management of psychopathology in these patients, remains unexplored. Here, we test the hypothesis that definitive treatment of PFH by ETS alleviates symptoms of anxiety and depression and thus reduces the burden to manage those symptoms by other means, e.g. psychiatric medications. Accordingly, we examine the history of psycho-social symptomatology, psychiatric diagnosis and psychiatric medication usage among PFH patients undergoing ETS at our institution.

MATERIALS AND METHODS

Study population

The study cohort consisted of 106 patients who received a diagnosis of PFH and underwent ETS in the Division of Thoracic Surgery at the Johns Hopkins Hospital between 1 January 2007 and 1 January 2014. Patients aged 18–40 years were considered for inclusion in the study. Patients were not excluded based on foci of sweating and severity of disease. For all cases, the patients' PFH had not satisfactorily responded to conservative treatment options, including topical creams, oral medications, iontophoresis or botulinum toxin injections. Preoperatively, patients underwent a careful clinical history with physical examination. ETS procedures was performed using a single-port, bilateral video-assisted thoracoscopic approach [20]. The sympathetic chain was accessed via the 3rd intercostal space on the anterior axillary line and ablated below the 3rd ganglion using electrocautery. Written informed consent was obtained for all patients, during which time adverse effects were thoroughly reviewed.

The Johns Hopkins DataMart case-mix database (Johns Hopkins Medicine, Baltimore, MD, USA) generated a control cohort consisting of 213 patients matched 2:1 by age and procedure date against the study cohort. Members of the control cohort had neither PFH nor any sweating-related chief complaints, but all had undergone a thoracic procedure performed by the Division of Thoracic Surgery at the Johns Hopkins Hospital between 1 January 2007 and 1 January 2014. Patients who had been diagnosed with a malignant neoplasm were not included in the control cohort, but no other diagnosis was categorically excluded.

Retrospective chart review

For both study and control cohorts, clinical and demographic information were extracted from the database of patient records. Diagnosis of anxiety disorders, including generalized anxiety disorder (GAD) and SAD, diagnosis of major depressive disorder (MDD), including single and recurrent episodes, and pre- and postoperative prescription of psychotropic medications were obtained through review of patient records or during psychometric evaluations. The 'preoperative' time point was defined as medication prescription on the day of surgery, and the 'postoperative' time point was defined as medication prescription status at least 1 year after surgery, ending on 1 January 2015.

Survey-based psychometric evaluation

All PFH patients completed questionnaire-based QOL and psychometric evaluations representing both pre- and postoperative

time points. Hyperhidrosis-related QOL and disease impact were evaluated using the Hyperhidrosis Impact Questionnaire (HHIQ), a 16-item inventory of daily limitations resulting from excess sweating. The first HHIQ section queries the extent to which excessive sweating resulted in limitations during given situations or activities on a 5-point Likert scale from 0 to 4, corresponding to 'not at all' and 'extremely/very much so', respectively. The second HHIQ section queries whether respondents had experienced negative feelings or avoided activities because of their sweating, and the percentage of 'yes' responses was analysed. Preoperative HHIQ was administered in writing prior to surgery, and postoperative HHIQ was administered in writing during follow-up appointments. Patients who did not complete a written postoperative HHIQ were administered the inventory via telephone.

Two psychometric surveys were administered to all PFH patients in the study cohort. Anxiety severity was evaluated using the Liebowitz Social Anxiety Scale (LSAS), a 24-item inventory of anxious symptomatology, whereas depression severity was evaluated using the Revised Center for Epidemiological Studies Depression Scale (CESD-R), a 20-item inventory measuring depressive symptomatology. Both inventories include validated threshold scores suggesting likely clinical diagnoses of an anxiety disorder or depression, respectively. Surveys were administered via telephone after the surgery date wherein patients answered each questionnaire twice, the first time to recall their mental state before ETS (preoperative) and then a second time to report their mental state at the time of the survey administration (postoperative). All participants gave informed consent as approved by the Johns Hopkins Medicine Institutional Review Boards.

Statistical analysis

Between-group differences (study versus control cohorts) were evaluated using Wilcoxon rank sum test for continuous variables and Pearson's χ^2 test with Yates' continuity correction for categorical variables. Within-group differences (pre- versus postoperative data points) were evaluated using the Wilcoxon signed-rank test with continuity correction for ordinal variables taking more than 2 distinct values and McNemar's χ^2 test with continuity correction for paired binary variables. In the comparisons of HHIQ, LSAS and CESD scores, *P*-values were reported with Bonferroni adjustment for multiple comparisons. Statistical computations were performed using R (version 3.4.1) (R Foundation, Vienna, Austria) and SPSS 19 (IBM, Armonk, NY, USA).

RESULTS

Cohort characteristics

There were no significant demographic differences between the study and control cohorts (Table 1). Of the 106 patients in the PFH cohort, 90 (84.9%) experienced palmar sweating, 73 (68.9%) experienced plantar sweating, 57 (53.8%) experienced axillary sweating, and 82 (77.4%) experienced sweating at multiple foci. Prior to surgical consultation, 29 PFH patients (27.4%) had botulinum toxin injections, 10 (9.4%) had iontophoresis, 68 (64.2%) were prescribed topical aluminium chloride, 48 (45.3%) were prescribed anticholinergics, and 27 (25.5%) were prescribed beta-blockers. No significant relationships were found between either the sweating foci or the previous treatment modalities and any of the study variables.

Table 1: Demographic and clinical characteristics of the study and control cohorts

Characteristics	Study cohort ($n = 106$)	Control cohort ($n = 213$)	*P*-value
Age (years)			0.2203[d]
Mean ± SD	28.2 ± 6.1	29.2 ± 6.8	
Median (IQR), *n* (%)	28 (23–33)	29 (24–35)	
Range[a]	18–40	18–40	
Gender, *n* (%)			0.3382[e]
Male	44 (41.5)	102 (47.9)	
Race, *n* (%)			0.4863[e]
White	73 (68.9)	137 (64.3)	
Black	21 (19.8)	55 (25.8)	
Other	12 (11.3)	21 (9.9)	
Procedure date (year)			–
Median (IQR)	2011 (2010–2012)	2010 (2009–2011)	
Range[b]	2007–2014	2007–2014	
Follow-up time[c] (months)			<0.01[d]
Mean ± SD	37.5 ± 21.3	44.6 ± 17.8	
Median (IQR)	36 (23–49)	48 (36–60)	

[a]Control cohort matched by age (18–40).
[b]Control cohort matched by procedure dates (2007–2014).
[c]Time between procedure date and 1 January 2015.
[d]Wilcoxon rank sum test.
[e]Pearson's χ^2 test.
IQR: interquartile range; SD: standard deviation.

Among the control cohort, the most common reasons for thoracic surgery included pneumothorax (22.5%), myasthenia gravis (12.7%), pectus excavatum (8.9%) and benign tumours (8.5%). A complete list of control cohort diagnoses is provided in Supplementary Material, Table S1, and a complete list of control cohort procedures is provided in Supplementary Material, Table S2. There were no significant differences in demographic or clinical characteristics among control group patients when stratified by reason for surgery or procedure type.

Diagnosis and medication history

At the time of surgery, 19 of the 106 PFH patients (17.9%) were diagnosed with either SAD, GAD or MDD. Among these 19 patients, 11 (10.4%) had SAD or GAD, and 12 (11.3%) had MDD. In the control group, 31 (14.6%) of the 213 patients had SAD, GAD or MDD. Of these 31 patients, 14 (6.6%) had SAD or GAD, and 22 (10.3%) had MDD. There was no difference between the cohorts in terms of proportion of patients diagnosed with either GAD, SAD or MDD (Fig. 1A).

Of the 106 PFH patients, 40 patients (37.7%) received a total of 54 unique psychotropic medication prescriptions preoperatively. Of the 213 control patients, 30 patients (14.1%) received a total of 37 unique prescriptions preoperatively. Non-parametric evaluation of presurgery medication rates indicated a significantly higher rate of psychotropic medication usage among PFH patients compared to the control group ($P < 0.01$) (Fig. 1B). Antidepressants, selective serotonin reuptake inhibitors in particular, were the most commonly prescribed category of medication for both cohorts. The overall distribution of medications, both by drug class and by individual prescriptions, between the 2 cohorts appeared to be similar (Table 2).

Twenty-one of the 40 PFH patients (52.5%) who were prescribed psychotropic medications before ETS were no longer being

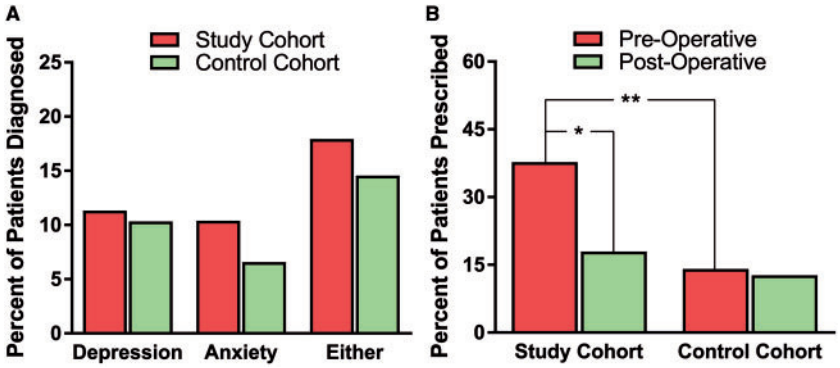


Figure 1: Psychiatric diagnosis and psychotropic medication prescription among the study ($n = 106$) and control ($n = 213$) cohorts. (**A**) Depression includes single episode and recurrent episode of major depressive disorder. Anxiety includes social anxiety disorder and generalized anxiety disorder. (**B**) *$P < 0.01$ (McNemar's χ^2 test with continuity correction), **$P < 0.01$ (Pearson's χ^2 test with Yates' continuity correction).

Table 2: Distribution of psychotropic medications prescribed to the study and control cohorts prior to surgery

Category	Medication (brand name)	No. of times prescribed (%)[a]	
		Study cohort ($n = 40$)	Control cohort ($n = 30$)
Antianxiety, *n* (%)	Alprazolam (Xanax)	2 (3.7)	2 (5.4)
	Diazepam (Valium)	0 (0.0)	1 (2.7)
	Clonazepam (Klonopin)	4 (7.4)	3 (8.1)
	Lorazepam (Ativan)	1 (1.9)	0 (0.0)
	Total	7 (13.0)	6 (16.2)
Anticonvulsant and mood-stabilizing, *n* (%)	Carbamazepine (Tegretol)[b]	0 (0.0)	1 (2.7)
	Gabapentin (Neurontin)	3 (5.6)	2 (5.4)
	Lamotrigine (Lamictal)	1 (1.9)	0 (0.0)
	Total	4 (7.4)	3 (8.1)
Antidepressant, *n* (%)	Bupropion (Wellbutrin)[b]	6 (11.1)	5 (13.5)
	Citalopram (Celexa)[b]	2 (3.7)	3 (8.1)
	Duloxetine (Cymbalta)[b]	3 (5.6)	1 (2.7)
	Escitalopram (Lexapro)[b]	0 (0.0)	2 (5.4)
	Fluoxetine (Prozac)[b]	11 (20.4)	7 (18.9)
	Mirtazapine (Remeron)[b]	1 (1.9)	0 (0.0)
	Paroxetine (Paxil)[b]	1 (1.9)	0 (0.0)
	Sertraline (Zoloft)[b]	7 (13.0)	4 (10.8)
	Venlafaxine (Effexor)[b]	7 (13.0)	3 (8.1)
	Total	38 (70.4)	25 (67.6)
Other, *n* (%)	Aripiprazole (Abilify)[b]	3 (5.6)	2 (5.4)
	Doxepin (Aponal)	1 (1.9)	0 (0.0)
	Pregabalin (Lyrica)	1 (1.9)	1 (2.7)
	Total		
Total, *n* (%)		54 (100.0)	37 (100.0)

[a]Percent calculated based on total number of prescribed medications for each cohort.
[b]Medications with diaphoresis listed as a side effect as per the Lexi-Drugs Online database.

prescribed those medications afterwards. In the control cohort, 3 of the 30 non-PFH patients (10.0%) who were prescribed psychotropic medications before thoracic surgery were no longer being prescribed those medications afterwards. The proportion of PFH patients whose prescription regimen ended after surgery was significantly greater than that of the control group ($P < 0.01$). Approximately 90% of the preoperatively prescribed control cohort patients maintained their psychiatric medication regimens after surgery, compared to only approximately 50% of the preoperatively prescribed PFH patients who maintained their psychiatric medication regimens after ETS. Additionally, the postoperative prescription rate for PFH patients was not significantly different than the pre- or postoperative prescription rates for the control cohort (Fig. 1B).

Psychometric evaluation

All 106 PFH patients completed pre- and postoperative HHIQ. All preoperative HHIQs were completed in written form prior to surgery. In total, 69 PFH patients completed the postoperative HHIQ in written form during follow-up appointments, and 37 PFH patients completed the same survey via telephone follow-up. There were no significant differences in postoperative HHIQ scores or in changes to HHIQ score after surgery, when stratified by the method of survey administration.

HHIQ scores for PFH patients improved significantly ($P < 0.01$) after ETS for all 16 HHIQ items (Fig. 2). Preoperative responses indicated that between 60% and 80% of PFH patients reported feeling dissuaded from participating in social activities due to excess sweating. Postoperative responses from the same patients indicated that up to 20% of PFH patients reported feeling dissuaded from participating in social activities due to excess sweating (Fig. 2B).

Out of the 106 PFH patients, 96 completed both pre- and postoperative LSAS and CESD-R, which were administered via telephone during the postoperative time point. Preoperative LSAS scores (median = 19.4, range 0–53) were significantly decreased after ETS (median = 6, range 0–36) ($P < 0.01$, Wilcoxon signed-rank test) (Fig. 3A). Preoperative CESD-R scores (median = 9, range 0–40) were also significantly decreased after ETS (median = 3, range 0–20) ($P < 0.01$, Wilcoxon signed-rank test) (Fig. 3B). Notably, the mean preoperative psychometric scores were found to be significantly below the diagnostic thresholds for both the LSAS (≥30) and CESD-R (≥16) (Fig. 3A and B). However, a proportion of patients did exceed the diagnostic threshold score for both the LSAS (17.6%) and CESD-R (16.7%) preoperatively. However, this proportion of patients significantly decreased for both the LSAS (2.1%) and CESD-R (3.1%) postoperatively (both $P < 0.01$, McNemar's χ^2 test) (Fig. 3C and D).

DISCUSSION

The present study is the first to investigate the efficacy of ETS in PFH patients who exhibit concomitant psychopathological symptomatology by examining psychiatric diagnoses and psychotropic

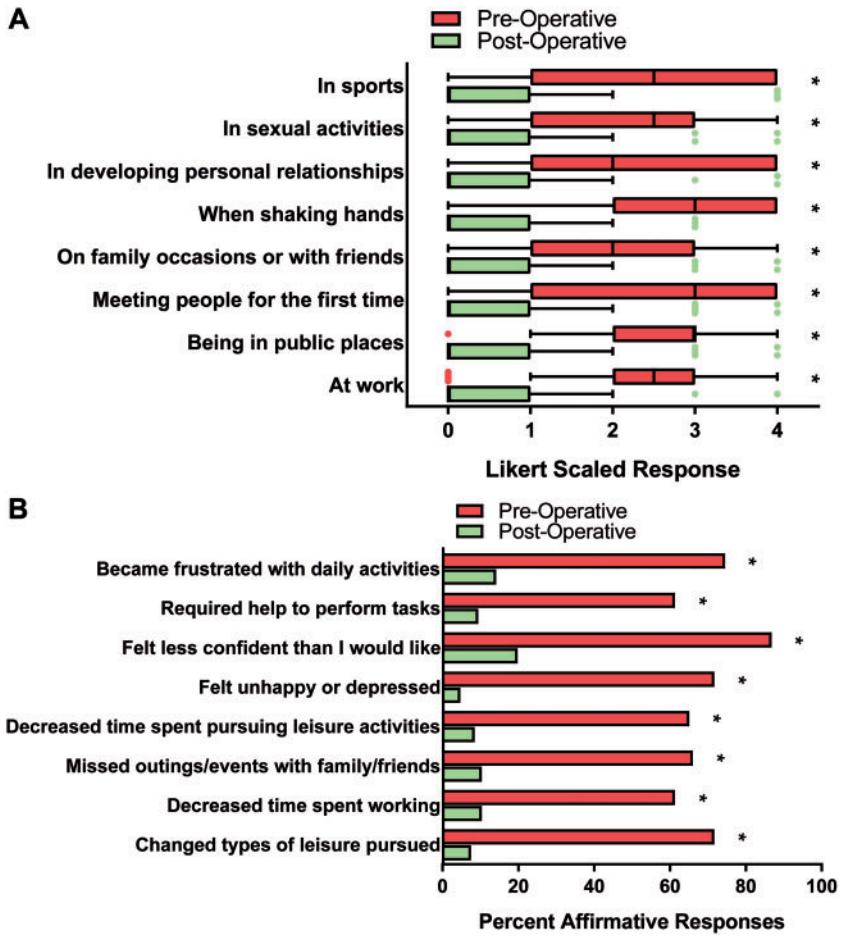


Figure 2: Hyperhidrosis impact questionnaire-assessed pre- and postoperative quality of life and sweating-related disability among the study cohort ($n = 106$). (**A**) Responses displayed on a Likert scale from 0 to 4; 0 = 'not at all', 1 = 'a little', 2 = 'somewhat', 3 = 'quite a bit' and 4 = 'very much so'. Median, interquartile range and range of data are represented. *$P < 0.01$ (Wilcoxon signed-rank test with continuity correction). (**B**) Responses displayed as percentage of 'yes' responses. *$P < 0.01$ (McNemar's χ^2 test with continuity correction).

medication prescription rates, and it demonstrates that a significantly greater number of PFH patients have a history of psychotropic medication prescription compared to control patients. Importantly, at 1 year after surgery, 53% of patients with PFH who were being prescribed psychotropic medications discontinued their prescriptions compared to only 10% of control patients who did so, suggesting that psychiatric symptomatology of patients changed in such a way as to warrant modification of their preoperative prescription regimens. The fact that PFH patients discontinued their medication after relief of excessive sweating by ETS is consistent with our finding that PFH patients were not more likely than controls to be diagnosed with primary anxiety or MDDs prior to surgery, suggesting that the social phobia and anxiety which develop in these patients are secondary in nature and represent a significant psycho-social sequelae of hyperhidrosis [9,21]. Moreover, this is bolstered by our finding that PFH patients experience substantial relief of psychological symptoms and improved QOL due to reduction of excessive sweating after ETS. Taken together, these data further support the hypothesis that the definitive reduction of sweating from ETS provides an effective treatment for the sweating-related psychological symptomatology of PFH, namely anxiety and depression [18].

Although it is difficult to infer the precise aetiology of the psycho-social phenomenon, our findings suggest that the anxious and depressive symptoms experienced by PFH patients may arise from excess sweating, rather than vice versa. Anxiety has been associated with other conditions of autonomic overexcitation such as postural tachycardia and vasovagal syncope, and in these cases, it has been shown that anxiety is primarily driven by vigilance of physical symptoms rather than trauma or neurosis [22]. In fact, correction of craniofacial PFH reportedly also resolves many symptoms of postural tachycardia and the various psychiatric sequelae thereof [23].

A likely role of PFH in psychopathology is supported by the psychometric data in this study. First, postoperative scores of both the LSAS and CESD-R suggest that ETS significantly reduces the number and severity of psychiatric symptoms (Fig. 3A and B). Second, preoperative scores of both the LSAS and CESD-R revealed that PFH patients, on average, do not meet the thresholds that would suggest a diagnosis of a primary SAD, GAD or MDD (Fig. 3C and D), which is consistent with observations in previous studies [9,12]. Taken together, these results suggest the existence of 2 distinct groups of individuals within the PFH patient population: (i) those whose psychiatric symptoms are elevated, but below a clinically significant threshold and primarily the result of excessive sweating, which can be corrected with surgery, and (ii) those whose medical history reflects the presence of

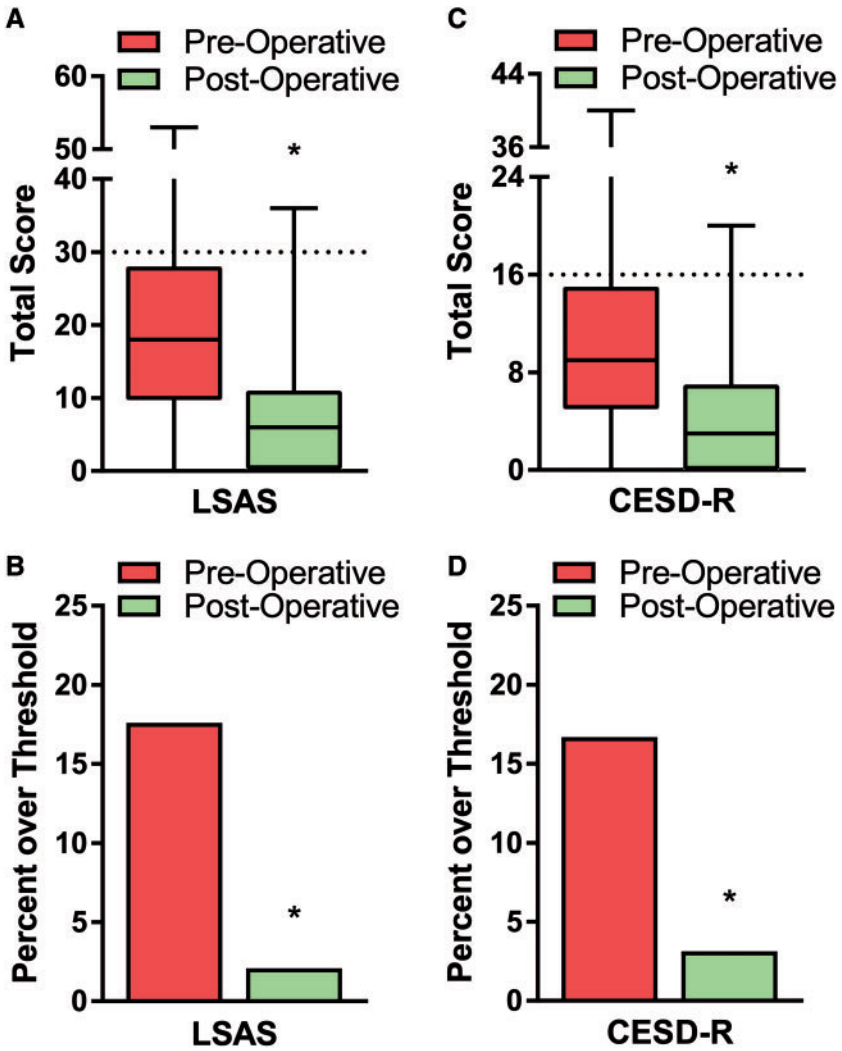


Figure 3: Psychometric evaluation of preoperative ($n = 102$) and postoperative ($n = 96$) anxiety and depressive symptoms among the study cohort. (**A, B**) Median, interquartile range and range of data are represented. *$P < 0.01$ (Wilcoxon signed-rank test with continuity correction). Dotted line represents the diagnostic threshold for the LSAS and CESD-R. (**C, D**) *$P < 0.01$ (McNemar's χ^2 test with continuity correction). CESD-R: Center for Epidemiological Studies Depression Scales; LSAS: Liebowitz Social Anxiety Scale.

a primary psychiatric disorder, which may have resulted from myriad converging factors, of which PFH is a potential one.

Furthermore, poor awareness by physicians of the relationship between PFH and psychopathology may underlie the observations in this study. Notably, many of the psychotropic medications prescribed to our PFH patients list further diaphoresis as a known side-effect as per the Lexi-Drugs Online database (Wolters Kluwer Clinical Drug Information, Inc., Hudson, OH, USA). Specifically, 9 of the 19 (47.4%) different medication types prescribed to our PFH patients, and 34 of the 54 (63.0%) total prescriptions, are ones that may exacerbate sweating (Table 2). This trend is not necessarily surprising considering that nearly four-fifths of antidepressants and anxiolytics prescribed in the USA are from non-psychiatrists, principally primary care physicians, who may have limited training in treating mental health disorders, and more importantly, in recognizing the linkage between less common conditions, such as PFH, and their associated psychosocial sequelae [24]. In fact, the patients with the greatest degree of sweating-related impairments are commonly treated for anxiety-related disorders before seeking medical or surgical treatment for excessive sweating [8], and they also are more refractory to treatments, such as medication or cognitive-behavioural therapy, than patients with SAD alone [8].

This study also reaffirms ETS as an effective treatment for PFH and evaluates ETS as it relates to psychiatric symptom management. More than one-third of our PFH patients received some form of psychiatric care involving psychotropic medication prescription prior to surgery. For a considerable proportion of these patients, correcting their hyperhidrosis seems sufficient to have resolved both excess sweat production as well as associated psychopathology at least to the extent that psychotropic medication prescription was discontinued after surgery. In fact, ETS lowered the psychotropic medication rate in our PFH patients to a level similar to that of the control group (Fig. 1). This suggests that surgical intervention not only successfully lowered the proportion of patients who required prescription of psychotropic medications but was also able to do so to levels comparable to that of the general population without PFH. This is further indication that, at least in this cohort of patients, PFH is potentially the driver of psychopathology, rather than vice versa. However, it is not only difficult to determine the degree to which a PFH patient's psychiatric symptomatology is predicted upon excessive sweating, but

Table 3: Psychiatric diagnosis and psychotropic medication prescription stratified by the presence ($n = 18$) or absence ($n = 88$) of compensatory sweating experienced after ETS

	Compensatory sweating		*P*-value[a]
	Yes ($n = 18$)	No ($n = 88$)	
Psychiatric diagnosis, *n* (%)			
Anxiety	2 (11.1)	9 (10.2)	0.9108
Depression	4 (22.2)	8 (9.1)	0.1091
Either	5 (27.8)	14 (15.9)	0.2316
Medication prescription, *n* (%)			
Preoperative	7 (38.9)	33 (37.5)	0.9118
Postoperative	2 (11.1)	19 (21.6)	0.3094

[a]Pearson's χ^2 test.

ETS: endoscopic thoracic sympathectomy.

it is also difficult to predict which PFH patients will demonstrate pronounced psychological benefit from surgery, consultation with mental health clinicians should be strongly considered.

Although ETS may have provided substantial relief for most patients, still approximately half of the PFH patients who were taking psychiatric medications preoperatively continued to do so postoperatively. It is difficult to know whether this group represents individuals with psychiatric disorders that would be present in the absence of hyperhidrosis or those whose psychiatric susceptibilities were activated or exacerbated in the presence of hyperhidrosis.

Notably, compensatory sweating (CS), an ETS-induced myelopathy resulting in increased sweating from untreated areas such as the lower back or trunk, has been shown to be the principal determinant of residual anxiety following ETS [25]. In our PFH cohort, 18 patients (17.0%) noted significant CS after ETS. The proportion of these patients who were prescribed psychotropic medications preoperatively was comparable to those patients who did not experience CS (38.9% vs 37.5%, respectively). However, after ETS, only 28.6% of patients who experienced CS decreased their medication load compared to 57.6% of patients who did not experience CS that decreased theirs (Table 3). Although the prevalence of CS remains non-negligible, in our study and in general, ETS outcomes appear to be stable and consistent in the absence of this adverse event [26]. Additionally, only severe CS, but not mild or moderate CS, has been shown to be significantly associated with lower patient satisfaction after ETS [27].

Of course, unforeseen variables may have potentially impacted the outcomes reported here. These include procedure quality heterogeneity, unrelated psychological risk factors such as past trauma or psychogenetics, or the presence of other psycho-social stressors. In particular, our comparator control group comprised various reasons for surgery and procedure type. Regardless, many PFH patients derive psychological benefit from ETS, while another proportion of PFH patients may benefit from targeted psychiatric treatments to help address residual anxiety or depressive symptoms that do not remit following surgery. Other limitations of the present study include medical record heterogeneity, use of patient self-reporting and retrospective psychometric evaluation. Additionally, caution is warranted when generalizing these findings to the entire PFH patient population due to exclusive accrual from a tertiary centre.

Although we believe the findings of the present study to be compelling, prospective and longitudinal replication of these data is certainly warranted. Specifically, systematic assessment of psychopathology, such as with the structured clinical interview format of Diagnostic and Statistical Manual of Mental Disorders (DSM), could standardize the characterization and diagnosis of psychopathology independent of self-reporting. Likewise, a quantitative assessment of hyperhidrosis severity would be useful to examine in which PFH patients is ETS most effective. Finally, the postoperative changes in medication usage observed in this study are unlikely unique to ETS as botulinum toxin injections have also shown similar outcomes [28,29]. However, the question of whether more conservative therapies can recapitulate the results of ETS is unknown, given that those treatments do not provide definitive, permanent relief from excess sweating.

The present study demonstrates that a considerable proportion of individuals with PFH present with concomitant psychiatric symptoms that can be ameliorated by effective treatment of their excessive sweating by ETS. Further research is needed to understand for whom this effect is most beneficial and to guide appropriate, multidisciplinary treatment approaches for the optimal management of patients at increased risk of psychiatric sequelae of hyperhidrosis.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *EJCTS* online.

Funding

This work was supported by Strategic Research Foundation Grant-Aided Project for Private Universities [S1511008L] from the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT), through a sub-award from the Juntendo University (to T.I.).

Conflict of interest: none declared.

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