Effect of sympathectomy level on the incidence of compensatory hyperhidrosis after sympathectomy for palmar hyperhidrosis

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Objective: Palmar hyperhidrosis can be psychosocially devastating. Sympathectomy provides effective treatment. The most common side effect after sympathectomy is compensatory hyperhidrosis, which can be debilitating. Controversy exists as to which and how many levels treated carry the lowest incidence of compensatory hyperhidrosis after sympathectomy for palmar hyperhidrosis.

Methods: Retrospective review was conducted on a video-assisted thoracoscopic surgical database including all patients who underwent video-assisted thoracoscopic surgical sympathectomy for palmar hyperhidrosis.

Results: Video-assisted sympathectomy was performed in 282 patients for palmar hyperhidrosis from May 2002 through July 2005; in all, 179 patients (64%) underwent division at T2 level only and 103 at levels T2, T3, and T4. The groups were similar in age and sex distribution. The rate of compensatory hyperhidrosis was significantly less in the T2 group (23 patients, 13%) than in the T2 through T4 group (35 patients, 34%) ($P = .011$). The most common site of compensatory hyperhidrosis in both groups was the lower back. Patients with compensatory hyperhidrosis were older (median 31 years vs 23 years, $P = .037$), had body mass index greater than 28 ($P = .048$), and underwent multiple level sympathectomy ($P = .004$).

Conclusion: Compensatory hyperhidrosis continues to occur after sympathectomy for palmar hyperhidrosis; however, a significant reduction in incidence can be achieved by dividing the sympathetic chain at a single level (T2). Patients who are older and/or have increased body mass index should be warned of their increased risk of compensatory hyperhidrosis after sympathectomy.

Hyperhidrosis is the secretion of sweat in amounts greater than physiologically needed for thermoregulation. It is most commonly an idiopathic condition. Idiopathic hyperhidrosis, also referred to as primary or focal hyperhidrosis, usually affects the face, axillae, palms, or soles. Medical management is often frustrating, and the response is usually transient. Surgical therapy is effective and is based on the interruption of transmission of impulses from the sympathetic ganglia to the sweat glands. Currently, a video-assisted thoracic surgical approach to sympathectomy is preferred.

Compensatory hyperhidrosis (CH) is the most common side effect of this procedure and is the most common reason for patients to forego sympathectomy. CH is generally considered to be a reactive thermoregulatory mechanism, with the extent of sympathectomy believed to influence its severity and frequency. In this series, two different surgical philosophies with regard to the treatment of palmar hyperhidrosis (PH) were reviewed. One surgeon (J.I.M.) performs

multiple divisions of the sympathetic chain (T2–T4), whereas two other surgeons (D.L.M. and S.D.F.) divide the chain at a single level (T2). Use of the latter technique at our institution has been described previously.¹ Because these two different techniques are being performed within in a single health care system for the same indication, we decided to compare the incidences of CH associated with these procedures to determine whether one technique is preferable for relief of excessive palmar sweating.

MATERIALS AND METHODS

Data were collected on a consecutive series of patients who underwent video-assisted thoracic surgical sympathectomy for medically refractory primary PH within the Emory Healthcare System from May 2002 through July 2005 by three different thoracic surgeons. The medical record, operative report, anesthesia record, and clinic charts were examined for each patient. Follow-up information was obtained from medical records and clinic charts. A postsympathectomy questionnaire was completed by each patient at the time of the postoperative visit, usually at 4 weeks. Specific questions detailed incidence of CH, other side effects of the procedure, postoperative pain, and satisfaction with the procedure. This study was approved by the Emory University institutional review board.

Statistical Methods

Data were stored with Excel spreadsheet software (Microsoft Corporation, Redmond, Wash), and analyses were performed with SAS 9.0 statistical software (SAS Institute, Inc, Cary, NC). Categorical values were compared with analysis of variance, the χ^2 test, or the Fisher exact test. Continuous variables were compared with the Student t test for normally distributed variables and the Wilcoxon test for nonnormally distributed variables. Multivariate regression analysis was used to identify independent variables that were related to CH.

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Abbreviations and Acronyms

BMI	=	body mass index
CH	=	compensatory hyperhidrosis
PH	=	palmar hyperhidrosis

Clinical Findings

There were 265 women (94%) and 17 men who underwent sympathectomy for PH. Median age was 24 years (range 14–62 years). All patients had been evaluated for secondary causes of hyperhidrosis. The final diagnosis in all 282 cases was primary PH of unknown etiology. Plantar hyperhidrosis was also present in 163 patients (59%). Medical treatment was exhausted in all cases before consideration for sympathectomy. Previous medical treatment consisted of topical agents (most commonly aluminum chloride) in all 282 cases (100%), oral medications (glycopyrrolate [Robinul, INN glycopyrronium bromide], propantheline bromide [Pro-Bathine], or β -blockers) in 223 (79%), iontophoresis in 51 (18%), palmar onabotulinumtoxinA (Botox, INN botulinum toxin type A) injections in 16 (6%), and other treatments in 85 (30%). Median period of medical treatment before sympathectomy was 59 months (range 3–480 months); 39 patients (14%) had a first- or second-degree relative with PH.

Surgical Technique

Sympathectomy was performed by two different procedures, depending on surgeon preference. The first procedure (D.L.M. and S.D.F.) was performed on an outpatient basis within the main operating room or in our ambulatory surgical center. The patients were placed in a supine position. General anesthesia was initiated with a single-lumen endotracheal tube. After the patient was asleep, the arms were extended to 90°. Excessive abduction of the upper extremities was avoided to prevent injury to the brachial plexus. Temperature probes were placed on each index finger. Each axilla was prepared in standard fashion. Attention was first directed to the right side. A single 4-mm incision was made vertically over the fourth rib along the midaxillary line. With a mosquito clamp, the chest cavity was entered over the fourth rib during suspension of ventilation. During continued ventilation suspension, a 3-mm, 30° rigid thoracoscope (KARL STORZ GmbH & Co KG, Tuttlingen, Germany) was placed. Alongside the thoracoscope, a standard laparoscopic Veress needle (Ethicon, Inc, Somerville, NJ) was placed. After the two instruments had been placed without difficulty, ventilation was resumed at decreased tidal volumes of 250 mL for women and 300 mL for men. Carbon dioxide insufflation was carried out to 10 mm Hg for approximately 60 to 90 seconds to allow partial collapse of the lung. The Veress needle was removed, and a 2-mm long electrocautery was placed through the same incision. A detailed examination of the apical and posterior chest was carried out for accurate identification of the anatomy of the sympathetic chain and its accessory nerves. Before division of the nerve, a finger temperature was taken for baseline measurement. The sympathetic chain was then divided over the second rib to complete the T2 sympathectomy, with all accessory nerves also divided with electrocautery. The cauterized ends of the nerves were separated from each other to allow at least a 1.0- to 1.5-cm gap, to diminish the chance of regrowth and possible recurrence of PH. A posttreatment temperature was taken 5 minutes after complete division of the nerve. The sympathectomy site was examined for hemostasis. A 2-mm suction catheter was then placed to the apex of the chest under direct visualization. The external end of the catheter was placed in a basin of sterile water to create a water seal to evacuate the pneumothorax. By means of sterile water immersion of the catheter, positive-pressure ventilation to 40 mm Hg, and suctioning, the pneumothorax was evacuated. After the pneumothorax had been evacuated, the catheter was removed. The skin was reapproximated with octylcyanoacrylate (Dermabond; Ethicon) adhesive and Steri-Strips (3M, St Paul, Minn). The left

side was completed in similar fashion. A 15-mL dose of 0.25% bupivacaine (Marcaine) was injected into each incision site before making the incision and at the time of closure. Also, 30 mg ketorolac was given intravenously before making the first incision.

The other sympathectomy procedure (J.I.M.) was usually performed as an inpatient procedure (observation stay) within our hospital's main operating room. General anesthesia was initiated with a double-lumen endotracheal tube. The patient was placed in a lateral decubitus position to facilitate a trans-axillary approach. The axillae were prepared in standard fashion. Attention was first directed to the right side. A 3- to 5-cm incision was placed in the axilla over the third rib. The chest cavity was entered over the third rib after initiation of single-lung anesthesia. During complete collapse of the lung, a 10-mm, 30° rigid thoracoscope (KARL STORZ) was placed. Detailed examination of the apical and posterior chest was carried out to identify accurately the anatomy of the sympathetic chain and its accessory nerves. The sympathetic chain was then divided over the second, third, and fourth ribs to complete the T2 to T4 sympathectomy with a standard long electrocautery. All accessory nerves were also divided with electrocautery. The cauterized ends of the nerves were separated from each other to allow at least a 1.0- to 1.5-cm gap to diminish the chance of regrowth and possible recurrence of PH. A 14F red rubber catheter was then placed to the apex of the chest under direct visualization. The external end of the catheter was placed in a basin of sterile water to create a water seal to evacuate the pneumothorax. With sterile water immersion of the catheter and positive pressure ventilation to 40 mm Hg, the pneumothorax was evacuated. After the pneumothorax had been evacuated, the catheter was removed. The incision was closed in layers in the usual fashion. The left side was completed in similar fashion after repositioning the patient in the right lateral decubitus fashion. Sterile dressings were applied and the patient was taken to the recovery room.

In the recovery room, an upright chest radiograph was obtained approximately 30 minutes after completion of the procedure. If the chest radiography was satisfactory and the patient was having minimal pain, the patient could be discharged after the T2 procedure but was usually observed overnight after the T2 to T4 procedure. Patients were asked to return to the clinic within 3 to 4 weeks after the procedure for follow-up.

Sympathectomies were completed bilaterally in all patients with division of the nerve at the T2 level or T2 to T4 level, respectively. Anatomically, 106 patients (38%) had accessory nerves, right-sided in 49, left-sided in 32, and bilateral in 25. All identified accessory nerves were also divided to complete the sympathectomy. Median operating times were 22 minutes (range 14–50 minutes) in the T2 group and 59 minutes (range 42–73 minutes) in the T2 to T4 group. Seven patients (2%) had a chest tube (10F) placed at the time of sympathectomy because of lysis of adhesions between the apex of the chest cavity and the lung; 6 (86%) of the chest tubes were removed within 4 hours.

RESULTS

Video-assisted thoracic surgical sympathectomy for PH was performed in 282 patients from May 2002 through July 2005; of these, 179 patients (64%) underwent division at the T2 level only and 103 patients (36%) underwent division at levels T2, T3, and T4. Median age, sex distribution, body mass index (BMI), and morbidity rate were similar between the groups (Table 1). The most common operative complication was pneumothorax in 6 patients (2%), and none of these patients had symptoms or required treatment. There were no operative deaths. Additionally, the satisfaction rate as detailed during postoperative visit was also similar between groups of patients. Patients who had division of the sympathetic chain at multiple levels, however, had a significantly higher incidence of CH ($P = .026$).

TABLE 1. Patient characteristics by level of sympathectomy

	T2 level (n = 179)	T2–T4 level (n = 103)	P value
Age (y, median)	23	24	.831
Sex (no.)			.912
Male	11	6	
Female	168	97	
Compensatory hyperhidrosis (no.)	23 (13%)	35 (34%)	.011
Morbidity (no.)	12 (7%)	9 (9%)	.693

Follow-up was complete for all 282 patients and ranged from 1 to 42 months (median 26 months). CH developed in 58 patients (21%), 23 in the T2 group and 35 in T2 to T4 group. In both groups, the most common areas of CH were the lower back and abdomen. Ten patients with CH (17%) required pharmaceutical interventions. Most patients reported a decrease or near complete resolution of CH within 6 to 9 months after surgery. Five patients (2%), however, stated that they wished that they had not undergone the procedure because of unrelenting CH even though their PH resolved; 4 patients (80%) were in the multilevel group and only 1 in the T2 group. Multivariate regression analysis demonstrated that multiple level sympathetic chain division, greater BMI, and older age were independent predictors for development of CH (Table 2).

Successful sympathectomy was achieved for 99% of palmar surfaces without recurrence. A single patient had recurrent sweating of the left hand 1 week after sympathectomy. Reoperation was performed 4 weeks after the sympathectomy, with division at the T3 level. The patient had no accessory nerves identified. The reoperation was successful without development of CH.

DISCUSSION

Sympathectomy for medical refractory primary PH is extremely successful. The incidence of CH is disturbing, however, and varies depending on the indication for the procedure, level of sympathectomy, and the number of levels treated.²⁻⁵ Controversy exists regarding which and how many levels should be divided. Hsu and colleagues⁶ demonstrated a significant reduction in the incidence of CH after switching from a T2 to T4 sympathectomy to a T2 sympathectomy, with CH reduced from 64% to 25%. Early in our experience, we routinely performed a three level (T2–T4) sympathectomy with removal of the entire chain with excellent results for control of PH, but our CH rate was greater than 90%. During the last 4 years, we have adapted Hsu and colleagues’ single-level sympathectomy procedure for PH. In this study, we achieved a significant reduction in the incidence of CH to 13% with a single-level sympathectomy. Unfortunately, our only dissatisfied patient in the T2 group was

TABLE 2. Characteristics and outcomes of patients with compensatory hyperhidrosis

	Patients with CH (n = 58)	All other patients (n = 224)	P value
Level (no.)			.004
T2	23 (40%)	156 (66%)	
T2–T4	35 (60%)	79 (34%)	
Morbidity (no.)	2 (4%)	19 (8%)	.361
Body mass index (kg/m ² , median)	28.2	24.5	.048
Sex (no.)			
Male	2 (3%)	15 (7%)	
Female	56 (97%)	209 (93%)	.218
Age (y, median)	31	23	.037

CH, Compensatory hyperhidrosis.

unhappy because of significant CH, even though she had complete resolution of her PH and plantar hyperhidrosis.

The mechanism of CH is related to the thermoregulatory function of the remaining sweat glands after the decrease in function of a large number of sweat glands.⁷ Treatment of CH is usually unsatisfactory. In a small number of patients, CH may respond to anticholinergic agents, such as glycopyrrolate, but the benefits are usually short-lived. A standard sympathectomy is a permanent procedure. Therefore, if CH develops, it is usually a permanent condition. If CH is unrelenting, a patient may undergo a sural nerve graft interposition to reestablish the continuity of the sympathetic chain. Telaranta⁸ claims that CH can be reversed by reconstructing the severed sympathetic trunk with a sural nerve interposition graft. The long-term results of this procedure, however, are in question.

Another possible way to deal with CH is to perform a reversible sympathectomy by placing clips on the nerve, instead of transecting it. These clips may be removed at a later date if CH is problematic. Lin and colleagues⁹ were the first surgeons to develop and describe this potentially reversible technique. One drawback of this procedure, however, is that in a small but significant percentage of patients the sympathetic impulse is not completely interrupted with the clips as it would be with a complete sympathectomy. Thus the overall satisfaction of this “reversible sympathectomy” is reduced because of failure to eliminate the primary hyperhidrosis. Others have also recommended this procedure for reversibility of CH.¹⁰⁻¹² We have operated on several patients who have had clips placed by other surgeons. We were successful in removing the clips without transecting the nerve, but none of the patients had their CH corrected. The clips more than likely caused permanent damage to the nerve that would not allow regrowth or acceptable signaling along its path. At present, an ideal reversible sympathectomy is not available to address the issue of post-sympathectomy CH.

GTS

In this series, three factors were found to have a significant impact on the development of CH: multilevel sympathectomy, BMI greater than 28 kg/m², and age older than 31 years. This is not the only series to show that multilevel sympathectomy results in increased rate of CH.^{13,14} Our study is unique, however, in that we were able to determine the difference in incidence of postsympathectomy CH between two different procedures for the same indication, PH, at a single institution. The incidence of CH was almost 3-fold greater in our multilevel sympathectomy group than in our single-level group.

Patients who seek surgery for primary PH vary in body mass. Patients who are heavier usually experience total body excessive sweating, rather than sweating in isolated areas.¹⁵ Patients who have a higher BMI also usually have more difficulty with thermoregulation.¹⁶ It is therefore not surprising that the patients with a higher BMI (>28 kg/m² in our series) had more CH, as was also observed by deCampos and colleagues.¹⁷ Patients who are heavier should be educated about their increased risk of CH after sympathectomy and told that their increased weight may also contribute to their underlying condition. It is essential that before proceeding with a sympathectomy in any patient that all conservative therapy be exhausted. If there is an issue with excessive weight, then that should be addressed before proceeding with a sympathectomy.

A patient's age can also affect a wide array of diseases and their associated outcomes. It was surprising that the patients in our series who were older (>31 years) had more CH than did our younger patients. The median ages of the two procedural groups were similar. This is the first series of which we are aware to show an increased incidence of CH in older patients. Increased age may be associated with excessive sweating because of secondary causes, such as hypertension, diabetes, hyperthyroidism, or other endocrine problems, but otherwise sweating usually diminishes with increasing age.^{18,19} When patients who are older than 25 years and have had symptoms for less than 5 years are referred to our institution for treatment of hyperhidrosis, they undergo a formal evaluation to rule out systemic disease that might be causing excessive sweating. All the patients in this series had primary hyperhidrosis with symptoms starting in childhood or adolescence. The increased rate of CH in our older patients was not related to secondary hyperhidrosis. Older patients should also be educated about increased risk of CH after sympathectomy for primary PH.

Our study has several limitations. First, it was a retrospective study. The surgical data on each patient were placed into a database prospectively, but the CH data were retrospectively reviewed from the postoperative patient CH questionnaires and clinic charts. Second, this study was not prospectively randomized for comparison between sympathectomy levels of incidence of CH after sympathectomy for PH. We believe, however, that because the operations were performed within a single health care system for the

same indication in both groups and the groups were demographically equivalent that the significant difference between the groups was valid. Finally, the follow-up was relatively short. Long-term success of this procedure has been well-documented, with late recurrence minimal.^{20,21} The natural history of prolonged CH is not known, but if it does not occur within the first 2 to 4 weeks after the sympathectomy, it will not develop later.^{22,23} Our early results suggest that a single-level sympathectomy for a patient with medical refractory PH has a high success rate and low incidence of CH.

In closing, CH can be as psychologically debilitating for affected individuals as their primary PH. A multicenter, prospective trial is warranted to determine at which level a sympathectomy should be performed for PH to achieve the greatest benefit with the lowest risk of CH. At present, we are extremely pleased with a T2 sympathectomy for our patients with medically refractory primary PH. Patients who are older and those with elevated BMI should be warned about their increased risks of CH. Ideal patient selection continues to be essential for the overall success of sympathectomy for PH.

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