Video-Assisted Sympathectomy for Essential Hyperhidrosis*

Effects on Cardiopulmonary Function

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Background: Essential hyperhidrosis is characterized by overactivity of the sympathetic fibers passing through the upper-dorsal ganglia (second and third thoracic ganglia [D2-D3]), and the treatment of choice is video-assisted thoracoscopic sympathectomy. Alterations in cardiopulmonary function after treatment have been reported.

Study objective: To evaluate cardiopulmonary function impairment after sympathectomy in patients with essential hyperhidrosis.

Design and setting: Prospective controlled trial at a pulmonary function unit of a university hospital.

Patients: Twenty patients (2 men and 18 women) with essential hyperhidrosis.

Measurements and results: Pulmonary function tests, including spirometry and thoracic gas volume, bronchial challenge with methacholine, and maximal exercise, were performed before and 3 months after D2-D3 sympathectomy. Video-assisted sympathectomy was performed using a one-stage bilateral procedure with electrocoagulation of D2-D3 ganglia. Pulmonary function values (spirometrics and volumes) were not statistically different in the two groups. The maximal midexpiratory flow was the only variable that showed significant changes, from 101% (SD, 26%) to 92% (SD, 27%) [p < 0.05]. Ten patients had positive bronchial challenge test results that remained positive 3 months after surgery, and 2 patients whose challenge test results were negative before surgery became positive after sympathectomy. Significant reductions in maximal heart rate (HR) and oxygen and carbon dioxide uptakes were observed during the maximal exercise test.

Conclusions: Video-assisted thoracoscopic sympathectomy is a safe treatment, and the observed modifications in cardiopulmonary function only suggest a minimal small airway alterations in the presence of positive bronchial hyperresponsiveness and mild sympathetic blockade in HR. The clinical importance of these findings is not significant. (CHEST 2005; 128:2702–2705)

Key words: autonomic function; cardiopulmonary function; essential hyperhidrosis; exercise testing; video-assisted thoracoscopic sympathectomy

Abbreviations: bpm = beats per minute; D2-D3 = second and third thoracic ganglia; HR = heart rate; kpm = kilopond-meters per minute; MMEF = maximal midexpiratory flow; PD20 = provocation dose of methacholine causing a 20% fall in FEV1; RQ = respiratory quotient; TLC = total lung capacity; VCO2 = carbon dioxide output; VO2 = oxygen uptake

Essential hyperhidrosis is characterized by excessive sweating of the palms, soles, and armpits, caused by sympathetic nervous system hyperactivity at the second and third thoracic ganglia (D2-D3).1

This exaggerated manifestation of the physiologic response of sweating2 affects 1% of the population.3 Treatment by video-assisted thoracoscopic sympathectomy, by which the sympathetic chain is interrupted at D2-D3 by electrocoagulation and resection, is safe and effective.4 Noppen et al3–7 reported effects of such treatment on cardiopulmonary function, such as reduction in FEV1 and total lung capacity (TLC), bronchial hyperresponsiveness, and a lower heart rate (HR) during maximal exercise. The observed effects were attributed to surgical denervation and were compared to the effects of treatment with β-blockers.

Patients with essential hyperhidrosis have auto-
nomic nervous system impairment with a predominance of the sympathetic system, and thoracoscopic sympathectomy modifies spirometric values, producing a reduction in HR during maximal exercise testing because of loss of the capacity of the sympathetic nervous system to respond. The aim of our study was to assess the effects of sympathectomy on cardiopulmonary function before and after 3 months of surgery and its clinical importance.

**Materials and Methods**

**Patients**

Twenty patients (18 women and 2 men) who had essential hyperhidrosis for 5 years were studied over a period of 2 years (mean age, 29 years; SD, 7.6 years; range, 17 to 43 years). Nine patients were smokers, and one patient was an ex-smoker. Physical examination was normal, and only two patients had a history of asthma, although they were not being treated. Thirteen patients (65%) had severe hyperhidrosis on the hands and feet, and 7 patients (35%) had hyperhidrosis in the armpits. In all, sweating was refractory to local treatment with botulinum toxin and to systemic treatment with anticholinergic medication.

**Study Design**

Spirometry and flow-volume loops were measured before and 3 months after surgery. Spirometry was performed (Datospir 120; Sibelmed; Barcelona, Spain) according to the standards of the Spanish Society of Pulmonology and Thoracic Surgery. At least three maneuvers were performed, and the two best reproducible maneuvers were recorded. FVC and FEV1 were required to be reproducible within 5%. We also measured maximal voluntary ventilation. Thoracic gas volume was measured (SensorMedics 2450 U; SensorMedics; Biltlven, the Netherlands) according to the standards of the European Respiratory Society. A dose-response test was performed with increasing doses of methacholine chloride (0.1 to 32 mg/mL) every 5 min. Provocation was stopped if the highest concentration (32 mg/mL) was tolerated, or if a 20% fall in FEV1 was induced; hence, the provocative dose of methacholine causing a 20% fall in FEV1 (PD20) was recorded. In our laboratory, bronchial hyperresponsiveness is defined if the PD20 is <16 mg/mL.

The next day, cardiovascular exercise testing was performed with a cycle ergometer (Collins CPX; Warren E. Collins; Braintree, MA) using a maximal, symptom-limited incremental exercise testing protocol consisting of 1-min stages with workload increments of 100 kilopond-meters per minute (kpm), to the maximum tolerated by patient, following the protocol of Jones. Patients breathed through a mouthpiece connected to a pneumotachograph. Three-lead ECG and transcutaneous oxygen saturation data were gathered continuously and stored on-line. Each minute, BP and HR were measured, and the patient was administered a questionnaire asking about chest pain, leg pain, and dyspnea. The patient could stop the test at any time. The variables measured were oxygen uptake (VO2), carbon dioxide output (VCO2), respiratory quotient (RQ), minute ventilation, HR, and maximal workload reached. Spirometric measurements were performed at baseline before exercise testing and at 1, 5, and 15 min after testing.

**Thoracoscopic Sympathectomy**

All interventions were performed in an operating theater and with the patient under general anesthesia and selective intubation. The patient underwent surgery in a semiprone position, sitting with back supported at a 45° angle and both arms abducted 90°. After the lung was partially collapsed, a thoracoscope was inserted through the second or third intercostal space at the midaxillary line. The sympathetic chain was identified by means of a monopolar electrocoagulator and then divided on the second rib and destroyed by thomocoagulation using the same coagulator. To evaluate the effectiveness of the technique during surgery, the digital temperature was measured. A gradual increase of 2° to 3°C indicated adequate sympathectomy. All patients underwent bilateral dorsal sympathectomy by video-assisted thoracoscopy and electrocoagulation of D2-D3 in 1 patient, third and fourth thoracic ganglia in 6 patients, and third thoracic ganglia only in the 13 remaining patients.

**Statistical Analysis**

Data are expressed as means (SD). A two-tailed t test was used to compare paired data recorded before and after surgery. A regression model was used to compare HR and workload during the maximal exercise test before and after surgery. A p value < 0.05 was considered statistically significant.

**Results**

In all patients, the disappearance of essential hyperhidrosis after sympathectomy was confirmed. During the postoperative period, only one patient required placement of a chest tube to treat pneumothorax. The rest were discharged without complications in 24 h. In the follow-up visit 1 month after surgery, the patients expressed high satisfaction despite compensatory hyperhidrosis present in 80%, located on the back (30%), chest (20%) or abdomen (15%). In the following visits, no patient complained about respiratory symptoms such as dyspnea or bronchial hyperresponsiveness. After 3 months of surgery, all patients had normal spirometric values, and the only change observed was a statistically significant decrease in maximal midexpiratory flow (MMEF), from 101% (SD, 26%) to 92% (SD, 27%) [Table 1].

Ten patients (50%) had a positive response to methacholine challenge that remained positive 3 months after sympathectomy, with a mean PD20 ranging from 1.8 mg/mL (SD, 2.3 mg/mL) to 0.87 mg/mL (SD, 0.79 mg/mL). Two patients had a negative bronchial challenge test result before surgery that became positive after surgery.

During the maximal exercise test, the peak HR decreased significantly after surgery, from 172 beats per minute (bpm) [SD, 17 bpm] to 164 bpm (SD, 15 bpm) [p < 0.05]. Figure 1 shows the relation between HR and load during the maximal exercise test using a regression model with an RQ from 0.99 to 0.95, before and after surgery.
Statistically significant differences between presurgical and 3-month follow-up values were found for maximal VO₂, maximal VCO₂, and RQ. These results are showed in Table 2. There were no significant differences between baseline and postoperative maximal exercise test values.

**Discussion**

The observed modifications in cardiopulmonary function after bilateral dorsal sympathectomy suggest that there is a slight effect of the intervention on the small airway, as evidenced by the presence of bronchial hyperresponsiveness in half of the studied patients and on a mild reduction in maximal HR.

In 1980, prior to the development of the current surgical technique, Molho et al. described symptomatic changes in pulmonary function in 15 patients, specifically a decrease of 20 to 25% in MMEF as a consequence of supraclavicular sympathectomy. Later, in 1995, when Noppen et al. compared spirometry and flow-volume loops before and 6 weeks after video-assisted sympathetic thoracotomy at D2-D3 in a group of 47 patients with essential hyperhidrosis, they observed no lasting respiratory symptoms such as dyspnea. Although those authors found a statistically significant decreases in FEV₁, MMEF, and TLC at 6 weeks of sympathectomy, reevaluation of 35 patients at 6 months showed that TLC had returned to normal values and MMEF remained altered. They concluded that thoracoscopic sympathectomy causes only minimal, subclinical changes in pulmonary function secondary to a temporary small decrease in lung volume, which is inherent to the thoracoscopic procedure. The permanent decrease in MMEF was attributed to the surgical denervation, and they suggested that bronchomotor tone may be influenced by the sympathetic nervous system, in contrast with the current opinion that airway bronchial motor tone is not influenced by this system.

Although the etiopathogenesis of asthma is now considered to be related to chronic airway inflammation, our results reveal that impairment in sympathetic nervous system in these patients may be able to produce an increase in bronchial motor tone. Half of our patients had a positive methacholine bronchial challenge test result before surgery, yet only two patients had a previous history of asthma. This observation is consistent with the theory proposed by Szentivanyi in the late 1960s that asthma is caused by an imbalance between two antagonistic systems: the α-adrenergic system and cholinergic hyperactivity, and hyporesponsiveness of the β-adrenergic system. This theory is partially supported by our findings, specifically by the implication that hyperreactivity is related to sympathetic nervous system

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**Table 1—Changes in Pulmonary Function Before and After Video-Assisted Thoracoscopic Sympathectomy**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC, %</td>
<td>97 (12)</td>
<td>96 (12)</td>
</tr>
<tr>
<td>FEV₁, %</td>
<td>101 (14)</td>
<td>98 (14)</td>
</tr>
<tr>
<td>FEV₁/FVC, %</td>
<td>86 (12)</td>
<td>82 (7)</td>
</tr>
<tr>
<td>MMEF, %</td>
<td>101 (26)</td>
<td>92 (27)</td>
</tr>
<tr>
<td>Residual volume, %</td>
<td>89 (29)</td>
<td>81 (21)</td>
</tr>
<tr>
<td>Functional residual capacity, %</td>
<td>86 (16)</td>
<td>83 (14)</td>
</tr>
<tr>
<td>TLC, %</td>
<td>100 (10)</td>
<td>96 (11)</td>
</tr>
<tr>
<td>PD₂₀, mg/mL</td>
<td>1.8 (2)</td>
<td>0.9 (0.8)</td>
</tr>
</tbody>
</table>

*Data are presented as mean (SD).†Statistically significant, p < 0.05.

**Table 2—Changes in Maximal Exercise Test Variables Before and After Video-Assisted Thoracoscopic Surgery**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workload at peak, kpm</td>
<td>874 (200)</td>
<td>853 (158)</td>
</tr>
<tr>
<td>VO₂ at rest, L/min</td>
<td>0.26 (0.007)</td>
<td>0.24 (0.005)</td>
</tr>
<tr>
<td>VO₂ peak, L/min</td>
<td>1.34 (0.43)</td>
<td>1.23 (0.38)</td>
</tr>
<tr>
<td>VCO₂ at rest, L/min</td>
<td>0.19 (0.006)</td>
<td>0.19 (0.005)</td>
</tr>
<tr>
<td>VCO₂ peak, L/min</td>
<td>1.80 (0.49)</td>
<td>1.66 (0.41)</td>
</tr>
<tr>
<td>RO at rest</td>
<td>0.73 (0.008)</td>
<td>0.80 (0.007)</td>
</tr>
<tr>
<td>RO peak</td>
<td>1.37 (0.20)</td>
<td>1.38 (0.16)</td>
</tr>
<tr>
<td>HR at rest, bpm</td>
<td>79 (12)</td>
<td>77 (11)</td>
</tr>
<tr>
<td>HR maximal, bpm</td>
<td>172 (7)</td>
<td>164 (15)</td>
</tr>
<tr>
<td>Systolic BP at rest, mm Hg</td>
<td>111 (10)</td>
<td>111 (18)</td>
</tr>
<tr>
<td>Systolic BP maximal, mm Hg</td>
<td>184 (24)</td>
<td>175 (31)</td>
</tr>
<tr>
<td>Diastolic BP at rest, mm Hg</td>
<td>71 (8)</td>
<td>68 (7)</td>
</tr>
<tr>
<td>Diastolic BP maximal, mm Hg</td>
<td>93 (9)</td>
<td>87 (14)</td>
</tr>
</tbody>
</table>

*Data are presented as mean (SD).†Statistically significant, p < 0.05.

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Figure 1. Relation between work and HR during maximal exercise test before and after surgery.
activity at different locations: the skin, the lung, and the heart. The bronchi of patients with essential hyperhidrosis behave like the bronchi of “pseudoasthmatic” patients before surgery, and that behavior persists and may increase after surgery, manifested by a decrease of MMEF and positive methacholine challenge test results.

Thoracoscopic sympathectomy, however, does not seem to influence exercise capacity, as it produces only minimal effects on the response of the heart. Our results suggest that hyperactivity of the sympathetic nervous system has a minimal effect on cardiac function in a maximal exercise test, consistent with the fact that HR at rest is under the influence of vagal tone, whereas during exercise increased HR is due to a decrease of vagal tone and an increase of sympathetic tone. Our finding that maximal HR decreased significantly after surgery was different from the results reported by Noppen et al. who found that HR decreased both at rest and at maximal exercise. Other researchers have found the behavior of HR during exercise after surgery to be similar to that of a patient who takes β-blockers, and that the hyperfunction of sympathetic fibers is completely abolished by thoracoscopic sympathectomy. The differences observed in metabolic parameters may be attributable to the fact that in symptom-limited testing of our patients, VO₂ and VCO₂ would be reduced because of lack of training after surgery.

The clinical repercussions of these respiratory events (bronchial hyperresponsiveness, decrease in MMEF and maximal HR) are slight for the patient, as is demonstrated by the fact that no patient reported respiratory or cardiac symptoms after surgery. We conclude that video-assisted thoracoscopic sympathectomy is a safe surgical treatment for essential hyperhidrosis. In relation to respiratory symptoms, this surgery produces slight bronchial obstruction, suggesting that in patients with essential hyperhidrosis bronchial motor tone is influenced by the sympathetic nervous system. Further, in relation to cardiac function, thoracoscopic sympathectomy does not affect metabolic parameters, and the patients can perform a maximal exercise test without complications, despite presenting a decrease in HR at rest.

REFERENCES


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