Arch Bronconeumol. 2010;**46(1)**:3-6

ELSEVIER DOYMA

ARCHIVOS DE BRONCONEUMOLOGIA

www.archbronconeumol.org

Original Article

Bilateral Dorsal Sympathectomy for the Treatment of Primary Hyperhidrosis: Effects on Lung Function at 3 Years

Laura Vigil,* Núria Calaf, Teresa Feixas, and Pere Casan

Unitat de Funció Pulmonar, Departament de Pneumologia, Hospital de la Santa Creu i de Sant Pau, Facultat de Medicina, Universitat Autònoma de Barcelona, Barcelona, Spain

ARTICLE INFO

Article history:
Received September 16, 2008
Accepted January 20, 2009
Available online May 29, 2009

Keywords:
Primary hyperhidrosis
Bilateral dorsal sympathectomy
Bronchial hyperresponsiveness

ABSTRACT

Introduction: Primary hyperhidrosis is characterized by excessive sweating of the palms, soles, and axillae due to overactivity of the sympathetic nervous system at the level of the second and third sympathetic thoracic ganglia. The treatment of choice is bilateral dorsal sympathectomy performed using video-assisted thoracic surgery (VATS). The objective of our study was to determine whether lung function changes observed in a group of patients prior to bilateral dorsal sympathectomy performed using VATS were still evident 3 years after surgery.
Patients and methods: Of the 20 patients studied at baseline, we were able to obtain data for 18 (3 men and 15 women; mean age, 35 y). They underwent spirometry and a bronchial challenge test with methacholine, and the fraction of exhaled nitric oxide (FE_{NO}) was measured. The results were compared with those of the tests performed before surgery.
Results: At 3 years from baseline, we detected a statistically significant increase in forced vital capacity from a mean (SD) of 96% (10%) to 101% (11%) (P=.008), and a statistically significant decrease in midexpiratory flow rate from 3.8 (0.9) L/s to 3.5 (0.9) L/s (P=.01). The results of the bronchial challenge test with methacholine and the FE_{NO} remained unchanged.
Conclusions: The lung function changes detected point toward minimal, clinically insignificant small airway alterations due to sympathetic denervation following bilateral dorsal sympathectomy performed 3 years earlier.

Simpatectomía dorsal bilateral en el tratamiento de la hiperhidrosis esencial: efectos a los 3 años sobre la función pulmonar

Palabras clave:
Hiperhidrosis esencial
Simpatectomía dorsal bilateral
Hiperrespuesta bronquial

RESUMEN

Introducción: La hiperhidrosis esencial se caracteriza por un exceso de sudoración en la palma de las manos, la planta de los pies y las axilas, debida a una hiperestimulación del sistema nervioso simpático que pasa a través del segundo y tercer ganglios torácicos simpáticos. El tratamiento de elección es la simpatectomía dorsal bilateral (SDB) por videotoracoscopia. El objetivo de nuestro estudio ha sido evaluar si las modificaciones en la función respiratoria halladas previamente en un grupo de pacientes intervenidos por SDB se mantenían a los 3 años de la cirugía.
Pacientes y métodos: Del grupo de 20 pacientes estudiados previamente, pudimos reunir a 18 (3 varones y 15 mujeres) con una edad media de 35 años. Se les realizaron una espirometría y una prueba de provocación bronquial con metacolina, y se determinó la concentración de óxido nítrico en aire espirado. Los resultados se compararon con los de las pruebas efectuadas antes de la cirugía.
Resultados: A los 3 años se detectó un incremento estadísticamente significativo del porcentaje de la capacidad vital forzada basal, que pasó de un valor medio ((desviación estándar) del 96 (10% al 101 (11% (p = 0,008). Respecto a las cifras iniciales del flujo máximo mesoespiratorio, se halló un descenso estadísticamente significativo a los 3 años de la cirugía: de un valor basal de 3,8 (0,9 l/s se pasó a 3,5 (0,9 l/s (p = 0,01). La prueba de provocación bronquial con metacolina y la concentración de óxido nítrico en aire espirado no experimentaron cambios a los 3 años.
Conclusiones: Las modificaciones en la función pulmonar indican una mínima afectación de la pequeña vía aérea, que persiste a los 3 años de la SDB, como consecuencia de la denervación simpática producida por la cirugía, pero sin ninguna significación clínica.

*Corresponding author.
E-mail address: lvigil@santpau.cat, lvigil@tauli.cat (L. Vigil).

0300-2896/$ - see front matter

Introduction

Primary hyperhidrosis is characterized by excessive sweating of the palms, soles, and axillae due to overactivity of the sympathetic nervous system at the level of the second and third thoracic ganglia (T_2-T_3). This condition is an exaggerated response to a physiologic action such as sweating, and affects approximately 1% to 2.8% of the population, depending on the series.[1] Although its pathophysiology is unknown, it is believed to be caused by hyperstimulation of the sympathetic nervous system that passes through the thoracic ganglia. This in turn could lead to abnormal innervations of the eccrine glands, which are ultimately responsible for excessive sweating on the palms.[2]

The treatment of choice is bilateral dorsal sympathectomy of the second and third thoracic ganglia performed using video-assisted thoracic surgery (VATS) in a single procedure. This approach is safe, fast, efficient, and minimally invasive. Previous series have shown mortality to be very low.[2,3] The most common side effect is compensatory sweating on the back, abdomen, buttocks, and lower limbs. There have also been reports of spirometric abnormalities and bronchial hyperresponsiveness, which are attributed to sympathetic denervation, indicating greater activity of the autonomic nervous system in patients with this condition.[4]

When we studied cardiopulmonary abnormalities in a group of patients who had undergone this procedure, we observed alterations in the small airways, although these had no clinical manifestations.[5] In this study, we evaluate the consequences and relevance of these abnormalities over a longer period of time.

Patients and Methods

In our previous study,[5] we analyzed modifications in lung function 3 months after surgery. All the patients had undergone forced spirometry, a bronchial challenge test with methacholine, and exercise testing with a cycle ergometer before surgery and 3 months after surgery. Three years after surgery we contacted the patients by telephone to reevaluate their lung function. Eighteen of the original 20 patients agreed to participate in the study. The other 2 refused to participate, although we do not know whether they had symptoms or had consulted with respiratory problems. The study population comprised 15 women and 3 men with a mean age of 35 years (range, 25-47 years). Ten (55.6%) were smokers. Only 2 (11.1%) had a history of mild intermittent asthma; this was well controlled and did not require treatment at the time of surgery or 3 years later. They had all undergone bilateral dorsal sympathectomy using VATS and electrocautery of the second and third ganglia. Lung function testing was repeated, although on this occasion we included determination of the fraction of exhaled nitric oxide (FE_{NO}) and we did not carry out exercise testing with a cycle ergometer. They were also asked about the presence of compensatory sweating and its location.

We performed spirometry testing using a Datospir 120 device (Sibelmed, Barcelona, Spain) according to the procedure set out by the Spanish Society for Pulmonology and Thoracic Surgery (SEPAR),[6] and determined the following standard spirometric variables: forced vital capacity (FVC), forced expiratory volume in 1 second (FEV_1), FEV_1/FVC ratio, and forced expiratory flow, midexpiratory phase ($FEF_{25\%-75\%}$). The bronchial challenge test with methacholine was performed according to the guidelines of the European Respiratory Society.[7] In our laboratory, we consider that bronchial hyperresponsiveness exists when the dose of bronchoconstrictor required to produce a 20% fall in baseline FEV_1 is less than 16 mg/mL. We previously determined FE_{NO} in particles per billion (ppb) using the chemiluminescence sensor SIR-N-6008 (SIR, Madrid, Spain) according to the guidelines of the American Thoracic Society.[8] We performed 2 technically correct determinations and considered the mean value as valid. The cutoff between healthy and ill established in our laboratory is 20 ppb.[9] We measured patient satisfaction according to the following scale: very satisfied, satisfied, or very unsatisfied. We compared the results with those obtained after surgery.[3]

Statistical Analysis

Data are expressed as mean (SD). Baseline and 3-year data were compared using Wilcoxon nonparametric tests due to the sample size. Correlations were also calculated using the Spearman rank correlation. SPSS version 15 was used for the analysis. Statistical significance was set at a *P* value of .05.

Results

Three years after surgery, patients expressed a degree of satisfaction that was similar to that expressed at the time of the procedure: 16 (88%) were very satisfied, 1 (6%) was not satisfied, and 1 (6%) was very unsatisfied due to compensatory sweating. During the 3-year period, they had not experienced respiratory problems related to effort dyspnea or symptoms indicating bronchial hyperresponsiveness. The most noticeable side effect was compensatory sweating (89%) on the trunk (56% of cases), abdomen (22%), or both (11%). Table 1 shows the distribution by gender and site.

All the patients had spirometry results within the reference limits 3 years after surgery. The values for FVC and FEV_1 did not show statistically significant differences, except when FVC was compared as a percentage of the reference value, increasing from a mean (SD) of 96% (10%) to 101% (11%) ($P = .008$). There was a statistically significant decrease in baseline $FEF_{25\%-75\%}$ 3 years after surgery: this fell from 3.8 (0.9) L/s at baseline to 3.5 (0.9) L/s ($P = .01$) (Table 2).

Table 1
Distribution of Compensatory Sweating 3 Years After Surgery According to Site and Gender

Compensatory Sweating	Gender		Total
	Male	Female	
No.	0	2	2 (11%)
Thorax	3	7	10 (56%)
Abdomen	0	4	4 (22%)
Thorax and abdomen	0	2	2 (11%)
Total	3 (17%)	15 (83%)	18 (100%)

Table 2
Changes in Lung Function 3 Years After Surgery[a]

	Baseline	At 3 Years
FVC, L	4.02 (0.7)	4.11 (0.6)
FVC, %	96 (9.5)	101 (11.2)[b]
FEV_1, L	3.40 (0.6)	3.44 (0.6)
FEV_1 (%)	101 (11.8)	104 (13.7)
FEV_1/FVC, %	84 (5.9)	83 (4.6)
$FEF_{25\%-75\%}$, L/s	3.76 (0.9)	3.45 (0.9)[b]
$FEF_{25\%-75\%}$, %	102 (22.1)	98 (22.3)[b]
FE_{NO} (ppb)	10 (9.4)	6 (5.4)

Abbreviations: $FEF_{25\%-75\%}$, forced expiratory flow, midexpiratory phase; FE_{NO}, fraction of nitric oxide in exhaled air; FEV_1, forced expiratory volume in 1 second; FVC, forced vital capacity.

[a]Data are expressed as mean (SD).

[b]$P < .05$

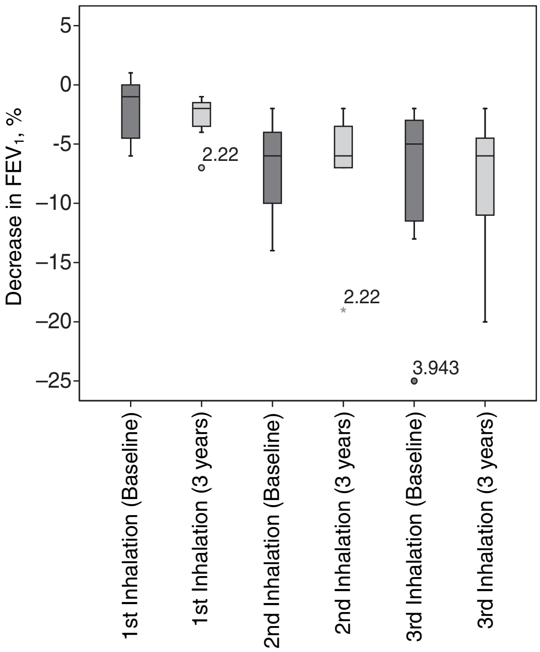

Figure. Decrease in forced expiratory volume in 1 second during the bronchial challenge with methacholine. The boxes representing the different inhalations at 3 years show a lower mean than at baseline. FEV_1 indicates forced expiratory volume in 1 second.

There were no changes in the results of the bronchial challenge test with methacholine 3 years after surgery. (The only patient in whom it was positive at baseline gave a negative result after 3 years). All the men had a negative result in the bronchial challenge test and the only patient with a positive result was a woman. Statistically significant differences were noticed, however, in the spirometry values of the bronchial challenge test: the fall in FVC, FEV_1, and $FEF_{25\%-75\%}$ values after inhalation of methacholine was greater 3 years after surgery.

The figure shows the fall in FEV_1 during the different inhalations of the bronchial challenge test with methacholine, both at baseline and 3 years after surgery. Analysis of the relationship between compensatory sweating and the challenge test with methacholine after 3 years revealed a nonsignificant correlation ($r = 0.3$; Spearman correlation coefficient = 0.3). We also analyzed the correlation between age 3 years after surgery and compensatory sweating; a negative relationship was observed, with a correlation coefficient of −0.4, which was statistically significant ($P = .05$).

FE_{NO} did not reach abnormal values in any of the 3 determinations. We only observed an increase after surgery—although this was not statistically significant—from 10 (9) ppb to 15 (13) ppb, before returning to even lower values 3 years after surgery (6 [5] ppb).

Discussion

The main observation of our study was that the functional abnormality detected in the small airway of patients who underwent bilateral dorsal sympathectomy to treat primary hyperhidrosis is still present 3 years after surgery, although the patients remain clinically asymptomatic.

Studies to date evaluate alterations in lung function at 1, 3, and 6 months after sympathectomy. Only 1 recent study provides data 1 year after surgery. Ponce González et al[10] studied a group of 37 patients who underwent forced spirometry before surgery, and at 3 months and 1 year after surgery. They observed a decrease in FVC, FEV_1, and $FEF_{25\%-75\%}$ at 3 months, although FVC returned to baseline values at 12 months, whereas FEV_1 and $FEF_{25\%-75\%}$ remained significantly low (−2.8% and −11.2%, respectively). These findings are consistent with ours, and corroborate the persistence of minimal bronchial obstruction 3 years after surgery. This appears to be associated with the influence of the sympathetic nervous system on bronchomotor tone.

As previously mentioned, the airway is innervated mainly by the parasympathetic nervous system. Sympathetic innervation, although scant, indirectly affects motor tone and could have caused the mild residual obstructive pattern after surgery. Despite the doubtful role of the sympathetic nervous system in the lung, a series of physiologic studies show the effect of sympathetic nervous activity after bilateral dorsal sympathectomy.[11,12] The first was by Noppen and Vincken,[4] who compared the results of lung function studies (spirometry, diffusion, and lung volumes using plethysmography) in 47 patients before dorsal sympathectomy performed using VATS, at 6 weeks, and at 6 months (previous studies had been performed using invasive techniques [thoracotomy]). A statistically significant decrease was observed in FEV_1, $FEF_{25\%-75\%}$, and total lung capacity 6 weeks after surgery. At 6 months, the authors again evaluated the 35 patients and found that total lung capacity had returned to normal values, whereas $FEF_{25\%-75\%}$ remained low. They attributed the permanent decrease in $FEF_{25\%-75\%}$ to the sympathetic denervation produced by surgery, and stressed that, in patients with primary hyperhidrosis, bronchomotor tone is influenced by the sympathetic nervous system. This contrasts with the common opinion that motor tone in the airway is not affected by this system. Both the study by Ponce González et al,[10] who evaluated their patients at 1 year, and our study, in which we evaluated patients at 3 years, show that persistence of the decrease in $FEF_{25\%-75\%}$ over time is related more to sympatholysis of the ganglia than to VATS.

As for challenge testing with methacholine, our results revealed no changes 3 years after surgery. Pre-surgery positive challenge test results remained unchanged, and, in the only patient whose result became positive after surgery, baseline values were again observed after 3 years. Although inflammation is now widely accepted as the cause of asthma,[13] autonomic nervous system disorders affecting the airway could contribute to the symptoms of asthma. In our patients, bronchial hyperresponsiveness does not seem to be associated with inflammation, since FE_{NO} remained below abnormal values.

Noppen and Vincken[14] also studied a group of 35 patients who underwent bronchial challenge with histamine 6 weeks and 6 months after sympathectomy. They concluded that the partial sympathetic denervation of the lungs with an intact parasympathetic nervous system would lead to increased bronchial hyperresponsiveness—especially when bronchomotor tone is increased—that could be compared with exacerbation of bronchial hyperresponsiveness observed after administration of β-blockers in patients with asthma. Nevertheless, none of the patients in the studies presented symptoms related to bronchial hyperresponsiveness.

In most of the series reviewed,[15,16] the main side effect of bilateral dorsal sympathectomy was compensatory sweating, present in approximately 80% of cases. The most frequent sites are the thorax, back, and abdomen, and the condition is generally not related to the type of surgery or the number of ganglia removed. Our study revealed that compensatory sweating was associated with the bronchial challenge with methacholine and age 3 years after surgery. We found a negative and statistically significant correlation with age, since the 2 patients who did not present compensatory sweating were older. We believe that more studies are necessary to confirm whether sympathetic hyperresponsiveness in these patients plays a role in the presence of compensatory sweating after bilateral dorsal sympathectomy. Nevertheless, after surgery, patients show a high degree of satisfaction, which more than makes up for the compensatory sweating.

The main limitation of our study is its sample size. Given that a Spanish cooperative group is working with sympathectomy performed using VATS, performing lung function tests on patients who are to undergo this type of surgery would provide us with more conclusive results through a larger sample size. We could even evaluate changes in lung function using the latest techniques, such as clipping. Nevertheless, we cannot completely rule out the existence of a confounder when analyzing the relationship between variables, although this may not be detected, as the changes take place in a single person.

In conclusion, bilateral dorsal sympathectomy by VATS can be considered a safe surgical procedure over time. Our study shows that the sympathetic nervous system affects the bronchomotor tone of patients with primary hyperhidrosis. We believe that studies with a larger sample size should be performed to confirm autonomic nervous system disorders affecting the airway in these patients.

References

1. Togel B, Greve B, Raulin C. Current therapeutic strategies for hyperhidrosis: a review. Eur J Dermatol. 2002;12:219-23.
2. Drott C, Gothberg G, Claes G. Endoscopic transthoracic sympathectomy: an efficient and safe method for the treatment of hyperhidrosis. J Am Acad Dermatol. 1995;33:78-81.
3. Moya J, Ramos R, Morera R, Villalonga R, Perna V, Macià I, et al. Results of high bilateral endoscopic thoracic sympathectomy and sympatholysis in the treatment of primary hyperhidrosis: a study of 1016 procedures. Arch Bronconeumol. 2006;42:230-4.
4. Noppen M, Vincken W. Thoracoscopic sympathicolysis for essential hyperhidrosis: effects on pulmonary function. Eur Respir J. 1996;9:1660-4.
5. Vigil L, Calaf N, Codina E, Fibla JJ, Gómez G, Casan P. Video-assisted sympathectomy for essential hyperhidrosis: effects on cardiopulmonary function. Chest. 2005;128:2702-5.
6. Roca J, Sanchis J, Agustí-Vidal A, Segarra F, Navajas D, Rodríguez-Roisin R, et al. Spirometric reference values from a Mediterranean population. Bull Eur Physiopathol Respir. 1986;22:217-24.
7. Sterk PJ, Fabbri LM, Quanjer PH, Cockcroft DW, O'Byrne PM, Anderson SD, et al. Airway responsiveness. Standardized challenge testing with pharmacological, physical and sensitizing stimuli in adults. Report Working Party Standardization of Lung Function Tests, European Community for Steel and Coal. Official Statement of the European Respiratory Society. Eur Respir J Suppl. 1993;16:53-83.
8. ATS/ERS recommendations for standardized procedures for the online and offline measurement of exhaled lower respiratory nitric oxide and nasal nitric oxide, 2005. Am J Respir Crit Care Med. 2005;171:912-30.
9. Fortuna AM, Feixas T, Casan P. Measurement of fraction of exhaled nitric oxide with the portable NIOX-MINO monitor in healthy adults. Arch Bronconeumol. 2007;43:176-9.
10. Ponce González MA, Julià SG, Santana RN, Rodríguez SP, Pérez PG, Freixinet GJ, et al. Long-term pulmonary function after thoracic sympathectomy. J Thorac Cardiovasc Surg. 2005;129:1379-82.
11. Barnes PJ. Neural control of human airways in health and disease. Am Rev Respir Dis. 1986;134:1289-314.
12. Noppen M, Dendale P, Hagers Y, Herregodts P, Vincken W, D'Haens J. Changes in cardiocirculatory autonomic function after thoracoscopic upper dorsal sympathicolysis for essential hyperhidrosis. J Auton Nerv Syst. 1996;60:115-20.
13. Plaza V, Álvarez F, Casan P, Cobos N, López A, Llauger M. Guía Española para el Manejo del Asma. Arch Bronconeumol. 2003;39:3-42.
14. Noppen MM, Vincken WG. Effects of thoracoscopic upper dorsal sympathicolysis for essential hyperhidrosis on bronchial responsiveness to histamine: implications on the autonomic imbalance theory of asthma. Respirology. 1996;1:195-9.
15. Moya J, Ramos R, Vives N, Pérez J, Morera R, Perna V, et al. Compensatory sweating after upper thoracic sympathectomy. Prospective study of 123 cases. Arch Bronconeumol. 2004;40:360-3.
16. Chou SH, Kao EL, Lin CC, Chang YT, Huang MF. The importance of classification in sympathetic surgery and a proposed mechanism for compensatory hyperhidrosis: experience with 464 cases. Surg Endosc. 2006;20:1749-53.