

# A randomized trial of T3-T4 versus T4 sympathectomy for isolated axillary hyperhidrosis

Marco Antonio S. Munia, MD, Nelson Wolosker, MD, PhD, Paulo Kauffman, MD, PhD, Jose Ribas de Campos, MD, PhD, and Pedro Puech-Leão, PhD, *São Paulo, Brazil*

**Introduction:** Video-assisted thoracic sympathectomy (VATS) is one minimally invasive definitive treatment for axillary hyperhidrosis. Different techniques exist for controlling axillary sudoresis, but they are temporary and have high cost. This study was conducted to compare the initial results from sympathectomy using two distinct levels for treating axillary sudoresis: T3-T4 vs T4.

**Methods:** Sixty-two patients with axillary hyperhidrosis were prospectively randomized for denervation of T3-T4 or T4 alone. All patients were examined preoperatively and were followed-up at 1 and 6 months postoperatively. Evaluated were the axillary hyperhidrosis treatment, the presence, location, and severity of compensatory hyperhidrosis, and the quality of life.

**Results:** All the patients said that their axillary hyperhidrosis was successfully treated by the surgery after 6 months. There was no treatment failure. Compensatory hyperhidrosis was present in 29 patients (90.6%) of the T3-T4 group and in 17 T4 patients (56.7%) after 1 month. After 6 months, all the T3-T4 patients presented some degree of compensatory hyperhidrosis vs 13 T4 patients (43.3%). The severity of the compensatory hyperhidrosis was also lower in the T4 patients ( $P < .01$ ). The quality of life was poor in both groups before the surgery, and was equally improved in both groups after 1 and 6 months of follow-up. There were no deaths or significant postoperative complications nor a need for conversion to thoracotomy.

**Conclusion:** Both techniques are effective for treating axillary hyperhidrosis, but the T4 group presented milder compensatory hyperhidrosis and had a greater satisfaction rate. (*J Vasc Surg* 2007;45:130-3.)

Axillary hyperhidrosis is an important problem that may lead to serious emotional and occupational disturbances. Local treatment and psychotherapy offer low effectiveness. Injection of botulinum toxin offers good results, but only temporarily (<6 months), and excision/resection of the eccrine sweat glands frequently presents low efficacy and high recurrence rates compared with sympathectomy.<sup>1-9</sup>

Video-assisted thoracic surgery (VATS) sympathectomy is a recognized procedure for the definitive treatment of palmar hyperhidrosis, but doubts still exist about its efficacy for treating axillary hyperhidrosis. To date, no randomized and prospective studies have compared VATS sympathectomy results from treating axillary hyperhidrosis by means of different levels of thermoablation of the sympathetic chain. The objective of the present study was to compare the results (>6 months) from the use of VATS sympathectomy at two resection levels, T3-T4 vs T4, in a prospective and randomized manner. The efficacy of the axillary hyperhidrosis treatment, the presence and severity of compensatory hyperhidrosis, and the patients' satisfaction were evaluated.

## METHODS

From May 2004 to July 2006, 62 patients with pure axillary hyperhidrosis (without palmar or facial hyperhidro-

sis) who underwent a VATS sympathectomy were studied prospectively and randomly. The institutional protocol applied to the patients was in accordance with the principles of the Ethics Committee for Analysis of Research Projects on Human Experimentation.

The criterion for inclusion in the study was a complaint of axillary hyperhidrosis with the intention of undergoing surgery after information about the risks and chances of compensatory hyperhidrosis was presented. The exclusion criteria were the existence of previous thoracic surgery or associated diseases, such as cardiac diseases, pulmonary infections, neoplasias, or diseases of the pleura or lungs that could increase the surgical risks, or when the patient's body mass index (BMI) was >25.<sup>10</sup>

Patients were randomized individually into two groups by using a randomization table: 32 patients underwent VATS sympathectomy with resection of the T3-T4 ganglia, and 30 patients underwent resection of the T4 ganglion alone. All the procedures were done by the same surgical team and with a standardized technique.

All the patients underwent the operation under general anesthesia and alternated selective intubation and pulmonary ventilation. Two incisions were used in each hemithorax: the first into the fourth intercostal space at the anterior axillary line and the second into the third intercostal space at the medial axillary line.<sup>11</sup>

After each sympathetic chain was identified, the patients randomized into the T3-T4 group underwent sympathectomy on the bodies of the third, fourth, and fifth ribs, followed by thermoablation of the segments isolated between them. The patients randomized into the T4 group underwent resection of the chain (sympathectomy) at the

From the Department of Vascular Surgery, University of São Paulo.

Competition of interest: none.

Reprint requests: Marco Antonio Munia, Joaquim Floriano St, 820 cj 193, CEP 04534-003, São Paulo, Brazil (e-mail: ma.munia@uol.com.br).

CME article

0741-5214/\$32.00

Copyright © 2007 by The Society for Vascular Surgery.

doi:10.1016/j.jvs.2006.09.011

fourth and fifth ribs, with thermoablation of the segment between them. After the sympathectomy, the lung was re-expanded under direct viewing and a small catheter (16F) was used to aspirate air from the pleural space. The same procedure was done on the contralateral chain. The use a chest drain was not routine. Lung expansion after the operation was assessed with a chest radiograph.

All the patients were re-validated as outpatients at 1 and 6 months after the procedure. The observers recording the findings were blinded to patient's treatment. Assessed were (1) the presence or absence of axillary hyperhidrosis reported by the patient and confirmed by the examiner and (2) the presence or absence of compensatory hyperhidrosis and its location and severity, again reported by the patient and confirmed by the examiner.

The severity of the sudoresis was graded as three levels: mild, moderate, or severe:

- Mild compensatory sweating was considered present when patients reported minor modifications in the location and severity of their sweating, such as visible sweating, but without expressing significant concern about this.
- Moderate compensatory hyperhidrosis was considered present when patients reported visible and embarrassing sweating or occasionally disabling situations caused by sweating.
- Severe compensatory hyperhidrosis was considered present when patients reported interference in their social and professional activities, such as the need for successive changes of clothes caused by sweating at the same intensity as their previous axillary hyperhidrosis but at other primary locations. It was defined as severe when it was visible, embarrassing, and led to at least one change of clothes during the day.
- Patients who did not notice any difference in the location or severity of their body sweating were considered to be unaffected by compensatory hyperhidrosis.

The patients' satisfaction ratings on the final result from the procedure, including both the treatment and any complications, was subjectively evaluated by means of a multiple choice subjective rating scale (four options) in which the patients could place themselves on a satisfaction scale as follows: 1, deficient (dissatisfied); 2, regular; 3, very good; 4, excellent.

**Statistical analysis.** For categoric variables, the  $\chi^2$  or Fisher's exact frequencies test were used, depending on the sample, for verifying associations between the type of surgery and the possible results and complications. These statistical tests for comparing the types of surgery with the variables of interest (axillary hyperhidrosis, incidence and severity of compensatory hyperhidrosis, and satisfaction) were performed in relation to each of the assessment periods. The associations between patients' ages, degrees of satisfaction, and ganglion resection level (T3-T4 or T4) were investigated using the Mann-Whitney *U* test. The significance level considered for all tests was  $P = 0.05$ .

**Table I.** Patient clinical characteristics

	T3-T4	T4	P
Mean age	25.06 (8.90)	26.67(4.77)	.189
Men/women	10:22	4:26	.092

**Table II.** Incidence and severity of compensatory hyperhidrosis following surgery

Group	1 month*			6 months*		
	Absent	Mild	Moderate/ severe	Absent	Mild	Moderate/ severe
T3/T4	3	14	15	4	17	11
T4	13	16	1	17	11	2

\*Level of statistical significance according to  $\chi^2$  test for these data is  $P < .001$ .

## RESULTS

The mean age and male/female proportions in the two groups were similar (Table I). Fifty-nine patients (95.16%) were discharged on the day after the surgery, and the remaining three patients (4.84%) were discharged 48 hours after the operation.

No cases of axillary hyperhidrosis were reported during the immediate postoperative period for either group, nor was Horner syndrome reported. Pleural drainage was necessary in three patients of the T3-T4 group because of significant pleural adherence. No recurrence of axillary hyperhidrosis in either of the groups was reported at the 1-month and 6-month follow-up.

The incidence and severity of compensatory hyperhidrosis are presented in Table II. The incidence of compensatory hyperhidrosis was lower in T4 group, both after 1 month and 6 months of follow-up. The severity of compensatory hyperhidrosis was lower in the T4 group, and no severe compensatory hyperhidrosis was noted at the 1-month and 6-month follow-ups in this group.

Patients who underwent T3-T4 resection maintained their compensatory hyperhidrosis rates during that time, whereas the incidence and severity of compensatory hyperhidrosis decreased from 1 to 6 months in the T4 group. The location of the compensatory hyperhidrosis did not differ between the two groups: the abdomen, back and legs were the regions most affected. No difference was noted in the triggering situations: most (21 in the T3-T4 group and 12 in T4) reported compensatory hyperhidrosis related to heat and intense physical activity.

The patients' satisfaction rates are presented in Table III. Patients of groups presented similar satisfaction rates. It needs to be emphasized that there were no dissatisfied patients in the T4 group and one patient in T3-T4 group after 6 months.

**Table III.** Patient satisfaction rates

Group	1 month*		6 months*	
	Completely satisfied	Moderately satisfied	Completely satisfied	Moderately satisfied
T3/T4	28	4	28	3
T4	29	1	29	1

\*Level of statistical significance according to Fisher's exact test for these data is  $P = .355$ .

## DISCUSSION

Axillary hyperhidrosis is a frequent condition that affects 23% of our operated patients. The great psychosocial disturbances among such patients lead to restrictions both on private life and social life. The efficacy of sympathectomy for treating palmar hyperhidrosis has been known for decades. With the use of thoracoscopy equipment enabling small incisions, this surgical procedure has largely come to present excellent results, with low morbidity, rapid postoperative recovery, and imperceptible scars.<sup>12</sup>

The initial results using VATS sympathectomy for treating axillary hyperhidrosis were good in only 68% to 89% of the cases.<sup>13,14</sup> With technical progress and the resection of lower ganglion levels (third and fourth ganglia), the results have become better, reaching a success rate of 94%.<sup>15</sup> We observed that both the T3-T4 and T4 resections were effective in all patients in our study. The main reason for obtaining these good results was the extreme care taken in identifying and resecting the correct ganglia, accomplished by an experienced specialized team<sup>16</sup> with >1500 bilateral surgical procedures.

One problem that has been found in several case series is the degree of recurrent axillary hyperhidrosis, which has ranged from 15%<sup>17</sup> to 65%.<sup>18,19</sup> In our series, we did not find any cases of recurrence in either group after 6 months of follow-up. The lack of recurrence observed in the study is due to the absence of technical failure among the patients operated.

The most frequent locations for compensatory hyperhidrosis described in the literature, and corroborated by our study, are the abdomen, back, feet, and gluteal region. In most cases, it is tolerable and does not lead to social disturbances or occupational disability. Patients are only inconvenienced when their symptoms are severe or when they do not receive adequate information before the operation. Patients must always be warned about this possible complication before the surgery because of the irreversibility of the method.

Resection of the T4 ganglion seems to be the key to these good results.<sup>20</sup> Our data demonstrate that T5 resection is not necessary, as recommended by other authors.<sup>13,20</sup> For T4 ganglion resection, a complete operation on T4 is necessary, consisting of sympathectomy on the upper margin of the fourth rib and the lower margin of the fifth rib, and also thermoablation of the chain between these points.<sup>21</sup> Through this, we have achieved satisfaction

rates after 6 months that are better than for the T3-T4 group and similar to published reports for T4 sympathectomy.<sup>16,22,23</sup>

With the advent of VATS sympathectomy, Horner syndrome has become a rare complication.<sup>17,18,24</sup> Its occurrence is now limited to indirect lesions of the stellate ganglion that are caused by diffusion of heat or excessive traction on the sympathetic chain. Because only the T3 and T4 ganglia were manipulated, we did not have this type of complication, regardless of the type of scalpel used (harmonic or electric). It is important to take care with manipulations on the left-side upper margin of the fifth rib because the thoracic duct crosses the aorta posteriorly at this location.

Compensatory hyperhidrosis is the complication most commonly related to VATS sympathectomy.<sup>22-25</sup> When the T2, T3, and T4 ganglia (more extensive and higher level) are resected, the occurrence of compensatory hyperhidrosis may reach 89% of the patients, with a high incidence of severe compensatory hyperhidrosis (35%).<sup>22</sup> In our series, with resection of lower levels, we found that 87.5% of the patients in the T3-T4 group and 43.3% in the T4 group presented this complication after 6 months. A lower incidence of compensatory hyperhidrosis of 8.5% was observed by Neumayer et al,<sup>25</sup> but this difference was due to the classification used for grading compensatory hyperhidrosis.

By stratifying the severity, we found another large statistical difference. In the T3-T4 group, compensatory hyperhidrosis of moderate or severe nature accounted for 34.4% of the group, whereas in the T4 group, only 6.7% of the patients had moderate compensatory hyperhidrosis and there were no severe cases. This leads us to believe that thermoablation of T3 is unnecessary.

We observed that mild compensatory hyperhidrosis increased from 14 to 17 cases between the 1-month and 6-month follow-up evaluations for the T3-T4 group, but more serious cases decreased. On the other hand, in the T4 group the number of mild cases decreased from 16 to 11 because many patients started to feel that they were free of these effects.

We did not use any objective measurement of the sudoresis because these methods can show only information at a single time point. There are no methods that can measure hyperhidrosis for all-day period.

## CONCLUSION

Despite the presence of compensatory hyperhidrosis, an improvement in quality of life was found for our entire series. The satisfaction rate was high in both groups, without statistical difference, both at the 1-month and 6-month follow-up. Long-term follow-up for these two groups may show whether these results will be maintained over time. In the event of late return of symptoms among the patients in the T4 group, it would be possible to operate on them again and extend the sympathectomy to the T3 ganglion.<sup>26,27</sup>

Resection of the T4 ganglion is preferable to resection of the T3 and T4 ganglia together, because despite their

equal efficacy for ablating axillary hyperhidrosis, T4 resection gives a lower rate of compensatory hyperhidrosis.

### AUTHOR CONTRIBUTIONS

Conception and design: MM, NW, PL  
Analysis and interpretation: MM, NW, PK, JC  
Data collection: MM, NW, PK, JC, PL  
Writing the article: MM, NW, PK, JC, PL  
Critical revision of the article: MM, NW, PK, JC, PL  
Final approval of the article: MM, NW, PK, JC, PL  
Statistical analysis: MM, NW  
Obtained funding: MM, NW, PK, JC, PL  
Overall responsibility: MM

### REFERENCES

1. Bechara FG, Sand M, Sand D, Altmeyer P, Hoffmann K, Surgical treatment of axillary hyperhidrosis: a study comparing liposuction cannulas with a suction-curettage cannula. *Ann Plast Surg* 2006;56:654-7.
2. Lawrence CM, Lonsdale Eccles AA. Selective sweat gland removal with minimal skin excision in the treatment of axillary hyperhidrosis: a retrospective clinical and histological review of 15 patients. *Br J Dermatol* 2006;155:115-8.
3. Glaser DA. The use of botulinum toxins to treat hyperhidrosis and gustatory sweating syndrome. *Neurotox Res* 2006;9:173-7.
4. Atkins JL, Butler PE. Hyperhidrosis: a review of current management. *Plast Recon Surg* 2002;110:222-8.
5. Rompel R, Scholz S. Subcutaneous curettage vs. injection of botulinum toxin A for treatment of axillary hyperhidrosis. *J Eur Acad Dermatol Venereol* 2001;15:207-11.
6. Proebstle TM, Schneiders V, Knop J. Gravimetrically controlled efficacy of subcorial curettage: a prospective study for treatment of axillary hyperhidrosis. *Dermatol Surg* 2002;28:1022-6.
7. Heckmann M, Ceballos-Baumann AO, Plewig G, Hyperhidrosis Study Group. Botulinum toxin A for axillary hyperhidrosis. *N Engl J Med* 2001;344:488-93.
8. Dressler D, Adib Saberi F, Benecke R. Botulinum toxin type B for treatment of axillary hyperhidrosis. *J Neurol* 2002;249:1729-32.
9. Goldman A. Treatment of axillary and palmar hyperhidrosis with botulinum toxin. *Aesthetic Plast Surg* 2000;24:280-2.
10. de Campos JR, Wolosker N, Takeda FR, Kauffman P, Kuznic S, Jatene FB, et al. The body mass index and level of resection: predictive factors for compensatory sweating after sympathectomy. *Clin Auton Res* 2005;15:116-20.
11. de Campos JR, Kauffman P, Werebe Ede C, Andrade Filho LO, Kusnick S, Wolosker N, et al. Quality of life, before and after thoracic sympathectomy: report on 378 operated patients. *Ann Thorac Surg* 2003;76:886-91.
12. Yazbek G, Wolosker N, de Campos JR, Kauffman P, Ishy A, Pucchi-Leao P. Palmar hyperhidrosis—which is the best level of denervation using video-assisted thoracoscopic sympathectomy: T2 or T3 ganglion? *J Vasc Surg* 2005;42:281-5.
13. Hsu CP, Shia SE, Hsia JY, Chuang CY, Chen CY. Experiences in thoracoscopic sympathectomy for axillary hyperhidrosis and osmidrosis: focusing on the extent of sympathectomy. *Arch Surg* 2001;136:1115-7.
14. Byrne J, Walsh TN, Hederman WP. Endoscopic transthoracic electrocautery of the sympathetic chain for palmar and axillary hyperhidrosis. *Br J Med* 1990;77:1046-9.
15. Rex LO, Drott C, Claes G, Gothberg G, Dalman P. The Boras experience of endoscopic thoracic sympathectomy for palmar, axillary, facial hyperhidrosis and facial blushing. *Eur J Surg* 1998;580(suppl):23-6.
16. Hsu CP, Chen CY, Hsia JY, Shai SE. Resympathectomy for palmar and axillary hyperhidrosis. *Br J Surg* 1998;85:1504-5.
17. Gossot D, Debrosse D, Grunenwald D. Endoscopic thoracic sympathectomy for isolated axillary hyperhidrosis. *Ann Dermatol Venereol* 2000;127:1065-7.
18. Gossot D, Galetta D, Pascal A, Debrosse D, Caliandro R, Girard P, et al. Long-term results of endoscopic thoracic sympathectomy for upper limb hyperhidrosis. *Ann Thorac Surg* 2003;75:1075-9.
19. Claes G. Indications for endoscopic thoracic sympathectomy. *Clin Auton Res* 2003;13(suppl 1):116-9.
20. Masters A, Rennie JA. Endoscopic transthoracic sympathectomy for idiopathic upper limb hyperhidrosis. *Clin Auton Res* 1992;2:349-52.
21. Lin CC, Wu HH. Endoscopic T4 sympathetic block by clamping ESB4 in treatment of hyperhidrosis palmaris et axillaris—experience of 165 cases. *Ann Chir Gynecol* 2001;90:167-9.
22. Licht PB, Pilegaard HK. Severity of compensatory sweating after thoracoscopic sympathectomy. *Ann Thorac Surg* 2004;78:427-31.
23. Licht PB, Jorgensen OD, Ladegaard L, Pilegaard HK. Thoracoscopic sympathectomy for axillary hyperhidrosis: the influence of T4. *Ann Thorac Surg* 2005;80:455-9.
24. Cameron AE. Specific complications and mortality of endoscopic thoracic sympathectomy. *Clin Auton Res* 2003;13(suppl 1):131-5.
25. Neumayer C, Zacherl J, Holak G, Fugger R, Jakesz R, Herbst F, et al. Limited endoscopic thoracic sympathetic block for hyperhidrosis of the upper limb: reduction of compensatory sweating by clipping t4. *Surg Endosc* 2004;18:152-6.
26. Lin TS. Endoscopic clipping in video-assisted thoracoscopic sympathectomy blockade for axillary hyperhidrosis. An analysis of 26 cases. *Surg Endosc* 2001;15:126-8.
27. Dewey TM, Herbert MA, Hill SL, Prince SL, Mack MJ. One-year follow-up after thoracoscopic sympathectomy for hyperhidrosis: outcomes and consequences. *Ann Thorac Surg* 2006;81:1227-32;discussion 1232-3.

Submitted Aug 1, 2006; accepted Sep 6, 2006.