

# Effect of Endoscopic Thoracic Sympathetic Block on Plantar Hyperhidrosis

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**Hypothesis:** Endoscopic thoracic sympathetic block at T4 (ESB4) provides excellent results in patients with primary hyperhidrosis (HH) of the upper limb. Most patients have combined palmo-plantar or palmo-axillary-plantar HH. This study evaluates the clinical outcome of patients with upper limb HH with special emphasis on plantar sweating and patients' quality of life.

**Design:** Review of a prospectively gathered database.

**Setting:** Tertiary care university teaching hospital.

**Patients:** The cohort included 73 patients (50 women and 23 men; mean age, 30.2 years). Twenty-six patients had palmar; 3, isolated axillary; and 44, combined HH. Sixty-six patients (90.4%) had concomitant plantar HH.

**Interventions:** One hundred forty-five operations were performed by applying one 5-mm clip above and below the fourth sympathetic ganglion.

**Results:** Of palms, 71.9% were completely and 28.1%

were nearly dry. Corresponding percentages were 45.1% and 50.5% for armpits and 4.5% and 37.9% for the soles, respectively. Of soles, 42.4% remained unchanged and 15.2% became slightly worse. Compensatory sweating occurred in 19.4% of patients, with 2.8% having severe compensatory sweating. Feet were rarely affected by compensatory sweating (5.6%). Gustatory sweating was reported by 31.9% of patients but did not bother them. Quality of life improved significantly after ESB4. Most patients (87.5%) were completely satisfied with the outcome; 9.7% were partly satisfied.

**Conclusions:** In the treatment of upper limb HH, ESB4 yields excellent success rates. Plantar sweating can be relieved in nearly half of patients, although exact neurophysiologic mechanisms remain unclear. Incidence of compensatory and gustatory sweating is low, contributing to a high patient satisfaction and improvement in quality of life.

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**P** RIMARY HYPERHIDROSIS (HH) is a common pathological condition resulting in psychosocial difficulties, physical discomfort, dermatologic diseases, and impaired quality of life. When conservative treatment fails, endoscopic thoracic sympathectomy (ETS) represents the preferred method of choice, offering a high cure rate of more than 95% for upper limb HH.<sup>1-3</sup>

Plantar HH is more difficult to treat because cutaneous problems are more frequently found.<sup>4</sup> Trench foot, pitted keratolysis, bromhidrosis, blisters, or even frostbite in cold weather due to moisture accumulation in the shoes have been described. Mycotic, bacterial, and viral infections are found at an increased rate secondary to excessive sweating in the feet, resulting in dermal mycosis, gram-negative infections, dyshydrotic eczema, or plantar warts.<sup>4</sup> For plantar HH, lumbar sympathectomy via ablation of L2 to L4 ganglia and their connections may be performed, denervating the distal third of the leg.<sup>5,6</sup> Removal of the first and second lumbar ganglion may interfere

with ejaculation, and orthostatic hypotension is another unwanted adverse effect of lumbar sympathectomy.<sup>5,7</sup> Consequently, open lumbar sympathectomy is nowadays rarely performed.

## See Invited Critique at end of article

In large series, 84% to 100% of patients referred for ETS because of upper limb HH additionally had plantar HH.<sup>3,8,9</sup> Nevertheless, reports on resective and ablative ETS procedures rarely describe the effect on plantar HH. Moreover, no data at all are available on changes of plantar HH after limited endoscopic thoracic sympathetic block at T4 (ESB4), which has been recently shown to effectively reduce unwanted adverse effects of ETS, compared with resective or ablative procedures formerly performed.<sup>10-12</sup>

The aim of the present study was to investigate whether ESB4 surgery affects plantar HH in patients with palmo-plantar and palmo-axillary-plantar HH. Moreover, spe-

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cial emphasis was placed on evaluation of patients' quality of life (QOL) and satisfaction for this type of surgical therapy.

## METHODS

From June 2001 to November 2003, 145 ESB4 procedures were performed on 73 patients (50 women at a mean  $\pm$  SD age of  $30.6 \pm 10.9$  years and 23 men at a mean  $\pm$  SD age of  $30.3 \pm 6.1$  years); 35.6% of the patients had palmar HH, 4.1% had isolated axillary HH, and 60.3% had combined palmar and axillary HH. Most of the patients also had plantar HH (90.4%). Detailed information on the patients treated by ESB4 are given in **Table 1**.

All patients had extensive conservative therapy before being referred for surgery. The procedure of ESB4 has been previously reported in detail.<sup>11,12</sup> In short, after general anesthesia was administered and single-lumen intubation and lateral decubitus positioning of the patient was completed, a pneumothorax was achieved with a Verres needle (Surgineedle, 150 mm; United States Surgical, a division of Tyco Healthcare Group LP, Norwalk, Conn). Two 5-mm trocars were inserted in the third and fifth intercostal space. After isolation of the sympathetic nerve, a 5-mm reusable clip applicator (Challenger Ti; B. Braun Austria GmbH-Aesculap) was used to block the sympathetic trunk above and below the fourth sympathetic ganglion. After aspiration of the pneumothorax, the skin incision was closed and no chest drain was used. In most cases (98.6%), bilateral ESB4 was performed in 1 operation. After surgery, chest radiographs were taken to rule out hemothorax or pneumothorax. Usually patients were discharged from the hospital on the first postoperative day.

All patient medical records were reviewed for assessment of postoperative success and complications. Symptoms were assessed preoperatively and postoperatively by a standardized questionnaire, physical examination, and personal interviews. Outcome, satisfaction, and adverse effects of treatment were evaluated. Sweating pattern before and after surgery ("hyperhidrosis index") was assessed by a visual analog scale (VAS) graded between 0 (no symptoms) and 10 (worst possible symptom). The patient's QOL was evaluated by a series of questions adopted from Keller et al<sup>13</sup> reflecting the common physical symptoms and social stigmata associated with primary palmo-plantar HH in daily life. Ten questions addressed the extent of sweating in cases of shaking hands, writing an examination, initiating intimate contact, driving a car, or wearing gloves, for example. Likewise, 5 questions reflected QOL concerning plantar HH. A summarized HH index was added, summing up scores for hands and feet, respectively.

Complete follow-up information was obtained from 72 patients (98.6%). The mean  $\pm$  SD observation period was  $19.5 \pm 4.7$  months (Table 1).

Statistical evaluation was composed of paired *t* tests and paired Wilcoxon signed rank tests for comparisons of preoperative and postoperative HH indexes. The Spearman correlation coefficient (*r*) was used to assess the relationship between parameters of interest (eg, correlation between extent of preoperative plantar HH and extent of compensatory sweating [CS] postoperatively).<sup>14</sup> Results are given as means and standard deviations. Percentages of complication and success rates are related to the number of procedures. A *P* value less than .05 was considered to indicate statistical significance. All analyses were performed using SAS statistical software version 8.2 (SAS Institute Inc, Cary, NC).

## RESULTS

### PERIOPERATIVE RESULTS

No patient died perioperatively and no conversion to open thoracotomy was necessary. Three patients (2.1%) had

**Table 1. Demographic Data**

Characteristic	No. (%) of Patients*
No. of procedures	145
No. of patients	73
Female	50
Age, y, mean $\pm$ SD	$30.2 \pm 9.4$
Bilateral operation	72 (98.6)
Palmar hyperhidrosis	26 (35.6)
Axillary hyperhidrosis	3 (4.1)
Combined hyperhidrosis	44 (60.3)
Plantar hyperhidrosis	66 (90.4)
No. of patients reevaluated	72 (98.6)
Follow-up, mo, mean $\pm$ SD	$19.5 \pm 4.7$

\*Unless otherwise indicated.

unilateral pneumothorax of more than 3 cm postoperatively, requiring chest-tube drainage. One patient required thoracoscopic revision because of intercostal artery bleeding after chest-tube drainage of a pneumothorax. Neither a complete nor a partial Horner syndrome was detected. Two patients (1.4%) with postoperative neuralgia were treated with nonsteroidal analgesics, and the complaints lasted for about 2 weeks at maximum. One wound infection (0.7%) was locally treated and required no systemic antibiotic therapy.

### OVERALL OUTCOME

Treatment success at follow-up is given in **Table 2**. The best results were obtained for palmar manifestation of HH, with 71.9% of limbs being completely dry at follow-up. All other palms were nearly dry (28.1%). These patients reported that a certain minimal moistness was maintained, which was regarded as comfortable. No patients with fissured palms were observed. Evaluation of axillary HH revealed that 50.5% of armpits showed marked improvement, and only 2 patients (4.4% of armpits) remained unchanged.

Plantar HH was present in 66 (90.4%) of 73 patients. Changes in plantar sweating before operation and at follow-up are shown in **Figure 1**; 4.5% of soles became completely dry and another 37.9% improved, 42.4% remained unchanged, and 15.2% of soles were considered worse postoperatively. Of these 10 patients, 6 patients graded plantar sweating worse by only 1 VAS point, 2 patients by 2 points, and 1 by 3 points. One female patient deteriorated from 5 to the maximum of 10 points on the VAS concerning plantar sweating.

One male patient with combined HH, who was completely satisfied with the postoperative outcome, developed a relapse about 9 months after the operation. Primarily, the palms were affected. This patient was reoperated on and T3 was blocked additionally. To date, his palms are still completely dry, and the patient is satisfied.

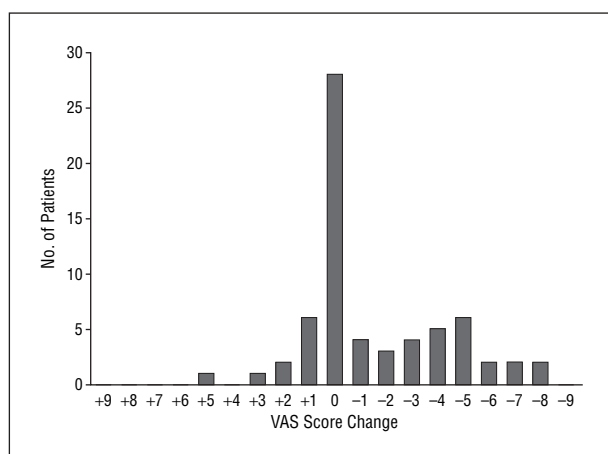
### ADVERSE EFFECTS

The most common adverse effect after ETS was CS affecting abdominal, lumbar, or groin regions. Compensatory sweating was found in 14 of the 72 patients rein-

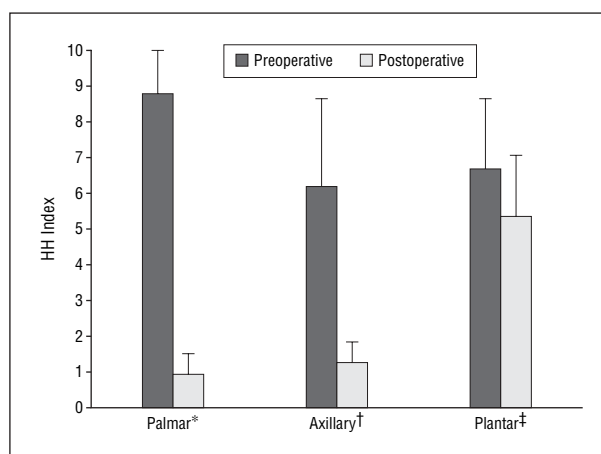
**Table 2. Outcome Data at Follow-up\***

	Completely Dry	Improved	Unchanged	Worse
<b>Treatment success</b>				
Palmar manifestation (139 limbs)	100 (71.9)	39 (28.1)	0	0
Axillary manifestation (91 limbs)	41 (45.1)	46 (50.5)	4 (4.4)	0
Plantar manifestation (132 limbs)	6 (4.5)	50 (37.9)	56 (42.4)	20 (15.2)
<b>Patient satisfaction</b>				
No. of patients	63 (87.5)	7 (9.7)	2 (2.8)	

\*For treatment success, data are presented as number (percentage) of treated limbs; for patient satisfaction, data are presented as number (percentage) of patients.



**Figure 1.** Changes in plantar sweating (before operation vs follow-up) in patients with primary hyperhidrosis treated by endoscopic thoracic sympathetic block at T4. Improvement in plantar sweating was noted when patients reported a decrease on the visual analog scale (VAS), ranging from 0 (no symptoms) to 10 (worst possible symptom).



**Figure 2.** Hyperhidrosis (HH) index before endoscopic thoracic sympathetic block at T4 and at follow-up, reflecting patients' quality of life depending on the extent of sweating in the affected body regions. Assessment was done using the visual analog scale, ranging from 0 (no symptoms) to 10 (worst possible symptom). Data are given as mean  $\pm$  SD. Asterisk indicates  $P < .01$  for palmar preoperative vs postoperative; dagger,  $P < .05$  for axillary preoperative vs postoperative; double dagger,  $P < .05$  for plantar preoperative vs postoperative.

investigated, with a mean  $\pm$  SD VAS score of  $5.86 \pm 2.50$ . This represents 19.4% of patients operated on (corresponding to 9.8% of the procedures performed). However, most of these patients did not feel impaired (3 patients [21.4%]) or felt hardly impaired (5 patients [35.7%]). However, 4 patients felt impaired (28.6%) and 2 patients (14.3%) reported their CS as unbearable. This means that 5.6% of all patients reinvestigated felt impaired by CS, and only 2.8% regretted having undergone the operation because of severe CS. One of these 2 patients insisted on having the clips removed, although he graded CS with only 5 VAS points. Unfortunately, his CS did only minimally improve afterward, and he was unsatisfied with the final outcome. The other patient graded her CS with 10 VAS points but refused to undergo a reversal operation.

Four patients reported CS in the feet (5.6%), whereas in the majority of patients the abdominal and lumbar regions were affected. Interestingly, none of the 7 patients who did not have plantar HH before operation developed CS. However, no correlation between the extent of preoperative plantar HH and extent of postoperative CS could be detected.

Gustatory sweating (GS) was reported by 23 patients (31.9%), corresponding to 16.1% of the procedures performed. The mean  $\pm$  SD VAS score for GS was  $3.13 \pm 1.75$ ,

but it did not represent a serious problem to any of these patients. No occurrence of vasomotor rhinitis was observed.

### QOL AND PATIENT SATISFACTION

**Figure 2** shows the results from the HH index reflecting patient QOL depending on the extent of sweating in the affected body regions. Patients reported a remarkable improvement in the palms from a mean  $\pm$  SD VAS score of  $8.78 \pm 1.20$  preoperatively vs  $0.94 \pm 0.57$  postoperatively ( $P < .01$ ). For the axillae, the mean  $\pm$  SD VAS scores fell from  $6.19 \pm 2.47$  preoperatively to  $1.28 \pm 0.57$  postoperatively ( $P < .05$ ). Reduction in feet was smaller, although still statistically significant (mean  $\pm$  SD VAS score,  $6.68 \pm 1.97$  preoperatively vs  $5.37 \pm 1.67$  postoperatively [ $P < .05$ ]). The summarized HH index decreased from 72.87 preoperatively to 5.17 postoperatively ( $P < .001$ ) for the hands. Likewise, the summarized score concerning feet fell from 31.65 to 23.40 ( $P < .01$ ).

At follow-up, 87.5% of patients were fully satisfied with the result, whereas 7 patients (9.7%) stated only partial satisfaction (Table 2). Two patients (2.8%) regretted hav-

ing undergone the operation, mainly because of severe CS; both have been described in detail earlier.

## COMMENT

Although widely underestimated, plantar HH may be a severe clinical problem, because most of the patients referred for surgery for upper limb HH also had plantar HH.<sup>3,8,9</sup> However, data on the effect of ETS on plantar HH are rarely found in the literature.<sup>15-20</sup> Moreover, no data have been available so far concerning changes of plantar HH after the limited procedure of blocking T4 solely (ESB4). In our series, ESB4 was a safe procedure with low complication rates similar to other high-volume centers.<sup>21</sup>

Excellent results have been obtained for patients with palmar HH after a mean follow-up of 19.5 months, confirming our initial results.<sup>11,12</sup> Success rates were lower for axillary HH, which has also been reported by other authors.<sup>22</sup> One possible explanation is that apocrine sweat glands, which are also present in the armpits and are not activated by the sympathetic nervous system, will not respond to sympathetic surgery.

In our series, 4.5% of soles were completely dry after ESB4. This is in clear contrast to results of Hsu et al,<sup>23</sup> who reported that 64% of patients with plantar HH were cured after T2 sympathectomy. To date, results like these cannot be explained by our current neuroanatomical or neurophysiologic knowledge.<sup>24,25</sup> However, our results are in accordance with other authors, presenting a cure rate of 6% after T2 to T7 sympathectomy and 6.7% after T2 transection.<sup>9,19</sup> In addition, more than one third of our patients reported an improvement in plantar sweating. Similar results have been obtained after bilateral T2 and T3 sympathectomy.<sup>16</sup> Nevertheless, the majority of patients remained unchanged or nearly unchanged. These data will be important in the future when providing comprehensive information to patients before ESB4.

Compensatory sweating is still the major unwanted adverse effect after ETS. Since it is difficult to evaluate the degree of CS, published data about its incidence are controversial, ranging from 28.9% to 98%.<sup>1,26</sup> In our series, all patients reporting an aggravation of sweating without special labor or psychologic stress were judged as compensatory sweaters. After a mean follow-up of 19.5 months, 19.4% of our patients reported CS. This is remarkably low compared with 55.6% after T2 to T4 sympathectomy<sup>11,12</sup> and even lower compared with single transection of the sympathetic nerve between the third and fourth ganglion.<sup>27</sup> Other authors reported CS ranging between 44% and 86% after ESB at different levels ranging between T1 and T4.<sup>28</sup> In another study, clipping of the upper part of the T4 ganglion resulted in 87.5% of patients exhibiting CS.<sup>29</sup> According to Reisfeld et al,<sup>3</sup> these numbers are of minor interest because the percentage of patients with severe CS is of major importance. In our series, 2 patients (2.8%) had severe CS. Choi et al<sup>29</sup> reported comparable data with 3.2% of patients exhibiting severe CS after limited T4 blocking. Altogether, the percentage of patients with severe CS after ESB4 is about 50% lower than after T2 to T4 sympathectomy.<sup>2</sup> We found CS in the feet in 6.1% of our patients. Similar results have been published by Chen et al<sup>17</sup> after a short follow-up of

2 weeks after bilateral T2 and T3 sympathectomy. In a long-term follow-up study, our clinic reported that the feet were primarily affected after T2 to T4 sympathectomy, with 32% of patients exhibiting CS in the feet.<sup>30</sup> In our present series, mainly the chest, abdominal, and lumbar regions were affected, which corresponds to most of the data available to date.<sup>21</sup> The reason for this variation in the distribution of CS remains unclear. Moreover, one has to emphasize the subjective character of this adverse effect.

Gustatory sweating was found in 31.9% of our patients, but none of them found it embarrassing or disabling. Although we tried to work out the reason for that increase in comparison with 2.1% of patients reporting GS at our initial follow-up after 7.5 months, no logical explanation can be given. Our efforts to evaluate the point when GS started also failed because most of the patients were unable to give detailed information. In comparison, after T2 to T4 sympathectomy, about 50% of patients reported GS.<sup>2,12,30</sup>

Sweating of the palms, axillae, and soles has been described as emotional sweating because its control is integrated with emotional, cognitive, and neuroendocrine functions and effects at multiple levels with the central nervous system.<sup>25</sup> Therefore, evaluation of procedures in sympathetic surgery should also account for these factors by adding QOL measures. Impressive results have been obtained for palmar and axillary manifestation of primary HH. For feet, improvement in QOL was also significant, although the difference between preoperative and postoperative scores was remarkably smaller. This finding might be explained by the fact that plantar HH is not the primary indication for ETS surgery.<sup>31</sup> Most of our patients (87.5%) stated full satisfaction. The low rate of unwanted adverse effects and the low incidence of recurrences might have contributed to these good results, although long-term results of ESB surgery are still needed for definitive comparisons with other methods.

In conclusion, limited sympathetic surgery by clipping T4 yields excellent success rates in the treatment of upper limb HH after a mean follow-up of 19.5 months. Nearly all patients undergoing ETS surgery also have plantar HH. These patients have equal chances for plantar sweating to improve or remain unchanged; only a minority will have it worsen. In general, CS and GS are low in comparison with other ETS procedures, contributing to a high patient satisfaction and QOL after ESB4.

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## Invited Critique

This article reviews patients with hyperhidrosis treated with hemoclips on the sympathetic chain above and below the fourth ganglion. Results, in percentage of anatomical areas rendered completely or “nearly” dry, for palms are 71.9% and 28.1%, respectively; for axillae, 45.1% and 50.5%; and for the soles, 4.5% and 37.9%. They reported compensatory sweating in 19.4% of patients, severe in only 2.8%. These procedures were done with minimal morbidity.

These results are good but do not identify the ideal operation. Alternatives range from electrocautery of the sympathetic chain and division only of the rami communicantes, to sympathectomy. In addition, there is a range of reported success and of the complication of compensatory sweating. For example, with sympathectomy, success rates of relief of palmar hyperhidrosis of 100% have been reported but with an incidence of compensatory sweating up to 88%, although only severe in 2% of patients.

Reports that have addressed the issue of plantar hyperhidrosis have concluded similarly that the soles of most patients are unaffected by a thoracoscopic sympathetic intervention, although a small number are improved.

An attraction of clipping is that it is theoretically reversible. However, the authors only attempted this in 1 patient and it was predictably unsuccessful as the clip is likely to cause permanent interruption of the chain and clips are not easy to remove.

While this article adds to the experience with thoracoscopic treatment of hyperhidrosis, I prefer sympathectomy up to the T1 ganglion and including T3 and or T4 depending on the extent of axillary involvement. This is the maximum operation to address the patient's primary problem. While the incidence of compensatory sweating is as high as 88%, this is generally described as mild and only severe in a small minority of patients. This is why I lean toward the more definitive operation until a report shows superiority by matching the results of sympathectomy while lowering the incidence of compensatory sweating.

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