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Background. **Compensatory sweating is noted frequently after sympathectomy and may be difficult to control in some patients. This prospective trial was projected to measure the impact of limited denervation on compensatory sweating while performing endoscopic thoracic sympathectomy.**

Methods. **One hundred seventy-eight patients (127 female and 51 male) with severe primary hyperhidrosis unsuccessfully treated by conservative means entered the study. Group A was treated with sympathectomy from T2 to T4. In group B sympathectomy was performed from T3 to T5. Physical condition was measured after 1, 6, and 24 months by means of the SF-36 Health Survey Test.**

Results. **Evaluation rate was 94.9%. Horner's syndrome was not detected, recurrence rate was 0.6%, and rate of persistent pneumothorax was 2.3%. Compensatory sweating was reported with 17.1% in group A and diminished to 4.9% in group B. Gustatory sweating was comparable in both groups (4.3% versus 4.9%). Satisfaction rate was 97% in patients with palmar hyperhidrosis, 95% for axillary hyperhidrosis, and 87% for facial hyperhidrosis. Discomfort originating from compensatory sweating was less than symptoms from primary hyperhidrosis 24 months after endoscopic thoracic sympathectomy in more than 90%. Only 7.1% of the entire group was not satisfied.**

Conclusions. **Our study demonstrates that limiting denervation beyond T2 ganglion offers good clinical results in axillary as well as palmar hyperhidrosis and may reduce the risk for compensatory sweating. In women, reduction was as high as 75% and in men, near 50%. Our impression is that severe compensatory sweating and the majority of stellate ganglion lesions occur as a result of starting sympathectomy at level T2.**

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Endoscopic (trans)thoracic sympathectomy (ETS) from ganglion T2 to T4 has evolved into an effective treatment for severe hyperhidrosis of the upper limb in the last two decades. Complications like hemorrhage or Horner's syndrome are rare, but side effects such as compensatory (reflex) and gustatory sweating may occur frequently.

Compensatory sweating is the most troublesome complication of sympathectomy, and it is said to be "the" quality marker of ETS. After extensive resection from the second to the fourth ganglion (T2 through T4), as well as after limited resection of the second ganglion (T2), the reported incidence of compensatory sweating ranges as high as 50% to 97%. Therefore the purpose of studies published lately [1–4] was to determine whether the incidence of compensatory sweating can be reduced by limiting sympathectomy to defined levels. Long-term follow-up showed that by limiting the dissection to T3 or T4 alone, clinical results would become as effective as with T2 through T4 dissection, minimizing the risks for compensatory sweating.

Other recent studies concluded that the extent of denervation does not influence the incidence and severity of compensatory sweating. Additional resection from T4 to T5 was said to improve results for armpit hyperhidrosis also [5]. Furthermore, the ongoing discussion about the importance of the dissection level has generated three different fractions of surgical techniques used for sympathectomy: clipping the sympathetic chain may be a reversible method, but removal does not necessarily implicate recovery of the sympathetic function. In these cases open nerve reconstructions of the divided sympathetic chain may be offered to give subjective relief of the symptoms from compensatory sweating combined with restoration of hyperhidrosis symptoms [6]. Classic resection, on the other hand, yields superior clinical results, yet the majority of surgeons ablate, probably because it is easier, requires a shorter operating time, and leads to fewer cases of Horner's syndrome. Anyway, there is no evidence that changing the dissection mode will influence the onset of compensatory sweating [6, 7].

This prospective study presents a single surgeon's experience (J.S.) with ETS for hyperhidrosis using the

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Table 1. Epidemiologic Data[a]

Variable	Group A		Group B	
	Female	Male	Female	Male
n	75	42	52	9
Mean age (yr)	31.7 ± 7.2	32.8 ± 6.9	34.8 ± 9.8	33.9 ± 11.4
Palmar hyperhidrosis	37	16	21	4
Axillary hyperhidrosis	31	18	31	5
Facial hyperhidrosis	7	8	/	/

[a] Group A endoscopic thoracic sympathectomy T2 through T4, group B endoscopic thoracic sympathectomy T3 through T5.

high-frequency ablation technique in the dissection of the sympathetic nerve leaving the connecting tissue between the ganglia untouched. The aim of the study was to measure the short-term outcome of patients suffering from severe palmar, axillary, or facial hyperhidrosis and the impact on compensatory sweating when changing the ablation modus from T2 through T4 to T3 through T5.

Material and Methods

From April 2000 to April 2003 a total of 178 patients (127 women and 51 men) with severe primary hyperhidrosis entered the study. All patients underwent selection after passing an algorithm that was specially designed by dermatologists and surgeons. The Institutional Review Board approved the study in November 1999. Written consent was obtained from every individual patient both for treatment and further evaluation. The first cohort starting April 2000 and ending March 2002 was treated with sympathectomy from T2 to T4. In the second cohort (April 2002 to April 2003) sympathectomy was performed from T3 to T5.

On the day before the operation a detailed physical investigation was performed. Sweat production in patients suffering mainly from axillary hyperhidrosis was measured by means of standardized gravimetry. Efficacy of sympathectomy in this subgroup was again tested gravimetrically 6 months later.

Physical condition was measured by means of the SF-36 Health Survey Test. Postoperative pain development based on questionnaires (visual analog scale) was measured on the first, second, and third postoperative days, and again later after 1, 6, and 24 months.

The physical conditions were checked again after 1, 6, and 24 months by using the German SF-36 Health Survey Test. This test is the compilation of the German National Health Interview and Examination Survey performed in 1998 [8]. The SF-36 questionnaire includes eight groups of quality indices: physical fitness (PF), social role and fitness (SRF), pain (P), general state of health (GSH), vitality (V), social fitness (SF), role fitness with psychologic restriction (FPR), and psychologic fitness (PSF).

Patients were kept fasted 6 hours before the operation. The supine position was used in all cases, and both arms were extended cranially. The procedure was performed under general anesthesia. A double-lumen endotracheal tube was used, and sympathectomy was always achieved bilaterally. Pneumothorax was established at 10 mm Hg with carbon dioxide. A 10-mm trocar was placed within the fifth intercostal space in the medioclavicular line, and a second 5-mm trocar was positioned within the armpit. The high-frequency monopolar diathermy was used to destroy the sympathetic nerve at the crossing point with the corresponding rib. The connecting tissue between two adjacent ganglia was spared. Kuntz nerve fibres were not coagulated additionally when detected during the procedure. Diathermy was performed by monopolar precise coagulation (ERBE Elektromedizin GmbH, Tuebingen, Germany) with unmodulated alternating current at 350 kHz, crest factor 1.4, and maximum performance at 50 W plus 20%. Thin Buelau drainages (8F thorax catheter, FB Medical) were used to evacuate trapped carbon dioxide and for monitoring of fistula formation. These drainages were extracted 4 to 6 hours later after checking the patient for persisting pneumothorax with roentgenography. All patients remained at the hospital overnight. Discharge was allowed after exclusion of pneumothorax on the first postoperative day by means of roentgenography.

The study was referred to and checked by the local statistician of the University of Witten-Herdecke. Data are expressed as mean ± standard error of the mean. To prove statistical relevance, the Student's t test with an alpha level of p less than 0.05 was used. The analysis of the SF-36 Health Survey was done with an SAS-supported, computerized program.

Results

Fifty-one male and 127 female patients entered the study (n = 178). Group A consisted of 75 female and 42 male patients (n = 117); in group B 52 female and 9 male patients (n = 61) were entered. Mean age in the entire group was 32.9 ± 9.7 years. The mean ages between male and female patients as well as between the two cohorts were not statistically different. In group A we found 53 patients with palmar hyperhidrosis, 49 with axillary hyperhidrosis, and 15 with facial hyperhidrosis as a leading symptom. In group B 25 patients complained about palmar sweating and 36 were impaired as a result of axillary hyperhidrosis (Table 1).

We had a total of 9 dropouts 24 months later (4 in group A and 5 in group B); therefore, 94.9% of the entire group could be evaluated. There were no deaths and no

Table 2. Endoscopic Thoracic Sympathectomy and Perioperative and Postoperative Complications[a]

Variable	Group A			Group B		
	Female	Male	Total	Female	Male	Total
n	75	42	117	52	9	61
Compensatory sweating	12 (16.7%)	8 (19.1%)	20 (17.1%)	2 (3.9%)	1 (11.1%)	3 (4.9%)
Gustatory sweating	2 (2.7%)	3 (7.1%)	5 (4.3%)	2 (3.9%)	1 (11.1%)	3 (4.9%)
Intercostal neuralgia	2	1	3	2	/	2
Horner's syndrome	/	/	/	/	/	/
Pneumothorax	2 (2.7%)	/	2 (1.7%)	1 (1.9%)	1 (11.1%)	2 (3.2%)
Hemorrhage	1	/	1	/	/	/
Impaired wound healing	1	/	1	/	/	/
Recurrence	1	/	1	/	/	/

[a] In group A endoscopic thoracic sympathectomy was performed from T2 to T4, in group B from T3 to T5.

severe complications in the postoperative course. In group A 5 patients reported gustatory sweating, in group B we found 3 patients with this complaint. Gustatory symptoms were noted most 6 months after the operation and had diminished to half at 24 months. There was no statistical difference between the two groups. Intercostal neuralgia was reported from 3 patients in group A and from 2 patients in group B. This problem resolved 6 months after the operation in all patients, but 2 required oral analgesics for a period of more than 2 months. Recurrence of hyperhidrosis was found in 1 male patient at 24 months. Horner's syndrome was not found in any patient. One female patient presented with a temporary hemorrhage. The problem resolved without reoperation. Persisting pneumothorax as a result of fistula formation was noted in 2 patients in group A and in 2 from group B. The difference did not reach statistical relevance. At month 24, 12 female and 8 male patients reported compensatory sweating in group A, whereas in group B 1 male and 2 female patients complained about this symptom. The difference between groups A and B reached statistical relevance ($p < 0.05$); the differences between female and male patients in both groups were also relevant ($p < 0.05$). Therefore, changing the denervation site from T2 through T4 to T3 through T5 decreased compensatory sweating (Table 2) in female and male patients. In patients with axillary hyperhidrosis preoperative gravimetry results were 162.3 ± 43.1 mg/min (group A) and 164.7 ± 39.9 mg/min (group B) in male patients, 145.6 ± 71.5 mg/min (group A) and 141.8 ± 65.7 mg/min in female patients. Six months later in male patients, armpit sweat production decreased to 42.1 ± 29.3 mg/min (group A) and 44.8 ± 31.8 mg/min (group B); in females sweating dropped to 37.3 ± 30.6 mg/min (group A) and 37.9 ± 28.7 mg/min (group B). The reduction reached statistic relevance ($p < 0.05$) in groups A and B. Differences between groups A and B were not significant.

All patients were asked to report about the results of the procedure by means of a visual analog scale 6 months after the procedure. Eighty-five to 100% satisfaction rate was interpreted as excellent, 70% to 85% was good, 60% to 70% was regular, and less than 50% was bad. Patients with palmar hyperhidrosis were found to have a 97% satisfaction rate, whereas patients with axillary hyperhidrosis reported 95%. Satisfaction rate after ETS for facial hyperhidrosis was 87%. It was furthermore interesting to see that all patients reported a slight relief in plantar sweating also (Table 3).

Patients reporting about compensatory sweating were studied with more emphasis. One month after ETS nearly 69% reported this problem. Thirty-six patients (20.2%) complained about severe impairment (36 of 178 patients). Five months later only one third of the patients were left with compensatory sweating symptoms, and 27 stated being heavily impaired (15.2%). Two years ahead of the ETS procedure, 23 patients (of 169) complained about compensatory sweating (13.7%). Eleven of these reported severe impairment (6.5%). On the other hand, already 1 month after ETS 85.9% reported that symptoms coming from compensatory sweating were perceived to a lesser extent than those arising from primary hyperhidrosis. Twenty-four months after surgery satisfaction was 92.9% in these patients. So we are left with 7.1% of patients who are not satisfied with the results, and therefore our overall success rate reaches 93% (Table 4).

Table 3. Postoperative Satisfaction Recorded 6 Months After Endoscopic Thoracic Sympathectomy (by Visual Analog Scale)

Variable	Excellent/Good (70%–100%)	Good/Regular (50%–70%)	Regular/Bad (0%–50%)
Palmar	86% (153/178)	11% (20/178)	4% (8/178)
Axillary	64% (115/178)	31% (56/178)	5% (9/178)
Facial	60% (107/178)	27% (49/178)	13% (23/178)
Plantar	33% (59/178)	18% (32/178)	49% (88/178)

Table 4. Postoperative Evolution of Compensatory Sweating (9 Dropouts Between Months 6 and 24) and Symptoms of Compensatory Sweating Lesser Than Primary Hyperhidrosis

Variable	Month 1	Month 6	Month 24
Severe impairment	20.2% (36/178)	15.2% (27/178)	6.5% (11/169)
Moderate impairment	39.3% (70/178)	16.3% (29/178)	3.6% (6/169)
Little impairment	9% (16/178)	3.9% (7/178)	3.6% (6/169)
Total	68.5%	35.4%	13.7%
Symptoms less than primary			
Yes	85.9% (153/178)	91.1% (162/178)	92.9% (157/169)
No	14.1% (25/178)	8.9% (16/178)	7.1% (12/169)

The German National Health Interview and Examination Survey (1998) included the Short Form 36-Questionnaire as an instrument for measuring health-related quality of life. For display purposes, we selected the subgroups with major surgical interest: physical fitness (PF), vitality (V), social fitness (SF), and psychological fitness (PSF). The normal values are taken from a group 30 to 39 years of age and are displayed as the arithmetic median.

In male patients PF values remained stable up to month 24 and did not differ from values in normal subjects. Preoperative values for V (not significant), SF ($p < 0.05$), and PSF ($p < 0.05$) were lesser and changed toward normal values already 1 month after ETS (Fig 1). In female patients the situation was comparable; PF was normal and preoperative values for V (not significant), SF ($p < 0.05$), and PSF ($p < 0.05$) were noted to be different from the normal population. Recovery and changing to normal was seen a little later and was complete 6 months after the operation (Fig 2).

In the next step SF-36 results in male and female patients were analyzed according to presence or absence of compensatory sweating. There was no statistically relevant difference seen between patients with and without this symptom after ETS in the evolution of postoperative quality of life, neither in male (Fig 3) nor in female patients (Fig 4).

Finally, 24 months after ETS more than 90% of those patients without compensatory symptoms recommended ETS and were willing to go in for this therapy a second time. There was no difference noted between male and female patients or between groups A and B. On the other hand, patients suffering from compensatory sweating were not willing to recommend surgery again so easily. Range of nonrecommendation was 25% to 50%. As group B is far smaller the percentage of discontent seemed to be higher but was also statistically blurred (Table 6).

Comment

The first reported operation on the upper sympathetic system was performed by Alexander in 1889. For some subsequent indications (angina pectoris, vasospastic disorders, abdominal pain in cancer patients), sympathectomy still has a limited application. The main indications today are hyperhidrosis (since 1920) and blushing. The technique of sympathectomy has been modified during the last century, with a trend to minimize the extent of surgery from open to minimally invasive approaches, and from resection of ganglia to thermoablation, thermotransection, clipping, and even differential dissection like ramicotomy. The sequelae of sympathectomy (mainly compensatory and gustatory sweating) present a major problem in a small percentage of operated on patients [9].

Review of the literature shows that, regarding surgical treatment of hyperhidrosis, sufficient controlled trials have not been carried out to bring down the indications for ETS into guidelines. Sympathectomy is considered a lifestyle operation; therefore, worldwide clinical investi-

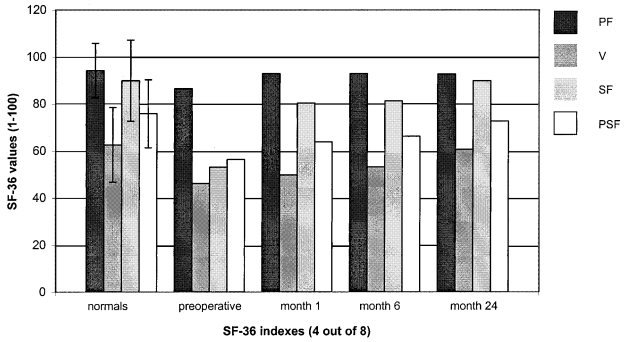

Fig 1. Evolution of postoperative quality of life by SF-36: male patients (n = 51). The index groups displayed are physical fitness (PF), vitality (V), social fitness (SF), and psychological fitness (PSF). Normal values are taken from a group 30 to 39 years of age.

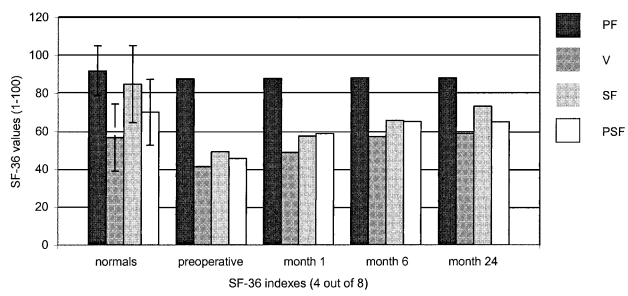

Fig 2. Evolution of postoperative quality of life by SF-36: female patients (n = 127). The index groups displayed are physical fitness (PF), vitality (V), social fitness (SF), and psychological fitness (PSF). Normal values are taken from a group 30 to 39 years of age.

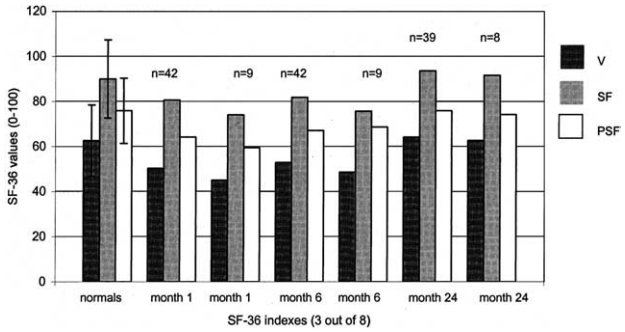

Fig 3. Evolution of postoperative quality of life by SF-36: effect of compensatory sweating (9 of 51 male patients). The index groups displayed are vitality (V), social fitness (SF), and psychological fitness (PSF). The differences between patients with (n = 9) and without (n = 42) compensatory sweating are pointed out (4 dropouts at month 24). Normal values are taken from a group 30 to 39 years of age.

gative interest is minor, and especially patients cannot be convinced to participate in randomized trials easily. A database review published in 2000 revealed that compensatory sweating rate is 52.3%, gustatory sweating, 32.3%, phantom sweating, 38.6%, and Horner's syndrome, 2.4%, and with cervicodorsal sympathectomy, more often after open approach [10]. These results are partially consistent with our findings. Standard approach for palmar hyperhidrosis is sympathectomy from T2 to T4. Our study shows that staying away from T2 ganglion may limit compensatory sweating. In women this reduction was as high as 75% and in men near 50% (Table 2). Most of the trials for sympathectomy in hyperhidrosis mentioned above included destruction of T2 ganglion.

Collegues with more experience in this therapy report even lesser complication rates. Lin and associates [11] from Taiwan presented a large series with 2,200 patients. Ablation of T2 ganglion was performed in patients with palmar sweating and from T3 to T4 in patients with axillary hyperhidrosis. Successful sympathectomy was achieved in 2,178 patients (99%). Unusual findings during ETS did occur at a rate of 5.6%. Surgical complications included pneumothorax (0.45%), hemothorax (0.09%), segmental atelectasis (0.55%), and mild wound infection (0.14%). Compensatory sweating was reported in 1,936 patients (88%) [11]. Table 5 shows a cross-section of ETS side effects collected during a period of 10 years from the literature [12–20]. Our results are consistent with international data published on this issue. Overall risk of surgical therapy for hyperhidrosis is therefore very low (Horner's syndrome, 0.6%; recurrence, 0.5%; hemorrhage, 0.6%; fistula, 1.1%).

Horner's syndrome is indeed a possible but rare complication of sympathectomy. The anatomic location of the second thoracic ganglion is commonly the second intercostal space (92.5%) at the level of the intervertebral disc between the second and third thoracic vertebra. Fused ganglia between the second thoracic and first thoracic (5%) and stellate (5%) ganglion are also possible. Our series is too small to detect Horner's syndrome and additionally discuss the effect of limited denervation on the risk of this complication. But taking into account that relative risk for Horner's syndrome is 0.6% (Table 5) and fused ganglia may be seen at a risk of 10%, the sparing of T2 during ETS might diminish overall risk to less than 0.05% [21]. To our impression the majority of stellate ganglion lesions occurs because of starting sympathectomy at level T2.

In our study postoperative quality of life was measured by the SF-36 questionnaire. The SF-36 is the authorized product of Ware and Sherbourne from 1992 that was created out of the Medical Outcomes Study. Population-adjusted analyses with the SF-36 have documented that the scales are comparable and reliable for Sweden, Holland, Germany, England, and the United States. The German version of the SF-36 was submitted to rigorous examination and has been tested in numerous German probands [8]. Our study included the SF-36 questionnaire in a large hyperhidrosis population undergoing ETS, using this instrument for differentiated longitudinal survey. Female and male patients did not differ substantially in PF values. The SF-36 values for vitality (V) were noted to be minimally out of range, and values for SF and PSF were abnormal for both male and female patients (Figs 1, 2). All these values returned to normal during a period of 24 months in spite of a 7.1% overall nonsatisfaction rate. The SF-36 values for V, SF, and PSF showed a tendency to smaller values in patients with compensatory sweating, but did not reach statistical relevance (Figs 3, 4). In a study published recently from Dublin, quality of life was assessed with the SF-36 after ETS for palmar hyperhidrosis also. Improvement for PF, PSF, and SF was seen. Although this was only a small patient cohort (n = 62) and only 66% of the entire group could be evaluated, quality of life was unanimously improved [22]. These results are consistent with the SF-36 data from our study.

The main aim of the study presented here was to find out whether there is an association between the extent of sympathectomy and the occurrence and severity of compensatory sweating. Leseche and coworkers [5] published data from a prospective trial concerned with this aspect. One hundred thirty-four patients (99 female, 35

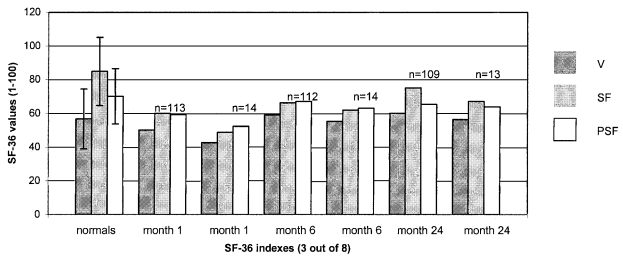

Fig 4. Evolution of postoperative quality of life by SF-36: effect of compensatory sweating (14 of 127 female patients). The index groups displayed are vitality (V), social fitness (SF), and psychological fitness (PSF). The differences between patients with (n = 14) and without (n = 113) compensatory sweating are pointed out (1 dropout at month 6, 4 dropouts at month 24). Normal values are taken from a group 30 to 39 years of age.

Table 5. Side Effects of Endoscopic Thoracic Sympathectomy Related to Extent of Denervation in Hyperhidrosis Patients[a]

Reference	Year	n	Horner	Recurrence	Hemorrhage	Pneumothorax
Hashmonai et al. [12]	1992	170	1.2%	4.1%	/	1.7%
Herbst et al. [13]	1994	480	2.5%	1.5%	0.4%	1.5%
Drott et al. [14]	1995	850	0.2%	2.0%	0.2%	1.1%
Zacherl et al. [15]	1998	630	3.8%	/	/	3.5%
Erak et al. [16]	1999	126	3.9%	/	/	17.5%
Lin et al. [17]	2002	2,000	0.1%	1.2%	0.1%	0.5%
Gossot et al. [18]	2001	940	0.4%	/	2.7%	1.3%
Ueyama et al. [19]	2001	7,017	0.3%	/	0.4%	0.5%
Gossot et al. [20]	2003	382	0.7%	/	3.1%	1.8%
Present study	2005	178	/	0.6%	0.6%	2.3%
Total		12,773	0.57%	0.45%	0.56%	1.1%

[a] Endoscopic thoracic sympathectomy was performed from T2 to T4.

male; mean age, 27.8 ± 6.7 years) entered this study. Routine follow-up with clinical examination was performed 1, 3, and 6 months after ETS during the first postoperative year and every year thereafter. Overall satisfaction rate was 97%. The mean follow-up was 44.3 months (range, 7 to 100 months), and complete follow-up was available in 132 patients (98.5%). Ninety-five patients (71.9%) developed compensatory sweating. Seventy patients (53%) judged their impairment as a result of compensatory sweating to be minor, and 25 patients (19%) judged it severe (16% embarrassing, 3% disabling). The results of a small subgroup (n = 7) with T3 through T5 sympathectomy unfortunately were not emphasized in this study. All the remaining patients had the T2 ganglion included in the denervation area. On univariate and multivariate analysis, the extent of denervation was not associated with the occurrence or the severity of compensatory sweating [5]. These findings are consistent with the clinical results of group A from our trial, which included resection of T2 ganglion.

Gustatory sweating, meaning facial sweating associated with the eating of hot spicy food or even smelling this food, was also noted in our patients [23]. There was no difference between the two groups, so preservation of T2 did not influence this side effect (Table 2).

Another study on compensatory sweating included 193 patients treated in Taiwan and 55 treated in Finland. Endoscopic sympathetic block (ESB) of the second thoracic ganglion was used for conflicted type of social phobia or blushing in 25 patients. Endoscopic sympathetic block 3 was used for facial sweating and blushing in 55 patients. Endoscopic sympathetic block 4 was used for hand and axillary sweating in 168 patients. Compensatory sweating was interpreted as the most important sign of unsuccessful surgery. Four of 25 patients in the ESB 2 group (16%) and three of 55 patients in the ESB 3 group (5.5%) had unacceptable compensatory sweating. No patient with compensatory sweating was found in the ESB 4 group. According to these findings, the various sympathetic disorders were organized into three main categories: those restricted to the facial area, like conflicted type social phobia and conflicted type blushing, were placed into group 1; those on the head and face, like sweating with or without blushing, into group 2; and those in the hands, axillae, and forearms, into group 3. Finally, differential surgical procedures for different disorders of the sympathetic system were proposed: ESB 2 for group 1, ESB 3 for group 2, and ESB 4 for group 3 disorders [4]. These results are consistent with our clinical findings in group B (Table 2). In group A (ETS T2 through T4), the rate of compensatory sweating was 17.1%; in group B (ETS T3 through T5), it was as high as 4.9%. The importance of T2 ganglion is pointed out again by this observation.

Another interesting aspect of our study was the evolution of compensatory sweating with time. During the first 4

Table 6. Recommendation for Endoscopic Thoracic Sympathectomy in Hyperhidrosis Given From Patients 24 Months After Surgery

	Group A				Group B			
	Male		Female		Male		Female	
	Compensatory Sweating		Compensatory Sweating		Compensatory Sweating		Compensatory Sweating	
Recommendation	Yes	No	Yes	No	Yes	No	Yes	No
Yes	5	28	9	54	/	7	1	45
	62.5%	90.3%	75%	91.5%	0%	100%	50%	91.8%
No	2	1	3	4	1	/	1	3
Indecisive	1	2	/	1	/	/	/	1

weeks more than 68% of patients experienced compensatory symptoms. This side effect was heavily reduced 5 months later and was only 13.7% 24 months after ETS. These findings are partially consistent with a study published recently from Taiwan. In 91 consecutive patients, attention was focused on satisfaction and the incidence of compensatory sweating. Eighty-eight patients (96.7%) exhibited this symptom with mean initial occurrence after 8.2 weeks. Compensatory symptoms progressively worsened to the maximum degree within another 2 weeks after onset (mean, 10.3 ± 1.8 weeks). In 19 patients (21.6%), symptoms of compensatory sweating improved spontaneously within 3 months after sympathectomy (mean, 13.3 weeks). None of these patients required repeated operation. The severity of compensatory sweating remained stable 6 months after surgery [24].

The latest studies on preservation of the sympathetic nerve trunk and limitations on the range of dissection, especially by performing ramicotomy, have postulated reduction in compensatory sweating. Comparing patients with ablation of T2 ganglion (n = 64) with patients with T3 ramicotomy (n = 83) has revealed that compensatory sweating is significantly reduced. On the other hand, symptoms from palmar hyperhidrosis could not be reduced to the extent that would have been achievable by simple ablation techniques (satisfaction rate, 68.6%) [25]. These findings are consistent with our results.

Patients with palmar hyperhidrosis in our study were found to have a 97% satisfaction rate, whereas patients with axillary hyperhidrosis reported 95%. Satisfaction rate after ETS for facial hyperhidrosis was 87%. Fifty percent of patients complaining about additional plantar sweating had minimal relief after surgery (Table 3). This finding has also been reported by Baumgartner and Toh [26] in 2003. From a series of 309 hyperhidrosis patients with T2 through T3 sympathectomy, 180 patients underwent prospective evaluation. They found that in 80% of all patients ETS could improve plantar hyperhidrosis when treated in combination with palmar hyperhidrosis. They also found compensatory sweating to be common, occurring in nearly half of the patients, but rarely extreme and problematic [26].

When compensatory sweating is noted, the first thing to do is to calm the patient—and the surgeon. More than 50% of compensatory symptoms disappear after a period of 6 months in the postoperative course. The conclusion that may be drawn at this point is that the onset of compensatory sweating remains unclear. With the lack of prospective randomized trials concerning the extent of sympathectomy and the surgical technique used, up to now we have no evidence that a limited denervation may diminish the risk of compensatory sweating after performing ETS. Influence of a preserved T2 or T5 ganglion on compensatory sweating also has not been investigated selectively yet. On the other hand, our study has shown clearly that in the presence of compensatory symptoms, satisfaction rate is extremely high in these patients, and that subjective restriction owing to compensatory sweating is improved to a certain extent when leaving T2 untouched. We have to meet the point of criticism that this is a nonrandomized trial. On the other hand, statistical problems associated with the surgical learning curve may be neglected in this case, as the performing surgeon (J.S.) has applied this type of operation on more than 100 patients before 2000 for the same and other indications. So the extent of denervation is the only variable that has been changed throughout the study. We have therefore decided to limit denervation from T3 to T4 ganglia in patients with palmar and axillary hyperhidrosis. We recommend the carrying out of a prospective, randomized trial that compares different extents of denervation focusing on T2 and T5 as well as on surgical ablation and clipping techniques.

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