Original Article

Thoracic autonomic nervous system surgery current application—a survey among members of the European Society of Thoracic Surgeons

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Background: Thoracic autonomic nervous system surgery is mainly used for hyperhidrosis/facial flushing, whereas cardiac and vascular indications are limited. The literature remains controversial regarding the correct indications and surgical technique, with the lack of homogeneous data being a major limitation. We designed a survey to investigate current practice among members of the European Society of Thoracic Surgeons (ESTS).

Methods: A 29-question ad hoc questionnaire was available to all ESTS members from December 2022 to February 2023. It included questions on demographics, indications, preoperative evaluation, technique, complications and follow-up. A descriptive analysis of the data is presented.

Results: The response rate was 7% and 121 of 123 valid responses were analysed. Sympathetic surgery was performed for hyperhidrosis/facial flushing, cardiac and vascular disease in 99%, 29% and 29% of respondents respectively. Palmar hyperhidrosis was the most common, followed by axillary, facial flushing and craniofacial hyperhidrosis. Catecholaminergic ventricular tachycardia was more common than long QT syndrome and Raynaud's over Buerger's disease. Data analysis showed that members preferred nerve cutting to clipping (66%, 64% and 58% for hyperhidrosis/facial flushing, cardiac and vascular disease respectively). Preference for the target level of nerve block varied significantly depending on the condition addressed. For most responders (65%), severe compensatory sweating was an adverse event, occurring in less than 10% of treated cases. Only 52% used a database for follow-up.

Conclusions: Current practice in sympathetic surgery in ESTS responders is consistent with the available evidence, although it is characterized by great heterogeneity in almost all aspects. A database could help to standardize patient selection, surgical techniques and follow-up, and provide the basis for future multi-institutional trials.

Keywords: Survey; European Society of Thoracic Surgeons (ESTS); sympathetic surgery; hyperhidrosis; autonomic nervous system

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Introduction

Thoracic autonomic nervous system surgery is based on interrupting the adrenergic action of the central nervous system. The first surgery on the thoracic sympathetic chain was performed by Alexander in 1889 (1) and was initially proposed to improve circulation in the extremities (2), while Kotzareff is credited with performing the first cervical sympathectomy for hyperhidrosis in 1920 (3). The first physiological perspective of sympathectomy in cardiovascular disease was published by Goetz in 1948 (4). With the advent of video-assisted thoracic surgery (VATS), the thoracoscopic approach became the gold standard. Similarly, sympathetic chain resection or the clipping technique became the most popular strategies (5). Over time, the indications have evolved: Jonnesco extended its use to exophthalmic goiter (6); Franck to glaucoma, idiotism and hyperthyroidism (7). However, many of these indications have become obsolete and palmar hyperhidrosis (PH) is now the most common (8). Several papers have been published to finally define the correct indications and techniques, but evidence is still scarce due to the lack of high-quality data. In conclusion, there are no guidelines, and the debate is still open. To assess the current clinical practice among thoracic surgeons, the European Society of Thoracic Surgeons (ESTS) decided to survey its members to obtain a state-of-the-art overview of thoracic autonomic nerve surgery. We present this article in accordance with the CROSS reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-1167/rc).

Highlight box

Key findings

- This survey has described the habits of a small group of respondents among European Society of Thoracic Surgeons members in the management of thoracic autonomic nervous system surgery.
- Response rate was 7%.
- Sympathetic surgery was adopted for hyperhidrosis/facial blushing, cardiac and vascular diseases by 99%, 29% and 29% of responders. Palmar was the most frequent hyperhidrosis condition, followed by axillary, facial blushing, and craniofacial hyperhidrosis.
- Members prefer nerve cutting over clipping.
- Nerve block target level preference changed significantly based on each addressed affliction.

What is known and what is new?

- Despite many publications in the literature, there are no guidelines for thoracic autonomic nervous system surgery.
- Despite a good level of agreement with the only consensus statement in the world literature, there was a heterogeneity of responses in each section of the questionnaire in this study's result.

What is the implication, and what should change now?

- Our results suggest the need for a common database that could help standardise patient selection, surgical techniques and follow-up, and provide the basis for future multi-institutional trials.

Methods

The survey consisted of 29 questions grouped into 4 topics (demographics, preoperative assessment, surgical technique, follow-up). As this was an interview with surgical members of the European Society of Thoracic Surgeons, not involving patients or sensitive data, no consent was required. Multiple choice responses were formatted to avoid ambiguous and uninformative responses. Some questions allowed for multiple answers. Four final questions investigated the use of a database and whether members felt it was appropriate to implement a shared database. Finally, an additional question assessed interest in participating in future studies. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Of the 1,683 ESTS members, 1,677 were successfully informed of the survey by email. The questionnaire was available from December 2022 to February 2023. It was submitted using the www.surveymonkey.com format, after approval by the ESTS Council. During this period, 3 email reminders were sent to encourage completion of the survey before the study closed. All responses were voluntary and anonymous. If a member completed the questionnaire twice, only the first attempt was considered. If a member

stated that they did not practice sympathetic surgery, any subsequent response was not included.

Demographic data and IP address allow us to detect repeated responses. If a member completed the questionnaire twice, only the first attempt was considered. If a member stated that they did not practice sympathetic surgery, any subsequent response was not included. Data are presented as numbers and percentages. Categorical variables were tested using the χ^2 test or Fisher's exact test for expected values less than 5, as appropriate.

Table 1 Demographic data of respondents

Demographic data	Percentage
Male	86%
Female	12%
No answer	2%
Academic hospital	71%
Supra regional nonacademic hospital	12%
Regional nonacademic hospital	12%
25–30 years old	2%
31–40 years old	25%
41–50 years old	30%
51–60 years old	30%
61–70 years old	13%

The table shows the demographic data as a percentage of 121 of the 123 respondents. In fact, one member answered twice incorrectly and another, who does not practice this type of surgery, did not continue with the compilation.

Statistical analysis

Data analysis was aimed at investigating any significant difference in the observed frequencies in favor of nerve resection or clipping for each condition at different nerve target levels (relative to the upper rib margin: R). Our aim was to understand whether respondents tended to adopt a preferred nerve block technique. In terms of nerve target, we looked at the level at which blocks are usually performed for both cutting and clipping techniques.

Results

From December 5, 2022, to February 27, 2023, a total of 123 actual respondents (response rate 7%) started the questionnaire. Everyone practiced thoracic autonomic nervous system surgery but one. One member fulfilled the survey twice. Therefore, the final number of responses that we considered was 121. Raw results for each question are reported in the supplementary file (Appendix 1 https://cdn.amegroups.cn/static/public/10.21037jtd-24-1167-1.pdf). Demographics are reported in *Table 1* and *Figure 1*.

Enrolment and preoperative assessment

Thoracic autonomic nervous system surgery was used to treat hyperhidrosis/facial flushing in 120 (99%) responders, and both cardiac and vascular disease in 36 (30%) responders. General practitioners and dermatologists were the specialists most likely to refer patients to thoracic surgeons, according to 81 respondents. Self-referral was mentioned by 78 respondents. Of those performing thoracic

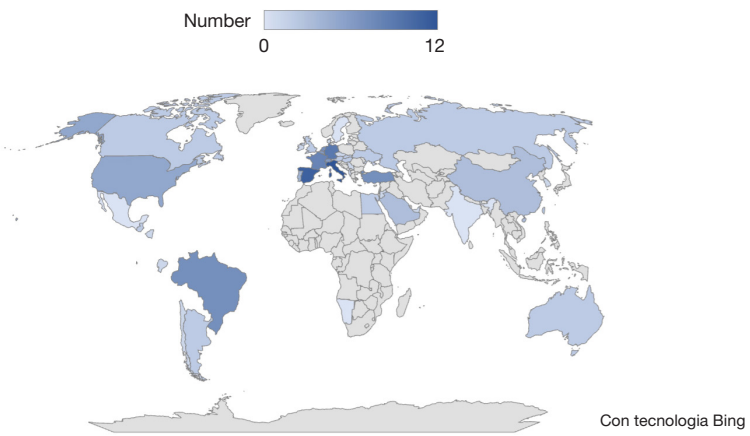

Figure 1 Worldwide distribution of members who completed the questionnaire.

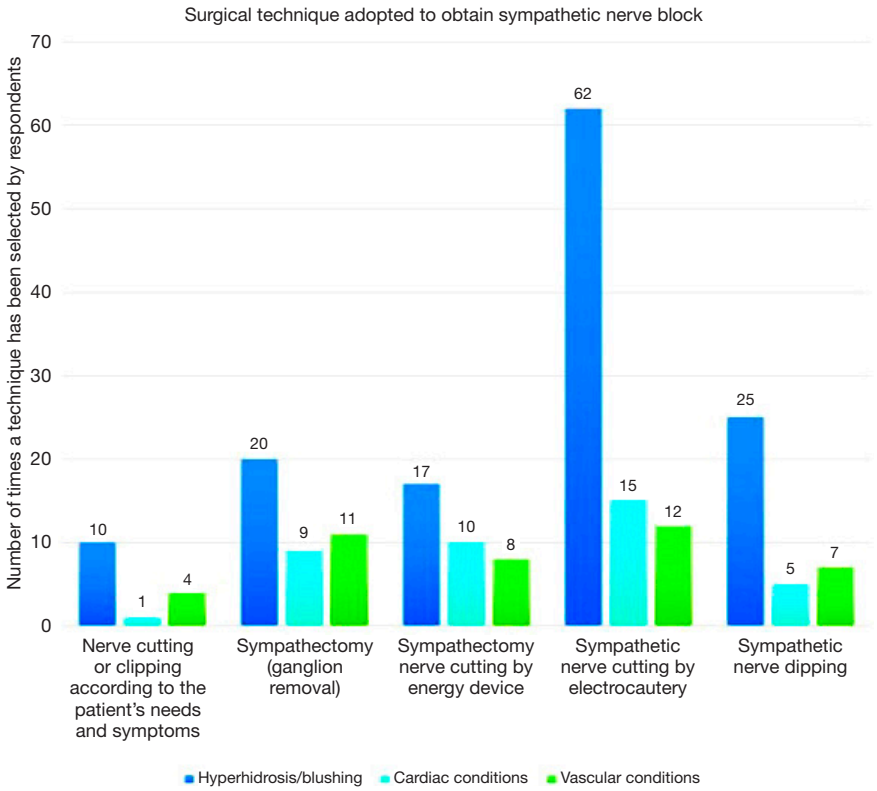

Figure 2 Distribution of surgical techniques used to obtain sympathetic nerve block.

autonomic nervous system surgery for hyperhidrosis/facial flushing, only 3% said they performed more than 75 cases per year, another 3% between 51 and 75 cases per year, 15% between 26 and 50, 36% between 10 and 25, 43% less than 10 cases per year. Conversely, for cardiac and vascular conditions, only 11% and 3% respectively reported performing more than 10 (but never more than 26) operations per year. Palmar and axillary conditions were treated surgically by 94% and 74% of respondents respectively, followed by facial flushing (43%) and craniofacial hyperhidrosis (CFH) (24%). Catecholaminergic ventricular tachycardia refractory to conventional therapy, long QT syndrome (LQTS) and arrhythmias were treated in 50%, 42% and 36% of responders respectively. Raynaud's syndrome and thromboangiitis obliterans (Buerger's disease) were treated in 83% and 36% of responders, respectively. Seventy-four out of 120 (61%) surgeons said they selected patients with hyperhidrosis based on personal experience, 20% used the Hyperhidrosis Quality of Life Scale (HDSS), 10% used the Hyperhidrosis Quality of Life Index (HidroQol) and 1.00% used the Dermatology Life Quality Index (DLQI).

Surgical technique

Biportal thoracoscopy was chosen by 50%, 58% and 50% of surgeons for hyperhidrosis/facial flushing, cardiac and vascular disease respectively, followed by uniportal (31%, 67% and 9%) and triportal (8%, 11% and 8%); The choice to operate on both sides during the same operation was made by 63%, 50% and 28% of the respondents, while the choice to operate on one side at a time was made by 12%, 9% and 31% for hyperhidrosis/facial flushing, cardiac and vascular diseases respectively. One-lung ventilation with or without intrapleural CO_2 was used by 73%, 89% and 81% of surgeons for hyperhidrosis/facial flushing, cardiac and vascular disease, respectively, while single-lumen intubation was used by 23%, 11% and 17% of surgeons. While awake surgery was performed by 4%, 0% and 3% of responders respectively. Nerve transection was chosen by 66%, 64% and 58% of respondents for hyperhidrosis/blushing, cardiac and vascular disease respectively, followed by nerve transection for hyperhidrosis/blushing alone (21%). In contrast, ganglion excision was the second choice for treating heart disease (25%) and vascular disease (31%) (*Figure 2*). A percentage

Table 2 Comparison in terms of preference between the clipping technique and the nerve cutting technique in hyperhidrosis/facial blushing

Condition-R level	Clipping %	Nerve cutting %	P value
PH-R2	8.01	18.7	<0.001
PH-R3	32.5	71.5	0.52
PH-R4	27.0	55.7	>0.99
PH-R5	3.20	6.50	0.02
PH-R6	No measures of association computed		
PH-Below R6	No measures of association computed		
AH-R2	4.10	18.9	<0.001
AH-R3	26.0	48.8	0.01
AH-R4	27.8	58.2	0.10
AH-R5	9.7	24.4	<0.001
AH-R6	No measures of association computed		
AH-Below R6	No measures of association computed		
FB-R2	28.4	46.3	0.009
FB-R3	19.5	33.3	<0.001
FB-R4	5.70	7.30	<0.001
FB-R5	2.4	1.6	<0.001
FB-R6	No measures of association computed		
FB-Below R6	0.01	0.8	0.008
CFH-R2	21.9	30.9	<0.001
CFH-R3	20.3	27.6	<0.001
CFH-R4	6.50	8.90	<0.001
CFH-R5	2.43	2.40	0.001
CFH-R6	No measures of association computed		
CFH-BelowR6	0.80	0.80	0.008

Data analysis showed a significance (P<0.05) in favour of nerve resection for most of the nerve target levels. R, rib; PH, palmar hyperhidrosis; AH, axillary hyperhidrosis; FB, facial blushing; CFH, craniofacial hyperhidrosis.

Table 3 Comparison in terms of preference between the clipping technique and the nerve cutting technique in vascular diseases

Condition-R level	Clipping %	Nerve cutting %	P value
BD-R2	4.87	10.6	0.01
BD-R3	15.4	24.4	<0.001
BD-R4	11.4	16.3	<0.001
BD-R5	4.87	5.70	<0.001
BD-R6	0.81	0.80	>0.99
R-R2	6.50	9.8	<0.001
R-R3	23.6	30.9	<0.001
R-R4	17.1	23.6	<0.001
R-R5	5.70	8.10	<0.001
R-R6	0.81	0.80	>0.99
V-R2	4.06	8.10	0.004
V-R3	15.4	22.0	<0.001
V-R4	10.6	17.1	<0.001
V-R5	4.87	6.50	<0.001
V-R6	0.81	0.80	>0.99
UCP-R2	3.25	5.70	<0.001
UCP-R3	8.13	11.4	<0.001
UCP-R4	7.31	9.80	<0.001
UCP-R5	3.25	3.30	<0.001
UCP-R6	0.81	0.8	0.02

Data analysis showed a significance (P<0.05) in favour of nerve resection for most of the nerve target levels. R, rib; BD, Buerger's disease; V, vasculitis; UCP, ulcers chronic pain.

of respondents (8%, 3% and 11% for the three conditions treated respectively) stated that they did not always use the same technique but modified it from time to time according to the needs and symptoms of the individual patient. Data analysis showed a significance (P<0.05) in favor of nerve transection for several hyperhidrosis/blushing, cardiac and vascular conditions (*Tables 2-4*). In terms of nerve target, for PH, R3 was preferred for cutting and clipping by 72% and 33% of the 120 responders, respectively, followed by R4 (56% and 27%), R2 (19% and 8%) and R5 (6% and 3%). For axillary hyperhidrosis (AH), level R4 was preferred by 58% and 28% of respondents, followed by R3, R5 and R2. For facial flushing, R2 (46% and 28%) was followed by R3, R4 and R5, as well as for CFH (*Figure 3*). The same questions were asked for each of the cardiac and vascular conditions (*Figures 4,5*). In addition, statistical analysis was performed to determine whether there was a significant difference between the frequencies with which a particular nerve target level was selected for each pathological condition. Given an R-level, from R2 to R6, and a surgical technique, we compared each condition to determine which was statistically more frequent. The results showed a significant (P<0.005)

Table 4 Comparison in terms of preference between the clipping technique and the nerve cutting technique in cardiac diseases

Condition-R level	Clipping %	Nerve cutting %	P value
HF-R2	4.06	6.50	>0.99
HF-R3	9.75	11.4	0.35
HF-R4	5.69	8.10	>0.99
HF-R5	3.25	4.10	–
HF-R6	0.81	0.80	>0.99
HF-R7	0.81	0.80	>0.99
HF-R8	0.81	0.80	>0.99
LQTS-R2	6.50	13.0	0,001
LQTS-R3	12.2	20.3	<0.001
LQTS-R4	7.31	16.3	<0.001
LQTS-R5	4.50	7.30	<0.001
LQTS-R6	0.81	1.60	0.01
LQTS-R7	0.81	1.60	0.01
LQTS-R8	0.81	0.80	0.008
CA-R2	6.50	11.4	<0.001
CA-R3	12.2	18.7	<0.001
CA-R4	8.13	17.9	<0.001
CA-R5	4.90	9.80	0.001
CA-R6	1.62	2.40	0.04
CA-R7	1.62	2.40	0.04
CA-R8	1.62	0.80	0.01
VRA-R2	13.0	13.0	<0.001
VRA-R3	20.3	20.3	<0.001
VRA-R4	17.0	17.1	<0.001
VRA-R5	8.94	8.90	<0.001
VRA-R6	1.62	1.60	<0.001
VRA-R7	1.62	1.60	<0.001
VRA-R8	0.81	0.80	0.008

Data analysis showed a significance (P<0.05) in favour of nerve resection for most of the nerve target levels. R, rib; HF, heart failure; LQTS, long QT syndrome; CA, cardiac arrhythmias; VRA, ventricular resistant arrhythmias.

difference in the frequency with which different conditions were reported for each target level, whether clipping or cutting. Respondents always preferred nerve block at R2 in CFH and facial blushing (FB) over PH and AH, R3 in PH and AH over FB and CFH, R4 in AH over PH, FB and CFH, R5 in AH over FB and CFH. We report that in the R4 nerve resection group, the surgeons surveyed preferred FB and CFH over AH and PH as indicated for the clipping group. Data were also analyzed for hyperhidrosis/blushing, cardiac and vascular disease (supplementary files are Available at: https://cdn.amegroups.cn/static/public/10.21037jtd-24-1167-2.pdf, https://cdn.amegroups.cn/static/public/10.21037jtd-24-1167-3.pdf, https://cdn.amegroups.cn/static/public/10.21037jtd-24-1167-4.pdf). We also investigated surgeons' opinions on the role of robotic-assisted thoracic surgery (RATS) and 6 of them responded that RATS will soon replace VATS in this surgery.

Perioperative management

Regarding chest drain management, 37% did not place a chest drain perioperatively, 36% removed it in the operating room and discharged the patient, 12% removed it on postoperative day (POD)-1 and discharged the patient, 7% removed the drain in the ward on the day of surgery and discharged the patient on POD-1, 4% removed it in the ward on POD-0 and then discharged the patient.

Follow-up

Pneumothorax was the most common complication reported by respondents (72%), followed by Claude Bernard Horner syndrome (32%), hemothorax and persistent air leak (24%), Harlequin syndrome (12%), chylothorax (4%) and empyema (0.83%). A total of 66% respondents experienced severe compensatory sweating in less than 10% of cases, 14% in 10–20% of cases, 3% in 20–30% of cases and 3% in more than 30% of cases. For severe compensatory sweating, 53% of respondents usually preferred non-invasive medical approaches such as oxybutynin or even referral to a dermatologist. Only 13% of respondents said they preferred a surgical approach, such as nerve declipping (8%), nerve reconstruction (3%) and diffuse sympathectomy (2%).

Sixty-three (53%) of respondents reported using a hyperhidrosis/blushing follow-up database. Of those, 37% investigated the level of patient satisfaction and in this case 29% recorded a satisfaction rate >90%. Finally, 94% agreed with the usefulness of a common database and 88% agreed with the need for guidelines.

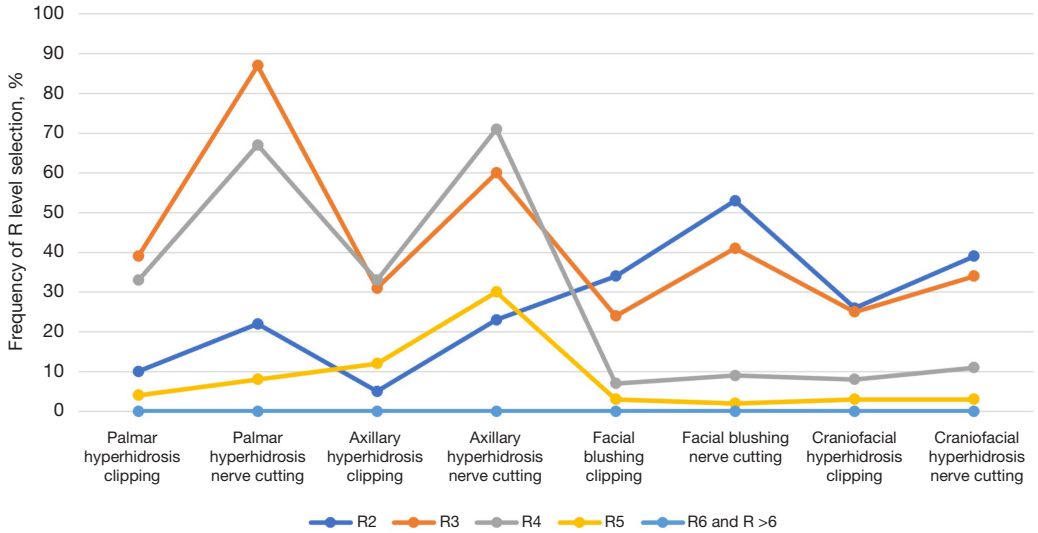

Figure 3 The frequency with which each nerve target level (R) was selected for each condition and surgical technique in hyperhidrosis.

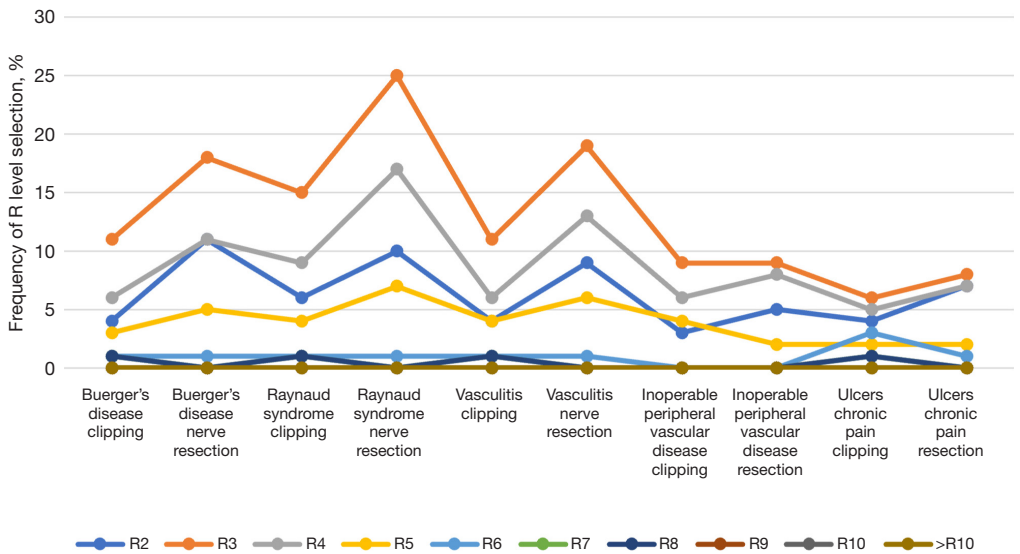

Figure 4 Frequency of each nerve target level (R) for each condition and technique in vascular conditions. The lines for R7, R9, R10, and >R10 fully coincide at the 0% level on the y-axis.

Discussion

There is still considerable controversy in the current literature regarding the correct indications and techniques for thoracic autonomic nervous system surgery. The lack of comprehensive, homogeneous and randomized data is one of the main reasons for the lack of guidelines. The recommendations published in 2011 (9) are still the most authoritative support available. In this scenario, we designed the present survey to investigate the current habits of the ESTS community. The aim of this survey was to give a broad description of the whole possible panorama of thoracic autonomic nervous system surgery. Within this framework, two main areas can be distinguished. The first was mainly aimed at obtaining demographic information to understand which pathologies were most commonly treated and by which specialists, and the second was mainly focused on surgical technique and strategy to assess whether there

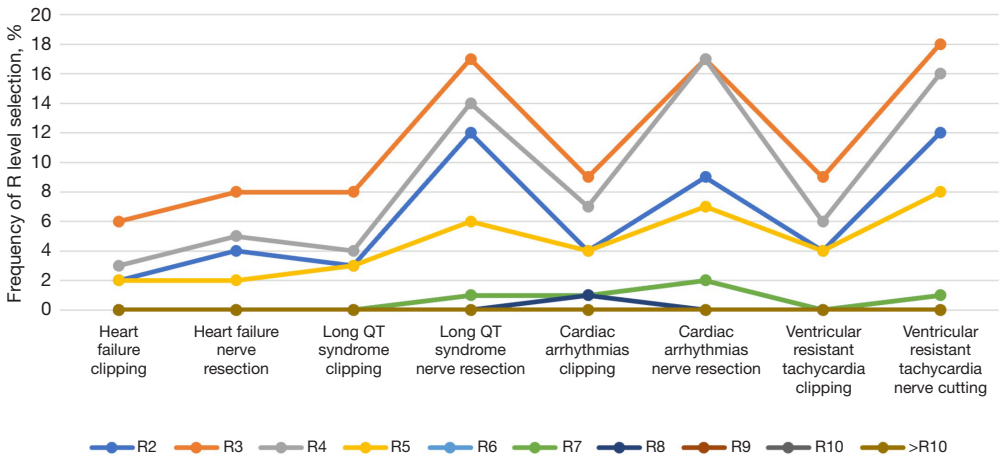

Figure 5 Frequency of each nerve target level (R) for each condition and technique in cardiac conditions. The lines for R6, R9, R10, and >R10 fully coincide at the 0% level on the y-axis.

was homogeneity of action.

The response rate was approximately 7%, which is lower than data reported in the literature on online surgical surveys [average response rate of 53.3%±24.5%, in surveys of healthcare professionals (10)], while previous ESTS surveys ranged from 8% to 23%. This result may indicate a lack of interest in the survey or that few surgeons are performing the technique. This could also be since the respondents were spread all over the world, but mainly in Europe, North America and Brazil, and not with the same distribution of hyperhidrosis prevalence, which varies in different parts of the world. In fact, the global prevalence of hyperhidrosis ranged from 2.8% to 4.8% in the United States, while in Asia it was estimated to be 13.95% in Japan and 18.4% in China (11). While this low response rate makes our survey less representative, it is also an indication that this issue, which is the domain of the thoracic surgeon, is under-reported. In addition, to better understand these data, it is worth noting that almost all respondents confirmed that they performed this type of surgery, thus representing a community of experts.

In 2022, Lee *et al.* published a paper on the knowledge of surgical management of hyperhidrosis among primary care physicians and the general public in the USA (12). The results were dramatic, concluding that neither primary care physicians nor the general public recognize the role of thoracic surgeons. On the contrary, our survey showed that general practitioners and dermatologists are the main referring physicians for hyperhidrosis, followed by cardiac and vascular surgeons for the pathologies in their field.

Primary hyperhidrosis/facial flushing was the most represented area of interest, treated by 99% of respondents, whereas only 30% performed this surgery for cardiac or vascular disease. In terms of volume, two data emerged: (I) the low number of procedures performed per surgeon (only 26 surgeons reported more than 25 cases per year); (II) the predominance of hyperhidrosis/facial flushing cases; 89% and 97% of those treating cardiac and vascular pathology, respectively, performed fewer than 10 cases per year. These data are consistent with the literature, but the low volumes recorded contrast with the high incidence of hyperhidrosis in the global population and some large population series (13). We would argue that there is a selection bias towards surgeons performing sympathectomies in this survey (99% of respondents), these are the surgeons who have general practitioners and dermatologist colleagues who understand the role of the thoracic surgeon in these patients. However, the remaining 93% of ESTS members may not have appropriate referral pathways for these patients due to a lack of knowledge from GPs or dermatologists.

Sympathetic blockade is widely used for palmar, axillary and facial hyperhidrosis, but indications are still controversial due to side effects (14). PH is the main indication for nerve block, while AH has been considered for surgery with VATS advent, also because medical therapy also guarantees good results. For CFH, surgery is considered the last option due to frequent side effects. Sympathetic blockade for blushing is less commonly used despite good results, probably because of the high complication rate (15). Our survey is consistent with this

trend, as 94% of respondents performed surgery for PH, 74% for AH and only 24% for facial hyperhidrosis. FB was treated by 43% of surgeons.

Nowadays, thoracic surgery of the autonomic nervous system has little place in cardiac pathology. Regarding arrhythmias, its role is still considered useful only in selected patients. Nerve block is re-emerging as a possible adjunctive therapy for ventricular resistant arrhythmias (16) in patients who do not respond to conventional medications. In channelopathies (LQTS and CPVT), the threshold for sympathetic block is somewhat lower (17,18). Recent paediatric guidelines (19) recommend cardiac sympathectomy for ventricular tachycardia (VT) or VT/fibrillation storm refractory to antiarrhythmic drugs, LQTS and catecholaminergic polymorphic VT. Criteria are still unclear regarding (I) patient selection and (II) bilateral versus left-sided approach (20). The emerging scenario among ESTS members is that only 30% of all responders performed thoracic autonomic nervous system surgery for cardiac dysfunction, 50% for ventricular resistant arrhythmias and 42% for LQTS. Furthermore, although the role of sympathetic denervation in cardiac functionally altered conditions has been highlighted (21), only 17% of responders chose to perform ganglion ablation.

Sympathetic surgery is not indicated in vascular obstructive patterns, whereas a benefit has been demonstrated in Buerger's disease (22). In spastic ischaemia, sympathetic surgery may improve ulceration or gangrene symptoms in advanced stages (23). Raynaud syndrome is the one that benefits most from sympathetic surgery in advanced stages, but the benefits are temporary (24). Only 30% of respondents underwent sympathetic surgery for vascular disease: 83% for Raynaud syndrome, 36% for Buerger's disease and 31% for vasculitis. In addition, 44% referred patients for surgery for chronic pain syndromes.

Both two-stage unilateral and single-stage bilateral approaches are effective and safe; the single-stage bilateral approach is probably associated with a lower incidence of compensatory sweating (25). This approach also seems to be preferred by our respondents. Data on surgery without a chest tube are poor (26). Respondents were also divided, with 37% saying they did not use a chest tube, and of those who did, the majority (45 members) preferred to remove it at the end of the operation. The core of sympathetic surgery is the nerve activity block. According to the STS expert consensus (9), this can be achieved by either cutting or clipping the nerve, as there is no clear advantage in terms of success and recurrence rate (27). Cutting is usually performed with electrocautery, but the use of energy devices has also been described. Some authors have argued that clipping should be preferred because it may offer reversibility in cases of poor satisfaction, such as severe compensatory sweating. However, the efficacy of clip removal is still controversial (28). Cerfolio *et al.* (9) stated that the failure of reversibility is probably related to perineural damage, which is usually irreversible. Although both techniques are widely used, ESTS responders seem to prefer cutting over clipping for most hyperhidrosis, cardiac and vascular conditions.

The correct level of interruption remains controversial, but it is generally accepted that the lower the interruption, the lower the risk of compensatory sweating. For this reason, R2 block has gradually been abandoned in favor of R2-free surgery, except in the case of flushing. However, the final correct target level (from R2 to R6) for each condition has not yet been defined. Again, the STS consensus (9) suggested the following pattern: (I) PH: R3 interruption; (II) R4 and R5 interruption for palmar-axillary, palmar-axillary-plantar, or AH alone; (III) R3 for patients with CFH without blushing. Our data suggest that a representative proportion of respondents followed this consensus. In fact, regardless of technique, surgeons preferred a different target level depending on the affection to be treated.

According to the literature, the most common complications are Bernard-Horner syndrome (0.7–3% of cases), pneumothorax requiring pleural tube drainage (1%), pleural effusion (1%), acute bleeding or delayed hemothorax (1%), chylothorax and persistent intercostal neuralgia (1%) (9). Our respondents experienced the same complications as above, but pneumothorax seems to be the most common. Severe compensatory sweating is the most feared side effect after sympathectomy for hyperhidrosis (9). Its incidence depends on several variables and ranges from 3.0% to 98.0% (29). Our results seem encouraging, since 66% of the responders had severe compensatory hyperhidrosis in less than 10% of cases and only a few (3%) in more than 30% of cases. Interestingly, only 13% of surgeons used surgery in cases of severe compensatory sweating, preferring a medical strategy despite the poor results. Unfortunately, only 52% of respondents said they had set up a patient follow-up database. In addition, only 70% of the databases recorded patient satisfaction. We believe that patient satisfaction is just as important in hyperhidrosis management as success or adverse event rates. In fact, paradoxically, there is often

an apparent discrepancy between a high satisfaction rate and severe compensatory sweating (30). Most respondents answered that RATS will not replace VATS, despite encouraging recent literature (31).

Since the lack of conclusive evidence in this area is due to the difficulty of comparing data from different series that are not very homogeneous, we believe that the solution may lie in the adoption of a common database. This should be designed to collect comparable information (e.g., using numerical scales) on preoperative patient characteristics, surgical techniques, and outcomes in terms of sweating management, compensatory sweating in specific body areas, and patient satisfaction. An international database could also ensure a significant number of enrolled patients in a scenario characterized by limited case numbers. This survey seems to confirm that respondents agree with our opinion. The study has potential limitations: (I) the data suffer from non-response bias: surgeons who perform sympathetic surgery are more likely to participate; (II) the results may not be representative of the entire ESTS community (the so-called "volunteer effect"); (III) participants may change their opinion as a result of participating in a study.

Conclusions

Our results do not constitute recommendations but simply reflect current clinical practice among ESTS and are also very limited by the low percentage of members who responded to the questionnaire. The data, limited to the results of our survey, revealed a behaviour that is fairly consistent with the literature and can be briefly summarized as follows: sympathetic surgery is most commonly used for hyperhidrosis/FB disorders (mainly palmar and AH), the R3–R4 block is generally the most commonly used, while the R2 block is generally preferred for facial flushing. Despite these indications of preference, a heterogeneity of responses was noted in each section of the questionnaire, indicating an absence of common behavior on the part of respondents. While this phenomenon is a consequence of the lack of common recommendations or guidelines, it also points to an absolute need. However, our questionnaire also reveals a worrying lack of data collection, particularly in terms of follow-up, for which it will be difficult to obtain hard evidence in the coming years. Our final message is therefore an invitation, addressed specifically to the scientific societies involved, to (I) promote the involvement of thoracic surgeons in these pathologies through cross-training events; (II) promote a data collection programme at international level to collect as much data as possible and, above all, in a homogeneous manner.

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Footnote

Reporting Checklist: The authors have completed the CROSS reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-1167/rc

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Ethical Statement: The authors are responsible for all aspects of the work to ensure that questions about the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). As this was an interview with surgical members of the European Society of Thoracic Surgeons, not involving patients or sensitive data, no consent was required.

References

1. Alexander W. The treatment of epilepsy. Edinburgh: Young J. Pentland, 1889.
2. Jaboulay M. La regeneration du goitre extirpe´ dans la maladie de Basedow et la section du sympathique cervical dans cette maladie. In: Martin E, editor. Chirurgie du Grand Sympathique et du Corps Thyro¨ide (Les Diffe´rents Goitres). Articles originaux et observations re unis, A Storck & Cie, Lyon, 1900: 3-5.
3. Kotzareff A. Resection partielle du tronc sympathique cervical droit pour hyperhidrose unilaterale (regions faciale, cervicale, thoracique et brachiale droits). Rev Med Suisse Rom 1920;40:111-3.
4. Goetz RH. The surgical physiology of the sympathetic nervous system with special reference to cardiovascular disorders. Surg Gynecol Obstet 1948;87:417-39.
5. Lin CC, Mo LR, Lee LS, et al. Thoracoscopic T2-sympathetic block by clipping--a better and reversible operation for treatment of hyperhidrosis palmaris: experience with 326 cases. Eur J Surg Suppl 1998;(580):13-6.
6. Jonnesco T. Le symathizue cervico-thoracico. Mason&Cie, 1923.
7. Francois-Franck M. Signification physiologique de la résection du sympathique dans la maladie de Basedow, l'épilepsie, l'idiotie et le glaucome. Bull Acad Med Paris 1899;41:565-94.
8. Ikonomidis JS, Boden N, Atluri P. The Society of Thoracic Surgeons Thoracic Surgery Practice and Access Task Force-2019 Workforce Report. Ann Thorac Surg 2020;110:1082-90.
9. Cerfolio RJ, De Campos JR, Bryant AS, et al. The Society of Thoracic Surgeons expert consensus for the surgical treatment of hyperhidrosis. Ann Thorac Surg 2011;91:1642-8.
10. Meyer VM, Benjamens S, Moumni ME, et al. Global Overview of Response Rates in Patient and Health Care Professional Surveys in Surgery: A Systematic Review. Ann Surg 2022;275:e75-81.
11. Oshima Y, Fujimoto T, Nomoto M, et al. Hyperhidrosis: A targeted literature review of the disease burden. J Dermatol 2023;50:1227-36.
12. Lee ACH, Ferguson MK. Knowledge of surgical management of hyperhidrosis among primary care physicians and the general public. Interact Cardiovasc Thorac Surg 2022;34:791-8.
13. Felisberto G Jr, Maria Cataneo AJ, Cristina Cataneo D. Thoracic sympathectomy for the treatment of primary axillary hyperhidrosis: systematic review and proportional meta-analysis. Ann Med 2021;53:1216-26.
14. Hashmonai M, Cameron AE, Licht PB, et al. Thoracic sympathectomy: a review of current indications. Surg Endosc 2016;30:1255-69.
15. Cameron AE. Specific complications and mortality of endoscopic thoracic sympathectomy. Clin Auton Res 2003;13 Suppl 1:I31-5.
16. Ajijola OA, Lellouche N, Bourke T, et al. Bilateral cardiac sympathetic denervation for the management of electrical storm. J Am Coll Cardiol 2012;59:91-2.
17. Wilde AA, Bhuiyan ZA, Crotti L, et al. Left cardiac sympathetic denervation for catecholaminergic polymorphic ventricular tachycardia. N Engl J Med 2008;358:2024-9.
18. Shah R, Assis F, Alugubelli N, et al. Cardiac sympathetic denervation for refractory ventricular arrhythmias in patients with structural heart disease: A systematic review. Heart Rhythm 2019;16:1499-505.
19. Al-Khatib SM, Stevenson WG, Ackerman MJ, et al. 2017 AHA/ACC/HRS Guideline for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. Circulation 2018;138:e272-391. Erratum in: Circulation 2018;138:e419-420.
20. Chihara RK, Chan EY, Meisenbach LM, et al. Surgical Cardiac Sympathetic Denervation for Ventricular Arrhythmias: A Systematic Review. Methodist Debakey Cardiovasc J 2021;17:24-35.
21. Atallah J, Fynn-Thompson F, Cecchin F, et al. Video-assisted thoracoscopic cardiac denervation: a potential novel therapeutic option for children with intractable ventricular arrhythmias. Ann Thorac Surg 2008;86:1620-5.
22. Haimovici H. Arterial thromboembolism of the upper extremity associated with the thoracic outlet syndrome. J Cardiovasc Surg (Torino) 1982;23:214-20.
23. Matsumoto Y, Ueyama T, Endo M, et al. Endoscopic thoracic sympathicotomy for Raynaud's phenomenon. J Vasc Surg 2002;36:57-61.
24. Coveliers HM, Hoexum F, Nederhoed JH, et al. Thoracic

sympathectomy for digital ischemia: a summary of evidence. J Vasc Surg 2011;54:273-7.
25. Ibrahim M, Menna C, Andreetti C, et al. Two-stage unilateral versus one-stage bilateral single-port sympathectomy for palmar and axillary hyperhidrosis. Interact Cardiovasc Thorac Surg 2013;16:834-8.
26. Shao GQ, Pang DZ, Zhang JT, et al. Spontaneous ventilation anesthesia combined with uniportal and tubeless thoracoscopic sympathectomy in selected patients with primary palmar hyperhidrosis. J Cardiothorac Surg 2022;17:177.
27. Findikcioglu A, Kilic D, Hatipoglu A. Is clipping superior to cauterization in the treatment of palmar hyperhidrosis? Thorac Cardiovasc Surg 2014;62:445-9.
28. Hynes CF, Marshall MB. Reversibility of Sympathectomy for Primary Hyperhidrosis. Thorac Surg Clin 2016;26:421-6.
29. Lyra Rde M, Campos JR, Kang DW, et al. Guidelines for the prevention, diagnosis and treatment of compensatory hyperhidrosis. J Bras Pneumol 2008;34:967-77.
30. Gharagozloo F, Meyer M, Tempesta B. Robotic Staged Bilateral Selective Postganglionic Sympathectomy for Upper-Extremity Hyperhidrosis. Surg Technol Int 2020;36:265-9.
31. Ravendran K, Babu B, Madouros N, et al. Robotic Sympathectomy for Hyperhidrosis. Cureus 2023;15:e33885.

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