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RESEARCH

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Long term outcomes and risk factors of compensatory hyperhidrosis after thoracoscopic sympathectomy in primary palmar hyperhidrosis patients: a retrospective single-center study

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Abstract

Objective This study aims to evaluate the long-term outcomes of compensatory hyperhidrosis (CH) after thoracoscopic sympathectomy and explore the risk factors affecting postoperative CH in primary palmar hyperhidrosis(PPH) patients.

Method A retrospective analysis was conducted on patients who underwent thoracoscopic sympathectomy in the thoracic surgery department of our hospital from January 2015 to May 2022. Long-term follow-up surveys was conducted to collect data on post-operative satisfaction, PPH recurrence, and CH occurrence. Postoperative CH outcomes were assessed using the HDSS and satisfaction scores scale. Univariate and multivariate logistic regression analyses were used to identify independent risk factors for postoperative CH.

Result A total of 152 patients was included in the final study, with 113 cases in the CH group and 39 cases in the nCH group. The incidence of postoperative CH was 74.3% (113/152), within which 33.6% (38/113) were severe CH. The median follow-up time was 3.1 years(2.5-5.5y) and the median interval of CH onset after surgery was 30 days (14-90d). Univariate analysis showed that body mass index(BMI), surgical time, and transected nerve level are correlated with CH, with statistically significant differences. Multivariate logistic regression analysis indicated a higher BMI (OR = 0.864, 95% CI 0.755–0.989, $P < 0.05$) is the independent risk factor for the occurrence of CH. There was no statistically significant difference in HDSS scores among CH patients at 1 month, 1 year, and 3 years after surgery.

Conclusion A higher BMI is the independent risk factor for postoperative CH after thoracoscopic sympathectomy. The incidence and severity of postoperative CH kept stable during a long term follow up.

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Keywords Compensatory hyperhidrosis, Primary palmar hyperhidrosis, Thoracoscopic sympathectomy, Body mass index

Introduction

Primary hyperhidrosis is a prevalent condition characterized by excessive sweating localized to specific regions of the body, including the hands, axillae, feet, and face. Severe primary palmar hyperhidrosis (PPH) significantly affects quality of life and social interactions, leading individuals to seek medical treatment. Thoracoscopic sympathectomy has been identified as the most effective treatment modality for PPH. Despite its efficacy in ameliorating postoperative symptoms, compensatory hyperhidrosis (CH) persists as the primary concern and most prevalent adverse effect, thereby diminishing patient satisfaction following thoracic sympathectomy. Predicting or alleviating postoperative compensatory hyperhidrosis (CH) has emerged as a significant concern in the context of endoscopic thoracic sympathectomy (ETS) [1–3].

Postopeative CH mainly manifested as sudden and unexplained sweating in one or more parts of the body other than the primary site, wtih a incidence of ranging from 3 to 90% according to literature [1, 4, 5]. Numerous previous studies have endeavored to identify predictors of this common adverse outcome following ETS [2, 6, 7]. The potential risk factors associated with CH has focused on variables such as the extent of sympathectomy, age, body mass index, climate, and surgical completeness [8–10]. However, there is limited research available on the long-term prognosis and satisfaction of postoperative CH. In this study, we aimed to investigate the incidence, location, and severity of CH after thoracoscopic sympathectomy, and identify factors related to the long-term outcomes of CH in patients.

Material and method

Study population

A retrospective analysis was conducted on patients with PPH who underwent thoracoscopic sympathectomy in department of thoracic surgery of The First Hospital of Putian from January 2015 to May 2021. The surgical indication of ETS in our center is patients diagnosed as PPH with the Hyperhidrosis Disease Severity Scale (HDSS) score of 3 or 4; HDSS is a four-scale self-reporting questionnaire widely used to evaluate the severity of hyperhidrosis and its impact on daily life [11]. Surgical contraindications included: (1) Secondary hyperhidrosis due to tuberculosis, hyperthyroidism, or hypothalamic disorders; (2) Bradycardia (heart rate < 55 beats per minute); Our study excluded (1) Patients with previous history of chest surgery or pulmonary severe infection including tuberculosis; (2) Patients who underwent unilateral thoracoscopic sympathetic nerve transection; This study was approved by the review board of The First Hospital of Putian, and the requirement for informed consent for the use of patients' medical record was waived. All methods were performed in accordance with the Declaration of Helsinki.

Surgical procedure

All patients underwent a bilateral uni-portal VATS sympathectomy with single lung ventilation and dual lumen intubation. The patient is positioned supine with the upper body tilted at 45 ° and arms extended at 90 ° for stabilization(see Fig. 1). A 1 cm incision was made in the third intercostal space along the anterior axillary line. A 3 mm trocar and thoracoscope were inserted, and an artificial pneumothorax was created with CO2 at 8mmHg. After exploring the thoracic cavity and identifying the sympathetic nerve, an electrocoagulation hook was used to cut off the target sympathetic nerve trunk. To ensure the comprehensive resection of potential sympathetic communicating nerve branches, the cauterization range extend approximately 2 cm horizontally along the rib surface adjacent to the target sympathetic nerve. During surgery, heart rate, blood pressure, blood oxygen levels, and changes in palm temperature and sweating were monitored. Effectiveness was indicated by a 1–2℃ increase in palm temperature and a shift from wet to dry palms. Once no air leakage or bleeding was confirmed, a drainage tube was placed in the chest cavity with its end in water to release gas. After the lung reinflated and no residual gas was detected (no bubbles), the tube was removed and the incision sutured.(see Fig. 2).

Follow up and data collection

All patients underwent a questionnaire survey and telephone follow-up, using the Hyperhidrosis Severity Scale (HDSS scale, see Supplementary material) to assess the severity of sweating after ETS. Data on patient demographics, postoperative satisfaction, recurrence rates, duration and severity of hand hyperhidrosis, location and severity of CH, and changes in CH at 1 month, 1 year, and 3 years post-surgery were collected.

Statistical analysis

Continuous variables were described in the mean standard deviation and analyzed with the independent t test or Mann-Whitney U test. Categorical variables were presented by frequency (%) and compared by using Chi-squared test or Fisher exact test. Univariable regression analysis was used to determine the variables for inclusion in the multivariable regression. The primary endpoint

Fig. 1 **A**. Surgical position for ETS; **B.** Location of surgical incision (third intercostal space of the anterior axillary line)

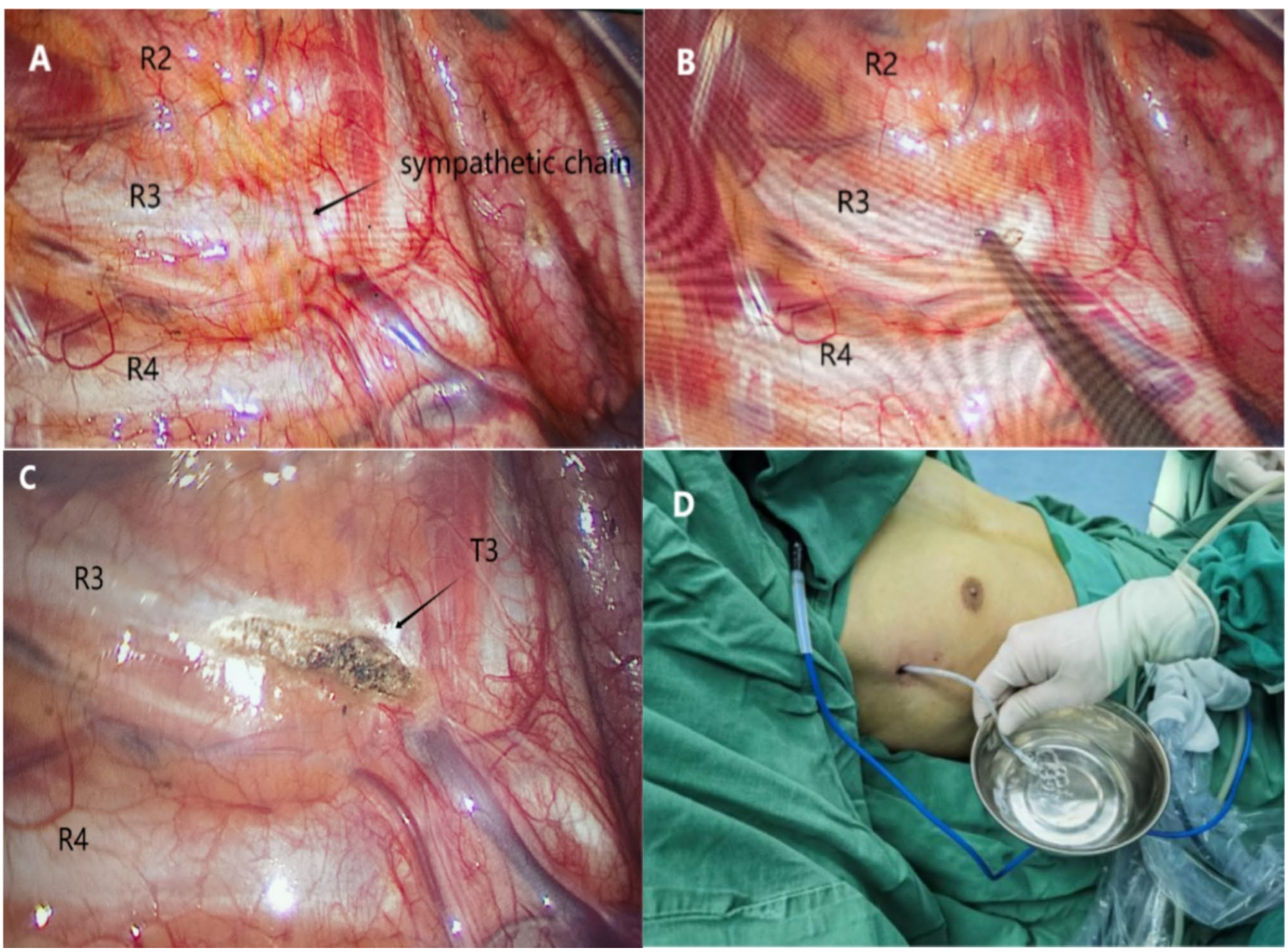

Fig. 2 surgical process of thoracoscopic T3 nerve sympathectomy. **A**. The THIRD rib is located and the sympathetic chain identified;**B**. Cauterization of T3 sympathetic nerve chain; **C**. Extend cauterization area to 2 cm aside the R3 rib surface to ensure a completed cut off of the Kuntz nerve and sympathetic communicating branch; **D**. A drainage tube is inserted into chest cavity with the distal end placed into water for air exhausting

was the postoperative compensatory hyperhidrosis. All statistical analyses were conducted with IBM SPSS 20.0 (SPSS Inc, Armonk, New York). All statistical tests were two tailed with the alpha threshold of significance set at 0.05.

Result

There were totally 165 patients with PPH who underwent ETS in the thoracic surgery department of our hospital from from January 2015 to May 2022, with 152 included in the final analysis (see the flowchar in Fig. 3). The charcteristics of the whole cohort was showed in Table 1.

Preoperative sweating area distribution

All 152 patients (100%) had palmar hyperhidrosis,118 patients(77.6%) combined with plantar hyperhidrosis, 64 patients(42.1%) combined with axillary hyperhidrosis,24 patients(15.8%) combined with chest and back hyperhidrosis, 22 patients (15.8%) combined with head and face hyperhidrosis, and 11 patients(7.2%) combined with hyperhidrosis in other areas.

Perioperative outcome

All patients underwent VATS sympathectomy without conversion. Of these, 104 (68.4%) had bilateral R3 nerve transection and 48 (31.6%) had bilateral R4 nerve transection, with a 100% intraoperative response rate. The average operation time was 35 min (range 26–45). Postoperative complications occurred in 12 patients (7.9%), including 1 case (0.7%) of transient Horner's syndrome and 11 cases (7.2%) of unilateral pneumothorax. Only 1 pneumothorax case required a closed thoracic drainage tube, while the others did not need special treatment. All pneumothorax patients were discharged successfully, with an average hospital stay of 2.74±1.40 days. The median follow-up was 3.1 years(2.5-5.5years).

Patients were categorized into compensatory hyperhidrosis (CH) and non-compensatory hyperhidrosis (nCH) groups. The CH group included 113 patients (62 males, 51 females) with an average age of 22.14±6.51 years and a BMI of 22.13±3.28 kg/m². In this group, 39 patients(34.5%) had a family history of PPH, and 25 patients(22.1%) were smokers. The average onset age for CH group was 8.43±3.17 years. Among them, 83 underwent bilateral R3 transection and 30 underwent bilateral R4 transection, with an average operation time of 37 min and a hospital stay of 2.72±1.33 days. The nCH group consisted of 39 patients (18 males, 21 females) with an average age of 21.44±6.47 years and a BMI of 20.73±2.40 kg/m²0.13 patients(33.3%) had a positive family history, and 7 patients(17.9%) had a positive smoking history, with an average onset age of 8.31±3.44 years. 21 patients(53.8%) underwent bilateral R3 resection surgery, and 18 patients(46.2%) underwent bilateral R4 resection surgery, with an average operation time of 30 min and a hospital stay of 2.82±1.60 days. The age, gender, family history, smoking history, onset age and hospital stay between the two groups were not statistically significant($P > 0.05$). There was a statistically significant difference in nerve transection levels between the two groups ($P = 0.023$). The CH group had a higher average BMI ($P = 0.015$) and longer average surgical time

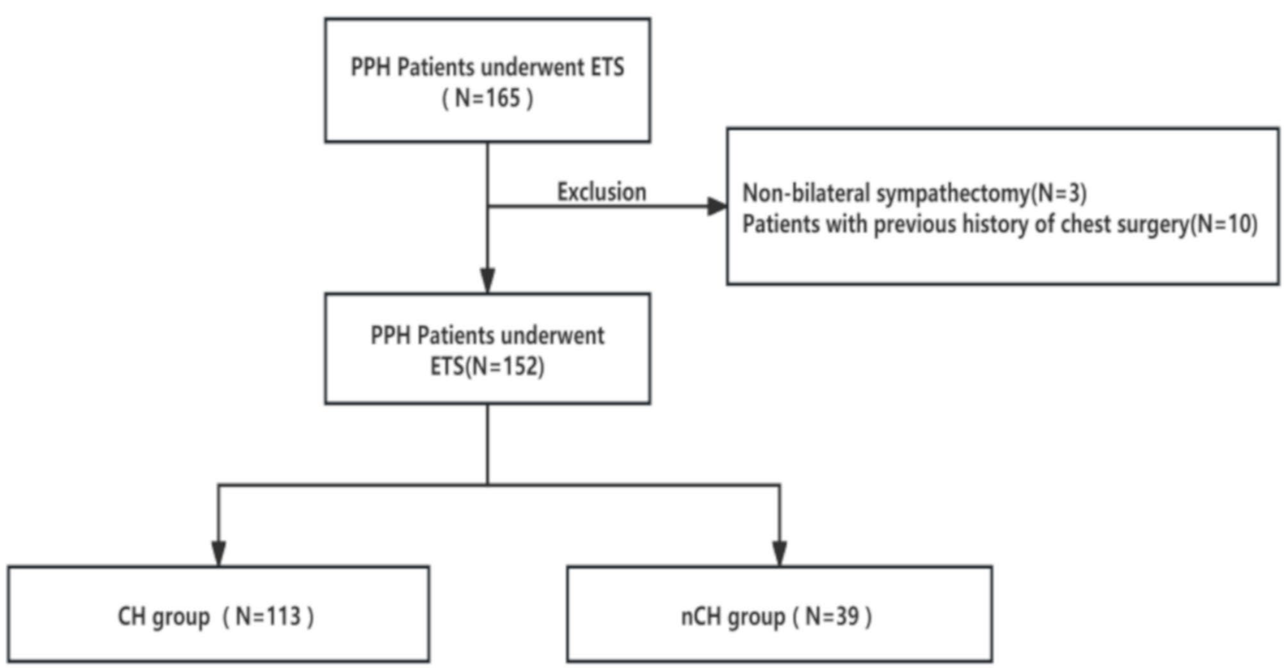

Fig. 3 Flowchart of the study

Table 1 Characteristics of the whole group and univariate and multivariate logistic regression analysis of risk factor for CH

Variable	Total(n = 152)	CH group (n = 113)	nCH group (n = 39)	Univariate logistic regression		Multivariate logistic regression	
				OR(95%CI)	P value	OR(95%CI)	P value
Gender(%)					0.347		
Male	80(52.6)	62(54.9)	18(46.2)	1			
Female	72(47.4)	51(45.1)	21(53.8)	0.705(0.340–1.464)			
Age	21.96 ± 6.49	22.14 ± 6.51	21.44 ± 6.47	0.982(0.925–1.043)	0.560		
BMI(kg/m^2)	21.77 ± 3.14	22.13 ± 3.28	20.73 ± 2.40	0.852(0.747–0.972)	0.015	0.864(0.755–0.989)	0.034
Onset age(y)	8.40 ± 3.23	8.43 ± 3.17	8.31 ± 3.44	0.988(0.879–1.109)	0.834		
Smoking(%)					0.581		
Smoker	32(21.1)	25(22.1)	7(17.9)	1			
Non-smoker	120(78.9)	88(77.9)	32(82.1)	0.770(0.304–1.953)			
Family history(%)					0.893		
Yes	52(34.2)	39(34.5)	13(33.3)	1			
No	100(65.8)	74(65.5)	26(66.7)	0.949(0.439–2.050)			
Preoperative treatment					0.417		
With treatment	43(28.3)	30(26.5)	13(33.4)	1			
Without treatment	109(71.7)	83(73.5)	26(66.6)	0.723(0.329–1.586)			
Operation time(min)	35(26,45)	37(29,50)	30(25,40)	0.972(0.945–1.001)	0.058	0.972(0.944–1.002)	0.067
Hospital stay(d)	2.74 ± 1.40	2.72 ± 1.33	2.82 ± 1.60	1.053(0.818–1.355)	0.692		
Nerve transection level					0.025	2.104(0.961–4.604)	0.063
Bilateral R3	104(68.4)	83(73.5)	21(53.8)	1			
Bilateral R4	48(31.6)	30(26.5)	18(46.2)	2.371(1.114–5.048)			
Recurrence of palmar hyperhidrosis(%)					0.383		
Yes	13(8.6)	11(9.7)	2(5.1)	1			
No	139(91.4)	102(90.3)	37(94.9)	1.995(0.422–9.427)			

Table 2 Postoperative CH distribution area and severity

CH distribution area	HDSS score				Total score
	4 points	3 points	2 points	1 point	
Back	0	20	30	24	74
Chest	0	10	21	19	50
Plantar	2	4	4	2	10
Head and face	2	3	10	2	17
Armpit	0	7	11	14	32
Thigh	0	6	24	9	39
Shank	0	1	2	4	7
Other area	0	5	15	10	30

(P=0.028) compared to the nCH group, both with statistical significance. A multivariate logistic regression analysis of risk factors between CH and nCH groups, identified higher BMI as the sole independent risk factor for CH. (OR=0.864, 95% CI 0.755–0.989, P=0.034).(**see** Table 1).

Postoperative CH distribution area and severity

113 patients (74.3%) developed compensatory hyperhidrosis, with a median onset time at 30 days after surgery (14-90days), with 33.6% (38/113) of which suffering from severe CH (HDSS≥3); The area distribution of postoperative CH area is listed in the following: with 65.5% (74/113) of the back, 44.2% (50/113) of the chest, 34.5% (39/113) of the thighs, 28.3% (32/113) of the armpits, and 15.0% (17/113) of the head and face. After surgery, there were 3 patients with gustatory hyperhidrosis and 13 patients (8.6%) with recurrent hand hyperhidrosis, with a median recurrence time of 1 month after surgery.(**see** Table 2).

Postoperative satisfaction after ETS

58 patients (38.2%) were very satisfied with the surgical results, and 50 patients (32.9%) were satisfied with the surgical results;30 patients (19.7%) felt average about the surgical results; Three (2.0%) patients were dissatisfied with the surgical results; 11 patients (7.2%) were very dissatisfied with the surgical results. Average satisfaction score of the CH group and nCH group were 3.74±1.17 and 4.46±0.88 respectively, which is statistically different(P=0.003). When focus on CH patients, the satisfactions between T3 and T4 group is not significantly different(P=0.168).(**see** Fig. 4).

Long term outcome of CH patients

The incidence of compensatory hyperhidrosis at 1 month, 1 year, and 3 years after surgery was 72.4% (110/152), 74.3% (113/152), and 73.7% (112/152), respectively, which is of no significant difference; The probability of severe CH occurrence at 1 month, 1 year, and 3 years after surgery was 28.2% (31/110), 33.6% (38/113), 34.5% (39/112), and there was also of no statistically significant

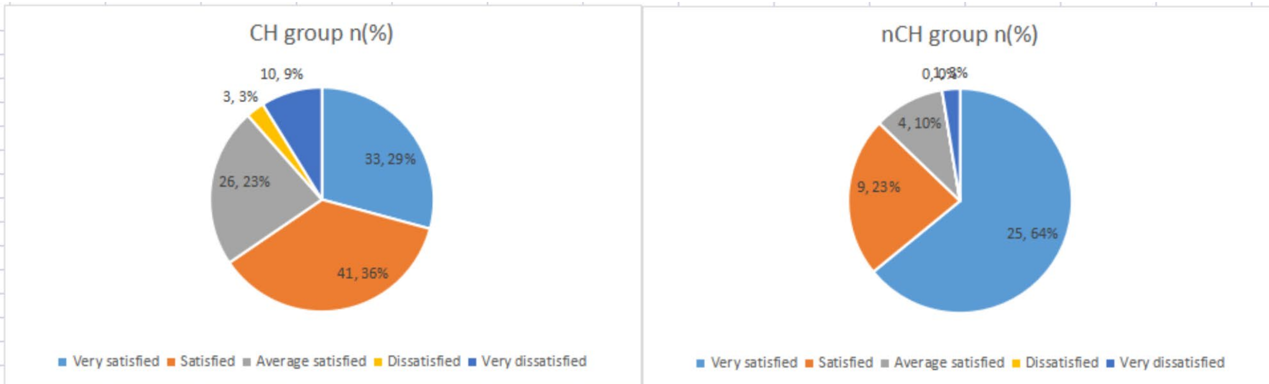

Fig. 4 Postoperative satisfaction between CH group and nCH group

Table 3 Long term outcome of HDSS score for PPH patients after ETS

Time interval after surgery	HDSS score *n*(%)					*P* value
	4 points	3 points	2 points	1 point	0 point	0.969
1month after surgery	3(2.0)	28(18.4)	41(27.0)	38(25.0)	42(27.6)	
1 year after surgery	4(2.6)	34(22.4)	40(26.3)	35(23.0)	39(25.7)	
3 years after surgery	4(2.6)	35(23.0)	35(23.0)	38(25.0)	40(26.4)	

difference. The HDSS score of CH patients was stable without no significant difference as time changes.(**see** Table 3).

Discussion

Our study indicated that ETS improves palmar sweating both short and long term, with a 71.1% satisfaction rate and a 74.3% incidence of postoperative CH, consistent with existing literature [4, 5, 7]. Our study found a high prevalence of thoracodorsal CH, with 65.5% in the back area and 44.2% in the chest area, aligning with previous reports. Sheer's research also found that 90% of ETS patients developed CH, primarily in the back (60%) and lower limbs (42.7%) [12]. Moon et al. have also confirmed chest and back area as the most common areas of CH [13]. The exact cause of the high rate of thoracodorsal compensatory hyperhidrosis (CH) remains unclear, but it may be linked to extensive sympathetic nerve transections affecting the upper limbs and thoracodorsal area. Moreover, the treatments for postoperative CH have been also proved to be of uncertain effect, varying from lifestyle changes, medication, topical or systemic therapies, iontophoresis, to surgery for severe cases. Various surgical methods for CH, based on prior sympathetic surgery, include unclipping, extended sympathectomy/sympathicotomy, and sympathetic nerve reconstruction. Therefore, it is of vital importance to prevent CH in those patients underwent ETS [14].

The R2-R4 sympathetic nerve transection is now widely accepted as the standard procedure for PPH [15]. A smaller scope and lower level of sympathetic nerve transection may theoretically result in less parasympathetic nerve interaction and a reduced risk of postoperative CH. Tu Yuanrong et al. examined 2206 PPH patients and found that both cutting and retaining R2 achieved 100% cure rates. However, the retaining R2 group reported higher postoperative satisfaction (98.1% vs. 94.2%) [15]. Zhang et al.'s meta-analysis has also indicated that R4 sympathectomy has a lower incidence of CH compared to R3 sympathectomy [16]. Experts have reached to the consensus that one single nerve transection (R3 or R4) is preferred for PPH rather than a multiple nerve transections due to a potential risk of postoperative CH [15]. Although the final multivariate regression does not identify sympathetic nerve transection level as an independent risk factor for postoperative CH, our study confirms that single sympathetic nerve transection is linked to high satisfaction and suggests that lower nerve transection levels may reduce CH incidence.

A study of 102 patients undergoing sympathetic nerve transection found that higher BMI strongly correlates with more severe postoperative CH, suggesting BMI is a potential risk factor [17]. Lukasz et al. has also confirmed that overweight patients (BMI > 25 kg/m^2) experienced more severe postoperative CH [18]. Univariate and multivariate logistic regression analysis in our study identify a bigger BMI as an independent risk factor for incidence of CH (OR = 0.86, 95% CI 0.76–0.99, $P < 0.05$). Therefore, for PPH patients with BMI > 25 kg/m^2, more strict patient selection and surgical indications should be carried out for ETS according to experience of our center.

The potential impact of age on postoperative CH has been reported by several literatures. Leiderman et al. reported a better symptom improvement effect but a similar CH occurrence after sympathetic nerve transection in elderly patients [19]. While Vascoselos et al. reported a lower incidence of postoperative compensatory hyperhidrosis (CH) in adolescents, with only 47.8% of 23 patients (average age 15.5) experiencing CH after ETS [20]. Woo et al. has also identified that being over 20 years of age constitutes an independent risk factor for CH [1]. Therefore younger age might reduce postoperative CH risk, but our study found no significant age-related difference in CH incidence. A prospective multicenter study with a substantial sample size could yield robust evidence for evaluating the potential impact of age.

The long-term outcome for CH incidence and severity remains uncertain due to conflicting results. Turhan et al. demonstrated a gradual decrease in CH after 5 years post-surgery [4], while Bryant et al. observed a gradual increase in CH within one year post-surgery [21]. Chiou et al. reported that CH occurred at a median time of 8.2 weeks after surgery, which was much longer than the median time of 1 month in our study [22]. This discrepancy may be attributed to several factors, as the majority of our patients were adolescent students who underwent ETS surgery during the summer. The external higher temperatures in summer always induce or worsen postoperative CH. Studies has indicated that incidence of CH reached its peak 1 year after surgery (77%), and gradually decreased from 1 to 3 years after surgery. Our study showed that the incidence of CH at 1 month, 1 year, and 3 years after surgery were 72.4%, 74.3%, and 73.7%, respectively with no significant difference in long-term incidence and severity of postoperative CH, the trend of which was similar to Bryant's study.

Limitation

Firstly, the small sample size and retrospective design of a single-center cohort inherently introduce selection bias. Secondly, the subjective nature of the scoring system for CH severity and postoperative satisfaction may hinder accurate long-term prognosis predictions for CH patients [23]. Thirdly, the exclusion of heart rate variability (HRV) parameters and other potential influencing factors(psychological assessment) in our study might affect the evaluation of postoperative CH outcomes. Therefore, future large-scale prospective studies with a wider range of clinical parameters are needed to thoroughly assess prognosis and risk factors for CH patients.

Conclusion

CH is the most frequent side effect after thoracoscopic sympathetic nerve transection, with higher BMI as an independent risk factor. The nerve transection level affects CH occurrence, PPH symptom improvement, and surgical satisfaction. The incidence and severity of CH remain stable over long-term follow-up.

Abbreviations

BMI	Body mass index
CH	Compensatory hyperhidrosis
ETS	Endoscopic thoracic sympathectomy
PPH	Primary palmar hyperhidrosis
VATS	Video-assisted thoracoscopic surgery

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13019-024-03086-y.

Supplementary Material 1

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None.

Author contributions

JXC and JKX collected the data; JG and ZYX performed ETS procedure; CBH and WCL analyzed these data; JXX wrote and revised this paper; JG and ZYX participated in the study design and draft the manuscript. All authors read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and informed consent of every human participant were waived. The Internal Review Board of Putian First Hospital's Ethics Committee reviewed and approved the present study.

Consent for publication

All the authors agree to the publication of this manuscript.

Competing interests

The authors declare no competing interests.

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