Original Article

The effects of sympathectomy ganglion levels on late complications in the treatment of hyperhidrosis

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Abstract

Introduction: Pathologically excessive sweating in areas such as the palmar, axillary and/or plantar together with sympathetic hyperactivity that occurs independently of systemic causes is called primary hyperhidrosis. Although primary idiopathic hyperhidrosis can be seen at any age, the disease is most commonly seen in adolescents and young adults. The frequency of male and female genders is usually equal. Some medical and minimally invasive methods can be used in the treatment of primary hyperhidrosis. However, the known curative gold standard treatment method for the disease is thoracoscopic thoracic sympathectomy operation.

Patients and Methods: In this study, a total of 150 patients who applied to Trakya University Health Practice and Research Center, Department of Thoracic Surgery, between 15 October 2008 and 15 June 2021 and underwent thoracoscopic thoracic sympathectomy due to the diagnosis of hyperhidrosis were evaluated retrospectively. The patients were separated into two groups. Thoracoscopic thoracic sympathectomy was performed on the T2–T4 in the first group (Group I – *n*: 88) and on the T3–T5 sympathetic ganglions in the second group (Group II – *n*: 62).

Results: The median age of patients included in the study was found to be 24 (20.75–28) years. Group I and Group II were similar in terms of gender characteristics, but Group II was older. Our success rate was found to be 92% ($n = 138$). There was no mortality, major complication such as bleeding requiring open thoracotomy, chylothorax or Horner's syndrome in any of the patients. Minor complications were seen in the early and late period of the operation at a low rate. Our overall compensatory hyperhidrosis rate was 52% ($n = 78$). Compensatory hyperhidrosis was detected more in Group I, although this was not statistically significant. We determined the overall satisfaction rate of our patients as 87.3% ($n = 133$). The satisfaction rates of the patients in Group I and Group II were found to be similar.

Conclusions: Thoracoscopic thoracic sympathectomy is a fast, safe and minimally invasive treatment method with a low complication rate. More than 90% success and a significant increase in psychosocial condition and professional quality of life can be achieved with this procedure. Future studies are needed to reveal the relationship between operated ganglion levels and the development of compensatory hyperhidrosis.

Keywords: Hyperhidrosis, sympathectomy, thoracoscopy, video-assisted thoracic surgery

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INTRODUCTION

Hydrosis is defined as the physiological exchange made by the body to ensure temperature adaptation with the external environment. Hyperhidrosis is defined as a disease characterised by excessive sweating in the relevant dermatome area innervated by the overly active sympathetic ganglion. Excessive sweating is observed in the hands, armpits, face and feet due to increased activity of the eccrine glands in the dermatomes innervated by the thoracic sympathetic chain.[1]

Hyperhidrosis is seen between 0.6% and 2.8% of the population, and symptoms begin to appear, especially in school age. Although it is more common in young- and middle-aged groups, it affects men and women equally. Hyperhidrosis can be classified as primary or secondary according to the presence of an underlying disease, as well as generalised or localised according to its location.[2]

Medical methods and/or surgical methods are used in the treatment of hyperhidrosis. The major indication for surgical procedures is palmar and axillary primary hyperhidrosis that does not respond to medical treatment.[2]

In this study, it was aimed to investigate the early- and late-term complications of patients who underwent thoracoscopic thoracic sympathectomy to the T2–T4 and T3–T5 ganglion levels due to primary hyperhidrosis in the Department of Thoracic Surgery, Trakya University Faculty of Medicine, the effects of both methods on the quality of life of the patients and the long-term results of the operation. The patients included in the study were examined in two groups. The first group (Group I – 88 patients) consisted of patients who underwent T2–T4 sympathectomy, and the second group (Group II – 62 patients) consisted of patients who underwent T3–T5 sympathectomy. Patients were grouped according to their primary complaint.

PATIENTS AND METHODS

In this study, 150 patients who underwent video-thoracoscopic thoracic sympathectomy with the diagnosis of primary hyperhidrosis at the Trakya University Faculty of Medicine Hospital Thoracic Surgery clinic between 15 October 2018 and 15 June 2021 were retrospectively examined. The decision to operate was made on the primary hyperhidrosis diagnostic criteria, taking into consideration the patient's complaints and physical examination findings. This study was carried out with the research application approval given by the Trakya University Faculty of Medicine Deanship Scientific Research Evaluation Commission.

The inclusion criteria for our study include the presence of a history of at least 6 months, absence of secondary hyperhidrosis, visible excessive sweating, excessive sweating being bilateral and symmetrical, excessive sweating disrupting daily life activities, excessive sweating starting before the age of 25 years, sweating not occurring during sleep and having a family history. The diagnosis is made by the absence of secondary hyperhidrosis and clinical observation.

Sympathectomy is not recommended in cases where secondary hyperhidrosis is observed.[3] Hyperhidrosis surgery is contraindicated in those with bradycardia-rhythm disorder detected on the electrocardiogram taken in the pre-operative period, those with serious cardiovascular disease, ongoing malignancy treatment, those with immune deficiency, those with a septic infective state, those who are morbidly obese, those with bleeding diathesis, those with refractory mental and personality disorders and those who do not accept compensatory hyperhidrosis preoperatively. In addition, sympathectomy is relatively contraindicated in patients with pleural disease (empyema, pleuritis and severe pleural adhesion secondary to previous thoracic surgery).[4] In our study, the indication was determined by considering contraindicated situations.

Surgical technique

Patients with primary hyperhidrosis underwent T2–T4 and T3–T5 sympathectomy operations. In the operative method, all cases were operated under general anaesthesia with double-lumen intubation. The patients were positioned in a 45° supine (semi-sitting) position, with the arms extended to the side without exceeding 90° of abduction. The operation was performed by making an incision of approximately 1 cm from the area where the third or fourth intercostal space meets the mid-axillary region, and the thoracic cavity was entered with rigid thoracoscopy (0° telescopes, Karl Storz, Germany) using a 10-mm trocar. The thoracoscope used had an internal lumen and was suitable for the use of surgical instruments such as thoracoscopic cautery from within the lumen. Carbon dioxide insufflation was not applied to the thoracic cavity in any patient. Nerves were cauterised at the desired rib level with thoracoscopic electrocautery. At the level of the three ribs, the Kuntz nerve was cauterised if the midline parietal pleura was present. The same procedure was applied to the contralateral thoracic cavity. One 24-Fr thorax drain was applied through the same incision, and the procedure was completed by suturing the incision area. All patients were monitored for their post-operative vital signs. Chest radiography was taken for the patients in the early post-operative period. After 12 h, the thorax drains were discontinued, and the patients were discharged after

the control chest radiography. Outpatient clinic checks were performed in the 1st week and the 1st month after discharge. The hospital data system was used for follow-up. Post-operative findings of the patients were confirmed by telephone. The post-operative follow-up period ranged from 4 to 77 months.

Statistical analysis

For continuous variables, the normality condition was checked with the Shapiro–Wilk test. The data of the two groups were compared with the Mann–Whitney *U*-test. The relationship between two categorical variables was examined using Pearson's Chi-square test or Fisher's exact test. The effect of T2–T4 and T3–T5 sympathectomy applications on recurrence was investigated with Cox regression analysis. Relapse-free survival times between the groups were examined with the Kaplan–Meier method, and Kaplan–Meier curves were compared with the log-rank test (using the RStudio programme, survival [v. 3.4-0] and surminer [v. 0.4.9] packages). Data are expressed as mean (95% confidence interval), median and 25th and 75th percentiles, while percentages are given for categorical variables. Statistical software SPSS version 23 (SPSS Inc., Armonk, NY, USA, serial number: 10240642) was used for analyses. The significance level was determined as $P < 0.05$.

RESULTS

The median age of the patients studied was 24 (20.75–28) years, and 52% ($n = 78$) were male. Demographic features of the patient groups were examined. The median age of the patients in Group I is 22.5 (19.25–26; minimum–maximum: 13–42) years, and 54.55% ($n = 48$) are male. The median age of the patients in Group II is 26 (22–42) years. 30 (minimum–maximum: 14–53) and 48.39% ($n = 30$) of the patients were male. As a result of the examination, it was seen that Group I and Group II were similar in terms of gender characteristics, but Group II was older [$\chi^2 = 0.55$, $P = 0.457$; $z = -3.59$, $P < 0.001$, Table 1].

When the complaint areas were examined, it was determined that the complaint of sweating in the hands and armpits was more common in Group II ($\chi^2 = 8.0$, $P = 0.046$). The complaint of sweating in the hands and armpits was seen in 34.09% ($n = 30$) in Group I and 56.45% ($n = 35$) in Group II. Complaints of sweating only in the hands, sweating in the hands, armpits and feet and sweating in the hands and feet were at similar rates in Group I and Group II [Table 2].

The rate of patients receiving medical treatment was not significantly different in Group I and Group II [$\chi^2 = 0.58$, $P = 0.446$, Table 3].

In the examination, it was concluded that the incidence of pre- and post-operative complications was not significantly different in Group I and Group II ($P = 0.569$, $\chi^2 = 0.96$, $P = 0.327$). Pre-operative complications were 1.14% ($n = 1$) in Group I and 3.23% ($n = 2$) in Group II, and post-operative complications were 17.05% ($n = 15$) in Group I and 11.29% ($n = 7$) in Group II. The most common complaint in post-operative complications was pain [Table 4]. Pain was present in 8% ($n = 12$) of patients in the post-operative period and was managed with analgesic treatment. 1.33% ($n = 2$) of patients experienced numbness in the arm, and 0.67% ($n = 1$) of patients experienced loss of sensation in the right arm. These patients with neuropathic symptoms were referred to physiotherapy. 0.67% ($n = 1$) of our patients had gustatory sweating that developed after meals. The patient's meal regimen was adjusted (avoiding spicy foods, not consuming acidic drinks, etc.), and suggestions were made. Wound infection, which developed at a rate of 0.67% ($n = 1$) in the post-operative period, was treated with dressing monitoring and antibiotic therapy. Prolonged air leakage was observed in 0.67% ($n = 1$) of patients in the post-operative period and was managed by continuing the thorax drain.

The success rate was evaluated according to the resolution of the patients' symptoms. Similar success rates were achieved in Group I and Group II ($\chi^2 = 0.40$, $P = 0.525$). Successful results were achieved at a rate of 93.18% ($n = 82$) in Group I and 90.32% ($n = 56$) in Group II [Table 5].

Compensatory hyperhidrosis was more common in Group I, although not statistically significant ($\chi^2 = 7.48$, $P = 0.006$). The compensatory hyperhidrosis rate was calculated as 61.36% ($n = 54$) in Group I and 38.71% ($n = 24$) in Group II. When compensatory hyperhidrosis was examined for each region, it was determined that sweating that developed only on the back was more common in

Table 1: Demographic features of groups

	Total (n=150)	Group I (n=88)	Group II (n=62)	Z/χ^2	P
Age, year – median (QS)	24 (20,75-28)	22,5 (19,25-26)	26 (22-30)	-3,59	<0,001
Sex - *n* (%)					
Female	72 (48)	40 (45,45)	32 (51,61)	0,55	0,457*
Male	78 (52)	48 (54,55)	30 (48,39)		

QS: Quarters span (25. - 75. percentile). Mann-Whitney U test, *: Pearson's Chi-square test

Table 2: Complaints and complaint duration according to groups

	Total (*n*=150)	Group I (*n*=88)	Group II (*n*=62)	χ^2	*P*
Complaint - *n* (%)					
Hand	16 (10,67)	11 (12,5)[a]	5 (8,06)[a]	8,0	0,046
Hand + armpit	65 (43,33)	30 (34,09)[a]	35 (56,45)[b]		
Hand + armpit + foot	30 (20)	22 (25)[a]	8 (12,9)[a]		
Hand + foot	39 (26)	25 (28,41)[a]	14 (22,58)[a]		
Complaint duration - *n* (%)					
1-3 years	10 (6,67)	7 (7,95)[a]	3 (4,84)[a]	13,63	0,003
3-5 years	16 (10,67)	14 (15,91)[a]	2 (3,23)[b]		
5-10 years	17 (11,33)	14 (15,91)[a]	3 (4,84)[b]		
>10 years	107 (71,33)	53 (60,23)[a]	54 (87,1)[b]		

Pearson's Chi-square test. [a,b]: Different letters indicate a significant difference between the groups according to the results of the post-hoc Bonferroni method, $P<0,05$

Table 3: Medical treatment status according to groups

	Total (*n*=150)	Group I (*n*=88)	Group II (*n*=62)	χ^2	*P*
Medical treatment - *n* (%)					
No	84 (56)	47 (53,41)	37 (59,68)	0,58	0,446
Yes	66 (44)	41 (46,59)	25 (40,32)		

Pearson's Chi-square test

Group I, while other regions were observed at similar rates in Group I and Group II (χ^2 = 13.36, P < 0.001, other; P > 0.05). The rate of compensatory hyperhidrosis on the back was 52.27% (n = 46) in Group I and 22.58% (n = 14) in Group II, and this was found to be statistically significant (P < 0.001) [Table 6].

The satisfaction rate indicates the increase in patients' satisfaction due to a decrease in their complaints. In the examination, it was determined that the satisfaction rates of the patients in Group I and Group II were similar (χ^2 = 0.85, P = 0.356). 85.23% (n = 75) of the patients in Group I and 90.32% (n = 56) in Group II stated that they were satisfied [Table 7].

There was no significant difference in the recurrence rates after hyperhidrosis treatment in Group I and Group II (χ^2 = 0.001, P = 0.989). Recurrence occurred at a rate of 11.36% (n = 10) in Group I and 11.29% (n = 7) in Group II.

During the follow-up period of the patients, it was observed that T2–T4 and T3–T5 sympathectomy applications did not have a significant effect on recurrence, and the risk of recurrence was similar in both the groups [heart rate = 0.80, P = 0.663, Table 8]. In our study, none of the patients were lost during follow-up.

The average recurrence-free survival of the patients who were followed up was calculated as 66.99 (61.76–72.23) months in Group I and 73.41 (67.55–79.27) months in Group II [Figure 1]. There was no significant difference in recurrence-free survival between the Group I and Group II (log-rank: P = 0.659). Kaplan–Meier curves regarding the follow-up period and recurrence rates of Group I and Group II are shared in Figure 2.

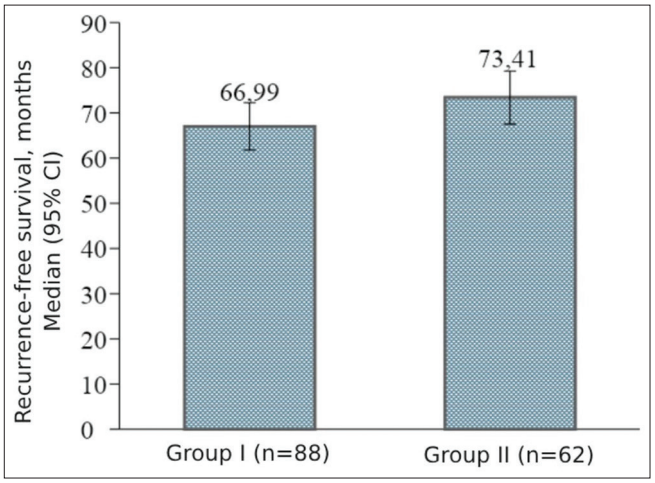


Figure 1: Average recurrence-free survival time after hyperhidrosis treatment in Group I and Group II (months). CI: Confidence interval

DISCUSSION

Loscertales *et al*.'s[5] study, the median age was 26 years, and the lowest and highest ages were 14 and 50 years, respectively. In Yanagihara *et al*.'s[6] study, the median age was 25 years, and the youngest and oldest ages were 12 and 56 years, respectively. As seen in all the literature, patients are frequently operated on in the post-adolescent period. The reason for this is thought to be that the symptoms of the patients increase during adolescence and the patients apply to the thoracic surgery outpatient clinic after applying various treatment methods. In our study, the median age of the patients was 24 (20.75–28) years, the lowest age was 13 years and the oldest age was 53 years.

In terms of gender characteristics, male and female genders are equally affected in the literature.[7] Of the patients to whom we performed video-assisted thoracic surgery (VATS) sympathectomy, 52% (n = 78) were male and 48% (n = 72) were female, and there was no significant

Table 4: Pre- and post-operative complication status according to groups

	Total (*n*=150)	Group I (*n*=88)	Group II (*n*=62)	χ^2	*P*
Preop complication - *n* (%)					
No	147 (98)	87 (98,86)	60 (96,77)	-	0,569*
Yes	3 (2)	1 (1,14)	2 (3,23)		
Postop complication - *n* (%)					
No	128 (85,33)	73 (82,95)	55 (88,71)	0,96	0,327
Yes	22 (14,67)	15 (17,05)	7 (11,29)		
Pain	12 (8)	7 (7,95)	5 (8,06)		
Gustatory sweating	1 (0,67)	0 (0)	1 (1,61)		
Air leakage	1 (0,67)	1 (1,14)	0 (0)		
Hemothorax	2 (1,33)	2 (2,27)	0 (0)		
Numbness in armpit	2 (1,33)	2 (2,27)	0 (0)		
Hair loss	1 (0,67)	1 (1,14)	0 (0)		
Loss of sensation in the right armpit	1 (0,67)	1 (1,14)	0 (0)		
Pain in cold weather	1 (0,67)	0 (0)	1 (1,61)		
Wound infection	1 (0,67)	1 (1,14)	0 (0)		

Pearson's Chi-square test, *: Fisher's (Exact) test

Table 5: Success status according to groups

	Total (*n*=150)	Group I (*n*=88)	Group II (*n*=62)	χ^2	*P*
Success status - *n* (%)					
No	12 (8)	6 (6,82)	6 (9,68)	0,40	0,525
Yes	138 (92)	82 (93,18)	56 (90,32)		

Pearson's Chi-square test

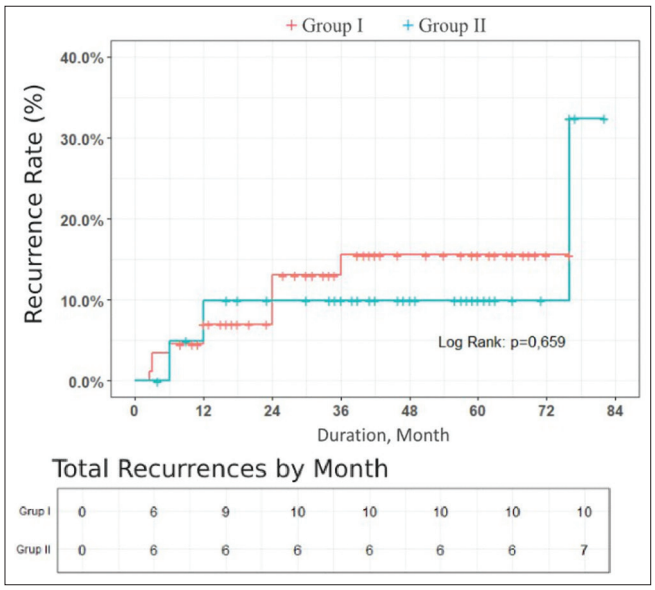


Figure 2: Kaplan–Meier curves regarding follow-up period and recurrence after sympathectomy treatment in Group I and Group II

difference in terms of gender characteristics in both the groups ($P > 0.001$). The number of male patients was found to be higher than female patients.

Sympathectomy operation in hyperhidrosis has become safe with the introduction of thoracoscopic methods into the literature. Approaches performed through open thoracotomy are associated with high surgical morbidity. Sympathectomies performed with thoracoscopy were performed using a single port or several ports. Sympathectomies performed using a single port result in better wound healing and less pain.[8] In our study, all sympathectomies were performed with the VATS single-port approach due to the advantages of single-port thoracoscopy.

The number of incisions in the sympathectomy operation varies between one and three ports.[9,10] While the increase in the number of incisions is a factor that facilitates surgical manipulation, it also creates a cosmetic disadvantage. In our study, the procedure was performed with a single port in all patients. For this reason, a better cosmetic appearance was achieved, and the pain was less due to fewer incisions.

Although rare, sympathectomy is performed in long QT syndrome. In our study, no patient underwent thoracoscopic thoracic sympathectomy due to long QT syndrome.

The operation can be performed with single or double-lumen intubation.[11] To ensure lung collapse, CO_2 insufflation can be administered to the thoracic cavity or an artificial pneumothorax can be created.[12] The procedure can be performed in the lateral decubitus or semi-sitting position.[12,13] In our study, all cases were operated under general anaesthesia with double-lumen intubation. The patients were positioned in a 45° semi-sitting position, with the arms not exceeding 90° of abduction. All cases were operated on by achieving lung collapse with the help of a double-lumen tube on the operated side.

Studies have reported that some authors terminated the operation without placing a thorax drain after the operation.[8,10,12,14] Loscertales *et al*.[5] reported that a thorax drain was applied at the end of the operation. In our study, the operation was terminated with a thorax drain in all our cases. Except for complications, in most of the cases, the drain was removed on the 1st day in accordance with the literature.

Table 6: Compensatory hyperhidrosis according to the groups

	Total (*n*=150)	Group I (*n*=88)	Group II (*n*=62)	χ^2	*P*
Compensatory hyperhidrosis - *n* (%)					
No	72 (48)	34 (38,64)	38 (61,29)	7,48	0,006
Yes	78 (52)	54 (61,36)	24 (38,71)		
Dorsum - *n* (%)					
No	90 (60)	42 (47,73)	48 (77,42)	13,36	<0,001
Yes	60 (40)	46 (52,27)	14 (22,58)		
Thorax - *n* (%)					
No	134 (89,33)	79 (89,77)	55 (88,71)	0,04	0,835
Yes	16 (10,67)	9 (10,23)	7 (11,29)		
Leg - *n* (%)					
No	128 (85,33)	71 (80,68)	57 (91,94)	3,68	0,055
Yes	22 (14,67)	17 (19,32)	5 (8,06)		
Hip - *n* (%)					
No	140 (93,33)	80 (90,91)	60 (96,77)	-	0,197*
Yes	10 (6,67)	8 (9,09)	2 (3,23)		
Face - *n* (%)					
No	143 (95,33)	82 (93,18)	61 (98,39)	-	0,240*
Yes	7 (4,67)	6 (6,82)	1 (1,61)		
Abdomen - *n* (%)					
No	142 (94,67)	85 (96,59)	57 (91,94)	-	0,276*
Yes	8 (5,33)	3 (3,41)	5 (8,06)		
Waist- *n* (%)					
No	145 (96,67)	84 (95,45)	61 (98,39)	-	0,405*
Yes	5 (3,33)	4 (4,55)	1 (1,61)		
Foot - *n* (%)					
No	143 (95,33)	86 (97,73)	57 (91,94)	-	0,126*
Yes	7 (4,67)	2 (2,27)	5 (8,06)		
Armpit - *n* (%)					
No	146 (97,33)	87 (98,86)	59 (95,16)	-	0,307*
Yes	4 (2,67)	1 (1,14)	3 (4,84)		
Hand - *n* (%)					
No	147 (98)	86 (97,73)	61 (98,39)	-	1,000*
Yes	3 (2)	2 (2,27)	1 (1,61)		
Perineum - *n* (%)					
No	148 (98,67)	87 (98,86)	61 (98,39)	-	1,000*
Yes	2 (1,33)	1 (1,14)	1 (1,61)		
Gluteal - *n* (%)					
No	149 (99,33)	87 (98,86)	62 (100)	-	-
Yes	1 (0,67)	1 (1,14)	0 (0)		

Pearson's Chi-square test, *: Fisher's Exact test

Table 7: Satisfaction status of patients according to groups

	Total (*n*=150)	Group I (*n*=88)	Group II (*n*=62)	χ^2	*P*
Satisfaction status - *n* (%)					
No	19 (12,67)	13 (14,77)	6 (9,68)	0,85	0,356
Yes	131 (87,33)	75 (85,23)	56 (90,32)		

Pearson's Chi-square test

In many studies, no operative mortality was observed.[8,10,12] There was no mortality in our study.

Pneumothorax is the most common complication of thoracoscopic sympathectomy operation. In Rodríguez *et al*.'s[15] study, the pneumothorax rate was 3.9% and 68.7% of these patients did not require thorax drain. In our study, prolonged air leakage was observed in 0.67% (n = 1) of patients and the tube thoracostomy remained for more than 24 h. Our pneumothorax rate was found to be lower than the literature because the air in the thorax was drained after the operation in all cases with a tube thoracostomy.

The study by Gossot *et al*.[16] included 467 cases, but only 3 of these cases had intraoperative bleeding. Right subclavian artery injury was detected in one case, and chylothorax was detected in two cases. In the case of subclavian artery injury, bleeding was controlled by thoracotomy. Chylothorax developed in one of the two patients during the right-sided sympathectomy operation and was treated by applying clips to the ductus thoracicus. The other case with chylothorax on the left was treated only with tube thoracostomy.[16] In our study, minimal haemorrhage was observed in 2% (n = 3) of the cases, but conversion to thoracotomy and chylothorax was not required in any of our patients.

In Gossot *et al*.'s[16] study, intercostal vein injury (300–600 cc haemorrhage) occurred in 5.3% of the cases and these were controlled with VATS without the need for thoracotomy.

Table 8: Recurrence rates according to groups

	Total (*n*=150)	Group I (*n*=88)	Group II (*n*=62)	χ^2	*P*	HR	*P*
Recurrence - *n* (%)							
No	133 (88,67)	78 (88,64)	55 (88,71)	0,001	0,989	0,80**	0,663*
Yes	17 (11,33)	10 (11,36)	7 (11,29)				

Pearson's Chi-square test, *: Cox regression analysis, **: Group I referance group

In Erdik *et al*.'s study,[13] intercostal vein injury was stopped by thoracoscopic methods in 1.6% ($n = 1$) of the cases. In our study, haemorrhage due to intercostal vascular injury was observed intraoperatively in 2% ($n = 3$) cases. During the operation, the injured vein was cauterised and bleeding was controlled.

Horner syndrome is found in 0.4% of the cases by Gossot *et al*.'s[16] study, in 0.4% of the cases by Rodríguez *et al*.'s[15] study and in 2.5% of the cases by Herbst *et al*.'s[12] study. In our study, Horner syndrome was not observed in any patient, and the reason for this was thought to be that R1 dissection was not performed and dissection was performed away from the satellite ganglion.

In studies, the incidence of gustatory sweating is observed at different rates. Gustatory sweating is found in Rodríguez *et al*.[15] in 0.2% of the cases, Jeganathan *et al*.[10] in 7.4% of the cases and Herbst *et al*.[12] in 50.7% of the patients. As seen in the literature, the frequencies of gustatory sweating vary over a wide range. In our study, gustatory sweating was seen in 0.67% ($n = 1$) of cases.

Compensatory hyperhidrosis has been reported at various rates in studies. Georghiou *et al*.[8] compensatory hyperhidrosis rate was at 45%, Jeganathan *et al*.[10] rate was at 77% and Herbst *et al*.[12] rate was 67.5%. Jeganathan *et al*.[10] found a compensatory hyperhidrosis rate of 65% in those who underwent T2–T4 sympathectomy and 35% in those who underwent T2–T3/T3–T4. Wang *et al*.[17] compared compensatory hyperhidrosis rates by applying an electrocautery hook or placing a titanium clip on the T4 thoracic sympathetic ganglion, and compensatory hyperhidrosis was observed as 52.8% in those performed with a hook and 22.8% in those performed with a clip. It has been reported that there is a lower rate of compensatory hyperhidrosis in those who have clips placed on T4. As seen in the literature, reflex hyperhidrosis sweating rates vary within a wide range. In our study, Group 1 and Group 2 sympathectomy operations performed due to palmar, axillary and plantar hyperhidrosis were compared in two groups. The compensatory hyperhidrosis rate was found to be 61.36% ($n = 54$) in Group I and 38.71% ($n = 24$) in Group II. In our study, the region where reflex sweating was most common was found to be the back region. When compensatory hyperhidrosis was examined for each region, it was determined that sweating that developed only on the back was more common in Group I, while other regions were observed at similar rates in Group I and Group II ($\chi^2 = 13.36$, $P < 0.001$, other; $P > 0.05$). The rate of compensatory hyperhidrosis on the back was 52.27% ($n = 46$) in Group I and 22.58% ($n = 14$) in Group II.

The success rate of thoracoscopic sympathectomy performed for primary hyperhidrosis is over 90% in the literature. The success rate was found to be 97.8%, 96%, 100% and 95.8%, in the Rodríguez *et al*.,[15] Georghiou *et al*.,[8] Loscertales *et al*.,[5] and Jeganathan *et al*.[10] studies, respectively. In our study, success rates were obtained in 92% ($n = 138$) of a total of 150 patients due to palmar, axillary and plantar hyperhidrosis. Similar rates of success were achieved in Group I and Group II ($\chi^2 = 0.40$, $P = 0.525$). Successful results were achieved at a rate of 93.18% ($n = 82$) in Group I and 90.32% ($n = 56$) in Group II. There was no statistical difference between the groups. Therefore, it was found to be similar to the results in the literature.

The recurrence rate was 2.8% in Rodríguez *et al*.'s[15] series, while in Jeganathan *et al*.'s[10] series, the recurrence rate was found to be 4.6%. In our study, no significant difference was found in the recurrence rates after hyperhidrosis treatment applied in Group I and Group II ($\chi^2 = 0.001$, $P = 0.989$). Recurrence occurred at a rate of 11.36% ($n = 10$) in Group I and 11.29% ($n = 7$) in Group II. During the follow-up period of the patients, it was observed that T2–T4 and T3–T5 sympathectomy applications did not have a significant effect on relapse, and the risk of relapse was similar in both the groups.

Çetinkaya[18] performed intercostal nerve reconstruction on 32 patients due to compensatory hyperhidrosis. Seventy-five per cent ($n = 24$) of the patients reported that their reflex sweating decreased. The median decrease in sweating was found to be 20% in all cases, and they were considered statistically significant.[18]

Baumgartner *et al*.[19] reported a failure rate of 4.2% in patients who underwent post-operative R3 sympathectomy and 4.1% in patients who underwent R2 sympathectomy. It was concluded that young age and accompanying plantar

sweating were effective as the cause of failure in both the groups. In our study, no patient experienced failure in the early post-operative period.

Patients' satisfaction and improvement in their quality of life after the operation are the most important indicators of the success of the procedure. Jeganathan *et al*.[10] found an 85% improvement in the quality of life in the post-operative period, and a decrease in the quality of life was detected due to reflex sweating in 5% of the cases. Rodríguez *et al*.[15] found a 97% improvement in quality of life, and no significant relationship was found between reflex sweating and satisfaction. In Loscertales *et al*.'s[5] study, the improvement in quality of life was found to be 95.3%. In our study, the total satisfaction rate was found to be 87.3% and the satisfaction rates of the patients in Group I and Group II were found to be similar ($\chi^2 = 0.85$, $P = 0.356$). 85.23% ($n = 75$) of the patients in Group I and 90.32% ($n = 56$) in Group II stated that they were satisfied. The main reason for dissatisfaction was thought to be compensatory hyperhidrosis, as also stated in the literature.

CONCLUSIONS

As a result, thoracoscopic thoracic sympathectomy is a good option for the treatment of primary hyperhidrosis. The most important disadvantage and most common complication is compensatory hyperhidrosis. Although CH was more common in the patient group who underwent T2–T4 sympathectomy than in those who underwent T3–T5 sympathectomy, no statistical difference was found. In both the groups, there is a visible increase in the patient's quality of life, daily activities and self-confidence. In our study, the satisfaction rate of our cases was found to be 87.33%. Since there is no statistically significant difference between T2–T4 and T3–T5 sympathectomies, we recommend that the operation method be selected according to the patients' symptoms.

In summary, thoracoscopic thoracic sympathectomy is a fast, reliable and minimally invasive method with a low complication rate, providing a success rate of over 90% and causing a significant increase in psychosocial and occupational quality of life. Still, we believe that future randomised controlled studies on the subject are needed.

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Conflicts of interest
There are no conflicts of interest.

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