Journal of Advances in Medicine and Medical Research

33(14): 101-110, 2021; Article no.JAMMR.69864
ISSN: 2456-8899
(Past name: British Journal of Medicine and Medical Research, Past ISSN: 2231-0614, NLM ID: 101570965)

The Effect of T3 versus T4 Thoracoscopic Sympathectomy on Hyperhidrosis

Karim Mohamed El Mesery[1*], Ahmed Emadeldeen Ghoneim[1], Abd Elhady Mohamed Taha[1] and Mohamed Mahmoud Abo Elnasr[1]

[1]Cardiothoracic Surgery Department, Faculty of Medicine, Tanta University, Tanta, Egypt.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMMR/2021/v33i1430976
Editor(s):
(1) Dr. Emin Umit Bagriacik, Gazi University, Turkey.
Reviewers:
(1) Naveen Kumar, Lady Hardinge Medical College, India.
(2) Giuseppe Consorti, Azienda Ospedaliero Universitaria "Ospedali Riuniti" Umberto I, Italy.
Complete Peer review History: http://www.sdiarticle4.com/review-history/69864

Original Research Article

Received 18 April 2021
Accepted 24 June 2021
Published 29 June 2021

ABSTRACT

Background: Primary hyperhidrosis is a disorder characterized by excessive sweating. However, surgical therapy is the most effective treatment for patients with primary hyperhidrosis. In between all different surgical approaches, video assisted thoracoscopic surgery (VATS) sympathectomy has been considered as a safe and minimally invasive procedure for palmer and axillary hyperhidrosis. The aim of this study was to evaluate the effectiveness of T3 vs. T4 sympathectomy regarding postoperative complications, recurrence and compensatory hyperhidrosis (CH) on 6 months follow up.
Methods: This prospective randomized study was conducted over 20 patients undergoing VATS sympathectomy diagnosed with palmar hyperhidrosis and failed medical treatment and undergoing thoracoscopic sympathectomy. Patients were divided randomly into two groups; group A (T3 sympathectomy) and group B (T4 sympathectomy).
Results: There was no significant difference between the two groups regarding the degree of treatment success, compensatory hyperhidrosis after one month and after 6 months. There was non-significant difference between the two groups regarding the recurrence, late postoperative complications and satisfaction.
Conclusions: Video-assisted T3 or T4 sympathectomy is a safe and effective procedure for

**Corresponding author: E-mail: karim.mesery@hotmail.com;*

treatment of palmar hyperhidrosis and T3 or T4 sympathectomy had no difference regarding to dryness and Compensatory Hyperhidrosis in follow-up for 6 months. Both techniques were effective for treating palmar hyperhidrosis with high rates of success and no recurrence for 6 months.

Keywords: Thoracoscopic sympathectomy, hyperhidrosis, cardiothoracic surgery.

1. INTRODUCTION

Primary hyperhidrosis is a disorder characterized by excessive sweating beyond thermoregulatory needs, especially in response to emotional stimuli. Primary hyperhidrosis has a prevalence of nearly 3%; severe hyperhidrosis affects face, hands, axillae, and feet in a common manner. Medical treatments, as local antiperspirants, systemic anticholinegic agents, iontophoresis, and botulinum toxin treat symptoms transiently. However, surgical therapy is the most effective treatment for patients with primary hyperhidrosis [1].

In between all different surgical approaches, video assisted thoracoscopic (VATS) sympathectomy has been considered as a safe and minimally invasive procedure for palmer and axillary hyperhidrosis [2].

In addition, it can be done using single or multiple ports [3,4].Both uniportal and biportal VATS sympathectomy have been proved to be effective, safe, and minimally invasive for palmer hyperhidrosis. The uniportal approach is associated with less postoperative pain and less operative time in comparison to the biportal one [5]. It also is considered a more reasonable procedure in the treatment of palmer hyperhidrosis in terms of esthetic results [6].

VATS technique has evolved and nowadays can be done with two or even one single thoracoscopic port [7,8]. Uncertainty exists about the most useful technique regarding the analgesic satisfaction of the patient on the postoperative period [9]. Surgery depends on the isolation and the dissection of the thoracic sympathetic chain with cauterization and ablation or clipping, the corresponding roots which are responsible for the excessive sweating in certain body areas [10].

With the development of many techniques, exploring the past builds a bridge to understand the future. In 1910, Jacobaeus reported inserting as ureteroscope into the thoracic cavity to make pleural inspection. He subsequently published a series of these cases and did a second incision to do pneumolysin for pneumothorax therapy for tuberculosis. Singer in 1924 utilized a specialized thoracoscope through which we can introduce many instruments, essentially the first uni-VATS. However, these thoracoscopic techniques were no longer used with the advent of medical therapy for tuberculosis [11].

Uni-VATS technique was first described by the senior author Rocco G in 2004 [12]. initially reported his use of the uniportal technique for wedge resections both for the diagnosis of interstitial lung disease and for the treatment of primary spontaneous pneumothorax. Since then, the procedure has become popular worldwide and is now a part of the routine practice of thoracic surgery. The early experience with uni-VATS could be attributed to the wide spread development of new optics and articulating instruments [13].

Surgical efficacy and patients' satisfaction predictor factors were studied, including body mass index (BMI), age, gender, quality of life before surgery, and chain resection level. [14]. Unfortunately the relationship between hyperhidrosis sites preoperatively and the improvement of patients' quality of life after surgery has not been studied yet [15].

The aim of this study was to evaluate the effectiveness of T3 vs. T4 sympathectomy regarding postoperative complications, recurrence and compensatory hyperhidrosis (CH) on 6 months follow up

2. PATIENTS AND METHODS

Our a randomized prospective study was conducted over 20 patients diagnosed with palmar hyperhidrosis and failed medical treatment and undergoing thoracoscopic sympathectomy undergoing VATS sympathectomy at Cardiothoracic Surgery Department, Tanta University Hospitals and other centers from August 2019 till January 2020 after approval from Ethical Committee and obtaining informed written consent.

2.1 Exclusion Criteria

- Patients with history of previous thoracic surgery,
- Patients with associated diseases that could increase surgical risks (e.g., cardiac diseases, pulmonary infections, neoplasia or diseases of the pleura or lungs), a body mass index <25.
- Patients who are unable to provide written informed consent or are already participating in another clinical trial.

Patients were divided randomly into two groups; group A (T3 symapthectomy) and group B (T4 sympathectomy). Randomization was done using sealed envelopes technique.

Patients included in the study were subjected to pre-operative preparation: full history taking, clinical examination, full laboratory investigations and radiological investigations.

2.2 Operative Technique

All patients were positioned in a semi-sitting position with their arms abducted during the operation. Routine monitoring during thoracoscopic sympathectomy includes ECG, pulse oximetry, noninvasive blood pressure and capnography. All surgical procedures were performed under general anesthesia using single lung ventilation via double lumen endotracheal tube inserted by anesthesia team. Essentially, to perform the sympathectomy, we used a rigid thoracoscope via a 10-mm trocar with an obturator and a cannula.

A separate channel was available inside the thoracoscope for the use of the forceps or the aspirator. Two 5mm ports was used for VATS inserted in 4th intercostal space, one at the midclavicular line and the other is at the mid axillary line. The operative approach was the same in both groups apart from the level of division of the sympathetic chain. Sympathetic chain was identified at the level of crossing of the third (T3 group) or the fourth (T4 group) costal heads. It was divided 1 cm wide after dissection of parietal pleura also the accessory nerve fibers along the ribs at this level also cautarized.
VATS trocars were removed after complete inflation of lung by anesthesia team. The catheter was removed, and the incisions were closed using an absorbable suture. The use of a chest drain was not routine. The same procedure was carried out on the contralateral chain in a different session after at least three months.

2.3 Post-operative Evaluation

Hemodynamics was evaluated and CXR was taken to rule out pneumothorax or pleural effusion. NSAIDs, may be used for post thoracoscopy pain, being an effective and safe alternative to opioids. All patients were followed up after 1 week, and 1 and 6 months respectively for late postoperative complications regarding; ptosis, anhidrosis, recurrence, compensatory hyperhidrosis. Degree of hyperhidrosis was measured subjectively using Hyperhidrosis Disease Severity Scale (HDSS) using a scale of 1 to 4 (1= none, 2=mild, 3=moderate, 4=severe).

Recurrence was evaluated at the site of preoperative hyperhidrosis only (0=none, 1=recurrence). Patient satisfaction and quality of life were also evaluated as satisfied or not satisfied.

2.4 Statistical Analysis

The data was analyzed with IBM personal computer with Statistical Package of Social Science (SPSS) version 22 (SPSS, Inc, Chicago, Illinois, USA). Quantitative parametric variables were presented as mean, standard deviation (SD) and range while qualitative data presented in the form numbers and percentages. They were analyzed using unpaired student's t- test for the comparison between the two groups. Qualitative variables were analyzed utilizing the Chi-square test. The level of significance was adopted at $p < 0.05$ and statistically highly significant at $p < 0.001$.

3. RESULTS

3.1 Preoperative Results

There was no significant difference between the two groups regarding gender, and age due to small sample size as shown in Table 1.

There was non-significant difference between the two groups regarding BMI, family history, and symptoms duration. Table 2.

Table 1. Relation between T3 versus T4 groups and their demographic data

	T3 (n = 10)		T4 (n = 10)		Total (n = 20)		Test of sig.	p
	No.	%	No.	%	No.	%		
Gender								
Female	8	80.0	6	60.0	14	70.0	x^2=	0.630
Male	2	20.0	4	40.0	6	30.0	0.231	
Age (years)								
≤ 25	3	30.0	7	70.0	10	50.0	x^2=	0.282
> 25	7	70.0	3	30.0	10	50.0	1.158	
Min. – Max.	22.0 – 40.0		20.0 – 39.0		20.0 –40.0		t=	0.403
Mean ± SD.	28.84 ± 12.53		27.56 ± 9.0		29.55 ± 1.46		0.939	

χ^2: Chi square test, t: Student t-test

Table 2. Relation between T3 versus T4 and Patients characteristics

	T3 (n = 10)		T4 (n = 10)		Total (n = 20)		Test of sig.	p
	No.	%	No.	%	No.	%		
BMI Mean ± SD.	27.67 ± 3.48		27.34 ± 5.40		26.37 ± 4.40		t=0.074	0.941
Family history (%)								
yes	3	30.0	4	40.0	7	35.0	t=39.484	0.416
no	7	70.0	6	60.0	13	65.0		
Symptoms duration (years) Mean ± SD.	8.84 ± 2.53		7.56 ± 2.0		8.27 ±1.74		t=37.939	0.638
Weight (kg) Mean ± SD	-		-		88.11 ± 11.97		-	-
Height (m) Mean ± SD	-		-		1.71 ± 0.04		-	-

χ^2: Chi square test, t: Student t-test

3.2 Postoperative Results

All cases in T3 and T4 groups had dry hands and no recurrence at all after one week**.** There was non significant difference between the two groups regarding the recurrence after 6 months. Table 3.

There was no significant difference between the studied groups after one month and 6 months regarding compensatory hyperhidrosis in both T3 group and T4 group. Table 4.

Regarding the satisfaction rate, there was no significant difference between the two groups divided into not satisfied and satisfied. Table 5.

Table 3. Relation between T3 versus T4 and the degree of hand dryness (Treatment success) after one week and recurrence after 6 months

Treatment success after one week	T3 (n = 10)		T4 (n = 10)		Total (n = 20)		X^2	p
	No.	%	No.	%	No.	%		
Dry hands	10	100.0	10	100.0	20	100.0	0	-
Wet hands (recurrence)	0	00.0	0	00.0	0	00.0		
Recurrence after 6 months								
None recurrence	10	100.0	10	100.0	20	100.0	0	-
	0	0	0	0	0	0		

Table 4. Relation between T3 versus T4 and compensatory hyperhidrosis after one month and 6 months

Compensatory hyperhidrosis one month	T3 (n = 10)		T4 (n = 10)		Total (n = 20)		X^2	p
	No.	%	No.	%	No.	%		
None	5	50.0	6	60.0	11	55.0	0.4	**0.669**
Mild	3	30.0	2	20.0	5	25.0	0.181	**0.527**
Moderate	2	20.0	2	20.0	4	20.0	0	-
Severe	0	00.0	0	00.0	0	00		
Compensatory hyperhidrosis after 6 months								
None	5	50.0	5	50.0	10	50.0	0	1
Mild	3	30.0	3	30.0	6	30.0	0	1
Moderate	2	20.0	2	20.0	4	20.0	0	1
Severe	0	00.0	0	00.0	0	0.0		0

Table 5: **Relation between T3 versus T4 and Patient satisfaction rates**

Patient satisfaction rates:	T3 (n = 10)		T4 (n = 10)		Total (n = 20)		X^2	p
	No.	%	No.	%	No.	%		
not satisfied	0	00.0	0	00.0	0	0.0		
satisfied	10	50.0	10	30.0	20	100.0	0	-

4. DISCUSSION

Few studies, however, have reported on the long-term results of VTS. Its side effects, especially compensatory sweating (CS), are well known, which is the main reason for dissatisfaction with the surgery [16].

Video thoracoscopic sympathectomy is a safe procedure, with a low rate of complications. The reported mortality rate was zero, until Ojimba and Cameron [17]. reported 9 deaths. The effectiveness of VTS has been demonstrated, but its drawback is that it is irreversible [18].

Since the interruption of the interganglionic T3–T4 trunk does not abolish the sympathetic tone to the hypothalamus and given that most of the fibers for the hand originate from T4, the best level of section to achieve good results in terms of efficiency and lower compensatory sweating rate is exactly between T3–T4 [19].

In the our study, there was female predominance with 70% female and 30% males which in agreement with the results by Abu-Gamila et al., [18] who stated that a higher proportion of females (76%) having VTS compared with males (24%) which revealed that more females were seeking VTS as a cure for PH compared with males . also de Souza Coelho et al. [20] commented that there was a predominance of female patients, a finding confirmed by Lin et al. [21].

This differs from what many authors have reported, as the majority of the papers found that the incidence of PH in men and women is the same, [22] that can be explained by the behavior in different areas.

In our study, the mean age of the studied patients was 29.55 ± 1.46 years which near to the results by Abu-Gamila et al. [23] who found that the mean age of the studied cases was 23.55 ± 6.12 years.

In this study, the family history of hyperhidrosis was 35% in all the studied cases which in line with de Souza Coelho et al. [24] who found that it was found in 31.1% of patients in this study, suggesting a familial factor. Also the family history of hyperhidrosis ranged from 15% to 50% [25].

In our study, regarding dry hands, the incidence was equal in both groups of T3 and T4. This might be due to the small sample size of our study. However, in the meta-analysis by Zhang et al. [26] it was stated that in the five articles that compared the rates of dry hands, there was no evidence of heterogeneity among them (p=0.98, I 2=0%). The incidence of dry hands was significantly higher in the T3 group than in the T4 group.

In our study, there was no significant difference between the two groups in satisfaction results as all the studied cases were satisfied with the results while in the study done by de Souza Coelho et al. [24] 75.0% of patients were very satisfied, 21.4% were satisfied, and 4.8% were dissatisfied.

Zhang et al. [26] stated in their meta-analysis that significantly higher satisfaction rates were found in the T4 group than in the T3 group (95% CI: 0.11 to 0.74, p=0.009).

Drott et al. [27] reported a success rate of 98.6% on 850 patients treated and, in 2001, Lin et al. [28] published the results of sympathectomy performed on 2,200 patients, reporting a successful treatment in 99%. The capacity of this method to guarantee proper results even after a long time is confirmed by numerous reports in literature [29].

Regarding to the recurrence rate, there was non-significant difference in between the two groups regarding to recurrence with P= 1 which agrees with the results by Abu-Gamila et al. [23] and Scognamillo et al. [19]

In our study, all patients of the two groups had no recurrence but in the study done by Abu-Gamila et al. [23] there was only 3.3% of patients had recurrence of their PH, also in another study by de Souza Coelho et al. [24] in the VTS group, 2 patients (4.8%) had recurrence. Also Zhang et al. [26] found that Seven articles compared recurrence rates between T3 and T4 with no significant difference in recurrence rates was found between the two groups.

The work by Drott et al. [27] showed a recurrence rate of 2% for an average follow-up of 31 months, while in 1998, after a follow-up ranging from 3 to 48 months, both Cohen et al. [30] and Hashmonai et al. [31] reported a recurrence rate of 0%. More recently, in 2004, Loscertales et al. [32] reported a 12-month recurrence rate of 0% on 106 patients treated, while Yano [33] published the results of 184 patients with 3% of recurrences after 2 years. The study of De Campos et al. [34] published in 2003 contains partially discordant data, but he reports recurrences of 8.2% after 12.6 months on 378 patients.

Compensatory sweating (CS) can be defined as excessive sweating that appears after sympathectomy or sympathetic block in anatomic areas different from those for which the patient was operated on. The emotional and social difficulties brought on the patients by excessive sweating are usually so great that most patients accept some degree of CS after the operation, provided they are relieved of their hyperhidrosis [19].

As regard to compensatory sweating, it was seen in 50% of all the studied cases with low significant difference in T4 than T3 because in T3 group; 5 cases had no compensatory sweating, 3 cases had mild and 2 cases had moderate degree, while in T4 group 6 patients had no hyperhidrosis, 2 cases had mild, and 2 cases had moderate degree. Meanwhile, in Zhang et al. [26] in their meta-analysis stated that ten articles compared CS rates. The incidence of CS was significantly lower in the T4 group than in the T3 group (95% CI: 2.87 to 9.53, p<0.00001) which was disagreement with our findings.

While in the study by Abu-Gamila et al. [23] it was seen in 20% of the studied cases. In another study, Eraki and Saad [35] in their study, stated that the incidence of CS was seen in 15% of VTS patients.

Compensatory sweating has been reported in 30% to 98% of postoperative patients by Leão et al., [36]; Reinsfeld et al. [37], and its mechanism has not been clearly established. Variable rates of CS have been reported with different levels of sympathectomy: 90.0% with T2 T3 [38] ; 55.5% [39] and 86.4% [40] with T2T3T4; 84.3% with T2T3T4T5 [41]; and 70% with T3T4 [42]. Leseche and colleagues [25] did not find a correlation between the extension of sympathectomy and CS, but it should be emphasized that in this series all patients had the T2 ganglion resected.

The physio pathological basis of compensatory sweating may be an uncontrolled regeneration of the nerve fibers, genetic factors or particular warm–wet climatic conditions. According to another theory, each individual must eliminate, physiologically, certain daily volumes; thus, the inhibition of palmar and axillary sweat glands leads to new areas of accentuated ‘‘compensatory’’ sweating [19]

Also, Yoon et al. [43] suggested that T3 sympathectomy has less side effects. The work published by Neumayer et al. [39] seems to confirm this theory: the degree of satisfaction is greater in patients treated with T4 block

compared to those treated with T2–T4 sympathectomy (100 vs. 80%), but especially in the first group the incidence of compensatory sweating is much lower (8 vs. 52%).

Gossot et al. [44] report compensatory sweating rates of 72.2% in the T2–T4 group and 70.9% in T4 group, but severe compensatory sweating able to influence normal daily activities is described in 27% of patients in the first group and in 13% in the second group

Weksler et al. [45] compared the compensatory sweating rates in patients who underwent transection of one or more sympathetic ganglion and they conclude that latter is not related to a higher incidence of compensatory sweating but increases its severity.

According to postoperative complications, the most common was compensatory sweating in 65% of the studied cases while Abu-Gamila et al., [46] who commented that the most common adverse effect of ETS is excessive CS seen in six (20%) patients in ETS patients but the incidence ranging from 30 to 90% in the study done by Schmidt et al. [47] ; Yazbek et al. [48], Ibrahim et al. [6].

De Souza Coelho et al. [24] also stated that, compensatory sweating was observed in 65 patients (77.4%) which was near to the results of our study.

In our study, regarding other postoperative complications; pneumothorax was seen in only a case (5%). Its incidences have been reported by Cerfolio et al. [49] ; Doft et al. [50] to be around 1-6%. De Souza Coelho et al. [24] also stated that pneumothorax was observed in only 1 patient (1.5%) in the VTS group.

5. CONCLUSIONS

Video-assisted T3 or T4 sympathectomy is a safe and effective procedure for treatment of palmar hyperhidrosis and T3 or T4 sympathectomy had no difference regarding to dryness and Compensatory Hyperhidrosis in follow-up for 6 months. Both techniques were effective for treating palmar hyperhidrosis with high rates of success and no recurrence for 6 months.

CONSENT AND ETHICAL APPROVAL

Our a randomized prospective study was conducted over 20 patients diagnosed with palmar hyperhidrosis and failed medical treatment and undergoing thoracoscopic sympathectomy undergoing VATS sympathectomy at Cardiothoracic Surgery Department, Tanta University Hospitals and other centers from August 2019 till January 2020 after approval from Ethical Committee and obtaining informed written consent.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Walling HW, Swick BL. Treatment options for hyperhidrosis. Am J Clin Dermatol. 2011;12:285-95.
2. Ambrogi V, Campione E, Mineo D, Paternò EJ, Pompeo E, Mineo TC. Bilateral thoracoscopic T2 to T3 sympathectomy versus botulinum injection in palmar hyperhidrosis. Ann Thorac Surg. 2009; 88:238-45.
3. Georghiou GP, Berman M, Bobovnikov V, Vidne BA, Saute M. Minimally invasive thoracoscopic sympathectomy for palmar hyperhidrosis via a transaxillary single-port approach. Interact Cardiovasc Thorac Surg. 2004;3:437-41.
4. Lin TS, Kuo SJ, Chou MC. Uniportal endoscopic thoracic sympathectomy for treatment of palmar and axillary hyperhidrosis: analysis of 2000 cases. Neurosurgery. 2002;51:S84-7.
5. Chen YB, Ye W, Yang WT, Shi L, Guo XF, Xu ZH, et al. Uniportal versus biportal video-assisted thoracoscopic sympathectomy for palmar hyperhidrosis. Chin Med J (Engl). 2009;122:1525-8.
6. Ibrahim M, Menna C, Andreetti C, Ciccone AM, D'Andrilli A, Maurizi G, 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.
7. Günal N, Ozpolat B, Dere Günal Y, Dural K. Single port thoracoscopic sympathectomy for primary palmar hyperhidrosis in adolescence. Turk J Med Sci. 2014;44:79-83.
8. Chen JT, Liao CP, Chiang HC, Wang BY. Subxiphoid single-incision thoracoscopic bilateral ablative sympathectomy for hyperhidrosis. Interact Cardiovasc Thorac Surg. 2015;21:119-20.
9. Young R, McElnay P, Leslie R, West D. Is uniport thoracoscopic surgery less painful

than multiple port approaches? Interact Cardiovasc Thorac Surg. 2015;20:409-14.
10. Thomsen LL, Mikkelsen RT, Derejko M, Schrøder HD, Licht PB. Sympathetic block by metal clips may be a reversible operation. Interact Cardiovasc Thorac Surg. 2014;19:908-13.
11. Moisiuc FV, Colt HG. Thoracoscopy: origins revisited. Respiration. 2007;74:344-55.
12. Rocco G, Martin-Ucar A, Passera E. Uniportal VATS wedge pulmonary resections. Ann Thorac Surg. 2004;77:726-8.
13. Jutley RS, Khalil MW, Rocco G. Uniportal vs standard three-port VATS technique for spontaneous pneumothorax: comparison of post-operative pain and residual paraesthesia. Eur J Cardiothorac Surg. 2005;28:43-6.
14. Neves S, Uchoa PC, Wolosker N, Munia MA, Kauffman P, de Campos JR, et al. Long-term comparison of video-assisted thoracic sympathectomy and clinical observation for the treatment of palmar hyperhidrosis in children younger than 14. Pediatr Dermatol. 2012;29:575-9.
15. Wolosker N, Yazbek G, de Campos JR, Munia MA, Kauffman P, Jatene FB, et al. Quality of life before surgery is a predictive factor for satisfaction among patients undergoing sympathectomy to treat hyperhidrosis. J Vasc Surg. 2010;51:1190-4.
16. Abd Ellatif ME, Hadidi AE, Musa AM, Askar W, Abbas A, Negm A, et al. Optimal level of sympathectomy for primary palmar hyperhidrosis: T3 versus T4 in a retrospective cohort study. Int J Surg. 2014;12:778-82.
17. Ojimba TA, Cameron AE. Drawbacks of endoscopic thoracic sympathectomy. Br J Surg. 2004;91:264-918.
18. Hsia JY, Chen CY, Hsu CP, Shai SE, Yang SS, Chuang CY. Outpatient thoracoscopic sympathicotomy for axillary osmidrosis. Eur J Cardiothorac Surg. 2003;24:425-7.
19. Scognamillo F, Serventi F, Attene F, Torre C, Paliogiannis P, Pala C, et al. T2-T4 sympathectomy versus T3-T4 sympathicotomy for palmar and axillary hyperhidrosis. Clin Auton Res. 2011;21:97-102.
20. Pêgo-Fernandes PM, Moreira LFP, Souza GEC, Bacal F, Bocchi EA, Stolf NAG, et al. Endoscopic left sympathetic blockade in the treatment for dilated cardiomyopathy. Arquivos brasileiros de cardiologia. 2010;95:685-90.
21. Lin CC, Mo LR, Lee LS, Ng SM, Hwang MH. Thoracoscopic T2□sympathetic block by clipping—a better and reversible operation for treatment of hyperhidrosis palmaris: experience with 326 cases. European Journal of Surgery. 1998;164:13-6.
22. Callejas M, Grimalt R, Cladellas E. Hyperhidrosis update. Actas Dermo-Sifiliográficas (English Edition). 2010;101:110-8.
23. Abu-Gamila R, Mohamed E, Nosair A. Thoracic sympathectomy for hyperhidrosis with and without botulinum toxin injection. Al-Azhar Assiut Medical Journal. 2019;17:302.
24. de Souza Coelho M, Silva RFKC, Mezzalira G, Neto NB, de Souza Stori Jr W, dos Santos AFR, et al. T3T4 endoscopic sympathetic blockade versus T3T4 video thoracoscopic sympathectomy in the treatment of axillary hyperhidrosis. The Annals of thoracic surgery. 2009;88:1780-5.
25. Lesèche G, Castier Y, Thabut G, Petit M-D, Combes M, Cerceau O, et al. Endoscopic transthoracic sympathectomy for upper limb hyperhidrosis: limited sympathectomy does not reduce postoperative compensatory sweating. Journal of vascular surgery. 2003;37:124-8.
26. Zhang W, Yu D, Wei Y, Xu J, Zhang X. A systematic review and meta-analysis of T2, T3 or T4, to evaluate the best denervation level for palmar hyperhidrosis. Scientific Reports. 2017;7:129.
27. Drott C, Göthberg G, Claes G. Endoscopic transthoracic sympathectomy: an efficient and safe method for the treatment of hyperhidrosis. Journal of the American Academy of Dermatology. 1995;33:78-81.
28. Lin C, Wu H, editors. Endoscopic t4-sympathetic block by clamping (ESB4) in treatment of hyperhidrosis palmaris et axillaris--experiences of 165 cases. Annales chirurgiae et gynaecologiae; 2001.
29. Chiou S-M, Chen S-C. Sensitivity, specificity and predictive value of intra-operative elevation of hand temperature to ensure a successful T2-sympathectomy in patients with palmar hyperhidrosis. Acta neurochirurgica. 1999;141:855-9.

30. Cohen Z, Levi I, Pinsk I, Mares AJ. Thoracoscopic upper thoracic sympathectomy for primary palmar hyperhidrosis—the combined paediatric, adolescents and adult experience. European Journal of Surgery. 1998;164:5-8.
31. Hashmonai M, editor The learning curve of thoracoscopic sympathectomy. Sixth world congress of endoscopic surgery, 1998; 1998: Monduzzi.
32. Loscertales J, Tristán AA, Loscertales MC, Merchán RJ, Arjona JG, Linares CA, et al. Tratamiento de la hiperhidrosis palmar por simpatectomía torácica. Resultados inmediatos y calidad de vida postoperatoria. Archivos de Bronconeumología. 2004;40:67-71.
33. Yano M, Kiriyama M, Fukai I, Sasaki H, Kobayashi Y, Mizuno K, et al. Endoscopic thoracic sympathectomy for palmar hyperhidrosis: efficacy of T2 and T3 ganglion resection. Surgery. 2005;138:40-5.
34. de Campos JRM, Kauffman P, de Campos Werebe E, Andrade Filho LO, Kusniek S, Wolosker N, et al. Quality of life, before and after thoracic sympathectomy: report on 378 operated patients. The Annals of thoracic surgery. 2003;76:886-91.
35. M E, H S. Outcome of ETS versus radiofrequency thympatholysis for long term treatment of patients with hyperhidrosis. Med J Cairo Univ. 2016;84:356-68.
36. Leão LEV, Oliveira Rd, Szulc R, Mari JdJ, Crotti PLR, Gonçalves JJS. Role of video-assisted thoracoscopic sympathectomy in the treatment of primary hyperhidrosis. Sao Paulo Medical Journal. 2003;121:191-7.
37. Reisfeld R, Nguyen R, Pnini A. Endoscopic thoracic sympathectomy for hyperhidrosis: experience with both cauterization and clamping methods. Surgical Laparoscopy Endoscopy & Percutaneous Techniques. 2002;12:255-67.
38. Licht PB, Jørgensen OD, Ladegaard L, Pilegaard HK. Thoracoscopic sympathectomy for axillary hyperhidrosis: the influence of T4. The Annals of thoracic surgery. 2005;80:455-60.
39. Neumayer C, Zacherl J, Holak G, Függer R, Jakesz R, Herbst F, et al. Limited endoscopic thoracic sympathetic block for hyperhidrosis of the upper limb: reduction of compensatory sweatng by clipping T4. Surgical Endoscopy And Other Interventional Techniques. 2004;18:152-6.
40. Fischel R, Cooper M, Kramer D. Microinvasive resectional sympathectomy using the harmonic scalpel. Clinical Autonomic Research. 2003;13:i66-i70.
41. Munia MAS, Wolosker N, Kauffman P, de Campos JR, Puech-Leão P. A randomized trial of T3-T4 versus T4 sympathectomy for isolated axillary hyperhidrosis. Journal of vascular surgery. 2007;45:130-3.
42. Hsu C-P, Shia S-E, Hsia J-Y, Chuang C-Y, Chen C-Y. Experiences in thoracoscopic sympathectomy for axillary hyperhidrosis and osmidrosis: focusing on the extent of sympathectomy. Archives of Surgery. 2001;136:1115-7.
43. Yoon S-H, Rim D-C. The selective T3 sympathicotomy in patients with essential palmar hyperhidrosis. Acta neurochirurgica. 2003;145:467-71.
44. Gossot D, Galetta D, Pascal A, Debrosse D, Caliandro R, Girard P, et al. Long-term results of endoscopic thoracic sympathectomy for upper limb hyperhidrosis. The Annals of thoracic surgery. 2003;75:1075-9.
45. Weksler B, Blaine G, Souza ZB, Gavina R. Transection of more than one sympathetic chain ganglion for hyperhidrosis increases the severity of compensatory hyperhidrosis and decreases patient satisfaction. Journal of Surgical Research. 2009;156:110-5.
46. Abu-Gamila R, Mohamed E, Nosair A. Thoracic sympathectomy for hyperhidrosis with and without botulinum toxin injection. Al-Azhar Assiut Medical Journal. 2019;17:302-7.
47. Schmidt J, Bechara FG, Altmeyer P, Zirngibl H. Endoscopic thoracic sympathectomy for severe hyperhidrosis: impact of restrictive denervation on compensatory sweating. The Annals of thoracic surgery. 2006;81:1048-55.
48. Yazbek G. Twenty months of evolution following sympathectomy on patients with palmar hyperhidrosis: sympathectomy at the T3 level is better than at the T2 level. Clinics [online]. 2009, vol. 64, n. 8. ISSN. 1980;5322:743-9.
49. Cerfolio RJ, De Campos JRM, Bryant AS, Connery CP, Miller DL, DeCamp MM, et al. The Society of Thoracic Surgeons expert consensus for the surgical treatment of hyperhidrosis. The Annals of thoracic surgery. 2011;91:1642-8.

50. Doft MA, Hardy KL, Ascherman JA. Treatment of hyperhidrosis with botulinum toxin. Aesthetic surgery journal. 2012;32:238-44.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/69864