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Unilevel (T3) versus Bilevel (T3 – T4) Sympathictomy in the Management of Palmar Hyperhidrosis; Does It Affect the Incidence and Severity of Postoperative Compensatory Sweating?

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Abstract

Background: Thoracoscopic sympathicotomy (TS) has emerged as the prevailing surgical approach for primary palmar hyperhidrosis (PH) due to its minimally invasive nature causing minimum morbidity and minimal stress. Compensatory hyperhidrosis (CH) is the most frequent and troubling complication following TS, and numerous strategies have been proposed to prevent its onset. This work aimed to compare T3 with T3-4 TS in the management of patients with PH regarding the incidence of postoperative CH.

Patients and Methods: This randomized study included 50 patients aged >18 years old, diagnosed with primary PH and scheduled for TS. The allocated patients were as signed into two groups; group A underwent only T3 sympathicotomy and group B underwent T3-4 sympathicotomy.

Results: Operative time reduced significantly in group A than in group B (19.6±4.31 vs 24.2±5.53min, p=0.002). Incidence and degree of postoperative CH were insignificantly different at 1m, 3m, and 6m between both groups. The incidence of postoperative axillary sweating was significantly lower in group B than group A at 1m (13 (52.0%) vs 21 (84.0%), p=0.032) and 3m (8 (32.0%) vs 17 (68.0%), p=0.011) and was comparable at 6m between both groups.

The numerical rating scale measurements at 0h, 2h, 4h, 8h, 12h, 20h, and 24h, hospital stay, patient satisfaction, pneumothorax, subcutaneous emphysema, and recurrence were comparable between both groups. None of the patients in either group had hemothorax.

Conclusions: Both the bilevel (T3 – T4) and unilevel (T3) approaches were safe and effective for treating patients with PH with comparable incidence of CH while postoperative axillary sweating was more prevalent in the unilevel (T3) group makingbilevel more suitable for patients with axillary sweating.

Key Words: *Unilevel – Bilevel – Sympathicotomy – Palmar Hyperhidrosis – Compensatory hyperhidrosis.*

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Introduction

PRIMARY palmar hyperhidrosis (PH) is a prevalent form of hyperhidrosis, affecting an estimated 0.6–1% of the population with excessive sweating of the palms and fingers **[1].** This condition can have a substantial impact on self-esteem, mental health, relationships, social connections, and career selections **[2,3].** Patients with primary hyperhidrosis (HH), compared to those without HH, report greater impairments in work/school performance, social performance, and emotional well-being **[4].**

Thoracoscopic sympathicotomy (TS) has emerged as the traditional surgical approach for treating PH, due to its minimally invasive nature and low rates of morbidity **[5].** Traditional surgery, which involves cutting the sympathetic chain at the T2–T3 or T2–T4 levels, can effectively alleviate PH symptoms. However, this surgical method is linked to a high incidence of complications, including compensatory hyperhidrosis (CH) and dry hands **[4].**

Several strategies have been explored to reduce the incidence of obstacles following TS, with limiting the extent of surgical dissection identified as a crucial factor **[6].** Some researchers have conducted TS at a single level and reported better outcomes, including similar symptom resolution and a lower

incidence of CH, compared to TS performed at multiple levels **[7-9].**

To the best of our understanding, a conspicuous scarcity of research exists comparing T3 versus combined T3 and 4 in the management of PH in the Egyptian setting, which was a good motive for us to conduct the present trial. This work aimed tocompare T3 with T3-4 TS in the management of patients with PH regarding the incidence of postoperative CH.

Patients and Methods

This prospective randomized interventional study carried out on 50 patients of age >18 years old, both sexes, American Society of Anesthesiologists (ASA) class I or II diagnosed with primary PH and scheduled for TS. The study was done with approval from the Ethical Committee Mansoura University Hospitals, Egypt. (Approval code: R.23.02.2073).Written informed consent was obtained from all patients. The study was performed from February 2022 to February 2023.

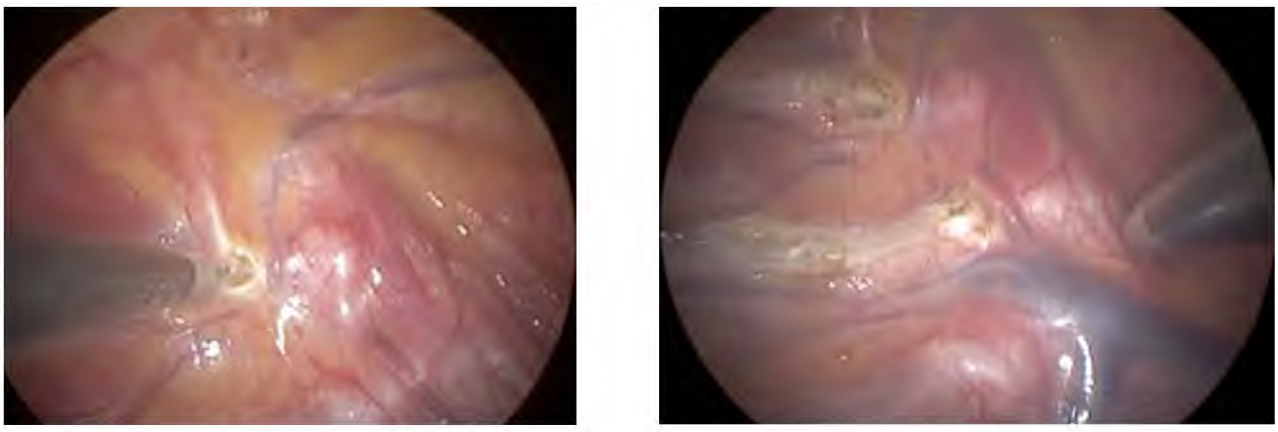
Exclusion criteria were secondary HH, previous thoracic surgery, and body mass index >30kg/m^2.

Fifty patients were allocated randomly by a computer-generated sequence through sealed opaque envelopes into two equal categories; group A involved patients who had only T3 TSand group B involved patients who had T3-4 sympathicotomy. The envelopes were opened by the chief nurse who was not incorporated in the study. Patient and outcome assessor were blinded to group allocation.

All patients received the typical preoperative preparation including proper history taking, clinical examination, and preoperative laboratory and radiological investigations. Moreover, all patients were reviewed by the anaesthesia team and their physical status was classified according to the ASA **[10].**

The surgical procedure:

All patients underwent the surgery under general anesthesia and orotracheal intubation. During the operation, all patients were placed in a semi-sitting posture while raising their arms. A 5-mm incision was made in the fourth intercostal space on the anterior axillary line of each hemithorax, through which a 5-mm diameter thoracoscope was introduced into the thoracic cavity. The second port was inserted in the second or third intercostal space at midaxillary line (working port). This allowed for the visualization of the T3 and T4 sympathetic ganglia. An electrocautery hook was then used to isolate and sever the sympathetic chain at the T3 level and the nerve of kuntz in Group A (Fig. 1) and at both the sympathetic chain T3 and T4 levels with nerve of kuntz in Group B (Fig. 2). We preserved sympathetic chain at T2 level in the two groups and isolate only the nerve of Kuntz at this level to avoid Horner syndrome from heat transmission to T1. Following TS, the lung was re-inflated under direct observation, while air was simultaneously removed from the pleural space after opening of the port air valve. The same procedure was performed on the opposite side. The incisions were sealed with absorbable sutures. Operative time and intraoperative complications were recorded.



(A) (B)

Fig. (1): (A) Cautery of the nerve of kuntz opposite T 2 and (B) Cautery of T3 sympathetic ganglia.

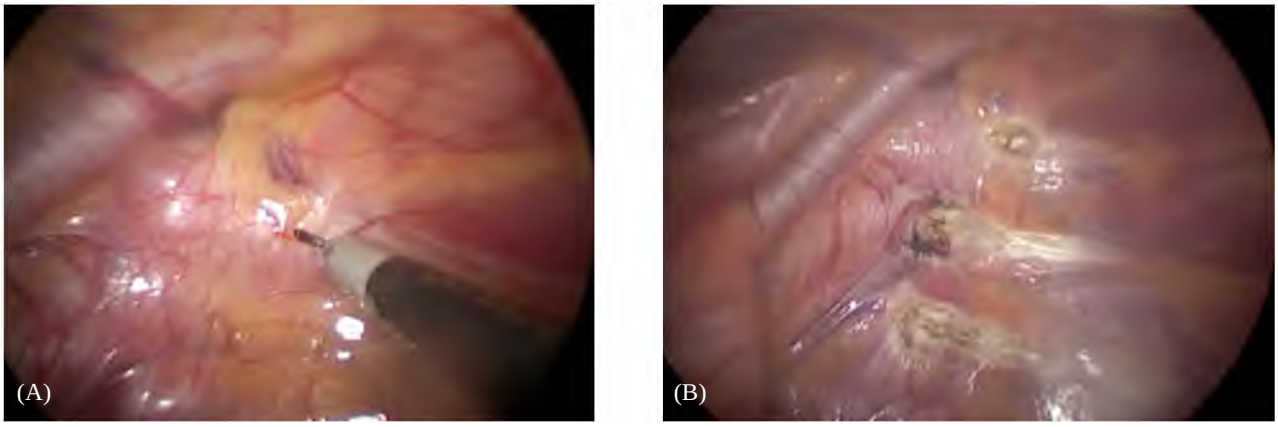


Fig. (2): (A) Cautery of nerve of kuntz and (B) After cautery of T3 and T4 ganglia Postoperative care.

After transferring all patients to the recovery room, they were all closely monitored in the internal ward.

Postoperative pain was assessed [via an eleven-point numerical rating scale (NRS), with 0 for no pain and 10 for the worst pain ever] at the recovery room, then every two hoursduring the initial eight hours after the operation, and then every four hours tillthe end of the first postoperative day ***[11]***.

Most patients were discharged from the hospital by the end of the firstpostoperative day unless complications were encountered. The incidence of complications including pneumothorax, hemothorax, andsurgical site infection was recorded.

Follow-up:

After stitch removal, follow-up visits were scheduled 1, 3, and six monthsafter the operation. The incidence of CHwas estimated. It was established while contemplating whether an individual would develop or endure worsening perspiration in areas of the body that were not present before the surgical procedure ***[7]***. Its location and severity were recorded as well. Severity was graded according to the Hyperhidrosis Disorder Severity Scale (HDSS) (four grades from one to four for minimal, mild, moderate, and maximal severity respectively ***[12]***. The incidence of recurrent hyperhidrosis was evaluated as well. Recurrence was defined as the reoccurrence of palm sweating in an individual whose palms were previously dry after the procedure ***[12]***.

Patient satisfaction with the procedure was graded according to a four grade Likert scale; dissatisfied, fair, very good, and excellent satisfaction ***[13]***.

The incidence of postoperative CH was the primary outcome while the secondary outcomes included operative time, procedure-related complications, duration of hospitalization, postoperative pain, patient satisfaction, and postoperative recurrence.

Sample size:

The required sample size was calculated using the IBM▾SPSS▾Sample Power▾version 3.0.1 (IBM▾ Corp., Armonk, NY, USA). A previous study reported that the incidence of CH after T3 sympathicotomy was 74.4% ***[14]*** and expected to be at least 28.3% with T3-4 sympathicotomy. With a power of 90%, a significance level of 0.05, group ratio 1:1 and two cases added to compensate drop-out, 25 cases were recruited in each group.

Statistical analysis:

SPSS v27 (IBM©, Armonk, NY, USA) were used for statistical analysis. The Shapiro-Wilks test and histograms were used to determine whether the data distribution was normal. Unpaired Student's *t*-test was used to analyze parametric quantitative data which were reported as mean and standard deviation (SD). The Mann-Whitney U test was used to assess non-parametric quantitative data, which were presented as median and interquartile range (IQR). The Chi-square test or Fisher's exact test were used to examine qualitative data, which were provided as frequency and percentage (%). A two-tailed *p* below 0.05 was deemed significant.

Results

In this study, a total of 63 patients were evaluated for eligibility. Of these, seven patients did not meet the inclusion criteria, and six patients declined to participate in the study. The remaining patients were randomly assigned to two groups, with 25 patients in each group. All patients who were allocated to the groups were followed-up and included in the statistical analysis. Fig. (3).

Demographic data were comparable between both groups. Operative time was significantly lower in group A than in group B (19.6±4.31 vs 24.2±5.53 min, p=0.002). Table (1).

NRS measurements at 0h, 2h, 4h, 8h, 12h, 20h, and 24h were comparable between both groups. Table (2).

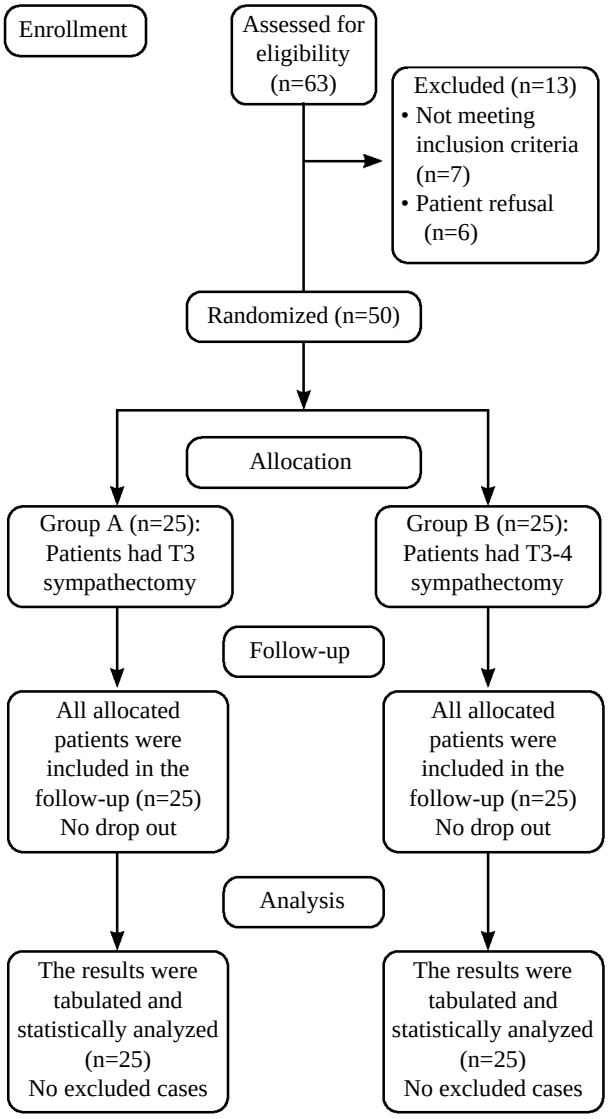


Fig. (3): CONSORT flowchart of the enrolled patients.

Table (1): Demographic data and operative time of the studied groups.

	Group A (n=25)	Group B (n=25)	*p*
Age (years)	26.32±5.34	24.64±4.86	0.251
Sex:			
Male	9 (36%)	7 (28%)	0.544
Female	16 (64%)	18 (72%)	
Weight (kg)	67.48±7.95	66.56±6.74	0.661
Height (cm)	166.4±7.27	167.48±6.36	0.579
BMI (kg/m^2)	24.39±2.56	23.85±2.99	0.497
ASA physical status:			
I	16 (64%)	18 (72%)	0.544
II	9 (36%)	7 (28%)	
Operative time (min)	19.6±4.31	24.2±5.53	0.002*

Data are presented as mean ± SD or frequency (%).
*: Significant as $p \leq 0.05$.
ASA: American Society of Anesthesiologists.
BMI: Body mass index.

Table (2): NRS of the studied groups.

	Group A (n=25)	Group B (n=25)	*p*
0 h	0 (0 - 1)	1 (0 - 1)	0.399
2 h	1 (1 - 2)	2 (1 - 2)	0.059
4 h	3 (2 - 4)	3 (2 - 4)	0.768
8 h	3 (2 - 4)	3 (2 - 5)	0.976
12 h	3 (2 - 4)	4 (2 - 5)	0.308
16 h	4 (2 - 5)	2 (2 - 3)	0.469
20 h	3 (2 - 4)	3 (2 - 5)	0.209
24 h	3 (2 - 4)	3 (2 - 5)	0.945

Data are presented as median (IQR).
NRS: Numerical Rating Scale.

The incidence and degree of postoperative CH were comparable at 1m, 3m, and 6m between both groups. Table (3).

Table (3): Postoperative CH of the studied groups.

	Group A (n=25)	Group B (n=25)	*p*
Incidence:			
1m	11 (44.0%)	14 (56.0%)	0.572
3m	10 (40.0%)	12 (48.0%)	0.776
6m	8 (32%)	9 (36%)	1
	N=11	N=14	
Degree at 1m:			
Minimal	2 (18.2%)	1 (7.1%)	0.822
Mild	5 (45.5%)	6 (54.5%)	
Moderate	3 (27.3%)	5 (45.5%)	
Severity	1 (9.1%)	2 (18.2%)	
	N=10	N=12	
Degree at 3m:			
Minimal	5 (50.0%)	2 (14.3%)	0.118
Mild	4 (40.0%)	3 (30.0%)	
Moderate	1 (10%)	6 (60.0%)	
Severity	0 (0.0%)	1 (10.0%)	
	N=8	N=9	
Degree at 6m:			
Minimal	6 (75.0%)	2 (14.3%)	0.060
Mild	2 (25.0%)	4 (50.0%)	
Moderate	0 (0.0%)	3 (37.5%)	
Severity	0 (0.0%)	0 (0.0%)	

Data are presented as mean ± SD or frequency (%).

The incidence of postoperative axillary sweating was significantly lower at 1m and 3m in group B than in group A (p=0.032 and 0.011 respectively) and was insignificantly different at 6m between both groups. Table (4).

Table (4): Postoperative axillary sweating of the studied groups.

	Group A (n=25)	Group B (n=25)	*p*
1m	21 (84.0%)	13 (52.0%)	0.032*
3m	17 (68.0%)	8 (32.0%)	0.011*
6m	11 (44%)	6 (76%)	0.135

Data are presented as frequency (%). *: Significant as $p \leq 0.05$.

Hospital stay and patient satisfaction were insignificantly different between both groups. Table (5).

Table (5): Hospital stay and patient satisfaction of the studied groups.

	Group A (n=25)	Group B (n=25)	*p*
Hospital stay (days)	1.16±0.47	1.24±0.52	0.573
Patient Satisfaction:			
Excellent	17 (68%)	13 (52%)	0.387
Very good	6 (24%)	7 (28%)	
Fair	2 (8%)	5 (20%)	
Dissatisfied	0 (0%)	0 (0%)	

Data are presented as mean ± SD or frequency (%).

Pneumothorax occurred in 1 (4%) case in group B and did not occur in any patient in group A. Subcutaneous emphysema occurred in 1 (4%) in group A and did not occur in any patient in group B while hemothorax did not occur in any patient in both groups. Recurrence occurred in 1 (4%) case in group B and did not occur in any patient in group A. Pneumothorax, subcutaneous emphysema, and recurrence were comparable between both groups. Hemothorax did not occur in any patient in either group. Table (6).

Table (6): Procedure-related complications and recurrence of the studied groups.

	Group A (n=25)	Group B (n=25)	*p*
Procedure-related complications:			
Pneumothorax	0 (0%)	1 (4%)	1
Subcutaneous emphysema	1 (4%)	0 (0%)	1
Hemothorax	0 (0%)	0 (0%)	–
Recurrence	0 (0%)	1 (4%)	1

Data are presented as frequency (%).

Discussion

PH is a physical disorder characterized by extreme perspiration in the hands. Its cause remains unclear, but it is commonly linked to an overactive sympathetic nervous system at its base, often resulting in the hyperactivity of sweat glands, which can be easily triggered by emotional responses *[15]*.

Currently, TS is the favored surgical method for treating PH. This procedure involves severing the chain of sympathetic thoracic nerves to interrupt the postganglionic fibers' transmission *[16]*. Various surgical techniques have been employed over the years, each yielding different outcomes *[17]*. Conventionally, the T2 ganglion was targeted as the primary site for innervation of the hands, leading to the majority of thoracic sympathectomies being performed at this location *[18,19]*. Despite this, a significant number of patients experience CH following T2 sympathicotomy, adversely impacting their quality of life *[20,21]*.

CH is the most frequent and troubling complication following sympathicotomy, and numerous strategies have been proposed to prevent its onset *[14]*. Chou and colleagues *[22]* suggested that CH might result from a reflexive reaction within the hypothalamus's sweating centers, although the precise mechanisms behind this phenomenon are still not fully understood. Lin's theory *[23]* suggests that alterations in sympathetic tone and disruptions in the hypothalamic reflex arc could stem from interventions on the upper thoracic sympathetic system.

Techniques such as blocking the lumbar sympathetic address plantar sweating or using iontophoresis and botulinum toxin injections for palmar sweating do not impact CH. These observations lend support to the idea that CH is related to the syndrome characterized by diminished sympathetic tone reflex response following sympathicotomy. It's believed that how well sympathetic tone is preserved and variations in sympathetic nerve supply may affect palmar sweating and the occurrence of CH differently among individuals *[24]*.

According to our results, the incidence and degree of postoperative CH were slightly higher and more severe in the bilevel (T3 – T4) group than the unilevel (T3) but without significant differences at 1m, 3m, and 6m between both groups.

The frequency of mild to moderate CH has been reported to be up to 89% in patients undergoing sympathicotomy. The severe type of CH, however, is more challenging to manage, less tolerable, and often more distressing for patients compared to their preoperative state. At present, no optimal therapy exists for CH, as conventional approaches often fall short of patient expectations *[25,26]*.

Multiple surgical techniques have been explored to decrease the CH rates. Many researchers believe that the occurrence and severity of CH are linked to the level and extent of the sympathicotomy. The removal of more sympathetic segments, particularly those involving T2, tends to result in a higher incidence of significant compensating reactions. Dewey et al. *[27]* found that limiting the HH resection to a single level can help by reducing substantial compensating reactions.

Research conducted by Reisfeld *[28]* indicates that as the surgical intervention ascends from lower to higher levels of the sympathetic nerve chain, additional nerve fibers are encountered, expanding the area of sympathetic denervation. Consequently, the higher the point of surgical intervention, the more extensive the sympathetic disruption, and the more severe the resulting CH. Based on the anatomical

features of the chain of sympathetic thoracic nerves, minimizing the extent of the nerve chain removal could help in narrowing and lessening the intensity of the sympathetic denervation caused by surgery, thereby making the denervation effects more precise [29]. Turhan and colleagues [21] conducted a comparison between T2 and T3 sympathectomies, recommending the avoidance of T2 ganglion denervation to reduce the likelihood of CH. Following this advice, sympathicotomy procedures at the T3 and T4 levels have become prevalent due to their association with lower rates of complications, including CH.

In a recent study, Xie [30] compared the correlation between PH and axillary and plantar sweating and the effects of T3 and T4 TS. The study retrospectively analyzed 100 PH patients who underwent either T3 (group A, included 49) or T4 (group B, included 51) TS. At discharge, both groups experienced no significant problems or fatalities. A significant difference in hand sweating levels was detected in all patients in T 4 group (p=0.031) compared to 44 out of 49 patients in T 3 group A. CH developed in 18 (36.7%) and 4 (7.8%) patients in T3 groups and T4 respectively after a 12-month monitoring. Furthermore, axillary sweating improved in 16 (48.5%) and 24 (77.4%) patients in T 3 and T4 groups respectively, with a difference that is statistically significant (p<0.05). T 4 group had a significantly higher satisfaction rating in comparison to T 3 group (p<0.01).

In randomized research, PH was subjected to either T2 or T3 levels of TS.In the T2 group, the success rate was one hundred percent, while in the T3 group, it was 97%; the CH incidence was 100% and 97%, respectively [31]. Another study comparing TS at T2-T4 levels with T3-T4 levels for PH found an insignificant difference between the two groups [32]. In addition, Wolosker et al. observed that reducing denervation magnitudes from T3 to T4 reduced the incidence of severe CH [33]. According to another hypothesis, once HH is eliminated in the targeted area, the body compensates by increasing additional locations of perspiration to conserve an overall equilibrium of sweating. This suggests that the more intense the sweating in the hands before surgery, the more the sweating is redirected to other areas after surgery, resulting in more severe CH, a finding that is consistent with previous research [34]. Our study is the first one that compares unilivel versus bilevel TS.

Abd Ellatif et al. [14] reported that mild to moderate CH comprises 64.4% of the T3 group and 26.9% of the T4 group, respectively (p=0.001). There were two patients (1.4 %) in the T4 group who exhibited severe CH, while there were thirteen patients (10%) in the T3 group (p=0.001). In the T4 group, a far greater proportion of patients (25.6% vs. 71.7%; p=0.001) did not have CH.

In our study, the incidence of postoperative axillary sweating was significantly lower at 1m and 3m in group B than in group A (p=0.032 and 0.011 respectively) and was comparable at 6m between both groups. Hospital stay and patient satisfaction were comparable between both groups. Pneumothorax, subcutaneous emphysema, and recurrence were comparable between both groups. Hemothorax did not occur in any patient in either group.

The complications associated with TS have been documented in earlier studies and encompass recurrence, intercostal neuralgia, CH, pneumothorax, Horner syndrome, hemothorax, and surgical site infection. In our research, there were no occurrences of Horner syndrome, Infection of the operative site, or hemothorax. Pneumothorax was observed in 1 (4%) patient in group B, while it did not occur in group A.

Research has indicated that the recurrence of PH may be attributed to The regeneration of sympathetic nerves to the stellate ganglion or partial sympathicotomy [30]. Other potential causes include irregular recognition of the sympathetic chain due to anatomical dissimilarities, adhesions, or localized pleural thickening, in our study, we observed that 1 (4%) patient in group B experienced a PH recurrence during the six-month monitoring, whereas all patients in group A attained satisfactory results.

Limitations of this study include a relatively small sample size, a single-center design, and a limited follow-up period. Therefore, additional multicenter studies with larger sample sizes and extended follow-up periods are necessary to verify our results.

Conclusions:

Both the bilevel (T3-T4) and unilevel (T3) approaches were safe and effective for treating patients with PH with comparable incidence of CH while postoperative axillary sweating was more prevalent in the unilevel (T3) group making bilevel more suitable for patients with axillary sweating.

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Conflict of Interest: Nil.

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كى العصب السمبثاوى على مستوى واحد (العقدة السمباثاوية الصدرية الثالثة) ام على مستويان (العقدة السمباثاوية الصدرية الثالثة والرابعة) لعلاج فرط تعرق كف اليدين وهل يؤثر على نسبة حدوث وشدة العرق العويضى بعد العملية

مقدمة: يعد كى العقد السمباثاوية الصدرية عن طريق المنظار الجراحى الطريقة المثلى لعلاج فرط تعرق كف اليدين وذلك بسبب الطبيعة الغير غازية مما يؤدى إلى نسبة أقل من المضاعفات.

العرق التعويضى بعد الجراحة يعد من أكثر المضاعفات وأكثرها اثارة للقلق وتم اتباع طرق جراحية عدة لمنع حدوثه بعد جراحات كى العصب السمبثاوى.

الهدف من الدراسة: هو مقارنة نسبة حدوث العرث التعويضى بعد كى العصب السمبثاوى على مستوى واحد (العقدة السمباثاوية الصدرية الثالثة) ام على مستويان (العقدة السمباثاوية الصدرية الثالثة والرابعة) لعلاج فرط تعرق كف اليدين.

الخطة البحثية: تم إجراء هذه الدراسة على ٥٠ من المرضى تم تشخيصهم بفرض التعرق بكف اليدين بأعمار أكبر من ١٨ عام وتم تقسيم المرضى إلى مجموعتين. المجموعة الأولى يتم فيها كى العقدة السمباثاوية الصدرية الثالثة فقط والمجموعة الثانية يتم فيها كى العقدة السمباثاوية الصدرية الثالثة والرابعة.

النتائج: لا يوجد اختلاف كبير فى نسبة حدوث العرق التعويضى بعد الجراحة بين المجموعتين وتم ملاحظة ذلك فى المتابعة الدورية للمرضى بعد إجراء العملية فى الشهر الأول والثالث والسادس.