



## **Protecting 2nd Thoracal Sympathetic Ganglion Decrease Compensatory Sweating in Palmar Hyperhidrosis?**

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### **Authors' contributions**

*This work was carried out in collaboration between all authors. Author MO designed the study, wrote the protocol and wrote the first draft of the manuscript. Author HY managed the literature searches, analyses of the study performed the spectroscopy analysis and Author GSS managed the experimental process. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Aims:** The aim of this retrospective study was to compare the outcomes of T2 protected and T2 included video-assisted thoracoscopic sympathectomy for palmar hyperhidrosis.

**Place and Duration of Study:** Department of Thoracic Surgery, Selcuk University Medical Faculty, Research and Educational Hospital, between January 2007 and January 2018.

**Methodology:** 278 patients were reviewed who got surgical sympathectomy for hyperhidrosis. They were divided into two groups, in first group we transected sympathetic chain on level the third rib (T3) and we preserved the sympathetic chain on level the second rib (T2), in second group we transected the sympathetic chain totally on T2 and T3 level. For all patients blood tests were studied for endocrine diseases such as hyperthyroidism, pheochromocytoma and Cushing's syndrome. The surgery was performed by opening the parietal pleura, identifying the sympathetic chain and

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dividing communicating branches using cautery. Postoperative complications were recorded.

**Results:** The mean follow-up period was 9 months. Most of the patients presented an improvement in palmar hyperhidrosis, without any difference between the groups. The initial satisfaction rate was 97,7% (n=176) in T2 protected group while in T2 included group was 96,9% (n = 95). Postoperatively, compensatory sweating was present in 13 (13,2%) patients of the T2 included group and in 10 (5,5%) patients in the T2 protected group. In addition, compensatory sweating was less severe in the T2 protected patients. There were no mortality or significant postoperative complications in this study.

**Conclusion:** Both techniques are effective for treating palmar hyperhidrosis, but T2 protected sympathectomy decreases the rate and severity of compensatory sweating.

*Keywords: Primary hyperhidrosis; sympathectomy; surgery; thoracoscopy.*

## 1. INTRODUCTION

Essential (primary) hyperhidrosis is an important problem that may lead to serious emotional and occupational disturbances. It is a sympathetic disorder characterized by excessive sweating. Hyperhidrosis affects between 0.5 - 1% of the general population and it is a problem of sympathetic dysregulation that may have an underlying genetic component [1]. Symptoms generally begin in childhood or early adolescence and rarely improve with age. To control their sweating, patients initially try nonsurgical conservative therapies, such as systemic anticholinergic drugs, psychotherapy or botulinum toxin injections, topical agents, and iontophoresis [2-3].

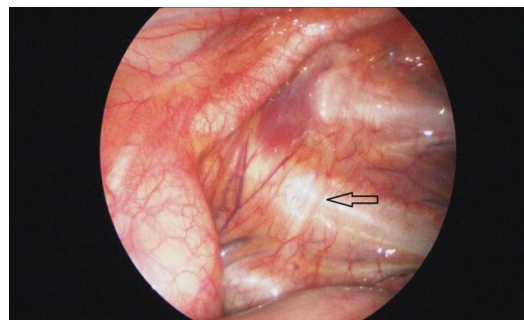
Sympathectomy is one of the most safe and effective treatment choices for essential hyperhidrosis. Surgical sympathectomies have been carried out since the 1900s [4]. Currently, the advancement in minimally invasive techniques revolutionized sympathetic surgery, allowing the surgeon to view the sympathetic ganglia through a small incision. (Fig. 1) Video-assisted thoracoscopic sympathectomy (VATS) is now the first line procedure chosen by surgeons for the treatment of hyperhidrosis. It is considered to be safe and successful in almost 98% of cases, since only 1-2% of patients experience recurrence of their hyperhidrosis [5]. However, compensatory sweating (CS) is a common complication of this procedure.

In this retrospective study we aimed to present the outcomes of our surgical experience in the management of palmar hyperhidrosis.

## 2. MATERIALS AND METHODS

Between January 2007 and January 2018, a total of 278 consecutive patients treated for palmar hyperhidrosis with VATS were retrospectively reviewed. Local ethical committee approved for

the study and informed consents from the patients were obtained. During the assessment, the patients were divided into 2 groups according to the level of sympathectomy: First group consisted of patients of whom sympathetic chain was transected completely at the level of the third (T3) rib bed and the second (T2) rib bed was preserved during surgery. And the second group consisted of patients of whom the sympathetic chain was transected completely at the level of the both T2 and T3 rib bed. The ganglion was left intact in all patients in both groups. Selection criteria included absence of previous thoracic surgery, repercussion on social life and professional activity, alteration of intimate relationship, inefficacy of medical treatment, patient motivation and determination. Preoperatively, all patients were investigated in terms of endocrine diseases such as hyperthyroidism, pheochromocytoma and Cushing's syndrome.



**Fig. 1. The sympathetic chain (The arrow shows T3 sympathetic ganglion)**

Each patient signed an informed consent after having been carefully informed about the possible side effects such as: Transient CS, interscapular pain, Horner's syndrome, pneumothorax and hemothorax. None of the patient was premedicated. After admission to the operating room standard monitoring consisting of

pulse oxymeter (SpO<sub>2</sub>), non-invasive blood pressure (NIBP) and a continuous electrocardiogram were applied. Anesthesia induction was achieved with 2 mg/kg of propofol, 0.5 mg/kg of rocuronium, and 2 mcg/kg of fentanyl. Total intravenous anesthesia (TIVA) was maintained with propofol 50 µg/kg/min and remifentanyl 0.1 µg/kg/min. One-lung ventilation was administered, using a double-lumen endotracheal tube. Invasive arterial monitorization was achieved to all patients after induction. Surgery was performed with the patients in semi-Fowler's position with arms abducted.

Thoracoscopic ports were placed respectively, in the fourth intercostal space on anterior axillary line. The lung was collapsed by CO<sub>2</sub> insufflation into the pleural cavity. The surgical technique usually consisted of opening the parietal pleura, identifying the sympathetic chain and dividing communicating branches using cautery (Fig. 2). Additionally, electro cautery ablation of accessory branches and Kuntz nerve (when present) was performed in all cases to prevent relapses. Postoperative chest radiography was performed routinely. Patients were followed up for a mean of 9 (6-24) months postoperatively. Evaluation included the success of the hyperhidrosis treatment, and the presence, location, and severity of CS. Postoperative complications such as CS, wound infection, chest pain, Horner's syndrome, hemo-pneumothorax were recorded. Chi-square test was used for comparison of nominal data. Significance level was considered as 0,05.

### 3. RESULTS

Demographic data of the patients are presented in table 1. There was no difference between the two groups in terms of demographic data.

There were no mortality and significant postoperative complications in this study and none of the patient was re-operated. No recurrence of palmar hyperhidrosis was reported at the follow-up periods in either of the groups. All of the patients presented an improvement in palmar hyperhidrosis, without any difference between the groups. Rate of complications in both groups were similar except for CS. Postoperatively, CS was present in 13 (13,2%) patients of the T2I group and in 10 (5,5%) patients of the T2P group ( $p < 0.05$ ). The areas of CS varied among patients. CS occurred in abdominal and gluteal region, anterior thoracic

wall and gluteal region only, in 13, 7 and 3 patients, respectively.



**Fig. 2. Dividing communicating branches using cautery**

A total of 3 patients had local wound infection (one in group T2P and 2 in group T2I - NS) and local wound healing was achieved with appropriate antibiotic therapy and local debridement. A total of 7 patients (2,5%) in both groups (4 T2I group, 3 T2P group - NS) developed pneumothorax and most of them were reabsorbed spontaneously and did not need further intervention. However, 3 patients (1,1%) required chest tube drainage. Temporary Horner's syndrome was observed in one patient in T2I group (0.50%) and this complication was completely resolved spontaneously within 2 weeks after operation. There was hemothorax for one patient (Table 1). Two patients in T2P group (1%) experienced hyperesthesia at the incision area. One patient complained of intercostal pain in T2P group that lasted approximately 1 year. Most of the patients were discharged within 24-48 hours after operation. Pneumothorax occurred in 7 patients and 5 of them discharged on the 4<sup>th</sup> postoperative day and 2 patients were discharged on the 10<sup>th</sup> postoperative day due to the persistent air leakage.

### 4. DISCUSSION

Primary hyperhidrosis is characterized by increased sympathetic activity at the upper thoracic ganglia. Several authors have described greater prevalence of palmar hyperhidrosis among women than men [6,7]. In contrast, according to some authors, there is no evidence for any difference in the prevalence of palmar hyperhidrosis between the genders [1]. Women usually seek treatment more frequently and therefore end up undergoing sympathectomy more often [8]. This is probably because of greater discomfort relating to esthetics as

**Table 1. Patients characteristics**

Patients characteristics		T2P Group	T2I Group
Gender	Male	82 (45,5%)	40 (40,8%)
	Female	98 (54,5%)	58 (59,1%)
Age mean (min-max) (years)		24,1 (14-56)	26,9 (15-57)
Satisfaction rate		176 (97,7%)	95 (96,9%)
Complications	Compensatory sweating	10 (5,5%)	13 (13,2%)
	Pneumothorax	3 (1,6%)	4 (4%)
	Wound infection	1 (0,5%)	2 (2%)
	Horner's syndrome	0	1 (1%)
	Hemothorax	1(0,5%)	0
Mortality		0	0

compared to men. There was no significant difference between genders (156 female versus 122 male) in our study. Similar to other studies on this subject, most of our patients initially showed symptoms during childhood and more than half had evidence of family distribution and history [9]. Because of the early clinical presentation for individuals with hyperhidrosis, most studies have assessed very young populations, usually in their second and third decades of life. In our study, the patients were also young, with a mean age of 24,1 years (T2P group) and 26,9 years (T2I group).

Although hyperhidrosis is a benign disorder and does not affect health, daily and social activities are affected. Therefore, a cure is usually desired. Conservative medical treatments (ie, anticholinergic drugs, psychotherapy or botulinum toxin injections) are not always effective and often requires repeated courses of therapy that can be dismantling on the long run [1-3]. Significant improvement in the quality of life can result from the surgery for hyperhidrosis. For many years, it was believed that the ideal treatment for palmar hyperhidrosis would be sympathectomy. However, patients with hyperhidrosis had the greatest relief from surgery. In such cases, VATS has become established as a safe, esthetic and effective minimally invasive method, with a success rate greater than 95% in most series [10]. Since the introduction of video-assisted thoracic surgery in the early 1990s and as a result of improved telescopes and video imaging technology, VATS has become a standard therapy for hyperhidrosis worldwide [11]. With the use of thoracoscopy equipment enabling small incisions and less surgical trauma, this surgical procedure has largely come to present excellent results, with low morbidity, rapid postoperative recovery, and imperceptible scars [12].

VATS can be performed by different surgical and anesthetic techniques, yet the degree of patient's compliance and satisfaction for such a procedure must be taken into account. As far as the type of anesthesia is concerned, this type of procedure usually requires single-lung ventilation to collapse the lung under general anesthesia even though more recently some authors have slowly discontinued the use of double-lumen tubes in favor of simple orotracheal catheters [7]. Maintaining the subsequent collapse of ipsilateral lung is usually achieved by the technique of one-lung ventilation. Both of these techniques can be preferred in appropriate patients.

The use of CO2 insufflation undoubtedly enhances visualization by displacing the lung and expediting the procedure; however, the report of serious complications has prevented us from using this type of aid [13]. As previously reported by Garcia and Espania in all cases via VATS: one or more ganglia between T2 and T5 are usually resected depending on the area affected by hyperhidrosis [14]. They recommend intervention on the T2 ganglia for facial hyperhidrosis and rubor, on the T3 ganglia for palmar hyperhidrosis and on the T3 and T4 ganglia for axillary hyperhidrosis. The effectiveness of the surgery can be evaluated by palmar skin temperature [15].

However, CS remains the most common and most disabling complication of VATS [16]. In most patients, a mild variation of increased sweating is an unavoidable consequence of sympathectomy to ensure the ablation of abnormal sweating of the palms. Nevertheless, severe CS may occur postoperatively in up to 10-40% of patients [17]. These discrepancies, although small, may be caused by differences in the definition and assessment of symptom severity. In this study, 8,2% (13% T2I group,

5,5% T2P group) of the patients presented CS. The body area affected by CS is another important point. The CS observed in our study was distributed in the body in the same way as described in the literature (ie, chest, abdomen, back, feet, and gluteal region) [16]. In most patients, it is tolerable and does not lead to social or occupational disturbances. Still, patients must always be warned before the surgery about the possibility of this complication [18].

Various methods have been evaluated to decrease the occurrence rates and severity of CS. The most important point is the number and level of excised ganglia. There seems to be a correlation between the CS and the extent and level of the sympathectomy. Several authors limited the extent of resections for hyperhidrosis to a single level to decrease the incidence of severe compensatory symptoms [12,19,20]. Neumayer et al and Choi et al reported their series of T4 sympathetic block for palmar hyperhidrosis [21,22]. The success rates were 100%, and the CS rates were 8% and 3%, respectively. Bonjer et al reported on a series in which only the T3 was resected and, thus, decreased CS [23]. In addition, the severity of CS might be reduced by limiting the extent of the denervation. When denervation is restricted, CS is expected to be mild [24]. On the other hand, some authors argue that limited sympathectomy does not reduce the incidence and severity of this complication [8]. In our studies, we found that 13% of the patients in the T2I group and 5,5% in the T2P group presented this complication after operations. Kuntz's fibres which usually cross the 3rd and 2nd thoracic ganglion, but sometimes they directly reach the brachial plexus running outside the main trunk and then these fibres should always be searched and when identified they should be sectioned selectively. Lin and Telaranta assumed that compensatory hyperhidrosis could be secondary to the interruption of the afferent fibres to the anterior part of the hypothalamus [25]. Dierent degrees of postoperative sweating have been found after dierent levels of sympathectomy. For example, severe reflex sweating is expected with the T2 procedure, whereas an unknown amount or no reflex sweating is found with the T4 procedure [26].

Shelley and Florence explained the phenomenon of CS after sympathectomy as a thermoregulatory function [27]. The sympathetic nervous fibers originate from the intermediolateral horns of the spinal cord between T1 and L2. Nervous impulses from the

target organs are transmitted as afferent negative feedback signals to the central nervous system, from where the efferent positive feedback signals return to the target organ. This system means that T2 interruption stops most negative feedback signals from T2 and below and provides the strongest positive feedback signal. Therefore, the efferent positive feedback signals to the sweat gland are strong and most severe CS results. T3 ganglionic interruption disrupts fewer afferent negative feedback signals, thus efferent positive feedback signals are weaker and CS is less severe. T4 interruption causes the least or almost no CS, because most of the afferent negative feedback signals are preserved. CS occurs in 30–70% of patients after T2, 17–25% after T3, and 3–8% after T4 sympathetic block [21]. According to many studies, the higher the level of ganglionic blockage (ie, T2 or T3), the greater the incidence of severe compensatory symptoms [28]. In other words, inclusion of T2 ablation results in significantly more severe CS than other levels not incorporating T2 [12].

Horner's syndrome has become a rare complication currently because the method has developed, surgical teams have become more experienced and video equipment providing adequate viewing of the sympathetic chain is now used. Its occurrence is limited to cases of indirect lesion of the stellate ganglion (T1) due to heat diffusion or excessive traction of the chain [29]. Heat transmission during this procedure led to the appearance of Horner's sign, but it had completely regressed by the time of the one-month follow-up. In our study, temporary Horner's syndrome was observed in a patient in T2 included group and this complication was completely resolved spontaneously within 2 weeks after operation.

## 5. CONCLUSION

VATS is a safe and effective treatment for palmar hyperhidrosis [30,31]. Recurrence rates are low and patient satisfaction is high. However, the incidence of post-operative CS is also high. In most cases, it is tolerable and does not represent a social or occupational disturbance. The incidence of postoperative CS appears to be dependent on the level and extent of the sympathectomy performed. In our experience, protecting the T2 ganglion results in less severe CS. Because of the lower severity of CS, we prefer the T2P method for treating palmar hyperhidrosis.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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