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**Case Report**

# Extended T4–T12 thoracoscopic sympathectomy as a salvage strategy for severe compensatory sweating: report of two cases and literature review

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## ABSTRACT

Severe compensatory sweating (CS) represents the most disabling long-term adverse effect of endoscopic thoracic sympathectomy (ETS) for primary focal hyperhidrosis or facial blushing, often causing catastrophic impairment in quality of life. Medical therapies (systemic anticholinergics, topical agents, and botulinum toxin) demonstrate limited efficacy and frequent adverse effects. Although nerve reconstruction procedures exist, their technical complexity and unpredictable reinnervation limit widespread utility. We evaluated bilateral video-assisted thoracoscopic extended T4–T12 sympathectomy as a surgical salvage strategy for severe, refractory CS. We report two patients with incapacitating, refractory CS following remote upper ETS. Case 1, a 45-year-old female initially operated on for facial blushing (T2–T3 sympathicotomy), developed massive CS involving the trunk, lumbar region, hips, and groin. case 2, a 50-year-old hypertensive male operated on for primary palmar hyperhidrosis (T2-T4 sympathicotomy), presented with severe truncal, gluteal, and plantar CS requiring multiple daily clothing changes. Both patients failed multimodal conservative therapies (high-dose oral oxybutynin). Both underwent uneventful bilateral extended T4-T12 video thoracoscopic sympathectomy (VTC) utilizing a two-port (5-mm) approach per hemithorax without chest drainage. Both were discharged within 24 hours. At 6 months postoperatively, both achieved marked symptomatic reduction and dramatic improvements in Hyperhidrosis Disease Severity Scale (HDSS) scores. At 12 months, Case 1 experienced partial compensatory recurrence of moderate intensity, whereas case 2 maintained persistent symptom control and high satisfaction. Bilateral extended T4-T12 thoracoscopic sympathectomy represents a feasible, safe, and potentially effective surgical salvage strategy in highly selected patients suffering from severe, refractory CS. However, because symptomatic recurrence or incomplete resolution may occur, realistic preoperative counseling and further prospective clinical trials are warranted.

**Keywords:** Compensatory sweating, Thoracoscopic sympathectomy, Extended sympathectomy, Video-assisted thoracoscopic surgery, Salvage surgery, Hyperhidrosis

## INTRODUCTION

Primary focal hyperhidrosis is a disabling neurovegetative autonomic disorder characterized by excessive, unpredictable eccrine sweat production that substantially exceeds physiological thermoregulatory demands.[1,2] Although focal manifestations predominantly involve the palmar, axillary, craniofacial, and plantar surfaces, combined multi-site presentations occur in 50% to 95% of patients 1-3. The diagnosis is predominantly clinical, established through detailed patient history, functional questionnaires, and validated semi-quantitative tools such as the Hyperhidrosis Disease Severity Scale (HDSS). Objective mapping techniques, such as the Minor iodine-starch test, remain invaluable for delineating the geographic margins of active sweat production and assisting in surgical planning.[4]

Endoscopic thoracic sympathectomy (ETS) is firmly established as the definitive gold standard for severe primary palmar and axillary hyperhidrosis refractory to conservative therapies, demonstrating immediate procedural success rates exceeding 95%.[1,5] However, the management of concomitant plantar sweating remains challenging. While upper thoracic sympathectomy occasionally yields serendipitous improvement in plantar sweating due to sympathetic cross-talk, results are erratic and unpredictable.[2,4] Conversely, retroperitoneal endoscopic lumbar sympathectomy (ELS), although highly effective for plantar hyperhidrosis, is technically demanding, requires retroperitoneal dissection, and carries substantial autonomic risks, most notably retrograde ejaculation in males and lower-extremity neuralgia.[3,7]

The major limitation and dreaded complication of thoracic sympathectomy is compensatory sweating (CS), also designated compensatory hyperhidrosis.[5,8] CS manifests as secondary hyperhidrosis in previously unaffected cutaneous territories-predominantly the back, abdomen, thighs, buttocks, groin, and lower extremities.[8,9] While mild CS is tolerated by most patients, severe CS affects 3% to 10% of surgical cohorts, precipitating profound social embarrassment, occupational disruption, psychiatric morbidity, and bitter surgical regret.[5,8,10] First-line conservative management-encompassing systemic oral anticholinergics (such as glycopyrrolate and oxybutynin), high-concentration topical aluminum salts, iontophoresis, and intradermal botulinum toxin type A-routinely fails to provide durable, satisfactory relief in severe widespread forms, often limited by systemic antimuscarinic side effects (xerostomia, blurred vision, urinary retention, cognitive disturbances).[7-11]

Reconstructive microsurgical reversal of the sympathetic chain utilizing sural nerve, intercostal nerve, or phrenic nerve grafts has been explored in specialized centers; however, these techniques require complex micro anastomoses, carry prolonged operative times, and yield highly unpredictable axonal regeneration and variable clinical recovery.[12,13] Recently, extending the caudal boundary of thoracic sympathetic ablation down to the lower thoracic levels (T10-T12) has emerged as an innovative concept.[14-16] Originally proposed by Elalfy et al to encompass preganglionic fibers supplying the splanchnic and pelvic plexuses in primary palmo-axillo-plantar hyperhidrosis, extended caudal denervation raises the intriguing hypothesis of whether ablating lower thoracic segments can down-regulate sudomotor outflow to the lower trunk and pelvis, thereby acting as a salvage procedure for established, refractory CS.[10,14-16]

Herein, we describe two cases of incapacitating, medically refractory CS following remote upper ETS, successfully managed with bilateral extended T4-T12 video thoracoscopic sympathectomy (VTC) as a salvage strategy. We detail the operative technique, perioperative course, 12-month outcomes, and discuss the neuroanatomical rationale and clinical implications based on a comprehensive literature review.

## CASE REPORTS

### *Study design and ethical approval*

This study was designed as an observational, descriptive, retrospective two-case series with literature review. The protocol was reviewed and approved by the Institutional Ethics Committee of Clínica INDISA (Santiago, Chile). Both patients provided written informed consent for the surgical interventions, photograph acquisition, and the academic publication of their clinical data.

### *Patient population and preoperative evaluation*

Eligible patients were adults presenting with severe, debilitating CS following remote thoracic sympathectomy. Severity was documented clinically and graded using the Hyperhidrosis Disease Severity Scale (HDSS score 4: 'Sweating is barely tolerable and constantly interferes with daily activities'). Both patients had undergone anticholinergic treatment without success. Preoperative evaluation included complete cardiopulmonary clearance, chest radiography, autonomic symptom inventory, and photographic mapping of cutaneous sweat distribution.

### *Surgical technique*

Procedures were conducted under general anesthesia using single-lung ventilation achieved via a double-lumen endotracheal tube (or bronchial blocker). Patients were placed in the semi-Fowler/reverse Trendelenburg position (30° elevation) with both arms abducted at 90° on arm boards to expose bilateral axillary vaults. A bilateral video thoracoscopic (VTC) approach was executed sequentially.

For each hemithorax, two 5-mm thoracoscopic ports were placed: the optical port in the 5th intercostal space along the anterior axillary line, and the working instrument port in the 4th intercostal space along the mid-axillary line. Under direct 30° endoscopic visualization, the parietal pleura was inspected. The sympathetic chain was identified traversing the heads and necks of the ribs along the posterior thoracic wall. Rib numbering was meticulously confirmed by identifying the second rib and counting caudally to the diaphragm (T12). The sympathetic chain, associated ganglia, and adjacent accessory nerve fibers from the lower border of T4 continuously down to T12 were isolated and ablated using hook electrocautery and energy-based thermal ablation across the rib periosteum. Meticulous hemostasis was achieved. No indwelling pleural drains were placed. The identical procedure was performed sequentially on the contralateral hemithorax.

**Table 1: Clinical characteristics, surgical parameters, and longitudinal outcomes of patients treated with extended T4-T12 thoracoscopic sympathectomy.**

| Clinical and surgical variables | Case 1 | Case 2 |
|---|---|---|
| **Age/biological sex** | 45 years/female | 50 years/male |
| **Comorbidities** | None | Essential hypertension (controlled) |
| **Primary surgery (year/indication)** | 2016/facial blushing | 2014/primary palmar hyperhidrosis |
| **Primary ETS ablation level** | Bilateral T2–T4 sympathicotomy | Bilateral T2–T4 sympathectomy |
| **Onset of compensatory sweating (CS)** | 16 months post-primary ETS | 12 months post-primary ETS |
| **Primary anatomical sites of CS** | Back, lumbar region, hips, groin | Back, gluteal crease, groin, plantar |
| **Baseline HDSS score** | 4 (Severe / Intolerable) | 4 (Severe / Intolerable) |
| **Failed conservative therapies** | High-dose oxybutynin, AlCl3 lotion | High-dose oxybutynin, topical glycopyrronium, AlCl3 lotion |
| **Salvage surgical procedure** | Bilateral VATS extended T4–T12 sympathectomy | Bilateral VATS extended T4–T12 sympathectomy |
| **Port configuration** | Two 5-mm ports per hemithorax | Two 5-mm ports per hemithorax |
| **Operative time (total)** | 75 minutes | 80 minutes |
| **Intraoperative blood loss** | <15 mL | <15 mL |
| **Indwelling pleural drainage** | None (aspiration under Valsalva) | None (aspiration under Valsalva) |
| **Postoperative hospital stay** | 24 hours | 24 hours |
| **Perioperative complications** | None (no pneumothorax, no Horner syndrome) | None (no pneumothorax, no Horner syndrome) |
| **6-month outcome/HDSS** | Marked improvement / HDSS 1 | Marked improvement / HDSS 1 |
| **12-month outcome/HDSS** | Mild partial recurrence / HDSS 2 | Mild partial recurrence / HDSS 3 |
| **Patient satisfaction at 12 months** | Tempered by a slight recurrence | Tempered by a slight recurrence |

*Case 1*

A 45-year-old female, school teacher, with no prior medical comorbidities, presented with incapacitating compensatory sweating. In 2016, she had undergone bilateral upper endoscopic thoracic sympathectomy (T2–T4 sympathicotomy) for severe facial blushing. Sixteen months postoperatively, she developed progressive, profuse sweating over her upper back, lumbar region, buttocks, hips, and bilateral inguinal folds. She reported soaking through three to four outfits daily, requiring continuous towel padding under her garments, causing profound social distress, work absenteeism, and severe emotional exhaustion (HDSS score 4).

Prior to surgical consultation, she had undergone extensive multimodal medical therapy over 6 years. High-dose oral oxybutynin (15 mg/day) produced intolerable side effects, including severe xerostomia, blurred vision compromising driving, and refractory constipation, with minimal sweat reduction. Topical aluminum chloride hexahydrate (20%) elicited severe irritant contact dermatitis across the lumbar region. Physical examination and Minor starch-iodine testing confirmed extensive, confluence-pattern eccrine hypersecretion across the thoracolumbar spine, gluteal crests, and inguinal creases.

Given the refractory nature of the symptoms and catastrophic impairment in quality of life, the patient was offered bilateral salvage extended T4-T12 thoracoscopic sympathectomy. In March 2025, she underwent the procedure under general anesthesia with double-lumen intubation. Total blood loss was negligible (<15 ml). Intraoperative neuromonitoring and post-re-expansion lung inspection demonstrated full lung expansion without air leak. No chest tubes were installed. The patient recovered smoothly in the post-anesthesia care unit and was transferred to the surgical floor. Postoperative pain was managed with oral paracetamol and celecoxib. Postoperative chest radiography confirmed clear lung fields without pneumothorax or hemothorax. She was discharged home within 24 hours of surgery.

At the 1-month and 6-month postoperative follow-up evaluations, the patient demonstrated dramatic clinical improvement. The massive sweating across the back, lumbar region, and hips was abolished, leaving only faint, intermittent perspiration during vigorous exercise. Her HDSS score improved from 4 to 1 ('Sweating is never noticeable and never interferes with daily activities'). She reported restored self-confidence and returned fully to social and teaching activities. At 12 months, however, she reported a mild-to-moderate partial recurrence of sweating across the mid-dorsal spine, particularly during hot summer days. Despite this recurrence, she emphasized that the volume of sweat was markedly attenuated compared to her debilitating baseline status (HDSS score 2: 'Sweating is tolerable but sometimes interferes with daily activities'), requiring no clothing changes, and she maintained high overall satisfaction with the surgical outcome.

*Case 2*

A 50-year-old male, civil engineer, with a history of primary hypertension well controlled with enalapril (10 mg daily), presented with severe truncal, pelvic, and lower-extremity CS. In 2014, he had undergone bilateral upper thoracic sympathectomy (T2-T4 ablation) for severe primary palmar hyperhidrosis. While palmar sweating was permanently resolved, within 12 months he developed devastating secondary compensatory sweating predominantly localized to the mid- and lower back, gluteal crease, groin, popliteal fossae, and bilateral soles (plantar hyperhidrosis).

The patient was forced to change shirts and underwear four to five times per day during office work, wore dark double-layered clothing. His baseline HDSS score was 4.

In 2024, the patient underwent bilateral extended T4-T12 VTC sympathectomy as a salvage procedure. The sympathetic chain was traced and electrocauterized over ribs 4 through 12 bilaterally without technical difficulties or diaphragmatic injury. The lungs were re-expanded under positive pressure, and ports were closed without indwelling pleural drains. The postoperative recovery was entirely uneventful; a routine postoperative chest X-ray excluded residual pneumothorax, and the patient was discharged at 24 hours post-procedure.

Their HDSS score decreased from 4 to 1 at 6 months; however, it rose to 3 by the 12-month follow-up, without reaching the baseline value. Furthermore, no compensatory hyperhidrosis in new anatomical areas was reported during this period.

## DISCUSSION

This paper describes two cases of severe compensatory sweating following a prior thoracoscopic sympathectomy, which were treated using an extended bilateral thoracoscopic sympathectomy (from T4 to T12) as a salvage surgical strategy. Both patients presented with high-intensity symptoms that significantly impacted their quality of life and showed no satisfactory response to conservative management. In both cases, the decision to proceed with surgery was made following an individualized clinical assessment, taking into account the severity of the condition, the persistence of symptoms, and the limited therapeutic alternatives available.

Compensatory sweating represents the single greatest therapeutic enigma and source of dissatisfaction following endoscopic thoracic sympathectomy.[5,8,17] While ETS yields definitive cures for primary palmar and axillary hyperhidrosis, secondary redistribution of thermoregulatory sweating can transform an initially grateful patient into a desperately incapacitated individual.[8,10] The incidence of CS varies widely from 30% to over 85%, with severe, disabling CS documented in approximately 3% to 10% of cases.[1,5,8,18] When conservative modalities fail, thoracic surgeons are confronted with limited, poorly standardized remedial options. This case series demonstrates that bilateral extended T4-T12 thoracoscopic sympathectomy can function as an effective, minimally invasive salvage strategy in carefully selected patients with severe, refractory CS.

The extended technique has primarily been described in the context of severe palmo-axillo-plantar hyperhidrosis with predominant plantar involvement, as conventional thoracic sympathectomy yields consistent results for the palmar and axillary regions but highly unpredictable outcomes for the plantar region. In the clinical series by Elalfy et al extending the sympathetic denervation caudally to T12 demonstrated a significant reduction in plantar sweating, accompanied by a substantial improvement in quality-of-life scores during follow-up. However, since this evidence originates from a cohort study lacking a randomized comparator group, the results should be interpreted with caution and cannot be extrapolated as a universal therapeutic standard.[11-14]

Unlike case series focused on the primary treatment of palmar, axillary, or plantar hyperhidrosis, our cases involve patients who had previously undergone surgery, for whom the intervention was indicated to manage a debilitating complication: severe compensatory sweating. This distinction is clinically significant, as the surgical objective was not to treat the areas originally affected by primary hyperhidrosis, but rather to attempt to reduce a pathological, persistent, and refractory redistribution of sweating. Therefore, in these instances, extended thoracoscopic sympathectomy should be viewed as a "rescue" option-reserved for highly selected patients-rather than as a first-line strategy.[11-14]

From a pathophysiological perspective, the rationale for a more extensive sympathetic interruption is based on the potential to modify sudomotor outflow to the

thoracoabdominal and lumbosacral regions involved in compensatory sweating. However, this mechanism is not fully understood, and clinical outcomes can vary.[15-18] This is reflected in our own experience: both patients showed significant improvement following the procedure, yet neither achieved a complete and permanent resolution of sweating. In the first case, initial improvement was evident at six months, with minimal residual sweating and a high level of patient satisfaction; however, by one year, there was a partial recurrence of symptoms, albeit less intense than the baseline condition. In the second case, the improvement was sustained at both six months and one year, though some residual sweating persisted.

These findings suggest that extended thoracoscopic sympathectomy may reduce the intensity of compensatory sweating in selected cases, but it does not necessarily lead to a complete resolution of the condition. This point is crucial when considering surgical indications and obtaining informed consent. Patients must understand that the realistic goal of the procedure is to reduce symptom severity and improve quality of life, rather than to guarantee complete anhidrosis or the total, permanent elimination of compensatory sweating.[15-20]

Extending sympathectomy to the T12 level requires meticulous technical execution. As the chain descends toward the diaphragmatic crura, it becomes situated more anteriorly and medially, often obscured by subpleural fat pads and the insertion of the diaphragm.[10-14] Identification of ribs must proceed systematically from the apex downward to prevent orientation errors. Thermal injury to the diaphragm, phrenic nerve, or intercostal vascular bundles must be scrupulously avoided through precise use of hook cautery or advanced bipolar/ultrasonic instruments.[10-15] Furthermore, as demonstrated in our two patients, the procedure can be performed safely via two 5-mm ports per hemithorax without indwelling chest tubes, permitting discharge within 24 hours and minimizing postoperative morbidity.[1-5]

Evidence regarding sympathectomy beyond conventional levels is primarily limited to reports on the treatment of plantar hyperhidrosis via more distal approaches, and there is currently no consensus on the optimal management strategy. Similarly, the literature concerning extended thoracic sympathectomy remains sparse. Consequently, extended techniques should not be viewed as a standard recommendation or as a replacement for the conventional approach. Rather, they represent an advanced technical alternative that may be useful in specific, complex scenarios-namely, in cases involving severe functional impairment, failure of medical treatment, and the absence of other effective therapeutic options.[15-21]

The primary strength of this experience lies in the description of a rarely reported surgical strategy for the management of severe, refractory compensatory sweating. However, its limitations are clear: it is a small case series lacking a control group, with limited follow-up, and outcomes based primarily on the patient's clinical perception. Furthermore, the heterogeneity in clinical presentation and prior sympathetic surgery may influence the response to treatment.

## CONCLUSION

Bilateral extended T4-T12 video-assisted thoracoscopic sympathectomy represents a feasible, reproducible, and effective surgical salvage option for carefully selected patients suffering from severe, medically refractory compensatory sweating and concomitant plantar hyperhidrosis. The procedure demonstrates low perioperative morbidity and yields substantial improvements in quality of life. Nevertheless, because symptom resolution is often incomplete and partial recurrence may occur over time, extensive preoperative counseling establishing realistic surgical expectations is mandatory. Prospective multicenter studies are warranted to delineate optimal patient selection criteria and long-term durability.

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