Original Article

Sympathotomy Instead of Sympathectomy for Palmar Hyperhidrosis: Minimizing Postoperative Compensatory Hyperhidrosis

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- ***Objective*: To determine whether anatomical modification of sympathectomy diminishes severe postoperative compensatory hyperhidrosis.**
- ***Patients and Methods*: From January 1, 2000, to June 1, 2001, we prospectively studied 10 consecutive patients with primary palmar hyperhidrosis, aged 14 to 42 years. Medical therapy had failed in all patients. A preoperative and postoperative evaluation and thermoregulatory sweat testing were conducted in all patients. All patients underwent sympathotomy (bilateral simple disconnection) of the second thoracic ganglion input into the brachial plexus, and no sympathetic ganglia were violated.**
- ***Results*: In the 10 patients, all 20 upper extremities improved postoperatively: 11 (55%) had near-complete cessation of palmar sweating, 8 (40%) had marked reduction in sweating, and 1 (5%) had delayed onset but full sweating at the end of the thermoregulatory sweat test. No intraoperative complications of hemopneumothorax or Horner syndrome occurred. Importantly, there were no moderate or severe postoperative hyperhidrosis complications.**
- ***Conclusion*: Sympathotomy to disconnect T2 ganglion input into the brachial plexus produces excellent results in the treatment of primary palmar hyperhidrosis and may lower the severity of postoperative compensatory hyperhidrosis complications. Long-term durability of the procedure requires further follow-up.**

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Surgical sympathectomy has been used in the management of palmar hyperhidrosis for decades.[1] As the operation was refined, removal of the stellate ganglion as part of the sympathectomy was abandoned because Horner syndrome with its associated pupillary and eyelid dysfunction was cosmetically unacceptable.[2] Surgeons began concentrating on removing the upper thoracic sympathetic chain to a variable extent but always inclusive of the second thoracic ganglion, the largest physiologic relay center of sympathetic neurons to the upper extremity.[3] Several surgical approaches have been used—posterior open[1,4] or percutaneous,[5] supraclavicular,[6] and transaxillary[4]—all successful in ameliorating the palmar sweating component of the syndrome. Endoscopic transthoracic approaches for sympathectomy have been used for more than 50 years,[7] and in the past decade they have become the procedure of choice because of markedly improved lighting and optics that allow excellent anatomical visualization of the sympathetic chain, minimal external scarring, faster operative times, and excellent results. Consequently, serious complications of hemothorax or visceral pleural disruption leading to major pneumothorax are rare. Postoperatively, Horner syndrome is also uncommon. Endoscopic transthoracic approaches combined with physiologic monitoring of sympathetic innervation to the hand via fingertip temperature probes and/or palmar arch Doppler blood flow measurement have resulted in successful outcomes for the palmar component of the syndrome.[8-12]

The pathophysiology of palmar hyperhidrosis remains obscure. Perhaps because of the diffuse nature of this subdivision of the nervous system, the most common complication resulting from surgical sympathectomy is increased sweating in other body areas, termed *compensatory hyperhidrosis*.[8] In most patients, a mild variation of increased sweating may be an unavoidable consequence of surgical sympathectomy to ensure ablation of abnormal sweating of the palms. However, severe compensatory hyperhidrosis may occur in 10% to 40% of postoperative patients.[8-13] Such patients sweat voluminously in other areas, such as the low back and buttocks, groin, and thighs, to such a degree that they are unhappy with the results of the surgery even when successfully applied to the initial complaint of marked palmar sweating. Few treatment options exist for patients with this complication.

Severe postoperative compensatory hyperhidrosis may be related to several factors. However, the extent of the sympathectomy and resultant large areas of anhidrosis appear to correlate with this unfortunate outcome,[6] possibly

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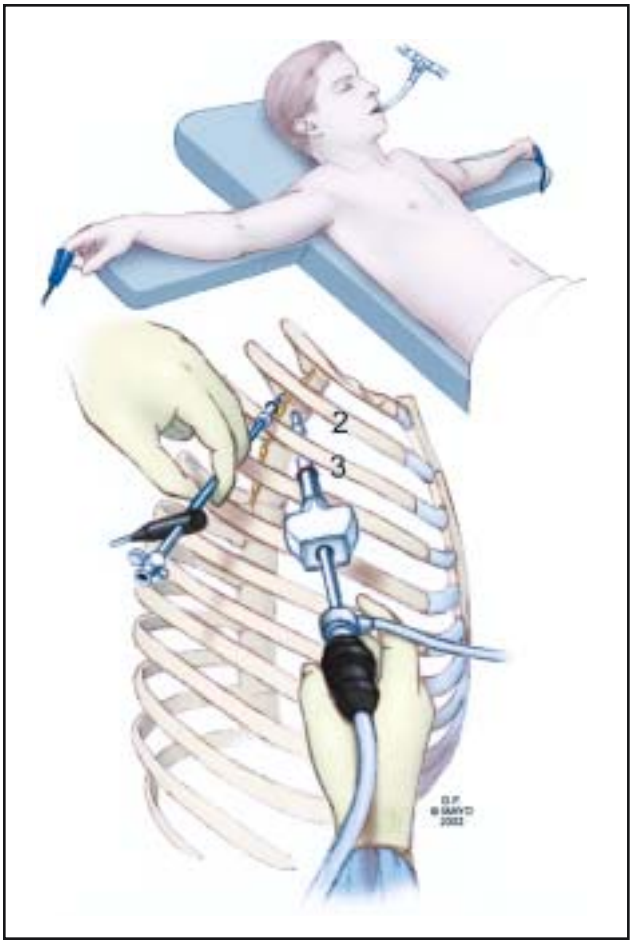

Figure 1. Drawing showing the semisitting position of a patient at surgery, with a double lumen endotracheal tube and bilateral index fingertip temperature probes. A biportal technique is shown, with the endoscope passed through the anterior axillary line at the third intercostal space and a cautery hook passed through the midaxillary line at the second intercostal space.

because the remaining skin areas still sweating are innervated by an abnormally active sympathetic system and must be overused for effective heat loss from the body. As a result, we tailored the operation on physiologic and anatomical[3,14-16] principles to ensure ablation of sympathetic innervation to the palms, using the least destructive procedure possible, and to produce the smallest area of skin anhidrosis. We prospectively analyzed 10 consecutive patients who underwent preoperative and postoperative neurologic assessment and thermoregulatory sweat testing (TST). Endoscopic transthoracic surgical sympathotomy was performed in all patients by simple disconnection of the second thoracic ganglion from the stellate ganglion (Figures 1-3). By using this simple disconnection, or sympathotomy, we hoped to avoid the severe form of any postoperative compensatory hyperhidrosis complications yet successfully treat the palmar component of hyperhidrosis.

PATIENTS AND METHODS

From January 1, 2000, to June 1, 2001, we prospectively studied 10 consecutive patients with a diagnosis of palmar hyperhidrosis in whom medical therapy had failed. The ages of the 7 women and 3 men ranged from 14 to 42 years. This study was approved by the Mayo Foundation Institutional Review Board, and no patients were included who refused enrollment. A comprehensive neurologic examination and medical history were used to verify idiopathic primary (essential) hyperhidrosis. A TST was used preoperatively to confirm the diagnosis and reveal areas of reduced or absence sweating elsewhere on the body. The Mayo Clinic Thermoregulatory Sweat Test is a modification of the Guttmann Quinizarin Sweat Test[17] and has been described previously.[18,19] A mixture of alizarin red, cornstarch, and sodium carbonate is painted onto the patient's skin, and the patient is placed in a tented heating cabinet with skin and oral temperatures recorded. Skin and oral temperatures are elevated to a temperature (38°C) at which all healthy patients sweat profusely, which turns the light orange–alizarin red mixture dark purple. The patient is removed from the cabinet and photographed with a digital camera, and a computer drawing is then obtained. The percentage of anhidrosis vs hidrosis is computer determined by comparing the different colored areas as a total of body surface area.

In our 10 patients, a variety of topical or oral medications had failed, and all had elected to proceed with the operation. All patients underwent identical bilateral sympathotomy with use of biportal or uniportal access and intraoperative physiologic assessment of the adequacy of sympathetic denervation of the palm with use of bilateral index fingertip temperature probe monitoring. All patients were reevaluated by follow-up neurologic examination, history, and TST no earlier than 3 months after surgery (range, 3.5-16 months; average, 5.6 months). Special attention was directed to the surgical success in managing the palmar hyperhidrosis and the degree of postoperative sweating elsewhere on the body. Any compensatory hyperhidrosis was arbitrarily rated as mild if no treatment was necessary and the patient had no significant concern; moderate if the patient found the increased sweating in other areas to be disagreeable and for which he or she would consider treatment; and severe if the patient had marked increased sweating elsewhere, had requested treatment, and was unhappy with the surgical outcome because of an increased postoperative sweating pattern.

RESULTS

Most of the patients had had palmar hyperhidrosis since childhood or early adolescence; 2 patients had been told by their parents that they noted sweaty hands and feet as early as 2 to 3 years of age. Of the 10 patients, 7 had a family history of palmar hyperhidrosis, meaning at least 1 first-degree relative also had this condition. Two of the patients were mother and daughter.

Of the 20 affected upper extremities, there was 100% patient satisfaction postoperatively. Nineteen upper extremities (95%) had successful surgical outcomes, with dry hands based on patient history and examination. Thermoregulatory sweat testing (Figure 4) revealed the following: 11 (55%) of 20 limbs were nearly completely dry, 8 (40%) limbs showed substantially reduced but partial sweating, and 1 (5%) showed delayed onset but full sweating of the left upper extremity at the TST end point (Table 1, patient 1) (Figure 4, 1a and 1b). The total percent anhidrosis of body surface area (using computer averaging) for this group averaged about 17% for sympathotomy compared with about 30% to 35% for traditional T2-T3 ganglionectomy. Only 1 patient had complete anhidrosis of one half of the forehead (Figure 4, 7a and 7b). Also, 5 patients had delayed sweating of the forehead, 4 had delayed sweating of the feet, and 4 had delayed sweating of the axilla. There was excellent correlation between any temperature elevation of the index finger identified at surgery and palmar response postoperatively.

No complications of hemopneumothorax or Horner syndrome occurred postoperatively. Of the 10 patients, 8 stated they had increased sweating in other areas, and all rated this as mild. No moderate or severe hyperhidrosis complications occurred (Table 1).

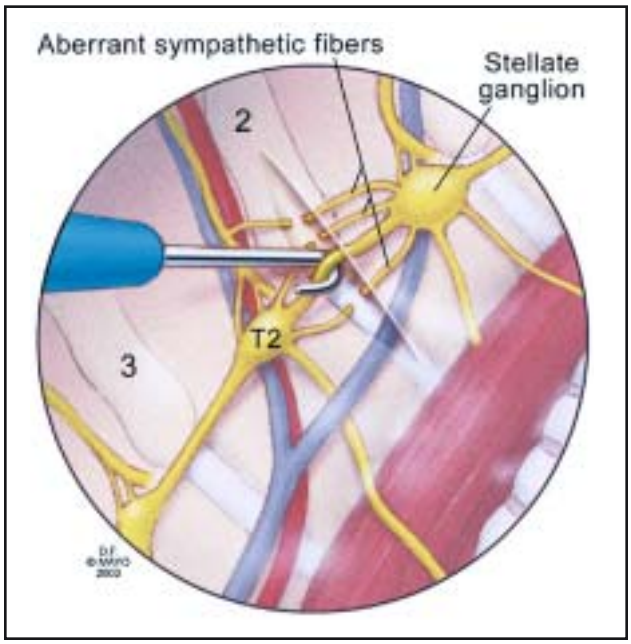

Figure 2. Drawing depicting cautery severance of the sympathetic trunk over the second rib and wide enough to sever any aberrant sympathetic fibers (nerves of Kuntz[14]) from the second thoracic ganglion (T2) to the brachial plexus above.

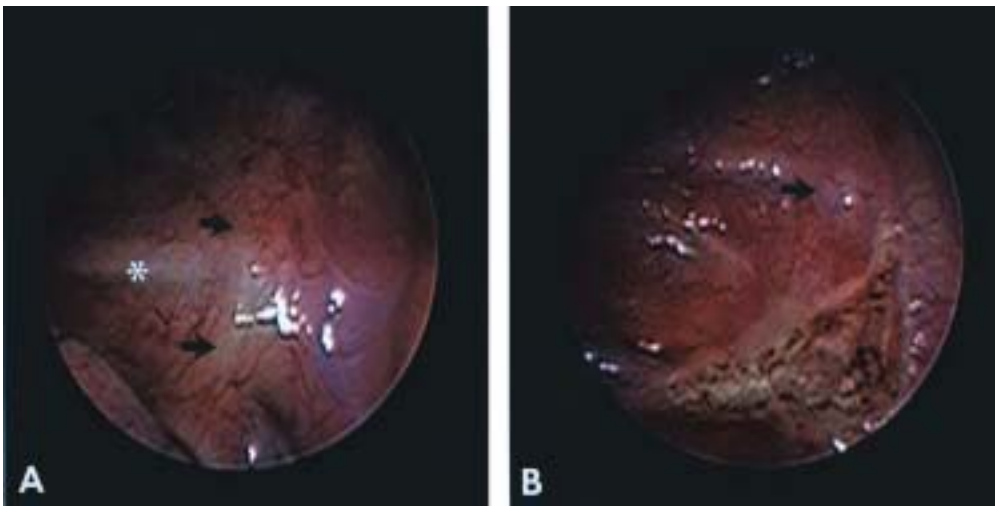

Figure 3. A, Endoscopic view of the sympathetic chain (arrowheads) crossing the second rib (asterisk). B, Wide cautery sympathotomy in a crescent-shaped incision across the second rib, severing any sympathetic input from T2 to the brachial plexus above. Arrowhead shows the remaining disconnected stellate ganglion complex inferior to and over the first rib.

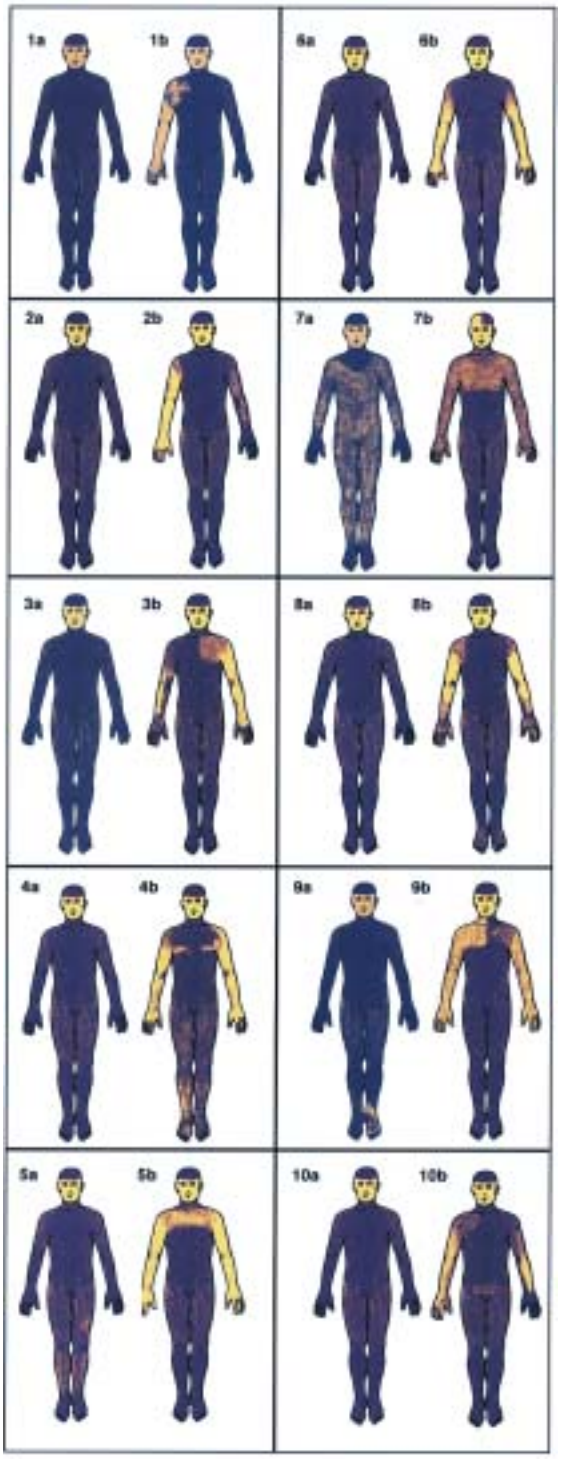

Figure 4. Preoperative (1a-10a) and postoperative (1b-10b) thermoregulatory sweat patterns in the 10 patients. Most patients exhibit postoperative symmetry between sides in their sympathotomy results. However, some do not, which is interesting given identical procedures per side. Note that patient 1 had delayed but normal sweating of the left upper extremity and hand postoperatively, but the hyperhidrosis component was absent from the palm.

DISCUSSION

Sympathotomy by simple disconnection of the T2 ganglion from the brachial plexus offers excellent control of palmar hyperhidrosis that is as good as or better than that obtained with more destructive procedures. Using the endoscopic route is safe, fast, and effective. Tailoring the procedure anatomically as a sympathotomy, with intraoperative physiologic confirmation of palmar sympathetic denervation by index finger temperature probe monitoring, appeared to diminish the severity of compensatory hyperhidrosis in this small but prospective series. There are perhaps 2 reasons.

1. More aggressive procedures targeting resection of several ganglia and intervening chain have correlated with the severity of compensatory postoperative hyperhidrosis because of extensive areas of skin anhidrosis, which may be a prerequisite to this complication.[6,8] Therefore, it is reasonable to assume that minimally destructive sympathotomy may produce a lesser extent of skin anhidrosis and a lesser degree of postoperative compensatory hyperhidrosis compared with more aggressive sympathectomies.

2. Any ganglion resection removes the white rami communicantes and its axons from cells in the intermediolateral cell column of the spinal cord. If these axons are injured or transected, the cell bodies in the spinal cord may die or reorganize (Figure 5). The spinal cord influence over the remaining sympathetic nervous system may be short-circuited by this reorganization; hence, increased sympathetic tone may occur in the remaining sweating body areas.[3,14-16]

Either or both of these mechanisms may play a role in severe postoperative compensatory hyperhidrosis, the most debilitating and common adverse effect of surgical therapy. Mild compensatory hyperhidrosis may occur with any destructive procedure of the sympathetic nervous system. However, severe postoperative hyperhidrosis syndrome, although poorly understood, may be due to increased sympathetic traffic mediated from ganglionectomy and/or alteration of sympathetic neurons and their connections in the spinal cord. Sympathotomy, the least destructive procedure possible for successful surgical management of palmar hyperhidrosis, appears to ameliorate postoperative compensatory hyperhidrosis. Clinically, this may be predicted based on 2 important findings on the postoperative TST. The percent (17%) anhidrosis with sympathotomy is less than that with T2-T3 ganglionectomy (35%), suggesting the patient's sweating pattern is substantially less altered with sympathotomy and therefore less susceptible to resultant severe compensatory hyperhidrosis as a complication. Also, forehead sweating may be diminished but preserved in 19 of 20 sides, which has correlated with a diminished degree of compensatory hyperhidrosis in other body areas as well.[20]

Table 1. **Characteristics of Patients Who Underwent Sympathotomy**

Patient	Family history	Dry hands		Sweating elsewhere		Considered the operation successful	Pleased with overall outcome	Temperature change at surgery (℃)	
		Right	Left	Diminished	Increased			Right	Left
1	Yes	Yes	No*	None	Mild—small of back, groin, feet	Yes	Yes	2.2	0
2	No	Yes	Yes	Axilla, forehead	Mild—chest, feet	Yes	Yes	8	10
3	Yes	Yes	Yes	Axilla, legs	None	Yes	Yes	2	2
4	Yes	Yes	Yes	Axilla, both feet	Mild—upper chest, groin	Yes	Yes	2	2.2
5	Yes	Yes	Yes	Both feet	Mild—posterior trunk	Yes	Yes	0.4	0.5
6	Yes	Yes	Yes	Forehead, feet	Mild—top of head while eating spicy foods or citrus fruits†	Yes	Yes	4	3.5
7	No	Yes	Yes	Axilla, forehead, feet	Mild—trunk	Yes	Yes	0.7	Not accurate
8	No	Yes	Yes	None	None	Yes	Yes	6	4
9	Yes	Yes	Yes	Forehead	Mild—legs, feet	Yes	Yes	0.7	1.0
10	Yes	Yes	Yes	Forehead	Mild—legs, back	Yes	Yes	1	1

*Normal sweating only with exercise, not anxiety.
†Only aberrant gustatory response.

It is important to consider new avenues for the treatment of the palmar component of hyperhidrosis—the target of therapy and minimization of the debilitating consequences of severe hyperhidrosis. Sympathotomy appeared to offer both in the current series.

CONCLUSION

Sympathotomy alone by disconnection of the T2 ganglion input into the brachial plexus produces excellent results in the treatment of primary hyperhidrosis and appears to lower the severity of postoperative compensatory hyper-

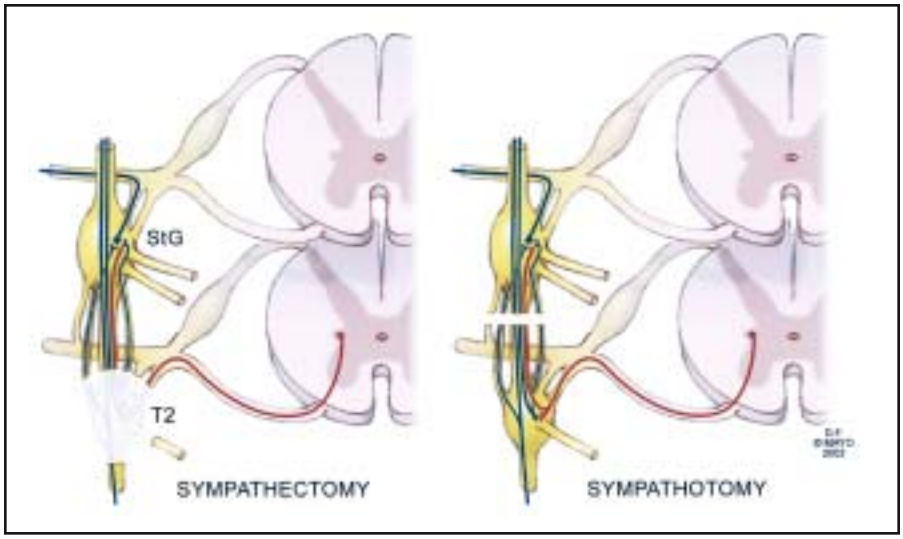

Figure 5. Schematic drawing of sympathectomy vs sympathotomy. Note that sympathectomy, with use of ganglionectomy and by definition, must sever the primary axon from the neuron in the intermediolateral cell column of the spinal cord (red) before primary or collateral synapse in the T2 ganglion. This injures all the neurons at this level of the spinal cord, some of which may die, and may predispose the patient to spinal cord reorganization and severe compensatory hyperhidrosis. Sympathotomy interrupts only axons after potential T2 ganglion synapses, a less injurious effect on the neuron, and is the least destructive procedure possible with successful treatment of palmar hyperhidrosis. StG = stellate ganglion.

hidrosis. Long-term durability of the procedure requires further follow-up.

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