Treatment of Hyperhidrosis: Minimally Invasive Percutaneous Thoracoscopic Sympathectomy

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Special article:

Objectives:

Familiarize the dermatology community with a safe and efficacious surgical procedure to treat medically intractable hyperhidrosis.

Participants:

The lead author performed the procedures at Cedars-Sinai Medical Center.

Evidence:

We review the evolution of surgical treatments for hyperhidrosis. The outcomes for our most recent minimally invasive surgery for hyperhidrosis are published.

Conclusion:

Minimally invasive thoracoscopic surgery for palmar and axillary hyperhidrosis is safe and efficacious with rapid recovery.

Introduction

Primary hyperhidrosis is an idiopathic condition causing excessive sweating. It can be a functionally morbid and even disabling disease. The onset of symptoms is usually during childhood or adolescence. Any part of the body may be affected, with the palms, axillae and soles of the feet representing the most common areas of complaint (Figure 1). Surgical technology has advanced over the past few years in the treatment for primary hyperhidrosis. We discuss the history, clinical findings, pathophysiology, and treatment options for hyperhidrosis.

Figure 1. The figure above shows the common clinical presentation of a patient with palmer hyperhidrosis.

Although epidemiologic data is limited, hyperhidrosis is a relatively common condition with a reported incidence of 0.15-0.25% in young Israelies (Adar et al, 1977). Hyperhidrosis occurs in as high as 1% of the Western Population, which is 20 times more frequent than in the Japanese or other Asian ethnic populations (Cloward, 1957; Cloward, 1969). Hyperhidrosis causes life-long social and in some cases debilitating functional morbidities. This condition is believed to have an autosomal recessive inheritance pattern with incomplete penetration (Ro KM, 2002). It is mediated by an abnormally hyperactive sympathetic nervous system. Complex regional pain syndrome (causalgia or reflex sympathetic dystrophy) and Raynaud's syndrome are conditions similarly caused by abnormal sympathetic nervous system regulation. The sympathetic system is controlled by the hypothalamus, which sends fibers to the thoracic and upper lumbar intermedio-lateral zone of the spinal cord where the sympathetic cell bodies reside. From there, the sympathetic fibers travel to the sympathetic chain found lateral to the spinal column. It can be thought of as a parallel nerve circuit to the spinal cord with bilateral intervertebral segment relays from the spinal cord to the sympathetic chain. Surgical correction of primary hyperhidrosis aims to interrupt the sympathetic signaling to palmar and axillary cholinergic sweat glands by cutting and removing the T3 (and possibly T4) ganglia and intervening sympathetic chain bilaterally. Because the sympathetic chain is, in effect, a parallel nerve circuit, the sympathetic nervous system innervation is not disrupted distally.

First line therapy-Medical Therapies.

Primary hyperhidrosis has traditionally been treated medically first. Systemic anticholinergic drugs have variable effectiveness. Unfortunately, they commonly cause undesirable side effects that include blurry vision, dilated pupils, constipation, hastened micturation, heart palpitations and mydriasis. As a result these drugs are unpopular with hyperhidrosis patients. Topical anticholenergics such as Drysol can be used to avoid the adverse effects of systemic anticholinergics. These agents have variable success but can cause skin irritation requiring further care (Sato, 1989).

Iontophoresis is another treatment first introduced by Bouman et al. (1952). This procedure is a low level electric current of about 15- 20 milliamps which is directly applied to the skin under an electrolyte solution for 30 minutes. This has to be repeated frequently initially a few times per week and eventually once every couple weeks. The current creates a “shock” that is perceived by many to be uncomfortable. Skin irritation and even burns are other side effects that are not uncommon. Results with iontophoresis are variable but typically the best success is in patient with mild symptoms only.

More recently, injection of Botulinum toxin (Botox) directly into the palmar subepidermal tissue has been tried. Reports by Shelley et al, 1998 and Schnider et al, 1997 outline the treatment with 6-50 injections in each palm. Shelley et al. found a diameter area of 1.2cm anhydrosis with each injection of 2 mouse units of Botulinum toxin. Schnider et al. compared the effect of botulinum toxin injection to that of sodium chloride solution. Overall results using Botox showed a 26% reduction in sweating 3-8 wks post injection and 31% reduction after 13 wks. Injection of botulinum toxin had a common side effect of mild transient muscle weakness that resolved in 2-5 weeks (Schnider, 1997) (Shelley, 1998). The thumb weakness that was reported resolved in 3 weeks. Additionally, the Botox injections had to be repeated at various intervals (usually between one and six months) to treat recurrences (Schnider, 1997). One report published a case of severe atrophy of the intrinsic muscles of the hand in a patient treated with intra-palmar Botox (Glass et al, 2008). Although the immediate short-term efficacy of Botox use for hyperhidrosis appears good, data on long-term use of Botox is not fully understood.

In many patients, the non-surgical treatments have limited efficacy, require a life-long use of the medications or repeated treatment modalities in the case of electric current application or botox injection. Furthermore, these treatments often time-consuming, expensive and have significant side-effects. As such, the quest for a more definitive treatment of this condition has lead to surgical intervention.

Preooperative Considerations:

It is important to reserve surgical intervention of primary hyperhidrosis for cases that are refractory to medical management. Also, the pre-operative work up is necessary to rule out secondary hyperhidrosis that are potentially treated medically. Some of the most important causes of secondary hyperhidrosis are paraneoplastic/neurologic syndrome, thyroxicosis, diabetes mellitus, gout, menopause, pheochromocytoma, chronic alcoholism, and spinal cord injury and medications such as tricyclic antidepressants and propranolol. Nocturnal hyperhidrosis can be associated with Tuberculosis and Hodgkin Disease. Psychological stimuli in addition to thermoregulatory signals from the cerebral cortex have also been shown to cause regional palmar sweating (Sato, 1989). Thyroid Function Panel, serum glucose levels, uric acid, and urine catecholamine level should be considered. Imaging should include at least a chest radiograph to role out pulmonary lesions.

Surgical procedure for medically intractable primary hyperhidrosis:

History and evolution of thoracic sympathectomy:
Thoracic sympathectomy was first introduced by Kotzareff et al in 1920. Resection of the upper thoracic sympathetic ganglia has been shown to be an effective and definitive treatment for primary hyperhidrosis. However, the early approaches to the high thoracic sympathetic chain were highly invasive. They were performed by either posterior paraspinal, supraclavicular or an open thoracotomy. Historically, these surgeries were performed predominantly by cardiothoracic surgeons. The surgical incision required to gain adequate surgical exposure was commonly greater than 4 inches long. The approach was associated with significant morbidity and proved to be more traumatizing and time consuming than the actual sympathectomy itself.

In 1951, Kux first described thoracic endoscopic procedure for the treatment of tuberculosis (Kux, 1951). The urologic endoscope was adapted for use in these early surgeries. The technology was subsequently enhenced with the development of the minimally invasive video-assisted thoracoscopic surgery (VATS) with endoscopic monitoring technology. This technology has enabled surgeons to obtain detailed and magnified visualization of the sympathetic ganglia through percutaneous portals, and thus eliminated the need for an open thoracotomy. Thoracoscopic sympathectomy surgery has decreased the morbidity that was experienced with early open procedures [10,22 Focus4]. VATS has been shown to accelerate patient recovery and improve patient satisfaction. In a series of 65 hyperhidrosis patients underwent 112 sympathectomies (Focus6) performed by VATS endoscopic sympathectomy and ganglionectomy. Overall, the outcomes for the VATS endoscopic sympathectomies were equivalent to those open surgical techniques with the morbidity, length of hospital stay, and time until return to normal activity substantially reduced. Complications and recurrence of symptoms were comparable with those demonstrated in previous reports. Furthermore, patient satisfaction and willingness to undergo a repeat operative procedure ranged from 66 to 99%.

Technological advancements have continued to pave the way for improved endoscopic sympathectomy surgery. Today, for example, the instruments are smaller in diameter and the endoscopes are higher quality resolution. Thus fewer and smaller access ports are used to perform the surgery. The VATS surgery has equavalent safety and efficacy as prior techniques. At our institution, we have been using a two small port technique to introduce the endoscope and a working endoscopic instrument (Figure 2). Different instruments can be inserted thru the working port including scissors, electrocautery, and a suction/irrigator, at the same time the endoscope is inserted. In addition to making the incision more cosmetically desirable, this approach provides a safe, easy access to the thoracic cavity. The high quality endoscopes today provide excellent resolution imaging to perform the sympathectomy surgery.

Figure 2. The 2mm 0-degree endoscope is introduced into the chest cavity through a Varess needle-port (posterior axilla port). The working instruments are introduced through a 3.5 mm flexible port (anterior axilla port). We elect not to use CO2 insufflation. Care must be taken with the 2 mm endoscope because it is fragile and easy to damage.

VATS sympathectomy has proven successful with high patient satisfaction in treating patients with palmar and axillary hyperhidrosis. Upper thoracic sympathectomy with ganglionectomies at T3 and T4 levels has been performed by multiple centers for the treatment of these conditions (AbuRahma, 1994, 1,3,7,10,11,21,24 Focus6).

Current surgical advances:

At our institution, we are now performing only T3 ganglionectomies and sympathetic chain resection, by dividing and removing the sympathetic chain above and below the T3 ganglion, for patients with symptoms of isolated bilateral palmar hyperhidrosis. If an accessory Nerve of Kuntz is identified (often branching off the T2 ganglion) this is divided and resected. It is necessary to identify these common accessory nerve branches to completely eliminate the patient's symptoms of excessive sweating. Additionally, we performing bilateral T3 ganglionectomy and intervening sympathectomy in patients who experience both palmar and axillary hyperhidrosis symptoms. It is worthwhile to note that patients with unilateral symptoms of hyperhidrosis must be thoroughly evaluated preoperatively for possible causes of secondary hyperhidrosis as previously mentioned.

We do not use previous technique of carbon dioxide insufflation for surgical exposure. This avoids the small but potential risk of decreasing cardiac stroke volume secondary to increased intrathoracic pressure. Instead, a double-lumen endotracheal intubation is used for single lung ventilation. This technique allows the ipsilateral lung to partially deflate and expose the upper thoracic sympathetic chain. Additionally, even though we are using smaller ports (2-5mm versus 10-mm) for access to the thoracic cavity, we can intentionally allow atmospheric pressure to equilibrate with the intrapleural cavity to cause a controlled pneumothorax. This provides enough exposure to successfully perform the sympathectomy. The partial lung collapse may be reversed after the sympathectomy by having anesthesia hold the patient's breath and provide positive pressure briefly as we use the endoscopic suction to aspirate intrapleural air. Once the lung is endoscopically visualized to be fully expanded, the endoscopic instruments can be withdrawn from the chest cavity.

Brief Description of Surgical Procedure:

The first port is introduced above the 4^{th} rib in the axilla. The endoscope is introduced through this port and the thoracic cavity is visually explored. The partially deflated lung is identified and gently swept away if necessary. The first rib is most often not visible. The rib heads from T2 to T4 are easily identifiable through the parietal pleura and are important landmarks during the thoracoscopic sympathectomy surgery. The sympathetic chain courses superficial to the segmental and intercostal vessels. The stellate ganglion lies within the first intercostal space cepholad the second rib head (Figure 3). The sympathetic chain is easily seen as it is a slightly raised, longitudinal structure running parallel to the spine and coursing over the rib heads. The parietal pleura from the second to third rib head is divided. Each sympathetic ganglion is located over or just caudal to the corresponding numbered rib (Figure 4). The exposed sympathetic chain and associated T3 (T4) ganglion is isolated, divided, then removed from the thoracic cavity. Hemostasis is achieved when necessary using bipolar cautery. The T2 ganglion is inspected to identify the accessory Nerve of Kuntz. If this is identified it is divided to ensure complete resolution of the hyperhidrosis.

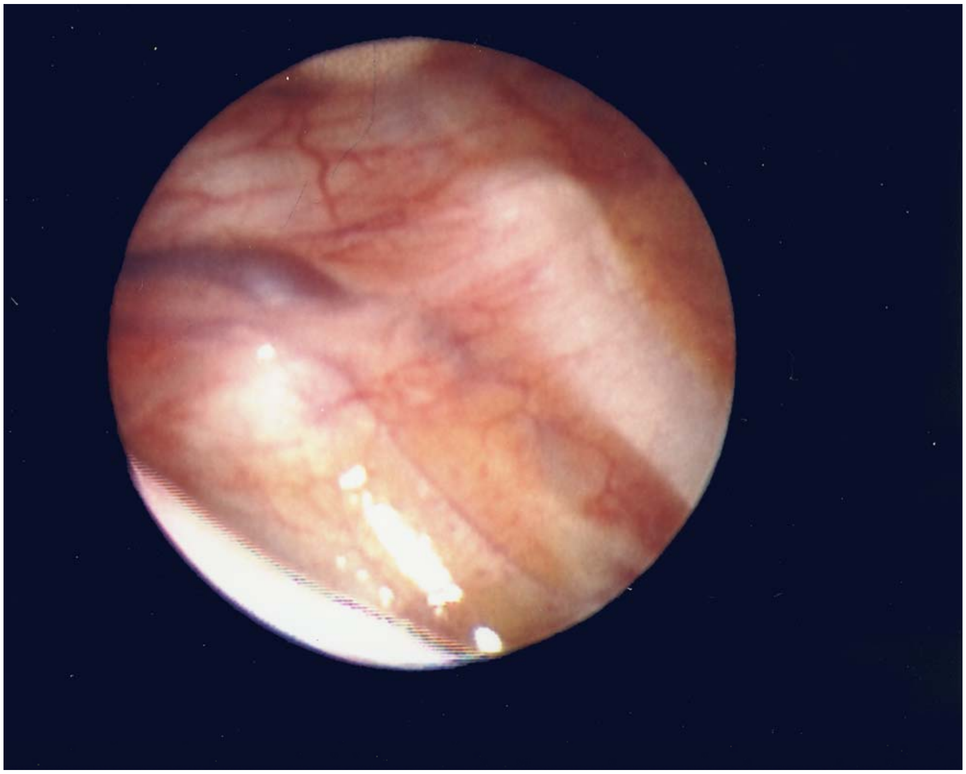

Figure 3. Endoscopic view of the left thoracic cavity. The image shows the sympathetic chain coursing over the second and third rib heads and deep to the semitransparent parietal pleura.

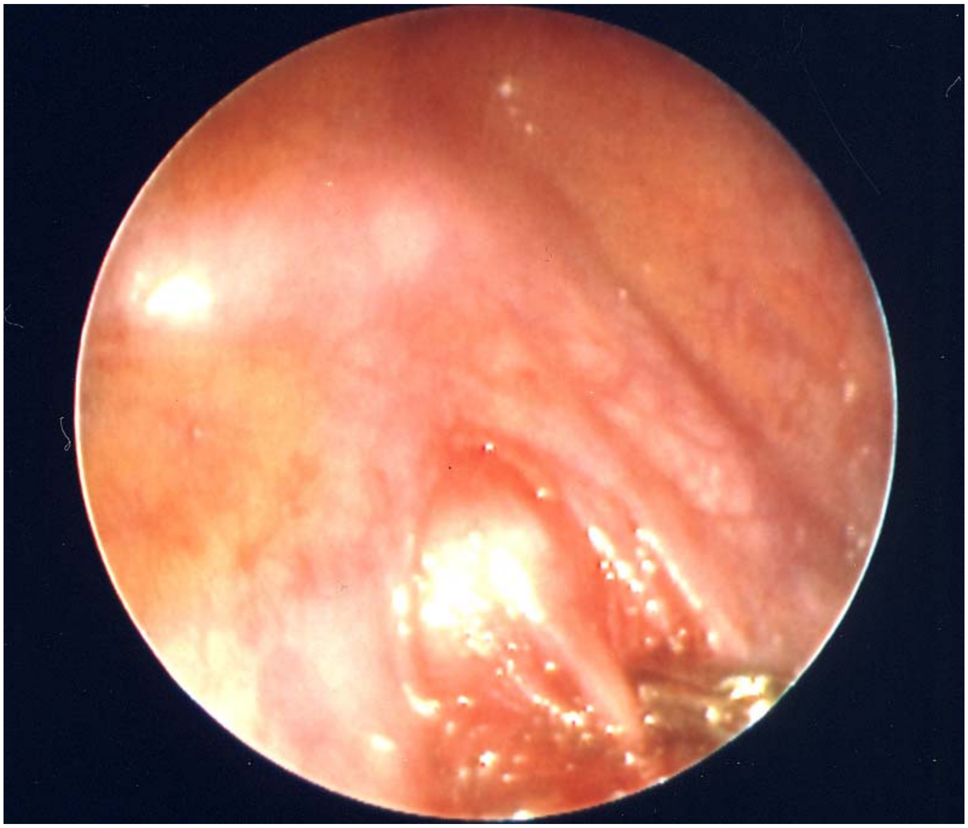

Figure 4. The sympathetic chain and T3 ganglion are visible through the parietal pleura that has been divided. The endoscopic grasper lies adjacent to the sympathetic chain below the third rib and T3 ganglion.

The best ganglion for resection in the treatment of palmar hyperhidrosis is still debatable. Studies have investigated the effectiveness of T2 versus T3 ganglion resection (Yazbek et al., 2005) and T2 versus T4 ganglion resection (Chou et al., 2005). It appears that resecting any combination of the T2, T3 or T4 ganglion is equally effective in providing greater than 98% symptomatic improvement in palmar hyperhidrosis (Yazbek et al. and Chou et al). Current literature also suggests that the there is less severe compensatory truncal hyperhidrosis when resecting T3 versus T2 ganglion (Yazbek et al. and Yoon et al, 2003) and infrequent compensatory hyperhidrosis when resecting T4 ganglion when compared to the T2 ganglion (Chou et al.). Yoon et al. (2003) chose to perform T3 ganglionectomy in patients with palmar hyperhidrosis and both T3 and T4 ganglion resection when patients also exhibited axillary hyperhidrosis. In their study of 27 patients (24 with palmar hyperhidrosis, 3 with both palmar and axillary hyperhidrosis) all reported high satisfaction at a mean follow-up of 19 months. All patients had complete resolution of hyperhidrosis with the exception of one patient who continued to have axillary symptoms and required revision T4 ganglion resection. One patient experienced mild truncal compensatory hyperhidrosis for one month following surgery. Thus, T3 selective ganglion resection for palmar hyperhidrosis symptoms and T3 and T4 ganglion resection for symptomatic palmar and axillary hyperhidrosis provides high success with a low incidence of compensatory truncal hyperhidrosis. In an additional study, Riet et al. (Reit, 2001) looked at selective T3 ganglion resection for palmar hyperhidrosis. They found 100% of patients had resolved hyperhidrosis, no recurrence of hyperhidrosis symptoms and no incidence of compensatory hyperhidrosis at 3.5 years postoperative (Riet, 2001).

The accessory nerve of Kuntz is typically a rami communicantes of T2, but can arise from T3 or T4. This accessory nerve (more than one may be present) can be identified prior to incising the parietal pleura as it courses parallel the sympathetic chain. This small nerve branch may continue to carry neural signals past the transected segment of the sympathetic nerve trunk and should be divided when identified to increase the success of decreasing palmar hyperhidrosis (Kuntz, 1927).

Several monitoring systems are available to assess for successful intra-operative sympathectomy to the palms. Palmar cutaneous temperature transducers are the simplest means to monitor for a 1 to 2 degree increase in hand temperature, and laser doplar flowmetry or arteriole dopler of the hands can measure for blood flow increase to the hands (Dickman, 2004; Klodell, 2005; Crandall, 2005; Eisenach, 2005).

The results of our last 26 patients using a two-port technique and the 2mm-5mm endoscopic instruments are reported.

- 1 or 2 portal technique (last 9 using 2 portal technique)
- No CO2 insufflation, double-lumen ET tube
- Minimum 6 month follow up
- 2 mm working instruments and 2 to 5 mm endoscope
- Last 11 patients have had identifiable pneumothorax < 20%, all asymptomatic on room air
- No ICU stay
- All 23 hour hospitalization
- 3 patients noted to have widened mediastinum postop…
    - First patient thought to be secondary to intraoperative bleeding
    - Anesthesia believes secondary to double-lumen endotracheal tube
    - All 3 completely resolved by first follow up at 10-14 days
- Resolution of symptoms 26 complete
- Compensatory sweating 8 of 26 (35%)
    - None affects quality of life
    - “Significantly bothersome”: 1* of 26
    - Lasting greater than 6 months 1* of 26
        - * Patient on catapres 0.1mg/day effectively treating compensatory hyperhidosis.
        - * Patient would still have surgery again.
- No instance of intercostals neuralgia with 2 portal technique and smaller (2 to 5mm instruments/endoscope)
- Transient pluritic chest pain is common, exacerbated with inspiration (2 to 4 weeks)
- No instance of Horner’s

DISCUSSION:
Hyperhidrosis is the commonest reason for thoracoscopic sympathectomy.
It is important, however, to reserve surgical intervention of idiopathic hyperhidrosis for cases that are recalcitrant to nonoperative interventions. Additionally, a pre-operative work up is necessary to rule out secondary hyperhidrosis that may be treated medically.

In the absence of secondary causes of hyperhidrosis, primary hyperhidrosis has traditionally been treated medically as first line therapy. Medications, topical therapies and treatments such as ionophoresis and Botox injections have variable effectiveness, undesirable side effects and require repeat treatment and can be costly and time consuming. Clearly, medical treatment of primary hyperhidrosis is far from perfect in treating a life-long, functionally morbid, and sometimes disabling disease. As such, the quest for a more definitive treatment of this condition has lead to surgical intervention.

Thoracic sympathectomy was first introduced by Kotzareff et al in 1920 and has proven to be an effective and definitive treatment for primary hyperhidrosis by upper thoracic sympathectomy. Approaches used in the past included required a more invasive approach with significant postoperative morbidity. Thoracoscopic technology has evolved allowing a minimally invasive procedure which is safe and effective. The small incisions are 3-5-mm, cosmetically desirable and hidden within the axilla. Furthermore, supine patient positioning, as compared to the common lateral decubitus positioning, decreases the total operating time and is gentler to the patient by avoiding repositioning for bilateral sympathectomy procedures.

The physiologic response of the body following sympathectomy can result in compensatory sweating in areas previously unaffected (Drott,1995). Compensatory hyperhidrosis is usually experienced on the trunk, face, posterior knees or inner thighs. This effect is usually transient lasting less than six months and is usually not troubling to the patient. Nevertheless, current technologies and a better understanding of the anatomical causes of compensatory hyperhidrosis has reduced this incidence.

The additional risks associated with the thoracoscopic approach and performance of the sympathectomy include pneumothorax, intercostal neuralgia, bleeding, and the sequelae of general anesthesia. Also, Horner’s Syndrome could occur which is associated with a T1, Stellate ganglion, injury (Johnson JP, 2002). Recalcitrant hyperhidrosis can also occur. These causes are typically avoided by simply dividing the accessory nerve(s) of Kuntz, avoiding stapling of the sympathetic chain (staples have been reported to dislodge) and removing the short segment of the sympathetic chain and ganglion (the nerve can otherwise grow back and re-anastomose). Interocostal neurovascular injury and postoperative intercostal neuralgia was once more common with use of the larger ports and instruments. This has been largely absent since using the smaller diameter instruments and ports of 3 to 5-mm and with careful insertion of the port over the superior border of the rib. Pneumothoraces that naturally result after opening the pleural cavity is desirable during the surgical procedure but then is easily reversed by having anesthesia return ventilation to the lung and provide a valsalva maneuver while one intrathoracic instrument is placed on suction and the endoscope is used to visualize complete re-inflation of the lung at the apex. Complications with VATS sympathectomy have become rare with our current understanding of the neural anatomy, advanced in surgical instrumentation, and our technical experience.

CONCLUSION

VATS sympathectomy surgery for primary hyperhidrosis is an effective and safe treatment which provides permanent improvement of palmar and axillary symptoms. The recent advances in technology have enabled this procedure to be performed endoscopically in an effective and safe manner with minimal and discrete scarring in the patient's axilla (Figure 5).

Figure 5. Arrows point to the two portal sites in the patient's axilla used for thoracoscopic sympathectomy. These incision sites at one year following surgery are cosmetically small and hidden.

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