Chapter 25

Thoracoscopic Sympathectomy

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Hyperhidrosis is a condition of sweating in excess of that required for normal thermoregulation. The onset of symptoms is usually during childhood or adolescence. Although any site on the body can be affected, the sites most commonly affected are the palms **(Fig. 25.1),** axillae and soles of the feet.. Hyperhidrosis causes life-long social and in some cases disabling functional morbidities in affected individuals. The second (T2) and third (T3) thoracic ganglia are typically felt to be responsible for palmar hyperhidrosis, while the fourth (T4) thoracic ganglia primarily controls axillary hyperhidrosis. Upper thoracic sympathectomy with ganglionectomies at T2, T3, and T4 levels has been performed by multiple centers for the treatment of these conditions. In the past, however, the approaches to the high thoracic sympathetic chain were highly invasive and were performed by either by posterior paraspinal, supraclavicular or an open thoracotomy. The introduction of minimally invasive video-assisted thoracoscopic surgery (VATS) 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. The technical aspects of the two- port thoracoscopic sympathectomy using 2-mm instruments will be described. We have changed from routinely doing T2-4 ganglionectomy and sympathectomy on all patients as a result of current research. We are now performing T3 ganglionectomies, dividing and removing the sympathetic chain above and below the T3 ganglion, for patients with symptoms of only palmar hyperhidrosis. We are adding the T4 ganglionectomy in patients who experience symptoms of both palmar and axillary hyperhidrosis.

Patient Selection

It is important to reserve surgical intervention of idiopathic hyperhidrosis for cases that are recalcitrant to nonoperative interventions. Additionally, a pre-operative comprehensive work up is necessary to rule out secondary hyperhidrosis that is potentially treated medically. Among the many causes of secondary hyperhidrosis are paraneoplastic/neurologic syndrome, thyroxicosis, diabetes mellitus, gout, menopause, pheochromocytoma, medications such as tircyclic antidepressants and propranolol, chronic alcoholism, and spinal cord injury. Nocturnal hyperhidrosis is specifically associated with Tuberculosis and Hodgkins Disease.

In the absence of secondary causes of hyperhidrosis, primary hyperhidrosis has traditionally been treated medically first. Systemic anticholinergic drugs have variable symptomatic treatment. However, they have common undesirable side effects that make these drugs unpopular. Topical anticholenergics such as Drysol can be used to avoid the adverse effects of systemic anticholinergics, but can cause regional irritation requiring further skin care. Another innovative treatment is direct application of current (15-20mA) over the palmar skin daily for 30 minutes. More recently, injection of Botulinum toxin (Botox) directly into the palmar subepidermal tissue has been tried.

Pre-operative Preparation

A complete laboratory work-up that includes thyroid function panel, serum glucose levels, uric acid, and urine catecholamine level should be performed in addition to routine imaging with at least a chest radiograph. The techniques described assume that bilateral endoscopic sympathectomies are the surgical goal being performed in a patient with symptoms of bilateral hyperhidrosis. A unilateral procedure may also be performed using these techniques if so desired. However, patients with unilateral symptoms must be thoroughly evaluated preoperatively for possible causes of secondary hyperhidrosis.

Operative Procedure

We prefer the double-lumen endotracheal intubation used for single lung ventilation. With this technique the ipsilateral lung can be deflated which provides the advantage of preventing the lung from obstructing the operative field. Before proceeding with the surgery on the contralateral lung, there should be verification from the anesthesiologist that the previously operative side lung is providing adequate ventilation. There have been reported cases of unrecognized hypoxia that led to death and/or severe cerebral ischemic injury. We routinely attempt to minimize incidence or at least the size of a postoperative pneumothorax by placing the suction/irrigator instrument at the apex of the thoracic cavity and endoscopically visualize lung reinflation (**Fig. 25.2).** When the lung is re-expanded to near completion, the endoscope and Varess needle port are withdrawn from the thoracic cavity. Next, the suction/irrigator is switched to the suction mode then completely withdrawn to evacuate any remaining air within the thoracic cavity. This port is then quickly sealed.

Palmar cutaneous temperature transducers can be used bilaterally to monitor for at least a one degree temperature increase which has been suggested to predict adequate sympathectomy and corresponding successful clinical outcomes. An alternative intraoperative method to monitor for successful sympathectomy is by laser Doppler flowmetry or arteriole Doppler of the hands. Blood flow to the hands increases following successful sympathectomies and thus palmar temperature increases secondary to this. This increased flow has been measured at an average of 48 +/- 7 perfusion units preoperatively increasing to 121 +/- 17 perfusion units following sympathectomy, and is measurable as early as 22 minutes after sympathectomy versus 34 minutes for the average measurable palmar skin temperature increase. Caution must be used, however, because the initial cautery to the parietal pleura for exposure to the sympathetic chain may result in increased palmar blood flow and thus inaccurately predict success of surgery.

The lateral decubitus position has typically been described for the VATS endoscopic sympathectomy. This positioning, however, requires that the patient be repositioned for surgery of the contralateral side for bilateral sympathectomies, adding significant operative time. Our preference for patient positioning is supine (Inderbitzi's position) with the patient's arms abducted to 90 degrees and the operative table tilted in about 30 degrees of reverse trendelenberg **(Figs. 25.3 and 25.4).** Reverse trendelenberg allows the deflated ipsilateral lung to fall away from the upper thoracic cavity, and aids in surgical exposure by revealing the sympathetic chain. This positioning provides sufficient bilateral, surgical access when using ports via the third intercostal space along the midaxillary line.

It is possible to perform the thoracic sympathectomy for hyperhidrosis via a single port technique. This requires precise placement of the port along the midaxillary line between the third and fourth ribs. A 10-mm Flexi-path port (Ethicon Endo-Surgery, Inc., Cincinnati, OH) is inserted with a blunt introducer through a 1.5 to 2-cm incision. The port can be secured to the skin using a staple gun. Care should be taken when introducing the thoracic ports to avoid the neurovascular bundle which courses directly below the rib. Preemptive analgesia for the skin incision and an intercostal block are recommended to reduce the incidence of intercostal neuralgia, one of the commonest complications following thoracoscopic sympathectomy. Additionally, a soft Flexi-path port and small diameter instruments; primarily a 5-mm endoscope and a 5-mm mini-Metzenbaum scissors with a monopolar electrocautery attachment help to decrease traumatic compression to the neurovascular bundle. Both of these above instruments can be manipulated through a single port despite them rubbing against each other at the portal site. Use of two instruments through a single port can in fact be difficult because the instruments tend to interfere with one another or experience friction against the plastic port. To correct for this problem, it is generally helpful to maneuver both instruments (endoscope and working instrument) together and slowly so that they are parallel and move together. The working instrument can be advanced and retracted, in a pistoning motion, beyond the endoscope. The instruments will tend to work in unison and not against each another when using this technique. Mineral oil can also be used to reduce friction of the instruments between each other and between the instruments and the port.

A second port can be placed to if surgical access to the sympathetic ganglion is fraught with too much struggle. The optimal site for this second port placement is best determined by viewing the existing thoracic cavity exposure through the endoscope. The likely positions will be either ventrally (anterior axillary line), dorsally (posterior axillary line) or caudally in the midaxillary line of the fourth intercostal space (between the fourth and fifth ribs). Care must be exercised when using a more cranial port than the third intercostal space as this places the subclavian artery or brachiocephalic vein at risk for injury. The second port should always be placed under direct observation within the thoracic cavity using the endoscope.

The 0-degree endoscope usually provides sufficient visualization for sympathectomies using a single or double port technique. A 30-degree scope offers increased circumferential visualization of the thoracic cavity. Additionally, the working instruments typically function best when working straight-on, whereas an angled scope can be positioned more tangential to the surgical field and thus less likely to physically hinder the working instrument.

We have recently adopted and modified a less invasive thoracoscopic sympathectomy surgery. This technique utilizes disposable, 3-mm Endopath access needles (**Fig. 25.5**, Model

#AN3MM, Ethicon Endo-Surgery, Inc., Cincinnati, OH) for access ports to the thoracic cavity. A 2-mm zero degree endoscope (**Figs. 25.6 and 25.7** Model #26008AA, Karl Storz, Charlton, MA) is placed through one Endopath needle and a 2-mm cautery shear is placed through the other. This is an attractive alternative to the larger ports and instruments typically used for thoracic sympathectomy surgery. Currently, we are using the smaller endoscopic instruments and a two-port technique placed in the 3rd intercostal space. The Endopath access needle is inserted posteriorly in the midaxillary line (**Fig. 25.8)** and the 2-mm 0-degree endoscope (Model #26008AA, Karl Storz, Charlton, MA) is fit neatly through this needle port. A 3.5-mm flexible port (**Fig. 25.9**, Model # 8903.072 Richard Wolf, Vernon Hills, IL) is placed 4-cm anterior to the Endopath needle port, in the anterior midaxillary line of the 3rd intercostal space (**Fig. 25.10).** This port is not only flexible but shorter than the Varess needle port and ribbed to prevent it from backing out **(Figs. 25.10 and 25.11).** A 3.5-mm combined electrocautery/scissor (Snowden Pencer, Tucker, GA), 2-mm electrocautery/hook instrument (Model #630-318, Jarit, J. Jammer Surgical Instruments, Hawthorne, NY), 2-mm suction/irrigator (Karl Storz, Charlton, MA) , and a 2-mm grasper instrument (Model # 89-2348, Snowden Pencer, Tucker, GA) can be used through this working port. The potential advantages using smaller instruments and a two-port technique are to decrease the incidence of postoperative intercostal neuralgia. Additionally, the two-port technique provides an improved angle to approach the sympathetic chain with the working endoscopic instruments.

Verify with anesthesia that the ipsilateral lung is deflated prior to introducing the Endopath access needle port into the thoracic cavity. Once the endoscope is introduced through the needle port, the thoracic cavity, lung and mediastinum are explored. Pleural adhesions to the lung parenchyma are not infrequently found. These adhesions must first be cauterized then divided to release the lung from the thoracic wall. The deflated lung is gently swept away from the upper thoracic spine if the sympathetic chain is not easily visualized by simply positioning the patient in reverse trendelenberg. The lung can also be swept caudally if necessary.

There are some notable differences in the anatomy of the right and left thoracic cavity. On the right, the subclavian artery and vein are typically identifiable but embedded within fat of the thoracic outlet at the chest apex. If visible, the first rib has a much higher take-off and smaller radius of curvature than the adjacent caudal ribs. The rib heads, beginning with the second rib, are readily identifiable through the parietal pleura and are an important landmarks during the thoracoscopic sympathectomy surgery (**Fig. 25.11)**. Additional landmarks to determine the T2, T3 and T4 ganglion of the sympathetic chain include the azygos vessels **(Fig. 25.12).** The azygos vein and azygos arch drain several large intercostal veins which are easily seen in the right thorax. The highest intercostal vein is formed by the union of the second, third and fourth intercostal veins. The continuation of the highest intercostal vein empties into the arch of the azygos. The first intercostal vein typically drains directly into the brachiocephalic vein. The union of the azygos arch and the brachiocephalic vein forms the superior vena cava in the right thorax.

In the apex of the left thorax, the aorta and brachiocephalic vessels lie next to one another **(Figs. 25.13 and 25.14).** Each of these vessels has a corresponding subclavian artery and vein that course parallel to each other and cross over the first rib head. This first rib head is thus not directly visible thoracoscopically. The second rib is usually the highest rib head easily visible articulating with the spine **(Fig. 25.15).** The second, third and fourth rib heads are easily visible and are key landmarks during the sympathectomy surgery. The stellate ganglion lies within the first intercostal space between the covered first rib head and the exposed second rib head. The highest intercostal vein is a continuation of the first segmental vein which often courses directly over the stellate ganglion and often crosses superficial to the subclavian artery to empty into the brachiocephalic vein.

The sympathetic chain is a slightly raised, longitudinal structure running parallel to the spine and coursing over the rib heads just deep to the semi-transparent parietal pleura. The parietal pleura from the third to fourth rib head is divided. Each sympathetic ganglion is located over or just beneath the corresponding numbered rib. The ganglion is distinguished from the sympathetic chain as a swelling of the chain to the T4 ganglion and is gently incised in line with and directly over the sympathetic chain. This is done under direct visualization using the 0-degree or 30-degree endoscope. Repeated palpation or manipulation of the sympathetic ganglion should be minimized as this may induce swelling, irritation or hyperemia and induce bleeding. Next, the exposed sympathetic chain and associated (T2)T3-T4 ganglion are isolated, cauterized, then excised and completed removed from the thoracic cavity. Hemostasis is achieved when necessary using bipolar cautery **(Fig. 25.16).**

The best ganglion for resection in the treatment of palmar hyperhidrosis is still debatable. Compensatory hyperhidrosis has been reported to be as high as 95% in patients following sympathetic ganglion resection. Fortunately, these symptoms typically resolve by six months. 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. It also appears that the there is less severe compensatory truncal hyperhidrosis when resecting T3 versus T2 ganglion and infrequent compensatory hyperhidrosis when resecting T4 ganglion when compared to the T2 ganglion resection. Inhibition of both palmar and axillary hyperhidrosis is typically an added benefit resulting from the T4 ganglion resection. The accessory nerve of

Kuntz is 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 nerve branch may continue to carry neural signals past the transected segment of the sympathetic nerve trunk and should be transected when identified to increase the success of decreasing palmar hyperhidrosis.

Post-operative Management and Complications

In spite of all the benefits offered by thoracoscopic sympathectomy, the potential complications are real. The physiologic response of the body following sympathectomy can cause compensatory sweating in areas previously unaffected and gustatory sweating. In a series of 850 patients who underwent this procedure, 55% experienced new trunk sweating, while 36% reported new gustatory sweating. In another study, up to 99% of treated patients (72 total patients) experienced compensatory sweating (17% gustatory) within 1 month of surgery. The technical complications associated with the endoscopic approach and performance of the sympathectomy carry further risks that include pneumothorax, intercostal neuralgia, damage to the great vessels, and the sequelae of general anesthetic use, as well as Horner syndrome associated with T1 ganglion injury, and recalcitrant hyperhidrosis.

Careful insertion of the port over the superior border of the rib reduces the risk of intercostal neurovascular injury and postoperative intercostal neuralgia. Initial port placement should be done using a blunt tip instrument and only after the ipsilateral lung has been deflated to avoid injury to the lung parenchyma. The second port, and any subsequent ports, should be placed under direct visualization if possible.

Clear visualization and identification of the T2 ganglion aids in identifying the stellate ganglion, located just cephalad to the second rib and usually covered by a small fat pad.

Avoiding manipulation of this fat pad and therefore potential injury to the stellate ganglion lessens the risk of Horner's syndrome. Furthermore, avoiding this fat pad minimizes the risk of injury to the subclavian artery, which lies just beneath it.

CONCLUSION

Thoracoscopic sympathectomy is an effective and safe definitive treatment for primary palmar hyperhidrosis. The recent advances in technology have enabled this procedure to be performed using endoscopes and endoscopic working instruments as small as 2-mm in diameter. This has resulted in less incidence of intercostal neuralgia and decreased scarring. Supine patient positioning with arms abducted to 90 degrees and slight reverse trendelenburg has enabled us to perform bilateral sympathectomy procedures without having to reposition the patient while under anesthesia. Awake thoracoscopic sympathectomies using local anesthetic and intravenous sedation versus general anesthesia may be a viable option in select patients in the near future.

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FIGURE LEGENDS

Fig. 25.1 The figure above shows the common clinical presentation of a patient with palmer hyperhidrosis.

Fig. 25.2 High power endoscopic view of the lung in the left thoracic apex completely reinflated. The tip of the 3-mm suction/irrigator is visible in upper right of image. After the lung is visualized to be completely inflated, the suction/irrigator is switched to suction mode and both the endoscope and the suction/irrigator are withdrawn from the thoracic cavity to minimize the potential for a pneumothorax.

Figs. 25.3 and 25.4 The patient is positioned supine in twenty degrees of reverse trendelenberg with arms abducted ninety degrees. Bilateral axilla are sterilely prepped and draped for sequential sympathectomies performed without the need for patient repositioning. Note that the monitors are positioned so that the surgeon and assistants can easily view them from either side of the patient. The comfortable working position is within the axilla of the patient, anesthesia at the head of the patient and the back table/mayo stand with instruments at the foot-end of the patient. The comfortable working position is within the axilla of the patient, anesthesia at the head of the patient and the back table/mayo stand with instruments at the foot-end of the patient **(3).** The diagram illustrates the supine patient positioning prior to draping. Note that the arms are fully abducted to ninety degrees to create surgical access to the axilla **(4).**

Fig. 25.5 An Endopath access needle (Model #AN3MM, Ethicon Endo-Surgery, Inc., Cincinnati, OH) 3-mm in diameter is used for the endoscopic port. A 2-mm endoscope fits nicely through this needle-port. The all metal port-endoscope provides minimal frictional resistance and thus smooth endoscopic manipulation during surgery.

Figs. 25.6 and 25.7 The endoscopes available are a 2-mm rigid (but fragile) 0-degree and a 3-mm 30-degree rigid scope (Model #26008AA for the 0-degree scope, Model #26008BUA for 30-degree scope, both by Karl Storz, Charlton, MA). A light cable in good condition and strong light source are important to optimize image clarity and visibility on the monitor. This is especially important when using the 2-mm endoscope.

Fig. 25.8 Supine positioning of the patient allows for bilateral sympathectomies to be performed without having to reposition the patient. Twenty degrees of reverse trendelenberg helps with gravity retraction of the lung apices. Thus, the upper thoracic sympathetic chain can typically be visualized without having to use carbon dioxide insufflation.

Fig. 25.9 A flexible, ribbed 3.5-mm port (model # 8903.072, Richard Wolf, Vernon Hills, IL) is used to accommodate the working instruments in the anterior axilla port of the 3th intercostal space. Figure 9 shows the reusable port and trochar side-by-side, and figure 10 shows the trochar inserted in the port. This attachment is how the instrument is assembled to penetrate the thoracic cavity.

Fig. 25.10 The 2-mm 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 use of the 2-mm endoscope as this is fragile and easy to break.

Fig. 25.11 (upper diagram) Diagramatic representation of upper thoracic sympathetic chain and the rib heads in the right thoracic cavitiy. Note that during surgery, direct endoscopic visualization of the subclavian artery, brachiocephalic vein and stellate ganglion are typically obscured by the overlying fat pad. (bottom diagram) The parietal pleura is semi-translucent. The rib heads, sympathetic chain and often the intercostal artery and vein are easily visualized. The pleura is incised along the sympathetic chain and the ganglion and any communicating rami are identified.

Fig. 25.12 In the right upper thorax, the sympathetic chain can again be seen coursing over the rib heads adjacent to and parallel with the azygos vein. The patient is positioned supine in these photos. The rib heads articulate with the vertebrae as illustrated in the diagram Figure 11.

Fig. 25.13 and 25.14 Endoscopic views of the left thoracic cavity. The upper image shows the sympathetic chain coursing over the second and third rib heads and deep to the semitransparent parietal pleura. The lower image shows the endoscopic cautery/metzenbaum scissors palpating the first rib head which lies within the apical fat pad.

Fig. 25.15 In the upper image, the thoracic aorta and brachiocephalic vein are visable. These vessels divide within the apical fat pad into the subclavian artery and vein and course over the head of the first rib. The second rib head is easily visualized. The endoscopic instrument is pointing to the sympathetic chain coursing over the third rib head in the lower photograph.

Fig. 25.16 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.