4g THORACOSCOPIC SYMPATHECTOMY

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1. Introduction

Thoracic sympathectomy (TS) is a procedure designed to interrupt the adrenergic effect of the central nervous system on the upper extremity. The predominant effects of sympathectomy are reduction of vasomotor tone and lowering of peripheral vascular resistance. These main effects are the prominents for the indications of various sympathetic disorders. Surgical removal of the upper thoracic sympathetic chain has demonstrated its clinical effectiveness in the management of a variety of autonomic-mediated disorders of the upper extremity [1]. Dr Aleaxder was the first to perform an operation on the upper sympathetic chain in 1889 [2]. This surgical treatment was first decribed in 1940s [3]. Goetz's excellent collective review in 1948 provided a historical and physiologic perspective of sympathectomy in cardiovascular disorders [4]. Through the paralel evolution of two seemingly unrelated and independent surgical developments—endoscopic surgery and thoracic sympathectomy—thoracoscopic sympathectomy has become the procedure of choice for thoracic sympathectomy [5,6]. Although Jaboulay in 1899 first proposed that sympathectomy might be of value in promoting circulation in the extremities [7], Kotzareff is credited with having performed the first cervical sympathectomy for hyperhidrosis in 1920 [8]. An anterior cervical approach to the thoracic sympathetic chain was described independently by Jonnesco [9] and Briining [10]. During the evolvement of this procedure many different surgical techniques were described in the literature. After the 1980s, the resection and/or cauterization of the sympathetic chain became popular, until Lin et al introduced a simple clipping technique [2]. The specific advantages and disadvantages of each of these surgical approaches have been thoroughly reviewed by Roos [11]. By the development of the aneststhetic techniques and single-lung ventilation provided a stimulus to expand the scope of diagnostic procedures and encourage the therapeutic application of thoracoscopic surgery. The advent of the thoracoscopic equipments the results of the procedure became much more better with lower morbidity and mortality for the selected upper extremity. Although there are many different techniques described in the literature there is still a debate which is the best surgical option. But the most important subject is there is even no concensus in describing the sympathectomy. Krasna made a very clear explanatory description for these surgical approaches [3]:

- Thoracoscopic; done with any means of thoracoscopy, including video-and standart eyepiece-assisted procedures,
- Video-assisted thoracic surgery (VATS); refers only to those procedures that use a video camera to help with visualization of the intrathoracic cavity,
- Sympathectomy; refers to procedures in which the sympathetic chain is resected, ablated, or divided,
- Sympathicotomy; refers to the division of the sympathetic chain without removal of any section thereof. Unless otherwise specified, this would exclude ablation techniques that are done without a directed division of the chain,
- Ablation; refers to procedure where the chain is destroyed using electrocautery or laser without directed division,
- Endoscopic thoracic sympathectomy; another common term used more often in the nonthoracic surgery literature for sympathectomy.

- Th2 sympathectomy- resection of the Th2 ganglion, generally achieved by resecting the sympathetic chain between the middle of the second rib (Th2 rib) and the third rib (Th3).
- Th2 sympathicotomy- division of the sympathetic c hain over the middle of the 2nd rib and division of the synmpathetic chain over the middle of the 3rd rib. This accomplishes isolation of the Th2 ganglion that is found in between the two cuts. (This nomenclature should be used for all subsequent levels-is- Th3 sympathectomy/ sympathicotomy- involves resection/ division of the nerve chain over the third and fourth ribs achieving Th3 ganglion isolation and so on).

2. Indications

Thoracic sympathectomy is indicated for a variety of sympathetic disorders. Thoracoscopic sympathectomy has the same indication with the open procedures. In the literature the most common accepted indications for TS are as follows:

1- Sympathetic maintained causalgia or pain,
2- Palmar hyperhidrosis,
3- Non reconstructible arterial insufficiencies,
4- Raynaud syndrome,
5- Facial blushing,
6- Axillary sweating,
7- Cold sensitivity after cold injury,
8- Angina pectoris,
9- Long QT syndrome,
10- Reflex sympathetic dystrophy (Shoulder-hand syndrome, Sudeck's atrophy),
11- Splanchnicectomy for pancreatic pain.

The most common indication, and the indication in which the results are most satisfactory , is hyperhidrosis. The other indications listed above are very limited and the results are not as satisfactory as the hyperhidrosis. Probably the other most promising results get are as follows; axillary sweating, fascial blushing, cold sensitivity.

3. Contraindiations

Although TS is a relatively safe operation applied as an outpatient procedure with very limited side effects and limitations, there are some contraindications.

The major contraindications are;

-Severe cardio-pulmonary insufficiency,

-Severe pleural diseases (empyema, pleuritis),

-Previous thoracotomy,

-Coagulopathy,

-Re-sympathectomies,

-Inability to maintain adequate arterial oxygen saturation with contralateral single-lung ventilation,

-Active infection.

There are also some relative contraindications as;

-Pleural adhesions and obliterations,

-Raynaud Syndrome with autoimmune disorders,

-Untreated hyperthyroidism,

-Very low heart rate,

-Infants and very small children,

-A very rare anatomical variant for right hemithorax; azygos lobe

4. Surgical Procedures

4.a. Surgical Equipment;

1- Video-endoscopic monitoring system,
   a) Optical telescope; 0° or 30° , 2mm, 5mm, 10 mm (Figure 1)
   b) Monitor,
   c) Carbondioxide insufflation system,
   d) Video-recorder (Figure 2)

2- Trocar with different sizes according to the surgeons preference and videoendoscopic equipment; 2mm, 3mm, 5mm, 10mm

3- Hook cautery

4- Grasper

5- Endoscopic scissors

6- Endoclips

7- Endoscopic aspirator

8- Suction catheters (Figure 3)

9- Silicone pad to place under the vertebral column (Figure 4).

10- All open surgical equipments shoul be kept by-side for any kind of emergencies.

4.b. Operating Room Set up

Operation room set up does not have so many differences from a conventional operation room. The most important equipment differing from conventional OR

Figure 1:
Optical telescopes

Figure 2:
Videoendoscopic monitoring system

is the video-endoscopic system. A very flexible operation table is very important for patient positioning (semi-fowler, trendelenburg, lateral decubitis etc). General anesthesia equipments with double lumen endotracheal entubation is essential (Figure 5).

4.c. Patient Positioning

According to the surgical technique; due to unilateral, bilateral operation, lateral decubitis, semi-fowler,fowler, supine, semi-prone positions could be chosen. If a bilateral operation is planned patient is in supine position with both arms abdducted (Figure 4, 6). For an unilateral approach lateral decubitis position is better. For uni-bilateral anterior approach semi-fowler or fowler position could be the choice.

4.d. Surgical Technique

In general the operation is performed in supine or semifowler position a pad placed under the vertebral column under general anesthesia using a double lumen endotracheal tube.Although awake operation can be performed without any endotracheal intubation [13]. Due to the procedure that will be applied to the sympathetic chain; transection, cauterization or clipping, tree port, double port or single port could be chosen respectively. The incision should be minimal due to the trocar size. We generally prefer double port with 5mm trocar in supine position with a silicone pad under the vertebral column. The first incision is made in the fourth submammary intercostal space just below the pectoral muscle as an access route for camera, and a second incision is made at third midaxillary intercostal space to introduce surgical instruments. 5mm trocars are employed, during brief disconnection of the endotracheal tube to deflate the lung when the pleural

Figure 3:
Endoscopic tools

Figure 4:
Silicone pad under the vertebral column

Figure 5:
Operation room setup

Figure 6:
Patient Positioning

cavity is entered to avoid damaging the lung parenchyma and for adequate visualization of the surgical field (Figure 7a,b). Prior to the insertion of the camera 8-10 mmHg 2L/min carbondioxide insufflation can be performed in collapsing the lung and assisting visibility. Also semi-fowler position allow gravity to help pull the upper lobes out of the field of dissection. As the most important and promising indication for TS is the hyperhidrosis Th2 level is the choice of the appropriate level. The selection of the level could be due to;

-For facial sweating or blushing, the Th2 level is isolated by dividing over or resecting between the Th2 and Th3 ribs. Some authors just make one cut over the middle or top of the Th2 rib without attempting to isolate the nevre further below. For patients with hand sweating, the Th2 and Th3 levels are isolated, Th3 and Th4 isolated for axillary sweating. In some reports Th4 level is accepted important for satisfactory results for axillary sweating.

-For specific fascial blushing high Th2 division taking care avoiding injury to stellate ganglion. Lower third of the stellate ganglion is also safe for Horner syndrome.

-For RSD, Raynaud Syndrome, causalgia Th2 to Th3 levels are satisfactory.

-For chronic pancreatic pain referred for splanchnicectomy Th4 to Th10 should be divided.

In order to perform a succsessful sypathectomy the defining the location of the sympathetic chain is essential. The pathway of the sympathetic trunk was classified into three types (Table 1)

The most common pathway is the medial type [14]. The position of the sypathetic ganglion is another factor affecting surgical results; the location of the sympathetic ganglion was generally known as to be located in the middle portion of the intercostal space but near the upper border of the third rib (Figure 8).

Table 1:
The pathway of the sympathetic trunk

Medial	Medial portion of rib heads
Head	Runs up on the rib heads
Lateral	Lateral portion of the rib heads

Figure 7a,b:
Trocar sites and insertion

Careful division of the nerve over the ribs can be achieved by using a shears cautery or a hook cautery. In this case care should be taken to avoid damage to the underlying perioteum because this can cause severe discomfort and sunburn-like pain in the postoperative period. Cauterize/divide the pleura for 5 cm laterally; in this way, if an aberrant nerve bundle of Kuntz is identified, it too is severed (Figure 9). The sympathetic chain is dissected free from surrounding tissue and the rami communicants were divided. Care is taken to avoid injury to the adjacent intercostal veins. The Kuntz nerve and accessory fibers are ablated with electrocautery whenever observed.Cautery should be avoided in the area proximal from the Th2 to preclude any hazard to the first thoracic ganglion and endoscopic scissors should be used. Separate the transected ends of the sympathetic chain as far as possible to prevent regrowth of the nerve. For the success of the procedure and prevention of side effects the anatomical variations and landmarks should be kept in mind. The most important altenate neural pathway is the Kuntz nerve which is located in the first intercostal space.

There are generally three types of alternate neural pathways (Table 2) [15]

The arrangement of the superior intercostal veins has surgical relevance because injury to these veins may cause troublesome bleeding that compromises dissection of the sympathetic chain. The superior intercostal vein is a large branch draining into the azygos vein in the region of the Th2. The prevertebral fascia overlying the longus colli muscle, which lies medial to the neck of the second rib, is an under-appreciated structure that may mimic the sympathetic chain. This is particularly so in asthenic patients.

After obtaining hemostasis, the lung is expanded. Gentle suction is applied to the trocar to evacuate intrathoracic air. And the incision is sutured. The same procedure is applied to the contralateral side. For awake TS the only difference is patients is under intercostal blockade and slight sedation. Generally we applied clip to T2 ganglia and applied suction while asked patient to take a deep breath. There is no need for chest tubes except the complicated cases.

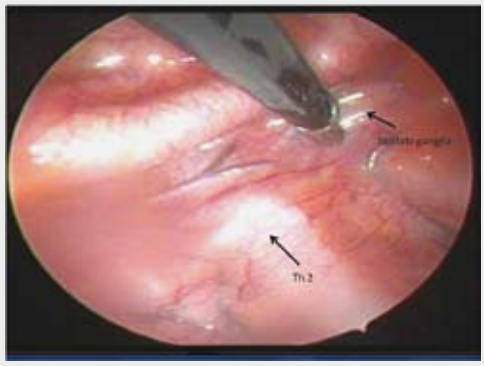

Figure 8:
Th 2 and Stellate ganglia

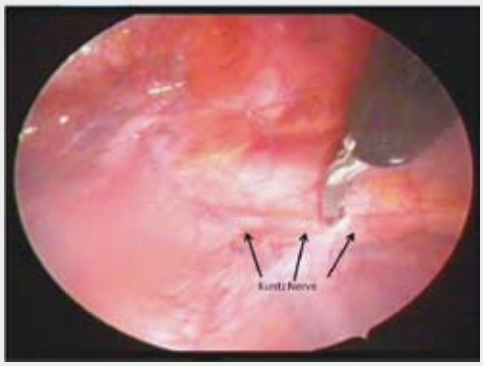

Figure 9:
Kuntz nerve

5. Postoperative care

The patient is extubated in the operating room (except awake operations). A postoperative chest x-ray is obtained in the recovery room and the respiratory status is monitored closely. If patient suffers pain analgesia should be given in order to enhance the patients respiration effort. The patient is transferred to a hospital room when appropriate. Typically around the globe this procedure is done as an outpatient operation with patients going home on the same day.

6. Complications and Avoidance

The potential complications of thoracoscopic sympathectomy include adverse occurrences that may result from any thoracoscopic procedure and complications specific to sympathectomy. Some general complications include:

-Pain
-Arrhythmia, severe bradycardia
-Hypotension
-Hypercarbia
-Hemorrhage
-Pneumothorax
-Persistent pulmonary parenchymal air leak
-Horner's syndrome
-Subcutaneous emphysema
-Severe compensatory sweating
-Paresthesias
-Infection

The most common complication is the compensatory sweating. Most of the authors addresses the injury of a long segment of sympathetic chain. The other complications are very uncommon. But the most disabiling complication is Horner's syndrome. This complication is very uncommon (0.5%). To avoid this complication resection should be limited to the upper Th2 but the lower 1/3 of the stellat ganglion could be safely removed. Avoidence of usage of electrocautery at this level is essential.

The other complications could be avoided by knowing the anatomical landmarks and careful surgical dissection.

7. References

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Table 2:
Types of alternate neural pathways

Type A	Demonstrable sympathetic connection to either the cervicothoracic, second thoracic ganglion or the interganglionic portion of the sympathetic chain between the cervicothoracic and second thoracic ganglia
Type B	The nerve of Kuntz occured as a variable intrathoracic ramus between the first and second ventral rami, proximal to the point where the first thoracic ventral ramus gives a large branch to the brachial plexus
Type C	Macroscopic sympathetic connections to either the first intercostal nerve or its lateral cutaneous branch

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