



Research Article

# Endoscopic Lumbar Sympathectomy for Plantar Hyperhidrosis: the Learning Curve and Initial Outcome

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## Abstract

**Background** Endoscopic Lumbar Sympathectomy (ELS), a definite treatment of Primary Plantar Hyperhidrosis (PPH), remains to be a challenge to thoracic surgeons due to unfamiliarity. Hence, the aim of this study is to evaluate the learning curve and clinical outcomes of ELS for PPH

**Methods** This study included a total of 42 consecutive patients who underwent ELS by a single operator between September 2019 and July 2020. The learning curves were made using the Cumulative Sum (CUSUM) method by incorporating the number of cases and three surgical technique-related factors, including operation time, postoperative complication, and clinical outcomes.

**Results** The average age of patients was  $28.3 \pm 9.2$  years; there were 24 (57.1%) females. There were no cases of operative mortality or major bleeding. In 23 (54.8%) patients, ELS was performed concurrently with Endoscopic Thoracic Sympathectomy (ETS). The average operative time of ELS was  $63.3 \pm 30.5$  min. Postoperative leg swelling and post-sympathetic neuralgia were seen in four and five patients, respectively. There was no case of postoperative retrograde ejaculation. Moreover, there was no compensatory hyperhidrosis in patients who received ELS only.

**Conclusions** ELS is known to be the most effective treatment of PHH, providing excellent short-term outcome. However, it is a challenging surgery. Nonetheless, with experience, it may be possible to overcome the associated risks and complications.

**Keywords:** Endoscopic lumbar sympathectomy; Learning curve; Primary plantar hyperhidrosis

## Introduction

Primary Plantar Hyperhidrosis (PPH), similar to other primary hyperhidrosis, is caused by an imbalance in the homeostasis of the autonomic nervous system [1]. Usually, PPH is accompanied by palmar hyperhidrosis [2]. A trigger in

the sympathetic nervous system, for any reason, may result in simultaneous sweating in the hands and feet. PPH, when compared with palmar hyperhidrosis, is arguably less problematic since the feet are covered by socks and shoes. However, it could still have negative impact on the quality of life, inducing physical and mental stress; it could exacerbate foot odor, cold feet, skin lesions, infections, unstable foothold, etc [3-5]. Like other primary hyperhidrosis, numerous non-surgical treatment methods have

been developed [4]. However, these methods are only temporary and not cost effective. In addition, medication-based treatments using various anti-cholinergic drugs are known to induce many side effects, resulting in a high drop-off rate [5]. As such, these methods are generally not preferred by patients. Therefore, surgical methods, like lumbar sympathectomy, are considered to be the preferred treatment methods for PPH. Moreover, there has been an increasing number of surgeons using Endoscopic Lumbar Sympathectomy (ELS) since its inception in the mid-1990s [5-7]. Endoscopic Thoracic Sympathectomy (ETS) is being performed in many institutions to treat primary palmar hyperhidrosis. ETS has been shown to temporarily resolve PPH; after a period of time, patients begin to show symptoms of PPH again. ETS, unlike ELS, is a simple surgical procedure, with a short operation time and minimal complications [6]. ELS is relatively riskier due to unfamiliar anatomy and higher risk of post-operative complications. And, as such, it is not widely used in many institutions around the world. To the best of our knowledge, although the surgical outcome of ELS has been reported in a few institutions, detailed discussions on its learning curve is lacking in the literature. Thus, herein, we retrospectively reviewed the surgical outcome of ELS in the treatment of PPH from a single surgeon in our institution, with a detailed discussion on the learning process.

## Materials and Methods

### Patients and Clinical Data

This study was approved by the Institutional Review Board of Gangnam Severance Hospital. Consecutive patients who were treated for primary plantar hyperhidrosis and underwent retroperitoneal endoscopic lumbar sympathectomy (ELS) between September 2019 and July 2020 were included in this study. A review of electronic records was performed; preoperative characteristics, disease status, operative technique, perioperative outcome, and postoperative outcomes were evaluated. The grade of compensatory hyperhidrosis, and recurrence/failure were investigated at each outpatient visit throughout the postoperative follow-up period. The grade of compensatory hyperhidrosis - or the degree of annoyance - was defined as none, mild, moderate, severe, or very severe. The degree of satisfaction was categorized as very satisfied, satisfied, moderate, dissatisfied, or very dissatisfied.

### Surgical Technique of Endoscopic Lumbar Sympathectomy and Endoscopic Thoracic Sympathectomy

Surgery was performed under general anesthesia and endotracheal intubation in supine position. Three trocar insertion sites were used on the lateral abdominal wall, in between the rib cage and hip bone, to insert three trocars. First, a 15mm skin incision was made on the middle of the lateral abdominal wall (from the umbilicus, the point made by a perpendicular line between the transverse line and lateral abdominal wall) by

splitting the external oblique muscle, internal oblique muscle, and transversalis muscle (in this order). Retroperitoneal space was considered to be established once the retroperitoneal fat was exposed. Next, a 12mm trocar (Covidien®, Spacemaker™ Pro) with a ‘space maker’ function was inserted. The ballooning allows for a medial movement of the peritoneum and an expansion of the retroperitoneal space, allowing for adequate surgical field of view. After removing the 12mm trocar and inserting a finger to sweep and confirm the space, 5mm ballooning trocars were inserted in both directions (one in the direction of the rib cage, and another in the direction of the hip bone). Then, under continuous CO<sub>2</sub> inflation, surgery was continued. To accurately detect the lumbar sympathetic chain, a Doppler flowmetry was used; the integrated laser Doppler flowprobes were attached to the soles of both feet to check the blood perfusion. After finding the third lumbar ganglion, sympathectomy via electro-cauterization (hook bovie) was performed. It was performed on the left side first, followed by the right side. All surgical procedures were recorded.

ETS was performed using two tiny incisions, one for 2-mm thoracoscope and the other for 3-mm instrument. If the patient had palmar hyperhidrosis, then R4 sympathectomy was performed; if axillary hyperhidrosis, then R4 and R5 sympathectomy was performed. To complete the transection of the potential bypass nerve fibers, we extended the transection range by approximately 2-cm, laterally along the surface. ETS was performed on the right side first, then on the left side. To finish the surgery, a 10-Fr chest tube was placed in the pleural cavity, and then the lung was inflated to check for air leaks. Once there was no more air leakage, the chest tube was removed. To detect the possibility of pneumothorax, postoperative routine chest radiography was performed in all patients prior to extubation in the operating room.

### Postoperative Patient Care

Immediately after the operation, an IV PCA device - a continuous infusion-type with elastomeric pump - was connected to patients and a solution containing 100 mL of fentanyl 10 µg/mL and ramosetron 0.3 µg (Accufuser Plus, Woo Young Medical, Chungbuk, Korea) was delivered, with a basal infusion rate of 2 mL/h, bolus dose of 0.5 mL, and a lockout period of 15 minutes. And, at 4 hours after surgery, abdominal X-rays in supine and erect positions were taken to check for peritoneal injury. All patients were monitored for one full day in the ward and discharged on postoperative day 1.

### Statistical Analysis and Cumulative Sum (CUSUM) Chart

All descriptive statistics are presented as the mean ± Standard Deviation (SD) for continuous variables. CUSUM chart technique was used to identify the learning curve. It monitored and plotted the deviation between the observed value and the reference value. The reference value of operation time, which is a continuous

variable, was assumed as the average, and the category variables - peritoneal tear and leg swelling - were assumed to be 0.05 and 0.03, respectively. The optimal cut-off point was determined as the point at which CUSUM began to stably decrease. All statistical analyses were performed using SPSS statistical software version 21.0 (SPSS, Inc., Chicago, IL, USA).

**Results**

**Clinical Characteristics of Plantar Hyperhidrosis Patients**

There was a total of 42 patients who received retroperitoneal ELS for plantar hyperhidrosis during the study period. The average age was 28.3 ± 9.1 years; 24 patients (57.1%) were female; 22 patients (52.8%) had received previous ETS; and 23 patients (54.8%) received ETS concurrently with ELS. Of the 22 patients who had previously received ETS, 7 patients showed recurrence of palmar hyperhidrosis and received ELS with a redo of ETS, concurrently. The mean operation time was 63.3 ± 30.4 minutes. These patients were discharged one day after surgery on average (Table 1).

Variables	Total, n = 42
Age, years	28.3 ± 9.1
Sex (male/female)	18 / 24
BMI, kg/m <sup>2</sup>	22.0 ± 3.4
Previous ETS (%)	22 (52.4)
ETS combine (%)	23 (54.8)
OP time, minute	63.3 ± 30.4
Hospital stay, days	1 (1 - 3)

BMI: Body Mass Index; ETS: Endoscopic Thoracic Sympathectomy; OP: Operation

**Table 1:** Baseline characteristics in endoscopic lumbar sympathectomy for plantar hyperhidrosis.

**Operative Results and Compensatory Hyperhidrosis**

All patients who underwent ELS had improved symptoms immediately after surgery. At the first follow-up (one week after the surgery), two patients (4.7%) showed recurrence. At the second follow-up (one-month after surgery), 38 patients (90.5%) were very satisfied and two patients were satisfied. These two

‘satisfied’ patients showed signs of slightly moist soles of the feet one week after the surgery. The remaining two patients showed recurrence, and were dissatisfied (Table 2). Compensatory sweating was investigated at the one-month follow-up. Twenty-three patients (54.8%) who underwent only ELS showed no signs of compensatory sweating; 19 patients (45.2%) who underwent ELS concurrently with ETS responded to have mild compensatory sweating. All patients who underwent ELS responded to have no compensatory sweating (Table 2).

Variables	Grade	Total, n = 42
Compensatory sweating, n (%)	None	23 (54.8)
	Mild	19 (45.2)
	Moderate	
	Severe	
	Very severe	
Satisfaction, n (%)	Very satisfied	38 (90.5)
	Satisfied	2 (4.8)
	Moderate	
	Dissatisfied	2 (4.8)
	Very dissatisfied	

**Table 2:** Degree of satisfaction and compensatory hyperhidrosis at one month after endoscopic lumbar sympathectomy with or without endoscopic thoracic sympathectomy.

**Perioperative and Postoperative Complications**

Of all patients who underwent ELS, there was no case of open conversion. There were two cases (4.7%) of genitofemoral nerve resection (mistaken for lumbar sympathetic chain). Peritoneal tear occurred in 7 patients (17.6%). Besides this, there were no other injuries to structures (Table 3). There were no issues related to retrograde ejaculation. Although four patients (9.5%) showed postoperative leg swelling, they all showed improvement at the one-week follow-up visit. Additionally, two patients (4.7%) showed abdominal discomfort, and another two patients (4.7%) showed wound problems. Five patients (11.9%) showed post-sympathetic neuralgia; however, this also improved at the one-week follow-up visit (Table 4).

Variables	Total, n = 42
Conversion to open, n (%)	0
Genitofemoral nerve resection, n (%)	2 (4.7)
Lumbar vessel injury, n (%)	0
IVC injury, n (%)	0
Ureter injury, n (%)	0
Lymphatic vessel injury, n (%)	0
Peritoneal tear, n (%)	7 (17.6)

IVC: Inferior Vena Cava

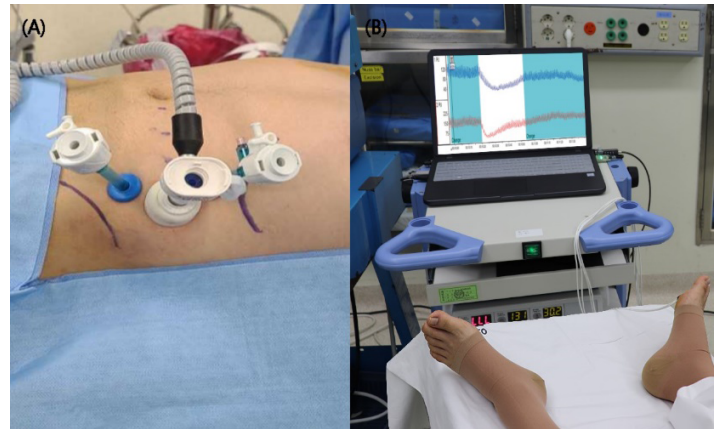
**Table 3:** Perioperative complication after endoscopic lumbar sympathectomy.

Variables	Total, n = 42
Retrograde ejaculation, n (%)	0
Leg swelling, n (%)	2 (4.7)
Abdominal discomfort, n (%)	0
Wound problem, n (%)	0
Post-sympathetic neuralgia, n (%)	0

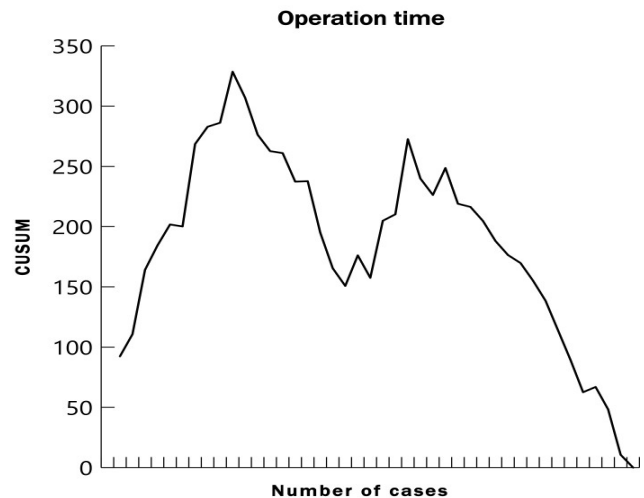
**Table 4:** Postoperative complication after endoscopic lumbar sympathectomy.

**CUSUM Charts**

The CUSUM chart depicting the learning curve is shown in Figures 1-4. Figure 2 shows the learning curve in terms of operation time, with a bimodal peak at 10<sup>th</sup> surgery and 24<sup>th</sup> surgery. Figure 3 shows the learning curve with respect to leg swelling; there appears to be a decrease in the frequency of leg swelling after the 18<sup>th</sup> surgery. Figure 4 shows the learning curve in terms of peritoneal tear; there appears to be a decrease in the frequency of peritoneal tear after the 24<sup>th</sup> surgery. Taking these together, about 20 operations may be needed to overcome the learning curve for ELS.



**Figure 1:** (A) Image of trocar placement during Lt. side endoscopic lumbar sympathectomy. Trocar was inserted on the lateral aspect of the abdomen, between the rib cage and hip bone. Surgery continued with the expansion of retroperitoneal space using spacemaker and CO<sub>2</sub>. (B) Image of Doppler flowmetry attached to the soles of the feet to monitor blood perfusion. Movement was confirmed on a graph in real time during sympathicotomy on L3 ganglion.



**Figure 2:** Cumulative sum (CUSUM) chart for operation time.

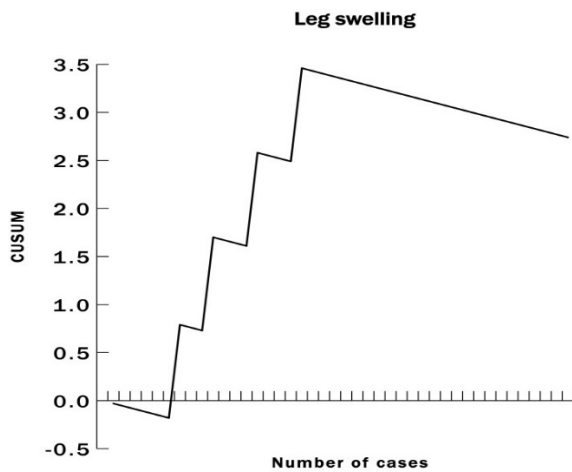


Figure 3: Cumulative sum (CUSUM) chart for leg swelling.

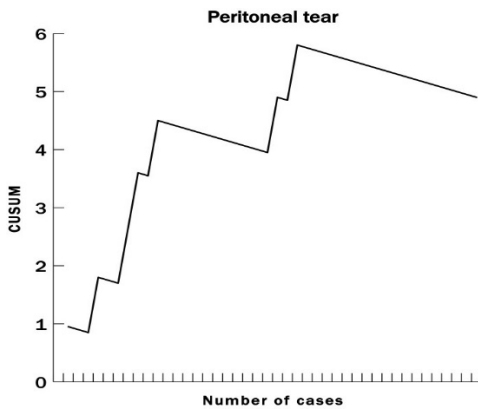


Figure 4: Cumulative sum (CUSUM) chart for peritoneal injury.

## Discussion

Based on our findings, ELS may be an effective and safe treatment method for PPH. We believe it may be comparable to ETS, which is applicable to both primary palmar hyperhidrosis and axillary hyperhidrosis. In fact, we found that ELS resulted in less compensatory hyperhidrosis than ETS. In addition, ELS combined with ETS also showed positive results. Nonetheless, about 20 cases were required to establish - or overcome - the learning curve. Lumbar sympathectomy was first introduced by Julio Diez in 1924 [8]. However, it did not gain much traction until Rieger et al. in 2000 with the introduction of retroperitoneal endoscopic approach, which showed to have good outcomes for treating PPH [5]. Still, it has not been widely adopted, since most thoracic surgeons are not familiar with the retroperitoneal approach because they have predominantly been performing sympathetic surgeries, like ETS. Moreover, there are challenges with unfamiliar anatomy, i.e., great vessel or nerve variation, required with the retroperitoneal approach. In addition, in most cases where PPH

is accompanied by primary palmar and axillary hyperhidrosis, ETS alone can yield a transient improvement - for a short duration of one week to one month. Hence, in many cases, only ETS may be recommended. However, since ELS only may result in temporary improvement, ELS should still be considered [3,4,7,9]. The most important part of ELS is to accurately identify the lumbar sympathetic chain. In the present study, there were two cases of surgical failure. Upon reviewing the recorded surgical videos, the lumbar sympathetic chain was not cut properly, which resulted from the misrepresentation of the genitofemoral nerve, potentially due to the unfamiliar anatomy of this area. This is a challenge for most surgeons without appropriate experience [10,11]. To mitigate this issue, we used a Doppler flowmetry on the soles of both feet during ELS [12,13]. We learned that by stimulating the lumbar sympathetic chain, the plantar blood flow changes in real time. This is important in reducing leg swelling, especially in obese patients. The risk of leg swelling is higher in patients with more lymphatic fat tissue, as it requires more dissection to find the lumbar sympathetic chain. Based on the CUSUM chart, the present study had more incidence of peritoneal tears than other studies. In cases with severe degree of peritoneal tears in the operation field, we inserted a 3-mm port under the umbilicus for de-airing (CO<sub>2</sub> gas venting) to continue on with the surgery. Moreover, we performed postoperative supine and erect abdominal X-rays to identify all peritoneal tears. Through this experience, we learned that the location of trocar insertion may be important in the retroperitoneal approach. When inserting the trocar on the lateral aspect of the abdomen, between the rib cage and hip bone, it may allow for easier manipulation of the lumbar sympathetic chain as the trocar is inserted more toward the medial side; however, it increases the chance of peritoneal tear. Conversely, as the trocar is inserted more downward toward the lateral side, the chance of peritoneal tear decreases, but manipulation of the lumbar sympathetic chain becomes difficult. There are several limitations to this study. This study was a retrospective study, conducted at a single institution with a single surgeon. Additionally, it only considered the immediate and short-term follow-up outcomes. However, to the best of our knowledge, this is the first study evaluating the learning curve of ELS, and we believe that this adds value to the existing knowledge. Nonetheless, a future large-scale study with long-term follow-up data is necessary.

## Conclusion

This study confirms the existing knowledge that ELS is the most effective treatment for PPH, providing excellent outcome. However, ELS is still a challenging surgery. About 20 cases were required to establish a learning curve and to see an improvement in the postoperative outcome. Like any treatment, there are risks and complications associated with ELS; however, it may be possible to overcome these with experience.

## References

1. Schick CH (2016) Pathophysiology of Hyperhidrosis. *Thorac Surg Clin* 26: 389-393.
2. Glaser DA, Hebert AA, Pariser DM, Solish N (2007) Palmar and plantar hyperhidrosis: best practice recommendations and special considerations. *Cutis* 79: 18-28.
3. Rieger R, Loureiro Mde P, Pedevilla S, de Oliveira RA (2011) Endoscopic lumbar sympathectomy following thoracic sympathectomy in patients with palmo-plantar hyperhidrosis. *World J Surg* 35: 49-53.
4. Rieger R, Pedevilla S, Lausecker J (2015) Quality of life after endoscopic lumbar sympathectomy for primary plantar hyperhidrosis. *World J Surg* 39: 905-911.
5. Rieger R, Pedevilla S, Pöchlauer S (2009) Endoscopic lumbar sympathectomy for plantar hyperhidrosis. *Br J Surg* 96: 1422-1428.
6. Loureiro Mde P, de Campos JR, Kauffman P, Weigmann S, Fontana A (2008) Endoscopic lumbar sympathectomy for women: effect on compensatory sweat. *Clinics (Sao Paulo)* 63: 189-196.
7. Nemeş R, Şurlin V, Chiuţu L, Georgescu E, Georgescu M, et al. (2011) Retroperitoneoscopic lumbar sympathectomy: prospective study upon a series of 50 consecutive patients. *Surg Endosc* 25: 3066-3070.
8. Fontaine R (1997) [History of lumbar sympathectomy from its origin to the present]. *Acta Chir Belg* 76: 3-16.
9. Rieger R (2016) Management of Plantar Hyperhidrosis with Endoscopic Lumbar Sympathectomy. *Thorac Surg Clin* 26: 465-469.
10. Singh S, Kaur S, Wilson P (2016) Early experience with endoscopic lumbar sympathectomy for plantar hyperhidrosis. *Asian J Endosc Surg* 9: 128-134.
11. Vlahovic TC (2016) Plantar Hyperhidrosis: An Overview. *Clin Podiatr Med Surg* 33: 441-451.
12. Kurganskiĭ OV (2006) [Method of laser Doppler-flowmetry in the assessment of efficiency of sympathectomy in patients with upper extremity ischemia]. *Vestn Khir Im I I Grek* 165: 71-73.
13. Ng I, Yeo TT (2003) Palmar hyperhidrosis: intraoperative monitoring with laser Doppler blood flow as a guide for success after endoscopic thoracic sympathectomy. *Neurosurgery* 52: 127-130.