Endoscopic Lumbar Sympathectomy for Focal Plantar Hyperhidrosis Using the Clamping Method

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Abstract: Surgical treatment for focal plantar hyperhidrosis is not yet well studied. Bilateral endoscopic lumbar sympathectomy (ELS), using the clamping method, was performed in 63 patients with focal plantar hyperhidrosis. Clamps were placed at L3 (46.0%) or L4 (52.4%), with one case at L2. All patients had improvement in foot sweating, with 96.6% achieving total anhidrosis. Five early cases had to be converted to an open surgical method. Complications were rare. No sexual problems were reported by the male patients. Compensatory sweating, already present in those with prior thoracic sympathectomy (n = 56), remained unchanged in 91.1% and no severe compensatory sweating occurred in those who had only ELS. Postoperative pain was minimal. ELS is a viable option in the treatment of plantar hyperhidrosis, whether after a thoracic sympathectomy or in primary cases of plantar hyperhidrosis. Use of the clamping method provides good results with minimal postoperative pain or other complications.

Key Words: hyperhidrosis, lumbar sympathectomy, plantar hyperhidrosis, foot sweating

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Focal hyperhidrosis that affects the hands, axilla, and feet is a well-known pathophysiologic problem that affects about 1.5% to 2.8% of the general population.[1] The impact of this ailment has been widely described.[2,3] Focal plantar hyperhidrosis is usually associated with the other sites of focal hyperhidrosis (palmar and axillary) and, although not as visible as palmar and axillary sweating, can in itself cause significant social and functional problems for patients. These can include foot odor, cold feet, and skin lesions from infections, unstable foothold either in shoes or when walking barefoot, and need to frequently change socks and even shoes. When conservative treatment with aluminum chloride lotions, iontophoresis, or even botulinum toxin injections does not provide long-lasting results, the surgical option is available. In these persistent and difficult cases, surgical interruption of the sympathetic nerves will eliminate the eccrine sweat gland production.[4] In the past, the very invasive nature of the surgical approach for plantar hyperhidrosis prevented widespread use of this method. However, the advantages of an endoscopic approach and use of clamping rather than resection of the nerves, now widely used for thoracic sympathectomy for palmar hyperhidrosis, have made it more feasible to offer a similar operation to patients affected with plantar sweating.[5,6]

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Initially, endoscopic lumbar sympathectomy (ELS) was performed just for selected groups of patients with occlusive vascular problems such as Buerger disease, Raynaud disease, and reflex sympathetic dystrophy, but with little noted success.[7–12] However, in the last few years, more clinical attention has been given to cases of focal hyperhidrosis. Although endoscopic thoracic sympathectomy (ETS) as the surgical treatment for palmar hyperhidrosis is well described,[2] only recently has ELS for plantar hyperhidrosis become clinically feasible for widespread use as technical and physiological questions were answered. Enough experience has been gained in this approach to dispel previous fears about retrograde ejaculation and other possible complications.

It was the aim of this study to show that ELS, using a clamping method, is a practical, safe, and effective option for treatment of plantar hyperhidrosis. The study reviewed the author's experience with 63 cases of lumbar sympathectomy for focal plantar hyperhidrosis, using a prospectively planned database. This article reports those findings, technical aspects and pitfalls of the procedure, and up to 2 years of follow-up. Emphasis is placed on lessons learned.

MATERIALS AND METHODS

Patients

Between June 2007 and September 2009, 63 patients underwent bilateral ELS—a total of 126 ELS procedures. The only indication was plantar hyperhidrosis. Table 1 summarizes the patient characteristics. The patient population was heavily female (79.4%) with a mean age of 30.6 years. A family history of hyperhidrosis was reported by 38.1%. All but 7 of the patients (88.9%) had previously undergone ETS or some form of thoracic sympathectomy. Those 7 had only lumbar sympathectomy for severe plantar hyperhidrosis that bothered them more than their palmar problem. The time interval between ETS and ELS for those patients who had the previous surgery ranged from about 4 months to 28 years, with a mean interval of 5.8 years (SD = 4.5; 2.9 excluding the one outlier). All patients had tried conservative measures to help them with their plantar hyperhidrosis, with little long-term success. The most common of these treatments included aluminum chloride lotions, iontophoresis machines, anticholinergic agents, and Botox injections. Last follow-up with the patients ranged from weeks postsurgery in the most recent cases to 23 months, with a mean follow-up time of 7.1 months (SD = 5.2).

Procedures

All patients underwent a preoperative evaluation, with a more extensive evaluation for those above the age of

TABLE 1. Characteristics of 63 Patients Undergoing Endoscopic Lumbar Sympathectomy

Sex: male/female	20.6%/79.4%
Age (y)	
Mean (SD)	30.6 (10.2)
Minimum-maximum	14.8-64.9
≤20	12.7%
21-40	71.4%
41-60	14.3%
>60	1.6%
Ethnicity	
White	71.4%
Asian	12.7%
Hispanic	11.1%
Middle eastern	4.8%
Family history	38.1%
Severity of plantar hyperhidrosis	
Severity rating "severe"	100%
Changed socks frequently	96.8%
Changed shoes frequently	57.1%
Recurrent infections	44.4%
Caused social problems	60.3%
Previous ETS for palmar hyperhidrosis	88.9%

ETS indicates endoscopic thoracic sympathectomy.

50 years. Risks and side effects were discussed thoroughly with each patient. Patients who had had previous ETS surgery (n = 56) were asked to describe any compensatory sweating they experienced, rated as mild (little interference with their life); moderate (some interference with their daily-life activities); or severe (in hot weather caused discomfort; soaked clothing requiring them to change clothes frequently during the day). After ELS, compensatory sweating was again rated and patients were asked whether there was any change from previous levels. A very detailed preoperative discussion was carried out about the possibility of an increase in the level of post-ELS compensatory sweating. The possibility that retrograde ejaculation might be a side effect of this procedure was discussed at length with the male patients, and only those men who had already had children or had a previous vasectomy were included in this early series of patients.

Data used in the study had been collected by medical chart review, telephone interviews, and e-mail or mail correspondence performed by the author as part of a routine, ongoing follow-up, and database. Patients were interviewed to determine whether they considered their symptoms to be "cured," "improved," or "unchanged." Compensatory hidrosis was rated as "severe" when sweating interfered with normal activity, usually by requiring a change of shoes or socks 2 to 3 times a day. It was considered "moderate" when the patient noted it but indicated it was not bothersome; or "mild" when the patient did not mention dampness or noted it only briefly in passing.

Surgical Technique

The ELS operation is performed with the patient under general anesthesia. All cases were performed bilaterally. Patients are supine with a rolled towel underneath their back to provide lordosis. The hands are placed along the body, and 2 securing straps are applied, one in the chest area and the second in the hip area. The skin is marked, and the line extends from the navel to the lateral abdominal wall. The tips of the ribs and the hip bones are marked. Starting on the left side, the patient is rotated with the left side up at about 30 degrees. An incision of about 18 mm is made in the lateral abdominal wall halfway between the hip bone and the rib cage. The superior iliac crest and the rib margin are good anatomic constants to use as markers in addition to the navel (Fig. 1). These should put the surgeon at or around L3. The incision is carried out through the scarpa's fascia down to the external oblique fascia. Then, with the help of the grid iron technique, the external oblique muscle, internal oblique muscle, and the transversalis muscle are opened. The retroperitoneal space is opened and the space is further developed with finger movements cephalad and caudally. A balloon space maker is inserted and, with the scope inside the balloon, the balloon is inflated until an appropriate size is achieved. Then the balloon is taken out and further enlargement of the space is obtained with insufflation. Initially, the pressure is set at 7 mm Hg and flow of 7 liters/minute and then raised to 10 to 12 mm Hg. With the scope at 10 mm 0 degrees, the surgeon can see the space and make sure that there is no tear made in the peritoneum. Looking cephalad and caudally, the surgeon can see the abdominal wall muscles

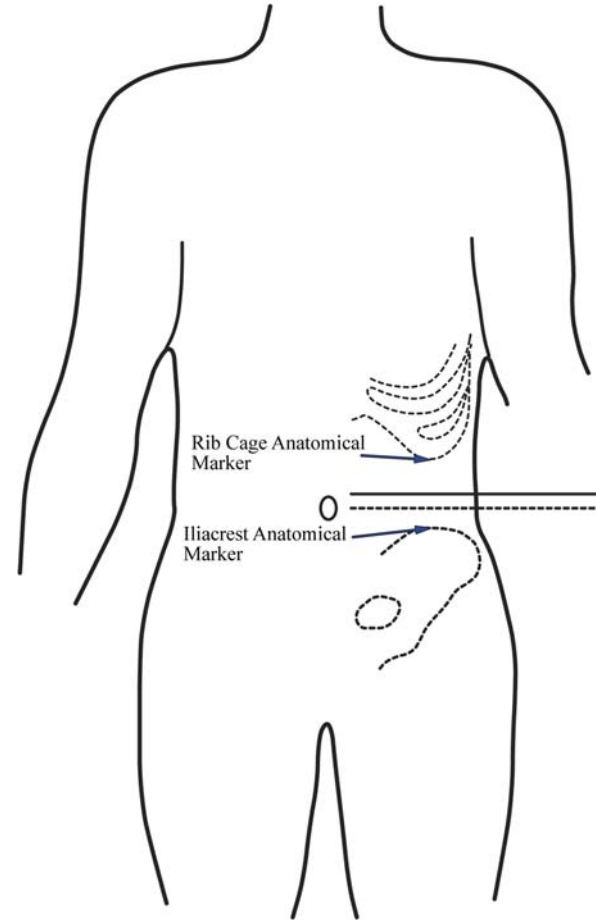

FIGURE 1. Line drawing showing the relationship of the hip, rib cage, and umbilicus. The solid line is drawn half-way between the rib cage and superior iliac crest, whereas the dotted line is drawn at the level of the umbilicus.

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FIGURE 2. Camera port and trocars in place on a patient.

separated from the peritoneum. Two more 5-mm trocars are inserted proximal and distal to the camera (Fig. 2). Working instruments such as hook cautery and endopeanuts are inserted, creating a space medial to the psoas muscle. The ureter and the genitofemoral nerves are identified (Fig. 3). At times, the ilioinguinal nerve can also be observed. The sympathetic chain lying medial to the psoas muscle is seen and clamped at the level of L-3 to L-4 using three to four 5 mm endoscopic clips (Ethicon, Somerville, NJ) (Fig. 4). Individual anatomic variation will put the targeted area sometimes closer to L3, sometimes closer to L4, and occasionally closer to L2. Some variation in placement of the clips may also occur because of venous structures such as the lumbar vein or big lymphatic vessels that must be avoided. If there is any clinical question about the position of the clips, fluoroscopy is used at this time to confirm appropriate location at or below L2. In early cases, temperature monitoring was performed but was abandoned as more experience indicated it was not necessary because once the nerve is freed from the surrounding fascia and mobilized, it is easy to apply the clips around the sympathetic trunk and to make sure that the clips encompass the whole nerve. After completion of the left side, the trocars are removed and the patient is rotated with the right side up. The same procedure is repeated on the right side, with special attention to the vena cava and possible lumbar veins (Fig. 5). Once completed, the external fascia is closed and skin incisions are closed. X-ray

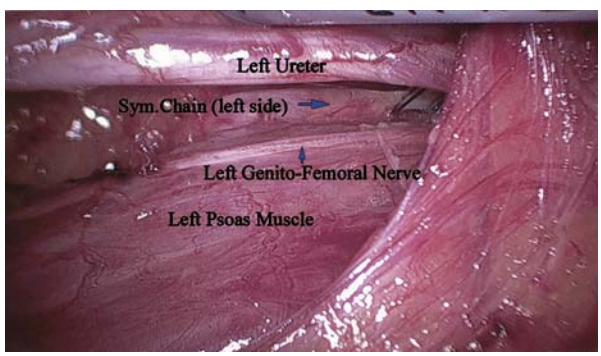

FIGURE 3. View through the camera showing the ureter, the genito-femoral nerve, and the psoas muscle on the left side, as well as the sympathetic (Sym) chain. Several clips can be seen in place. Care must be taken not to confuse the genito-femoral nerve with the sympathetic chain.

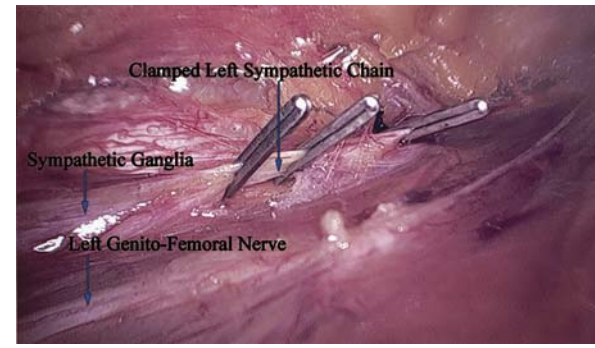

FIGURE 4. Closer view of 3 Ethicon endoscopic clips in place on the left sympathetic chain at the L3 level.

verification of the clip location is carried out in the recovery room. Early patients in the series stayed overnight in the hospital, but now the procedure is performed on an outpatient basis.

Data Analysis

Although primarily a descriptive study, some inferential statistical analyses were also performed. Comparisons of 2 categorical variables (eg, level of clamping by compensatory sweating category) were performed using χ^2 or Fisher exact test. Criterion for statistical significance was set at $P \leq 0.05$, 2-tailed.

RESULTS

The ELS clamping was performed at the level of L-3 in 46.0% of cases, L-4 in 52.4%, and L-2 in 1 case (1.6%). Operating time for bilateral cases was 75 to 115 minutes. Blood loss was minimal. All patients reported a total or major reduction in their plantar hyperhidrosis, with 96.6% achieving anhidrosis or "cure."

There was a learning curve for this procedure. Five patients (7.9%) in the early part of the series had to be converted to an old-fashioned open technique, which loses the superb visualization. The primary reasons for the conversion had to do with attention to a few important steps in creating the retroperitoneal space. Both obesity and also very athletic and physically fit individuals posed relative difficulty because in such individuals the peritoneum is very adherent to the psoas muscle. In addition, in individuals with very well-developed psoas muscles, the

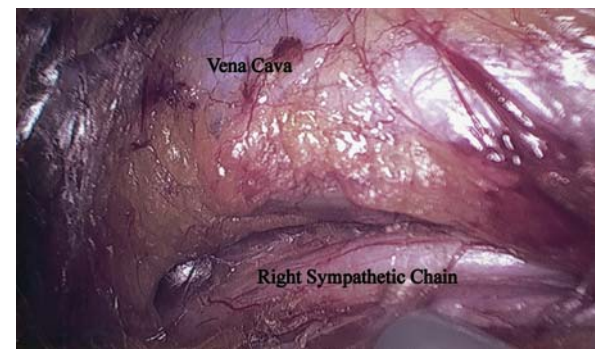

FIGURE 5. View showing the right sympathetic chain in relation to the vena cava.

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sympathetic chain tends to be buried behind them. Once these pitfalls were identified, all further patients were performed endoscopically, with no need for conversion to an open approach. It should be noted that even after the open approach, patients went home the next morning.

The navel is usually located at the L-3 level and can serve as a landmark for clip application. Note, however, that in the male population the navel can be somewhat lower than in the female. Postoperative x-rays were taken to verify clip location, but no differences in outcome were observed based on variations in clip placement. In some patients, the clips were not at the same level on the 2 sides because of anatomic reasons (eg, large lumbar veins).

Complications

In 1 patient, the clip was mistakenly applied on the ilioinguinal nerve. The mistake was recognized in the recovery room. The patient was taken back, the clips were removed, and clips were applied to the sympathetic chain, after which the foot became dry. The neurotemesis disappeared in 4 weeks. There was one case of lymph duct injury in an obese patient. The procedure was aborted and completed at a later time, with no residual problems.

Air escaping into the peritoneal cavity can cause problems in maintaining the retroperitoneal space. There is a preferential flow of the insufflated air into the peritoneal cavity. If the space becomes obliterated, a 5-mm trocar can be inserted into the abdomen allowing completion of the operation. This air escape can happen with or without an obvious tear and occurred in 12 cases in this series without requiring conversion to an open procedure. Nor were added trocars used. If too much air is noted in the abdominal cavity at the end of the procedure, a small opening in the peritoneum can evacuate this excess air.

With ETS surgery, there is the likelihood of some postoperative pain. On the basis of this series of ELS patients, postoperative pain is less of a problem. None of the patients required pain management other than an oral pain killer several hours after the surgery. Eleven of the early patients (17.5%) reported some neuralgia and use of such pain killers. With experience, it was determined that the less dissection and cleaning around the vertebral bodies where the sympathetic chain runs, the less likely the patient is to have neuralgia or pain in the postoperative period. There was no difference in the rate of neuralgia based on lumbar level clamped, with 17.2% of L3 and 18.2% of L4 cases reporting some neuralgia and medication use ($\chi^2 = 0.009$, $P > 0.05$). Postoperative temporary edema in the feet occurred in 35 patients (55.6%) but was self-limited. Postural hypotension is a postoperative possibility about which patients are counseled. In the current group, 2 patients described short-lived hypotensive episodes. One patient reported back pain. No postoperative retrograde ejaculation was noted in any of the male patients.

This author considers compensatory sweating of some degree to be a given outcome of ETS. Therefore, all 56 patients who had a previous ETS were graded for compensatory sweating before the ELS procedure, with grades of mild (28.6%), moderate (64.3%), and severe (7.1%). Transepidermal water loss or evaporation studies were not performed. However, 91.1% of the patients with previous ETS rated their compensatory sweating as unchanged after as compared with before the ELS procedure. There was no difference based on level of clamping (L3 vs. L4, Fisher exact $P = 0.355$). Five patients felt it had increased in severity; 4 rated the increase from mild before to moderate after; and 1 increased from moderate before to severe after. In the 7 patients with no prior thoracic sympathectomy, 1 rated post-ELS compensatory sweating as mild and the other 6 as moderate. However, post-ELS compensatory sweating is limited primarily to the lower leg areas. There was no statistically significant relationship of final compensatory sweating grade for all patients to level of clamping ($\chi^2 = 3.57$, $P > 0.05$).

One patient who had only ELS but also has severe palmar hyperhidrosis described a temporary high level of compensatory sweating which became moderate a few weeks after the ELS procedure. Like in patients after ETS, there is the possibility of temporary resweating beginning 3 to 4 days after the ELS, and this occurred in 7 patients (11%). Patients should receive preoperative counseling about this and be reassured that it is usually short-lived. One patient in this series experienced a surprising but short-term recurrence in palmar sweating. One patient had a partial recurrence of sweating at the lateral aspect of 1 foot within weeks of the ELS procedure. She was reoperated and a clip was added in a higher position. This provided an improved result.

DISCUSSION

Focal hyperhidrosis is most likely a genetic problem that affects about 1.5% to 2.5% of the general population.[1,2] The clinical presentation of plantar hyperhidrosis is similar to palmar hyperhidrosis, but is more likely to start later in life possibly because of later maturation of the eccrine sweat glands in the plantar region. It creates both social and functional problems. Conservative measures are usually met with little long-term success in patients with severe hyperhidrosis. The treatment for focal palmar hyperhidrosis is described elsewhere and includes both conservative treatments and ETS for those who fail conservative treatment.[2,5,13–15] Focal axillary hyperhidrosis that fails conservative treatment can be treated either with excision of the axillary sweat glands or with axillary suction curettage.[16,17]

Until recently, there was little to offer patients with plantar sweating who did not respond to conservative treatment or who were little improved after ETS for the primary indication of palmar hyperhidrosis. The medical establishment is often lacking the appropriate information for patients regarding how to deal with this problem or where to direct patients to find treatment. Although injection of botulinum toxin has been used for axillary hyperhidrosis, there are few studies of its efficacy for plantar hyperhidrosis, and injections in the sole of the foot can be quite painful. This and the fact that these painful injections have to be repeated regularly makes this approach undesirable for many patients. Percutaneus injection of sympatholitic agents such as phenol has been described,[18] but the uncontrolled spread of the injected phenol can produce undesired complications and phenol is not available in the United States.[19] Computed tomography-guided injections of 50% or higher concentration of alcohol can be a good temporary measure but has a high recurrence rate.[20]

The surgical treatment of plantar hyperhidrosis is not as common and not as well known as its older brother, ETS. However, owing to pioneering work in Brazil and

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Austria, the surgical modality has become more widespread, with reproducible results.[4,21,22] Once the learning curve is mastered, the ELS procedure can be accomplished on a routine basis. The superb visualization that is obtained with current endoscopic equipment allows a safe and precise approach to the lumbar sympathetic chain. A quick resumption of normal activity is also possible because of the relative low level of pain.

On the basis of the author's considerable experience performing ETS with clamps and that reported by others, with results comparable with those obtained with resection, it was deemed appropriate to perform the ELS procedure using clamps rather than resection.[5,23–26] One potential advantage of this approach is that it leaves a permanent marker and in case of a mistaken nerve identification, the clamp can be removed with little or no long-term side-effects. As experience was gained, it became clear that the less dissection or less interruption of side branches whose nature is not clearly defined, the less the postoperative pain. Unless there is total identification of every branch and its function, this author recommends clamping or dividing only the main trunk. The exact length of the sympathetic trunk that should be eliminated is not clear.[27] The pathophysiology and the anatomic relations of the sympathetic chain are well described in text books and surgical journals. Eccrine sweat gland production is controlled by sympathetic fibers originating at T12, L-1, and L-2. Studies have shown that interruption of the sympathetic trunk in the lumbar region from the L-3 level will interrupt the sympathetic innervation from that level to the caudally located L-4 to S-3 levels, producing anhidrosis of the feet.[28] In fact, L-2 is the anatomic site where no more sympathetic flow is generated distally. Especially in the male population, the clips should not be above L-2. More than one clip is placed to assure definite cessation of nerve impulses over a 1 to 2 cm area. However, on the basis of the good results in producing anhidrosis in this study, it does not seem necessary to place clips at more than one node as long as they are at or below L2.

It was not always possible to identify the ganglia, but just clamping the trunk seems to provide the same result because nearly all patients experienced cure of sweating. In one patient, the degree of sweat reduction in the left foot did not match the anhidrosis on the right foot. Postoperative x-rays and operative pictures showed that the right-sided clips were placed 7 mm lower than those on the left. In contrast, in other cases where there was not an exact bilateral matching location of the clips, no differences resulted. We should bear in mind the possibility that the sympathetic ganglia on either side could be located differently. In addition, the clips may need to be placed differently depending on the location of certain arterial or venous structures. Clinical experience and judgment play a role in clip placement decisions. In this series of patients, there was no discernible difference in outcome between placement of the clamps at L3 or L4.

The potential of producing sexual dysfunction in males is a concern that has been raised by a number of authors as ejaculation is the result of sympathetic nerve stimulation.[3,13,29] However, these studies were often dealing with lumbar sympathectomy for peripheral vascular problems where patients may already have had some degree of sexual dysfunction because of advanced age and vascular issues.[30,31] In this series of patients operated strictly for plantar sweating, there were no cases of retrograde ejaculation problems. Another recent report also found that permanent sexual function disorders were unlikely when lumbar sympathectomy was performed at L-3 or L-4.[21] The main supply for sympathetic innervation comes from Th12-L1, so sexual damage is unlikely as long as one stays below L-2 in performing ELS surgery.[32] As we know from the anatomy of the thoracic sympathetic chain, there is no direct and absolute correlation between the vertebral body and the level of the corresponding ganglia. This also seems to be so with regard to the lumbar sympathetic chain.[33] In this series, the navel was used as a guideline to the L3 level and was usually consistent with the midpoint of the superior iliac crest and lower rib cage. We did not take preoperative x-rays. In males, particularly somewhat obese males, the navel is usually at a lower vertebral level. In those cases, the midpoint between the superior iliac crest and the lower rib cage was used as the primary guide for where the camera was inserted. Keeping those anatomic bearings, the clamps were applied at the right location.

Compensatory sweating is expected after ETS. Although it is usually mild to moderate, about 3% to 5% of patients will report severe compensatory sweating after ETS.[2,5] Before performing ELS on patients who have had a previous ETS, a determination of their pre-ELS compensatory sweating levels should be documented, although even patients with severe compensatory sweating may wish to undergo the ELS procedure. This study found little change in the levels of compensatory sweating in those patients with prior ETS. Only a few patients rated their compensatory sweating as increased, and significant compensatory sweating has been found to be rare after ELS alone.[21] Some research suggests that even in the presence of an increase in the amount of compensatory sweating after ELS, patients rate their quality of life as improved.[22] One possible reason for little change in compensatory sweating after ELS may be that not many additional ganglia are eliminated from sending their impulses higher up in the chain. In those patients without previous ETS, this study found no severe compensatory sweating. In addition, we should keep in mind that compensatory sweating from ELS is primarily limited to the lower leg areas. Only 1 female patient who also had a severe case of palmar hyperhidrosis but chose to have only ELS developed temporary moderate-to-severe postoperative compensatory sweating that abated after 2 weeks. Longer-term follow-up will be required to address some of these issues.

Postoperative neuralgia and pain were noted in some early cases in this series. The more dissection and the more mobilization of the lumbar sympathetic chain of the vertebrae, the greater the postoperative pain. After adopting the same principle learned while performing ETS in a large series of patients, that less is better, postoperative pain and neuralgia were noted in fewer patients.[5] It is well known that sensory innervation around the vertebral bodies is very rich, therefore avoiding any interruption of this complex network of nerves will also reduce the risk of postoperative pain and long-term neuralgia.

About 11% of patients reported a temporary recurrence of their sweaty feet 3 to 4 days after ELS. This clinical fact is well known to happen in approximately 40% of patients after ETS. A simple explanation is that the sweat production is neurotransmitter mediated and the sweat production process might have already begun before the cutting or clamping of the nerves.

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CONCLUSIONS

The wider knowledge about the pathophysiology of plantar hyperhidrosis, improvements in surgical instrumentation, and clinical experience now makes ELS a viable option in the treatment of plantar hyperhidrosis, either after a thoracic sympathectomy or in primary cases of plantar hyperhidrosis. Use of the clamping method provides good results with minimal postoperative pain or other complications.

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REFERENCES

1. Strutton DR, Kowalski JW, Glaser DA, et al. US prevalence of hyperhidrosis and impact on individuals with axillary hyperhidrosis. *J Am Acad Dermatol*. 2004;51:41–48.
2. Grondin SC. Hyperhidrosis. *Thorac Surg Clin*. 2008;18: 125–234.
3. Hornberger J, Grimes K, Naumann M, et al. Recognition, diagnosis and treatment of primary focal hyperhidrosis. *J Am Acad Dermatol*. 2004;51:274–286.
4. Rieger R, Pedevilla S. Retroperitoneoscopic lumbar sympathectomy for the treatment of plantar hyperhidrosis: technique and preliminary findings. *Surg Endosc*. 2007;21: 129–135.
5. Reisfeld R. Sympathectomy for hyperhidrosis: should we place the clamps at T2-T3 or T3-T4? *Clin Auton Res*. 2006;16: 384–389. [Epub November 2, 2006].
6. Moran KT, Brady MP. Surgical management of primary hyperhidrosis. *Br J Surg*. 1991;78:279–283.
7. Wittmoser R. Die retroperitoneoskopie als neu methode der lumbalen sympathikotomie. *Fortschr Endoskopie*. 1973;4: 219–221.
8. Beglaibter N, Berlatzky Y, Zamir O, et al. Retroperitoneoscopic lumbar sympathectomy. *J Vasc Surg*. 2002;35:815–817.
9. Hourlay P, Vangertruyden G, Verduyckt F, et al. Endoscopic extraperitoneal lumbar sympathectomy. *Surg Endosc*. 1995;9: 530–535.
10. Kathouda N, Wattanasirichaigoon S, Tang E, et al. Laparoscopic lumbar sympathectomy. *Surg Endosc*. 1997;11:257–260.
11. Watarida S, Shiraishi S, Fujimura M, et al. Laparoscopic lumbar sympathectomy for lower-limb disease. *Surg Endosc*. 2002;16:500–503. [Epub November 16, 2001].
12. Elliott TB, Royle JP. Laparoscopic extraperitoneal lumbar sympathectomy: technique and early results. *Aust N Z J Surg*. 1996;66:400–402.
13. Atkins JL, Butler PEM. Hyperhidrosis: a review of current management. *Plast Reconstr Surg*. 2001;110:222–228.
14. Haider A, Solish N. Focal hyperhidrosis: diagnosis and management. *CMAJ*. 2005;172:69–75.
15. Reisfeld R, Berliner KI. Evidence-based review of the nonsurgical management of hyperhidrosis. *Thorac Surg Clin*. 2008; 18:157–166.
16. Ou LF, Yan RS, Chen IC, et al. Treatment of axillary bromhidrosis with superficial liposuction. *Plast Reconstr Surg*. 1998;102:1479–1485.
17. Bechara FG, Gambichler T, Bader A, et al. Assessment of quality of life in patients with primary axillary hyperhidrosis before and after suction-curettage. *J Am Acad Dermatol*. 2007;57:207–212. [Epub March 26, 2007].
18. Reid W, Watt K, Gray TG. Phenol injection of the sympathetic chain. *Br J Surg*. 1970;57:45–50.
19. Fraser I, Windle R, Smart JG, et al. Ureteric injury following chemical sympathectomy. *Br J Surg*. 1984;71:349.
20. Nickel J, Jahnel A, Andersen R. CT-gestutzte lumbale sympathikolyse bei hyperhidrosis plantaris. *Rofo*. 2004; 176:122.
21. Rieger R, Pedevila S, Pochlauer S. Endoscopic lumbar sympathectomy for plantar hyperhidrosis. *Br J Surg*. 2009;96: 1422–1428.
22. Loureiro MP, de Campos JR, Kauffman P, et al. Endoscopic lumbar sympathectomy for women: effect on compensatory sweat. *Clinics (Sao Paulo)*. 2008;63:189–196.
23. Lin CC, Mo LR, Lee LS, et al. Thoracoscopic T2 block by clipping: a better and reversible operation for the treatment of hyperhidrosis palmaris: experience with 326 patients. *Eur J Surg*. 1998;164(suppl 580):13–16.
24. Lin T-S, Huang L-C, Wang N-P, et al. Video-assisted thoracoscopic T2 sympathetic block by clipping for palmar hyperhidrosis: analysis of 52 cases. *J Laparoendosc Adv Surg Tech*. 2001;11:59–62.
25. Reisfeld R, Nguyen R, Pnini A. Endoscopic thoracic sympathectomy for hyperhidrosis. Experience with both cauterization and clamping methods. *Surg Laparosc Endosc Percutan Tech*. 2002;12:255–267.
26. Baumgartner FJ. Surgical approaches and techniques in the management of severe hyperhidrosis. *Thorac Surg Clin*. 2008; 18:167–181.
27. Simeone FA. The anatomy of the lumbar sympathetic trunks in man (with special reference to the question of regeneration after sympathectomy). *J Cardiovasc Surg*. 1979;20:283–288.
28. Edwards EA. Operative anatomy of the lumbar sympathetic chain. *Angiology*. 1951;2:184–198.
29. Nicolas C, Grosdidier G, Granel F, et al. Endoscopic sympathectomy for palmar and plantar hyperhidrosis: results in 107 patients. *Ann Dermatol Venereol*. 2000;127:1057–1063.
30. Quayle JB. Sexual function after bilateral lumbar sympathectomy and aorto-iliac by-pass surgery. *J Cardiovasc Surg (Torino)*. 1980;21:215–218.
31. Rose SS. Lumbar sympathectomy. *Acta Chir Belg*. 1977;76: 123–126.
32. Rose SS. An investigation into sterility after lumbar ganglionectomy. *Br Med J*. 1953;1:247–250.
33. Low PA, ed. *Clinical Autonomic Disorders: Evaluation and Management*. 2nd ed. Philadelphia: Lippincott-Raven; 1997: 17–29.

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