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Safety and Efficacy of Lumbar Sympathectomy for Plantar Hyperhidrosis: A Systematic Review

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Safety and Efficacy of Lumbar Sympathectomy for Plantar Hyperhidrosis: A Systematic Review

Abstract

Background: Hyperhidrosis, or excessive sweating, is a physiological disorder that affects 1-3% of the population. Plantar hyperhidrosis, though not life-threatening, is nonetheless an extremely debilitating disorder in psychosocial and medical regards. It can negatively affect intimate relationships, prevent participation in barefoot activities, ruin shoes, and cause skin infections. Several options are available to manage this condition such as topical aluminum chloride solutions, oral anticholinergic medications, iontophoresis machines, and even botulinum toxin injections. However, these treatments are either temporary or ineffective. Recently, lumbar sympathectomy emerged as a cure for plantar hyperhidrosis. The purpose of this study is to provide a systematic review of the evidence thus far for providers and patients considering lumbar sympathectomy for plantar hyperhidrosis when conservative measures have failed.

Method: An extensive literature search was performed using MEDLINE, Web of Science, CINAHL, and Evidence Based Reviews Multifile. The following keywords were used: *Lumbar sympathectomy, plantar hyperhidrosis, sympathectomy, hyperhidrosis, and foot.*

Results: After removing duplicate and irrelevant studies during the literature search, a total of nine were found. One article is a randomized controlled trial and the remaining are case reports and observational studies. All studies point to successful treatment in the majority of patients with plantar hyperhidrosis by performing lumbar sympathectomy using a variety of techniques. Yet most of the authors admit occasional occurrence of side-effects such as compensatory sweating, post-operative neuralgia, and temporary sexual dysfunction in one man.

Conclusion: Lumbar sympathectomy appears to be a relatively safe and effective option for resolving plantar hyperhidrosis when conservative treatment is unsuccessful. Nevertheless, there are unwanted events that may occur. Ideally, prospective randomized controlled trials should be conducted to further confirm the efficacy and safety of lumbar sympathectomy, including which method is superior, in eradicating plantar hyperhidrosis while minimizing potential adverse effects.

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Degree Name

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Lumbar sympathectomy, plantar hyperhidrosis, sympathectomy, hyperhidrosis, and foot

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Safety and Efficacy of Lumbar Sympathectomy for Plantar Hyperhidrosis: A Systematic Review

Diana M. Seaders



A Clinical Graduate Project Submitted to the Faculty of the

School of Physician Assistant Studies

Pacific University

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For the Masters of Science Degree, August 11, 2012

Faculty Advisor: Dr. Mary Von

Clinical Graduate Project Coordinator: Annjanette Sommers MS, PA-C

Biography

Diana Seaders is a native of Oregon. She attended the University of Arkansas in Fayetteville where she earned a Bachelor of Science degree in Kinesiology. She then went on to complete a Masters of Business Association degree at Willamette University's Atkinson Graduate School of Management in Salem, Oregon. During that time, she developed and ran a business, raised funds for Meals on Wheels and studied abroad in Denmark. After 3 years as a pharmaceutical representative, her true passion to practice medicine as a PA came to the fore. She entered the world of clinical research while volunteering at City Center Church's free clinic as well as for Volunteers in Medicine in Central Oregon. She was accepted into Pacific University's Physician Assistant program in 2010.

Abstract

Background: Hyperhidrosis, or excessive sweating, is a physiological disorder that affects 1-3% of the population. Plantar hyperhidrosis, though not life-threatening, is nonetheless an extremely debilitating disorder in psychosocial and medical regards. It can negatively affect intimate relationships, prevent participation in barefoot activities, ruin shoes, and cause skin infections. Several options are available to manage this condition such as topical aluminum chloride solutions, oral anticholinergic medications, iontophoresis machines, and even botulinum toxin injections. However, these treatments are either temporary or ineffective. Recently, lumbar sympathectomy emerged as a cure for plantar hyperhidrosis. The purpose of this study is to provide a systematic review of the evidence thus far for providers and patients considering lumbar sympathectomy for plantar hyperhidrosis when conservative measures have failed.

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Results: After removing duplicate and irrelevant studies during the literature search, a total of nine were found. One article is a randomized controlled trial and the remaining are case reports and observational studies. All studies point to successful treatment in the majority of patients with plantar hyperhidrosis by performing lumbar sympathectomy using a variety of techniques. Yet most of the authors admit occasional occurrence of side-effects such as compensatory sweating, post-operative neuralgia, and temporary sexual dysfunction in one man.

Conclusion: Lumbar sympathectomy appears to be a relatively safe and effective option for resolving plantar hyperhidrosis when conservative treatment is unsuccessful. Nevertheless, there are unwanted events that may occur. Ideally, prospective randomized controlled trials should be conducted to further confirm the efficacy and safety of lumbar sympathectomy, including which method is superior, in eradicating plantar hyperhidrosis while minimizing potential adverse effects.

Keywords: *Lumbar sympathectomy, plantar hyperhidrosis, sympathectomy, hyperhidrosis, and foot*

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Table I: Characteristics of Studies

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List of Abbreviations

EBM.....	Evidence-based Medicine
ELS.....	Endoscopic Lumbar Sympathectomy
ETS.....	Endoscopic Thoracic Sympathectomy
GRADE.....	Grading of Recommendations Assessment, Development and Evaluation
HDSS.....	Hyperhidrosis Disease Severity Scale
RCT.....	Randomized Controlled Trial
VAS.....	Visual Analogue Scale

Safety and Efficacy of Lumbar Sympathectomy for Plantar Hyperhidrosis: A Systematic Review

BACKGROUND

Hyperhidrosis, or excessive sweating, is a physiological disorder that affects 1-3% of the population.¹ It can occur in areas of the body that possess a concentrated amount of sweat glands, for example, the hands, axillae, and feet. Many conservative modalities of treatment are available for this condition such as topical aluminum chloride solutions, oral anticholinergic medications, iontophoresis machines, and even botulinum toxin injections. However, there are a multitude of hyperhidrosis patients who do not appropriately respond to conservative management and a more advanced approach is indicated.²

Sympathectomy is a surgical option that arose in 1920 to treat patients with occlusive vascular issues such as Buerger disease, Reynaud's disease, and other myriad medical conditions including hyperhidrosis.² Over the years, the technique of the sympathectomy has evolved greatly. Endoscopic thoracic sympathectomy (ETS) has been performed for several years, and is now a documented safe and effective method for eradicating palmar hyperhidrosis and, in about 15% of cases, plantar hyperhidrosis³ yet, up until very recently, there was no cure for plantar hyperhidrosis. A similar procedure, lumbar sympathectomy, emerged in the early 1950s, but with it came potential adverse effects involving neuralgia and even sexual dysfunction in men. As with thoracic sympathectomy, compensatory sweating usually in the legs, abdomen, or back is also a common adverse result with lumbar sympathectomy. Lumbar sympathectomy has been performed more commonly in the last decade for plantar hyperhidrosis as more

experience was gained to minimize adverse effects.³ Lumbar sympathectomy entails either clamping or resecting the sympathetic ganglia between the levels of L2-L4 causing nerve disruption to ensue cessation of plantar sweat. Most surgeons completely resect the lumbar sympathetic ganglia, but a conversation with Raphael Reinfeld, MD, FACS (November 2011) of Los Angeles confirmed he is currently the only surgeon in the world to use the “clamping method” in lumbar sympathectomy. The “clamping method” entails 3-4 5mm titanium clips on each side of the sympathetic chain as opposed to complete resection.

The purpose of this study is to provide a systematic review of the evidence thus far, for providers and patients considering lumbar sympathectomy for plantar hyperhidrosis. Plantar hyperhidrosis, though not life-threatening, is nonetheless an extremely debilitating disorder both psychosocially and medically. It can negatively affect marital or other intimate relationships, prevent participation in barefoot activities, ruin shoes, and cause skin infections as well as lesions. Knowing there is a safe and effective way to treat this condition is of critical value.

METHODS

An extensive literature search was performed using MEDLINE, Web of Science, CINAHL, and Evidence Based Reviews Multifile using the following search terms: *lumbar sympathectomy, plantar hyperhidrosis, sympathectomy, hyperhidrosis, and foot.* Articles not addressing lumbar sympathectomy specifically for plantar hyperhidrosis were excluded.

RESULTS

After removing duplicate and irrelevant articles, a total of nine remained. One article is a randomized controlled trial (RCT) and the remaining are case reports and observational studies. The nine studies³⁻¹¹ in this review took place between 2001 and 2011 and originated in Austria, Brazil, Poland, Taiwan, and the United States (see Table I). All studies point to successful treatment in the majority of patients with plantar hyperhidrosis by performing lumbar sympathectomy at the L2-L4 level accessed using a variety of techniques. Two studies used a “single access site” to conduct the bilateral procedure. All operations were initially endoscopic, with five cases needing to be converted to an open procedure. One case performed the lumbar sympathectomy solely on the right side of the sympathetic ganglia. No perioperative mortality occurred in any of these cases. The majority of the patients experienced plantar anhidrosis and reported satisfaction with the results. Yet most authors of these articles admit occurrence of side-effects such as compensatory sweating, post-operative neuralgia, and temporary sexual dysfunction in one man. A few patients developed one-sided recurrence of plantar hyperhidrosis (see Table II).

In the United States, Reisfeld³ published an observational study assessing 63 patients with severe plantar hyperhidrosis who underwent bilateral endoscopic lumbar sympathectomy (ELS) between June 2007 and September 2009. The patient population consisted of mainly females (79.4%) with a mean age of 30.6 years. The ethnicity of the participants was comprised primarily of Caucasian (71.4%), with the remaining being a mix of Asian, Hispanic, and Middle Eastern. All but seven of the patients had previously undergone thoracic sympathectomy more than four months prior. Dr. Reisfeld performed

ELS using the “clamping method.” All patients reported a major or total reduction in their plantar hyperhidrosis, as 96.6 % achieved complete anhidrosis. Compensatory sweating, already existing in those patients who had a previous thoracic sympathectomy, remained the same in 91.1%. No severe compensatory sweating occurred in patients who only had ELS. There was no reported sexual dysfunction. There were some surgical complications nevertheless. Pedal edema occurred in 35 patients but was temporary in nature. Eleven of the “early cases” experienced post-operative neuralgia, while patients who underwent the procedure as Dr. Reisfeld became experienced, did not. Transient postural hypotension was noted in two patients. Reisfeld reports that five of the “early cases” had to be converted from endoscopic to an open surgical procedure. In one patient, the titanium clips were mistakenly applied to the ilioinguinal nerve. The error was discovered in the recovery room, after which the patient was taken back to the operating room and the clips were removed from the ilioinguinal nerve and correctly placed on the sympathetic chain. There was also one case of a lymph duct injury in an obese patient where the procedure was stopped, and completed at a later time.³

In Austria, Rieger et al⁵ published an observational study in 2009 that included his outcomes from an earlier study in 2007. These two articles evaluated the results of endoscopic lumbar sympathectomy for plantar hyperhidrosis in 90 patients: 59 men and 31 women. Plantar hyperhidrosis was eliminated in 87 of the patients, but recurred in three. Compensatory sweating ensued in 40 patients, post-sympathectomy neuralgia transpired in 38 patients. One man experienced temporary loss of ejaculation. Overall, 86 patients were either “partly” or “very” satisfied with the results and 83 would have the procedure again if needed.⁴⁻⁵

Rieger et al⁶ continued their research in Brazil with endoscopic lumbar sympathectomy following thoracic sympathectomy in patients with palmo-plantar hyperhidrosis. Dr. Rieger confirmed this 2011 observational study examined the results of the procedures in Brazil, but included some previously published outcomes from Austria as well (written communication, November 2011). The article includes 130 patients: eight men and 122 women aged 13-43 years. Plantar hyperhidrosis was resolved in 93 patients, but three patients developed a one-sided recurrence. Compensatory sweating either developed or increased in a total of 24 patients. Transient post-operative neuralgia was noted in 18 patients. 80% of participants were “very satisfied” with the results and 17% were “partially satisfied.”⁴⁻⁶

Loureiro et al⁷ conducted the only RCT thus far regarding lumbar sympathectomy. The RCT, which took place in Brazil, assessed endoscopic lumbar sympathectomy in women and its effect on quality of life as well as level of compensatory sweating. Thirty-one females between the ages of 17-44 years with plantar hyperhidrosis post thoracic sympathectomy were enrolled. The participants were randomly assigned to either laparoscopic retroperitoneal lumbar sympathectomy (Group A) or no surgical intervention (Group B-control). Quality of life was assessed via questionnaires in both groups before and after surgery. Direct sweat measurements were recorded by evaluating trans-epidermal water loss pre- and post-surgery as well. There were no intraoperative complications, but three patients encountered prolonged post-operative pain (defined in this study as greater than ten days). Eight patients experienced worsened compensatory sweating. Yet the amount of foot sweat significantly decreased and quality of life significantly improved in Group A versus Group B ($P < 0.5$).⁷

Also in Brazil, Coehlo et al⁸ published an observational study assessing five females, ages 13-22, with plantar hyperhidrosis who underwent bilateral retroperitoneoscopic lumbar sympathectomy by unilateral access during the months of January through March 2009. All patients had previously received a thoracic sympathectomy that did not alleviate their plantar hyperhidrosis. At the follow-up consultations, all patients reported a complete resolution of their plantar hyperhidrosis. No intraoperative complications were reported. Patients were discharged home 12.6 hours after surgery. One patient reported a new onset of compensatory sweating.⁸

Stekaniak et al⁹ conducted a research study in Poland with videoscopic bilateral lumbar sympathectomy in twelve patients between July 2008 and July 2009. Ten patients were women and two were men, ages 19-41 years. It is unknown whether these participants previously received an ETS. Due to “learning curve” issues, six “initial cases” needed to be split into two operations and the rest were performed bilaterally at the same time. Results were measured subjectively using a symptom visual analogue scale (VAS, 1-10) and objectively using gravimetry to measure sweat output before and after the procedure. At the three month follow-up visit, symptoms measured on the VAS decreased from 6.17 +/-3.9 to 1.33 +/- 0.58, and plantar sweating was reduced from 8.75 +/- 2.56 to 0.67 +/- 1.15 (p=0.5). In one case, plantar dryness was actually so severe that the patient had to consult a dermatologist. All patients experienced “post-sympathectomy syndrome,” pain in the buttocks and thighs. In nine patients, the pain resolved after about one month. The pain was not resolved completely in three of the patients.⁹

In Taiwan, Li et al¹⁰ describe a case report in 2011 involving a 27 year old male with plantar hyperhidrosis who received a laparoendoscopic lumbar sympathectomy

using one single access site. The participant was given a Hyperhidrosis Disease Severity Scale (HDSS) assessment before and after the operation. The patient's HDSS score pre-sympathectomy was measured at a 4, signifying that the hyperhidrosis was "intolerable and interfered with his daily activities." At the one month post-operative visit, the patient's HDSS score decreased to a 1, indicating that "any sweating that may occur is tolerable and never interferes with daily activities." Normal ejaculation was noted one week after surgery. Neither post-operative neuralgia nor compensatory sweating were reported at the one month follow-up.¹⁰

Also in Taiwan, Tseng and Tseng¹¹ published a case report describing an endoscopic extraperitoneal lumbar sympathectomy that was performed on the right side of a 23 year old female with plantar hyperhidrosis. This participant had already undergone thoracic sympathectomy five years prior for palmar hyperhidrosis. At age 20, she began to develop plantar hyperhidrosis. Immediately after the right lumbar sympathectomy, the temperature of the right foot increased 6 degrees Celsius and became dry, while the left foot remained unchanged. However, at the follow-up visit, both feet were warm and dry. No adverse effects or complications were reported.¹¹

DISCUSSION

Summary of Findings

Plantar hyperhidrosis, though not a medical emergency, is nonetheless an extremely debilitating disorder both psychosocially and medically. The primary goal of this study is to provide a systematic review of the evidence thus far, for providers and patients considering lumbar sympathectomy for plantar hyperhidrosis. The nine included

articles³⁻¹¹ in this review were published between 2001 and 2011, providing comprehensive and recent data. The patient population was rather diverse as the studies were conducted in Austria, Brazil, Poland, Taiwan, and the United States. This signifies that the results could be generalized to a wide variety of patients. Overall, lumbar sympathectomy using a variety of techniques appears to be a relatively safe and effective option for resolving plantar hyperhidrosis when other conservative measures have failed. Yet there are adverse events that may occur such as compensatory sweating, post-operative neuralgia, and, very rarely, temporary sexual dysfunction in men. The possibility of recurrence reported in the work of Rieger et al⁵⁻⁶ remains a potential as well.

Female Patients

One point of discussion is the majority of patients operated on were female. This is most likely due to the potential risk of retrograde ejaculatory issues in men following lumbar sympathectomy. While sexual dysfunction was reported in merely one man and resolved in a week, it has become very rare with more surgical experience. Nevertheless, this possibility must be taken into consideration for future male patients with plantar hyperhidrosis considering lumbar sympathectomy.

African Americans

Though a wide variety of nationalities were represented, it was noted there were no African Americans in any of the cases. A telephone conversation with Dr. Reisfeld (December 2011) confirmed he has seen African American patients for palmar

hyperhidrosis, but not plantar hyperhidrosis, despite his Los Angeles location which is home to a widely diverse population. As the etiology of hyperhidrosis is believed to stem from genetics, one might hypothesize the reason the African American population is not represented in these studies is due to hereditary. Socioeconomic factors, such as lack of health insurance or lower income, quite possibly play a role as well.

Surgical Techniques to Mitigate Adverse Effects

Previously mentioned, Dr. Reisfeld³ of the United States is currently the only surgeon in the world to perform lumbar sympathectomy using the clamping method. His reasoning for this is: 1) The titanium clips provide a marker to demonstrate where the nerve disruption is occurring and 2) The clips, theoretically, allow the possibility of reversal. As noted, this served one patient well where the clip was erroneously applied to the ilioinguinal nerve and Dr. Reisfeld was able to correct the situation. As stated earlier, five of Dr. Reisfeld's "early cases" necessitated conversion from endoscopic to an open procedure. Dr. Reisfeld states that further experience has resolved that issue. As mentioned, post-operative neuralgia is a potential and concerning adverse effect that can occur with lumbar sympathectomy. Dr. Reisfeld noted a decrease in this occurrence with less dissection of the anatomy during the procedure.³

Coehlo et al⁷ in Brazil and Li et al¹⁰ in Taiwan both performed the lumbar sympathectomy using unilateral access. In applying this method, the purpose of Coehlo et al⁷ and Li et al¹⁰ was to reduce post-operative complications and also to produce a more aesthetically pleasing outcome in regards to the number and location of scars. The surgical technique utilized in Taiwan by Tseng and Tseng¹¹ involving a 23 year old

female is quite fascinating. Though the reason was not specified, only the right side of the lumbar sympathectomy was performed and yet the procedure eradicated the patient's plantar hyperhidrosis in both feet! This method may be worth pursuing in future patients if it will accomplish the same goal with a less invasive procedure.

Measurable Results

The ability to assess measurable results is essential in evaluating the effectiveness of a treatment or procedure. The work of Louriero et al⁸ in Brazil is rather compelling, being the only *RCT* conducted regarding the outcomes of lumbar sympathectomy. Louriero et al⁸ performed subjective assessment using quality of life questionnaires as well as objective measurement of sweat output before and after surgery. Stefaniak et al⁹ in Poland also demonstrated measurable results using the subjective VAS completed by the patients and objective evaluation of sweat output pre and post procedures.

Limitations of Study

There is considerable risk of bias in these studies, as the authors are the surgeons performing the lumbar sympathectomies. In this respect, negative outcomes should negate bias. Where Reisfeld³ is far more descriptive of patient population used and events that occurred, both positive and negative, case report authors such as Li et al¹⁰ and Tseng and Tseng¹¹ are less disclosing. It might be safer to assume that Dr. Reisfeld's very candid results³ are more reliable than Li et al¹⁰ or Tseng and Tseng.¹¹

The variability between studies is noteworthy as well. The lumbar sympathectomies were performed in many ways, using a variety of access sites, using

titanium clamps versus complete resection of the sympathetic ganglia, and in one instance only one side was performed versus both. The methodology used to measure or report results varied from study to study as well. These differences hinder true comparison to a certain degree.

An email from Dr. Rieger of Austria confirmed overlap between his studies. Dr. Rieger acknowledged his study in 2009 included results from 2007. His 2011 article included new patients from Brazil and several previous Austrian cases, but it is not clear which ones, which concludes this study is not protected against participation selection bias.

Quality of Evidence

The methodology of how these studies were performed in regards to evidence-based medicine (EBM) is weak, but is typical in surgical research.¹² At this time, there is a deficiency with RCTs investigating lumbar sympathectomy for plantar hyperhidrosis with only one in existence. Lack of adequate sample size is also a significant issue in ascertaining comprehensive results. The data of Rieger et al⁶ in Austria and Brazil carry heavier weight with a larger number of 130 patients assessed, whereas the case reports provided by Li et al¹⁰ and Tseng and Tseng¹¹ only provide information for one patient's experience. Based on study design, the quality of evidence of the entire nine studies³⁻¹¹ reviewed must be graded as "low" according to the Grading of Recommendations Assessment, Development and Evaluation (GRADE) tool.¹³ "Low" quality of evidence signifies that "further research is very likely to have an important impact on the confidence in the estimate of effect and is likely to change the estimate."¹³

CONCLUSION

Overall, lumbar sympathectomy using a variety of techniques appears to be a relatively safe and effective option for resolving plantar hyperhidrosis when other conservative measures have failed. Yet there are adverse events that may occur such as compensatory sweating, post-operative neuralgia, and, very rarely, temporary sexual dysfunction in men. Ideally, randomized controlled trials with well-matched comparison groups and further standardized methods to measure results should be conducted to solidify the safety and efficacy of lumbar sympathectomy, including which method is superior, in eradicating plantar hyperhidrosis while minimizing potential adverse effects.

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Tables

Table I. Characteristics of Reviewed Studies

Study	Year/ Location	# of Participants	Sex of Patient/s	Age Range	Previous Thoracic Sympathectomy?	Study Design
Reisfeld ³	2010/ United States	63	50 Female 13 Male	14-64	56 Yes 7 No	Observational ^a
Rieger R and Pedevilla S ⁴	2007/ Austria	8	3 Female 5 Male	23-62	4 Yes 4 No	Observational ^a
Rieger et al ⁵	2009/ Austria	90	31 Female 59 Male	15-69	24 Yes 66 No	Observational ^a
Reiger et al ⁶	2011/ Austria & Brazil	130	122 Female 8 Male	13-43	Yes	Observational ^a
Loureiro et al ⁷	2008/ Brazil	31	Female	17-44	Yes	Randomized Controlled Trial
Coelho et al ⁸	2010/ Brazil	5	Female	13-22	Yes	Observational ^a
Stefaniak et al ⁹	2010/ Poland	12	10 Female 2 Male	19-41	Unknown	Observational ^a
Li et al ¹⁰	2011/ Taiwan	1	Male	27	No	Case Report
Tseng and Tseng ¹¹	2001/ Taiwan	1	Female	23	Yes	Case Report

^a Lacks control group

Table II. Summary of Findings

Study	Intervention	Comparison	Outcomes	Adverse Effects	Comments
Reisfeld ³	Bilateral Endoscopic Lumbar Sympathectomy Using Clamping Method	None	96.6% achieved plantar anhidrosis	Transient post-operative pedal edema: 35 patients Neuralgia: 11 patients Postural hypotension: 2 patients	5 "early" patients necessitated conversion to open technique
Rieger R and Pedevilla S ⁴	Endoscopic Lumbar Sympathectomy	None	Plantar anhidrosis achieved in 100% of cases	Post-sympathectomy neuralgia: 4 patients Minor compensatory sweating: 5 patients	1 of 8 patients not satisfied due to long-term neuralgia
Rieger et al ⁵	Endoscopic Lumbar Sympathectomy	None	Plantar hyperhidrosis eliminated in 97% 3% experienced one-sided recurrence	Temporary loss of ejaculation: 1 patient Post-sympathetic neuralgia: 38 patients Compensatory sweating: 40 patients	Data includes research article from 2007
Reiger et al ⁶	Endoscopic Lumbar Sympathectomy	None	Plantar hyperhidrosis eliminated in 97% 3% experienced one-sided recurrence	Transient post-sympathectomy neuralgia occurred in 18 patients	Includes some data from 2007 and 2009 research
Loureiro et al ⁷	Endoscopic Lumbar Sympathectomy	No surgery	Decreased trans-epidermal water loss; Increased quality of life	Compensatory sweat increase in 8 patients; Prolonged post-operative pain in 3 patients	Quality of life questionnaires and sweat measurements were performed pre and post surgery p>0.05
Coelho et al ⁸	Bilateral Retroperitoneoscopic Lumbar Sympathectomy by Unilateral access	None	Resolution of plantar hyperhidrosis in all patients	New onset of compensatory sweating in 1 patient	Unilateral access was used to decrease post-operative complications and external scarring
Stefaniak et al ⁹	Videoscopic Bilateral Lumbar Sympathectomy	None	Reduction in plantar sweating by 8.75 ±2.56 to 0.67 ±1.15 (p = 0.05) Reduction in symptoms by 6.17 ±3.9 to 1.33 ±0.58 (p = 0.018)	All patients experienced "post-sympathectomy syndrome"	Gravimetry was used to measure sweat output
Li et al ¹⁰	Laparoendoscopic Single-site Retroperitoneal Lumbar Sympathectomy	None	Anhidrosis; HDSS score: 1	None reported	Normal ejaculation detected the 1st week of follow-up
Tseng and Tseng ¹¹	Right Endoscopic Extraperitoneal Lumbar Sympathectomy	None	Bilateral plantar anhidrosis	None reported	Anhidrosis achieved in both feet though sympathectomy was performed on only one side

^a Only study reviewed with intervention