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Objective evaluation of plantar hyperhidrosis after sympathectomy

Nelson Wolosker,[I] Augusto Ishy,[II] Guilherme Yazbek,[I] José Ribas Milanez de Campos,[II] Paulo Kauffman,[I] Pedro Puech-Leão,[I] Fábio Biscegli Jatene[II]

[I] Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo, Division of Vascular and Endovascular Surgery, São Paulo/SP, Brazil.
[II] Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo, Division of Thoracic Surgery, São Paulo/SP, Brazil.

OBJECTIVE: The aim of the present study was to prospectively, randomly, blindly, and objectively investigate how surgery affects plantar sudoresis in patients with palmar and plantar hyperhidrosis over a one-year period using a sudorometer (VapoMeter).

METHODS: From February 2007 to May 2009, 40 consecutive patients with combined palmar hyperhidrosis and plantar hyperhidrosis underwent video-assisted thoracic sympathectomy at the T3 or T4 ganglion level (15 women and 25 men, with a mean age of 25 years).

RESULTS: Immediately after the operation and during the one-year follow-up, all of the patients were free from palmar hyperhidrosis episodes. Compensatory hyperhidrosis of varying degrees was observed in 35 (87.5%) patients after one year. Only two (2.5%) patients suffered from severe compensatory hyperhidrosis. There was a large initial improvement in plantar hyperhidrosis in 46.25% of the cases, followed by a progressive regression of that improvement, such that only 30% continued to show this improvement after one year. The proportion of patients whose condition worsened increased progressively (from 21.25% to 47.50%), and the proportion of stable patients decreased (32.5% to 22.50%). This was not related to resection level; however, a lower intensity of plantar hyperhidrosis prior to sympathectomy correlated with worse evolution.

CONCLUSION: Patients with palmar hyperhidrosis and plantar hyperhidrosis who underwent video-assisted thoracic sympathectomy to treat their palmar hyperhidrosis exhibited good initial improvement in plantar hyperhidrosis, which then decreased to lesser degrees of improvement over a one-year period following the surgery. For this reason, video-assisted thoracic sympathectomy should not be performed when only plantar hyperhidrosis is present.

KEYWORDS: Sweating; Hyperhidrosis; Video-Assisted Thoracic Sympathectomy; Autonomic Ganglia.

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E-mail: nwolosker@yahoo.com.br

Tel.: 55 11 2151-5423

INTRODUCTION

Plantar hyperhidrosis (PLH) is a very common complaint (1) and is usually associated (more than 80% of cases) with palmar hyperhidrosis (PH) (2). Patients undergoing thoracic sympathectomy to treat palmo-plantar hyperhidrosis (HH) recover with anhidrosis of the hands in more than 95% of cases (3), thereby improving their quality of life (QOL) (4).

The few studies on the evolution of feet sweating after thoracic sympathectomy have been based on subjective evaluations. The patients reported good initial improvement in PLH immediately after surgery; however, this improvement subsided over the one-year period following surgery (5,6).

Tests for the objective quantification of sweating have been developed (7,8,9,10). Recently, a device known as a VapoMeter has been used to quantify the diffusion of water vapor through the skin under controlled conditions of temperature and humidity. We used this device to assess the outcomes of treatment for primary palmar HH by video-assisted thoracoscopic sympathectomy (VATS) in 40 patients (11).

There are no studies of long-term sweating of the feet using objective evaluation of sudoresis in patients with palmoplantar HH submitted to thoracic sympathectomy.

The aim of the present study was to prospectively and objectively investigate how surgery affects plantar sudoresis in the feet of patients with palmo-plantar HH over a one-year period using a sudorometer (VapoMeter).

No potential conflict of interest was reported.

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METHODS

From February 2007 to May 2009, 40 patients with combined palmar and plantar hyperhidrosis underwent VATS (15 women and 25 men, with a mean age of 25 years) in a prospective, randomized, blind, and controlled study according to the guidelines of the Ethics Committee for Analysis of Research Projects on Human Experimentation at our institution. None of these patients exhibited HH in other parts of the body. In addition to these patients with HH, we also evaluated 20 healthy participants (10 men and 10 women) without any previous history of hyperhidrosis to form a control group (CON), which served as a reference and comparison standard when following the subjects who underwent the operation. The demographic data are described in Table 1.

The patients underwent VATS at two levels: 20 patients at the T3 ganglion level and 20 patients at the T4 level. All of the procedures were performed by the same surgical team using stable surgical techniques throughout the study.

The patients were informed that they would be subjected to one of two levels of VATS routinely used in our group: T3 or T4. Randomization was performed by a computer-generated list prior to the beginning of the protocol. This list remained confidential and under possession of a single person who did not participate in the study. The inclusion of patients in groups T3 and T4 was announced to the team immediately prior to the operation.

All patients underwent surgery under general anesthesia in a semi-seated position while inclined at 45°. Two 5 mm mini-incisions were made: the first at the fourth intercostal space on the anterior axillary line, into which the thoracoscope was introduced, and the second at the second intercostal space on the medial axillary line, into which an electric or harmonic cautery was introduced. For sympathectomy at the T3 ganglion level, after identification of the sympathetic chain, the patients underwent resection of the chain (sympathicotomy) on the body of the third (R3) and fourth ribs (R4), followed by thermoablation of the segment isolated between them (the ribs). For the T4 ganglion level, the patients underwent sympathicotomy on the body of the fourth (R4) and fifth ribs (R5), followed by thermoablation of the segment isolated between them (the ribs). The same procedure was performed on the contralateral chain at the same level in all cases.

Immediately after the operation and during the one-year follow-up, none of the patients reported any episodes of palmar hyperhidrosis. There was no mortality, and it was not necessary to convert the videothorascopic procedure into an open surgery in either of the groups.

The outpatient evaluation, quantification of sweat, and application of the QOL questionnaire were performed by an independent observer who did not participate in the operation and had no knowledge of the level of surgical intervention. The team responsible for the operative procedures did not participate in any phase of the outpatient evaluations. The level of the thermoablated ganglion was revealed to the patients only after completing one year of follow-up.

Six patients exhibited slight/weak pleural adherences, which were detached using an endoscopic scalpel. Only one patient had a right-side residual pneumothorax (2.5%) during the immediate postoperative period, which amounted to less than 10% and did not require pleural drainage. One patient had paresthesia (2.5%) in the upper right limb, which regressed within the first month of follow-up.

Compensatory HH was observed in varying degrees in 35 patients (87.5%) after one year. Only two (2.5%) patients suffered from severe compensatory HH.

The patients' PLH complaints were investigated using a VapoMeter, a noninvasive, portable instrument (Delfin Technologies Ltd., Kuopio, Finland). This device measures transepidermal water loss (TEWL) using a closed measurement chamber that eliminates external interference from air currents. The instrument is placed on the skin and maintains contact with the skin surface for approximately 10 seconds. The evaporation rate is calculated from the rise in relative air humidity inside the closed chamber of the device, and this value is quantified in $g/m^2/h$ (increase in the water mass per unit of evaporation area per unit of time).

The measurements were performed at the HH outpatient clinic in a climate-controlled room at a temperature between 21 and 24℃, independent of the season of the year. All of the patients remained at rest for 20 to 30 minutes prior to the measurements to reduce external influences. The measurements were made on the plantar face (Figure 1).

Objective quantification of plantar sweating was performed using the VapoMeter prior to the operation and at one week, one month, six months, and one year after the operation. In the control group, we performed only one quantification of sweating in the same location. The principal investigator performed all of the evaluations.

We performed two types of objective assessments of PLH. First, we evaluated the average plantar sweating in each group of patients before surgery and at seven days, 30 days, six months, and one year after surgery.

Second, each foot was evaluated, and the changes in the measurements for sweating were compared over time. In this second analysis, we compared the values obtained at the time points after the surgery with the values obtained prior to surgery. We considered sudoresis to be improved for each period when the values were 25% lower than the initial value for the same foot; worse when the values were 25% greater than the initial value; and stable when the values changed by less than 25% from the original measurement.

Finally, we studied the relationship between the level of resection and the evolution of the amount of sudoresis for each foot after surgery. We empirically considered 41.5 $g/m^2/h$ as the maximum reference value for normal sudoresis (25% greater than baseline).

Table 1 - Demographic data from patients in both groups.

	Control	Plantar hyperhidrosis undergoing T3	Plantar hyperhidrosis undergoing T4
Age (mean ± SD)	25.8±7.0	25.1±5.5	25.0±7.1
Body mass index	22.3±2.9	21.8±1.4	23.0±1.4
Gender (male:female)	10:10	7:13	8:12

Figure 1 - Location for the measurement of the feet.

Statistical Analysis

For the variable age, a one-way analysis of variance (ANOVA) test was used. For gender, the x^2 test was used. For the pre-operative and post-operative (at one week, one month, six months, and one year) evaporation rates of the feet in the T3 and T4 ganglia groups, a two-way ANOVA was used. The Bonferroni multiple comparisons test was applied when a statistically significant difference was detected.

The Friedman test was used to assess the association between HH outcomes at seven days, one month, six months, and one year.

The chi-square frequency test was used for comparisons between T3 and T4 at each time point. The level of statistical significance was set to 5%.

RESULTS

Objective quantifications of average plantar sweating prior to the operation and at one month, six months, and one year after the operation are presented in Table 2 according to the resection level.

There were significant differences between the control group (27.69) and patients with HH (64.04 and 56.84) ($p<0.01$) (Table 2). However, there was no difference between the levels of resection in the different periods.

Table 2 - Mean plantar sweating before and after sympathectomy.

	Control	T3	T4
BEFORE	27.69	64.04	56.84
1 MONTH		53.60	66.44
6 MONTHS		60.82	73.71
12 MONTHS		86.78	64.98

Table 3 - Evolution of the amount of sudoresis for each foot over time.

	7 Days	1 Month	6 Months	12 Months
IMPROVED	37 (46.25)	31 (38.75)	29 (36.25)	24 (30.00)
STABLE	26 (32.5%)	19 (23.75%)	20 (25.00%)	18 (22.50%)
WORSE	17 (21.25)	30 (27.5)	31 (38.75)	38 (47.50)

Friedman $p=0.1738$.

Analyses of the amount of sweating for each foot at one week, one month, six months, and one year after the operation are presented in Table 3.

A total of 37 feet (46.25%) showed an initial improvement in plantar hyperhidrosis, followed by a progressive regression of the improvement, such that the improvement was sustained in only 30% of feet after one year. The proportion of feet whose condition worsened increased progressively (from 21.25% to 47.50%), and the proportion of stable patients decreased (32.5% to 22.50%).

Table 4 displays the changes in the amount of sweat for each foot according to the resection level (T3 and T4) at one week, one month, six months, and one year after the operation.

Both groups showed similar changes in the amount foot sweating over time, the first month being the only exception, which was not maintained.

Table 5 presents the changes in sudoresis for each foot according to the amount of sweat prior to surgery (either less than 41.5 $g/m^2/h$ or greater than 41.5 $g/m^2/h$) at the different time points after the operation.

After one week, we observed that the feet that previously exhibited more sweating (greater than 41.5 $g/m^2/h$) had a higher rate of improvement and stability and a lower rate of deterioration compared with the feet that exhibited less sweating. After one year, only five feet with less sweating had improved, and 54.2% were worse. For the group with the most sweating, 32.2% improved, 44.6% worsened, and 23.2% were stable.

DISCUSSION

The surgical method of choice for treating HH is VATS, which most frequently involves resections of the third or fourth ganglion for the treatment of PH (12).

Table 4 - Changes in the amount of sudoresis for each foot according to the resection level (T3 and T4) over time (in this table, patients are analyzed, not individual feet).

Time point	Status	T3 Freq. (%)	T4 Freq. (%)	*p*-value
7 Days	Improved	20 (50.0)	17 (42.5)	0.340
	Stable	10 (25.0)	16 (40.0)	
	Worse	10 (25.0)	7 (17.5)	
1 Month	Improved	15 (37.5)	16 (40.0)	0.040
	Stable	14 (35.0)	5 (12.5)	
	Worse	11 (27.5)	19 (47.5)	
6 Months	Improved	17 (42.5)	12 (30.0)	0.509
	Stable	9 (22.5)	11 (27.5)	
	Worse	14 (35.0)	17 (42.5)	
12 Months	Improved	10 (25.0)	14 (35.0)	0,398
	Stable	8 (20.0)	10 (25.0)	
	Worse	22 (55.0)	16 (40.0)	

p-value obtained from the chi-square frequency test.

Table 5 - Changes in the amount of sudoresis for each foot over time according to the amount of sudoresis prior to surgery. Values less than or greater than 41.5 were compared.

Time point	Status	Less than 41.5 Freq. (%)	Greater than 41.5 Freq. (%)	*p*-value
7 Days	Improved	8 (33.3)	29 (51.8)	0.002
	Stable	5 (20.8)	21 (37.5)	
	Worse	11 (45.9)	6 (10.7)	
1 Month	Improved	7 (29.2)	24 (42.9)	0.498
	Stable	7 (29.2)	12 (21.4)	
	Worse	10 (41.6)	20 (35.7)	
6 Months	Improved	7 (29.2)	22 (39.3)	0.400
	Stable	5 (20.8)	15 (26.8)	
	Worse	12 (50.0)	19 (33.9)	
12 Months	Improved	5 (20.8)	18 (32.2)	0.579
	Stable	6 (25.0)	13 (23.2)	
	Worse	13 (54.2)	25 (44.6)	

p-value obtained by the chi-square test.

When the resection level is higher (T3), hands will exhibit less sweating; when the resection level is lower, there is a reduced likelihood that the patient will present with compensatory HH (13,14,15). This procedure is safe and has a low complication rate (16,17,18,19), as confirmed by our study, where the patients did not experience any repercussions. In this case series, 40 consecutive bilateral sympathectomies were performed, and we obtained full success in all cases in terms of improving hand sudoresis.

Compensatory HH (13,14) is the most frequent and important problem related to VATS. At level T3 and especially at level T4, HH is less severe than at level T2 (15).

Usually, patients with HH have excessive sweating in more than one location. In this study, we analyzed 40 patients with HH in the hands and feet, which is the most common combination. In many situations, PLH levels can be as great as or greater than PH levels (20). In patients with PLH as the primary complaint, lumbar sympathectomy is the treatment of choice (21), which was not the case in this study because PH was the principal complaint of every patient, whereas PLH was secondary.

In this study, we obtained data through an objective method previously used and validated for the measurement of sweating in humans (22). In previously published studies that evaluated the results of sympathectomy in the treatment of PLH, most of the data were based on the patients' subjective reports (4,5). Although the subjective data were most often associated with the perception of sudoresis and with satisfaction after surgery, objective data for comparison with previously published studies (11) were rarely obtained.

Because we observed that there was great variability in the extent of sweating between the two feet of a single individual (there was disagreement in 15 patients), we decided to evaluate the variations of sweating by foot and not by individual.

We initially analyzed the average of the objective values for each group and observed that on average, the TEWL rates for the T3 and T4 ganglion groups were higher than those in the control group, which provides objective evidence. After surgery, on average, we did not observe significant changes over time regarding the persistence of PLH. These analyses were not significant because the standard deviation in each case was high. Additionally, with this type of analysis, we could not determine the individual repercussions of feet sudoresis over time, which is why we decided to analyze the changes in sudoresis for each foot. We used the original measurement for each foot and compared it with the subsequent measurement for each patient using the initial measurement as the point of reference. We defined three possibilities for each case: improvement when the levels were 25% higher than the initial levels, worsening when they were 25% lower than the initial levels, and stability when the values were intermediate.

In our series, 46.25% of the patients had an improvement in their foot HH one week after VATS, and 30% reported improvement one year after VATS. This objective result was similar to the results of previous subjective studies. In a previous study by our group (5), we found a significant improvement in 23.4% of patients and only one case of cure (1.4%) based on subjective data. Hsu et al. (23) reported better results, with improvement in 64% of patients after sympathectomy at the T2 level using a subjective method of analysis.

This large initial improvement, which has also been described by other authors (5,6), and the subsequent worsening have no convincing anatomical or physiological explanations. The improvements were likely a result of stress reduction caused by the patients' postoperative palmar anhidrosis, which may have caused an improvement in the patients' emotional states. This new situation may break the negative feedback loop that might be leading to plantar sweating.

The worsening of PLH over time (an increase in the proportion of patients with no improvement from 21.25% to 47.50%) may be related to the return of the emotional stress that was initially lessened because of the high degree of satisfaction obtained from postoperative palmar anhidrosis and to the effect of compensatory HH.

After analyzing the effect of thoracic sympathectomy on PLH and taking the resection level into consideration, we observed a decrease in improvement in the T3 group from 50% to 25% and a decrease in the T4 group from 42.5% to 35.0%.

A comparison of PLH prior to surgery and at one month after treatment revealed that a lower intensity of HH before sympathectomy resulted in a poorer outcome. Similar data were observed for patient satisfaction after sympathectomy in a previous study, in which a worse preoperative QOL for patients undergoing sympathectomy to treat primary hyperhidrosis reflected a better postoperative improvement in QOL (24).

The innervations of the legs and feet are well known. The preganglionic fibers arise from the spinal medulla at its lower thoracic segment and from the first and second lumbar segments (T10 to L2), and they subsequently cross over to the corresponding ganglions of the sympathetic chain. These fibers progress down the chain and form synapses with the postganglionic neurons located between the fourth lumbar ganglion and third sacral ganglion, from which the postganglionic fibers arise and become incorporated into the nerve branches of the sacral plexus to innervate the lower extremities (25). Although the results presented in this case series cannot be explained by our current scientific knowledge, it is important to have such data so that comprehensive information can be provided to patients prior to VATS.

Patients with palmar and plantar hyperhidrosis who underwent VATS to treat their palmar hyperhidrosis exhibited good initial improvement in plantar hyperhidrosis, which was not sustained over a one-year period following surgery. For this reason, VATS should not be considered when only plantar hyperhidrosis is present.

AUTHOR CONTRIBUTIONS

Wolosker N designed and conceived the study, performed the data analyses, and contributed to the discussion. Ishy A designed the study, collected the data and performed the surgeries. Yazbek G, de Campos JR and Kauffman P conducted the analyses and contributed to the discussion. Puech-Leão P and Jatene FB conceived the study and contributed to the discussion.

REFERENCES

1. 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(4):255-67, http://dx.doi.org/10.1097/00129689-200208000-00011.
2. Yamashita N, Tamada Y, Kawada M, Mizutani K, Watanabe D, Matsumoto Y. Analysis of family history of palmoplantar hyperhidrosis in Japan. J Dermatol. 2009;36(12):628-31, http://dx.doi.org/10.1111/j.1346-8138.2009.00732.x.
3. Kao MC, Lin JY, Chen YL, Hsieh CS, Cheng LC, Huang SJ. Minimally invasive surgery: video endoscopic thoracic sympathectomy for palmar hyperhidrosis. Ann Acad Med Singapore. 1996;25(5):673-8.
4. de Campos JR, Kauffman P, Werebe EC, Andrade Filho LO, Kusniek S, Wolosker N, et al. Quality of life, before and after thoracic sympathectomy: report on 378 operated patients. Ann Thorac Surg. 2003;76(3):886-91, http://dx.doi.org/10.1016/S0003-4975(03)00895-6.
5. Neumayer C, Panhofer P, Zacherl J, Bischof G. Effect of endoscopic thoracic sympathetic block on plantar hyperhidrosis. Arch Surg. 2005;140(7):676-80, http://dx.doi.org/10.1001/archsurg.140.7.676.
6. Wolosker N, Yazbek G, Milanez de Campos JR, Kauffman P, Ishy A, Puech-Leao P. Evaluation of plantar hyperhidrosis in patients undergoing video-assisted thoracoscopic sympathectomy. Clin Auton Res. 2007;17(3):172-6, http://dx.doi.org/10.1007/s10286-007-0420-5.
7. Asahina M, Yamanaka Y, Akaogi Y, Kuwabara S, Koyama Y, Hattori T Measurements of sweat response and skin vasomotor reflex for assessment of autonomic dysfunction in patients with diabetes. J Diabetes Complications. 2008;22:278-83, http://dx.doi.org/10.1016/j.jdiacomp.2007.03.009.
8. Kuwabara S, Tamura N, Yamanaka Y, Misawa S, Isose S, Bae JS, et al. Sympathetic sweat responses and skin vasomotor reflexes in carpal tunnel syndrome.Clin Neurol Neurosurg. 2008;7:691-5, http://dx.doi.org/10.1016/j.clineuro.2008.04.004.
9. Tetteh HA, Groth SS, Kast T, Whitson BA, Radosevich DM, Klopp AC, et al. Primary Palmoplantar Hyperhidrosis and Thoracoscopic Sympathectomy: A New Objective Assessment Method. Ann Thorac Surg. 2009;87(1):267-75, http://dx.doi.org/10.1016/j.athoracsur.2008.10.028.
10. Krogstad AL, Skymne A, Pegenius G, Elam M, Wallin BG. No compensatory sweating after botulinum toxin treatment of palmar hyperhidrosis. Br J Dermatol. 2005;152(2):329-33.
11. Ishy A, de Campos JR, Wolosker N, Kauffman P, Tedde ML, Chiavoni CR, et al. Objective evaluation of patients with palmar hyperhidrosis submitted to two levels of sympathectomy: T3 and T4. Interact Cardiovasc Thorac Surg. 2011;12(4):545-8, http://dx.doi.org/10.1510/icvts.2010.252015.
12. Liu Y, Yang J, Liu J, Yang F, Jiang G, Li J, et al. Surgical treatment of primary palmar hyperhidrosis: a prospective randomized study comparing T3 and T4 sympathicotomy. Eur J Cardiothorac Surg. 2009;35(3):398-402, http://dx.doi.org/10.1016/j.ejcts.2008.10.048.
13. Yazbek G, Wolosker N, de Campos JR, Kauffman P, Ishy A, Puech-Leao P. Palmar hyperhidrosis–which is the best level of denervation using video-assisted thoracoscopic sympathectomy: T2 or T3 ganglion? J Vasc Surg. 2005;42(2):281-5, http://dx.doi.org/10.1016/j.jvs.2005.03.041.
14. Yazbek G, Wolosker N, Kauffman P, Campos JR, Puech-Leão P, Jatene FB. Twenty months of evolution following sympathectomy on patients with palmar hyperhidrosis: sympathectomy at the T3 level is better than at the T2 level. Clinics. 2009;64(8):743-9, http://dx.doi.org/10.1590/S1807-59322009000800006.
15. Wolosker N, Yazbek G, Ishy A, de Campos JR, Kauffman P, Puech-Leao P. Is sympathectomy at T4 level better than at T3 level for treating palmar hyperhidrosis? J Laparoendosc Adv Surg Tech A. 2008;18(1):102-6, http://dx.doi.org/10.1089/lap.2007.0030.
16. Cameron AE. Specific complications and mortality of endoscopic thoracic sympathectomy. Clin Auton Res. 2003;13 Suppl 1:I31-5.
17. de Campos JR, Kauffman P, Wolosker N, Munia MA, de Campos Werebe E, Andrade Filho LO, et al. Axillary hyperhidrosis: T3/T4 versus T4 thoracic sympathectomy in a series of 276 cases. J Laparoendosc Adv Surg Tech A. 2006;16(6):598-603, http://dx.doi.org/10.1089/lap.2006.16.598.
18. Munia MA, Wolosker N, Kauffman P, de Campos JR, Puech-Leão P. A randomized trial of T3-T4 versus T4 sympathectomy for isolated axillary hyperhidrosis. J Vasc Surg. 2007;45(1):130-3, http://dx.doi.org/10.1016/j.jvs.2006.09.011.
19. Munia MA, Wolosker N, Kaufmann P, de Campos JR, Puech-Leão P. Sustained benefit lasting one year from T4 instead of T3-T4 sympathectomy for isolated axillary hyperhidrosis. Clinics. 2008;63(6):771-4.
20. Lin TS, Fang HY. Transthoracic endoscopic sympathectomy in the treatment of palmar hyperhidrosis–with emphasis on perioperative management (1,360 case analyses). Surg Neurol. 1999;52(5):453-7, http://dx.doi.org/10.1016/S0090-3019(99)00111-1.
21. Loureiro M de P, de Campos JR, Kauffman P, Jatene FB, Weigmann S, Fontana A. Endoscopic lumbar sympathectomy for women: effect on compensatory sweat. Clinics. 2008;63(2):189-96.
22. De Paepe K, Houben E, Adam R, Wiesemann F, Rogiers V. Validation of theVapoMeter, a closed unventilated chamber system to assess transepidermal water loss vs. the open chamber Tewameter. Skin Res Technol. 2005;11(1):61-9, http://dx.doi.org/10.1111/j.1600-0846.2005.00101.x.
23. Hsu CP, Chen CY, Lin CT, Wang JH, Chen CL, Wang PY. Video-assisted thoracoscopic T2 sympathectomy for hyperhidrosis palmaris. J Am Coll Surg. 1995;179(1):59-64.
24. Wolosker N, Yazbek G, de Campos JR, Munia MA, Kauffman P, Jatene FB, et al. Quality of life before surgery is a predictive factor for satisfaction among patients undergoing sympathectomy to treat hyperhidrosis. J Vasc Surg. 2010;51(5):1190-4, http://dx.doi.org/10.1016/j.jvs.2009.11.078.
25. Maccarty CS. Surgical procedures on the sympathetic nervous system for peripheral vascular disease. In: Allen EV, Barker NW, Hines EA, editors. Peripheral vascular diseases, 3rd ed. Saunders, Philadelphia; 1962. p. 805-18.