BTSS Guidelines

Guidelines for the prevention, diagnosis and treatment of compensatory hyperhidrosis*

Diretrizes para a prevenção, diagnóstico e tratamento da hiperidrose compensatória

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Abstract

With the objective of establishing guidelines for the prevention, diagnosis and treatment of compensatory hyperhidrosis, consensus meetings were held. Attendees included a general surgeon and thoracic surgeons affiliated with the Brazilian Society of Thoracic Surgery. The topics addressed were those that would ostensibly broaden multidisciplinary knowledge. Based on recent guidelines for the prevention, diagnosis and (clinical and surgical) treatment of compensatory hyperhidrosis, as well as on a review of the medical literature, the participants prepared a preliminary text, whose recommendations were revised and subsequently approved by all of the participants. The consensus text was posted on the Internet, becoming the object of further corrections and revisions prior to taking on its present form.

Keywords: Hyperhidrosis/therapy; Hyperhidrosis/surgery; Sympathectomy/methods; Postoperative complications; Thoracic surgery, video-assisted.

Resumo

Com o objetivo de se estabelecer diretrizes para a prevenção, o diagnóstico e o tratamento da hiperidrose compensatória, foram realizadas reuniões consensuais com a participação de cirurgiões torácicos filiados à Sociedade Brasileira de Cirurgia Torácica e um cirurgião geral em que foram abordados tópicos de modo a abranger conhecimentos multidisciplinares. A partir de textos recentes com diretrizes para a prevenção, o diagnóstico e tratamento (clínico e cirúrgico) da hiperidrose compensatória, e baseados em revisão bibliográfica, os participantes elaboraram um texto preliminar, cujas recomendações foram submetidas à aprovação dos participantes, possibilitando uma revisão geral do texto final. Deste modo, obteve-se um texto básico que, veiculado pela internet, tornou-se objeto de novas correções e revisões até alcançar a forma final atual.

Descritores: Hiperidrose/terapia; Hiperidrose/cirurgia; Simpatectomia/métodos; Complicações pós-operatórias; Cirurgia torácica vídeo-assistida.

Introduction

Currently, the increase in sweating in the postoperative of thoracic sympathectomy is designated compensatory hyperhidrosis (CH) or reflex hyperhidrosis (RH). The correct term to describe this condition should be based on an understanding of the anatomy of the sympathetic chain and on the neural pathophysiology of this side effect, which is still controversial in the literature.

The excessive production of sweat is known as hyperidrosis or, more often, hyperhidrosis. Therefore, hyperhidrosis is the production of sweat in quantities larger than those

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necessary for thermoregulation. It can be mild, moderate or intense.

When excessive sweating affects only a specific part of the body, such as the hands, axillae, feet or face, it is called localized hyperhidrosis.[1]

In the current surgical treatment for localized hyperhidrosis, thoracic sympathectomy has produced excellent results. However, low-intensity CH still occurs in most cases. Nevertheless, patients report high levels of satisfaction due to the success of the surgery in controlling primary hyperhidrosis.

The side effect that causes the most patient dissatisfaction and discomfort is intense postoperative hyperhidrosis, either CH or RH.

Occurring in the postoperative period of thoracic sympathectomy surgery, CH is characterized by mild to profuse sweating that is typically symmetric. It affects body regions unaffected by the sympathectomy and that did not previously present abnormal sweating, such as the dorsal region, abdomen and, at times, the lower limbs.

Figure 1 - Photograph of the thoracic and abdominal regions of a patient with compensatory hyperhidrosis.

Definition

We can define CH as perspiration in areas that did not present abnormal preoperative sweating and in higher quantities than those necessary for thermoregulation. It can be mild, moderate or intense.[2,3]

Diagnosis

The signs and symptoms of CH begin immediately after thoracic sympathectomy surgery. The condition can worsen with climate changes, as well as with the psychological and emotional alterations that these patients might develop. The symptomatology is more intense and notable on hot days.

It is possible for CH to affect the inferior portion of the chest (generally below the nipple), dorsal region, abdomen, lumbar region, pelvic waist, popliteal fossa and lower limbs (Figure 1). In some cases, patients complain that plantar hyperhidrosis becomes more uncomfortable.

Patients with intense symptoms have to change their clothes several times a day, greatly affecting their daily and professional activities and having severe consequences for their quality of life.

It must be borne in mind that this disorder severely affects the psychological state of the patient, which tends to be chronically poor or even to worsen, bringing the patient to the brink of desperation.

Classification

The clinical presentations of CH can be classified as mild, moderate or intense:

- Mild CH: sweating that occurs in low quantities, triggered by ambient heat, psychological stress or physical exercise. The sweat that forms does not flow. Therefore, there is no need to change clothes. Therefore, the sweating is tolerable and does not cause embarrassment to the patient.
- Moderate CH: sweating occurs in moderate quantity, triggered by ambient heat, psychological stress or physical exercise. The sweat coalesces into droplets that flow, although not necessitating a change of clothes. Therefore, the sweating, although uncomfortable, does not embarrass the patient.
- Intense CH: sweating occurs in large quantities, triggered with low or without ambient heat, psychological stress or physical exercise. The sweat coalesces into droplets that flow profusely, requiring a change of clothes one or more times a day. Therefore, the sweating is

uncomfortable and causes embarrassment to the patient.

Occurrence

Regardless of the technique, it is most important to choose the appropriate level in order to obtain the best surgical result. Studies suggest that only one ganglion should be approached for the different types or complaints of localized hyperhidrosis, and lower ganglion level translates to a lower probability of developing intense CH (Chart 1).[4-6]

Since the adoption of these standards more than ten years ago, the intense CH index has decreased from 4% to less than 0.9%.

We emphasize that, aiming at eliminating the possibility of occurrence of intense CH, there are surgeons that defend surgery in the T4 level, both for axillary and palmar hyperhidrosis, reporting excellent results in efficacy and zero incidence of hyperhidrosis (Chart 2).[7,8]

Note: thoracic sympathectomy is not indicated for the treatment of plantar hyperhidrosis. Curiously, 50% to 58% of patients present significant symptom relief of this complaint after thoracic sympathectomy. However, the anatomical and functional mechanisms involved in this improvement remain unclear.[9]

Pathophysiology

The CH condition was first described in 1933 as follows: "*Some of our patients have stated emphatically that the secretion of sweat has been considerably more profuse in the areas not affected by the operation. At first we were inclined to regard this merely as an error of observation, the usual amount of sweat being considered excessive when contrasted with the completely dry denervated area. However, the remark has been so frequently made, and it has been possible to observe the profuse secretion so often, that the possibility of compensatory hypersecretion cannot be excluded.*"[10]

Since that time, CH has been considered the principal side effect of sympathectomy, giving impetus to a number of studies aimed at understanding its pathophysiology and promoting its prevention and treatment.

In the literature regarding cases of bilateral lumbar sympathectomy and even transections of the spinal cord below the T8-T10 level, there is no reference to CH, although several studies have reported a greater intensity of CH when surgery is performed at the T2 level.[11,12]

Sweating is regulated in the hypothalamus, more precisely in the preoptic region. Its sympathetic efferent discharges are likely controlled by mechanisms of negative or positive feedback from the sympathetic afferent pathways.

Sympathectomy at the T2 level would block the afferent projection negative feedback to the hypothalamus, since it would section practically all afferent pathways, and would favor CH appearance at the periphery, due to the continuous efferent projections from the hypothalamus. Sympathectomy below this level would section a smaller number of afferent pathways, avoiding the feedback blockage and decreasing CH.

By understanding that CH is a result of a lack of negative feedback to the hypothalamus after sympathectomy, we found out that this side effect is more pronounced when sympathectomy is

Chart 1 - Current indications of the level of thoracic sympathectomy in the treatment of localized hyperhidrosis.

Localized hyperhidrosis	
Surgical level	Surgical indications:
T2	Craniofacial hyperhidrosis, associated with redness of the face
T3	Mild craniofacial hyperhidrosis
T3	High-intensity palmar hyperhidrosis
T4	Low-intensity palmar hyperhidrosis
T4	Axillary hyperhidrosis
T5	Axillary hyperhidrosis
L2-L3	Plantar hyperhidrosis

T: thoracic chain sympathetic ganglion; and L: lumbar chain sympathetic ganglion.

Chart 2 - Estimates of intense compensatory hyperhidrosis occurrence according to the surgical level and, in parallel, considering all study samples.

Estimates of intense compensatory hyperhidrosis			
Estimates according to the surgical level		Estimates considering all study sample	
T2	42.6%	T2	3-4.5%
T3	27.3%	T3	1-2.9%
T4	0.6%	T4	< 1% or NR
T5	NR	T5	< 1% or NR
L2-L3	NR	L2-L3	< 1% or NR

T: thoracic chain sympathetic ganglion; L: lumbar chain sympathetic ganglion; and NR = not reported.

performed on the T2 ganglion, where there is greater convergence of afferent pathways to the hypothalamus. However, when the sympathectomy is more caudal, the adverse effect is less pronounced.[13,14]

Treatment

The main objectives of the treatment of a patient with CH are to reduce or control profuse, intolerable sweating and, consequently, to prevent a loss in professional and social functioning, attempting to maximize patient quality of life.

General treatment considerations

Early diagnosis and immediate initiation of treatment, aimed at preventing functional incapacity and irreversible psychological trauma, are essential to controlling CH.

The treatment begins with the education of patients and their families, discussing the long-term treatment options, as well as their risks and benefits of such treatment. Since therapeutic planning is regarded as a dynamic and constantly revaluated process, therapeutic decisions should always be made in collaboration with the patient.

In addition to soliciting the opinion of the thoracic surgeon, it is highly recommended that a multidisciplinary team evaluate the patient.

Nonpharmacological treatment

Weight control

In general, an increase in body mass index (BMI) is associated with a greater need to sweat. Therefore, patients with CH should be instructed to maintain their BMI within the normal range.[15]

This index is calculated by the following formula: BMI = weight in kilograms divided by height in meters squared (kg/m^2).

The BMI value indicates whether an adult is overweight, obese or under the weight considered healthy. The criteria adopted by the National Health and Nutrition Examination Survey II are more detailed than those used by the World Health Organization (Chart 3).

However, the most precise method of determining whether an individual is obese is measuring the percentage of body fat. This measurement should be performed by a qualified professional, using a skinfold caliper. Portable skinfold calipers are also available.

Nonthermogenic diet

Food intake stimulates the sympathetic nervous system to increase salivation. This stimulus comes from taste, smell and even sight. The sympathetic stimulus may have a systemic effect, depending on the micronutrient composition of the diet, in some cases causing an increase in body sweating.

Some types of food have been reported to be sympathetic nervous system activators, leading to metabolic and endocrine responses 30-40 min after their intake. Such foods include certain legumes, pepper, garlic, coriander, cinnamon, ketchup, salt, ginger, chocolate, coffee, pork, viscera, red meat, milk, milk derivatives, strawberries, cola-based soft drinks and mate (*Ilex paraguariensis*) infusion, as well as black, green, chamomile tea.

Regarding the diet composition, proteins are the highest contributors to activate the sympathetic nervous system, that is, activate thermogenesis, followed by carbohydrates. Carbohydrates stimulate the synthesis of insulin, leading to an increase in norepinephrine levels and, consequently, an increase in body temperature. Fats do not have thermogenic effect, as many people believe. They are the most neutral of the three substances.

In young people who practice bodybuilding, the intake of food supplements with high quantities of proteins and carbohydrates can also trigger increased sweating.

Physical exercise

Every patient with CH should be instructed to practice physical exercise. Patients who engage in exercise lose more than just water and salt when they sweat. A daily 30-min walk seems to be little,

Chart 3 - Body mass index criteria adopted by the National Health and Nutrition Examination Survey.

Condition	BMI, kg/m^2	
	Women	Men
Underweight	< 19.1	< 20.7
Normal weight	19.1-25.8	20.7-26.4
Marginally overweight	25.8-27.3	26.4-27.8
Above ideal weight	27.3-32.3	27.8-31.1
Obese	> 32.3	> 31.1

BMI: body mass index.

even insufficient, but can avoid weight increase in sedentary individuals. Any additional exertion is sufficient to lose weight and reduce the BMI.

Although sweating is important to cool the skin on hot days, the lost water must be replaced. Therefore, care should be taken to fully replace all fluids lost.

The excessive body heating, especially in areas submitted to sympathectomy, can cause malaise or dehydration.[16]

Clothing

Clothes, either social or professional, should be readapted to make them tolerable to the patient.

A thin dry-fit T-shirt, made of synthetic material (polyamide or spandex), can help distribute the sweat more evenly when used under the shirt.

Changing clothes one or more times a day is often necessary, especially on hot, humid days.

Climate

Ambient temperature plays an important role in cooling the human body. When the environment is hotter, more humid and less ventilated, the thermal sensation of heat increases, with a consequent increase in sweating intensity.

On hot summer days, CH is more intense and notable. Patients with CH have a lower tolerance for exposure to sun, especially in areas submitted to sympathectomy. Conversely, such patients present improvement in cold environments with low humidity and good ventilation. The moderate climate of mountain towns can also favor the patient.

The patient should be instructed to register favorable and unfavorable climate conditions in an attempt to predict CH.

Work activities

Patients should be instructed to transfer to areas where the environmental temperature is controlled by air conditioning systems. Occasionally, medical affidavits or expert evaluation will be required to confirm this need.

Sleep

The use of antidepressants can help reestablish the quality and quantity of sleep.

Pharmacological treatment

Among the possible options to treat CH are topical medications, intradermal application of botulinum toxin and oral medications. Several attempts are often necessary to determine the best option or drug therapy.

Topical applications

Since many patients refuse to use anticholinergic drugs, due to their side effects, topical applications constitute a viable alternative and are well tolerated.

Aluminum salts have proven effective in decreasing sweating, with an estimated efficacy of 60% to 80% in reducing CH. Their effect is not immediate, beginning after 48 h of use.[17]

It is recommended that an ethyl alcohol solution with 20% aluminum chloride hydroxide ($Al_2(OH)5Cl.2H_2O$) and 1% dimethicone be generously applied twice a day (at night, before sleeping, and in the morning, after showering) in regions with CH. The skin should be dry—the solution should be applied before the sweating begins.

A loss in the antiperspirant effect can occur, which can be regained by discontinuing the treatment for approximately four days, after which the applications can be resumed.

As a side effect, skin irritation can occur, principally in areas with more sensitive skin, and often improves after the discontinuation of the treatment.

Intradermal applications

In rare cases, botulinum toxin has been used as a therapeutic choice when there is a well defined area to administer the product.

Oral medication

Several attempts to manage oral medication are often necessary to establish the best pharmacological option or combination, especially due to the side effects.

Anticholinergic drugs are extracted from plants (atropine and scopolamine) or are produced synthetically. They work by inhibiting the production of acetylcholine.

Anticholinergic drugs are also called antimuscarinic drugs, which are acetylcholine competitor antagonists in muscarinic receptors.

Several anticholinergic drugs currently available are synthesized in laboratories. Oxybutynin chloride has demonstrated promise. According to various authors, the use of anticholinergic drugs, especially oxybutynin chloride, can be of great help in the control of primary hyperhidrosis or in CH when patients tolerate their side effects. For many patients, a decrease in reflex sweating levels after treatment with anticholinergic drugs makes the discomfort acceptable, especially on hot days.

Oxybutynin chloride is a weak cholinergic blocking agent. Although it has only one third the power of propantheline and one twenty-fifth the power of atropine, its spasmolytic effect is two times greater than that of the propantheline and ten times greater than that of atropine.

Oxybutynin is immediately absorbed by the gastrointestinal tract, its concentration peaking at three to 6 h after intake. It is effective for 6-10 h, or even up to 24 h with continuous-use formulations. It is metabolized by the cytochrome P450 enzymatic systems, especially by CYP3A4, and its half-life is 2-3 h. The lowest dose of oxybutynin is 5 mg at bedtime. At that dosage, the patient will not present side effects. Generally, the effective dose requires the intake of 15 mg a day—three intakes of 5 mg fractioned over the course of the day. However, any increase in dosage should be progressive in order to ensure patient compliance with the treatment (Chart 4).

In some cases, the side effects of anticholinergic drugs are not tolerated, resulting in noncompliance with treatment. As a result, some patients prefer to use these drugs only on social occasions. The side effects are dose-dependent. Therefore, the lowest necessary dose should be adjusted in order to obtain improvement in hyperhidrosis. In this sense, other drugs with lower anticholinergic effect have been tested, such as propantheline and extended-release tolterodine tartrate. Among the side effects are xerostomia (dry mouth), postural hypotension, dizziness, drowsiness, blurred vision, xerophthalmia (mydriatic effect), intestinal constipation, dyspepsia, difficulty to urinate, nausea, headache, peripheral edema, tachycardia and hypertension. The administration of an excessive dose can cause agitation, delusion and instigation of chemical dependence. Anticholinergic drugs should be administered with care in patients with urinary tract obstruction, glaucoma, hypothyroidism, reflux esophagitis, hiatal hernia, ulcerative colitis, prostatic hyperplasia, autonomic neuropathy, hypertension or myasthenia gravis, as well as in those with cardiovascular, hepatic or renal diseases.

Contra-indications to the use of oxybutynin are hypersensitivity to the drug, untreated glaucoma, partial or total intestinal obstruction, urinary retention and megacolon (Chart 5). However, we should be alert to the fact that some drugs can cause a transitory, or even prolonged, increase in sweating:

- Antidepressants: bupropion
- Serotonin reuptake inhibitor tricyclic antidepressants: fluoxetine, sertraline, venlafaxine, etc.
- Antimigraine drugs: sumatriptan, naratriptan, rizatriptan and zolmitriptan
- Antipyretics: dipyrone, acetaminophen and aspirin
- Nonsteroidal anti-inflammatory drugs: sodium diclofenac
- Cholinergic agonists: bethanechol chloride and pilocarpine
- Gonadotropin-releasing hormone agonists: gonadorelin, nafarelin, goserelin and leuprolide
- Hypoglycemic agents: insulin and sulfonylureas
- Sympathicomimetics: phenylephrine and beta-agonists
- Miscellaneous: alcohol, bromocriptine, calcium blockers, cyclosporine, hydralazine, niacin, nitroglycerine, omeprazole, opioids, sildenafil, tamoxifen, theophylline and tramadol

Multidisciplinary treatment

In addition to the evaluation made by the thoracic surgeon, a multidisciplinary evaluation of the patient is highly recommended, with the participation of the following professionals:

Dermatologist

The physiological changes caused by sympathectomy, whether dry skin or CH, require long-term follow-up treatment.

Chart 4 - Regimen proposed for a progressive increase in the dose of oxybutynin chloride.

Dose, mg	Period, days
2.5	15
5	15
5 + 5	60
5 + 5 + 5	180

Chart 5 - Some drugs used in the control of compensatory hyperhidrosis.

Drugs and recommended doses in compensatory hyperhidrosis			
Drug	Recommended doses		Side effects, contraindications, and observations
	adult	child	
Synthetic anticholinergic agents			
Oxybutynin chloride	ID: 5-15 mg/day MD: 20 mg/day	> 5 years: 5 mg 2× day; maximum 8/8 h. > 6 years: same as adult.	See the text for the list of side effects and contraindications. Do not use in case of narrow angle glaucoma.
Tolterodine tartrate	ID: 2-4 mg/day MD: 8 mg/day	Its safety and efficacy in children were not established.	See the text for the list of side effects and contraindications. Do not use in case of narrow angle glaucoma.
Propantheline bromide	ID: 15-30 mg/day MD: 120 mg/day	Its safety and efficacy in children were not established.	In high doses it has nicotinic effects that cause neuromuscular transmission blockage. Do not use in case of narrow angle glaucoma.
β-blockers			
Propanolol	ID: 40-80 mg/day MD: 320 mg/day	1-3 mg/kg/day.	They help in the treatment of coexisting diseases, such as panic syndrome, anxiety, and essential tremor. Do not use in case of asthma.
Tricyclic antidepressants			
Amitriptyline	ID: 10 mg/day MD: 150 mg/day	0.25-1 mg/kg/day.	It may cause weight gain in the long run. Often causes the same side effects as anticholinergic agents. It helps in the treatment of depression.
α-adrenergic agonists			
Clonidine	ID: 0.1-0.2 mg/day MD: 2.4 mg/day	5-10 µg/kg/day every 12/12 h. Maximum 25 µg/kg/day in doses every 6/6 h. MD: 0.9 mg/day.	It should be used with care in patients with cardiovascular problems, sinus node disease, and chronic renal insufficiency. It should not be discontinued abruptly.

Note: when prescribing the drug, all information contained in the manufacturer's directions for use should be considered, as well as the clinical essays published in the literature. ID: initial dose; and MD: maximum dose.

Nutritionist

In order to provide dietary orientation, it is important that a nutritionist be brought in to prescribe low thermogenic capacity diets that can reduce sweating and maintain patient weight within the range of normality.

Endocrinologist

Overweight patients or those with metabolism-related problems should be monitored by an endocrinologist. Metabolism and thyroid function evaluations are critical in patients who cannot maintain their BMI within the range of normality.

Psychologist

Psychological treatment helps as a support to minimize the symptoms.

Psychiatrist or neurologist

Similarly to primary hyperhidrosis, CH is induced by mental stress or anxiety. Treatment with antidepressants or drugs that affect the central nervous system should be accompanied by follow-up treatment by a psychiatrist or neurologist.

Physical education professional

The physical education professional provides guidance and follow-up to physical exercises,

contributing to improve the physical conditioning and, consequently, the quality of life of patients.

Acupuncturist

The acupuncture techniques employed in CH are still being studied, and their results are variable.

Surgical treatment

The surgical treatment of CH is currently a challenge for those working in the field of thoracic surgery. The main surgical methods that are under study are sympathetic chain reinnervation, follow-up surgical intervention to remove the clip and lumbar sympathectomy.

Sympathetic chain reinnervation

Based on several studies in the literature, we conclude that intense CH occurs especially when sympathectomy includes the T2 sympathetic ganglion.[12] In fact, the lower the sympathectomy section, the lower the possibility of CH, as we can observe in lumbar sympathectomy.

When patients with intense CH are analyzed, we observe that the amount of released sweat seems to be much greater than was that occurring at the primary hyperhidrosis location, not translating a simple compensation or sweating transference from one site to the other. Therefore, this hyperhidrosis seems to be reflex, mediated neurologically in the sweating regulatory center in the hypothalamus.

In order to avoid this neurologically mediated reflex, the sympathetic afferents to the hypothalamus should be restored, allowing negative feedback to block the efferent projection of the sweating regulatory center on the periphery.[14] Therefore, only the reinnervation of the sectioned sympathetic chain could recover this reflex.

The sympathetic chain reinnervation, either with sural nerve grafts or intercostal nerve remnants, was performed in 51 patients due to postsympathectomy side effects. Most patients with CH had been submitted to surgery for redness of the face. The CH diminished in 81% of the patients, and 29% reported that they had practically no more CH or that they had normal sweating patterns. The same CH pattern persisted in only 19% of the patients.[19,20]

Follow-up surgical intervention to remove the clip

The postoperative results of sympathectomy, sympathicotomy and sympathetic blockage with clipping are similar.[21,22]

However, in patients submitted to sympathetic blockage by clipping of the sympathetic chains, there is the possibility of a second surgery to remove the metallic clip, aiming at nerve regeneration in cases that develop CH.[23]

The current clips have a pressure of approximately 150 g, and nerve transmission can be interrupted by compression greater than 44 g without the necessity of sectioning the nerve.[24,25]

Although there is no reference in Portuguese, the term "sympathetic chain clipping method" is preferred for being more specific. The proposed term "sympathetic chain clamping" might suggest the act of blocking and releasing something within a short period of time.[26]

The clip removal in the late postoperative period has been indicated in cases of intense CH and post-sympathetic-blockage Horner's syndrome, as well as in the occurrence of severe bradycardia.

It should be emphasized that earlier clip removal increases the chance of CH reversion. Although this statement makes a certain amount of sense, considering that shorter duration of nerve "compression" improves the result, it is recommended in the world medical literature that the clip removal be performed three months after the surgery in order to obtain a better result.

There are reports in the literature of 60-80% nerve recovery with CH cessation after clip removal. In a recent study, 13 patients with intense CH were submitted to a second operation to remove the clips, and ten patients recovered, returning to their initial patterns.[14]

In a national study sample of 226 patients submitted to sympathetic blockage with clipping, the surgery to remove the clip was performed in four patients due to the presence of intense CH, and good results were achieved in two patients.[27]

To remove the clip, a new surgical procedure is necessary, which is relatively simple and similar to the blockage technique. The clip removal is performed with endoscopic forceps, taking appropriate care with adherences close to larger veins.

Therefore, although the sympathetic blockage with clips is the only nonresectional technique that has been used in the treatment of localized hyperhidrosis, its reversibility is still not totally guaranteed, and patients should be fully informed of this.

Lumbar sympathectomy

Thoracic sympathectomy improves plantar hyperhidrosis by 65%.[28,29]

Over the years, this effect seems to have decreased in a considerable percentage of patients.[30]

In a recent report, its success rate was only 13.3% after two years.[27] Of the patients who do not improve, a small portion can present worsening of plantar hyperhidrosis or it can appear in patients who did not have it before the thoracic sympathectomy.[31,32] In such cases, the secondary appearance of plantar hyperhidrosis could be considered a form of CH. This situation is still not often reported in the literature and merits better reflection before it is considered in this consensus.

It is speculated that the persistence of plantar hyperhidrosis after thoracic sympathectomy changes patient focus to the plantar sweating. This could cause patients to overestimate the amount of plantar sweating. Objective data on sweating measurement are necessary to differentiate between patient impression and reality.

Lumbar sympathectomy surgery cannot currently be considered a form of CH treatment. It should be used exclusively in the treatment of primary plantar hyperhidrosis of feet or after thoracic sympathectomy in patients with persistent plantar hyperhidrosis.

Lumbar sympathectomy has been performed exclusively in women. In men, there is a risk, albeit low, of developing ejaculatory alterations.

This surgery has a real potential to increase CH. Therefore, this possibility, occurring in approximately two thirds of the operated cases, should be discussed with the patient.[33-35] In addition, until more detailed data on this undesirable effect becomes available, it is prudent to avoid lumbar sympathectomy in patients who have previously presented intense CH.

Even the worsening of CH after lumbar sympathectomy has no negative impact on quality of life. Generally, women feel very satisfied with the control of plantar hyperhidrosis, even though there is an increase in CH.

It has been observed that these alterations occur at several levels and that, different from thoracic sympathectomy, they are independent from the sympathetic chain resection level, since the surgeon always attempts to remove the L2 and L3 lumbar ganglia.[36]

Few studies have associated lumbar sympathectomy, hyperhidrosis and compensatory sweating. In one study, the appearance of CH was reported in five of eight cases of endoscopic lumbar sympathectomy to control plantar hyperhidrosis. However, the author did not specify which case had been previously submitted to thoracic sympathectomy.[37]

In another study involving 56 patients submitted to thoracic sympathectomy, 34 patients presented some worsening in CH (60.7%).[38]

Final considerations

Since CH is a chronic disorder, it requires follow-up and multidisciplinary treatment. Total CH remission, albeit the final objective of the multidisciplinary treatment, is rarely achieved.

Over the years, thanks to advancements in the knowledge of thoracic sympathectomy pathophysiology and better selection of patients who can be submitted to thoracic sympathectomy, the occurrence of CH has decreased significantly. Indicating cranial resections in the T4 ganglion demands careful analysis concerning its risk/benefit relationship, especially in patients with high BMI.

In patients who need sympathectomy in T2 and T3 ganglia, the sympathetic blockage with clipping has been employed in the sympathetic chain. These techniques are still being studied and might become the surgical treatment of choice due to the possible reversion with the clip removal.

It should be emphasized that, despite all efforts and strategies to reduce the occurrence of intense CH, the best we can currently offer to our patients is prevention. Therefore, it is in the indication of the level of sympathetic chain resection that we have a real possibility to avoid its incidence. Consequently, our main objective should be surgery with zero incidence of intense CH, since it seems clear that "prevention is still the best treatment".

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References

1. Tu YR, Li X, Lin M, Lai FC, Li YP, Chen JF, et al. Epidemiological survey of primary palmar hyperhidrosis in adolescent in Fuzhou of People's Republic of China. Eur J Cardiothorac Surg. 2007;31(4):737-9.
2. de Campos JR, Kauffman P. Simpatectomia torácica: indicações e cuidados. . [book on the internet] [cited 2008 May 8]. Available from: http://www.sbct.org.br/_LivroVirtual/download/SIMPATECTOMIA_TORACICA.pdf
3. Furian MB. Complicações da simpatectomia. [book on the internet] [cited 2008 May 8]. Available from: http://www.sbct.org.br/_LivroVirtual/download/COMPLICACOES_SIMPATECTOMIA.pdf
4. 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.
5. Ribas Milanez de Campos J, 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.
6. Munia MA, Wolosker N, Kauffman P, de Campos JR, Puech-Leao P. A randomized trial of T3-T4 versus T4 sympathectomy for isolated axillary hyperhidrosis. J Vasc Surg. 2007;45(1):130-3.
7. Lin CC, Wu HH. Endoscopic t4-sympathetic block by clamping (ESB4) in treatment of hyperhidrosis palmaris et axillaris--experiences of 165 cases. Ann Chir Gynaecol. 2001;90(3):167-9.
8. Furian MB. Prevention of intolerable reflex hyperhidrosis in the treatment of palmaris and/ or axillary hyperhidrosis with T4 sympathectomy: a experience with 416 patients. 7th International Symposium on Sympathetic Surgery: 2007 Mar 20-22; Muro Alto, Brazil.
9. 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.
10. Ross JP. Sympathectomy as an experiment in human physiology. Br J Surg. 1933;21:5-19.
11. Fast A. Reflex sweating in patients with spinal cord injury: a review. Arch Phys Med Rehabil. 1977;58(10):435-7.
12. Riet M, Smet AA, Kuiken H, Kazemier G, Bonjer HJ. Prevention of compensatory hyperhidrosis after thoracoscopic sympathectomy for hyperhidrosis. Surg Endosc. 2001;15(10):1159-62.
13. Lin CC, Telaranta T. Lin-Telaranta classification: the importance of different procedures for different indications in sympathetic surgery. Ann Chir Gynaecol. 2001;90(3):161-6.
14. Chou SH, Kao EL, Lin CC, Chang YT, Huang MF. The importance of classification in sympathetic surgery and a proposed mechanism for compensatory hyperhidrosis: experience with 464 cases. Surg Endosc. 2006;20(11):1749-53.
15. de Campos JR, Wolosker N, Takeda FR, Kauffman P, Kuzniec S, Jatene FB, et al. The body mass index and level of resection: predictive factors for compensatory sweating after sympathectomy. Clin Auton Res. 2005;15(2):116-20.
16. Sihoe AD, Liu RW, Lee AK, Lam CW, Cheng LC. Is previous thoracic sympathectomy a risk factor for exertional heat stroke? Ann Thorac Surg. 2007;84(3):1025-7.
17. Nascimento LP, Raffin RP, Guterres SS. Aspectos atuais sobre a segurança no uso de produtos antiperspirantes contendo derivados de alumínio. Infarma. 2004;16(7-8):66-72.
18. Fredericks CM, Green RL, Anderson GF. Comparative in vitro effects of imipramine, oxybutynin, and flavoxate on rabbit detrusor. Urology. 1978;12(4):487-91.
19. Telaranta T. Secondary sympathetic chain reconstruction after endoscopic thoracic sympathicotomy. Eur J Surg Suppl. 1998;(580):17-8.
20. Privatix Clinic [Homepage on the internet]. Tampere, Finland: The Clinic. [updated 2008 Sep 1; cited 2008 May 8]. Refined reversal surgery of ETS; [about 6 screens]. Available from: http://www.privatix.fi/index.shtml?&a=0&s=navig_03&l=en&d=05_results
21. Stori Jr WS, Coelho MS, Guimarães PS, Bergonse Neto N, Pizarro LD. Bloqueio por clipagem de gânglios simpáticos torácicos no tratamento da hiper-hidrose. An Bras Dermatol. 2006;81(5):425-32.
22. Yoon YH, Lee DY, Kim HK, Cho HM. Reoperation for essential hyperhidrosis. Asian Cardiovasc Thorac Ann. 1999;7(1):56-8.
23. Lin CC, Mo LR, Lee LS, Ng SM, Hwang MH. Thoracoscopic T2-sympathetic block by clipping--a better and reversible operation for treatment of hyperhidrosis palmaris: experience with 326 cases. Eur J Surg Suppl. 1998;(580):13-6.
24. Beltran KA, Foresman PA, Rodeheaver GT. Quantitation of force to dislodge endoscopic ligation clips: EndoClip II vs. Ligaclip ERCA. J Laparoendosc Surg. 1994;4(4):253-6.
25. Denny-Brown D, Brenner C. Lesion in peripheral nerve resulting from compression by spring clip. Arch Neurol Psychiatr. 1944;52:1-19.
26. 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.
27. Coelho MS, El Haje S, Ostroski A, Santos AF. T3 endoscopic sympathetic blockade X T3 videothoracoscopic sympathectomy in the treatment of palmar hyperhidrosis. 7th International Symposium on Sympathetic Surgery: 2007 Mar 20-22; Muro Alto, Brazil.
28. de Campos JR, Kauffman P, Werebe Ede C, 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.
29. de Campos JR, Kauffman P, Werebe Ede C, Andrade Filho LO, Kuzniek S, Wolosker N, et al. Questionário de qualidade de vida em pacientes com hiperidrose primária. J Pneumol. 2003;29(4):178-81.
30. Fukushima H, Makimura S, Takae H, Yao Y, Ishimaru S. Endoscopic thoracic sympathectomy for palmar, axillary and plantar hyperhidrosis: intermediate-term results [Article in Japanese]. Kyobu Geka. 2001;54(5):379-83.
31. Chen HJ, Liang CL, Lu K. Associated change in plantar temperature and sweating after transthoracic endoscopic T2-3 sympathectomy for palmar hyperhidrosis. J Neurosurg. 2001;95(1 Suppl):58-63.

32. Andrews BT, Rennie JA. Predicting changes in the distribution of sweating following thoracoscopic sympathectomy. Br J Surg. 1997;84(12):1702-4.
33. Gossot D, Galetta D, Pascal A, Debrosse D, Caliandro R, Girard P, et al. Long-term results of endoscopic thoracic sympathectomy for upper limb hyperhidrosis. Ann Thorac Surg. 2003;75(4):1075-9.
34. Drott C, Claes G. Hyperhidrosis treated by thoracoscopic sympathicotomy. Cardiovasc Surg. 1996;4(6):788-90; discussion 790-1.
35. Herbst F, Plas EG, Függer R, Fritsch A. Endoscopic thoracic sympathectomy for primary hyperhidrosis of the upper limbs. A critical analysis and long-term results of 480 operations. Ann Surg. 1994;220(1):86-90.
36. Loureiro MP, Roman N, Weigmann SC, Fontana A, Boscardim PC. Simpatectomia lombar retroperitoneoscópica para tratamento da hiper-hidrose plantar. Rev Col Bras Cir. 2007;34(4):222-4.
37. Rieger R, Pedevilla S. Retroperitoneoscopic lumbar sympathectomy for the treatment of plantar hyperhidrosis: technique and preliminary findings. Surg Endosc. 2007;21(1):129-35.
38. Loureiro MP, Cury AM, Bley AG. Simpatectomia lombar retroperitoneal endoscópica. Rev Col Bras Cir. 2004;31(4):274-75.