Side effects, complications and outcome of thoracoscopic sympathectomy for palmar and axillary hyperhidrosis in 406 patients

Pedro M. Rodríguez a,*, Jorge L. Freixinet a, Mohamed Hussein a, Jose M. Valencia a, Rita M. Gil a, Jorge Herrero a, Araceli Caballero-Hidalgo b

a Thoracic Surgery Department, Hospital Universitario de Gran Canaria “Dr. Negrín”, C/ Barranco de la Ballena s/n, 35020 Las Palmas de Gran Canaria, Spain
b Research Unit, Hospital Universitario de Gran Canaria “Dr. Negrín”, Las Palmas de Gran Canaria, Spain

Received 13 January 2008; received in revised form 29 April 2008; accepted 19 May 2008; Available online 2 July 2008

Abstract

Background: Thoracic sympathectomy (TS) is the treatment of choice for severe primary hyperhidrosis. However, complications, side effects and satisfaction have not been well defined. Objective: To analyze the complications, side effects, satisfaction degree and quality of life of patients after TS for primary upper limb hyperhidrosis. Methods: One-year follow-up after 406 consecutive TS for primary upper limb hyperhidrosis. Results: Bilateral TS was completed in all patients. Complications arose in 23 cases (5.6%), with pneumothorax being the most frequent. The success rate after discharge, 6 and 12 months was respectively, 100%, 98.1% and 96.5% for palmo-axillary hyperhidrosis; 100%, 99.3% and 97.8% for isolated palmar hyperhidrosis and 100%, 85.7% and 71.4% for isolated axillary hyperhidrosis. No persistence of hyperhidrosis was observed. Global recurrence was 3.7% (28.5% axillary hyperhidrosis group). Compensatory sweating (CS) appeared in 55% and was not related to the extension of the TS. Being female was a predisposing factor of CS ($p < 0.004$). Excessive dryness appeared at 9% and was associated with extensive TS ($p < 0.001$). Plantar hyperhidrosis improved at 33.6%, worsened at 10% and remained stable during the follow-up. Satisfaction degree decreased with the passage of time and was associated with recurrence. Quality of life was excellent at discharge, 6 and 12 month in 100%, 100% and 97%, respectively.

Conclusions: Pneumothorax is the most frequent complication of TS. CS is the main and undesirable side effect, appears with the passage of time, and is not related to the extension of TS. Being female is the only predictor factor of suffering CS. Plantar hyperhidrosis improves initially, although tends to reappear. Excessive dryness appears in extensive TS and does not improve over time. Postoperative satisfaction degree is high but decreases over time owing to the appearance of recurrence. Effectiveness and the absence of CS determine an excellent quality of life. Six percent of the patients regret the surgery because of severe CS. Informed patients of possible side effects before TS is essential.

# 2008 European Association for Cardio-Thoracic Surgery. Published by Elsevier B.V. All rights reserved.

Keywords: Hyperhidrosis; Thoracic sympathectomy; Complications; Side effects

1. Introduction

Hyperhidrosis (HH) is characterized by excessive perspiration in many different areas of the body, especially craniofacial regions, axillae, palms and feet. This affects the sufferer’s work and education, and poses both psychological and social problems [1]. It begins in infancy and adolescence, and its cause is unknown. Standing out in its physiopathology is an anomalous stimulus by the sympathetic nervous system upon the sweat glands through the para-vertebral sympathetic chain, located in T1–T5.

Among predetermining factors are geography and genetics. It is prevalent in western populations 0–6.1%, in the U.S. 2.8%, and in Asian countries up to 3%. In 57% of the cases there is a family history.

There are many medical treatment alternatives, but in general these are not satisfactory. Most notable of these are topical agents (aluminium), systemic anticholinergics, iontoforesis, chemical sympathetic block, injections with botulinum toxin and suction-curettage (axillary hyperhidrosis) [2].

Thoracoscopic sympathectomy (TS) between T1 and T5 is the most utilized surgical treatment because of its high efficiency and safety. It provokes anhydrosis of the upper extremities [1]. Surgical techniques are often irreversible (sympathicolyis, sympathectomy), although recently a reversible technique has been described which uses a sympathetic block with clips [3].

TS causes complications and side effects, which have a decisive effect on postoperative satisfaction and has prompted variations in technique with the aim of minimizing...
them. The follow-up on the complications and side effects has the benefit of allowing us to obtain necessary information for patients and professionals.

2. Patients and methods

A prospective study between January 1999 and November 2006 on 406 patients (241 women, 59%) with an average age of 25.1 ± 9.1 years (range 13–66 years) diagnosed with upper extremity HH treated with TS. Palmar and axillary HH presented in 260 cases (64%), isolated palmar in 139 cases (34%) and isolated axillary HH in 7 (2%).

2.1. Surgical technique

The technique was bilateral and sequential and performed at the same surgical time. The surgical technique consisted of double-lumen endotracheal tube, general anesthesia and semi-seated position with the upper extremities abducted. A 5 mm trochar was inserted at the anterior axillary line, third intercostal space, in order to introduce the endoscopic dissector, and a second trochar of 11.5 mm in the anterior axillary line, fourth intercostal space, for the video camera. The sympathetic ganglionar chain was identified and sympathectomy was carried out using electrocoagulation at the T2–T3 level (isolated palmar HH, n = 139), T3–T4 (isolated axillary HH, n = 7), and T2–T4 (palmar–axillary HH, n = 260). Sympathectomy at level T2 was amplified laterally to include Kuntz's accessory nerve fibers. After visually confirming pulmonary re-expansion, the drainage tube was removed and the patient sent to the recovery room where an X-ray was done. Two patients had a chest tube placed at the time of sympathetomy because of required lysis of apical pleural adhesions. Patients were discharged after ensuring pulmonary re-expansion. TS was T2–T4 in 260 cases (palmar–axillary HH), T2–T3 in 139 cases (isolated palmar HH) and T3-T4 in 7 cases (isolated axillary HH), respectively.

2.2. Studied variables

Age, sex and type of HH were analyzed, as well as family history, presence of plantar HH, previous medical treatment, surgical technique (extension and level), complications, hospital stay, and side effects. Also, the following variables were defined:

- Effectiveness: Anhidrosis or hyperhidrosis in the desired area.
- Persistence of HH: Even sweating at time of discharge.
- Recurrence: Re-emergence of sweating one month after TS.
- Pain: Pain related to surgery and classified according to the Analog visual pain scale (AVPS): mild (1–5), moderate (5–8), severe (8–10).
- Compensatory sweating (CS): Excessive sweating considered abnormal in other parts of the body after TS. Classified as mild (minimal, intermittent), moderate (not interfering with daily life), and severe (systemic, interfering with daily life).
- Gustatory sweating: Facial sweating after eating foods.

Excessive dryness: Dryness affecting the hands and requiring hydration.

2.3. Satisfaction degree

Classified according to the Analog visual scale (AVS): much better (AVS 9–10); better (AVS 6–8); worse (AVS 3–5); much worse (AVS 0–2).

2.4. Quality of life

To evaluate the quality of life, patients were given a form to fill out with pertinent data as in Health Questionnaire SF-36. Classified as excellent, good, poor, and very poor.

2.5. Data collection

The variables of the study, satisfaction grade and quality of life were analyzed in the preoperative period, time of discharge and at 6 and 12 months after surgery.

2.6. Statistical analysis

Quantitative variables were described using index of centralization and dispersion: mean, standard and range deviation. Normality hypothesis of said variables was contrasted using the Kolmogorov–Smirnov test for only one sample. Qualitative variables analyzed the absolute frequency of the appearance of each of the categories such as relative frequencies. The comparison of categorical data was done using the chi-squared test or Fisher’s exact test when necessary. Quantitative variables and ordinal qualitative variables were compared among groups using Mann–Whitney test. The statistical significance level was set at p < 0.05. We used for the analysis the statistical software package SPSS, version 15 for Windows.

3. Results

Thirty-five percent of the patients had a family history of HH and 76.7% had associated plantar HH. Eighty-seven percent underwent some form of medical treatment before TS, especially antitranspirant drugs.

Bilateral TS was completed in all of the patients and the mean operative time was 27 min (19–47). There were no deaths, major intra-operative problems or conversion to thoracotomy. None of the patients had an infection of his/her wound.

There were complications in 23 patients (5.6%) consisting of: 16 cases of pneumothorax (3.9%) in which 11 were less than 20% and did not require pleural drainage, 2 cases of unilateral and transitory Horner syndrome (0.5%), 2 cases of hemotherax requiring pleural drainage (2.5%), 1 case of quilotorax (0.25%) treated with video-assisted thoracic surgery (VATS), 1 case of cubital nerve neuropaxia (0.25%) from which the patient recovered in 21 days, and 1 case of subcutaneous cervico-thoracic emphysema (0.25%).

The average hospital stay was 1.1 days (1–15 days). The 15-day hospital stay was for the patient with the post-operative quilotorax, which required VATS re-intervention.
The effectiveness (Fig. 1) at the time of discharge, 6 months and 12 months was, respectively: 100%, 98.1%, and 96.5% (palmar–axillary HH); 100%, 99.3% and 97.8% (isolated palmar HH); 100%, 85.7% and 71.4% (isolated axillary HH). No cases of persistent HH were observed after discharge.

Pain at the time of discharge affected 93% of the patients and was related to the surgical wounds. At 6 months postoperatively, 59.1% of the patients complained about pain with an average of 4 weeks duration (1 day–24 weeks). Pain was considered mild (46%), moderate (9%) or severe (4.1%), according to AVPS. Fifteen percent confirmed dysesthesias around the surgical wound, and one patient suffered from cubital neuropaxia, which healed in 21 days without scars.

Global recurrence occurred in 15 patients (3.7%) during follow-up. There were nine cases of recurrence in the palmar–axillary HH group (3.4%), four in the isolated palmar HH group (2.8%) and two in the isolated axillary HH group (28.5%). In 13 cases (86.7%) the recurrence occurred 6 months after surgery. Recurrence was considered level in nine cases (60%), moderate in three (20%) and severe in three (20%). In the three cases of severe recurrence (one palmar, two axillary), a successful resympathectomy was done. There was not a statistically significant relationship between the recurrence and extension of denervation ($p = 0.740$).

CS occurred in 223 patients (55%). A total of 75.9% of patients with CS were women ($p < 0.004$), Table 1. In 24 cases (10.8%) it appeared before 6 months and in 199 cases (89.2%) between 6 and 12 month (Fig. 2). It was classified as level in 198 cases (88.8%), moderate in 21 cases (9.4%) and severe in 4 (1.8%). The most frequent locations were the back (67%), abdomen (61%), lower extremities (54%), thorax (9.7%) and generalized in 1.3% (3 patients). As far as the evolution over time, 11 patients (4.9%) reported improvement, 176 (79%) had no change and 34 patients (15.2%) got worse. Ten percent of the patients with CS requested medical treatment. A statistically significant association was not found between the CS with age, family history, type of HH and extent of TS ($p = 0.649$).

In reference to patients with plantar HH (Fig. 3), 33.6% improved, 56.4% remained the same, and 10% had an increase. In 70% of the patients with an improvement in plantar HH, it occurred at the time of discharge and in the remaining 30% before 6 months postoperatively. A total of 21.3% of patients with worsening of their plantar HH had a T2–T3/T3–T4 TS compared with 4.3% of the T2–T4 group ($p < 0.001$).

The satisfaction questionnaire was filled out by 397 patients (98%). Degree of satisfaction is expressed in Table 2. Degree of satisfaction was much better at the time of discharge, 6 and 12 months in 100%, 99%, and 90%, respectively. Patients with HH recurrence had a statistically significant degree of satisfaction ($p < 0.001$). However,
there was not statistical significance between CS and satisfaction degree (p > 0.843) (Table 2).

The quality of life questionnaire was filled out by 397 patients (98%). The motives for surgery were work-related problems (60%), school-related problems (20%), social problems (10%) and psycho-emotional problems (10%). Results are expressed in Table 3. Previous to surgery was very poor in 95% of the patients and poor in 5%. Quality of life was excellent at the time of discharge, at 6 months and 12 months in 100%, 100% and 97% of patients. A statistically significant relationship between CS with a worse quality of life (p = 0.083) was not found (Table 2). Six percent of the patients did not recommend the surgical intervention for severe and incapacitating CS.

4. Discussion

The medical treatment of severe HH is not efficient, and that is the reason why TS has become the treatment of choice. This is done through exeresis (sympathectomy), ablation (sympathectomy) or blockage with clips, with an efficiency of over 90% [5, 3]. The extension of the TS could be one or several levels of the chain and sympathetic ganglia (truncular denervation) or limited to the communicative branches (selective denervation), which is much less frequently utilized [6].

While good initial results are well demonstrated, the effectiveness, complications, side effects and long-term satisfaction are not well defined. The principal factors that determine effectiveness of TS are the type of HH and the passage of time. Initial effectiveness reached 99.2% with a rate of satisfaction at 97% [6]. The effectiveness of isolated axillary HH is less than that of palmar HH without discernible cause, and moreover decreases over time: 100% at the time of discharge and 98% at 12 months. Munia describes that T3 and T3–T4 are effective techniques for treating axillary HH [7]. In some studies on effectiveness, a 6-month follow-up showed a 98% and 63% satisfaction rate for palmar HH and axillary HH, respectively. In our case, after 12 months of surgery the effectiveness was similar for the isolated palmar HH and palmo-axillary HH groups (97.8% and 95.6%, respectively). However, isolated axillary HH was 85.7% and 71.4% at 6 and 12 months, which is similar to the published data released so far (Fig. 1).

Persistence of HH is observed in up to 1.9–2.8% of the cases, and is usually due to an erroneous or incomplete TS, or the existence of accessory Kuntz fibers. The most common causes are technical difficulties due to pleuropulmonary adhesions, anomalous vascularization, medial placement of the chain, or error in locating the first costal arch (the first arch seen is actually the second). Treatment is sympathectomy with special emphasis on visualizing possible accessory fibers [8]. We did not observe any case of persistence in our series.

Recurrence of HH appears between 1% and 27% of the patients at 3 years after surgery. Seventy-five percent of the recurrence appears at the first 6 months and its intensity in the majority of cases is level to moderate. The most common causes are incomplete TS, or nerve regeneration [8]. Factors that can determine its frequency are the type of HH, the extension of the TS and postoperative time. According to several authors, it is more frequent in isolated axillary HH (13.7%) than in palmar HH (8.2%) [1]. Lin obtained a relapse at 5 years of 1.3% and 16.7% for palmar and axillary HH, respectively [5]. In some studies a higher percentage of recurrence at 2 years is cited for TS T2 in comparison with T2–T3 (19% vs 3%), for which they conclude that T2 TS is more inclined to recurrence [9]. On the other hand, TS of communicating branches increases relapse when compared to truncal TS (5% vs 0% respectively). The time factor is verified by observing how the percentage of recurrence at the 1st and 5th year for axillary and palmar HH is 4.1% and 16.7% vs 0% and 1.3%, respectively. Global recurrence in our patients was 3.7% (15 patients), and in the axillary group it reached 28.5%. In our series, 86.7% of these recurrences appeared between 6 and 12 months, it is not related with the extension of the DS (p = 0.740), which is in line with figures reported by other authors [10]. As in persistence, the treatment of recurrence is surgical reintervention, with a success rate over 80%, as in our three cases [8].

Complications of TS can reach 10%. Ninety-five percent of these are due to VATS surgery (subcutaneous emphysema, pneumothorax, hemothorax and atelectasis) and other more generic problems such as infection of the wound. Pneumothorax is the most frequent complication and only needs pleural drainage in 30% of the cases [11]. In our experience, pneumothorax was the most common complication and required pleural drainage in 31.2% of the cases. Hemothorax usually occurs because of vascular intercostal lesions and, to a lesser degree, lesions of the subclavial vessels, acigus vein, pulmonary parenchyma, and rarely cardiac lesions. Treatment is usually pleural drainage and necessitates the conversion to thoracotomy in less than 0.5%. Horner syndrome is variable (0.5–17%) and is produced by lesions, which are direct (bisturi) or indirect (chain traction, freeing

Table 2
<table>
<thead>
<tr>
<th>Compensatory sweating</th>
<th>Yes (%)</th>
<th>No (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction degree (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Much better</td>
<td>89.7</td>
<td>90.2</td>
</tr>
<tr>
<td>Better</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Worse</td>
<td>4.9</td>
<td>5.2</td>
</tr>
<tr>
<td>Much worse</td>
<td>1.3</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Table 3
<table>
<thead>
<tr>
<th>Quality of life before and after thoracoscopic sympathectomy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Pre-surgical</td>
</tr>
<tr>
<td>Discharge</td>
</tr>
<tr>
<td>6 month</td>
</tr>
<tr>
<td>12 month</td>
</tr>
</tbody>
</table>

Data are percentage.

P.M. Rodríguez et al. / European Journal of Cardio-thoracic Surgery 34 (2008) 514—519
and work-related [9,11]. In our series, being female was a side effect, its etiology is unknown and its most important predisposing factor to suffer SC (differences in frequency or intensity of CS [6]). Various studies have shown a relationship between extension and CS (Table 1). Incidence varies between 70% and 90%, although some authors cite 100% (TS T2–T3) [9] and others only 12% (TS T2) [16]. It is classified as level in 60% of the cases, moderate in 30%, and severe or incapacitating in 10%, although some studies cite this last figure between 35% and 61% [14,17]. Affected regions for CS are, in order of frequency, the back, the abdomen, and the thighs. More than 90% appears before 6 months (range 3–2 years), and its onset after 12 months has a better prognosis [9,10]. CS does not change with time in 70%, 10% worsens and 20% improves, usually within the first 2 postoperative years. In our experience, CS occurred in 55% (1.8% severe) of patients. In 24 cases (10.8%) it appeared before 6 months and in 199 cases (89.2%) between 6 and 12 months. It was classified as level in 198 cases (88.8%), moderate in 21 cases (9.4%) and severe in 4 (1.8%). The most frequent locations were the back (67%), abdomen (61%), lower extremities (54%), thorax (11%) and generalized in three patients. As far as the evolution over time, 176 (79%) had no change, 34 patients (15.2%) got worse and 11 patients (4.9%) reported improvement. A negligible percentage of patients request medical treatment.

The relationship between frequency and severity of CS with extension of TS is not clear and the results are varied. Some studies do not establish this relationship observing CS rates at 100% (severe 76%) in T2–T3 and 90% in T2 (severe 50%), without statistical differences [9]. In another study the comparison between T2–T3 and T2–T4 had no significant differences in frequency or intensity of CS [6]. Various studies have shown a relationship between extension and CS. Schmidt showed that avoiding TS T2 lowers CS between 50% and 75% and Dewey demonstrates that TS that includes T2 produces more severe CS [18,19]. Nevertheless, TS T2 lowers the probability of CS when compared to T2–T4 (64% vs 24%), and TS exclusively in T3 maintains efficiency and decreases CS [20]. The selective sympathectomy of the communicating branches decreases CS, but with unacceptable recurrence rates. In our study we did not see a relationship between extension of TS and frequency and/or severity of CS (p = 0.649, Table 1).

There are very few studies that relate the probability of CS with the type of surgical technique used. Neumayer describes that blockage with clips in T4 produces 8.5% CS as opposed to 55.6% in T2–T4 sympathicolyis, with similar efficiency [21]. The main advantage of the blockage technique is its reversibility in cases of incapacitating CS, which disappears between 2 and 30 days after removing the clip.

Gustatory sweating has a variable frequency (1–32%) [22] and its etiology is unknown, although some authors theorize about abnormal nerve regeneration. Its relationship to extension is very controversial and many studies do relate it to extension (TS T2–T4 33.3%, T4 2.1%) [21,22]. Nevertheless, other authors have not observed differences between T2–T4 and T3–T5 (4.3% vs 4.9%). In our series this side effect appeared only once after TS T2–T4 for palmar–auxiliary HH.

Excessive dryness of the hands has not been studied well so far, although there are series in which there is a rate of up to 42%. We observed it in 9% of our cases. Its etiology is unknown and its frequency and severity is not related to the technique and/or extension. However, in our series 100% of the patients with TS T2–T4 sufferer excessive dryness of hands compared to 4.3% in T2–T3 TS group (p < 0.001). Other lesser-known adverse effects are vasomotor rhinitis (2.4%), hypersensitivity to cold and phantom sweating [23].

Cardiopulmonary function. TS produces minimal small airway alterations in presence of positive bronchial hyperresponsiveness and mild sympathetic blockade in heart rate. The clinical importance of these findings is not significant [24].

Up to 69% of patients with HH of the upper extremities also suffer from plantar HH and this modification cannot be explained by conventional anatomy [25]. The improvement of plantar HH is 50% at 6 months postoperative and decreases to 23.4% at 12 months as a consequence of recurrence [25]. In general, 15.2% get worse, 42.4% stay the same, and 42.4% improve, although there are described improvements of up to 82% [1]. An increase in intraoperative plantar temperature is described as a predicting factor for improvement of plantar HH (88.1% vs 48.8%). It has been shown that up to 35% of patients without operative plantar HH may develop it after TS for HH of the upper extremities. In our series (Fig. 2), we saw an improvement at discharge in 45% and same in 55% of the patients. At 6 months, improvement was 33.6% and a worsening in 10%. At 12 months the results were almost the same, except for a slight increase in plantar HH (13%). In our study, the worsening of the plantar HH was more frequent in the T2–T3/T3–T4 TS group in front of T2–T4 TS (21.8% vs 4.3%, p < 0.001). Recent publications demonstrate the effectiveness of retroperitoneal lumbar sympathectomy in the treatment of plantar HH.

The most influential factors in the postoperative degree of satisfaction are the type of HH, recurrence, time after surgery and side effects [1]. According to the literature, the percentage of satisfaction of TS for HH is over 90% [1,3,14].
although some works obtain less satisfaction (78%) [10]. In general, the satisfaction in axillar HH is less than that in palmar (95% vs 97%, respectively), due to a higher percentage of recurrence and lower efficacy [18]. As time passes, satisfaction decreases, due to the appearance of CS and/or recurrence [1,17]. Other less frequent causes of dissatisfaction are the existence of complications such as Horner’s syndrome, reversion to thoracotomy, or severe pain [1,6]. In our series the satisfaction upon discharge and at 6 and 12 months was 100%, 99%, and 90%, respectively (Table 1). In our study, the decrease in postoperative satisfaction was associated with recurrence and not with CS ($p < 0.001$). Six percent of our patients regret the operation, a percentage that is similar to that of other authors.

As for quality of life, 100% of the patients had difficulties with work and school and suffered social and psychological problems, which motivated the consult. In the preoperative phase, 97% of the patients characterized their quality of life as poor or very poor. After 30 days postoperatively, 86.4% said their lives were good or excellent. The principal factors which determine the increase in postoperative quality of life are the efficacy of the TS, the absence of CS and improvement in plantar hyperhidrosis [1,4,25]. However, 90% of the patients with CS tolerate this side effect better than the HH. In our series, after 12 months postoperatively, 97% of the patients reported a marked improvement in their quality of life (Table 2). In the remaining 3%, this improvement did not occur because of severe CS (1.8%) or recurrence (1.2%).

We conclude TS in the treatment of palmar—axillary HH has very few complications, the most frequent of which is pneumothorax. CS is the most frequent and undesirable side effect, appears between 6 and 12 months, is not related to the extension of the TS and female sex is a predictor factor of suffering. Plantar HH improves at first, although in some cases tends to reappear, and relates to extensive TS. Excessive dryness appears in extensive TS (T2—T4) and does not improve over time. Postoperative satisfaction degree is high but decreases over time owing to the appearance of recurrence. Treatment of recurrence is surgical re-intervention. Effectiveness and the absence of CS determine an excellent quality of life. However, 6% of the patients regret the surgery because of severe CS or recurrence. Informing patients of possible side effects before TS is essential.

References