T4 sympathectomy for palmar hyperhidrosis: looking for the right operation

Tarek Mahdy, MD, Tamer Youssef, MD, Hesham Abd Elmonem, MD, Waleed Omar, MD, and Atef Abd Elateef, MD, Mansoura, Egypt

Most surgeons still perform T2 or T2–3 sympathectomy for palmar hyperhidrosis (PH), but both of these treatments can cause severe side effects. Some recent articles advocating T4 sympathectomy have obtained satisfactory results. The aim of this study was to compare the outcomes of 3 different levels of sympathectomy. Between July 2003 and July 2006, we treated 60 patients (20 men and 40 women, mean age 26 years) who suffer from palmar hyperhidrosis by endoscopic thoracic sympathectomy (ETS). Patients were divided into 3 groups according to the level of sympathectomy: ETS2, ETS3, and ETS4 (20 patients in each group). Data were collected by review of medical charts, outpatient clinic notes, and telephone interviews. Patients were asked whether they considered their symptoms to be “cured” or “unchanged.” The degree of hand dryness was assessed subjectively. Postoperative complications (wound infection, chest pain, and Horner’s syndrome) were assessed. Any occurrence of gustatory sweating, rhinitis, presence and region of reflex compensatory sweating, and recurrence was noted. Patient satisfaction was assessed. Treatment success at follow-up was 90% for the ETS2, 95% for ETS3 patients, and 100% for the ETS4 patients. In the ETS2 and ETS3 groups, a higher rate of overdryness of limbs was observed (35% and 20%, respectively). The compensatory sweating was mild in the ETS4 group, whereas moderate-to-severe reflex sweating was more common in the ETS2 and ETS3 groups. About 40% of ETS2 groups and 25% of ETS3 group patients were unsatisfied with their operation. All patients of the ETS4 group were satisfied with the outcome. In conclusion, ETS4 sympathectomy is an effective method for treating PH and it decreases the rate of compensatory hydrosis (CH).

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From the Mansoura Faculty of Medicine, Department of Surgery, Mansoura University, Mansoura, Egypt

PALMAR HYPERHIDROSIS is a benign sympathetic disorder. It does not threaten health but does affect daily activities. In addition, social activities are seriously affected, which leads to social withdrawal and even depression. It is a problem of sympathetic dysregulation that may have an underlying genetic component.

Endoscopic thoracic sympathectomy (ETS) is a safe, simple, and effective method of treating palmar hyperhidrosis. The ideal result of operative treatment for palmar hyperhidrosis is to avoid excessive sweating or overdryness but to maintain a slight level of moisture in the hands. Hashmonai et al emphasized that although a dry hand is considered the expected positive outcome by surgeons, it is not necessarily considered the best outcome by patients.

Reflex sweating, which was known in the past as compensatory hyperhidrosis, is one of the most common side effects and the main reason for patients’ dissatisfaction with the operation. Reflex sweating is manifested by increased sweating in parts of the body other than the hands, such as the back, abdomen, groin, and thighs. Although reflex sweating occurs in most patients, it is usually mild and not troublesome by the patients as their original symptoms. Nevertheless, reflex sweating may make the patient regret having had the procedure. Many different methods have been suggested to lower the incidence of reflex sweating. Rennie and Bonjer et al stressed the importance of minimizing the extent of sympathetic nerve injury. Gossot et al reported that selective resection of rami communicantes decreased the rate of severe compensatory sweating.

Lin and Telaranta introduced a new classification of sympathetic disorder according to segmental distribution of sympathetic innervations. According
to the classification, interruption of the T2 ganglion may ameliorate facial blushing and vibration disorder, T3 ganglion for facial sweating and blushing, T4 for palmar sweating, and T5 for axillary sweating (bromidrosis).

Most surgeons perform T2 or T2–3 sympathectomy for palmar hyperhidrosis. Recently, several authors treated palmar hyperhidrosis following the Lin-Telaranta classification and obtained very good results, but the published comparative studies of T2, T3, and T4 sympathectomy are lacking.

In this prospective study, we compare the postoperative results of the 3 different levels of thoracoscopic sympathectomy (T2, T3, and T4 sympathectomy) in patients with palmar hyperhidrosis. We have also evaluated which level of ganglion interrupted is the best for palmar hyperhidrosis.

**PATIENTS AND METHODS**

Between July 2003 and September 2006, we treated 60 patients (20 men and 40 women, mean age 26 years) who suffered from palmar hyperhidrosis by ETS. Patients were divided into 3 groups according to the level of sympathectomy: ETS2, ETS3, and ETS4 (20 patients in each group). The group selection remained in closed envelopes that were opened on the morning of the operation. A detailed informed consent was obtained from all patients after approval from local ethics committee.

**Surgical technique.** The conventional ETS method by the 2-port approach was the operative procedure performed. Under general anesthesia with single lumen endotracheal intubation, the patient was placed in the semi-Fowler’s position with arms abducted. The lung is collapsed by CO₂ insufflation into the pleural cavity. Two ports are introduced: 1 in the axilla for insertion of the endoscope and the other in the middle or posterior axillary line at the level of the nipple for insertion of the diathermy probe. Because the first rib was usually difficult to visualize through thoracoscopy, the second, third, fourth, and fifth ribs were identified according to the anatomic landmark of the first rib covered by an area of bright yellow fat at the costovertebral junction. At the level where the sympathetic chain crossed the ribs, the parietal pleura were opened with the diathermic hook. The upper and lower ends of the intended ganglion were coagulated completely by diathermy at the head of the upper and lower ribs, for example, the fourth and fifth ribs for T4 ganglion. After being separated from the surrounding tissue, the sympathetic chain was cauterized gently and transected completely, but the ganglion was left in position without removal by manipulation. The level of transection was marked by clips to be checked postoperatively. The CO₂ gas was then expelled from the chest cavity, the lung expanded, and the port skin incisions closed with single stitches. The same procedure was repeated on the other side. Postoperative chest radiography was performed routinely. All patients whose intraoperative estimated rib count was not confirmed by postoperative chest radiography were excluded from the study.

Data were collected by review of medical charts, outpatient clinic notes, and telephone interviews. Patients were analyzed for descriptive variables [age at operation, sex, body mass index (BMI), and family history] by reviewing the medical charts. Patients were followed for about 1 year postoperatively. All patients completed the follow-up. The first follow-up assessment was performed by examining the patient in the outpatient clinic, and the data were collected during an interview by an independent observer unaware of surgical details. Follow-up was completed later through telephone interviews at 3, 6, and 12 months. During an interview, patients were asked to state whether they considered their symptoms to be “cured,” or “unchanged.” The degree of hand dryness was assessed subjectively (no dry feeling, tolerable dry feeling, dry feeling requiring lotions, or wet hands). Postoperative complications (including wound infection, chest pain, and Horner’s syndrome) were assessed.

Any occurrence of gustatory sweating, rhinitis, presence and regions of reflex, compensatory sweating, and recurrence was noted. Based on the patient’s comments, “severe” compensatory sweating was indicated when the patient mentioned that sweating interfered with his or her normal activity, for example, when clothing had to be changed 2 or 3 times per day. “Moderate” compensatory sweating was noted when the patient indicated that his or her sweating was not bothersome. “Mild” compensatory sweating was considered when the patient did not mention dampness or made only a brief reference to his or her sweating. Based on a series of questions, patient satisfaction was rated on a 5-point scale that ranged from “very unsatisfied” to “very satisfied.” Finally, the patients were asked whether they would recommend the procedure to a friend.

Unless stated otherwise, all data are expressed as mean ± standard deviation (SD) or as percentages. Descriptive and inferential statistical analyses were performed using both parametric and nonparametric procedures as appropriate. Comparisons of categorical/ordinal variables were performed using...
chi-square analysis for trends. Satisfaction ratings were grouped simply as “satisfied” or “unsatisfied” for statistical comparison. Continuous variables were compared using an independent group $t$-test. Criterion for statistical significance was set at $P < .5$, 2-tailed.

RESULTS

Demographic data are shown in Table I. The age, sex, BMI, and family history were comparable among the ETS2, ETS3, and ETS4 groups. All patients had a follow-up of more than 6 months in all groups.

Complication rates were almost identical for both groups (Table II). No patients died perioperatively, and no conversion was necessary. No complete Horner’s syndrome was observed, and only 1 patient (in the ETS2 group) exhibited a mild miosis. Residual pneumothorax occurred in 10% of patients, all of which subsided without intervention. No incidence of hemopthorax occurred. Patients who suffered from postoperative neuralgia manifested by numbness in the inner aspect of the upper arm were treated by nonsteroidal analgesics, and the complaints lasted for approximately 2 weeks maximum. One wound infection was treated locally and with antibiotics in the ETS3 group.

Treatment success (lack of palmar hyperhidrosis) at follow-up was 90% for the ETS2, 95% for ETS3 patients, and 100% for the ETS4 patients (Table II). In the ETS2 and ETS3 groups, a greater rate of overdryness of the limbs was observed [7 patients (35%) and 4 patients (20%), respectively]. Two patients had persistently wet palms in the ETS2 group (10%) and 1 patient (5%) in ETS3 group, whereas no failures were observed in the ETS4 group.

The incidence of postoperative reflex sweating was decreased substantially from 12 patients (60%) in the ETS2 group to 9 patients (45%) in the ETS3 group and to 2 patients (10%) in the ETS4 group (Table III; $P = .003$). Likewise, some patients noticed facial sweating when eating spicy or hot food (gustatory sweating). Facial sweating was markedly less frequent in the ETS4 group [30 patients (10%), 5 patients (25%), and 1 patient (5%), respectively; $P = .018$]. No significant differences were detected concerning the occurrence of vasomotor rhinitis.

As shown in Fig 1, reflex sweating was mild in the ETS4 group, whereas moderate-to-severe reflex sweating was more common in the ETS2 and ETS3 groups. The areas of reflex sweating varied among patients. The back was the most commonly affected site and was involved in 60% of patients. In the order of decreasing frequency, the other body parts involved were the posterior aspect of the legs (15%), thighs (15%), and other miscellaneous areas (10%).

The degree of patient satisfaction after the operation was included in the questionnaire (Fig 2). About 40% of the ETS2 group and 25% of the ETS3 group were unsatisfied with their operation, mostly because of reflex sweating, overdryness, and recurrences. All patients of the ETS4 group were satisfied with the outcome.

DISCUSSION

Sweating is influenced by 2 factors: emotional stimulation (central control) and environmental temperature (peripheral control). Palm, axillary, plantar, and facial hyperhidrosis are induced emotionally and are not related to environmental temperature. Although hyperhidrosis is a benign disorder and does not affect health, daily and social activities are affected. Therefore, a cure is usually desired. ETS using video-assisted thoracoscope has become established as a safe and effective treatment with a success rate greater than 95% in most series.

The main side effect of ETS is severe reflex sweating over the trunk area, which is encountered postoperatively by some patients. In most patients,
a mild variation of increased sweating is an unavoidable consequence of sympathectomy to ensure the ablation of abnormal sweating of the palms. Nevertheless, severe reflex sweating may occur postoperatively in 10% -- 40% of patients. Instead of the palms, these patients start sweating in other areas, such as the lower back, buttocks, groin, and thighs, often to such a voluminous degree that they are unhappy with the results of ETS even when their initial symptom of marked palmar sweating is abolished successfully. Few treatment options exist for patients with this complication.11,15

Prevention or control of the degree of reflex sweating is an important aim in the treatment of hyperhidrosis. Variable results exist on the severity of reflex sweating in correlation with the extent of sympathectomy. Andrews and Rennie16 have reported the incidence of reflex sweating to occur in 36 of 42 patients after T2–T3 ETS. Their results reveal an incidence of 22% severe, 38% moderate, and 22% slight reflex sweating in their patients. Lai et al17 observed reflex sweating in 99% of their patients after T2 or T2–T3 ETS. Shelley and Florence18 explained the phenomenon of compensatory sweating after sympathectomy as a thermoregulatory function. Although difficult to prove, the severity of compensatory sweating seems to parallel the extent of ganglia removed.5

Various methods have been evaluated to decrease the occurrence rates of reflex (compensatory) sweating. Bonjer et al8 reported on a series in which only the T3 was resected and, thus, decreased compensatory hyperhidrosis. Gossot et al9 account the rates of compensatory hyperhidrosis of 72% after T2 to T4 ablation and 71% in the group that underwent only selective section of the rami communicantes. They state that no difference exists in the incidence of compensatory hyperhidrosis between the 2 groups, although they report the occurrence of 27% and 13% of compensatory hyperhidrosis, respectively, so severe as to limit the daily activities. These numbers show a statistically significant difference between the 2 groups.

Lin and Wu19 used a T4-sympathetic block by clamping (ETS4) in the treatment of 165 patients of palmar and axillary hyperhidrosis and attained excellent operative results without reflex sweating. According to them, the preservation of sympathetic tone to the head was found to be the main factor in avoiding reflex sweating in ETS. They concluded that the lower the sympathetic ganglion is ablated, the more sympathetic tone to the head is preserved.

In the current study, different levels of sympathectomy were performed; all methods brought about good effects in reducing palmar hyperhidrosis. In contrast, a large discrepancy of satisfaction was noted among patients, and postoperative complications accounted for nearly all the disparity in satisfaction. The most important variable that influenced satisfaction after the operation was the presence of palmar overdryness and the severity of reflex sweating. Compared with ETS2 and ETS3, it seemed that ETS4 for palmar hyperhidrosis was a more effective approach that minimized postoperative complications, including palmar overdryness, presence of reflex sweating, and regions of reflex sweating.

The correlation between the level of interruption of the sympathetic trunk and the severity of reflex sweating was reported.20 Inclusion of T2 ablation results in significantly more severe reflex
sweating than other levels not incorporating T2. In the current series, different degrees of reflex sweating were found at different levels of sympathectomy. Compared with ETS2, the severity of reflex sweating was related directly to ETS3 and significantly inversely related to ETS4. The distributions of the preferential location of reflex sweating among the 3 groups were comparable, with the back and lower extremities the most common regions. When compared with groups ETS2 and ETS3, ETS4 had less areas involved. Several other authors have described that the most common region was the posterior aspect of the trunk.

Several authors limited the extent of resections for hyperhidrosis to a single level to decrease the incidence of severe compensatory symptoms. Neumayer et al and Choi et al reported their series of T4 sympathetic block for palmar hyperhidrosis. The success rates were 100%, and the reflex sweating rates were 8% and 3%, respectively. These discrepancies, although small, may be caused by differences in the definition and assessment of symptom severity. Neumayer et al stated that no clear criterion can be used to evaluate reflex sweating. It is also difficult to say whether the sympathectomy is successful. These results can only be assessed subjectively by patients.

To explain this phenomenon, the sympathetic nervous fibers originate from the intermediolateral horns of the spinal cord between T1 and L2. Each pathway consists of preganglionic and postganglionic neurons. The nerve fibers distributed to the sweat glands are postganglionic fibers that develop from the ganglia in the sympathetic trunks. These fibers then go through the gray ramus communicans and join with the corresponding spinal nerves in the target organ. In the sympathetic trunks, ganglia may go upward and downward before leaving and distributing to the target organ. Therefore, distributions overlap and do not necessarily supply the same part of the body from the same spinal segment. The efferent fibers are accompanied by afferent fibers. The autonomic nervous system functions through positive and negative feedback mechanisms. Nervous impulses from the target organs (eg, sweat glands) are transmitted as afferent negative feedback signals to the central control center (hypothalamus), from where the efferent positive feedback signals return to the target or- gan. This system means that T2 interruption stops most negative feedback signals to the central nervous system. Therefore, the efferent positive feedback signals to the sweat gland are strong and most severe reflex sweating results. Reflex sweating always occurs on the lower abdomen, back, and thighs and never on the upper body or face, because the nerve has already been blocked. T3 ganglionic interruption disrupts fewer afferent negative feedback signals, so that efferent positive feedback signals are weaker and reflex sweating is less severe. T4 interruption causes the least or almost no reflex sweating, because most of the afferent negative feedback signals are preserved. Reflex sweating occurs in 30–70% of patients after T2, 17–25% after T3, and 3–8% after T4 sympathetic block.

Therefore, the changing pattern of excessive sweating is not really a compensation but a reflex response. Some other facts in clinical practice support this concept. Excessive sweating can be induced after sympathectomy for nonsweating sympathetic disorders such as the T2 sympathetic block for pure facial blushing; and no reflex sweating is found after lumbar sympathectomy for planter hyperhidrosis. According to many studies, the higher the level of ganglionic blockade (eg, T2 or T3), the greater the incidence of severe compensatory symptoms.

In conclusion, ETS4 sympathectomy seems to be a superior method for treating palmar hyperhidrosis with high rates of success and no recurrence. Most importantly, the rate of compensatory sweating is decreased to a minimum.

**REFERENCES**


