Thoracoscopic limited T-3 sympathicotomy for primary hyperhidrosis: prevention for compensatory hyperhidrosis

Do Heum Yoon, M.D., Ph.D., Yoon Ha, M.D., Ph.D., Yong Gou Park, M.D., Ph.D., and Jin Woo Chang, M.D., Ph.D.

Department of Neurosurgery, Brain Tumor Project and Brain Research Institute, Yonsei University College of Medicine, Seoul, Korea

Object. Compensatory hyperhidrosis is a major and troublesome complication of thoracoscopic sympathectomy for primary hyperhidrosis. The incidence of compensatory hyperhidrosis has been reported to be as high as 50 to 97% in the patients who underwent sympathetic ganglia resection. In this study the authors evaluate the role of thoracoscopic T-3 sympathicotomy for primary hyperhidrosis and the prevention of compensatory hyperhidrosis.

Methods. Thoracoscopic T-3 sympathicotomy was performed in 27 patients with either isolated palmar hyperhidrosis (24 cases) or that in combination with axillary hyperhidrosis (three cases) during a 3-year period. In the cases of combined palmar/axillary hyperhidrosis, the T-4 sympathetic ganglion also was coagulated. The mean follow-up period was 19.7 months. Surgery-related results were determined on the basis of complications, compensatory hyperhidrosis, and patient-related satisfaction.

In the immediate postoperative period all 24 patients with palmar hyperhidrosis reported complete alleviation of their symptoms. One patient with palmar/axillary hyperhidrosis in whom axillary hyperhidrosis did not completely resolve underwent a repeated T-4 sympathicotomy 1 month after the initial surgery. Another patient suffered mild compensatory hyperhidrosis of the trunk 1 month postoperatively. The long-term satisfaction rate in all 27 patients was high. One patient required placement of a chest tube to treat pneumothorax. Other complications such as Horner syndrome, intercostal neuralgia, gustatory hyperhidrosis, and pulmonary edema were not observed.

Conclusions. Thoracoscopic limited T-3 sympathicotomy is an effective method to treat primary hyperhidrosis, its rate of compensatory hyperhidrosis is low, and its rate of long-term patient satisfaction is high.

KEY WORDS • hyperhidrosis • sympathicotomy • thoracoscopy • compensatory sweating

Primary hyperhidrosis is a pathological condition of excessive perspiration of unknown cause, resulting in severe occupational, emotional, and social disadvantages. Thoracoscopic upper-thoracic sympathectomy has been considered the treatment of choice for primary palmar hyperhidrosis.\cite{15,19}

Resection of the sympathetic chain produces long-term relief of hyperhidrosis. Many surgeons prefer resecting the T2–4 sympathetic ganglia.\cite{9} Sympathectomy can be associated with high success rates (> 90%) in decreasing hyperhidrosis.\cite{5,17} Despite this achievement, the high incidence of postprocedure compensatory hyperhidrosis (50–90%)\cite{8,12,23,25} is a major concern.\cite{20} Because it is believed that the extent and level of resection are related to compensatory hyperhidrosis,\cite{26} some surgeons favor an ablative procedure (sympathicotomy) rather than resection. Sympathicotomy has been reported to be an easily performed procedure requiring a short operative time.\cite{2,32} Furthermore, repeated sympathectomy is possible if the initial procedure fails to resolve symptoms. The level at which the sympathicotomy should be performed is not yet well established. Limited T-2 to multilevel (T2–T5) sympathicotomy has been undertaken to treat primary palmar hyperhidrosis.

The goal of this study was to evaluate the effectiveness of sympathicotomy for sympathetic ganglia (T-3) in terms of alleviating palmar hyperhidrosis and reducing the incidence of compensatory sweating.

Clinical Material and Methods

Patient Population

We enrolled all consecutive patients who had undergone thoracoscopic sympathicotomy for primary palmar and axillary hyperhidrosis between February 1999 and February 2002 at the Yonsei University Medical Center in Seoul. There were 15 men and 12 women whose mean age was 21.9 years (range 16–28 years). Of the 27 patients, 24

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Abbreviation used in this paper: SD = standard deviation.
suffered palmar hyperhidrosis and three both palmar/axillary hyperhidrosis.

Symptom Assessment

All patients in whom the sympathetic chain was electrically cauterized at the third ganglion (palmar hyperhidrosis) and the third and fourth ganglia (palmar/axillary hyperhidrosis) were included and interviewed us-ing optimized questionnaires. A linear analog scale was used to assess the degree of palmar, facial, trunk, and plantar sweating (range 0–10 [0 = anhidrosis; 10 = excessive sweating]), as well as the patient’s satisfaction with surgery (range 0–10 [0 = regrets surgery; 10 = completely satisfied]). Compensatory hyperhidrosis was graded as follows: none (absent compensatory hyperhidrosis); mild (minor and intermittent excessive sweating); moderate (embarrassing or visible sweating); and severe (disabling sweating requiring one or more changes of clothing per day). Furthermore, patients were also asked whether they had experienced gustatory hyperhidrosis (facial sweating at the sight or smell of food), intercostal neuralgia, or Horner syndrome.

Statistical Analysis

Significant differences between the pre- and postoperative degree of sweating were calculated using the paired Student t-test. A probability value of less than 0.05 was considered significant.

Surgical Procedures

After induction of general anesthesia, biluminal orotracheal intubation, and supine positioning with abduction of both arms to expose the axilla, the anesthesiologist suctioned air from the lumen of the endotracheal tube to deflate the lung. The operating table was positioned at a 15° incline to cause the lung on the side to be surgically treated to fall toward the diaphragm. An 11-mm trocar (Carl Storz, Culver City, CA) was inserted into the pleural cavity in the fourth intercostal space in the midaxillary line. The lung was compressed by injection of 1 to 2 L of CO2. After visualization of the sympathetic chain by inserting blunt endoscopic instruments through the 11-mm trocar, the third and fourth ribs were identified. At the level at which the sympathetic chain crossed these ribs, the parietal pleura were opened using a diathermic hook. Straight electrocautery scissors guided in via the 2-mm trocar of the third intercostal space in the midaxillary line were used to completely coagulate the T-3 sympathetic ganglion at the level of the third rib head (palmar hyperhidrosis) and T-3 and T-4 sympathetic ganglia (palmar/axillary hyperhidrosis). The sympathetic chain and ganglia were gently cauterized and divided completely but were left in position without removal by manipulation. The Kuntz fiber or other accessory sympathetic chains were carefully inspected and coagulated as well. Finally, the lung was reinflated. The skin wound was closed while continuous positive airway pressure was applied. The same procedure was performed bilaterally. The bilateral operation required approximately 40 minutes. A chest radiograph was obtained postoperatively and again before discharge. If necessary, a chest tube was inserted in cases of postoperative pneumothorax.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>male/female ratio</td>
<td>15:12</td>
</tr>
<tr>
<td>mean age (yrs)</td>
<td>21.9 ± 4.27*</td>
</tr>
<tr>
<td>hyperhidrosis</td>
<td></td>
</tr>
<tr>
<td>palmar</td>
<td>24</td>
</tr>
<tr>
<td>palmar/axillary</td>
<td>3</td>
</tr>
<tr>
<td>mean hospital stay (days)</td>
<td>2.89 ± 1.21*</td>
</tr>
<tr>
<td>mean follow-up period (mos)</td>
<td>19.7 ± 4.23*</td>
</tr>
<tr>
<td>mean degree of postop satisfaction</td>
<td>7.93 ± 0.83*</td>
</tr>
<tr>
<td>no. of postop complications</td>
<td>2†</td>
</tr>
<tr>
<td>no. of recurrences</td>
<td>0</td>
</tr>
</tbody>
</table>

* Presented as the mean ± SD.
† One patient suffered postoperative pneumothorax requiring chest tube insertion and the other suffered mild compensatory hyperhidrosis 1 month postoperatively.

Results

The data characterizing the patients are summarized in Table 1. Most patients were discharged on (12 cases) or before (10 cases) the 1st postoperative day (mean hospital stay 2.89 ± 1.21 days). In one patient, pneumothorax necessitated insertion of a chest tube. In the immediate postoperative period all 24 patients with palmar hyperhidrosis and two patients with palmar/axillary hyperhidrosis reported complete resolution of symptoms. During the mean follow-up period of 19.7 months, there were no reported complications such as dry limb, gustatory hyperhidrosis, intercostal neuralgia, or Horner syndrome. No recurrences developed during the follow-up period. The mean self-reported degree of postoperative satisfaction was 7.93; in all cases individual scores were greater than 7.

One patient noted a mild degree of compensatory hyperhidrosis (Table 2). He experienced increased sweating on his back during exercise; however, this was not bothersome.

Repeated sympathicotomies was performed in one patient with palmar/axillary hyperhidrosis who had undergone T-3 and T-4 sympathicotomies. Although palmar hyperhidrosis responded well, axillary sweating did not improve. He was fully satisfied after the T-4 sympathicotomy 1 month after the first operation.

A significant difference in the degree of sweating was observed between pre- and postoperative periods (p < 0.001; Fig. 1). In the preoperative period, the mean degree of sweating was 7.85 ± 0.72 (mean ± SD), with no reported score less than 7. Postoperatively, most patients

<table>
<thead>
<tr>
<th>Grade</th>
<th>No. of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>26 (96.3)</td>
</tr>
<tr>
<td>mild</td>
<td>1 (3.7)</td>
</tr>
<tr>
<td>moderate</td>
<td>0 (0)</td>
</tr>
<tr>
<td>severe</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
Sympathicotomy for primary hyperhidrosis

noted a score of 3 or 4 (3.63 ± 0.56). Moreover, excessive dryness was not reported (Score 0–1).

Discussion

Patients with primary palmar hyperhidrosis sometimes avoid social interactions such as grasping or shaking hands and experience difficulties in writing. The cause of this condition remains unknown, but it affects mostly young adults. Although palmar hyperhidrosis is the most common presentation, some patients additionally experience axillary hyperhidrosis. Topical and oral agents sometimes alleviate the symptoms in mild cases. Surgical treatment is required in severe cases, however. The key aspect of surgery is interruption of the transmission of sympathetic nerve impulses from ganglia to nerve endings. The standard procedure involves removal of the T-2 and T-3 sympathetic ganglia by electrocautery for primary palmar hyperhidrosis, as well as the T-4 or T-5 ganglia for axillary hyperhidrosis. This treatment involves a minimally invasive procedure that can be performed quickly and easily, provides an excellent view of the sympathetic chain, and for which admission is reduced to 2 or 3 days.

The mean operative time for a sympathicotomy has been shown to be significantly less than that of sympathectomy. Resection requires almost twice the time needed for ablation. Furthermore, sympathicotomy is technically easier than sympathectomy, which is another important reason why the former is preferred. Few techniques for sympathicotomy have been introduced. One is to transect sharply the sympathetic chain and ganglia, another to ligate the sympathetic chain with vascular clip. Electrocoagulation of the sympathetic ganglia and chain is preferred for sympathicotomy because it is technically easier to perform than sympathectomy and other forms of sympathicotomy.

Compensatory hyperhidrosis is the most common and distressing complication of this procedure. This is characterized by sweating in the nondenervated portions of the body, mostly over the trunk and upper thighs, after sympathectomy. The pathogenesis of compensatory hyperhidrosis is considered to be partly caused by thermoregulatory response after sympathetic denervation. The overall amount of sweat over the entire body does not change, and the residual sweat glands attempt to compensate for the loss of neural regulating sweat glands. The residual sweat glands always respond rapidly to thermal stimuli rather than psychological stimuli, and normal hypothalamic function has been demonstrated. The proper procedure to resolve this problem has not been determined. It has been suggested that the severity of compensatory hyperhidrosis is correlated with the extent of sympathectomy. The greater the number of glands removed from thermoregulatory control, the greater is the response anticipated from the remaining glands. For that reason, a limited resection of T-2 sympathetic ganglion is preferred; however, even though this procedure has a high success rate, it also seems to result in a higher incidence of compensatory hyperhidrosis (Table 3). In the present study, one patient (3.7%) developed compensatory hyperhidrosis. These results are identical to those of the previous studies in which the authors reported a low incidence of compensatory hyperhidrosis after T-3 sympathectomy.

The incidence of Horner syndrome following sympathectomy seems to be higher than that following sympathectomy. One possible mechanism to explain post-sympathectomy of Horner syndrome is the traction force exerted on the sympathetic trunk during resection, which is not required when performing sympathicotomy. Furthermore, heat propagation during the T-2 sympathetic

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**TABLE 3**

Summary of series on the treatment for primary palmar hyperhidrosis

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>No. of Patients</th>
<th>Level of Op</th>
<th>Success Rate (%)</th>
<th>Procedure</th>
<th>Compensatory Hyperhidrosis (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drott &amp; Claes, 1996</td>
<td>1163</td>
<td>T2–3</td>
<td>98</td>
<td>sympathicotomy</td>
<td>55</td>
</tr>
<tr>
<td>Cohen, et al., 1998</td>
<td>223</td>
<td>T2–3</td>
<td>98.7</td>
<td>sympathectomy</td>
<td>44.4</td>
</tr>
<tr>
<td>Rex, et al., 1998</td>
<td>785</td>
<td>T2–3</td>
<td>99.4</td>
<td>sympathectomy</td>
<td>59.8</td>
</tr>
<tr>
<td>Zacherl, et al., 1998</td>
<td>187</td>
<td>T1–4</td>
<td>98.7</td>
<td>sympathicotomy</td>
<td>67</td>
</tr>
<tr>
<td>Lin, 1999</td>
<td>438</td>
<td>T2</td>
<td>99.3</td>
<td>sympathectomy</td>
<td>86</td>
</tr>
<tr>
<td>Lin &amp; Fang, 1999</td>
<td>1360</td>
<td>T2</td>
<td>99.2</td>
<td>sympathectomy</td>
<td>84</td>
</tr>
<tr>
<td>Nicholas, et al., 2000</td>
<td>125</td>
<td>T2–4</td>
<td>98.5</td>
<td>sympathectomy</td>
<td>91</td>
</tr>
<tr>
<td>Riet, et al., 2001</td>
<td>14</td>
<td>T3</td>
<td>100</td>
<td>sympathectomy</td>
<td>0</td>
</tr>
<tr>
<td>Han, et al., 2002</td>
<td>179</td>
<td>T2–3</td>
<td>99.4</td>
<td>sympathectomy</td>
<td>67.3</td>
</tr>
<tr>
<td>present study</td>
<td>27</td>
<td>T3</td>
<td>100</td>
<td>sympathectomy</td>
<td>3.7</td>
</tr>
</tbody>
</table>
ganglion procedure results in electrical damage to nearby stellate ganglions. Therefore, we could safely avoid stellate ganglion injury by preserving the T-2 sympathetic ganglion.

In the patients who have undergone thoracic sympathectomy excessively dry hands have been reported as another troublesome sequela. Patients sometimes require moisturizing cream to preserve the wetness of their hands. By limiting the extent of sympathectomy to T-3, the incidence of this phenomenon could be reduced without compromising the outcome. These results suggest that T-3 sympathectomy has a relatively minor sympathetic influence on upper-extremity function relative to conventional T2–3 sympathectomy.

It has been known that the T-2 sympathetic ganglion is the key innervating element of the upper extremity. Some authors have proposed that preservation of the T-2 sympathetic ganglion may increase the failure rate of sympathectomy to resolve hyperhidrosis. Dry hands and risk of thermal injury to stellate ganglion causing Horner syndrome, however, are increased after T-2 compared with T-3 lesioning. We therefore suggest that sympathectomy of the T-3 ganglion alone is more acceptable than T-2 lesioning and additionally that T-3 sympathectomy is a less demanding technique that can be expected to increase the safety of the procedure, especially in the hands of a less experienced surgeon.

It has been reported that symptoms recur usually within 2 years of surgery. The incidence of recurrence varies according to the procedure. Although the recurrence rates reported for sympathectomy are lower, the higher rates for sympathectomy are acceptable to many surgeons. In our experience, the recurrence rate after T-3 sympathectomy is not significantly higher than that for other procedures. Possible causes of recurrence include incorrect localization of sympathetic ganglion, missed Kuntz fiber, anatomical variances, or axonal regeneration. In our experiences, careful inspection of anatomical variances in sympathetic chain including Kuntz fiber, as well as careful localization of the correct level by using an endoscopic device to palpate the first rib, are important steps in reducing recurrences. Well-designed, case-control, long-term studies, however, are required to resolve the controversies regarding the effectiveness and complications of the various surgical procedures.

Conclusions

On the basis of our findings, we conclude that thoracoscopic limited T-3 sympathectomy is an easy, safe, and effective method to treat patients with primary palmar hyperhidrosis. This method reduces postoperative complications, especially compensatory hyperhidrosis, without disturbing the patient’s satisfaction.

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Sympathicotomy for primary hyperhidrosis


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Address reprint requests to: Jin Woo Chang M.D., Ph.D., Department of Neurosurgery, Yonsei University College of Medicine, C.P.O Box 8044, Seoul 120-752, Korea. email: jchang@yumc.yonsei.ac.kr.