

# Thoracoscopic Sympathetic Surgery for Hyperhidrosis

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## Abstract

Resectional surgery of sympathetic nerves has been known to be the most effective treatment for essential hyperhidrosis and the application of thoracoscopic electrocauterization has provided a minimally-invasive procedure with the least morbidity and a resultant higher satisfaction rate. This paper describes our experience on the 1,167 cases of thoracoscopic sympathetic surgery for the treatment of essential hyperhidrosis. A total of 1,167 patients (674 males (58%) and 493 females (42%), mean age of 26.4 years with palmar (930), craniofacial (190) or axillary (47) hyperhidrosis underwent thoracoscopic sympathetic surgery from July 1992 to March 1999. Since the T2-4 sympathectomy, first performed in July 1992 for a patient of palmar hyperhidrosis, the operative methods have been altered to achieve a higher satisfaction level with the least complication by adopting less invasive procedures. Our current standard procedures being performed are T3 and T2 clipping for palmar and craniofacial hyperhidrosis and T3,4 sympathectomy for axillary hyperhidrosis, all using a 2 mm needle thoracoscope. As the surgical procedures have been transited to a less invasive method with limited resection using the newest endoscopic devices, the average operation time and complications such as Horner's syndrome and compensatory hyperhidrosis have gradually decreased and thus the long-term satisfaction rate has been raised up to 98% for palmar hyperhidrosis, 92% for craniofacial hyperhidrosis and 89% for axillary hyperhidrosis. The recurrent cases (14/1167) were treated successfully with reoperations of thoracoscopic sympathetic surgery. The optimal goal of therapy could be achieved by complete elimination of the hyperhidrotic symptom, by decreasing the incidence and degree of compensatory hyperhidrosis through a selective and limited resection, and by adopting the least invasive procedures. Sympathectomy has provided the advantages of a limited extent of denervation and the resultant decrease of compensatory hyperhidrosis compared to sympathectomy. The reversible method of clipping may be an effective, provisional means for cases of severe, intractable compensatory sweating. For craniofacial hyperhidrosis, T2 sympathectomy or clipping has been proven to be superior to the T1 sympathectomy due to the decreased occurrence of Horner's syndrome and T3,4 sympathectomy providing a satisfactory outcome with less compensatory hyperhidrosis for axillary hyperhidrosis.

**Key Words:** Hyperhidrosis, sympathectomy, sympathetic clipping

## INTRODUCTION

Essential hyperhidrosis is an idiopathic condition of profuse sweating in certain areas of the body, usually in the palm, sole, head, face or axilla, above and beyond physiologic needs. It results from hypersensitive reaction to sudomotor function controlled by sympathetic nerves, and unlike sweating in response to normal thermal stimuli, it is affected more by psychological or emotional tension.<sup>1,2</sup> The consequent discomfort and withdrawal from social life may be-

come a debilitating problem to affected persons; the reported incidence of essential hyperhidrosis is as high as 0.6–1.0% in certain populations.<sup>3</sup> Previously-attempted conservative therapies including topical agents, systemic anticholinergics and iontophoresis showed only temporary, unsatisfactory effects. Since 1920 when Kotzareff first performed thoracic sympathectomy, resectional surgery of sympathetic nerves has been known to be the most effective and lasting treatment for hyperhidrosis.<sup>4,7</sup> Postoperative morbidity and a long convalescence of open thoracic sympathectomy was solved by the application of thoracoscopy in performing sympathectomy, first described in 1943,<sup>8</sup> and several hundred thoracoscopic sympathectomies were performed in Europe during the 1940s.<sup>9</sup> In 1987 a thoracoscopic method was developed in which the upper thoracic sympathetic ganglia were electrocauterized.<sup>5</sup> And recent development of a video endoscopic system has enabled wide

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application of thoracoscopic sympathectomy, pursuing minimally invasive procedures with fewer complications. The purpose of this paper was to report our experience of thoracoscopic sympathetic surgery performed for 1,167 patients with essential hyperhidrosis during the period from July 1992 to March 1999.

**MATERIALS AND METHODS**

**Patients**

1,167 patients (674 males and 493 females) with hyperhidrosis underwent thoracoscopic sympathetic surgery at Yongdong Severance Hospital, Yonsei University College of Medicine, Seoul, Korea from July 1992 to March 1999. Their mean age at the time of operation was 26.4 years, ranging from 10 to 67 years. There were 930 cases of palmar hyperhidrosis, accounting for 80% of total cases, 190 (16%) cases of craniofacial hyperhidrosis and 47 (4%) cases of axillary hyperhidrosis. Annual incidence was gradually increased from 1 case in 1992, 51 cases in 1994, 68 cases in 1995, 208 cases in 1996, 357 cases

in 1997, 365 cases in 1998 and 117 cases up to March 1999 (Table 1).

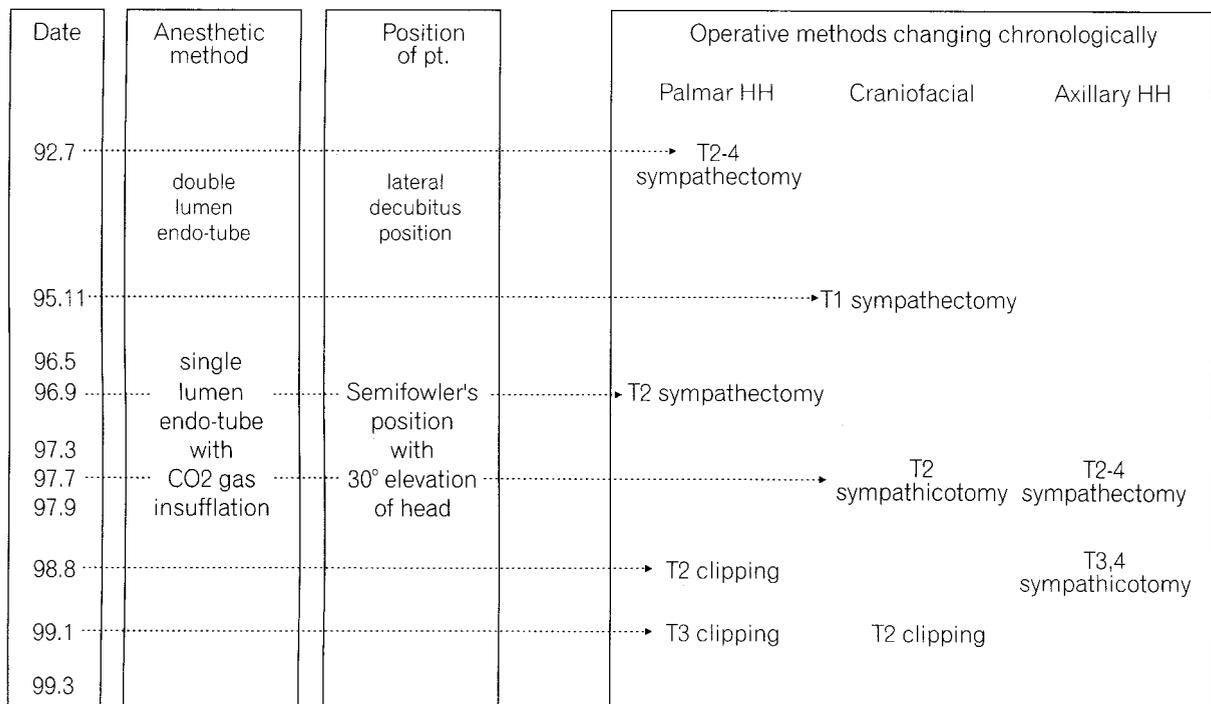
**Operative procedures**

Surgical techniques and anesthetic methods have been altered to achieve a higher satisfaction rate with the least discomfort by adopting less and less invasive procedures along with the development of endoscopic devices. Up until May 1996, patients were operated in both lateral decubitus positions, necessitating in-

**Table 1. Patient Profile**

Age group (years)	Sex		Type of HH	
	M	F	No. of patients	1,167
≤ 10	1			
11 - 20	229	166	palmar	980
21 - 30	313	180	craniofacial	190
31 - 40	112	109	axillary	47
≥ 41	31	26		

HH, hyperhidrosis.



HH, hyperhidrosis

**Fig. 1. Transition of operative methods.**

traoperative change of position. Since then, a semi-fowler's position with 30-degree elevation of the upper body and abduction of the arms has been used. A single lumen endotracheal tube replaced the double lumen tube which was needed for a one-lung ventilation until September 1997; instead, 1500–1700 cc of CO<sub>2</sub> gas was instilled into the thoracic cavity under 6 mmHg pressure to gradually deflate the lung. A larger amount of CO<sub>2</sub> gas instilled into the thoracic cavity or any faster deflation of the ipsilateral lung has precipitated hypotension in our experience. The operating devices have also been changed from the 10 mm thoracoscope to the smaller 5 mm and 2 mm-needle thorascopes and other endoscopic devices for smaller and fewer skin incisions, less pain, less complication, shorter hospital stay and reduced cost (Fig. 1). For palmar hyperhidrosis, T2-4 sympathectomy using a 10 mm thoracoscope was performed from July 1992 to September 1996, and since then T2,3 or T2 sympathectomy has been done to limit the extent of resection for minimizing compensatory hyperhidrosis, while and T2 sympathectomy using a 2 mm needle thoracoscope has been performed since July 1997. Only two 2-mm incisions were made in the anterior axillary line over the third and fourth intercostal spaces. After the diathermy of the selected sympathetic ganglion over the corresponding rib, the lung was reinflated by using 10 Fr. pediatric thoracic tubes which were removed on the operating table. The patients were discharged on the same operating day after excluding any complications such as pneumothorax, hemothorax or Horner's syndrome. From August 1998, clipping of the sympathetic nerve using an endoclip with a pressure of 150 grams (Ligaclip, Ethicon) has been

used as a reversible method with a possible removal of the clips in cases of severe, disabling compensatory hyperhidrosis. For craniofacial hyperhidrosis, T1 ( $\pm$  T2-5) sympathectomy was performed from November 1995 to July 1997 and then T2 sympathectomy has been more widely adopted for reduced occurrence of compensatory hyperhidrosis and Horner's syndrome, while and T2 clipping was also used after August 1998. T2-4 sympathectomy was first attempted for axillary hyperhidrosis in March 1998, but was converted to T3-4 sympathectomy and then T3,4 sympathectomy to minimize compensatory hyperhidrosis.

## RESULTS

The average operation time for bilateral procedures was 53.8 minutes (min.), 46.2 min. and 38.0 min. for T2-4 sympathectomy, T3,4 sympathectomy and T2 or T3 clipping, respectively. The time was shortened to 32.5 min. for T3,4 sympathectomy and 28.7 min. for T2 or T3 sympathectomy due to reduced dissection. Postoperative complications included pneumothorax, hemothorax, neuralgia of the upper extremities and shoulders and more problematic Horner's syndrome and compensatory hyperhidrosis. Horner's syndrome occurred in 8% of craniofacial hyperhidrosis after T1 sympathectomy but decreased to 2% after T2 sympathectomy. The incidence and degree of compensatory hyperhidrosis were in direct relation to the extent of resection; 58% of patients suffered from embarrassing compensatory sweating in non-denervated portions of body after T2-4 sympathectomy, 38% after T2 or T3 sympathectomy,

Table 2. Comparative Results between Different Operative Methods

Results	T1 thectomy	T2-4 thectomy	T2,3/T3,4 thectomy	T2/T3 thectomy	T3,4 thicotomy	T2/T3 thicotomy
Size of thoracoscope	10 mm	10 mm	10/5 mm	5/2 mm	2 mm	2 mm
Mean operation time (minute)	77.6	53.8	46.2	32.5	28.7	38.0
Embarrassing compensatory HH (%)	55.1	58.0	*	38.5	21.0	20.0
Horner's syndrome (%)	8.0	*	*	*	2.0	*
Long term satisfaction rate (%)	70.1	79.7	*	95.0	97.6	96.5

Thectomy, sympathectomy; thicotomy, sympathectomy; HH, hyperhidrosis.

\* not analyzed.

Table 3. Overall Satisfaction Level according to the Types of Hyperhidrosis

	Palmar HH	Craniofacial HH	Axillary HH
Long term satisfaction rate (%)	97	93	89

HH, hyperhidrosis.

21% after T2 or T3 sympathicotomy and 20% after T2 or T3 clipping. Satisfaction rate was higher in less invasive methods with limited resection due to less compensatory hyperhidrosis being 79.7% after T2-4 sympathectomy, 95% after T2 or T3 sympathectomy, 96.5% after T2 or T3 clipping and 97.6% after T2 or T3 sympathicotomy. Patients with palmar hyperhidrosis were more satisfied (97%) than craniofacial hyperhidrosis (93%) or axillary hyperhidrosis (89%). 14 (10%) patients (6 males and 8 females, mean age 22.5 years ranging from 15 to 53 years) underwent reoperations for recurrence of hyperhidrotic symptom. There were 10 cases of palmar hyperhidrosis, 3 cases of craniofacial hyperhidrosis and 1 case of axillary hyperhidrosis. Average time interval between the initial operation and reoperation was 55 days ranging from 1 to 361 days and the average operation time was 41.5 min. for a unilateral procedure and 67.5 min. for bilateral procedures. The evaluated causes of initial failure included incorrect site of resection or division, incomplete diathermy, slippage of clip or missed Kuntz fiber. All the recurred cases were satisfied after reoperations (Table 2 and 3).

## DISCUSSION

The sympathetic nervous system, part of the vegetative nervous system, sends signals to the 2 to 4 million eccrine sweat glands distributed over the entire body surface for the production and secretion of sweat. The peripheral nerve fibers start in small ganglia of nerve cells located segmentally in the intercostal portions of the sympathetic trunk. The elimination of some of these nerve ganglia has been adopted to cure essential hyperhidrosis. The micro-invasive thoracoscopic sympathectomy has been developed to access the sympathetic ganglia in the thorax and it has become the method of choice to

cure hyperhidrosis of the palms, face and axillae. Transition of surgical and anesthetic methods has been pursued for achieving a higher satisfaction rate from definitive alleviation of sweating, minimal invasiveness of the procedure, and the fewest complications along with the development of endoscopic devices. When Kotzareff in 1920 and Leriche in 1934 first performed the thoracic sympathectomy for palmar hyperhidrosis, they resected T2-4 ganglia,<sup>10</sup> but Hyndman, Wolkin in 1942 and Love and Jurgin in 1964 reported that resection of T2 ganglion was sufficient to alleviate sweating in the palms. The preganglionic fibers of sympathetic nerves to the eccrine glands of the palm and axillae arise from the lateral horn of the T (thoracic) 2-8 segments of the spinal cord, and are fused with postganglionic fiber at the stellate ganglion or T2 ganglion. All the sympathetic nerve fibers to the upper extremities run through the T2 ganglion so that elimination of the T2 ganglion was assumed to be sufficient for palmar hyperhidrosis.<sup>11,12</sup> Roos had pointed out the necessity of cutting out the Kuntz fiber (the extraneural pathway of gray rami communicantes), lateral and parallel to the main sympathetic trunk,<sup>12</sup> found in 10% of patients.<sup>13</sup> In 1992, we first performed T2-4 sympathectomy using a 10mm thoracoscope for a patient with palmar hyperhidrosis, but today we use T2 sympathicotomy or clipping using a 2 mm needle thoracoscope. This limited surgical intervention has the advantages of better cosmetic effects, reduced pain, reduced compensatory hyperhidrosis and fewer other complications, faster recovery, shortened or no hospitalization, and lower cost, all contributing to a high satisfaction rate of 98%. For patients of craniofacial hyperhidrosis, we resected sympathetic ganglia of T1 to T5 segments from November 1995 to August 1997. The nerve fibers from T1 to T5 sympathetic ganglia are distributed over the face and scalp and the resection of T1 ganglion was considered essential for craniofacial hyperhidrosis. But the T1 ganglion is very close to the stellate ganglion which is associated with the oculociliary pathway, and sympathetic innervation to the eyes occurs partially through the T1 ganglion, so resection of the T1 ganglion may cause Horner's syndrome.<sup>14</sup> Although the T2 sympathetic ganglion is not the main pathway of innervation to the face, alleviation of craniofacial hyperhidrosis was clinically experienced and reported after T2 sympathectomy for palmar hyperhidrosis

with associated craniofacial sweating.<sup>15</sup> Most fibers from the T2 ganglion innervate the palmar area and only a few fibers are distributed to the face, but not in the ocular region where resection of the T2 ganglion could hardly cause Horner's syndrome and at the same time, relieve craniofacial hyperhidrosis.<sup>14,16,17</sup> During T1 sympathectomy, Horner's syndrome may occur as a result of damage to the stellate ganglion while separating the connecting portion of the stellate ganglion and the T1 ganglion or by indirect injury by electrocoagulation, or it may occur as a result of the anatomical variant of connecting fibers of the ciliospinal center onto the T5 ganglion beyond stellate ganglion without any damage to the stellate ganglion.<sup>17</sup> Its incidence has been reported as 43% with permanent symptoms occurring in from 2% to 8%.<sup>3,18,19</sup> Therefore, we have performed T2 sympathectomy from September 1997, T2 sympathicotomy from November 1997 and T2 clipping from July 1998. A decreased incidence of Horner's syndrome and compensatory hyperhidrosis from conversion to these procedures was the main factor for the increased satisfaction rate. For axillary hyperhidrosis, T2-4 (or more) sympathectomy has been attempted, with and disappointing results including residual sweating in approximately 20% of cases and little effect on the concomitant osmidrosis and troublesome compensatory hyperhidrosis from the wide area of denervation. The importance of ablating T4 in the control of axillary sweating is supported by the fact that using the supraclavicular approach, which finds T4 relatively inaccessible, thereby confining ablation usually to T2 and T3, yielding results of only 8% complete axillary drying and 78% partial drying.<sup>19,20</sup> We have thus performed T3,4 sympathectomy or T3,4 sympathicotomy from March 1997 and have obtained an 89% satisfaction rate, which was higher than previously reported. It could even be raised by controlling the associated osmidrosis with topical agents, iontophoresis or liposuction. The supportive measures should be differentiated for eccrine osmidrosis, caused by secondary infection of excessive sweats by the bacteria and fungus in the corneal layer from the apocrine osmidrosis in which the secretion of apocrine glands may be degraded by bacteria on the skin surface to produce an odor. Further concerns include are the reduction of the incidence and degree of compensatory hyperhidrosis and prevention of recurrence. Compensatory hyperhidrosis is the char-

acteristic sweating in the non-denervated portions of the body, mostly over the trunk and upper thighs after sympathectomy. It probably represents a thermoregulatory response and is a common occurrence, ranging from 37% to 75%.<sup>21-23</sup> The overall amount of sweat over the entire body does not change and the residual glands attempt to compensate for the loss of secretory glands and always respond rapidly to thermal stimulus rather than psychological stimulus, and this was precisely graded, indicating a normal hypothalamic function. The frequency of compensatory hyperhidrosis reflects the extensiveness of the denervation. The larger the number of glands removed from thermoregulatory control, the greater the response that one can anticipate from the remaining glands.<sup>23</sup> Lai, Gossort and Hederman have reported the incidence of compensatory sweating as high as 98.6%, 72.2% and 64% respectively after T2-4 sympathectomy<sup>24-26</sup>; 45% was reported by Noppen after T2,3 sympathicolysis<sup>27</sup>; no occurrence was observed by Bonjer after T2,3 sympathicotomy<sup>28</sup>; while 24% was reported by Hederman after T2 sympathicotomy. Rennie et al. has suggested that resection of more than two ganglia should be avoided. Since a direct relationship between the extent of resection and the degree or frequency of compensatory hyperhidrosis has been proven evident, we have also aimed for more limited resection and have searched for reversible means in cases with markedly severe compensatory sweating. Based on the reports made by Denny-Brown and Brenner, which showed that compressing power of more than 44 grams can block the transmission of nerve impulses for resecting or dividing the nerve fibers,<sup>29</sup> we have performed sympathetic nerve clipping by using an endoclip (Ligaclip, Ethicon) for palmar and craniofacial hyperhidrosis since August 1998. Also, one case of neurolysis using the sural nerve was performed for severe compensatory hyperhidrosis in August 1999 and the results of long-term follow-up should be noteworthy. Recurrent cases are not frequent, but they are very annoying to patients and perplexing to surgeons. The possible causes may include incorrect localization, inadequate diathermy, missed Kuntz fiber or other accessory nerves of anatomical variance<sup>30-33</sup> or axonal recovery.<sup>5,33-35</sup> From our experience, we have learned that careful localization of the correct level, first by palpating the hidden first rib by using an endoscopic device and then by

inspection of anatomical variances including the Kuntz fiber, are important steps to prevent or lower the chance of recurrence. Also, lateral extension of the sympathicotomy line to about 3 to 5 cm lateral to the sympathetic chain along the mid-surface of the corresponding rib is recommended<sup>15,36,37</sup> and the intraoperative use of a monitoring device such as a surface temperature probe or plethysmography might help.<sup>38</sup> Thoracoscopic sympathetic surgery has been accepted as the treatment of choice for palmar, craniofacial and axillary hyperhidrosis and the operative techniques have progressively evolved into less and less invasive methods. Since August 1998, T2 and T3 sympathetic clippings are being performed for craniofacial and palmar hyperhidrosis and T3,4 sympathicotomy for axillary hyperhidrosis in our institution. Developing new techniques for reducing compensatory hyperhidrosis remains as the main task for future research.

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