Topographical considerations under video-scope guidance in the T3,4 levels sympathetic surgery

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Abstract

Introduction: Anatomical variation of the sympathetic nervous system is known to be one of the main causes of failure and dissatisfaction after sympathetic surgery. However, there are only few reports on the descriptive analysis of sympathetic nerve variants. The purpose of this study is to investigate the anatomical variations of the sympathetic trunk at the levels of T3 and T4 ganglia considered in a topographic approach for sympathetic procedures and to further improve the postoperative outcome.

Materials and methods: From June 2003 to January 2004, 44 patients with palmar hyperhidrosis underwent bilateral T3,4 ramicotomy via video-assisted thoracoscopic surgery. The anatomy of T3 and T4 sympathetic ganglia, pathway of sympathetic trunk, and rami-communicantes were recorded on video and still cut images for descriptive analysis.

Results: The thoracic sympathetic trunks were mostly lying against the heads of the ribs, but there were variants of sympathetic trunk running along the medial side of the rib heads of 3rd, 4th and 5th ribs, respectively in 9.0%, 18.0% and 37.5% of the cases. There were also variants running along the lateral side of rib heads near the neck portion in 12.5%, 10.2% and 8.0% of the cases. The 3rd ganglion was located within the intercostal space (59.1%) or at the level of the upper border of the 4th rib (36.4%) or upon the 4th rib (4.5%). The location of the 4th ganglion was in the intercostal space (18.2%), the upper border of the 5th rib (44.3%) or upon the 5th rib (37.5%). The ascending rami were found at the level of the 3rd ganglion in 48.8% and the 4th ganglion in 45.5% of the cases. The descending rami were located at the level of 3rd and the 4th ganglion in 8.0% and 6.8%, respectively. And the middle rami were found in all cases except one.

Conclusions: It may be difficult to localize the sympathetic trunk in some cases of severe obesity; a careful inspection has to be performed from the medial side of the rib heads to the neck portion. The obvious ‘downward shift of ganglion’ in the position shown as the thoracic sympathetic trunk descends is to be deliberated in T4 sympathetic surgery. Many ascending and descending accessory pathways of sympathetic nerve were observed; therefore, a lateral extension of electrocoagulation at the level of upper and lower rib border is necessary to impose a complete blockage of sympathetic nerve stimulus.

Keywords: Sympathectomy; Sympathetic nerve; Anatomical variation

1. Introduction

Thoracoscopic sympathetic surgery has gained general acceptance in the treatment of palmar hyperhidrosis due to the simplicity and high success rate of surgery [1]. However, there was 0—5% incidence of dissatisfaction due to operation failure or postoperative resweating. Mostly, it related to anatomical variations of the sympathetic nerve such as the sympathetic trunk pathway, the location of sympathetic ganglion, and accessory pathways of the sympathetic nerve [2,3].

In the past, the anatomical research of sympathetic ganglion was mostly confined to the second sympathetic ganglia because the conventional sympathetic surgery of palmar hyperhidrosis was mainly performed at this level. Recently, the level of sympathetic surgery descends from the second ganglion to the third or fourth ganglion in order to decrease the compensatory sweating because the incidence of compensatory sweating was high after T2 sympathetic surgery [4,5]. However, there are only few studies on the anatomical variations of T3,4 level sympathetic nerves. The purpose of this study is to investigate the topographic variations at the levels of the 3rd and 4th sympathetic ganglia which are the targets of sympathetic surgery in the treatment of palmar hyperhidrosis.

2. Patients and methods

From June 2003 to January 2004, 44 patients with palmar hyperhidrosis underwent bilateral T3,4 ramicotomy via video-assisted thoracoscopic surgery. The sympathetic...
trunk pathway, the position of sympathetic ganglia, and rami-communicantes were recorded on video images upon which a systematic analysis was made focusing on the anatomical variations. The mean ages were 29.6 ± 11.5 years (range, 14—52 years) and the male to female ratio was 30 to 14.

2.1. Video recording

The procedures were performed during T3,4 ramicotomy where a 5 mm telescope (Olympus Winter & Ibe, Germany) was used. Initially, we recorded the pathway of the sympathetic trunk from the level of the 2nd rib to the 5th rib before dissection of parietal pleura; then, the parietal pleura were opened along the main sympathetic trunk from the upper border of the 3rd rib to the lower border the 5th rib. The sympathetic trunk was carefully dissected to evaluate the position of ganglion and at each level sympathetic ganglia from the upper and lower rib borders were inclusively recorded. A T3,4 ramicotomy was then performed and recorded. The number of rami-communicantes was counted after the resection of rami-communicantes.

2.2. Anatomical analysis of sympathetic nerve

The pathway of the sympathetic trunk was classified into three types, medial, head or lateral types according to its location relative to the rib heads. The sympathetic trunk is defined as a medial type when it lies in the medial portion of rib heads, a head type when it runs up on the rib heads and a lateral type, when it lies in the lateral portion of rib heads (Fig. 1).

The sympathetic ganglion was classified as type I, II, III according to its position. Type I was when the ganglion was located in the middle of intercostal space, type II ganglion, when located from the lower portion of intercostal space up to the upper margin of lower rib, and type III ganglion when located upon the lower rib (Fig. 2).

The rami-communicantes were classified as three types, based on the anatomical relationship of intercostal nerve with the surrounding ganglia: ascending rami was when the rami-communicantes originates from intercostals nerve and runs for superior ganglion; middle rami was defined as rami-communicantes originating from intercostals nerve and running for same level ganglion; descending rami was defined as rami-communicantes originating from intercostals nerve and running for inferior ganglion (Fig. 3).

3. Results

Table 1 shows the pathway type of the sympathetic trunk on the 3rd, 4th, and 5th rib. The most common pathways of right and left sympathetic trunks on the 3rd, 4th and left 5th ribs were head type, but medical type (56.8%) was the most common pathway type for the right 5th sympathetic chain. The sympathetic trunk pathway shows a tendency to run more medially as it goes downward and the right side

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<td>Medial</td>
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<tr>
<td>3rd rib</td>
<td>6 (13.6%)</td>
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<td>4th rib</td>
<td>14 (31.8%)</td>
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<td>5th rib</td>
<td>25 (56.8%)</td>
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Fig. 1. The type of sympathetic trunk pathway. Medial type was defined as the sympathetic trunk running along the medial portion of rib head; head type was defined as the sympathetic trunk running along the rib head; lateral type was defined as the sympathetic trunk running along the lateral portion of rib head.

Fig. 2. The classification of sympathetic ganglion position. Type I: the main rami-communicantes connected to the sympathetic ganglion on the middle intercostals space, type II: above the upper border of lower rib, type III: on the lower rib.

Fig. 3. The type of sympathetic trunk pathway.
sympathetic trunk runs more medially than the left side. Notably, 4.5—18.2% of the left sympathetic trunk and 13.6—56.8% of the right side trunk was medial type.

The 3rd ganglion was located in the middle of intercostal space (59.1%), at the upper border of the 4th rib (36.4%), or on the 4th rib (4.5%). The 4th ganglion was located in the middle of the intercostal space (18.2%), at upper border of the 5th rib (44.3%), or on the 5th rib (37.5%). There was 'downward shift' in position as the thoracic sympathetic trunk descends (Table 2).

Fig. 3. The classification of rami-communicantes in three types. Middle rami: transverse oblique rami connected to same level ganglion, ascending rami: oblique rami connected to upper level ganglion, and descending rami: oblique rami connected to lower level ganglion.

4. Discussion
Anatomical variation of the sympathetic trunk pathway is one cause of postoperative bleeding and re-sweating. Lin et al. [6] reported that the incidence of operation failure was only 1% of 2200 cases sympathetic surgery, and the probability that the surgeon experienced the inoperable case was 5.1%. Half of these cases were related to medial position of sympathetic nerve. Wang et al. [7] reported 8.6% and 7.1% of medial side running at the 2nd and 3rd ganglion levels in the right side and 10.0%, 11.4% in the left. In our study, there was 13.6%, 31.8%, 56.8% medial running in the right at the 3rd, 4th and 5th rib levels, respectively, and 4.5%, 4.5%, 18.2% in left side. The pathway of the sympathetic trunk has a tendency of medial shifting as it runs downward.

Although the incidence of medial pathway was lower in the left side, the medial running of the left sympathetic nerve is clinically more important due to the aortic arch. Because the rib head at the level of the 4th, 5th rib is located near to the aortic arch, the probability of aorta injury is higher in case of the sympathetic trunk running medial to the rib heads. The operation may be impossible when the aorta is tortuous but a careful dissection can be attempted. When there is difficulty in finding the sympathetic trunk due to severe obesity, a pleura dissection from the medial side of the rib head is helpful to find the sympathetic trunk because the sympathetic trunk runs on the opposite side of rib head in 5—30% of such cases.

The position of the sympathetic ganglion is another factor affecting surgical results; the location of the sympathetic ganglion was generally known as to be located in the middle portion of intercostal space, but there are many anatomical variations. Chiou et al. [8] reported 85% ganglions were located in the upper margin of lower rib. Chung et al. [9] reported 78% ganglion that were located in the middle intercostals space and upper margin of rib. Pick et al. [10] analyzed cadavers and reported a downward shift of upper thoracic sympathetic ganglion through the autopsy.

This study revealed that approximately 40% of the 3rd ganglion was not located in the middle intercostal space, and only 18.2% of the 4th ganglion was located at the middle intercostal space. There was a ‘downward shift’ in position as the thoracic sympathetic trunk descends. The downward

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<td>Ascending</td>
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<tr>
<td>3rd ganglion</td>
<td>24 (54.5%)</td>
<td>16 (36.4%)</td>
<td>3 (6.8%)</td>
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<tr>
<td>4th ganglion</td>
<td>6 (13.6%)</td>
<td>23 (52.3%)</td>
<td>15 (34.1%)</td>
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Table 3
Types of the rami-communicantes on the base of intercostal nerve

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<tr>
<td>3rd ganglion</td>
<td>18 (40.9%)</td>
<td>43 (97.3%)</td>
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<tr>
<td>4th ganglion</td>
<td>24 (54.5%)</td>
<td>44 (100.0%)</td>
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shift has a clinical significance. Most sympathetic procedures have been performed at the rib level. Clipping is especially performed at the upper border of the ribs. According to our results, more than 40% of the 3rd ganglion should be partially or totally clipped when T4 clipping was performed. The confirmation of ganglion through the full dissection of pleura from the upper to the lower rib borders is required for an optimal surgical outcome after sympathetic surgery.

The sympathetic ganglion cells are activated mainly by stimuli received through afferent preganglionic neurons in the spinal cord. The activated sympathetic stimulus was conducted from the spinal cord to the sympathetic ganglion via the intercostal nerves and rami-communicantes sequentially. The preganglionic fibers to the arm originate mostly from the 3rd to the 6th spinal segments and the 3rd and 4th segments were considered as main lesions [11].

The rami-communicantes of the 3rd and 4th ganglion have various anatomical variations. Cho et al. [12] reported on the variations of rami-communicantes. The rami-communicantes were classified into three types: transverse rami connected to the intercostal nerve of the same level; ascending rami connected to the higher level; descending rami to the lower level. The incidence of ascending rami and descending rami arising from the third thoracic sympathetic ganglion was 5.9% and 26.2%, respectively. And in the 4th thoracic sympathetic ganglion, the incidence of ascending rami was 4.8% and descending rami was 8.3%, respectively. When the anatomical structures of both sides were compared, only 14.3% had similar anatomy of the rami-communicantes bilaterally.

In our study, middle rami which communicate at the same level as ganglion were found in all cases except one, and superior rami was found in 48.9% at the 3rd ganglion level and 45.5% at the 4th ganglion level. Inferior rami at the 3rd and the 4th ganglion were found in 8.0% and 6.8%, respectively. Considering that the analysis was based on the video recording images, there may have been more accessory pathways in the thoracic sympathetic trunk and intercostal nerves.

The sympathetic surgery confined to the sympathetic ganglion may not completely block all the sympathetic stimuli because many accessory pathways exist. Additional procedures are necessary to block all accessory pathways of the sympathetic nerve for complete blocking of nerve stimuli. Gossort et al. [13] proposed a lateral extension of electrocoagulation of the upper border of rib to decrease the recurrence rate. And Chung et al. [10] reported that accessory pathways of rami-communicantes may originate in the intercostal nerve within 15 mm from the ganglion. The electrocoagulation extending laterally at least 20 mm from the sympathetic trunk is necessary for a complete blockade of sympathetic stimulus. We also propose that a lateral extension of electrocoagulation of the upper and lower rib more than 20 mm lateral from the sympathetic trunk is necessary to decrease the recurrence rate.

In conclusion, the incidence of medial type sympathetic trunk was 5—30% in this study so a careful inspection of the sympathetic trunk in the medial side of the rib heads to the neck portion is recommended for some cases of severe obesity when it is difficult to localize the sympathetic trunk. The tendency of ‘downward shifting of sympathetic ganglion’ in position as the thoracic sympathetic trunk descends and the location of the sympathetic ganglion at upper border of lower rib on the 3rd rib in up to 40% of the cases are to be deliberately considered in T4 sympathetic surgery. A lateral extension of electrocoagulation dissection along the upper and lower rib borders is to be performed to block all the ascending and descending accessory pathways and impose a complete interception of sympathetic nerve stimulus.

References