Comparative analysis of T2 selective division of rami-communicantes (ramicotomy) with T2 sympathetic clipping in the treatment of craniofacial hyperhidrosis

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Abstract

Objective: The main cause of dissatisfaction after sympathetic trunk blocking surgery (T2 sympathectomy, sympathetic clipping) for craniofacial hyperhidrosis is compensatory sweating. Preserving sympathetic trunk may decrease the incidence of compensatory sweating, and we introduce T2 ramicotomy, which may better preserve the sympathetic nerve trunk in order to reduce compensatory sweating.

Methods: From January 2000 to November 2002, video-assisted thoracoscopic (VAT) T2 sympathetic clipping and VAT ramicotomy were performed in 44 patients suffering from craniofacial hyperhidrosis. Twenty-two patients underwent T2 sympathetic clipping (group 1), and 22 underwent division of T2 rami-communicantes (group 2). We retrospectively analyzed the rate of satisfaction, dryness of face, and grade of compensatory sweating. Results: Both groups were similar with respect to facial dryness ($P = 0.099$). Group 1: excessive dry 5 patients (22.7%), dry 17 patients (77.3%); group 2: excessive dry 3 patients (13.6%), dry 15 patients (68.1%), and persistent sweating 4 patients (18.3%). The rate of satisfaction was 77.3% in group 1, and 63.6% in group 2 with no significant difference ($P > 0.05$). The rate of compensatory sweating in group 2 (72.7%) was significantly lower than in group 1 (95.4%) ($P < 0.039$). The chance of embarrassing and disabling compensatory sweating was lower in group 2 than in group 1; 76.5% (embarrassing in 8 patients, disabling in 9) in group 1, and 36.4% (embarrassing in 7 patients, disabling in 1) in group 2 which was statistically significant ($P < 0.006$).

Conclusions: T2 ramicotomy for craniofacial hyperhidrosis lowers the rate of compensatory sweating and excessive dryness of face compared to T2 clipping.

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Keywords: Hyperhidrosis; Sympathetic surgery; Rami-communicantes

1. Introduction

Craniofacial hyperhidrosis hindering daily life is an indication for endoscopic thoracic sympathetic surgery. However, endoscopic thoracic sympathetic surgery for craniofacial hyperhidrosis is not a popular procedure due to low satisfaction rate mainly from the reason of compensatory sweating [1]. To decrease compensatory sweating, surgical dissection has been reduced during endoscopic thoracic sympathetic surgery, although these changes did not substantially reduce the incidence of compensatory sweating [2,3]. From July 2001, we applied second thoracic (T2) ramicotomy, and compared surgical results with T2 sympathetic clipping which has been the procedure performed for the treatment of craniofacial hyperhidrosis.

2. Material and methods

We investigated 22 patients (group 1) suffering from craniofacial hyperhidrosis who underwent T2 sympathetic clipping between January 2000 and February 2002, versus 22 patients (group 2) who underwent T2 ramicotomy between July 2001 and November 2002. We excluded multi-focal hyperhidrosis (combined with palmar, axillary and plantar hyperhidrosis) in this study. Patients were
followed-up by telephone questionnaire and the follow-up duration was 20.1 ± 7.7 months in group 1 and 10.8 ± 2.0 months in group 2.

Facial dryness was graded as excessive dry, dry, and persisting (no improvement after operation), and persistent sweating is defined as operation failure. Compensatory sweating was graded as absent, minor and intermittent, embarrassing (visible sweating), and disabling (need to get changed during the day).

Data were analyzed using SPSS 11.0 (SPSS, Chicago, IL) and P-value less than 0.05 was considered statistically significant. The distribution of continuous variables was expressed as mean ± SD. Categorical variables were analyzed using the χ²-test and continuous data using the Student’s t-test.

2.1. Operative techniques

Operation was performed with the patient in semi-fowler’s position, under the general anesthesia, using a single lumen endotracheal tube. One port was made for the insertion of surgical instruments, and another port was made for the insertion of a 5 mm telescope (Olympus Winter and Ibe, Germany). To deflate the lung in order to visualize the upper thoracic sympathetic chain 1500–1700 ml of CO₂ gas was instilled into the thoracic cavity. The parietal pleura was opened along the main sympathetic trunk using a diathermy and the sympathetic chain was dissected with scissors without diathermy in order to prevent thermal injury. In sympathetic clipping, the chain was clipped with an endoclip (Liga clip, Ethicon Co.) on the upper border of the second rib to block sympathetic innervation of upper extremity below the second sympathetic ganglion (Fig. 1a). In T2 ramiotomy, a similar dissection was carried out but the main sympathetic trunk was lifted to visualize rami-communicantes which usually have connection from the second intercostal nerve to the second sympathetic ganglion. Rami-communicantes occasionally ascend or descend from the second intercostal nerve to other ganglions. After confirming T2 rami-communicantes, it was divided with scissor followed by electro-coagulation to a certain extent along the lateral side of sympathetic trunk at second and third ribs to divide other rami-communicantes and Kuntz fiber (Fig. 1b). After bleeding control, 16 Fr chest tube was inserted and the lungs expanded. The same procedures were performed in the contralateral side. Chest tube was removed in the recovery room after confirming chest X-ray for pneumothorax or hemothorax. Most patients were discharged on the day of the operation.

3. Results

Groups 1 and 2 were similar in terms of age, operation time and hospital stays (Table 1). Groups 1 and 2 were not significantly different in terms of facial dryness.
In group 1: excessive dry 5 patients (22.7%), dry 17 patients (77.3%); in group 2: excessive dry 3 patients (13.6%), dry 15 patients (68.1%), and persistent sweating 4 patients (18.3%) where persistent sweating occurred within 1 month.

Satisfaction rate in group 2 was 63.6% (14/22), which was similar but little lower to that in group 1 (77.4% (17/22)) \( (P = 0.322) \). The main cause of dissatisfaction was compensatory sweating (5 patients, 1 patient combined with gustatory sweating) in group 1, and persistent sweating (4 patients), gustatory sweating (2 patients), and compensatory sweating (2 patients) in group 2 (Table 2). The incidence of mild to disabling compensatory sweating in group 2 was 72.7%, which was significantly lower than in group 1 (95.4%) \( (P = 0.039) \). In particular, the incidence of embarrassing to disabling compensatory sweating was lower in group 2 (36.4%—embarrassing in 7, disabling in 1) in comparison to group 1 (76.5%—embarrassing in 8, disabling in 9) which was statistically significant (Fig. 2) \( (P = 0.006) \).

There was no mortality in both group and complications occurred in 5 patients (2 neuralgia, 2 gustatory sweating, 1 Horner’s syndrome) in group 1, and 7 complications in 5 patients (4 neuralgia, 1 gustatory sweating, 1 Horner’s syndrome, 1 pneumothorax) in group 2.

### 4. Discussion

Craniofacial hyperhidrosis is caused by hypersensitive reaction of the sudomotor function which is controlled by the first and second thoracic sympathetic ganglion. The sympathetic fibers for the craniofacial region pass mainly through rami-communicantes of the T2 sympathetic ganglion and possibly the caudal bundles of T1 as they ascend longitudinally in the sympathetic trunk to transverse stellate ganglion and upper cervical ganglia [4].

In order to treat craniofacial hyperhidrosis, it is necessary to contain T1 ganglion within the dissection plane for complete cure although dissection of this area may cause Horner’s syndrome during T1 sympathectomy due to injury of stellate ganglion which is in proximity to T1 ganglion. Kao et al. [5] noted facial dryness in patients who had undergone T2 sympathectomy for the treatment of palmar hyperhidrosis, and recommended T2 sympathetic surgery in the treatment of craniofacial hyperhidrosis. Also other groups reported reduction of the incidence of Horner’s syndrome after introduction of T2 sympathetic clipping in the treatment of facial hyperhidrosis [6,7].

Preganglionic fibers of sympathetic nerve to the upper extremity originate mostly from spinal segments T3 to T6, and postganglionic fibers of the sympathetic nerve originate from T2 and to a lesser extent T3 ganglia [8]. Preservation of sympathetic innervation below T3 spinal segment is necessary in order to prevent dryness of hand following sympathetic surgery in patients with craniofacial hyperhidrosis.

We changed procedure to ramicotomy in treating patients with facial hyperhidrosis with the aim of preventing Horner’s syndrome and to reduce the incidence of anhidrosis of hands. It is necessary to preserve T1 ganglion and below the T3 ganglion, and therefore introduced selective division of T2 rami-communicantes.

Compensatory sweating is a troublesome, often difficult to assess, side effect of sympathetic surgery with the incidence varying from 3 to 98% [9,10]. Most large series report incidence of compensatory sweating exceeding 80% [11–13] due to dysfunction in thermo-regulation [14]. Berkow’s surface area formation showed that the function of sweat gland diminishes by as much as 40% after sympathectomy, and although difficult to prove, it appears

### Table 1

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>T2 clipping</th>
<th>T2 ramicotomy</th>
<th>( P )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (M/F)</td>
<td>15/7</td>
<td>22/0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age (years)</td>
<td>42.9 ± 10.1</td>
<td>37.4 ± 9.8</td>
<td>0.950</td>
</tr>
<tr>
<td>Operation time (min)</td>
<td>44.9 ± 8.8</td>
<td>51.4 ± 10.2</td>
<td>0.634</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>1.6 ± 1.2</td>
<td>1.4 ± 0.7</td>
<td>0.217</td>
</tr>
</tbody>
</table>

\( (P = 0.099) \).

### Table 2

<table>
<thead>
<tr>
<th>Dryness and satisfaction</th>
<th>T2 clipping</th>
<th>T2 ramicotomy</th>
<th>( P )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>17</td>
<td>15</td>
<td>0.099</td>
</tr>
<tr>
<td>Excessive dry</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Persisting</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Satisfied (%)</td>
<td>17/22 (77.4%)</td>
<td>14/22 (63.6%)</td>
<td>0.322</td>
</tr>
<tr>
<td>Cause of dissatisfaction</td>
<td>Compensatory sweating (5), gustatory sweating (1)</td>
<td>Compensatory sweating (4), gustatory sweating (2)</td>
<td>Compensatory sweating (2)</td>
</tr>
</tbody>
</table>
that compensatory sweating was more severe when large number of ganglions were removed [15,16]. According to Lin et al. [17], hypothalamus receives afferent thermal information from the central and peripheral thermal receptors and releases efferent signals to the sweat glands. After T1 or T2 sympathetic surgery, negative feedback signs from T1 and T2 sympathetic ganglia to hypothalamus is blocked causing efferent signals from the hypothalamus to be amplified. These amplified signals induce excessive sweating with exception in the area of sympathetic nerve denervation.

Gossot et al. [18] compared T2, 3, 4 sympathectomy with T2, 3, 4 ramicotomy and reported no difference between the two groups in terms of development of compensatory sweating (72.2 versus 70.9%, respectively). However, in terms of severity of compensatory sweating (embarrassing, disabling) causing inconveniences of daily life, they reported incidence of 27 and 13%, respectively. This finding postulates that by preserving the sympathetic trunk, it was possible to reduce the severity of compensatory sweating.

The method of sympathetic clipping may have some advantage over sympathectomy or ramicotomy. By clipping the sympathetic trunk, it is theoretically possible to check proper placement of a clip intraoperatively by chest X-ray, and a clip can be removed in patients with excessive compensatory sweating if necessary in order to reverse to a state of preoperative status. Lin et al. [19] proposed that by removing a clip within 1 month of surgery, innervation of sympathetic nerve can be recovered and reported that 5 of 326 patients who underwent T2 sympathetic clipping had to undergo reoperation due to intolerable compensatory sweating and four patients recovered from the excessive compensatory sweating. However, clipping technique has no application in ramicotomy due to small diameter of the rami-communicantes and effective blocking of nerve conduction is not possible.

One other reason that sympathetic clipping cannot reduce the incidence of compensatory sweating is that facial and upper extremity sympathetic nerves were simultaneously denervated by T2 clipping and this does not selectively limit the extent of sympathetic denervation confined to face. However, T2 ramicotomy preserves the main sympathetic trunk and also T3, 4 areas of sympathetic nerve innervation, thus selectively denervating the branches of nerve innervating the face.

Although we were able to decrease the incidence of compensatory sweating with T2 ramicotomy, some problems exist. The incidence of operation failure after T2 ramicotomy was higher than T2 clipping, and this may be due to anatomical variations of T2 sympathetic ganglion and rami-communicantes. According to Jung et al. [20], 50% of T2 ganglion was not located in the second intercostal space, and anatomical variations of rami-communicantes connecting to second intercostal nerve on first and second sympathetic ganglion were present in 31.8%. The Kuntz fiber between the first and second intercostal space was present in 68.2% [20], and the distance from Kuntz fiber to sympathetic trunk was less than 15 mm. Partial division of rami-communicantes or Kuntz fiber is the most likely cause of operation failure leading to persistent sweating, and therefore to increase the success rate of T2 ramicotomy, we electrocoagulated to a certain extent along the lateral side of the sympathetic trunk at second and third rib with the purpose of dividing the remnant rami-communicantes and Kuntz fiber.

5. Conclusion

T2 ramicotomy in patients with craniofacial hyperhidrosis lowers the incidence of compensatory sweating compared to T2 clipping although the rate of operation failure was higher than T2 clipping. Further anatomical and clinical study regarding ramicotomy is necessary in order to decrease the operation failure rate thus increasing patients’ satisfaction.

References

Appendix A. Conference discussion

Dr T. Lerut (Leuven, Belgium): You concluded that you might have to perform reoperations. Did you have to perform any reoperations in this series, and, if so, how did you proceed, what were the difficulties and what were the results?

Dr Kim: Four patients had persistent sweating and two patients underwent reoperation. The operation method was T2 sympatheticotomy. However, due to a wide dissection of the pleura during the original operation, mild to moderate pleural adhesions was noted in the apex. When compared to the T2 sympatheticotomy performed in a fresh case, pleural adhesion was a problem causing difficulties in dissection of the pleura. The outcome was satisfactory with minimal compensatory hyperhidrosis.

Dr T. Laisaar (Tartu, Estonia): Did you use the same method, ramicotomy, in cases of axillary and palmar hyperhidrosis?

Dr Kim: We performed T3 ramicotomy in palmar hyperhidrosis and T3-4 ramicotomy in axillary hyperhidrosis.

Dr Laisaar: And did you have any complications postoperatively? What I’m especially interested in is did you have pain, postoperative pain in these patients if you performed a ramicotomy?

Dr Kim: In our early experience we used the diathermy scissors and this diathermy scissors may coagulate intercostal nerve which caused numbness and pain in the arm. But at present we do not use coagulating diathermy, and in order to prevent diathermy injury, we are only using scissors to cut rami communicantes.