

Electrocautery versus Ultracision versus LigaSure in Surgical Management of Hyperhidrosis

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Abstract

Objective The aim of the study was to evaluate the sympathectomy procedures for primary hyperhidrosis in terms of complications and effectiveness.

Methods From January 2010 to September 2012 we performed 130 sympathectomies in 65 patients, 27 males (42%) and 38 females (58%). Electrocoagulation was used in 20 procedures (15%), ultrasonic scalpel in 54 (42%), and radiofrequency dissector in 56 (43%). Seven patients (11%) underwent bilateral sympathectomy in the same surgical session, while in 58 (89%) the right surgical approach was delayed 30 days from the first procedure.

Results We noticed 12 complications (9%): (a) chest pain in 6 patients (4 with electrocoagulation, 1 with ultrasonic scalpel, and 1 with radiofrequency dissector), which disappeared in 20 ± 1 day; (b) paresthesias in 3 electrocoagulation patients, was solved in 23 ± 5 days; (c) bradycardia in 1 ultrasonic patient, normalized in 4th postoperative hour; (d) unilateral relapse in 2 electrocoagulation patients after the second side approach, positively treated in 1 patient by resurgery in video-assisted thoracoscopy (VAT). The quality-adjusted life year and the quality of life evaluation revealed a statistically significant improvement ($p = 0.02$) in excessive sweating and general satisfaction after surgery, with Ultracision and LigaSure showing better findings than electrocoagulation.

Conclusion The latest generation devices offered greater efficacy in the treatment of hyperhidrosis, minimizing complications and facilitating the resumption of normal work and social activity of patients.

Keywords

- ▶ VATS
- ▶ sympathectomy
- ▶ Ultracision
- ▶ LigaSure
- ▶ complications

Introduction

Primary hyperhidrosis has a high social impact, with a percentage of 2.8% in the United States¹ and 4.6% in some areas of China.² There are many nonsurgical treatments³: (a) topical therapy with aluminum; (b) iontophoresis; (c) oral and systemic medications (anticholinergic drugs, atropine and glycopyrrolate); (d) botulinum toxin; and (e) hypnosis and acupuncture. The disadvantage of such techniques is not only in the temporary nature of the benefits, but also in their high costs and indecisive results. The thoracoscopic surgical

method is still controversial because of the lack of widely accepted approach. Cerfolio et al,⁴ in an extensive review of the literature, clarified the level of interruption of the sympathetic chain to reduce complications but did not establish the best surgical procedure. Although sympathectomy with clips⁵ and the section of the rami communicantes (ramicotomy) and Kuntz nerve⁶ have been proposed, selective bilateral sympathectomy (excision of sympathetic trunk, rami communicantes, and ganglia) seems to have the best effectiveness with total satisfaction of patients.⁷ Black et al,⁸ in 233

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endoscopic sympathectomies with laser, revealed 0.85% bleeding, 0.43% pulmonary edema, and 0.85% failed procedure. Chang et al,⁹ reevaluating retrospectively 234 patients treated with sympathectomy of T2, T3, T4 for palmar hyperhidrosis, displayed the compensatory sweating (CS) incidence of 92% T2, 92% T3, and 80% T4. CS seems to be because of the damage of the reflex arc between the sympathetic chain and the hypothalamus.¹⁰ The use of an instrument to minimize the lateral transmission of heat is fundamental for reduction of complications. The main device to allow fast and safe dissection is yet to be identified. The purpose of the retrospective study was to analyze three different surgical options in terms of complications and quality of life (QOL).

Materials and Methods

Between January 2010 and September 2012, we performed 130 sympathectomies in 65 patients, 27 males (42%) and 38 females (58%), with a mean age of 27 ± 1 year (range: 18–40 years). Palmar hyperhidrosis was found in 31 patients (48%), palmar and axillary in 16 (25%), axillary in 8 (12%), palmar and plantar in 6 (9%), and facial in 4 (6%). Electrocoagulation (Covidien, Mansfield, Massachusetts, United States) was used in 20 procedures (15%), ultrasonic scalpel (Ethicon EndoSurgery, Cincinnati, Ohio, United States) in 54 (42%), and radiofrequency dissector (Covidien) in 56 (43%) (– **Table 1**). Patients were randomly assigned to each group in the chronological order described above, after approval of the study by the ethics committee. The three groups appeared homogeneous. In fact, the male/female ratio and age were as follows: (1) 4:6, with an average age of 24 ± 1 year (range: 18–30 years) for electrocoagulation; (2) 11:16, with an average age of 28 ± 1 year (range: 19–36 years) for Ultracision; (3) 12:16, with an average age of 29 ± 1 year (range: 19–40 years) for LigaSure. We decided to use the electrocautery in a small number of patients because its features, advantages, and disadvantages have already been widely discussed in literature. We have carefully considered the new devices which are not yet fully evaluated. The internal organization of the hospital did not require an informed consent of the patient about the device used. No patient revealed vagal syncope or symptoms in clinical history. Seven patients (11%), two men and five women, underwent bilateral sympathectomy in the same surgical session because of professional sport activity and contra-

indication to discontinuation of contraceptive treatment for over 21 days (our hospital requires discontinuation of oral contraceptives at least 3 weeks before a general anesthesia). In 58 patients (89%), the right surgical approach was delayed 30 days after the first procedure in the left side, using the same device. The length of hospitalization was 1 day.

Surgical Approach

Thoracoscopic sympathectomy was performed under general anesthesia. Single-lung ventilation by bronchial obturator and the lateral decubitus position associated with a slight anterior rotation of the patient favored the exposure of the sympathetic chain. We performed the excision of sympathetic trunk, rami communicantes, and ganglia to the rib levels (R) 3 for craniofacial, R3–R4 for palmar-only or for palmar and axillary, R4 for axillary and R3–R5 for palmar and plantar hyperhidrosis. Two surgical accesses were performed: (1) in the sixth intercostal space along the posterior axillary line, for the 8 mm trocar and 0 degree optic; (2) in the fourth intercostal space, to 5 cm laterally from the spinal cord, for the 5.5 mm or 11.5 mm trocars in case of use of the electrocoagulation or the last-generation devices, respectively. In fact, LigaSure and Ultracision required sympathetic nerve exposure by Endo Grasp or Endo Dissect Covidien, Massachusetts, United States. Drainage was placed in the posterior port and removed on the table after reventilation of the lung. Wounds were closed in layers with 2.0 poly-filament (Cincinnati, United States) in the intercostal muscle and 3.0 absorbable monofilament (Cincinnati, United States) in the subcutaneous and dermal tissues as uninterrupted suture. The clinical check-up associated with chest X-ray and electrocardiogram at 4 hours from intervention led to discharge from the hospital.

Statistical Analysis

Analysis was performed using SPSS 22. Data about QOL in relation to sweating and general satisfaction, before and after intervention, were collected by questionnaires and were entered into a database using SPSS Data Entry II (SPSS Inc., Chicago, Illinois, United States). Results were expressed as mean \pm and standard deviation (range 95%). The chi square test was the method to compare the frequencies of the groups. The t-test for independent samples was employed. All *p* values less than 0.05 were considered to indicate significance and confidence interval at 95%.

Table 1 Distribution of patients among the three surgical groups

Hyperhidrosis	Electrocoagulation (no. of patients)	Ultrasonic scalpel (no. of patients)	Radiofrequency dissector (no. of patients)
Palmar	6	15	10
Palmar and axillary	3	4	9
Axillary	1	4	3
Palmar and plantar	–	3	3
Facial	–	1	3

Quality of Life

Effectiveness evaluation for each technique was performed based on the quality-adjusted life year (QALY)^{11,12} and the QOL protocol proposed by Amir et al¹³ and de Campos et al.¹⁴ We used QOL and QALY to assess the findings of different methods applied in the surgical approach over time. All patients underwent starch iodine test to define an area of residual disease after surgery. The EuroQol questionnaire, administered before surgical treatment and at 40 ± 1 month after intervention in the course of clinical evaluation of the patients, was expressly modified by our statisticians based on the pathology studied. The dimensions of health status taken into consideration were the following: (1) care for themselves, (2) usual activity, (3) pain/discomfort, and (4) anxiety/depression. Three levels of severity were evaluated through specific scores for single dimension: (1) none, (2) moderate, and (3) severe. The synthetic value of QOL at the time of the interview (time trade-off method) was obtained by the specific algorithm. QALY equal to 1 was considered excellent; from 0.50 to 0.99 was good; and from 0 to 0.49 was poor. The result of the algorithm was multiplied by the follow-up, obtaining the QALY. The QOL questionnaire was applied 7 days before and 40 days after the surgical approach directly during the check-up of patients. Five levels of satisfaction were considered (very poor, poor, good, very good, and excellent), deriving from 20 questions divided into 5 sections. The total score ranged from 20 to 100. QOL was classified as follows: from 20 to 35 excellent; from 36 to 51 very good; from 52 to 68 good; from 69 to 84 poor; and > 84 very poor.

Results

The time of intervention was 18 ± 2 minutes and total operating room time was 54 ± 3 minutes. No operative iatrogenic complications were noticed. No patients displayed compensatory or gustatory sweating.

Clinical Outcomes

We observed chest pain in four electrocoagulation, one Ultracision, and one LigaSure patients, disappearing in 20 ± 1 day. Three patients treated with electrocoagulation showed paresthesias, solved in 23 ± 5 days. One ultrasonic patient displayed bradycardia (43 beats per minute) after completion of the sympathectomy on the right side, normalized in the 4th postoperative hour. We showed two recurrences after the second side electrocoagulation intervention, demonstrated with the residual darkened area by starch iodine test. This complication was positively resolved in one patient by uniportal (2.5 cm incision along the posterior axillary line in the fifth intercostal space) VAT resurgery (one patient refused reoperation). Patients with palmar and plantar hyperhidrosis revealed high satisfaction for the reduction in pedal sweating of approximately 20%.

Quality-Adjusted Life Year and Quality of Life

The evaluation after surgical treatment of the reduction of the excessive sweating displayed: (1) an excellent QALY in 9

electrocoagulation, 26 ultrasonic scalpel, and 27 radiofrequency dissector patients; (2) a good QALY in 1 Ultracision (EuroQol = 0.87) and 1 LigaSure (EuroQol = 0.89) patients because of moderate anxiety; (3) a poor QALY in 1 electrocoagulation patient (EuroQol = 0.12) because of recurrence of sweating after intervention. The general satisfaction analysis showed: (1) an excellent QALY in 9 electrocoagulation, 27 ultrasonic scalpel, and 28 radiofrequency dissector patients; (2) a poor QALY in 1 electrocoagulation patient (EuroQol = 0.15) because of recurrence of sweating. The enhancement of the quality of life assessment revealed: (1) an excellent QALY in 8 electrocoagulation, 27 in ultrasonic scalpel, and 28 in radiofrequency dissector patients; (2) a good QALY in 1 electrocoagulation patient (EuroQol = 0.91) because of re-surgery; and (3) a poor QALY in 1 electrocoagulation patient (EuroQol = 0.20) because of recurrence of sweating. The findings of the QOL protocol were similar to those of EuroQol. In fact, the excessive sweating and general satisfaction before surgery improved after surgical approach (**Table 2**) with statistical significance $p = 0.02$. **Table 3** displayed the statistically significant advantages ($p = 0.0001$) of intervention of the QOL protocol. The performance status of Ultracision and LigaSure was better than electrocoagulation, whereas no difference was found while comparing the two new-generation devices (**Table 4**).

Discussion

Our study highlighted that endoscopic sympathectomy with ultrasonic scalpel and radiofrequency dissector was a valid surgical approach compared with electrocoagulation, facilitating the management of primary hyperhidrosis. These techniques provided an effective answer to the increased demand for minimally invasive surgery, because of a greater consciousness of the pathology by patients and doctors of general medicine. Sympathetic trunk interruption with clips does not seem to allow an immediate improvement in symptoms. For this reason, the potential reversibility of the clipping method is thwarted by the latency time of the effect.¹⁵ However, not all trials have confirmed a delay in the freedom of symptoms by clipping, the positive effect of which occurs within a few minutes.⁵

Surgical Method

We performed R3–R5 sympathectomies for plantar hyperhidrosis with an acceptable reduction of pathological sweating. This choice seems to agree with Cerfolio et al⁴ who recommended a R4–R5 excision, although the lumbar sympathectomy was the main approach to resolve completely the excessive pedal sweating.¹⁶ Single-lung ventilation allowed the rapid identification of the level of resection, avoiding complications. The short-term outcomes of Chang et al⁹ revealed 1 patient (0.4%) with hemothorax and 33 patients (14.1%) with pneumothorax, 6 of which required a pleural drainage. We waited 30 days before doing the second side in a majority of patients because the incidence of compensatory symptoms is linked to the extent of sympathetic chain resection. This may partly explain the lack of compensatory

Table 2 Evaluation of clinical parameters (sweating and general satisfaction) before and after surgery

Clinical parameters	Excellent	Good	Very poor	Total	p-Value
Before surgery					
Electrocoagulation	0 (0%)	1 (50%)	9 (14.3%)	10 (15.4%)	–
Ultracision	0 (0%)	1 (50%)	26 (41.3%)	27 (41.5%)	0.137
Ligasure	0 (0%)	0 (0%)	28 (44.4%)	28 (43.1%)	–
Total number of patients	0	2	63	65	–
After surgery					
Electrocoagulation	8 (12.7%)	1 (50%)	1 (1%)	10 (15.4%)	–
Ultracision	27 (42.9%)	0 (0%)	0 (0%)	27 (41.5%)	0.02
Ligasure	28 (44.4%)	0 (0%)	0 (0%)	28 (43.1%)	–
Total number of patients	63	1	1	65	–

Note: Coefficient of concordance: 0.94; $r = 0.91$.
P, Chi square test.

reactions in our experience. In fact, Lin and Telaranta¹⁷ classified the sympathetic disorders based on the sympathetic innervations to facilitate and specify the single-level excision. However, a modification of this classification was necessary to get good results in the palmar hyperhidrosis.¹⁸ We observed only one reduction in heart rate in 130 procedures (0.8%) with harmonic scalpel, which was resolved spontaneously. This demonstrated that the alteration of electrophysiology of the heart and the appearance of a vagal hypertonus are linked to the section of the sympathetic nerve and not to the device used. Five cardiac arrests were described in literature,^{19–22} requiring cardiopulmonary maneuvers for reanimation and a pacemaker implantation in two cases. Our decision to postpone surgery for a month was justified by the need to inhibit any possible complication which would not be accepted by the patient because of the clinical, aesthetic, and psychological complexity of hyperhidrosis.

Quality-Adjusted Life Year and Quality of Life

The choice of two different questionnaires with different items, associated with the starch iodine test, allowed us a real and objective assessment of the effects of the three techniques applied. Although we found a general improvement in QOL after surgical approach, we noticed complications in 14% of the patients (nine patients) with the traditional method in respect to 4.6% (three patients) patients in total with the new devices. In our study, Ultracision and

LigaSure revealed high QALY and QOL (clinical, emotional, and physical) in all 55 patients (100%) operated. Electrocoagulation displayed a reduction in QALY and a poor QOL because of two relapses, of which only one retreated surgically with video-assisted thoracoscopy. Statistically significant differences were not found comparing the Ultracision with the LigaSure. de Campos et al,²³ evaluating the electric versus harmonic scalpels, showed that there is no correlation between the type of device used and the chest pain in the 1st month after VATS. Licht et al,²⁴ studying 158 VATS patients, highlighted Horner syndrome complication rate of 6% (three patients) with electrocoagulation and 0.9% (one patient) with ultrasonic scalpel.

Mechanical Characteristics of the Devices

Electrocautery transforms electric current into high frequency signals which allow the cutting and clot actions. Coagulation was because of evaporation of water molecules at temperatures near 100°C and to carbonization of the tissue at higher values (100–400°C). Many authors^{25,26} linked the sympathectomy complications to the thermal transmission from the electric scalpel. However, we think that the handling, the low intercostal dissection, and the rapid nerve exposure were the undisputed advantages of electrocoagulation. The harmonic scalpel dissects the tissue and simultaneously seals the blood vessels using high-frequency mechanical vibrations (55,500 cycles/s). The energy produced

Table 3 The improvement of quality of life with surgical treatment

	Excellent	Good	Very poor	Total	p-Value
Before	0 (0%)	2 (50%)	63 (98.4%)	65 (100%)	0.0001
After	62 (100%)	2 (50%)	1 (1.6%)	65 (100%)	–
Total number of patients	62	4	64	–	–

Coefficient of concordance: 0.94; $r = 0.91$.
P, Chi square test.

Table 4 T-test for independent samples showed better results with Ultracision and LigaSure than electrocautery

	t-value	df	p-Value
Electrocoagulation vs. Ultracision	3.39673	4	0.0005
Electrocoagulation vs. LigaSure	3.39987	4	0.0002
Ultracision vs. LigaSure	1.0568	4	NS

Abbreviations: df, degree of freedom; NS, no significance.

by the mechanical movement of the scalpel blade induces the breakage of the hydrogen chains, with denaturation of cellular proteins and coagulation of tissue at a temperature between 50 and 100°C.²⁷ The reduced manageability and the increased intercostal dissection were offset by temperatures at which the Ultracision works, without carbonization and drying of the tissues. The excellent vision (because of the lack of production of surgical smoke), the limited thermal damage because of the inferior propagation of heat and optimum cutting explained our results, although there is no agreement in literature about the actual advantages of the ultrasonic scalpel.²⁸ The effectiveness of the LigaSure is related to the combination of compressive pressure and bipolar radiofrequency energy, which acts through the fusion of collagen and elastin. The system provides a significant saving of healthy tissue because of a lateral thermal spread inferior to 2 mm but, in our experience, this aspect did not entail more benefits than the harmonic scalpel. Radiofrequency dissector can be used in wedge-resections of the lung parenchyma, with a minimal complication rate. Unfortunately, there are no experiences regarding the use of LigaSure in the sympathectomy. Wilkinson²⁹ in 1984 performed 15 sympathectomies (4 bilateral) by percutaneous radiofrequency with good to excellent results. We noticed no difference between LigaSure and Ultracision for depth and extension of thermal tissue damage, which appeared reduced following the lifting up of the sympathetic chain. We opine that the only disadvantage consists in the rectilinear distal end (while in the electrocoagulation it is curved at a 90 degree angle), which made the approach to the sympathetic nerve difficult without a second device for lifting the trunk and ganglia. This led to a thoracoscopic access diameter slightly greater than that practiced with electrocautery, despite the small size of the last-generation devices.

Conclusion

Although our study was not based on a large number of patients, which could also explain the absence of compensatory sweating, we experienced a high level of LigaSure and Ultracision acceptance by the patient ensuring a rapid

functional and psychological recovery. This aspect facilitated the reintegration to normal daily work and social life. The limited heat transfer resulted in a reduced neuromuscular stimulation, minimizing deep and near tissue trauma. In fact, we found postoperative pain in a smaller percentage of patients than electrocoagulation though the new devices needed a wider thoracoscopic access. This was because of the reduction in temperature developed and the imperceptible neurological distress. Given the continuing reduction in the budget of the National Health System in Italy, it is obvious that the higher costs of Ultracision and LigaSure (€620.00 and €612.00, respectively) compared with electrocautery (€58.50) can be accepted only on the grounds of a return to proportionate health for the patient. As this study had a nonrandomized setting, the results met the criticism that the electrocautery group may have been statistically underrepresented. Therefore, a prospective randomized trial should be projected.

Conflict of Interest

None declared.

Acknowledgment

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