Sympathetic Skin Response in Hyperhidrosis: An Electrophysiological Evaluation for Surgical Treatment

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Abstract - Sympathetic skin response (SSR) was measured in 20 patients with hyperhidrosis both before and after receiving the endoscopic transthoracic sympathectomy. Their ages ranged from 17 to 58 (mean 29.7). Eleven of them were female; nine were male. For each patient, operative effects were estimated by comparing the amplitude ratio (the postoperative amplitude to the preoperative amplitude) of the palmar SSR and the pedal SSR in the same individual. Differences were calculated by student paired t-test. The results showed that comparing with pedal SSR, the amplitude ratio of the palmar SSR revealed a significant degree of decrement while the latency ratio was not significantly different. Three patients still presented partial sudomotor activity detected by SSR. The amplitude ratio of SSR is a good electrophysiological guide for evaluating operative effect on hyperhidrosis. In the future, intraoperative measurement of SSR may become a feasible way to obtain an optimal degree of sympathectomy with least recurrence.

Key words: Hyperhidrsis, Sympathetic skin response, Sudomotor activity, Endoscopic transthoracic sympathectomy

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INTRODUCTION

Hyperhidrosis is a fluctuating nuisance which is usually aggravated by physical and emotional stress. It can pose serious psychological and social handicaps. Although several ways, including the subjective feeling of the patient, local sweating rate and transcutaneous capillary blood flow, have been developed to evaluate the sudomotor activity, none of them is satisfactory. Direct recording of sympathetic skin response (SSR) was introduced a few years ago[1,2]. It has been used in the past to evaluate the autonomic function in patients with dysautonomia, polyneuropathy, syncopy, and spinal cord injury[3,5-8]. This test is an electrophysiological technique for assessing function of cutaneous sympathetic fiber by monitoring a change in voltage measured from the surface of the skin. This electrodermal activity is attributed to sudomotor activity. It differs from the previous sweating tests in that a quantitative electrical stimulation which mimicks a tensive condition is given to induce the change of sudo-

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motor activity. Theoretically, a maximal response can be acquired if sufficient electrical intensity is used. Besides, it is quantitatively measurable and noninvasive. In this study, we used this dynamic parameter, namely, SSR, to evaluate the operative effect of sudomotor activity in hyperhidrosis. We tried to work out its sensitivity in detecting partial destruction of the nerve.

MATERIALS AND METHODS

Twenty consecutive patients with hyperhidrosis were collected from the Department of Surgery in National Taiwan University Hospital from August 1990 to May 1991. They were free from any neurologic deficit except for the sweating problem. None of them had any evidence of diabetes mellitus, cardiovascular disorder, renal dysfunction, electrolyte imbalance, neuromuscular disorder, dysautonomia, or dehydration. Eleven of them were female; nine were male. Their ages ranged from 17 to 58 years old (mean 29.7). Their height ranged from 151 to 178 cm. All of them received the electrophysiological test one day before and then after the operation.

SSR was performed in an air-conditioned, dark and quiet room. The ambient temperature was kept within 24-26°C; the humidity was kept within 55-65%; the skin temperature was monitored and remained above 32°C. During recording, the patients breathed smoothly, and lay comfortably supine, alert and unanesthetized. Electrical stimulation (single square wave with 100 us duration and 250 mA voltage) was applied to the left median nerve at wrist through surface electrodes. More than 10 stimulations were given to each individual at irregular time intervals after the base line was stable and at least two minutes had elapsed. Silver-silver chloride (Ag-AgCl) disc electrodes were placed on their right hand and sole with the active lead over volar side and the reference lead over dorsal side. Electric gel was applied on the skin surface. Recordings were obtained from an EMG machine (Mystro II of Medilec Corp) with a filter frequency of 0.1-50 Hz and sweep duration of 10 seconds. Only five of these responses with the stand-

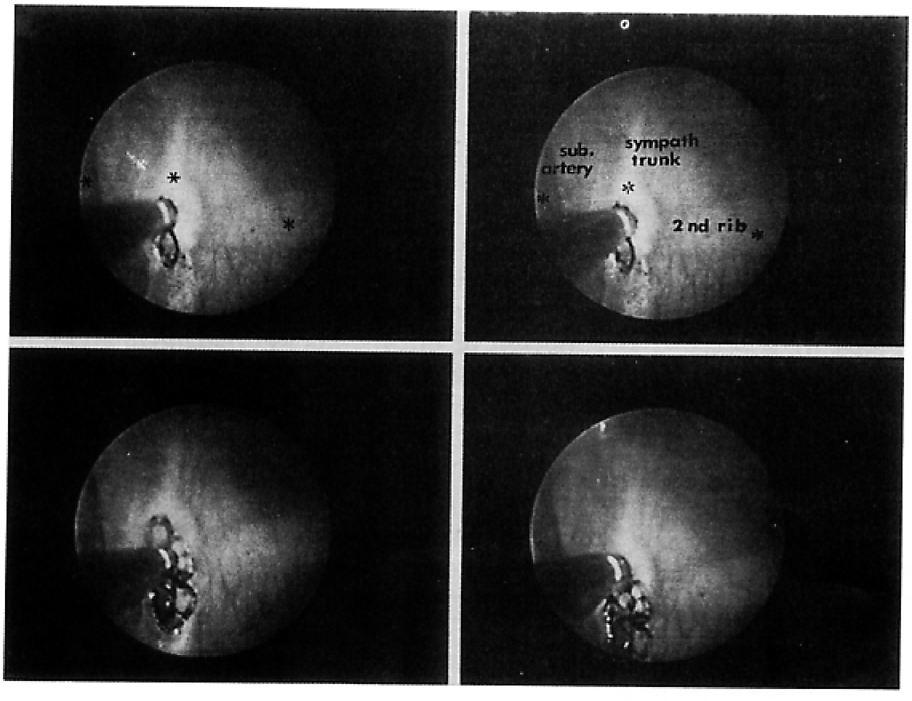

FIG. 1. Endoscopic view of the left T2 sympathetic segment during its vaporization by a contact laser probe. Subclavian artery, sympathetic trunk, and second rib were indicated in this figure.

Table 1. *Clinical features and SSR results of hyperhidrosis*

No.	Age	BH (cm)	Palm Lat@		Sole Lat		Palm Amp.		Sole Amp.	
			Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	48	158	1.36	1.13	1.91	1.73	4.90	0.46	2.20	1.80
2	25	156	1.52	*	2.27	1.98	0.08	0.00	0.09	0.14
3	29	176	1.35	*	1.78	1.78	0.72	0.00	0.36	0.46
4	20	167	1.29	*	1.70	1.97	2.26	0.00	1.34	1.51
5	28	161	1.30	1.29	1.73	2.02	1.88	0.07	1.07	1.08
6	19	172	1.33	*	1.96	1.91	4.38	0.00	2.40	1.08
7	18	173	1.40	*	1.74	1.88	1.20	0.00	2.90	0.08
8	24	173	1.52	*	1.98	*	0.87	0.00	0.34	0.00
9	18	162	1.44	1.34	1.88	1.86	2.44	0.07	0.07	0.01
10	26	170	1.34	*	1.75	1.73	2.00	0.00	0.89	0.76
11	28	151	1.14	0.95	1.52	1.76	2.20	0.03	2.08	0.47
12	23	164	1.30	*	1.80	1.73	1.48	0.00	0.90	2.80
13	36	178	1.34	*	1.80	1.75	0.37	0.00	0.89	1.14
14	43	155	1.12	1.12	1.82	1.55	2.66	0.50	4.40	2.78
15	42	152	1.00	1.01	1.66	1.35	0.92	0.68	1.90	1.84
16	58	158	1.17	*	1.80	1.84	4.10	0.00	0.72	0.38
17	21	162	1.29	*	2.93	2.44	2.00	0.00	1.76	1.50
18	21	162	1.18	*	1.98	2.09	2.45	0.00	1.32	0.12
19	28	163	1.24	*	1.70	1.69	1.10	0.00	0.44	0.48
20	39	151	0.88	*	1.26	1.35	0.77	0.00	0.48	0.78

* Absence of pick-up; @ Amplitude in mV, Latency in second.

ard negative-positive biphasic waveform and maximal amplitude were sampled and averaged. The data were displayed by a high impedance input amplifier and an oscilloscope with two recording channels and multiple stored channels. The latency was measured from the stimulus artefact (electrical stimulus) to the onset of the response wave. The amplitude was measured from the baseline to the negative peak. Operation was performed under general anesthesia with alternating one-lung ventilation. After establishment of a partially collapsed lung, the thoracoscope coupled with a laser optical fiber was introduced into the pleural cavity to extirpate T2 sympathetic segment[9-11] (Fig 1). The procedure was considered to be complete when there was a remarkable increment of finger skin microcirculation (more than 50% above the original level) measured by laser Doppler flowmeter. This was followed by a gradual elevation of temperature (usually more than 3°C if the original finger temperature was below 30°C). Operative effect was estimated by the amplitude (Amp) ratio of palmar SSR (the postoperative to the preoperative amplitude) of the same individual. Because it was difficult to control all the influencing factors of SSR of different individuals under different conditions, the same individual's amplitude ratio of pedal SSR was used as the control. Differences between experimental group and control were calculated by student paired t-test.

RESULTS

The typical SSR revealed a negative-positive biphasic waveform with relatively consistent amplitude (Fig 2). The clinical features (including age and height) and SSR results (including the preoperative and postoperative latencies and amplitudes) were listed in Table 1. Before the operation, the reflex latency of SSR was 1.28 ± 0.16 second

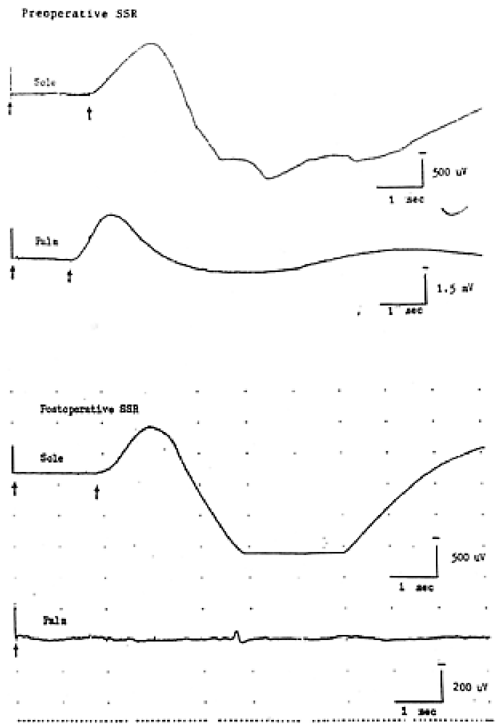

FIG. 2. Example of the SSR recorded in the palm and sole of patient No. 10 preoperatively and postoperatively. Arrows indicate the stimulus and onset of the response.

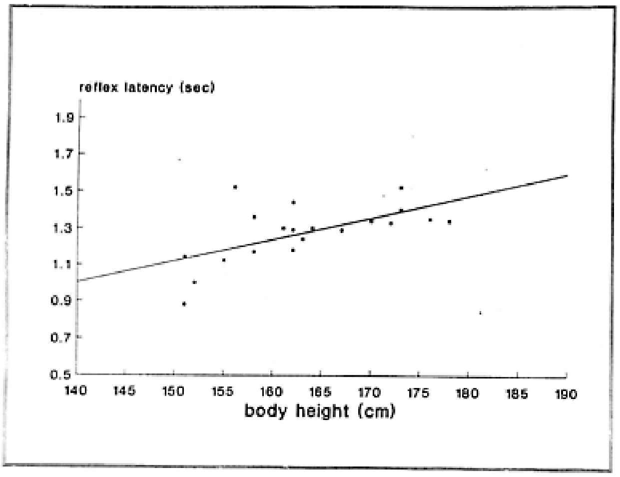

FIG. 3. Regression of palmar reflex latency (second) (Y) plotted against body height (cm) (X). Y=0.0118X-0.649 (p<0.01)

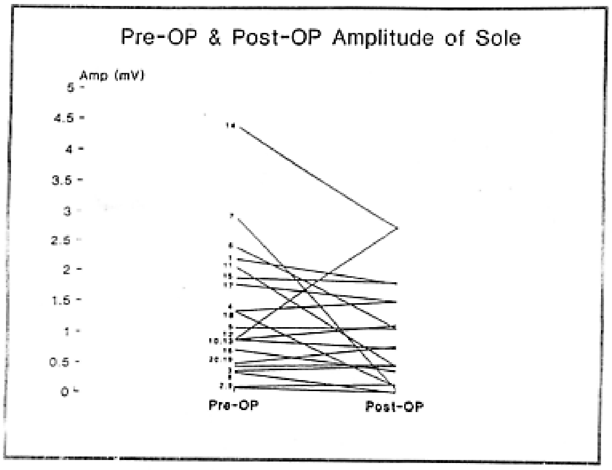

FIG. 5. Changes of the amplitude of the pedal SSR (preop: preoperation, postop: postoperation; patient numbers listed in Table 1 were indicated.)

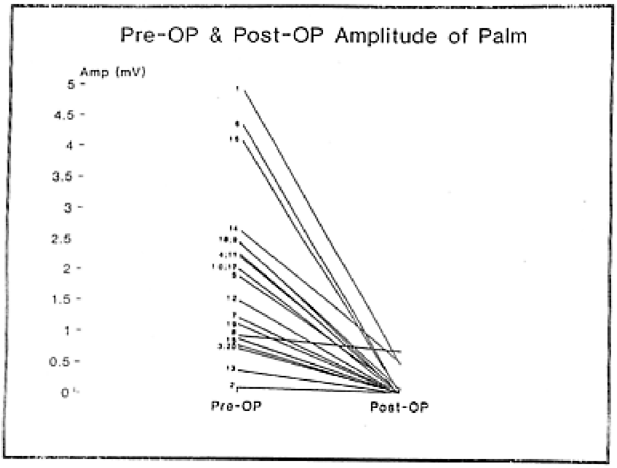

FIG. 4. Changes of the amplitude of the palmar SSR (preop: preoperation, postop: postoperation; patient numbers listed in Table 1 were indicated.)

Table2. *Latency changes of sympathetic skin response (mean ± standard deviation)*

	Preoperative (sec)	Postoperative (sec)	Latency Ratio (post/pre)
Palm	1.28 ± 0.16	1.14 ± 0.14	0.93 ± 0.08
Sole	1.85 ± 0.32	1.81 ± 0.24	0.98 ± 0.15
			p = 0.566

Table 3. *Amplitude changes of sympathetic skin response (mean ± standard deviation)*

	Preoperative (mV)	Postoperative (mV)	Amplitude Ratio (post/pre)
Palm	1.94 ± 1.29	0.09 ± 0.20	0.06 ± 0.17
Sole	1.33 ± 1.06	0.96 ± 0.83	0.89 ± 0.72
			p< 0.001

(mean ± SD) in the palm and 1.85 ± 0.32 second in the sole (Table 2). The amplitude of SSR was 1.94 ±1.29 mV in the palm and 1.33 ± 1.06 mV in the sole (Table 3). The correlation coefficients (r) of latency and height were 0.616 ($p < 0.01$, two tailed t-test, Fig. 3) for the palm and 0.148 ($p > 0.2$, two-tailed t-test) for the sole.

After receiving the operation, the palmar skin temperature was increased in all patients (Increment: 4.68 ± 2.18°C). The amplitude change of the palmar and pedal SSRs were shown in Fig.4 and 5 respectively. There was a significant decrement of the amplitude of palmar SSR when it was compared with the change of the pedal SSR of the same individual by student paired t-test ($p < 0.001$, two tailed t-test) (Tab. 3). However, no significant change was found for the latency ratio (p=0.566, two tailed t-test) (Table 2).

DISCUSSION

Previous studies[4,5] reported a significant correlation between the body height (BH) and the palmar reflex latency of SSR. Our study also supported this finding (palmar reflex latency=0.0118 x BH-0.649, $p < 0.01$, Fig.3). However, no significant correlation could be found between the height and the pedal SSR latency in this study ($p > 0.2$).

Reflex latency was usually used as the main parameter for evaluation[4,5] because it had a narrow distribution range. However, it was quite constant and insensitive in our study (Table 2). This could be reasonably deduced by the rationale that partial injury to unmyelinated axon presented itself mainly as diminished amplitude instead of delayed reflex latency.

Although higher than normal SSR amplitude[15] was to be expected in hyperhidrotic patients, some of them showed very low SSR amplitude (patient No. 2,9). This made the preoperative SSR amplitude of hyperhidrotic patients distributed over a wide range (0.082-4.9 mV for the palm and 0.09-4.4 mV for the sole). It might reflect two possibilities. One was that the threshold of maximal SSR varied among different individuals, depending on different psychophysiological conditions. Thus a higher SSR amplitude might be elicited by another set of stimulation condition in patient No. 2 and 9. The other possibility was that SSR measured the relative change of electrodermal activity and it would be minimized if persistent excessive sweating was present. Owing to the large standard deviation, we conducted this study by intra-individual comparison to avoid inter-individual variation.

Despite the fact that all of the twenty patients were subjectively anhidrotic at the time when postoperative SSR were performed, still significant partial palmar SSR response could be detected in three patients (patient No.1,14,15 with amplitude ratio of 0.09, 0.19, 0.74 in the palm and 0.82, 0.63, 0.97 in the sole respectively). After operation, these three patients did not sweat under emotional stimuli but only during heat stress. This finding supported the idea that SSR was a more accurate sensitive guide in measuring residual sweating ability. In patient No. 12, the increased SSR amplitude of the sole (300%) was probably derived from compensatory hyperhidrosis[12]. Such findings were similar to the previous reports by Adar[11] and Shih[14]. In Adar's series, 50% continued to suffer from plantar hyperhidrosis after upper dorsal sympathectomy.

In conclusion, the SSR amplitude, rather than the reflex latency, is more useful in the evaluation of operative effect of hyperhidrosis. Because of the great variability between different individuals, we suggest to calculate the SSR amplitude ratio of the palm using that of the sole as control. Remarkable decrease of the SSR amplitude ratio in the palm with minimal change in the sole usually suggests a good operative effect. In the present stimulation condition, SSR can induce partial response of the palm in 15% (3/20) of the subjectively anhidrotic patients. There are 25% of the patients whose SSR of the sole can not be elicited properly after the operation. The reliability of the amplitude may be increased by greater stimulation intensity[16]. Serial follow-up of these patients to investigate the correlation between recurrent rate and the change of the amplitude ratio is now underway. Further study is needed to elucidate SSR under general anesthesia. In the future, this intraoperative SSR may become a promising monitor for optimal extirpation of the proper sympathetic segment to achieve lowest recurrent rate.

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