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The "Senobi" breathing exercise ameliorates depression in obese women through up-regulation of sympathetic nerve activity and hormone secretion

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ABSTRACT

Obese individuals have an increased risk of developing depression. This study aimed to determine whether the "Senobi" breathing exercise (SBE), a stretching-breathing exercise that we have established, could relieve depression, especially in obese women. Forty premenopausal women, aged 40 to 49 years, participated in the present study. Twenty were healthy, and the other 20 were obese (body mass index > 25 and body fat > 30%) and in a depressive state (OWD). Sympathetic nerve activity determined by analyzing heart rate variability, and the hormone levels in the urine were investigated before and 30 min after one minute of SBE. The relative proportion of sympathetic nerve activity among healthy women in the daytime was 79.2 ± 2.3%, whereas that in OWD group was 30.4 ± 1.9%. After one minute of SBE, significant up-regulation of sympathetic nerve activity and increased concentrations of catecholamines, estradiol, and growth hormone (all P values < 0.001) were observed in OWD group. After 30 days of SBE, the sympathetic nerve activity and hormone levels had recovered in OWD group, and the depressive state, as evaluated by the Hamilton Depression Scale, had ameliorated. The "Senobi" breathing exercise was found to be effective for amelioration of depression in obese women possibly through up-regulation of sympathetic nerve activity and hormone secretion.

The worldwide incidence of depression is 8–12%, and is increasing (2), being expected to account for the second biggest disease burden by 2020 (20). Depression is now recognized as a disease that relapses recurrently, and in patients with recurrent depression, a high frequency of obesity and bronchial asthma has been reported (6). A reciprocal link between depression and obesity was recently confirmed by a meta-analysis (15). Therefore, novel approaches for the treatment or prevention of depression in obese individuals are urgently required.

It has been reported that in perimenopausal women, age-related changes in ovarian estrogen production may alter the function of the autonomic nervous system and thus predispose them to depression (27). Following initial studies of the association between obesity and autonomic nervous activity, we focused on depression, especially that affecting obese women. The posture of obese women in a depressive state (OWD) is generally stooped, resembling that of patients with Parkinson's disease (19, 29). With regard to the relationship between posture and breathing, and that between breathing and the autonomic nervous system (23), "Yoga" is reported to be an effective alternative approach to the treatment of depression (28). However, the mechanism by which "Yoga" improves depression has not been properly investigated scientifically.

From the viewpoint of posture and breathing, we have recently established a stretching-breathing ex-

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ercise known as the "Senobi" breathing exercise (SBE), which involves only one minute of stretching together with both abdominal breathing and thoracic respiration. Surprisingly, we have found that SBE ameliorates bronchial asthma (25) and obesity (26) through its ability to normalize autonomic nervous function. Therefore, in the present study, we investigated whether SBE could ameliorate depression, especially in obese women, and attempted to clarify the effect of SBE on autonomic nervous function in OWD.

METHODS

Participants. After obtaining appropriate informed consent in writing, 20 healthy women and 20 OWD (both groups premenopausal) participated in the present study in 2009. The mean age of the healthy group was 43.1 ± 2.6 years, and that of the OWD group was 43.5 ± 8.3 years. OWD was defined as a body mass index (BMI) of > 25, body fat > 30%, and satisfying more than 15 items of the 17-item Hamilton Depression Scale (HAM-D). None of the women had taken any medication.

Measurement of autonomic nervous activity. Autonomic nervous activity was measured using a patented analyzer, SA-3000P (Tokyo Iken Co., Ltd., Tokyo, Japan), which determines the relative proportions of sympathetic and parasympathetic nerve activity by analyzing heart rate variability combined with acceleration plethysmography.

Measurement of hormone levels in the urine. Urine samples were collected before and 30 min after a one-minute session of SBE in the morning (from 9 : 00 a.m. to 12 : 00 a.m.). While healthy women performed SBE once only at the beginning of study, OWD performed SBE 3 times a day before every meal for 30 days, and then urine samples were collected before and 30 min after a one-minute session of SBE in the morning. The urinary concentrations of catecholamines, 5-hydroxyindole acetic acid (5-HIAA), estradiol (E2), and growth hormone (GH) were measured at BML General Laboratory (Saitama, Japan). Urinary concentrations of adrenaline, noradrenaline, dopamine, GH, and E2 were corrected by urinary creatinine level. Because autonomic nervous activity can be modified by pain stimulation, examination of the hormone concentrations in blood samples was considered to be inappropriate.

Statistical analysis. The significance of differences was analyzed statistically by *t* test with Welch's correction or Mann-Whitney *U* test using SPSS software (IBM SPSS Statistics Ver.18; SPSS Inc., Chicago, IL). The level of significance was set at $P < 0.05$.

RESULTS

Representative case

A 46-year-old obese woman with depression participated in the present study in November, 2009. All the data obtained before and after a one-minute session of SBE at the start, together with those after 30 days of continuous SBE, are shown in Fig. 1. Surprisingly, we found that sympathetic nerve activity and the levels of the examined hormones were increased after only one minute of SBE. After 30 days, the depressive state evaluated using the HAM-D was found to have ameliorated without the need for any medication such as anti-depressants.

Measurement of autonomic nervous activity

The relative proportion of sympathetic nerve activity in OWD group was significantly lower than that in healthy women before SBE (30.4 ± 1.9% *vs.* 79.2 ± 2.3%, $P < 0.001$) (Table 1). Although no significant change in sympathetic nerve activity was observed in healthy women after one minute of SBE, that in OWD group was significantly increased from 30.4 ± 1.9% to 58.2 ± 2.8% ($P < 0.001$) (Table 1).

After 30 days, the relative proportion of sympathetic nerve activity in OWD group was significantly increased to 60.3 ± 5.1% compared to that at the baseline examined at the beginning of study before performing SBE ($P < 0.001$), and sympathetic nerve activity was still up-regulated to 66.8 ± 5.1% ($P < 0.001$) immediately after one minute of SBE (Table 1).

Measurement of hormone levels in the urine

At the baseline examined at the beginning of study, the urinary concentrations of catecholamines (noradrenaline, dopamine), 5-HIAA, E2, and GH were significantly lower in OWD group than those in healthy women before one minute of SBE (all *P* values < 0.001) (Table 2). After one minute of SBE, although no significant change was observed in healthy women, the urinary concentrations of these hormones were significantly increased in OWD group compared to those in healthy women (all *P* values < 0.001) (Table 2).

After 30 days, the urinary concentrations of these hormones were increased in OWD group before

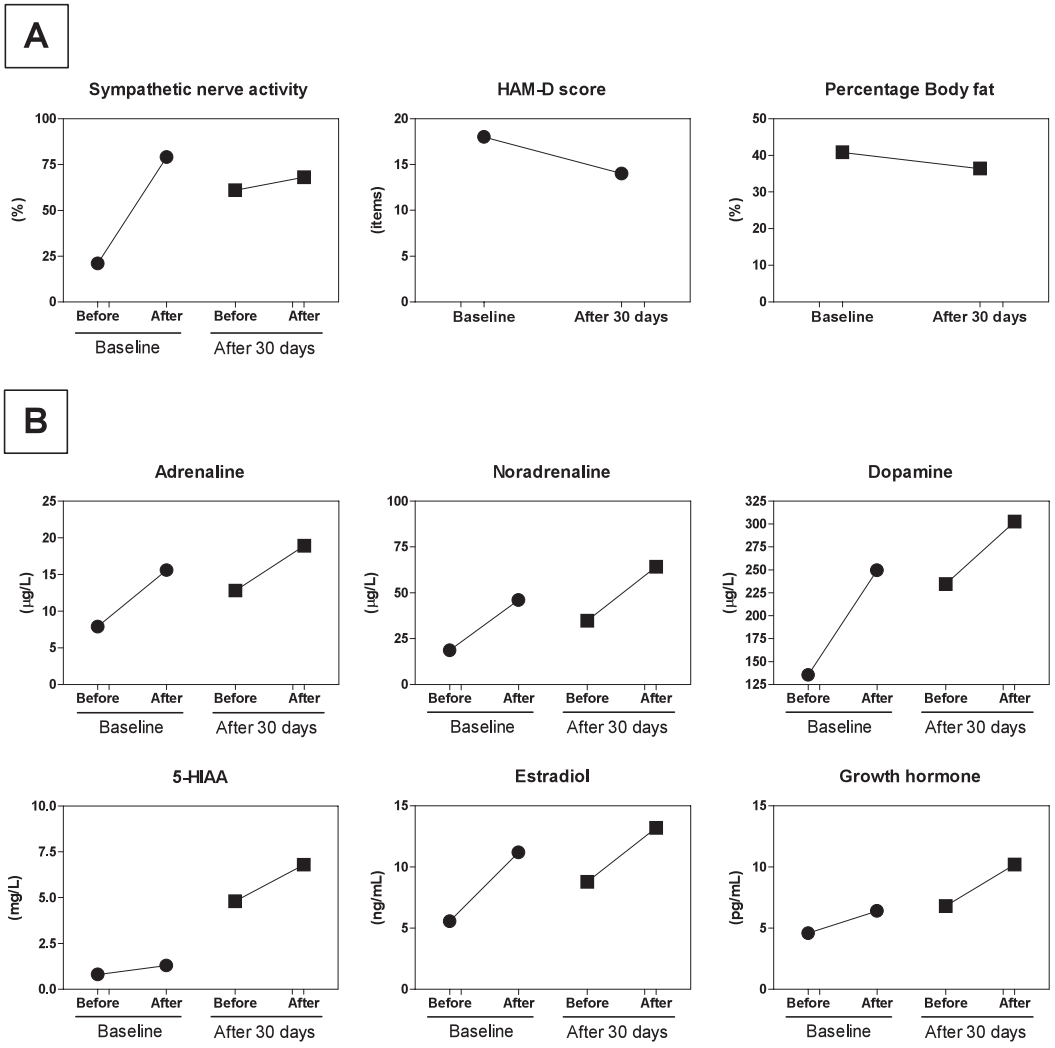

Fig. 1 Changes in sympathetic nerve activity, urinary hormone levels, the Hamilton Depression Scale score, and percentage body fat in a representative obese woman with depression before and after performing the "Senobi" breathing exercise. The results of sympathetic nerve activity (A), urinary levels of catecholamines, 5-hydroxyindole acetic acid (5-HIAA), estradiol, and growth hormone (B), the 17-item Hamilton Depression Scale (HAM-D) score (A), and percentage body fat (A) in a 46-year-old obese woman with depression before and after one minute of "Senobi" breathing exercise.

SBE relative to those at the baseline examined at the beginning of study. The concentrations of these hormones were still significantly increased immediately after one minute of SBE (all P values < 0.001) (Table 2).

Percentage body fat

After continuing SBE 3 times a day for 30 days, a significant reduction of percentage body fat was observed ($35.3 \pm 2.3\%$ to $31.6 \pm 2.6\%$, $P < 0.001$) in OWD group (Table 1).

HAM-D scale

The HAM-D score in OWD group was significantly decreased from 18.9 ± 6.6 to 13.3 ± 2.5 ($P < 0.001$) after continuing SBE for 30 days (Table 1).

DISCUSSION

A marked increase of sympathetic nerve activity was evident in OWD group compared with healthy women as a result of performing the stretching-breathing exercise, SBE. In fact, we found that a recovery was evident after only one minute of SBE. Consistent with our results, a decrease of sympathetic nerve activity in obese individuals has already been reported as the "Mona Lisa" hypothesis, a term derived from the acronym formed by "Most Obesity

Table 1 *Sympathetic nerve activity, percentage body fat, and HAM-D score before and after SBE*

	Healthy	Obese women in a depressive state	
	Baseline	Baseline	After 30 days
n	20	20	
Age (years)	43.1 ± 2.6	43.5 ± 8.3	
Sympathetic nerve activity (%)			
Before	79.2 ± 2.3	30.4 ± 1.9]**	60.3 ± 5.1*
After	76.3 ± 1.6	58.2 ± 2.8]**	66.8 ± 5.1
Percentage body fat (%)	24.4 ± 0.1	35.3 ± 2.3	31.6 ± 2.6*
HAM-D score (items)		18.9 ± 6.6	13.3 ± 2.5*

The values are presented as means ± SD. *$P < 0.001$ (compared to the baseline), **$P < 0.001$. SBE, "Senobi" breathing exercise; Before, before one minute of SBE; After, after one minute of SBE; HAM-D, 17-item Hamilton Depression Scale.

Table 2 *Hormone levels in the urine before and after SBE*

	Healthy	Obese women in a depressive state	
	Baseline	Baseline	After 30 days
n	20	20	
Noradrenaline (μg/g Cre)			
Before	79.2 ± 2.3	30.4 ± 1.9]**	64.2 ± 2.9*]**
After	76.3 ± 1.6	58.2 ± 2.8]**	85.9 ± 2.8]**
Dopamine (μg/g Cre)			
Before	486.2 ± 156.6	188.5 ± 65.8]**	377.9 ± 176.6*]**
After	491.9 ± 172.5	374.8 ± 152.1]**	559.7 ± 237.6]**
5-HIAA (μg/g Cre)			
Before	2.58 ± 0.90	1.13 ± 0.62]**	3.92 ± 3.20*]**
After	2.46 ± 0.58	3.51 ± 0.42]**	6.89 ± 2.46]**
Estradiol (μg/g Cre)			
Before	5.5 ± 0.1	3.0 ± 10]**	5.4 ± 2.1*]**
After	5.0 ± 0.2	5.7 ± 2.6]**	8.9 ± 3.1]**
Growth hormone (ng/g Cre)			
Before	7.2 ± 1.5	3.0 ± 1.7]**	7.4 ± 2.4*]**
After	6.8 ± 1.6	7.9 ± 2.1]**	13.2 ± 3.4]**

The values are presented as means ± SD. *$P < 0.001$ (compared to the baseline), **$P < 0.001$. SBE, "Senobi" breathing exercise; 5-HIAA, 5-hydroxyindole acetic acid; Before, before one minute of SBE; After, after one minute of SBE; Cre, creatinine.

kNown Are Low In Sympathetic Activity" (Working of the sympathetic nerves is decreased in the large majority of obese persons) (3). It was also reported that sympathetic nerve revitalization decreases when the action of leptin on the central nervous system is weak (10, 16).

Obesity often occurs because of abnormal eating behavior. Especially, the disorder of binge eating is closely related to OWD (17), and noradrenaline plays a major role in feeding action through the beta receptor (4). Another important role of noradrenaline is to burn fat and diminish visceral fat. Therefore, the low concentration of noradrenaline in OWD revealed in the present study might result in obesity and depression. In OWD, secretion of noradrenaline was quickly restored after SBE, and exceeded that in healthy women.

Estrogen improves the steatolysis action of noradrenaline, and it is considered that the reduced secretion of estrogen together with a decrease of ovarian function, which occurs before menopause in women, leads to obesity (11, 21) and depression (27). When we examined urinary E2 before and after one minute of SBE, a surprising increase was revealed. Although hormone-replacement therapy is performed as a treatment for menopausal syndrome, problems of adverse effect still remain. Instead of the replacement, an increase of E2 at the source of

origin by SBE would be a better treatment without any adverse effect.

Abdominal adiposity is related to the production of GH, and its decrease influences not only obesity (30) but also a depressive state (1). Furthermore, a decrease of GH secretion is reported to be associated with metabolic syndrome and type 2 diabetes (7, 14, 31). Although administration of GH decreases visceral fat and LDL cholesterol, especially in obese women (8, 18), it is not a widely performed treatment because of its adverse effects and high cost. When safety and effectiveness are expected, considerable time and exercise are required for the production of GH (12, 13, 22). However, only after one minute of SBE, a surprising increase of GH was revealed only in OWD group, together with an increase of dopamine. Moreover, we also found that SBE increased the production of 5-HIAA in OWD. 5-HIAA is a metabolic product of serotonin (5HT), which is the well-known "happy hormone" in the brain (9, 24). Consequently, an increase of these hormones would likely be responsible for recovery of the HAM-D score in OWD group. As depression is also considered to reflect a state of imbalance of the hypothalamus-pituitary gland-adrenal gland (HPA) axis (5), depression might be improved by recovery of the HPA-axis after 30 days of SBE.

In conclusion, an effective stretching and breathing exercise, SBE, was confirmed to improve depression in OWD. Moreover, we revealed that SBE was able to revitalize sympathetic nerve activity together with recovery of secretion of hormones such as catecholamines, 5-HIAA, E2, and GH. Our results suggest that SBE should be recommended as an additive treatment for OWD, because it requires no cost, only a little time, and minimal space, and can be adapted safely to other dietary methods.

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