

The Study on Physical Therapy Modality to Reduce Body Fat

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The purpose of this study was to investigate the physical therapy modality in order to reduce body fat. Transcutaneous electrical nerve stimulation of two specific acupuncture points, that is, "Liang-Qiu" and "Gong-Sun", bilaterally was examined in order to determine the effect of this stimulation on body fat and body weight in 10 subjects obese or overweight.

The subjects were randomly divided into two groups: (1) an Acu-TENS group which received acupuncture-like TENS applied to four acupuncture points, and (2) a Con-TENS group, which received conventional TENS applied to the same points.

A repeated measure analysis of variance revealed a significant reduction of body fat for the Acu-TENS group versus the Con-TENS group, but did not show a significant reduction of body weight for the Acu-TENS group versus the Con-TENS group.

Further studies are needed to determine whether there are other acupuncture points, stimulation method or characteristics that can enhance the effect of the treatment without side effects.

INTRODUCTION

In general obesity refers to an excessive accumulation of body fat and overweight is defined as exceeding an optimal weight listed by sex and age in a table of standard values.

A people's concern is heightening about health, those who have excessive weight and fat exert themselves regardless of sex and age to have an ideal weight. Particularly female persons are more concerned about their physical beauty and are inclined to pay more attention to maintaining ideal body fat and weight.

Accordingly, in order to keep good health and appearance people employ all sorts of treatments: sitotherapy including dieting and fasting; psychotherapy; exercise of jogging, swimming and aerobic dancing; pharmacotherapy administering oral and skin medication; and performing local operation to eliminate fat or controlling absorption of food, etc

(Brownell et al., 1987).

In spite of people's continuing efforts to reduce fat and maintain a proportioned figure, the problem of regulating body fat and weight doesn't seem to be easily solved since each of the methods used has its own merit and demerit. According to the literature, there are different theories concerning obesity : genetic theory, fat cell theory and set point theory. And weight loss becomes more difficult to those who have experienced repeated dieting. The low carbohydrate, high protein, and moderate fat diet reduces weight very rapidly during the first two weeks, but this is due to changes in water balance, not loss of fat. It is possible to reduce body weight 10–12 pounds a year if 100kcal extra exercises are accompanied (Brownell, 1986 ;

Brownell et al, 1987). Likewise, diet and exercise have some effect on the reduction of body fat and weight, but each method has its own merit and demerit, causing effective application very difficult.

Physical therapy generally refers to the methods used in physical treatment such as massage, manual therapeutics, acupuncture and treatment using ultrasonic and electrical devices. In this study Transcutaneous Electrical Nerve Stimulation (TENS), which is generally used to relieve pains, is adopted and electrical stimulus is give to the acupuncture points selected based on this Oriental medical practice.

Attempts to develop effective cures by applying electrical stimulus to selected acupuncture points have been extensively made generally for relieving pain and Leo's reflex sympathetic dystrophy (1983) and Paris et al's ankle inversion sprain (1983) were introduced. Added to these efforts countless comparative studies between acupuncture and TENS have been made. Then Oliveri's pain relief treatment giving electrical stimulus to auricle (1986) and Tim's similar application of electrical stimulus for hypertnesive blood pressure (1991) were reported. The use of acupuncture points, which was conventionally a means of pain relief, now stands out to be a probable method to solve other problems.

From an Oriental medical point of view the cause and mechanism of obesity is rather complex and is related to age, diet, work, emotion and heredity. Therefore, acupuncture is extensively applied to wight loss and Zhau et al. reported (1983) that acupuncture treatment lowered the mean basal gastric motility and delayed gastric emptying after meal. Liu observed (1989) that acupuncture facilitated the function of an obese person's pituitary, adrenal cortex and sympathetic nerves, and helped the metabolism of fat, calorie increase, and consumption of accumulated fat. Lei reported (1987) that he treated 42 patients with a significance of 73.3% by applying needles

to two acupuncture points, Liang-Qiu and Gong-Sun for 20 minutes and replacing them with intradermal needles; this proved that acupuncture treatment reduced gastric motility and controlled gastric acid secretion.

Though all sorts of efforts have been made to solve obesity problems and control body weight, no good treatment has yet been found to maintain ideal weight and fat without causing side effects. In this study the authors of the article have decided to develop a physical therapy in which electrical stimulus instead of acupuncture is applied to the selected acupuncture points: diet, exercise and the use of medicine are all excluded from the study. The application of TENS to acupuncture points seems to be the first attempt to get the same effect as that of acupuncture. In this study female adults were divided into two groups each of which received TENS with different intensity and frequency at the selected acupuncture points and then fat and weight were checked twice to discover changes.

The writer of the article present a hypothesis that fat rate and body weight can be controlled by applying acupuncture-like TENS to the selected 4 acupuncture points for a set period of time and it can be more effective in reducing the fat rate and body weight than the use of conventional TENS.

Physical therapy for fat loss generally includes acupuncture, manual therapeutics and massage, but the current study exclusively uses acupuncture-like TENS in two limited ways of electrical stimulation.

The originally set standard for adult females with a fat rate over 30% encountered difficulty in finding subjects and was lowered to 25%, including some less than obese.

The daily intake of food and consumption of calories was not examined owing to the difficulties related to the duration and analysis of the test.

METHODS

1. Subjects

Sixteen healthy female adults with a 25% fat rate volunteered to be in the test after hearing a general explanation of the experiment. Through the process of history taking and physical examination 6 persons who were found to be inadequate for some reason were excluded from the test. In order to prevent unexpected accidents, those who conceived or would conceive (the others agreed upon no conception during the experiment) and those who showed the slightest clinical problem were excluded. The test started with 10 subjects finally.

2. Apparatus Used

For the measurement of body fat a bioimpedence measuring instrument was used – its brand name EZ Comp 1500, a Japanese made portable, operated by 9V dry batteries manufactured by 3M. For the measurement of body weight CAS (Korean made) was used, weighing as little as 100gm. For electrical stimulation, a TENS SW 805A portable manufactured by Dongyang Electronics was used, operated by 6V dry batteries. A carbon-filled flexible electrode pad was used.

3. Test Plan and Procedure

(1) Examination of the Subjects

The day before the test started an examination was given in which the height, weight and fat rate of the subjects were measured. To reduce measurement error the sole examiner administered the entire examinations. The fat rate test was given between 10:00 and 11:00 AM and the intake of food and drinks was controlled beforehand to minimize an effect on bioimpedence. Three examinations were given at one month's intervals.

The test procedure was as follows: each time was tested 3 times and the mean values were taken as sample. Height was measured to the mm with a height measuring instrument. Weight was measured to 100gm with a scale and fat rate was measured with a bioimpedence measuring instrument. The contact plates were cleaned with alcohol and dried before use and the electrodes were applied to the wrist and the dorsum of a hand and to the ankle and the dorsum of a foot. The measuring instrument was operated when the subject was in a calm state and the digital values obtained were taken as a sample.

(2) Electrical Stimulation

For electrical stimulation TENS, a physical therapy device, was used and, as for acupuncture points, two Liang-Qiu points and two Gong-Sun points, which are normally used for the reduction of the fat rate in Oriental medicine, were selected. The actual locations of the points are shown in Figure 1. The Liang-Qiu points are located a double length of the middle phalange of finger over the lateral superior margin of the patella and the Gong-Sun points are located in the basal of the first metatarsal bone of the medial side of a foot one length of the middle phalange of a finger in the first posterior metatarsophalangeal joint of the anterior inferior margin (Kim Hyun-Jae et al, 1981). The precise locations of the points were determined by qualified Oriental medical doctors and no measuring instrument was used.

The subjects were randomly divided into two groups: one was given high intensity stimulus in a low frequency of 2Hz with an acupuncture-like TENS and the other moderate intensity stimulus in a high frequency of 60Hz with a conventional TENS. Each treatment was given for 20 minutes between 10:00 and 11:00 AM and was repeated five times a week.

4. Analysis

The data were statistically treated by use of SAS. The repeated ANOVA was performed to examine the significance of changes in fat rate and body weight. The items that showed significant changes were contrast-tested.

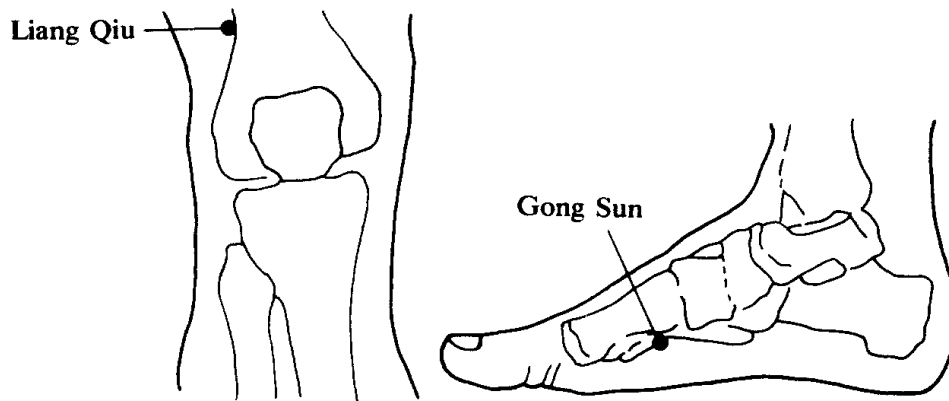


Figure 1. Anatomical locations of the two acupuncture point used in the study

RESULTS

The changes in the subjects fat, weight and water measured by group before the treatment are shown in Table 1 and 2.

Table 1. Fat, body weight and water measurements in Acu-TENS group before treatment

N	Age(y)	Measurement			
		HT(cm)	Fat(%)	BW(kg)	Water(I)
1.	35	158.3	27.6	64.4	30
2.	33	158.0	25.5	56.2	27
3.	32	163.2	28.3	62.0	29
4.	39	159.0	26.7	59.6	27
5.	27	165.0	26.5	53.0	26
\bar{X}	33.2	160.7	26.92	59.04	27.80
SD	4.83	3.19	1.07	4.54	1.64

Table 2. Fat, body weight and water measurements in Con-TENS group before treatment

N.	Age(y)	Measurement			
		HT(cm)	Fat(%)	BW(kg)	Water(I)
1.	31	160.4	33.5	55.6	25
2.	34	160.7	30.6	58.6	27
3.	36	156.0	25.3	65.0	29
4.	36	159.3	34.7	55.2	24
5.	28	158.5	25.3	61.8	30
\bar{X}	33.0	159.0	29.88	59.04	27.00
SD	3.46	1.88	4.44	3.84	2.55

Table 3 and 4 show fat, weight and water measured before the treatment and one and two months after the treatment.

Table 3. Fat(%), body weight(kg) and water(I) measurements in Acu-TENS group

N.	Measurement								
	Fat1	Fat2	Fat3	BW1	BW2	BW3	Wat1	Wat2	Wat3
1.	27.6	25.3	26.5	64.4	63.1	62.8	30	30	30
2.	25.5	25.3	28.1	56.2	55.9	55.2	27	27	26
3.	28.3	27.9	25.8	62.0	59.2	59.2	29	28	28
4.	26.7	25.4	24.1	59.6	58.4	59.4	27	27	26
5.	26.5	22.3	22.2	53.0	51.9	51.5	26	26	26
\bar{X}	26.92	25.24	25.34	59.04	57.70	57.62	27.80	27.60	27.20
SD	1.07	1.98	2.27	4.54	4.15	4.35	1.64	1.52	1.79

Acu-Tens group received acupuncture-like TENS at four acupuncture points.

Table 4. Fat(%), body weight(kg) and water(I) measurements in Con-TENS group

N.	Fat1	Fat2	Fat3	Measurement					
				BW1	BW2	BW3	Wat1	Wat2	Wat3
1.	33.5	32.3	36.2	55.6	56.0	57.0	25	25	25
2.	30.6	30.2	32.8	58.6	58.4	57.4	27	27	25
3.	25.3	28.1	26.5	65.0	63.0	64.2	29	29	29
4.	34.7	32.5	33.0	55.2	54.6	54.1	24	24	24
5.	25.3	27.0	26.2	61.8	61.0	60.6	30	30	30
\bar{X}	29.88	30.02	30.94	59.04	58.60	58.66	27.00	27.00	26.60
SD	4.44	2.46	4.40	3.84	3.46	3.86	2.55	2.55	2.70

Con-TENS group received conventional TENS at the same acupuncture points.

Table 5 shows the fat changes of the two groups by average and standard deviation. Table 6 presents the weight changes of the two groups also by average and standard deviation.

Table 5. Mean and standard deviation of changes between %fat measurement

Group ^a	Measurement			
	Pretreatment Versus 1 month treatment		Pretreatment Versus 2 month treatment	
	\bar{X}	SD	\bar{X}	SD
Acu-TENS	-1.68	1.64	-1.58	2.60
Con-TENS	0.14	2.07	1.06	1.71

^a Acu-TENS group received acupuncture-like TENS at the same acupuncture points; Con-TENS group received conventional TENS at the same acupuncture points.

Table 6. Mean and standard deviation of changes between body weight and measurement

Group ^a	Measurement			
	Pretreatment Versus 1 month treatment		Pretreatment Versus 2 month treatment	
	\bar{X}	SD	\bar{X}	SD
Acu-TENS	-1.34	0.91	-1.42	0.95
Con-TENS	-0.44	0.55	-0.38	1.16

Acu-TENS group received acupuncture-like TENS at the same acupuncture points; Con-TENS group received conventional TENS at the same acupuncture points.

The following show the results obtained by ANOVA. In Table 7 and 8 significant changes of fat ($df=1$, $p<0.05$) are found between the two groups, but no significant changes are found depending on the time of treatment.

Table 7. Repeated Analysis of Variance for fat (%)

Source	DF	Type III SS	Mean Square	F value	Pr>F
Group	1	148.29	148.29	6.34	0.035
Error	8	187.16	23.39		
Month	2	3.06	1.53	0.72	0.504
Group-Month	2	9.12	4.56	2.13	0.151
Error(Month)	16	34.31	2.14		

Table 8. Analysis of Variance of Contrast Test for fat(%)

Source	DF	Type III SS	Mean Square	F value	Pr>F
1:2	1	5.92	5.92	1.71	0.227
Group(1:2)	1	8.28	8.28	2.38	0.161
Error(1:2)	8	27.78	3.47		
1:3	1	0.67	0.67	0.14	0.718
Group(1:3)	1	17.42	17.42	3.61	0.09
Error(1:3)	8	38.64	4.83		

Table 9 and 10 also show no significant weight changes, but, again depending on the time of treatment, significant changes($p<0.05$) are found. A significant weight loss($p<0.05$) is found after the first and second month of treatment. The weight loss after the first month of treatment was statistically more significant.

Table 9. Repeated Analysis of Variance for weight

Source	DF	Type III SS	Mean Square	F value	Pr>F
Group	1	3.13	3.13	0.06	0.805
Error	8	387.38	48.38		
Month	2	5.34	2.67	6.73	0.007
Group-Month	2	1.59	0.79	2.01	
Error(Month)	16	6.34	0.39		

Table 10. Analysis of Variance of Contrast Test for weight

Source	DF	Type III SS	Mean Square	F value	Pr>F
1:2	1	7.92	7.92	14.01	0.005
Group(1:2)	1	2.02	2.02	3.58	0.095
Error(1:2)	8	4.52	0.56		
1:3	1	8.10	8.10	7.22	0.027
Group(1:3)	1	2.70	2.70	2.41	0.15
Error(1:3)	8	8.97	1.12		

In Table 11 and 12, the group treated with acupuncture-like TENS shows significant weight loss ($p<0.01$) after the first and second month of treatment.

Table 11. Repeated Analysis of Variance for weight with Acu-TENS group

Source	DF	Type III SS	Mean Square	F value	Pr>F
Month	2	6.364	3.18	8.87	0.009
Error	9	2.86	0.35		

Table 12. Analysis of Variance of Contrast Test for weight with Acu-TENS group

Source	DF	Type III SS	Mean Square	F value	Pr>F
1:2	1	8.97	8.97	10.91	0.029
Error(1:2)	4	3.29	0.82		
1:3	1	10.08	10.08	11.18	0.028
Error(1:3)	4	3.60	0.90		

Figure 2 and 3 present the mean changes of fat and weight in graphs.

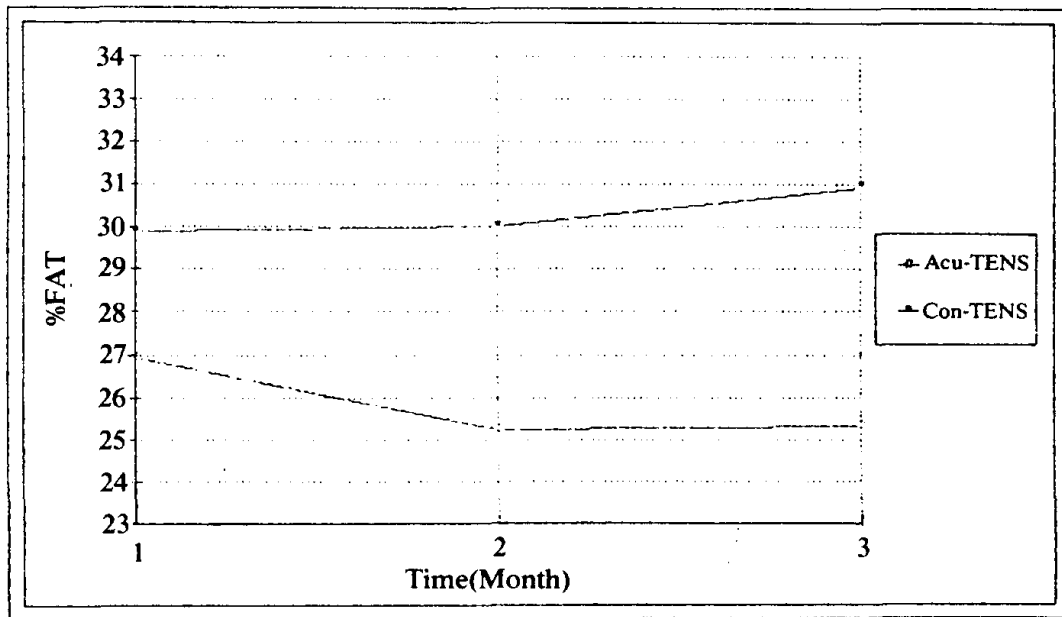


Figure 2. Mean changes in body fat(%) over time for Acu-TENS and Con-TENS groups (\circ = Acu-TENS group ; \bullet = Con-TENS group).

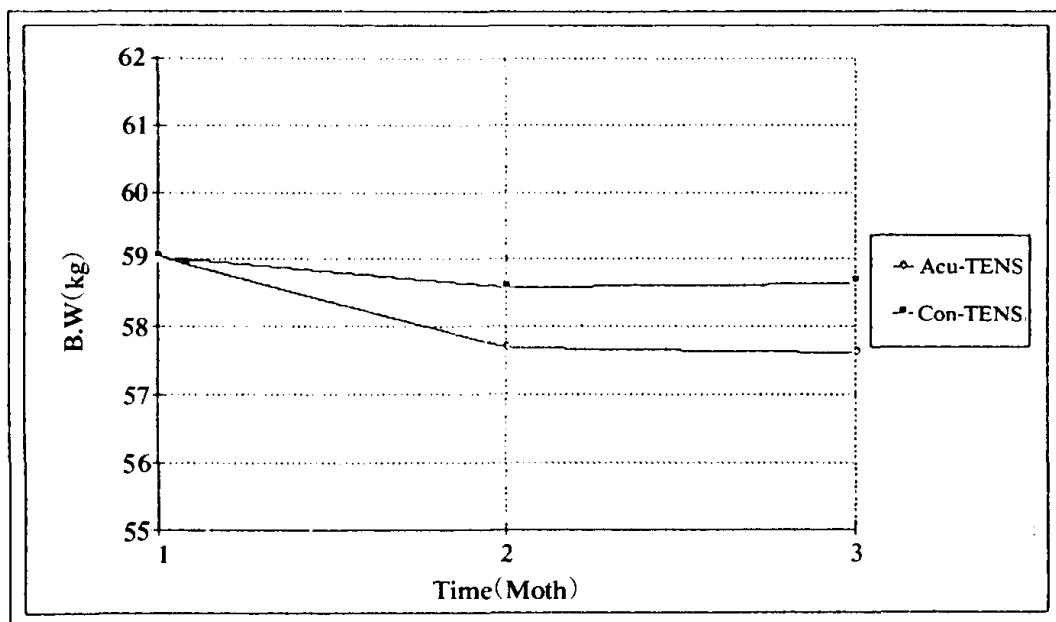


Figure 3. Mean changes in body weight(kg) over time for Acu-TENS for Con-TENS groups (\circ = Acu-TENS group; \bullet = Con-TENS group).

DISCUSSION

Many efforts have recently been made to maintain ideal body fat and weight in a variety of ways : diet, exercise, pharmacotherapy, Surgical operation, and physical therapy. It has been pointed out that the various attempts to reduce excessive fat and weight have not comp up with satisfactory answers as they all have merits and demerits (Brownell et al, 1987).

There are different kinds of treatments and particularly the treatments using stimulation to acupuncture points involve acupuncture, manual threapeutions (Ohasi, 1973), ultrasound therapy (Kohe, 1975 ; Roseman, 1974), laser therapy (Snyder, 1986 ; Kleinkort, 1984: King, 1990), electrical therapy using surface electrodes(Waylonis, 1976; Fox, 1976; Lein, 1989; Longobardi, 1989; Neighbours, 1987), etc. The application of electrical stimulation to acupuncture points by using surface electrodes is solely used in this study. TENS has no infection risk and produces no fear in the subject since needles are not used. It is easy to operate; it can be used even at home (Melzak, 1984; Pomeranz, 1988). TENS gives high intensity stimulus by using a low frequency of 2-4Hz. and the conventional electrical stimulation gives moderate intensity stimulus by using a high frequency of 50-100Hz. These are typical treatments used mainly for pain relief(Ruskin, 1984; Diane, 1986).

The results of this study partially support the following hypothesis: TENS treatment in which high intensity electrical stimulation is applied to selected acupuncture points, Liang-Qiu and Gong-Sun by using low frequency can reduce body fat and weight to a certain degree; the use of low frequency and high intensity TENS is more effective in reducing fat and weight than the use of high frequency and moderate intensity of the conventional electrical stimulation.

There are a couple of factors which make the application of TENS to selectd acupuncture points less effective in reducing body fat and weight than the use of acupuncture needles(Lei, 1987). It is difficult to get a real sense of Qi by use of an acupuncture-like TENS however intense the electric current is, but acupuncture does. Even with a most proper TENS, the subjects will dislike electrical stimulation and it will be difficult to get the same effect as the thin and long Type III nerve fiber does(Pomeranz, 1988). And it is judged that the intensity of electric current used in this treatment may have been inadequate.

A significant difference in fat loss was found between the groups, but no significant difference was found in weight loss. This is hard to explain;

it is judged that the number of subjects was too small and the absorption and consumption of calories was not properly controlled.

It was in the acupuncture-like TENS group that a significant weight loss was found in the conventional TENS group as was expected. It is judged that habituation was formed in the nervous system during the repeated, monotonous, electrical stimulation. This is also hard to explain, but tolerance of the body might have developed to repeated electrical stimulation (Pomeranz, 1988).

It is not clear why there is no significant difference in fat rate owing to the time of treatment. It is reported that a radical weight loss during the first 2 weeks does not mean a fat loss but water balance (Brownell, 1986). Considering Brownell's work, this report and Lei's (1987) argument that the stimulation of the acupuncture points, Liang-Qiu and Gong-Sun, delays gastric emptying and suppresses gastric acid secretion, it is judged that the reduction of body fat a month after the treatment was not so much owing to the effect of absorbed calories as owing to the facilitation of fat metabolism or consumption of accumulated fat as Liu argued (1988). That body weight reduced while fat did not after a month of treatment seems to suggest what is reduced is not fat but water. However, the magnitude of water reduction was so great that precise measurement and analysis was impossible.

Concerning the acupuncture points used in this study, the literature explains that Liang-Qiu is mainly used for the cure of gastritis and gastralgia and Gong-Sun for the cure of gastralgia and both chronic and acute enteritis (Kim Hyun-Jae et al., 1981). However, there is a lack of support to show how the acupuncture points Gong-Sun and Liang-Qiu for the cure of gastrointestinal disorders can physiologically affect fat and weight reduction. It is pointed out that Lei (1987) reported the stimulation of these acupuncture points repressed gastric emptying and gastric acid secretion and Liu (1988) observed the facilitation of fat metabolism, calorie increase, and consumption of accumulated fat. It is still unclear, that reducing the ingestion of food was possible by affecting the stomach directly. It is judged, as Liu (1989) reported, that stimulating functions of hypophysis, adrenal cortex and sympathetic nerve resulted in the facilitation of metabolism of fat and the consumption of accumulated fat.

Therefore, further studies are recommended on the methods of electrical stimulation, selection of acupuncture points, and correct measurements of calories if possible. An improved and more convenient physical therapy physiologically well supported for fat reduction and weight loss should be developed while eliminating all the side effects.

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