

Assessment of BMI in obese patients after semiconductor laser acupuncture therapy

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Background/aim

There is an urgent need to diminish BMI due to the increased prevalence of chronic critical diseases accompanied by overweight and obesity. Laser acupuncture (LA) is a complementary modality that might lower the BMI by diminishing the abdominal and visceral adipose tissue content and influencing the regulation of the lipid metabolism process. It is a painless tool which is almost free from side effects. The aim of the present study is to assess the BMI in obese patients after semiconductor LA therapy.

Patients and methods

This is a randomized clinical trial study that enrolled 111 obese patients who visited the Acupuncture and Laser Clinic, Excellence Medical Centre, National Research Centre, Cairo, Egypt. They received 19 successive LA sessions for 2 months without any intervention concerning their routine lifestyle. Low-level laser irradiation was applied at certain acupuncture points according to the principles of Traditional Chinese Medicine. Laser parameters were wavelength 850 nm, and power density 200 mW. Calculated energy 6 J/cm² for 24 s per acupoints. The anthropometric measurements were done on all participants before and after the end of LA sessions.

Results

The present result indicated that there is a significant decrease in weight ($P < 0.05$), with a percent of changes -5.8% . Additionally, the BMI showed a significant decrease ($P < 0.05$), with a percent of changes -6.1% after 2 months of stimulated LA sessions compared to before laser therapy. Also, more than 15 sessions gave 95% sensitivity, 100% specificity for successful significant response, and the number of LA sessions had a significant good utility in predicting successful responses in weight reduction and BMI management.

Conclusion

The upgrading of the conducted LA sessions had a promising value in different grades of obesity and was safely applicable for BMI management.

Keywords:

acupuncture, BMI, low-power laser, obesity

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Introduction

Obesity proved to worsen the prognosis of coronavirus disease 2019 (COVID-19) patients. The increased BMI may aggravate the symptoms of the disease, leading to hospitalization with a higher mortality rate [1]. Consequently, the increased BMI that resulted in overweight and obesity is a great threat to health, economic, and social stability worldwide. Obesity increases the probability of developing the metabolic syndrome (hypertension, hyperlipidemia, diabetes mellitus), and cardiac diseases such as myocardial infarction, heart failure, and malignancy. Any of these diseases are accompanied by an increased death rate in COVID-19 cases [2]. However, the impact of obesity on COVID-19-infected patients is controversial in literature. Many studies showed no correlation between obesity and deterioration of COVID-19 cases [3].

The BMI is usually performed to obtain the outcome of the nutritional status of the patients. BMI is a simple way to identify overweight and obesity. It is calculated by dividing the weight in kilograms by the square and the height in meters. Patients having a BMI higher than 25 and less than 30 are considered overweight. BMI, which is more than 30, indicates obesity, which is classified into three classes (first from 30 to 35, second from 35 to 40, and third above 40) [4]. Obesity leads to the death of four million people worldwide because of its cardiovascular complications. Five percent of children and 12% of adults have obesity globally [5].

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Obesity is caused by hormonal disturbances, sedentary life, and foods high in calorie. The increased consumption of saturated fats from animal sources, white bread, white flour, high-sugar beverages, and processed foods causes obesity. A balanced diet regime and a physically active pattern of life are essential for controlling obesity. Medications and even surgery may be needed in some cases [6].

The American Food and Drug Administration approved five medications for obesity management. However, orlistat is the only one available globally [7]. Also, all these medications fail to decrease body weight by more than 5% in most cases [8]. They are frequently associated with many side effects, such as diarrhea, vertigo, headache, nausea, vomiting, inverted sleep rhythm, hypertension, and even cardiovascular diseases [7,9]. New antiobesity medications are under trials and seem to be promising, but not yet approved [9].

Recently, laser acupuncture (LA) treatment of obesity showed good results but lacked comparative studies due to different laser parameters applied [10]. LA is a technique used to stimulate acupoints with low-power laser light instead of the traditional needles. Laser is painless and safe and preferred over needles by many patients [11]. LA action is transmitted via the afferent fibers to the central nervous system, then, in turn, activates both the hypothalamus and limbic system. Therefore, the appetite center in the hypothalamus could be regulated [12].

LA efficiency is not restricted to obesity treatment but may also manage symptoms accompanied by obesity, such as constipation, heavy body sensation, and menstrual cycle disorders. During laser sessions, patients are educated concerning diet regimes, suitable exercise, and healthy patterns of life. LA exerts its therapeutic effect through actions on various biochemical markers such as leptin and ghrelin. Laser also adjusts lipid, glucose metabolism, insulin sensitivity, and inflammatory markers [13]. Therefore, the benefits of LA may be better than the weight loss diet regime [14]. However, evaluating the beneficial effect of LA is still challenging due to the deficiency of high-quality clinical trials with sufficient treatment sessions, so the aim of the present study is to assess the BMI in obese patients after semiconductor LA therapy.

Patients and methods

Patients

This interventional randomized clinical trial study was conducted at Acupuncture and Laser Outpatient

Clinic, Medical and Scientific Center of Excellence, National Research Centre, Cairo, Egypt. In this clinical trial, we recruited 111 patients, ages range from 15–18, with calculated BMI more than 25.0. The exclusion criteria included patients who received anti-inflammatory steroid therapy and medications for hypercholesterolemia, diabetic patients, patients with chronic digestive disorders more than 3 months (diarrhea, constipation, and gastritis), abnormal kidney or liver functions, and pregnancy were also excluded from the study. Finally, cases who performed regular exercise at least two to three times per week (30–45 min each session) or who had contraindications to LA were also excluded.

Study design

Patients had received successive laser acupuncture sessions over the 2 months study period, with a frequency of two sessions per week. The anthropometric measurements were done on all patients precompletion and postcompletion of the LA sessions.

Ethical considerations

This study was considering the ethical rules for the medical research involving human participants according to the Declaration of Helsinki in 1964 and was reviewed and approved by the Ethical Committee of the National Research Centre, Cairo, Egypt, with approval number 01431223. All participants signed a written illustrative and informed consent prior to their inclusion in the study.

Anthropometric measurements

Body weight and height were measured, following the recommendations of the 'International Biological Program' [6]. Body weight was determined to the nearest 0.01 kg using a Seca Scale Balance, with the participant wearing minimal clothes and no shoes. Body height was measured to the nearest 0.1 cm using a Holtain portable stadiometer. BMI=weight (in kg) divided by height (m²), was calculated. Four categories of BMI of the study population were tabulated in Table 2 according to the WHO issued guidance about BMI [4].

Acupuncture points

The stimulated acupoints were used according to the principles of Traditional Chinese Medicine and the recommendations of evidence-based studies of the management of obesity and overweight with acupuncture [15]. The body acupoints used were ST25 (Tianshu), SP15 (Daheng), bilateral Quchi (LI11), bilateral ST36 (Zusanli), bilateral Sanyinjiao

(SP6), Guanyuan (CV4), and Zhongwan (CV12). In addition to the Shen Men (TF4) auricular acupuncture point that was applied with routine ear-pressing plasters (Vaccaria ear seeds; Beijing Zhongyan Taihe Medicine, Beijing, China). After sterilizing the acupoints with 75% alcohol preparation pads, the acupuncturist inserted the ear-pressing plaster with the seed into the acupoints on a single ear alternatively during the two sessions per week thus to be kept on the ear for 3 days. All participants were requested to apply pressure to the auricular points before eating.

Laser acupuncture session

LA was directed to each body acupoint continuous wave's 200 mW power density, and 6 J/cm² for 24 s per acupoint with wavelength 850 nm. The participating group had received direct contact low-level LA therapy for a maximum 19 sessions with a frequency of two sessions per week. Laser-protection goggles were asked to be worn during each session. There was no reported adverse effect due to laser irradiations.

Statistical analysis

Data were gathered, authenticated, encoded, and analyzed using the Statistical Package for the Social Sciences (SPSS), version 22. (SPSS Inc., Philadelphia, Pennsylvania, USA). The mean and SD were presented for continuous variables. The independent *t* test was used to compare quantitative data between the two groups. While qualitative data is described as numbers and percentages and then compared using χ^2 test. Pearson's correlation analysis was used when looking at the relation between two quantitative variables within the same group. The variables that had the greatest effect on inflammatory mediators between cases were identified using multiple linear regressions. The level of statistical significance for all tests was set at *P* value less than 0.05. The percent of

Table 1 Demographic characteristics of obese cases

Variables	
Age (year)	16.3±0.7
Sex	
Male	23 (20.72)
Female	88 (79.28)
Height (m)	1.628±0.073

Data expressed as mean±SD and *n* (%).

change between two values has been done using the formula: (treated–control/control)×100.

Results

The present study enrolled 111 obese participants in age range of 15–18 years old. Demographic data is shown in Table 1. The majority of the study populations were female 79.28%, while the male were 20.72%, with mean height 1.628±0.073 m, weight 99.49±22.67 kg, and BMI 37.50±7.80 kg/m². More than 1/3 of cases had morbid obesity and half of cases with class I (*n*=33) and class II (*n*=23) obesity, while cases that were enrolled in class III were 38 cases.

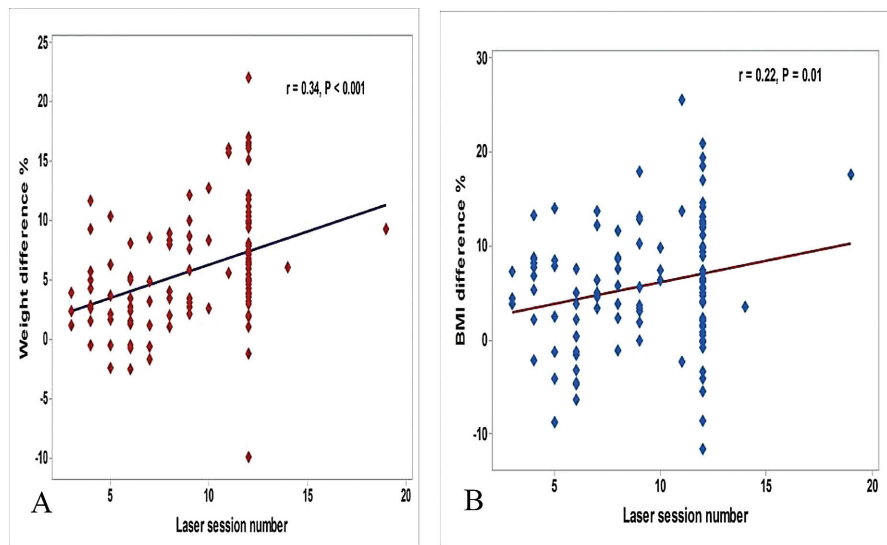
The anthropometric measurements in obese patients before and after 2 months of LA sessions were reported in Table 2. The weight of obese cases after LA therapy exhibited significant decreases (*P*<0.05) than the weight of cases before laser therapy (93.69±22.03 vs. 99.49±22.67 kg/m²), with a percent of change –5.8% reduction. Additionally, the BMI showed significant decreases (*P*<0.05) than the BMI of obese cases before therapy (baseline) (35.23±7.33 vs. 37.50±7.80 kg/m²), with a percent of change –6.1% reduction. Moreover, the frequency of obesity classes showed significant changes (*P*<0.05) after the completion of the 12 successive LA sessions. Furthermore, more than 1/3 (37.84%) of cases responded well during the study duration, as shown in Table 2.

Table 2 BMI in obese patients before and after 2 months of laser acupuncture therapy

Variables	Before laser therapy (baseline)	After laser therapy
Weight (kg)	99.49±22.67	93.69±22.03*
Change difference (%)		–5.8
BMI (kg/m ²) [#]	37.50±7.80	35.23±7.33*
Change difference (%)		–6.1
Obesity classes**		
Overweight	17 (15.32)	26 (23.42)
Obesity class I	33 (29.73)	32 (28.83)
Obesity class II	23 (20.72)	29 (26.13)
Obesity class III	38 (34.23)	24 (21.62)
Weight reduction response		42 (37.84)

Data expressed as mean±SD and *n* (%). *Significant difference than before treatment at *P* value less than 0.05, using *t* test. **Significant difference than before treatment at *P* value less than 0.05, using χ^2 test.

Figure 1



Pearson's correlation between percentage of changes differences in weight (a) and BMI (b) after two months of therapy with the number of laser acupuncture sessions.

Table 3 Utility of laser session number in perdition of successful weight reduction

Cutoff	Sensitivity (%)	95% CI	Specificity (%)	95% CI	PPV (%)	NPV (%)
11.5	64	0.4803–0.7845	67	0.5429–0.7756	30	89
15.5	95	0.005820–0.1616	100	0.9479–1.000	100	83

PPV, positive predictive value; NPV, negative predictive value.

The minimum number of recorded LA sessions in the study duration was three successive sessions, while the maximum number was 19 sessions. Successive upgrades in laser stimulation of acupuncture points led to remarkable cumulative effects, resulting in significant control of BMI. However, Pearson's correlation between the change difference percent in weight and BMI were significantly positive with the number of LA sessions ($r=0.190$, $P=0.030$ and $r=0.220$, $P=0.010$, respectively), shown in Fig. 1.

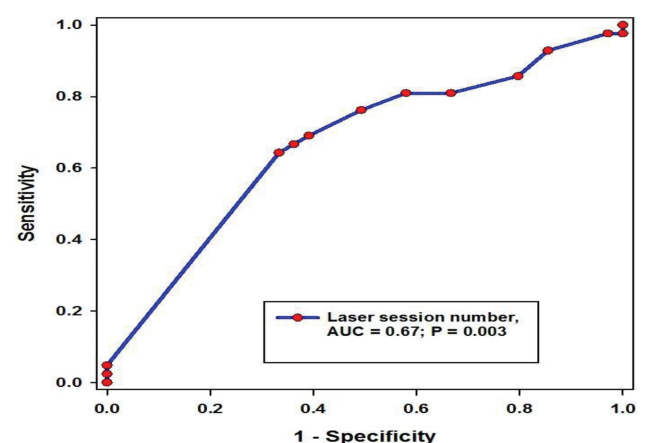
At cut-off point more than 11 sessions, the sensitivity and specificity 64 and 67%, respectively. However, more than 15 sessions gave 95% sensitivity, 100% specificity, and positive predictive value for a successful significant response (Table 3). The number of LA sessions had a significant utility in predicting successful response in weight reduction, the area under the curve=0.670, $P=0.003$ (Fig. 2).

Discussion

This interventional study enrolled 111 overweight and obese patients. They were subjected to laser body acupuncture. A significant reduction in body weight

and BMI had been detected. The mechanism of action of LA in the management of obesity was controversial. However, many studies showed that it has the same mode of action as needle acupuncture. All participants signed a written illustrative and informed consent prior to the study. All participants signed a written illustrative and informed consent before the study [16,17].

Figure 2



ROC curve of laser session number in predicting successful weight reduction response. ROC, receiver operating characteristic.

MRI has demonstrated that LA stimulates centers in the brain that boost the body's metabolism [18]. Von Deneen *et al.* [19], proved that acupuncture affects many neurophysiological pathways, such as dopaminergic signaling. Acupuncture also increases the secretion of satiety hormones and the basal metabolic rate.

Furthermore, LA was reported to induce the formation of several temporary pores in the adipocytes enhancing apoptosis leading to release of lipids [20]. LA can also affect the gene expression in the adipocytes inducing changes in their morphology [21,22]. These changes stimulate the mitochondria to increase cyclicadenosine monophosphate and adenosine triphosphate synthesis. Thus, lipase enzyme is activated and triglycerides are broken and converted into fatty acids and glycerol [23].

Consecutively, LA might be suggested to suppress the production of ghrelin hormone, leading to a decrease hunger sensation [24]. Additionally, it can reduce blood glucose and insulin resistance [24,26]. Thus, leading to increase of insulin sensitivity resulted in reduction of several inflammatory cytokines such as interleukin 1, interleukin 8 and tumor necrosis factor. Meanwhile, the improvement of insulin sensitivity facilitates weight reduction [27–29].

Agouti gene-related protein is a peptide hormone expressed in the arcuate nucleus of the hypothalamus. Its release was increased during fasting, inducing hunger and leading to obesity. Stimulating acupuncture points ST36 and LI11 decreases both appetite and body weight through the inhibition of agouti gene-related protein expression in obese rats [30].

Since, cholecystokinin is secreted from the gastrointestinal system and transmitted to the brain through the vagus nerve. Therefore, activation of cholecystokinin had resulted in decreased appetite and weight reduction [31], which could be achieved by applying acupuncture sessions to ST40, CV12, and CV4 [32]. Moreover, stimulating the abdominal acupoints (ST25, CV4, and CV12) and lower limbs acupoints (ST36 and ST40) was observed to decrease weight by increasing serum cholecystokinin and decreasing leptin [33].

Concerning auricular needle acupuncture, it was found that stimulating specific ear acupoints may induce action potentials in the hypothalamic ventromedial nucleus of the hypothalamus which inhibit hunger sensation. Auricular acupuncture might decrease neuropeptide Y which increases the desire to eat and delays satiety. Keeping on, it increases the basal

metabolic rate by enhancing a sympathomimetic effect. It helps in weight reduction through increasing insulin sensitivity and combating inflammatory cytokines same as laser body acupuncture [34].

Low-power laser has been approved by the Food and Drug Administration as a safe, painless, noninvasive modality to treat simple generalized and localized obesity [35]. However, there is marked variations of power, energy and frequency of laser sessions applied in the literature. In many research papers, laser parameters used are not mentioned. We used GaAlAs laser with 850 wavelength, continuous wave, 200 mW power and 6 J were applied on each acupoint with frequency two times per week. Sebayang *et al.* [36] used lower power (50m W) than we applied plus lower energy over each point (4J). However, they did not mention the wavelength of their laser device. They concluded that LA is statistically more effective in reducing weight when combined with diet regime than diet intervention alone. We tried higher joule in our study because world association of laser therapy recommended that low-power laser is safe whatever the energy applied as long as we exclude the cases where laser should be contraindicated [37].

Woźniak *et al.* [38] proved also that combining LA with a low calorie diet was more effective in decreasing body weight, BMI, and waist hip ratio than low caloric diet alone in menopausal women. On the contrary, El-Mekawy *et al.* [16] and Hassan *et al.* [39] showed no improvement statistically in group of patients receiving LA and calorie-restricted diet over those on diet only concerning weight, BMI, and waist hip ratio. This may be due to very low caloric diet given to all the patients included in the study who were classified as class II obesity.

All the previous studies including ours, did not have a control group where cases are exposed to sham laser. In the literature, many trials had been performed including control groups. Tseng *et al.* [17] showed that LA decreased body weight, BMI, waist circumference, waist hip ratio when compared with sham laser (control group). However, no two groups Tseng *et al.* [17], also recorded that LA suppress the appetite by increasing fullness sensation and decreasing the feeling of hunger.

Hung *et al.* [25] concluded that BMI and free fat mass decreased in the group receiving low-level LA therapy compared with the control group exposed to sham laser after about 3 weeks of treatment. Laser was given five sessions per week (total of 15 sessions). In our study,

BMI showed significant decrease after the same period of time. However, we gave two sessions per week and improvement was detected after session 11 in the third week. Reduction of weight was more significant when period of time was extended. Patients given 19 sessions (over 6 weeks) showed better results.

On the contrary, Liu *et al.* [40] showed that LA showed no improvement over sham laser. They applied 24 LA sessions with no significant body weight and BMI improvement over the sham group. This negative result may be due to stimulation of only two acupoints (ST25 and SP15). We conducted the laser device over 11 acupoints according to the traditional Chinese medicine guidelines [41].

In literature, many published articles demonstrated the efficiency of auricular acupuncture in management of overweight and obese patients, whether used alone or combined with laser body acupuncture as in this trial. A systemic review and meta-analysis of randomized controlled trials recorded a significant reduction in weight, BMI, body fat and waist circumference. All these parameters showed a 95% confidence interval [42–46].

Conclusion

In conclusion the cumulative influence of the successive conducted LA sessions showed a promising value in reducing body weight and BMI. However, further studies with different low-level LA parameters should be performed.

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Nil

Conflicts of interest

There are no conflicts of interest.

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