Acupuncture in the treatment of obesity: a narrative review of the literature

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ABSTRACT

Obesity is one of the leading health risk factors worldwide and is associated with several other risk factors and health problems including type 2 diabetes mellitus, cardiovascular disease and malignancies. Current conventional therapeutic strategies for obesity cannot achieve adequate weight control in all patients, so complementary types of treatment are also performed. Acupuncture, one of the oldest healing practices, represents the most rapidly growing complementary therapy which is recognised by both the National Institutes of Health and the WHO. A previous review concluded that acupuncture was superior to lifestyle advice, to sham acupuncture and to conventional medication. In this narrative review, the possible mechanisms of actions and the results of recent experimental and clinical studies with different forms of acupuncture (eg, body, auricular, manual and electroacupuncture) are presented. In particular, the effects of acupuncture on anorexigenic and orexigenic peptides, insulin resistance, lipid metabolism and inflammatory markers are discussed. Both experimental and clinical current data suggest that acupuncture exerts beneficial effects on the mechanisms of obesity. Some data suggest that electroacupuncture may be more effective than manual acupuncture; however, the most effective frequency remains controversial. Combination of different forms of acupuncture with diet and exercise seems to be necessary for achieving and maintaining weight loss. Further prospective clinical trials are needed to establish the effectiveness of this complementary method for obesity treatment.

INTRODUCTION

The prevalence of obesity is rapidly increasing worldwide, even in developing countries where it coexists with childhood malnutrition. Obesity is one of the leading health risk factors globally, since 1.1 billion people (>10% of the world population) are classified as overweight.[1–3] Furthermore, obesity is associated with several other risk factors and health problems including insulin resistance, hyperinsulinaemia, type 2 diabetes mellitus, hypertension, dyslipidaemia, coronary heart disease, gallbladder disease and certain malignancies.[4]

Current conventional therapeutic strategies for obesity (ie, diet, physical exercise, drugs and bariatric surgery) cannot achieve adequate weight control in all patients. Complementary types of treatment are therefore being tested and, in this context, acupuncture is one of the most rapidly growing complementary therapies. In the USA, the National Institutes of Health consensus panel recommends acupuncture as a useful clinical procedure and thus created the National Center for Complementary and Alternative Medicine with the object of integrating complementary therapies into mainstream clinical practice.[5 6] Acupuncture is among the oldest healing practices in the world.[5] It exerts its effect through the insertion of thin metallic needles at specific points on the body that can be manipulated manually or by electrical stimulation. The WHO suggests the application of acupuncture to a wide range of conditions including musculoskeletal diseases, neurological disorders, gynaecological disorders, addictions and dentistry.[7]

Contemporary evidence suggests that the neurophysiological effect of acupuncture seems to be exerted by CNS activation which is essential for autonomic nervous system modulation and consequently neuroimmune and hormonal regulation.[8 9]

Based on these mechanisms, experimental and clinical observations suggest a role for acupuncture in treating metabolic abnormalities as well. Thus, the use of acupuncture has been suggested as a possible alternative treatment method for obesity, which represents a major metabolic disorder.[10 11]

A previous review found evidence of effectiveness of acupuncture on loss of body weight. In the present review the possible mechanisms of actions and the results of recent experimental and clinical studies with different forms of acupuncture (eg, body, auricular, manual and electroacupuncture (EA)) are presented.

SEARCH METHODS

We searched MEDLINE (up to 1 March 2011) for relevant publications using combinations of the following keywords: acupuncture, EA, auricular acupuncture, obesity treatment, insulin resistance, lipids, leptin, ghrelin, neuropeptide Y (NPY), body weight, inflammatory markers, animal studies and clinical trials. We also examined the reference list of articles identified by this search strategy and selected those we judged relevant, according to our keywords.

Several studies were located that were published in Chinese with English language abstracts. We excluded studies where we could not extract sufficient data from the English abstract since our resources did not include translation from Chinese. Considering the volume of literature, we did not perform formal quality assessment.

POSSIBLE MECHANISMS OF ACTIONS FOR ACUPUNCTURE

According to both animal and clinical studies, several mechanisms involved in body weight regulation and obesity may be influenced by acupuncture. The results of these studies will be further presented in the relevant section.

Anorexigenic and orexigenic peptides

The hypothalamic arcuate nucleus (ARC) responds to satiety and hunger signals, forming the origins of the central neural response to alterations in energy balance.[12] ARC contains at least two populations of neurons that have opposite influences on food intake: one population expresses the anorexigenic peptides α-melanocyte-stimulating hormone (α-MSH), derived from pro-opiomelanocortin, and the cocaine and amphetamine-regulated transcript (CART) peptide, whereas the other population expresses the orexigenic peptides NPY and agouti-related peptide (AgRP). Neurons in the ARC innervate various other hypothalamic targets that express melanocortin and NPY receptors.[10 13–15]

Furthermore, there are certain hypothalamic nuclei that regulate satiety and hunger such as the hypothalamic ventromedial nucleus (a satiety centre) and the lateral hypothalamus (a hunger centre).[16]

Apart from neuropeptides, peripheral peptides are also involved in the regulation of the hypothalamic neurons, and consequently in the control of food intake and energy expenditure, such as leptin and ghrelin.[16] Leptin is a peptide secreted by adipose tissue that effectively reduces hyperphagia and obesity by inhibiting the expression of NPY and by enhancing the expression of α-MSH in the hypothalamus.[14] Obesity is associated with elevated circulating leptin levels, a finding that implies the presence of leptin resistance in obese individuals.[14] Ghrelin is a growth hormone secretagogue, predominantly synthesised in the stomach, that increases AgRP and NPY expression in the hypothalamus and blocks leptin-induced feeding reduction, subsequently leading to increased food intake and body weight.[16]

Of note, a part of the cavum conchae is innervated by the auricular branch of the vagal nerve[17] which is stimulated in order to achieve a degree of appetite suppression.[18]

Glucose metabolism and insulin resistance

Obesity, mainly the central or visceral type, is a predisposing factor for the development of insulin resistance and type 2 diabetes mellitus. Furthermore, relationships between visceral obesity, increased free fatty acids and insulin resistance have been reported.[19] Thus, lowering plasma free fatty acid levels may positively affect insulin sensitivity. Of note, progressive reductions in plasma insulin growth factor-1 (IGF-1) levels are involved in obesity-related insulin resistance and increased insulin secretion.[20] Therefore, any intervention that increases IGF-1 levels may lead to improved insulin sensitivity.

In overweight and obese individuals, weight loss and especially decreases in intra-abdominal adipose tissue may improve insulin sensitivity.[21] Serotonin-induced secretion of β endorphin from the adrenal gland may stimulate the opioid receptor in peripheral muscle to increase peripheral glucose utilisation, resulting in decreased plasma glucose levels.[22] Stimulation of cholinergic nerves may also reduce plasma glucose levels[23] and improve insulin resistance.[24]

Effects on lipid metabolism

Obesity is characterised by atherogenic dyslipidaemia—that is, elevated levels of low-density lipoprotein cholesterol (LDL-C) and triglycerides and decreased levels of high-density lipoprotein cholesterol (HDL-C).[25] These lipid disorders significantly increase the cardiovascular risk of obese individuals and should be effectively treated.

Dietary fat-induced β endorphin secretion from the hypothalamus is related to the hedonic preference and ingestion of fat.[26] Thus, the induction of β endorphin secretion independently of meals may lead to a

healthier low-fat diet and consequently to an improved lipid profile.

Inflammatory markers

Obesity is associated with low-grade inflammation resulting from chronic activation of the innate immune system, which can subsequently lead to insulin resistance, impaired glucose tolerance and type 2 diabetes mellitus. Furthermore, obese patients have increased levels of several inflammatory markers that are associated with an elevated vascular risk.[27] In obesity, white adipose tissue produces inflammatory molecules including tumour necrosis factor α (TNFα) and interleukin 6 (IL-6), both of which can alter insulin sensitivity by triggering different key steps in the insulin signalling pathway.[28] In contrast, in obesity the production of adiponectin from the white adipose tissue is downregulated.[28] As adiponectin exerts anti-inflammatory, antiatherogenic and insulin-sensitising properties,[29] obesity-related hypoadiponectinaemia further enhances inflammation, atherosclerosis and insulin resistance in obese individuals.

There are several anti-inflammatory pathways: (1) the humoral pathway targeting macrophages in the inflammatory area, enhancing the production of anti-inflammatory cytokines such as IL-10 and increasing anti-inflammatory hormone levels such as glucocorticoids; (2) the β endorphin pathway; (3) the norepinephrine pathway; and (4) the most recently discovered cholinergic pathway, a neural mechanism that suppresses the innate inflammatory response via the acetylcholine-induced suppression of cytokine synthesis;[30] activating this pathway by nicotine in both genetically obese and diet-induced obese mice significantly improved glucose homeostasis and insulin sensitivity via suppression of adipose tissue inflammation without changes in body weight.[31]

ANIMAL STUDIES

Experimental evidence suggests that acupuncture has multifaceted favourable effects on obesity such as weight loss,[32–45] regulation of obesity-related peptides,[32–50] reduction of insulin resistance[35 38 39 40 48 51 52] and improvement of the lipid profile.[35 38 39 40 48 51 52] Overall, EA is the method most widely used in experimental studies[32 33 35–41 45 48 51–53] as its parameters can be precisely characterised and the results are more or less reproducible. The impact of acupuncture on obesity has been investigated mainly in rats, with the exception of a recent study on mice.[51]

Effects on body weight

The majority of studies located by our search concluded that both acupuncture[34 42–44] and EA[32 35 37–41] were effective in reducing body weight in obese rats. Acupuncture influences the levels of neurotransmitters in the CNS and results in significant body weight reduction.[34 42–44] With regard to EA, the results concerning the ideal frequency of stimulation are conflicting: one study found that 100 Hz EA had a greater effect on obesity than 30 Hz EA[40] while another study concluded that 2 Hz EA was more effective than 100 Hz EA.[32] These major discrepancies could be attributed to the different study design, selected acupuncture points and duration of the two studies. In addition, three studies reported weight reduction after EA in rats that were not initially obese.[33 36 45] In one study 2 Hz EA administered once every other day in lean rats subjected to long-term food restriction produced additional reduction in body weight,[33] in a second study 100 Hz EA applied to ad libitum fed normal rats decreased food intake and body weight,[36] and in a third study 100 Hz EA resulted in weight loss (−3.3%) and suppression of abstinence syndrome in rats rendered dependent on morphine while 2 Hz EA did not.[45]

On the other hand, body weight did not change in a rat polycystic ovary syndrome (PCOS) model characterised by insulin resistance and adiposity following 2 Hz EA for 4–5 weeks.[48 52] Similarly, abdominal EA did not induce weight loss in *Psammomys obesus*, a model of insulin resistance and non-insulin-dependent diabetes mellitus,[53] but these results could be attributed to the short duration of the intervention (5 days). Finally, in a recent study, 3 Hz EA administered for 8 consecutive weeks in obese diabetic mice did not reduce body weight, although body mass gain and food intake decreased in the EA group.[51] Therefore, acupuncture may be less effective in lowering body weight in experimental models that combine obesity and insulin resistance.

Effects on obesity-related peptides

The favourable effects of acupuncture on body weight in obese rats are attributed to its positive regulatory action on neurotransmitters in the CNS and especially in the hypothalamus. It is generally accepted that acupuncture acts on the satiety centre situated in the hypothalamic ventromedial nucleus[34 43 46 47] and increases its electrical activity. Acupuncture also seems to influence the feeding centre in the lateral hypothalamic area,[34 44 47] but its effects there are less clear. In particular, auricular acupuncture was reported to either suppress[47] or not affect the neuronal activity of the lateral hypothalamus[34] whereas another study concluded that acupuncture increased the activity of the lateral hypothalamic area.[44] These discrepancies may be partly explained by differences in the selected acupuncture points, the techniques used to record the central nervous activity or the duration of the intervention. Finally, it is suggested that a regulatory action on serotonin and its metabolism in the raphe nuclei is one of the possible mechanisms for weight reduction by acupuncture.[42]

Experimental data suggest that EA can upregulate the expression of obesity-related peptides in the

hypothalamus, decrease food intake and induce weight loss.[32 33 37 41] When EA was administered three times per week for 4 weeks in obese rats, increased expression of the anorexigenic peptides α-MSH[41] and CART peptide[32] was observed in the hypothalamic ARC. Furthermore, 2 Hz EA applied to lean rats subjected to long-term food restriction resulted in downregulation of the orexigenic peptides NPY (in ARC) and ghrelin (in the stomach).[33] Another study reported that, after treatment with EA for 15 consecutive days, the expression of obestatin (an anorexigenic peptide) was increased in the hypothalamus of obese rats.[37] Finally, a recent study concluded that 2 Hz EA treatment acted through ARC to significantly inhibit food intake and body weight gain in rats fed a high-fat diet and that the stimulation of α-MSH expression and release might be involved in the mechanism.[49]

With regard to leptin, 100 Hz EA applied to non-obese rats for 4 weeks produced a significant increase in leptin levels.[36] In contrast, EA was shown to reduce leptin levels, in parallel with its weight loss effect, in experimental models of obesity.[35 38 40] Furthermore, when EA or sibutramine were administered using a rat obesity model, serum leptin levels decreased more in the EA group than in the sibutramine group.[35] Since obesity is characterised by hyperleptinaemia and leptin resistance, the EA-induced reduction of circulating leptin levels in obese rats may exert a beneficial effect on leptin regulation. Of note, low frequency EA applied to PCOS rats for 4–5 weeks restored leptin expression in visceral adipose tissue without affecting serum leptin levels.[48] In a recent study, EA treatment led to a decrease in the plasma leptin levels and an increase in leptin receptor expression in the hypothalamus in diet-induced obese rats.[50]

Effects on glucose metabolism and insulin resistance

Apart from leptin, insulin levels may also be affected by EA in obese rats and mice.[35 38–40 48 51–53] Insulin sensitivity, as determined by euglycaemic hyperinsulinaemic clamp, was normalised in PCOS rats after 2 Hz EA stimulation for 5 weeks.[48 52] Four other studies reported decreased serum insulin levels after EA treatment in obese rats.[35 38–40] Furthermore, 3 Hz EA for eight consecutive weeks in diabetic and obese mice resulted in a beneficial effect on insulin resistance established through the intraperitoneal insulin tolerance test.[51] EA was shown to increase IGF-1 concentrations[48] and influence intracellular signalling pathways in the muscle[52] that may, at least in part, account for the marked improvement of insulin sensitivity in these studies.

In contrast, abdominal EA in diabetic and obese rats, although inducing a sustained hypoglycaemic effect, did not influence insulin levels compared with EA in non-specific points.[53]

Moreover, in experimental models of diabetic rats, EA was shown to regulate blood glucose levels by increasing insulin sensitivity,[54 55] inducing secretion of β endorphin[56 57] or stimulating cholinergic nerves.[23 24] Regarding insulin resistance, EA has been reported to improve insulin sensitivity via several mechanisms (eg, lowering plasma free fatty acid levels,[24 58] increasing plasma IGF-1 levels or stimulation of glucose transport in skeletal muscle independently of insulin).[59 60]

Effects on lipid metabolism

Another important impact of EA is the improvement of lipid parameters.[44 38–40 52] When EA and diet were applied in obese rats for 15 days, total cholesterol and free fatty acid levels decreased significantly.[52] Furthermore, EA was more effective than sibutramine in reducing total cholesterol, triglycerides and LDL-C concentrations.[35] Interestingly, high-frequency EA was reported to restore abnormal lipid metabolism[38 40] more effectively than low-frequency EA.[40] Low-frequency EA was shown to lower LDL-C and HDL-C in PCOS rats,[52] whereas it had no significant effect on total cholesterol and triglycerides in obese diabetic mice.[53] Of note, in hypercholesterolaemic mice, EA was reported to reduce cholesterol levels and regulate the expression of various genes directly involved in cholesterol metabolism.[61–63]

Effects on inflammatory markers

EA was shown to restore the expression of adipose tissue genes such as leptin, IL-6 and uncoupling protein-2 which are associated with insulin resistance, obesity and inflammation in rats with PCOS.[48] EA plus diet adjustment can also decrease the levels of serum TNFα.[39]

CLINICAL STUDIES

The usefulness of acupuncture in treating obese patients has been studied over recent decades.[64] A meta-analysis of 29 randomised controlled trials with different types of acupuncture by Cho *et al*[11] found that acupuncture was associated with significant body weight reductions compared with lifestyle measures, placebo or sham treatments and conventional medication (average weight reduction with acupuncture 1.72 kg (CI 0.50 to 2.93) vs lifestyle measures; 1.56 kg (CI 0.74 to 2.38) vs placebo or sham treatments and 1.90 kg (CI 1.66 to 2.13) vs conventional medication, respectively). Nevertheless, this meta-analysis included Chinese studies and a quality assessment conducted within the study found that the quality was poor in two-thirds of studies.

A systematic review of the use of Chinese medicine and acupuncture for the treatment of obesity was published recently and included 44 trials on acupuncture treatment.[64] The reviewers concluded that acupuncture was more effective than placebo or lifestyle

Table 1 Clinical studies of manual acupuncture for obesity

Study	n	Experimental and control groups	Measured variables	Results
Sun and Xu[66]	161	Acupuncture Herbal supplement (active controls)	▶ BW ▶ Circumference of chest, abdomen, arms and legs ▶ Appetite ▶ Sleep ▶ Bowel movement ▶ TC, TG and HDL-C	Acupuncture group significantly better for BW reduction (p<0.001) but also decreased appetite, TC and TG
Mazzoni *et al*[67]	40	Acupuncture (n=20; 12 dropped out) Sham acupuncture (minimal acupuncture and somatic moxibustion) (n=20; six dropped out)	▶ BMI ▶ Eating attitudes (BES) ▶ Anxiety (STAI) ▶ Depression (BDI) ▶ Obesity-related quality of life (ORWELL 97)	Non-significant difference in BMI and obesity-related quality of life. Acupuncture group: improvement in anxiety and depression
Wang[68]	120	Acupuncture Diet tea+diet	▶ BMI	BMI reduced significantly in the acupuncture group (p<0.05) compared with the diet group
Wozniak *et al*[69]	69	Acupuncture+low calorie slimming diet (n=36) Low calorie slimming diet (n=33)	▶ Mean BW ▶ BMI	Significant differences in both parameters (p<0.01) in favour of the combination group
Nourshahi *et al*[70]	27	Diet+exercise+acupuncture Diet+exercise Control	▶ BW ▶ Skin fold thickness ▶ BMI ▶ Fat mass	Significant decrease (p<0.05) in BMI and fat mass in both intervention groups compared with control group No significant differences between intervention groups regarding lean body mass
Yang *et al*[71]	61	Acupuncture, n=31 Control (diet adjustment+aerobic exercise), n=30	▶ BW ▶ WHR	Significantly lower BW (p<0.05) in favour of the acupuncture group Non-significant difference in WHR between the two groups
Gucel *et al*[72]	40	Body acupuncture (n=20) Sham (n=20)	▶ BW ▶ BMI ▶ Insulin ▶ Leptin ▶ Ghrelin ▶ Cholecystokinin	Significantly lower BW, BMI and cholecystokinin (p<0.001) in favour of the acupuncture group. Significantly lower insulin and leptin (p<0.05) in favour of the acupuncture group. Significantly higher ghrelin (p<0.001) in favour of the acupuncture group

BDI, Beck Depression Inventory; BES, Binge Eating Scale; BW, body weight; BMI, body mass index; BE, β endorphin; EA, electroacupuncture; HOMA-IR, homeostasis model assessment-insulin resistance; HDL-C, high density lipoprotein cholesterol; Ig, immunoglobulin; LDL-C, low-density lipoprotein cholesterol; ORWELL 97, Obesity Related Well-being Questionnaire; STAI, State-Trait Anxiety Inventory; TNFα, tumour necrosis factor α; TC, total cholesterol; TG, triglycerides; WC, waist circumference; WHR, waist–hip ratio.

modification in reducing body weight, and was as efficacious as conventional anti-obesity drugs but with fewer reported adverse effects. However, the low quality of many of the trials puts these conclusions into question.[65] The studies included in the present review are summarised in tables 1 (manual), 2 (auricular) and 3 (EA), while studies that were excluded are summarised in table 4 (online only).

Table 2 Clinical studies of auricular acupuncture for obesity

Study	n	Experimental and control groups	Measured variables	Results
Shirashi *et al*[73]	1081	Auricular acupuncture in mildly obese (n=5) Auricular acupuncture in non-obese healthy (n=55) Sham acupuncture (n=520) Control (n=501)	▶ BW ▶ Body fat	BW and fat significant reduction in mildly obese after acupuncture treatment (p<0.001) No difference in sham and control groups after treatment
Hsu *et al*[74]	45	Auricular acupuncture (n=23)Sham auricular acupuncture (n=22)	▶ BW ▶ BMI ▶ WC ▶ Ghrelin ▶ Leptin	No significant differences in percentage reduction in BW, BMI and WC between groups After treatment, group A revealed a significant increase in ghrelin level (p<0.05) and decrease in leptin level (p<0.001), whereas group B showed no significant changes in these levels
Shen *et al*[75]	14	A: auricular acupuncture for 4 weeks, then sham auricular acupuncture B: sham auricular acupuncture for 4 weeks, then auricular acupuncture	▶ BW ▶ Sympathomimetic effects	Decreased BW and sympathomimetic effects were observed in both groups in the first 4 weeks of stimulation, with no difference between groups The sympathomimetic effects and BW reduction were sustained in group A in the second 4 weeks of stimulation; such effects were not observed in group B

BMI, body mass index; BW, body weight; WC, waist circumference.

Table 3 Clinical studies of EA for obesity

Study	n	Experimental and control groups	Measured variables	Results
Richards and Marley[18]	60	Acupuncture: EA to acupuncture ear points Sham: EA to thumb	▶ Suppression of appetite ▶ Weight loss	Significantly higher weight loss and mean weight loss in favour of acupuncture group (p<0.05) Suppression of appetite in 95% of acupuncture group whereas no suppression in sham group
Cabioğlu and Ergene[76]	55	EA (n=22) Sham EA (n=12) Diet restriction (n=21)	▶ BW ▶ TC ▶ TG ▶ HDL-C ▶ LDL-C	Weight reduction in patients with EA application significantly higher compared with diet and sham groups (p<0.05) Significant decreases in total cholesterol, LDL-C and triglyceride levels in favour of EA compared with sham EA (p<0.05) Non-significant changes in HDL-C levels in the three groups
Hsu *et al*[77]	54	A: EA first B: Sit-up exercise first	▶ BW ▶ BMI ▶ WC	At end of trial, no significant differences between groups in all measurements Both groups had significant reductions in BW (p=0.004; 0.001), BMI (p=0.003; 0.021) and WC (p≤0.001; 0.001) compared with baseline values
Hsu *et al*[78]	63	A: EA (n=22) B: Sit-up exercises (n=20) C: Control (n=21)	▶ BW ▶ BMI ▶ WC	Significantly greater percentage reductions in BW (p=0.009, 0.004), BMI (p=0.008, 0.016) and WC (p=0.013, 0.006) in EA compared with sit-up exercises or control
Cabioğlu and Ergene[79]	40	EA (n=20) Diet programme (n=20)	▶ Leptin ▶ BE ▶ Weight loss	Significant decreases in BW in favour of EA group (p<0.0001) Decreases in serum leptin levels (p<0.0001) and increases in serum BE (p<0.05) in favour of EA group
Cabioğlu and Ergene[80]	52	EA (n=20) Sham EA (n=12) Diet restriction (n=20)	▶ Weight loss ▶ Serum insulin ▶ C-peptide levels ▶ Glucose levels	Significant increases in serum insulin and C-peptide and decreases in BW in favour of EA (p<0.001) Significant decreases in plasma glucose in both EA and diet restriction group compared with sham EA (p<0.01)
Cabioglu *et al*[81]	165	EA Sham EA Diet restriction	▶ Weight reduction ▶ Phobia, anger, anxiety, obsession, paranoid symptoms and depression	Weight reduction in EA group significantly greater than in other groups (p<0.001) Significant decreases in phobia, anger, anxiety, obsession, paranoid symptoms and depression in EA group compared with sham EA and diet groups
Cabioglu *et al*[82]	63	EA (n=24) Sham EA (n=13) Diet restriction (n=23)	▶ BW ▶ IgG ▶ IgA ▶ IgM ▶ IgE	Non-significant changes in serum IgA, IgM and IgE levels in the three groups Significant weight reduction in favour of EA group (p<0.0001) Modulations in serum IgG (p<0.001) in EA compared with the other two groups
Luo and Li[83]	60	Manual acupuncture (n=20) EA (n=20) Control (n=20)	▶ Serum leptin ▶ Adiponectin	Significant decreases in leptin and increases in adiponectin in EA compared with other two groups (p<0.05) Decreases in leptin (p<0.005) and increases in adiponectin (p<0.01) in manual acupuncture group
Cabioglu *et al*[84]	58	EA (n=20) Sham EA (n=15) Diet restriction (n=23)	▶ Weight reduction ▶ Lipoprotein A ▶ Apolipoprotein A ▶ Apolipoprotein B	Significant weight reduction in both EA (p<0.001) and diet restriction groups (p<0.001) Weight reduction in EA group was more significant (p<0.001) than in sham EA and diet restriction groupsLipoprotein A and apolipoprotein B significantly decreased (p<0.05) only in EA group No effect on apolipoprotein A
Abdi *et al*[85]	161	EA and manual acupuncture (n=79) Manual acupuncture at non-acupuncture points (n=82)	▶ BW ▶ HC ▶ WC ▶ Lipids ▶ hs-CRP	BW, HC, WC and LDL reduced significantly in EA group (p<0.05) compared with other group hs-CRP did not significantly change between the two groups

BW, body weight; BMI, body mass index; BE, β endorphin; EA, electroacupuncture; HDL-C, high density lipoprotein cholesterol; HC, hip circumference; hs-CRP, high-sensitivity C-reactive protein; Ig, immunoglobulin; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol; TG, triglycerides; WC, waist circumference.

Effect of different types of acupuncture on body weight alone

Body manual acupuncture seems to be more effective in reducing body weight than sham,[72] herbal supplement,[66] diet alone[69 68] or diet and exercise[71] in some studies, while others[67 70] found no effect.

The evidence on auricular acupuncture is also mixed, with positive[75 73] and negative[74] results when compared with sham acupuncture. For EA the evidence is more positive; the majority of studies suggest that EA induces significantly greater weight loss than sham EA,[18 72–74 76 80–82 84] diet,[76 79 80–82 84]

exercise[78] or acupuncture performed at no acupuncture points[85] whereas only one study concluded that EA and exercise resulted in similar reductions in body weight.[77]

Effects on obesity-related peptides

As already mentioned, obesity is characterised by hyperleptinaemia and leptin resistance. Both manual[72 83] and auricular acupuncture[74] as well as EA[79 83] exert a beneficial effect on leptin resistance and cause a significant decrease in plasma leptin levels in obese patients compared with sham[72 74] or diet alone.[79] In addition, manual[72] and auricular[74] acupuncture significantly increase ghrelin levels in comparison with sham, while EA seems to cause a remarkable increase in β endorphin[79] and adiponectin[83] in parallel to weight loss.

Effects on glucose metabolism and insulin resistance

Studies of the effect of acupuncture on insulin levels have mixed results, showing an increase[80] and decrease[72] after treatment. In one study,[80] EA decreased serum glucose levels through the increase of serum insulin and C-peptide levels compared with sham EA or diet restriction. On the other hand, a recent study showed that manual acupuncture decreased insulin levels[72] in obese women compared with sham, and the authors suggest that acupuncture improves insulin sensitivity and normalises insulin levels. Additional research is needed to further explain the therapeutic effects of acupuncture on glucose metabolism and insulin sensitivity.

Effects on lipid metabolism

Both manual[66 85] and EA[76 84 85] are reported to have a beneficial effect on lipid metabolism in addition to weight loss. Significant decreases in total cholesterol,[66 76] LDL-C[76 85] and triglycerides[66 76] were observed whereas HDL-C did not change significantly.[76] In another study[84] there were significant decreases in lipoprotein A and apolipoprotein B and no changes in apolipoprotein A levels.

Effects on inflammatory markers

In obese women, EA was reported to produce modulations of serum IgG associated with a significant weight loss compared with sham EA and diet restriction[82] while IgA, IgM and IgE did not change. Similarly, high-sensitive C-reactive protein did not differ among obese subjects treated with manual acupuncture and EA and those who received acupuncture at no acupuncture points.[85]

Effects on psychological outcomes

Acupuncture also seems to improve the psychological status of obese patients; anxiety (measured by State-Trait Anxiety Inventory) and depression (measured by Beck Depression Inventory) improved after 12 weeks of acupuncture although body weight did not change.[67] In another trial, significant decreases in phobia, anger, anxiety, obsession, paranoid symptoms and depression were observed in the EA group compared with the sham and diet groups.[81]

CONCLUSIONS

Both experimental and current clinical data suggest that acupuncture (in different forms) exerts beneficial effects on obesity. Apart from a reduction in body weight, body mass index, waist and hip circumference, acupuncture seems to affect many biochemical markers of obesity such as insulin resistance, glucose and lipid metabolism, obesity-related peptides (eg, leptin, ghrelin) and inflammatory markers. However, further prospective clinical trials are needed to establish the effectiveness of this complementary method for obesity treatment. Some data suggest that EA may be more effective than manual acupuncture; however, the most effective EA frequency remains controversial. Combinations of different forms of acupuncture with diet and exercise seem to be necessary to achieve and maintain weight loss.

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