Effect of laserpuncture at the ear acupoint MA-IC 3 Endocrine on fasting plasma glucose and oral glucose tolerance in prediabetic patients

A Prabaswari¹, H Mihardja¹*, A Sristiarti¹, S Soebardi²
¹Department of Medical Acupuncture, Faculty of Medicine, Universitas Indonesia, Jakarta, 10430, Indonesia
²Department of Internal Medicine, Faculty of Medicine, Universitas Indonesia, Jakarta, 10430, Indonesia
*E-mail: hasanmihardja@gmail.com

Abstract. Prediabetes is characterized by blood glucose levels higher than normal but not high enough to be classified as full-blow diabetes. Prediabetic patients are at an increased risk of developing type 2 diabetes within a decade unless they adopt a healthier lifestyle that includes weight loss and increased physical activity. Alternative therapies, such as laserpuncture, are being continuously refined and may be applicable to prediabetes treatment. The aim of the present study was to examine the effects of laserpuncture on fasting plasma glucose (FPG) and oral glucose tolerance (OGT) levels in prediabetic patients. A single-blind randomized controlled trial was conducted involving 26 patients allocated into a laserpuncture or a sham laserpuncture group. Laserpuncture therapy was administered two times weekly at the MA-IC 3 Endocrine ear acupoint for 6 weeks. FPG and OGT levels were used to measure the primary outcome. At 6 weeks, mean change in FPG was significantly different between the groups (laserpuncture group, 10±7.810 mg/dl and sham laserpuncture group, −4.08±10.943 mg/dl). Mean change in OGT was −3.38±30.065 and −6.23 9.774 mg/dl in the laserpuncture and sham laserpuncture groups, respectively (p<0.05). These results suggest that laserpuncture showed a positive effect on FPG and OGT levels in prediabetic patients.

1. Introduction
The American Diabetes Association has defined prediabetes as a condition of impaired glucose tolerance and/or impaired fasting glycemia. Other definitions state that prediabetes is a condition in which blood glucose levels are higher than normal, but not high enough to be classified as full-blown diabetes [1-3]. Prediabetes is usually attributed to insulin resistance and β-cell dysfunction, which precede the increasing glucose levels [2].

Some evidence showing an association between prediabetes and initial stages of nephropathy, chronic kidney disease, peripheral nephropathy, diabetic retinopathy, and increased risk of macrovascular complications exists. Multifactorial risk scores using noninvasive assessment and basic evaluation of blood metabolism in addition to glycemic scores could optimize diabetes risk estimation. Lifestyle changes are considered a basic diabetes prevention strategy, with evidence showing a decrease in risk of approximately 40%-70% [4].

Laserpuncture is an alternative therapy developed as an acupuncture method using a low-energy laser; its advantages over manual acupuncture include the avoidance of pain, vasovagal syncope, skin trauma, and infections. Furthermore, laserpuncture consumes lesser time than manual acupuncture [5, 6].

There have been several studies on type 2 diabetes mellitus (DM) treatment using acupuncture. A study by Adriani F, dkk (2012) [7] involved a randomized controlled trial on 54 subjects with type 2
DM divided into two groups of 27 subjects each. One group received electroacupuncture treatment at the ear acupuncture point MA-IC 3 Endocrine with a denserisperse wave for 30 min, whereas the other group underwent manual acupuncture treatment at the same acupuncture point for 30 min. The electroacupuncture group experienced a decrease in fasting plasma glucose (FPG) levels from 157.26±24.485 to 142.59±26.771 (p<0.05), while the manual acupuncture group experienced a decrease in FPG levels from 149.67±21.485 to 148.74±21.326 (p<0.05). The decrease in FPG was statistically significant in both the groups (p<0.05). Based on the above findings, the aim of the present study was to investigate the effects of laserpuncture at the ear acupuncture point MA-IC 3 Endocrine on FPG and oral glucose tolerance (OGT) levels in prediabetic patients.

2. Methods
The study consisted of a single-blind randomized controlled trial involving 26 patients who were at risk of DM, as assessed on the basis of the presence of a close relative with type 2 DM and obesity (BMI>25) at Cipto Mangunkusumo Hospital, Jakarta during February–May 2014. The research was approved by the Health Research Ethics Committee, Faculty of Medicine Universitas Indonesia-Cipto Mangunkusumo Hospital on January 27th 2014 (53/H2.F1/ETIK/2014), and permission from the Cipto Mangunkusumo Hospital was obtained with license number 85/TU-K/Lit/II/2014.

The inclusion criteria of the study were the age of 20–55 years, meeting prediabetes criteria per the Consensus of Management and Prevention of type 2 Diabetes Mellitus in Indonesia 2011 (FPG, 100–125 mg/dl and/or OGT, 140–199 mg/dl) [8], providing informed consent, and participating in the entire study based on the schedule.

Exclusion criteria were pregnancy; DM therapy; contraindications to ear acupuncture treatment (skin infection, ear wound, or cauliflower ear); contraindications to laserpuncture (history of malignant tumor or pre-cancer, dermatitis solaris, skin damage due to sun exposure, exacerbation of chronic diseases, such as lupus erythematosus and skin tuberculosis); increased photoallergic response, such as that to high dose corticosteroids or arsenic-containing medication; history of incurable epilepsy; infection with fever >38 °C; heart failure; or psychosis-like severe depression. Drop-out criteria included two consecutive instances of patient absence during therapy.

All patients consenting to participate in the study by signing an informed consent form in a confidential and voluntary manner without coercion, fulfilling the inclusion criteria, and not being excluded on the basis of the exclusion criteria were included in the study. The patients were instructed to fast from 11 PM to 9 AM (10 h), during which they were allowed to drink water without any sugar. The next day, they were administered 75 g glucose (for adults) in 250 ml water and were asked to drink it in 5 min. The patients continued fasting until the next blood examination. For 2 h after drinking the glucose solution, the patients rested and did not smoke. FPG and OGT levels were evaluated by a medic/paramedic and a trusted laboratory. Next, the patients were divided into a laserpuncture group or a sham laserpuncture group through a randomized block and table method.

The ear laserpuncture was performed via stimulation for 1 min using a Konftec laser at a 660-nm wavelength with a AlGaInP diode laser, with settings comprising a red wave, a continuous wave, 35 mW power, and a dose of 1.78 J. The therapy was performed twice a week for 12 sessions over 6 weeks. FPG was evaluated with plasma glucose testing after the patients fasted for 10 h [8]. OGT was evaluated with oral glucose tolerance test (OGTT) using an enzymatic method involving glucose oxidation [1]. FPG and OGT levels were tested at the beginning (first day) and at the end (sixth week) of the study by a medic/paramedic and a trusted laboratory.

3. Results
The study was conducted on a total of 90 patients. All patients were at DM risk, had parents or sibling(s) with DM, and/or BMI>25 kg/m². After FPG and/or OGT testing, there were 28 subjects who fulfilled the inclusion criteria. These patients were randomly allocated into two groups: the laserpuncture group and the sham laserpuncture group. All the allocated patients participated in the study for 6 weeks, and two patients dropped out because of illness.

An equality test performed comparing the two groups in terms of age, sex, relatives with DM history, BMI, initial FPG level, and initial OGT level yielded a p-value of >0.05, indicating that the two groups were comparable (Table 1).
Table 1. Patients’ characteristics

| Characteristic                  | Laserpuncture Group (n=13) | Sham Laserpuncture Group (n=13) | p   |
|--------------------------------|---------------------------|--------------------------------|-----|
| Age (year)                      |                           |                                |     |
| Mean (SD)                       | 41.69 (10.95)             | 41.69 (9.88)                   | p>0.05 |
| Sex                            |                           |                                |     |
| Male, n (%)                     | 6 (46)                    | 5 (38)                         | p>0.05 |
| Female, n (%)                   | 7 (54)                    | 8 (62)                         |     |
| Body mass index (Median Min–Max)| 26.4 (22–42.7)            | 26 (18.7–34.5)                 | p>0.05 |
| Relative with type 2 DM         |                           |                                |     |
| Yes, n (%)                      | 10 (77)                   | 9 (69)                         | p>0.05 |
| No, n (%)                       | 3 (23)                    | 4 (31)                         |     |
| Initial FPG level (dl)          |                           |                                |     |
| Mean (SD)                       | 108.31 (7.28)             | 102.15 (10.55)                 | p>0.05 |
| Initial OGT level (dl)          |                           |                                |     |
| Mean (SD)                       | 120.23 (33.39)            | 117.31 (30.58)                 | p>0.05 |

Table 2. Comparison of changes in FPG levels in the laserpuncture group and the sham laserpuncture group

| Change in FGP level (dl)        | Laserpuncture Group | Sham Laserpuncture Group | p   |
|--------------------------------|---------------------|----------------------------|-----|
| Mean (SD)                       | 10 (7.810)          | −4.08 (10.943)             | <0.05** |

** Mann–Whitney test

The mean FPG level change in the laserpuncture group was 10 mg/dl and that in the sham laserpuncture group was −4.08 mg/dl. The Mann–Whitney test yielded a p-value of p<0.05, showing a statistically significant difference in FPG level change between the groups (Table 2).

Table 3. Comparison of changes in OGT levels in the laserpuncture group and the sham laserpuncture group

| Changes in OGT level (dl)       | Laserpuncture Group | Sham Laserpuncture Group | p   |
|--------------------------------|---------------------|----------------------------|-----|
| Mean (SD)                       | −3.38 (30.065)      | −6.23 (9.774)              | <0.05** |

** Mann–Whitney Test

As shown in Table 3, the mean change in OGT level in the laserpuncture group was −3.38 mg/dl and that in the sham laserpuncture group was −6.23 mg/dl. The Mann–Whitney test yielded a p-value of 0.048 (p<0.05), showing a statistically significant difference in OGT level change between the groups.

4. Discussion

The present study was aimed at investigating the effects of laserpuncture on FPG and OGT level changes in prediabetic patients. Among 90 subjects aged 20–55 years who were at risk for DM due to the presence of parents or siblings with DM or had BMI>25 kg/m², there were 28 subjects who fulfilled the prediabetes criteria, with FPG levels between 100–125 mg/dl and/or OGT level ≥140 mg/dl. This observation showed that the prevalence of prediabetic patients at the Cipto Mangunkusumo Hospital was 31.1%.

Studies using the ear acupoint in prediabetic patients have not been reported previously. Adriani et al (2012) have conducted a study on the effect of electroacupuncture at the ear acupoint MA-IC 3
Endocrine on FPG level in type 2 DM patients in Banjar city [8]. The aim of this preliminary study was to establish the effect of the laserpuncture on FPG and OGTT levels in prediabetic patients.

The ear acupoint MA-IC 3 Endocrine is innervated by the nervous anterior vagus rami auricularis. Because this vagus nerve innervates internal organs, the acupuncture-mediated stimulation of this nerve may activate pancreatic beta cells to secrete insulin. Acupuncture-mediated stimulation may inhibit the sympathetic or parasympathetic nervous systems. The stimulation of parasympathetic nerves via cholinergic nerve fibers triggers the secretion of acetylcholine, which stimulates insulin secretion and acts on pancreatic beta cell receptors. In addition, this triggers the release of proteins, which play a role in insulin signaling, such as insulin-like growth factor. These mechanisms may mediate acupuncture-induced increase in insulin action by increasing insulin sensitivity and decreasing insulin resistance [7].

An individual’s ability to maintain FPG level within the normal range can be evaluated by testing FPG and glucose serum response after glucose intake. Maintaining normal FPG levels depends on hepatic glucose production, peripheral tissue glucose, and hormones controlling glucose metabolism. The failure of this function could increase or decrease FPG level. FPG test after glucose intake is a sensitive method to detect abnormalities in glucose metabolism. Nondiabetic individuals show increased FPG following glucose intake, which triggers insulin secretion, causing glucose disposal through the insulin system and bringing the glucose back to within the normal range. Glucose disposal is evaluated using OGTT, which is used to diagnose early diabetes; however, OGTT is not performed in routine medical screening and is not recommended for use in patients with clinical manifestation of diabetes and hyperglycemia [9,10].

5. Conclusion
The results indicate that laserpuncture has a positive effect on FPG and OGTT levels in prediabetic patients. Laserpuncture as alternative therapies should be continuously refined and may be applicable to prediabetes treatment.

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