

Effect of Laser Acupuncture Versus Aerobic Exercises on Insulin Resistance in Patients with Type 2 Diabetes Mellitus

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Abstract

Background: According to the International Diabetes Federation, 20.9% of the Adults in Egypt were estimated to have Diabetes on 2021, the percentage is expected to rise to 23.4% by 2045. The increased number of patients is associated with a huge cost for the healthcare system and the country economy. The long-term effects of Diabetes may lead to loss of physical independence of the patients and lowered quality of life. The drug treatments are not always satisfactory in treating the hyperglycemia and avoiding the long-term complications, hence emerged the need of finding complementary and alternative approaches to with less or no side effects to tackle the problem and provide the best control over the blood glucose levels.

Aim of Study: Was to investigate the effect of Laser Acupuncture versus Aerobic exercises on Insulin resistance in patients with type II Diabetes Mellitus and to compare between them.

Subjects and Methods: Forty Type II diabetic patients with aged ranged between 40-50 were randomly divided into two groups as Group A (n=20) was treated by Laser acupuncture on the five Acupuncture points Zhongwan (CV-12), Zusanli (ST 36), Sanyinjiao point (SP6), Feishu point and Shenshu point, for 8 weeks, 3 times per week. While Group B (n=20) was treated by Aerobic Exercises in form of walking on treadmill for 8 weeks - 3 sessions per week for 8 weeks in form of 40 minutes every other day Intensity: 65-75% of maximum heart rate.

Results: In Group A the mean value of Fasting Blood Glucose improved significantly by 7.26 % ($p < 0.001$) while the mean value of Fasting Plasma insulin did not show significant change ($p = 0.100224$), so HOMA IR improved significantly by 9.11% ($p < 0.001$).

In Group B the mean value of Fasting Blood Glucose improved significantly by 11.55% ($p < 0.001$) while the mean value of Fasting Plasma insulin changed significantly by 7.53% ($p < 0.001$) so the HOMA IR improved significantly by 23.67% ($p < 0.001$).

Conclusion: Both laser acupuncture and aerobic exercises improve insulin resistance in patients with type 2 diabetes mellitus, however aerobic exercises showed better results with significant difference of the Fasting blood glucose levels and the homeostasis model assessment of insulin resistance HOMA-IR and with no significant difference in fasting plasma insulin level.

Key Words: Aerobic exercise – Blood glucose – Insulin resistance – Physical activity – Type 2 diabetes – Laser acupuncture.

Introduction

DIABETES mellitus (DM) is a long term gradual disorder in which there is systemic excess of glucose in the bloodstream. It is a major health challenge with a growing prevalence wide-reaching. Currently around 537 million subjects are diabetic patients in the world, and on average, one out of each 10 adults (ages 20-79) is suffering from diabetes. In 2021, 6.7 million adults lost their lives because of diabetes and its complications [1].

Type 2 Diabetes Mellitus (T2DM) is one of the most common metabolic disorders worldwide and its development is primarily caused by a combination of two main factors: Defective insulin secretion by pancreatic β -cells and the inability of insulin-sensitive tissues to respond to insulin [2].

Studies showed that all patients should be advised to practice regular daily physical activity appropriate for their physical capabilities (e.g walking). Most adults should engage in at least 150 minutes of moderate or vigorous-intensity aerobic activity per week, spread over at least 3 days [3].

Numerous experimental studies have demonstrated that acupuncture can correct various metabolic disorders such as hyperglycemia, overweight,

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hyperphagia, hyperlipidemia, inflammation, altered activity of the sympathetic nervous system, and insulin signaling defects, all of which contribute to the development of insulin resistance [4].

Laser Acupuncture is photonic stimulation of acupuncture points and areas to initiate therapeutic effects similar to that of needle acupuncture and related therapies together with the benefits of Photo Biomodulation [5].

Aerobic training increases mitochondrial density, insulin sensitivity, oxidative enzymes, compliance and reactivity of blood vessels, lung function, immune function, and cardiac output. Moderate to high volumes of aerobic activity are associated with substantially lower cardiovascular and overall mortality risks in both type 1 and type 2 diabetes. In type 1 diabetes, aerobic training increases cardiorespiratory fitness, decreases insulin resistance, and improves lipid levels and endothelial function. In individuals with type 2 diabetes, regular training reduces A1C, triglycerides, blood pressure, and insulin resistance [6].

Homeostasis model assessment was first developed in 1985 by Matthews et al. It is a method used to quantify insulin resistance and beta-cell function from basal (fasting) glucose and insulin (or C-peptide) concentrations. HOMA is a model of the relationship of glucose and insulin dynamics that predicts fasting steady-state glucose and insulin concentrations for a wide range of possible combinations of insulin resistance and β -cell function [7].

This study was done to investigate the effect of laser acupuncture and aerobic exercises on insulin resistance in patients with type 2 diabetes mellitus and compare between them.

Subjects and Methods

Subjects, Material and Methods Subjects' characteristics and general experimental design:

Study subjects:

Forty male diabetic patients with incidence of diabetes 2-5 years ago were selected from Al-Khana Central Hospital. The study began September 2016 till March 2017, the patients were with body mass index between 25 and 35kg/m² treated by oral antihyperglycemic drugs. These patients were assigned to two groups equal in number. The patients were diagnosed and examined to confirm absence of cardiovascular, orthopedic or neurological conditions. Their ages ranged from 40-50 years.

Evaluated parameters:

Patients were examined by an internist for heart or cardiovascular diseases incompatible with the physical activity. All the patients were weighed shoeless and wearing light clothes by the same scale and their height was measured using wall meter. In addition, a standard fabric meter was used to measure the waist to hip ratio.

Demographic information was recorded and primary tests including fasting blood sugar (FBS) and fasting serum insulin were conducted. Then HOMA IR was calculated.

Insulin resistance was measured using HOMA-IR formula. It is a method used to quantify insulin resistance using the formula (fasting glucose x fasting insulin)/405.

Procedures:

Treatment procedures:

- The treatment period was 8 weeks with frequency of 3 sessions per week.
- The sessions were supervised and participation assessed. All subjects were free to withdraw from the study at any time. All participants provided their informed consent after receiving a detailed explanation of the study. The Ethics Committee of Research in Faculty of Physical Therapy, Cairo University approved the study with number: P.T.REC/012/001397. The data of all the participants were available for analysis. The detailed protocol was as follows:

Group A:

It includes 20 patients that treated by ILS 1050 laser device on acupuncture points of diabetes in addition to the medical treatment. Each acupuncture point received laser for 90 seconds 3 sessions per week for 8 successive weeks.

The instrument used was Diode laser device. It was used for biostimulation of the acupuncture points. It has a pen probe with a diameter of 1 cm. The device has a wavelength of 905nm in the red region of the visible spectrum and a power output of 0-250mW. The probe was applied with slight pressure for 30 second at each point. The laser group received laser acupuncture at (Zhongwan Point, Zusanli point, Sanyinjiao point, Feishu point, Shenshu point).

Group B:

Received the medical treatment in addition to aerobic exercises training.

Duration of the session was 40 minutes; the first 5 minutes was for warming up and stretching exercises then 30 minutes on the treadmill then the last 5 minutes for the cool down. The warm-up phase was conducted through performing slow movements and stretching exercises for 5 minutes, warm up as a preparation for the more strenuous activity associated with the second phase of the exercise program to avoid any muscle injuries The main exercise phase was conducted through using the treadmill for 30 minutes in the following manner and preparation:

- The walking shoes were well cushioned heel, good arch support, adequate to room and flexible slip-resistant soles.
- Wearing loose-fitting and layered clothing appropriate for the weather.
- Use of good posture, look forward (not at the ground) and the chin and head should be up.
- Walking along a straight line, pushing off toes, concentrate on Landing on heel, rolling through the step and pushing off with toes. Use the natural spring of calf muscles to propel the body forward.

$$\text{Heart Rate Max} = 220 - \text{age in years}$$

The Cool down Phase was conducted through performing slow movements and stretching exercises similar to those in the warm-up phase for 5 minutes as a recovery from the more strenuous activities of the main exercise phase.

Frequency: 3 sessions per week for 8 weeks,

Mode: Aerobic exercises in form of walking on the treadmill.

Intensity: Intensity: 65-75% of maximum heart rate.

The patients were observed during exercise training where perceived exertion rate should vary between 12 and 15 on the scale.

Results

There is no significant difference between both groups in age, height, weight, BMI and waist/hip ratio.

There is no significant difference between both groups in Fasting glucose level, fasting plasma insulin and HOMA-IR.

In Group A the mean value of Fasting Blood Glucose improved from 150.8 ± 6.54 to 139.85 ± 6.47 ($p < 0.001$) which is significant while the mean value of Fasting Plasma insulin changed from 11.69 ± 2.5 to 11.63 ± 2.59 ($p = 0.100224$) which is not significant so the HOMA IR improved from 4.39 ± 1.03 to 3.99 ± 0.925 ($p < 0.001$) which is significant.

In Group B the mean value of Fasting Blood Glucose improved from 149.75 ± 6.42 to 132.45 ± 4.31 ($p < 0.001$) which is significant while the mean value of Fasting Plasma insulin changed from 12.21 ± 2.1 to 11.29 ± 2.14 ($p < 0.001$) which is significant so the HOMA IR improved from 4.52 ± 0.87 to 3.45 ± 0.74 ($p < 0.001$) which is significant.

So it was concluded that The Aerobic Exercises was found to improve the results better than the Laser Acupuncture with significant difference between the LA group and Exercise group regarding the fasting glucose level and HOMA IR values as p -values were (0.00012) and (0.0152) respectively. But without significant difference in the fasting plasma insulin level as p -value was (0.0923).

Table (1): Anthropometric parameters between the two groups.

Variable	Group name LA Group No.=20 Mean ± SD	AE Group No.=20 Mean ± SD	p -value	Significance
Age (years): Mean±SD	45.2±4.8	44.65±5.35	0.55	NS
Height (cm): Mean±SD	173.9±5.8	175.2±6.28	0.503	NS
Weight (kg): Mean±SD	91.35±12.29	91.3±11.26	0.9	NS
BMI: Mean±SD:	30.1±2.74	29.6±2.54	0.6	NS
WHR: Mean±SD	1.14±0.04	1.13±0.039	0.54	NS

SD: Standard deviation.
 p -value is significant at < 0.05 .

Table (2): Comparison of pre-intervention measures Between Laser Acupuncture group and Exercise group.

Group name	LA Group No.=20 Mean \pm SD	AE Group No.=20 Mean \pm SD	<i>p</i> -value	Significance
Fasting blood glucose	150 \pm 6.54	149.75 \pm 6.42	0.61	NS
Fasting plasma Insulin	11.6 \pm 2.5	12.21 \pm 2.1	0.53	NS
Insulin Resistance (HOMA IR)	4.39 \pm 1.03	4.52 \pm 0.87	0.67	NS

Table (3): Comparison between pre and post of Group A Laser Acupuncture measures.

Results of paired <i>t</i> -test within LA group	Pre Mean \pm SD	Post Mean \pm SD	Paired <i>t</i> -test & <i>p</i> -value	Significance
FBG	150.8 \pm 6.54	139.85 \pm 6.47	<i>t</i> -test=6.58 <i>p</i> <0.001*	S
FPI	11.69 \pm 2.5	11.63 \pm 2.59	<i>t</i> -test=1.73 0.100224	NS
HOMA IR	4.39 \pm 1.03	3.99 \pm 0.925	<i>t</i> -test=5.34 <i>p</i> <0.001*	S

Table (4): Comparison between pre and post Group B Aerobic exercise measures.

Results of paired <i>t</i> -test within each group	Pre Mean \pm SD	Post Mean \pm SD	Paired <i>t</i> -test & <i>p</i> -value	Significance
FBG	149.75 \pm 6.42	132.45 \pm 4.31	<i>t</i> -test=11.13 <i>p</i> <0.001*	S
FPI	12.21 \pm 2.1	11.29 \pm 2.14	<i>t</i> -test=5.59 <i>p</i> <0.001*	S
HOMA IR	4.52 \pm 0.87	3.45 \pm 0.74	<i>t</i> -test=8.47 <i>p</i> <0.001*	S

* Significant *p*-value (*p*<0.05).

Table (5): Comparison between LA group and AE group post treatment.

Results of unpaired <i>t</i> -test between the 2 groups	LA group Mean \pm SD	AE group Mean \pm SD	<i>p</i> -value	Significance
Fasting glucose level	139.85 \pm 6.47	132.45 \pm 4.31	0.00012	S
Fasting Insulin Level	11.63 \pm 2.59	11.29 \pm 2.14	0.092315135	NS
HOMA IR	3.99 \pm 0.925	3.45 \pm 0.74	0.01526682	S

* Significant *p*-value (*p*<0.05).

Discussion

This Study was a comparison between the Effect laser Acupuncture and aerobic exercise training on insulin resistance in male patients with Diabetes mellitus Type II.

Forty Diabetic patients Type II with high insulin resistance (Diagnosed by Physician and confirmed by Laboratory investigations) were selected from

physical therapy department in Alkhanka Central hospital with age will be ranged from 40-50 years old who are taking anti hyperglycemic drugs These patients were assigned to two groups equal in number.

Group A:

Consisted of 20 patients. They received laser acupuncture therapy in addition to oral hypoglycemic drugs.

Group B:

Consisted of 20 patients. They received oral hypoglycemic drugs and aerobic exercises training in form of waking on treadmill for 8 weeks-3 sessions per week in form of 40 minutes every other day.

The Outcomes of the two treatment Plans was evaluated by measuring of Fasting blood glucose and fasting plasma Insulin levels with calculating the homeostasis model for Insulin resistance (HOMA-IR).

Random blood glucose level was measured before and after the session to monitor the patients for hypo or hyperglycemia that may indicate the emergency stop of the session.

Statistically, The Results of this Study revealed that, although post-intervention records improved in comparison to pre-intervention Records in both groups. There were statistically no significant Difference ($p < 0.05$) in comparing group A and B regarding Fasting plasma Insulin level, while improvement of Fasting Glucose levels and HOMA IR was statistically significant in favor of Aerobic exercises group.

But when comparing between pre-intervention and post-intervention records in Laser Acupuncture group (group A) it was found that the fasting glucose level and HOMA IR were improved by 7.26% and 9.11% respectively with significance but there was no significance improvement in fasting plasma insulin level. And when comparing between pre-intervention and post-intervention records in Aerobic exercise group (group B) it was found that fasting blood glucose, fasting plasma insulin and HOMA IR improved significantly by 11.55%, 7.53% and 23.67% respectively.

The results agrees with numerous recent studies that applied laser acupuncture for insulin resistance in human and in rats, Yuan Li et al., 2019 showed "Effect of Compound Laser Acupuncture-Moxibustion on Blood Glucose, Fasting Insulin and Blood Lipids Levels in Type 2 Diabetic Rats" which concluded that The compound laser acupuncture-moxibustion of 10.6 μm and 650nm had positive effects on the regulation of hyperglycemia and insulin resistance in T2DM rats, which may be a potential treatment for T2DM, and also provide an alternative to the traditional acupuncture and moxibustion therapy [8].

Also agreeing with Hironori Nakamura and his colleagues in Effects of acupuncture stimulation on blood glucose concentration in the Otsuka Long-

Evans Tokushima Fatty (OLETF) rat, an animal model for type-2 diabetes mellitus which stated that Application of acupuncture stimulation to OLETF rats significantly reduced blood glucose concentrations, and the results suggest that this was an effective treatment for type-2 diabetes mellitus. Although the elevation of body weight was not significantly inhibited, the brightness and fineness of their hair coat were greatly improved by acupuncture treatment in AcOLETF rats [9].

Also, the results are agreeing with (El-Mekawy et al., 2014) in the study Effect of laser acupuncture combined with a diet-exercise intervention on metabolic syndrome in post-menopausal women, in which there was a significant decrease in blood-glucose levels in both the control group (16.65%) and the treatment group (30.08%). In addition insulin decreased 23.51 % in the control group and 32.1% in the treatment group. 12 In addition there were no significant differences in blood-glucose and insulin levels in the 2 groups after treatment Laser Acupuncture group showed a significant decrease in the waist-hip ratio, fasting blood glucose and insulin levels, HOMA-IR [10].

The study results come in accordance with what (Chen C et al., 2018) concluded in their system review "Acupuncture for type 2 diabetes mellitus: A systematic review and metaanalysis of randomized controlled trials" who stated that the current available evidence shows that compared to sham acupuncture or no acupuncture control, acupuncture is beneficial for improving glyceimic control, blood lipids and blood pressure control, helping losing weight in the management of T2DM.

Acupuncture plus hypoglycemic agents can achieve better effects than hypoglycemic agents alone, considering its overall potential benefits on the endocrine system, acupuncture could be recommended as a supplementary therapy in T2DM patients with metabolic disorders or obesity patients.

Acupuncture and electroacupuncture stimulation have been evaluated in view of their ability to lower blood glucose in hyperglycemic humans and animal models at several acupuncture points [10].

The results in the study are agreeing with (Kadoglou et al., 2007) in their study where, 6 months of aerobic exercise training in 60 adults with type 2 diabetes led to reductions in HbA 1 c ($-0.63\% \pm 0.41$ vs $0.31\% \pm 0.10$, $p < .001$), fasting plasma glucose ($-18.6 \text{ mg/dL} \pm 4.4$ vs $4.28 \text{ mg/dL} \pm 2.57$, $p < .001$), insulin resistance (-1.52 ± 0.6 vs 0.56 ± 0.44 , $p = .023$); as measured by homeostatic

model assessment), fasting insulin ($2.91\text{mU/L} \pm 0.4$ vs $0.94\text{mU/L} \pm 0.21$, $p=.031$), and systolic blood pressure ($-6.9\text{mm Hg} \pm 5.19$ vs $1.22\text{mm Hg} \pm 1.09$, $p=.010$) compared with the control group [11].

The results disagree with the decrease in fasting blood-glucose levels in Hassan et al. (2014). Hassan et al., compared the effects of therapeutic laser acupuncture, acupuncture, and diet therapy along with physical activity in healthy obese women. In that study, there were no difference in fasting blood-glucose level both in the nutrition group ($p=0.625$) and the laser acupuncture group ($p=0.456$). This could be because that study's therapy sessions were conducted one time per week. In the current study, there was a significant lowering of fasting blood-glucose levels in both groups [12].

In the current study, the results come in agreement with (Boulé NG) and his colleagues in their Meta-analysis evaluating the positive effects of aerobic exercise for patients with type 2 diabetes has repeatedly showed that aerobic exercise improves glycemic control, insulin sensitivity, oxidative capacity, and significant related metabolic parameters when compared to patients in sedentary control groups [13].

In this regard, aerobic exercises have been shown to increase skeletal muscle mitochondrial content and oxidative enzymes, resulting in dramatic improvements in glucose and fatty acid oxidation and increased expression of proteins involved in insulin signaling [14].

Also results coincided with (Colberg and his colleagues, 2016) as they stated in their study that aerobic and resistance training programs improves healthier skeletal muscle, adipose tissue, liver, and pancreatic function [15].

The results come in agreement with the results of Shahgholian, et al., 2015 study who studied effects of aerobic exercise on blood glucose in continuous ambulatory peritoneal dialysis patients where 22 patients divided into two equal groups with no significant differences in demographic characteristics including age, gender, duration of dialysis, and underlying cause of renal failure At baseline, the mean (SD) FBS levels were 118.5 (9.0) mg/dl in the test group and 117.8 (15.5) mg/dl in the control group. The corresponding values were 108.2 (14.3) and 117.2 (15.1) mg/dl, respectively, after 8 sessions of exercise and 93.6 (12.5) and 117.4 (15.4) mg/dl respectively, after 16 sessions (at the end of the study). While the mean FBS levels of the two groups were not significantly

different either before the intervention ($p=0.910$) or after the 8th session ($p=0.167$), significantly lower levels were observed in the test group after the 16th session ($p=0.001$) [16].

Conclusion: Within The Limitations and from the Obtained Data of the present study the most Notable Conclusion that both laser acupuncture and aerobic exercises improve insulin resistance in patients with type 2 diabetes mellitus. However Aerobic exercises showed better results with a significant difference in Fasting Blood glucose, fasting plasma insulin and HOMA-IR compared to laser acupuncture.

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تأثير الوخز بالإبر بالليزر مقابل التمارين الهوائية على مقاومة الأنسولين في المرضى الذين يعانون من داء السكري من النوع

الخلفية: وفقاً للاتحاد الدولي للسكري، قُدر ٢٠.٩٪ أن من البالغين في مصر مصابون بالسكري بحلول عام ٢٠٢١، ومن المتوقع أن ترتفع النسبة إلى ٢٣.٤٪ بحلول عام ٢٠٤٥. ويرتبط زيادة عدد المرضى بتكلفة باهظة للرعاية الصحية النظام واقتصاد البلد. قد تؤدي الآثار طويلة المدى لمرض السكري إلى فقدان الاستقلالية الجسدية للمرضى وانخفاض جودة الحياة. العلاجات الدوائية ليس مرضية دائماً في علاج ارتفاع السكر في الدم وتجنب المضاعفات طويلة المدى، ومن هنا ظهرت الحاجة إلى إيجاد طرق تكميلية وبديلة مع آثار جانبية أقل أو معدومة لمعالجة المشكلة وتوفير أفضل تحكم على مستويات السكر في الدم.

هدف الدراسة: دراسة تأثير الوخز بالإبر بالليزر والتمارين الهوائية على مقاومة الأنسولين لدى مرضى السكري من النوع الثاني والمقارنة بينهما.

الموضوعات والطرق: تم تقسيم أربعين مريضاً من مرضى السكري من النوع الثاني تتراوح أعمارهم بين ٤٠-٥٠ بشكل عشوائي إلى مجموعتين حيث تم علاج المجموعة أ (عدد = ٢٠) بالوخز بالإبر بالليزر على نقاط الوخز بالإبر الخمس (CV-12)، Zhongwan (ST 36)، Zusanli، ونقطة سانجياو (SP6)، ونقطة فيشو ونقطة شينشو، لمدة ٨ أسابيع، ٣ مرات في الأسبوع. بينما عولجت المجموعة ب (عدد = ٢٠) بالتمارين الهوائية في شكل مشي على جهاز المشاية الكهربائية لمدة ٨ أسابيع - ٣ جلسات في الأسبوع في شكل ٤٠ دقيقة كل يومين. الكثافة: ٦٥-٧٥٪ من الحد الأقصى لمعدل ضربات القلب.

النتائج: في المجموعة (أ)، تحسنت القيمة المتوسطة لنسبة الجلوكوز في الدم أثناء الصيام من 6.54 ± 150.8 إلى 6.47 ± 139.85 ($p < 0.001$) بنسبة ٧.٢٦٪ وهو أمر ذو دلالة إحصائية بارزة بينما تغير متوسط قيمة الأنسولين في بلازما الصيام من 2.05 ± 11.69 إلى 2.05 ± 11.63 ($p = 0.100224$) (وهو ليس ذو دلالة إحصائية لذا تحسنت مقاومة الأنسولين من 10.3 ± 4.39 إلى 0.925 ± 3.99 ($p < 0.001$)) بنسبة ٩.١١٪ وهو أمر ذو دلالة إحصائية بارزة في المجموعة (ب)، تحسنت القيمة المتوسطة لجلوكوز الدم أثناء الصيام من 6.42 ± 149.75 إلى 6.31 ± 132.45 بنسبة 11.05 ($p < 0.001$) وهو أمر ذو دلالة إحصائية بارزة بينما تغير متوسط قيمة الأنسولين في بلازما الصيام من 2.11 ± 12.21 إلى 2.14 ± 11.29 ($p < 0.001$) بنسبة وهو تغير بارز لذا تحسنت مقاومة الأنسولين من 0.87 ± 4.02 إلى 0.74 ± 3.45 بنسبة 23.67 ٪ ($p < 0.001$) وهو أمر بارز إحصائياً.

استنتاج: يعمل كل من الوخز بالإبر بالليزر والتمارين الهوائية على تحسين مقاومة الأنسولين لدى مرضى السكري من النوع الثاني ولكن التمارين الهوائية أظهرت نتائج أفضل مع اختلاف كبير في مستويات الجلوكوز في الدم أثناء الصيام وتقييم نموذج التوازن لمقاومة الأنسولين HOMA-IR مع عدم وجود فرق كبير في مستوى الأنسولين الصائم في البلازما.