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ORIGINAL ARTICLE

Blue or red: which intravascular laser light has more effects in diabetic patients?

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Abstract The effects of intravascular laser irradiation of blood (ILIB), with 405 and 632.8 nm on serum blood sugar (BS) level, were comparatively studied. Twenty-four diabetic type 2 patients received 14 sessions of ILIB with blue and red lights. BS was measured before and after therapy. Serum BS decreased highly significant after ILIB with both red and blue lights ($p<0.0001$), but we did not find significant difference between red and blue lights. The ILIB effect would be of benefit in the clinical treatment of diabetic type 2 patients, irrespective of lasers (blue or red lights) that are used.

Keywords Intravascular laser irradiation of blood · Intravascular laser therapy · Diabetes type 2 · Blood sugar

Introduction

During the past three decades, a lot of experimental studies have shown that low-level laser therapy (LLLT) has positive effects on different pathologies [1, 2]. One of the methods for LLLT is intravascular or intravenous laser irradiation of blood (ILIB). This is a safe and effective method of laser therapy especially for systemic disorders which has been used in Russia, China, and Iran since more than 20 years ago [3–9]. ILIB is done using UV, blue, and red lights but the relationship between optical elements including wavelength, energy density, power output, and duration of irradiation with biological effects of laser needs more investigations. It seems that using near infrared spectral range, cytochrome C oxidase [10] and in the blue range porphyrin-containing enzyme and flavoproteins [11] are important acceptors. The method of intravascular laser blood irradiation was first used by the Soviet scientists in 1981 [12]. Originally, this method was developed for the treatment of cardiovascular diseases [13]. Improvement of rheological properties of the blood as well as improvement of microcirculation and reduction of the area of infarction had been proved [14, 15]. Vasodilatation in capillaries and collateral vessels due to increased release of NO from monocytes has critical importance [16]. Obviously, there seem to be generalized effects of the intravenous blood irradiation on almost every organ system so that this therapy may be employed in the treatment of various diseases causally or additively. At first, only the helium-neon laser (632.8 nm) was used in this therapy. For many years, Russian studies showed that helium-neon laser had various effects on many organs as well as on the hematologic and immunologic system. These kinds of studies were mainly published in Russia and it has been little noted in other parts of the world. In China, ILIB has been applied clinically for treatment of acute cerebral infarction and cardiovascular disease, and the results have been encouraging [14, 15]. The medical effects are determined by predominance of systemic healing mechanisms including biostimulative, analgesic, antiallergic, immunocorrective, antitoxic, vasodilative, antiarrhythmic, antibacterial, antihypoxic, spasmolytic, anti-inflammatory, and other properties [17]. ILIB reduces glucose, cholesterol, low-density lipoproteins (LDL), and very low-density lipoproteins (VLDL) and stabilizes hormonal and immune system status [18]. It is suggested that blue light irradiation may increase arginine and nitric oxide (NO) production. Arginine causes the release of various hormones such as insulin, glucagon, adrenal catecholamines, prolactin, and growth hormone. Because of ILIB's wide effects, it can be used in complex diseases like diabetes mellitus [19].

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Diabetes mellitus is an extremely devastating disease with many serious complications and surgical and chemotherapeutical treatments are not fully effective. Using LLLT seems to be effective in managing diabetes and its complications [3–5, 20, 21].

The aim of this study is to compare blue and red light effect on the BS level in diabetic type 2 patients.

Materials and methods

After approval of the ethics committee of research projects, 24 diabetic type 2 patients (9 males: (37 %) mean age, 63.7±12.4 and mean age of diabetes history = 14.6±8.1 years; 15 females: (63 %) mean age, 63.9±7.7 and mean age of diabetes history = 11.7±5.2 years) referred to the laser clinic of Milad Hospital who agreed to participate entered the study. The entire participant filled out the written consent. This study conducted according before and after study design. Each of the blue and red laser therapy was prescribed at least seven times for each patient, and the BS level of all the patients was measured before and after laser therapy using ExiChek Blood Glucose Monitoring System (Exir Company, Iran).

After testing normality of data using Kolmogorov-Smirnov, repeated measure ANOVA statistic test was used to show any statistical difference in before and after comparison groups and any probable interactions of the color of laser applied and time of repetition. Data were analyzed by IBM SPSS version 21.

Laser irradiation

ILIB was administered through a sterile, disposable catheter in a vein in the forearm. A sterile disposable optic fiber was passed through the catheter and 1–2 mm of its tip was placed in the vein. This is a safe process just like a serum injection. For red light group, a 630-nm laser apparatus (Mulat, Russia) was used and for blue light group, a 405-nm laser apparatus (Azor, Russia) was used. The power output and the spot size were 1.5 mW and 0.01 cm^2. We used a continuous mode for irradiation and the time of irradiation was 30 min for both groups. The treatments were carried out every other day 1 day using blue light and 1 day using red light up to 14 sessions, 7 sessions using blue light and 7 sessions using red light [7].

Blood sugar was checked before and 15 min after ILIB using glucometer (ExiCheck, Iran).

The patients used their medications as regular and received ILIB too. During the course, we decreased medications if needed according to the BS level.

Results

The test was conducted among 24 patients and the mean of blood sugar has decreased after both red and blue irradiation in all seven repetitions (Fig. 1). This effect was highly significant ($p<0.0001$). Repeated measure ANOVA statistic test shows that there is not any statistical significant difference between red and blue light irradiation in this case ($p=0.417$). The time of repetition has no significant effects in this reduction as well ($p=0.401$).

Discussion

Our previous studies have shown that using low-level lasers is beneficial for a wide range of conditions, including hyperglycemia, neuropathy, and wound healing in diabetic patients [4, 5, 20, 21]. In this study, we compared the effects of blue and red laser lights on BS level in diabetic type 2 patients. Our results showed that ILIB with both red and blue lights can significantly decrease blood glucose level in diabetic patients ($p<0.0001$), but we did not find significant difference between blue and red lights on BS level.

The most common used wavelengths for ILIB include 890, 630, 650, and recently 450 nm. According to the Russian studies, ILIB increases oxygen content and reduces the partial pressure of carbon dioxide. It eliminates tissue hypoxia, stimulates oxygenation, activates the nonspecific mechanisms of anti-infectious immunity, and normalizes tissue metabolism. It raises activity of complement, reduces the content of C-reactive protein, increases the plasma level of immunoglobulins (IgG, IgA, IgM), decreases the aggregation ability of thrombocytes, and activates fibrinolysis which enhances peripheral circulation [22]. Earlier, Lebed'kov et al. studied the effect of ILIB on the blood lipid and phospholipid components in diabetic patients. They showed that ILIB significantly affects blood components [8]. Yudong et al. studied the effects of ILIB on the index of blood and hyperlipidemia. They reported that triglyceride, cholesterol, and the rheology index of blood have obviously been improved. They suggested that intravascular He-Ne laser irradiation could be used to prevent hyperlipidemia and cardiocerebral vascular diseases [23]. Ramdawon used ILIB in combination with LLLT and acupuncture laser therapy to control blood sugar in diabetic patients. They concluded that even in advanced cases of diabetes mellitus, the pancreas had the ability to restore its function and it was possible to bring down the blood glucose level to normal values without the use of any hypoglycemic medications. They suggested that laser energy could stimulate and regenerate pancreatic tissues, including the β-cells of the Islets of Langerhans, even in advanced disease states [24].

Tiedan et al. studied the effects of red laser light on the blood of diabetic patients. Their results showed that ATPase

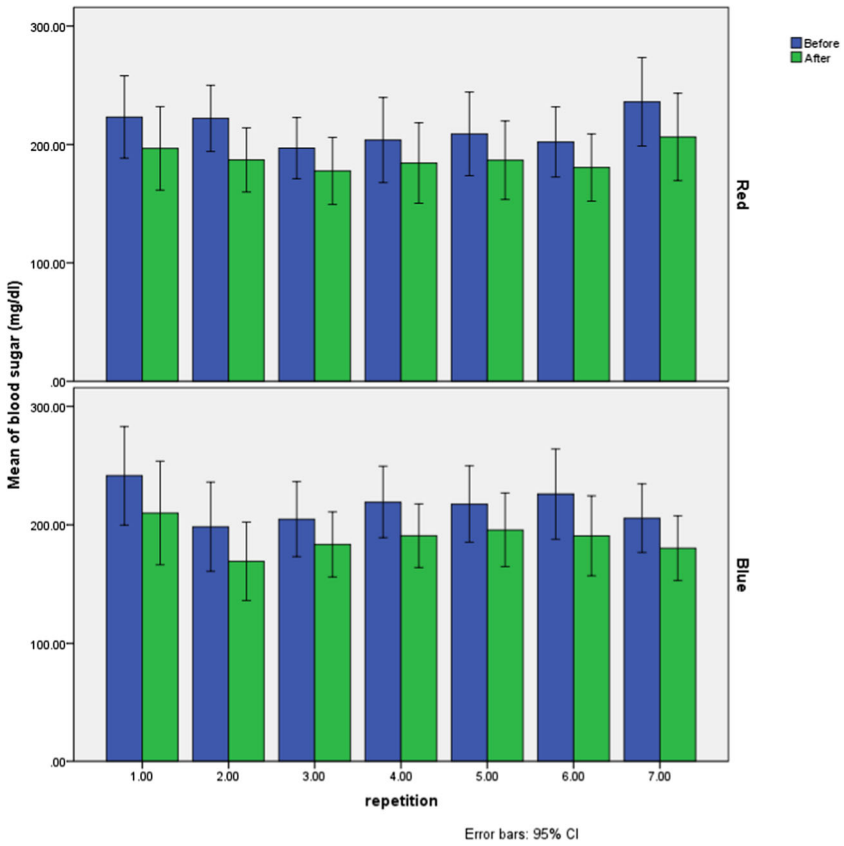

Fig. 1 The mean of blood sugar (mg/dl) before and after red/blue laser treatments in seven repetitions

was significantly lower in diabetic patients than that in control subjects, and low-energy He-Ne laser irradiation could markedly activate Na^+/K^+-ATPase, Ca^{2+}/Mg^{2+}-ATPase. They suggested that intravascular low-energy He-Ne laser irradiation of blood might be a new complex therapeutics for diabetes [25].

Recent studies have showed that blue and red light irradiation can increase production of arginine and nitric oxide. Arginine causes the release of various hormones such as insulin, glucagon, growth hormone, and prolactin [19]. Mittermayr et al. reported that blue laser light can facilitate the release of nitric oxide and affect tissue perfusion [26].

Jianhong et al. evaluated the effects of ILIB in patients after cerebral infarction. Their results showed that the plasma cholesterol, triglyceride, plasma viscosity, fibrinogen, and ESR decreased. They suggested that the treatment can regulate lipid metabolism and improve the characteristics of hemorrheology [6]. Ying et al. also considered the decrease of plasma viscosity and fibrinogen and the increase of erythrocyte deformability after ILIB [14]. Mi et al. compared the effect of ILIB with different wavelengths for the treatment of patients with cerebral infarction. Their results showed that irradiation with lasers of 532, 632.8, and 650 nm may enhance serum concentration of Cu, Zn superoxide dismutase and the index increased significantly after irradiation with laser of 532 nm. The laser irradiation decreased serum concentration of endothelin-1 at the same energy, but revealed no significant effect to serum concentration of GMP. They suggested that the photobiological effects of stimulation may depend on the laser wavelengths [27]. Xiaosen et al. compared the fluorescence spectra from venous blood of normal human after irradiation with 530 and 632.8 nm lasers. They reported that the spectral profiles of blood induced by these two lights were different. They also suggested that these two wavelengths interact differently and therefore each particular wavelength have a distinct biological effect on blood [28]. Huajiang et al. studied the effect of blue laser light (488 nm) on arteries and veins [29].

Tong et al. compared the effects of different wavelengths on immune components in mice and intracellular free calcium in human lymphocytes. They reported that more positive effects were produced by 532, 632.8, and 652 nm [30].

Chenzhong et al. evaluated the effects of different wavelengths on serum concentration of nitric oxide, β-endorphin (β-End), and nitric oxide synthase (NOS) activity of mice. Result showed that irradiation of 532 and 632.8 nm significantly raised serum NO concentration, laser of 532, 632.8, and 650 nm evidently raised serum NOS activity, and serum β-End concentration increased significantly after irradiation of laser of 532 nm. They suggested that wavelength was an important factor in LLLT [9].

Previous studies show the effects of different wavelengths of laser irradiation on complex pathologies like diabetes, and some studies compare the effects of different wavelengths on

cerebral infarction, blood components, etc., but in this study for the first time, we compared the effect of blue and red laser lights on blood sugar level in diabetic patients. Although we did not find significant difference between these two wavelengths, but the highly significant effect of ILIB using each of these wavelengths on decreasing BS level suggests this method as an effective therapeutic method in diabetic type 2 patients. ILIB may be an effective therapy in diabetic patients, alone or along with medications. As a systemic treatment, ILIB affects on metabolism [19], vascular system and makes micro and macro vasodilatation [19, 26], has therapeutic effects on diabetic neuropathy [20], improves immune system [22] without any of medications side effects, and therefore may be a promising treatment for diabetic patients.

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References

1. Mester E, Mester AF, Mester A (1985) The biomedical effects of laser application. Lasers Surg Med 5:31–39
2. Lubart R, Wollman Y, Friedmann H, Rochkind S, Laulicht I (1992) Effects of visible and near-infrared lasers on cell cultures. J Photochem Photobiol B 12:305–310
3. Ramdawon DP. Bioresonance Information Laser Therapy of Diabetes Mellitus
4. KazemiKhoo N, Iravani A, Arjmand M, Vahabi F, Lajevardi M, Akrami S et al (2013) A metabolomic study on the effect of intravascular laser blood irradiation on type 2 diabetic patients. Lasers Med Sci 28:1527–1532
5. Kazemi-Khoo N (2006) Successful treatment of diabetic foot ulcers with low-level laser therapy. Foot 16:184–187
6. Jianhong Z, Bin J, Jianzhong F (2000) Low-energy He-Ne laser intravascular irradiation therapy for cerebral infarction. Chin J Rehabil 4:006
7. Weber M, Fußgänger-May T, Wolf T (2007) The intravenous laser blood irradiation—introduction of a new therapy. Lasers Med Sci: 664–706
8. Lebed'kov E, Tolstykh P, Marchenko L, Turkina T, Krivikhin V (1998) The effect of the laser irradiation of the blood on its lipid and phospholipid components in diabetes mellitus. Voen Med Zh 319:37–38, 95
9. Chenzhong Y, Daping F, Xiaoning Z, Zhengrong H, Zuxuan Z (1998) Biological effects of intravascular low level laser irradiation with five different wave length. J Applied Laser 2:012
10. Karu T (1999) Primary and secondary mechanisms of action of visible to near-IR radiation on cells. J Photochem Photobiol B: Biol 49:1–17
11. Lewis JB, Wataha JC, Messer RL, Caughman GB, Yamamoto T, Hsu SD (2005) Blue light differentially alters cellular redox properties. J Biomed Mater Res B Appl Biomater 72:223–229
12. Manteifel V, Karu T (2005) Structure of mitochondria and activity of their respiratory chain in successive generations of yeast cells exposed to He-Ne laser light. Izv Akad Nauk Ser Biol 32:556–566
13. KazemiKhoo N, Babazadeh K, Lajevardi M, Dabaghian FH, Mostafavi E (2014) Application of low-level laser therapy following coronary artery bypass grafting (CABG) surgery. J Lasers Med Sci 5: 86–91
14. Ying HZH (1998) The studies of hemorheological indexes blood lipid and fibrinogen after the treatment of CVD with ILIB. Chin J Hemorheol 4:027
15. Yinghua C, Wenming X (2002) Mechanism analysis on ILIB improving the property of rheology of blood. Laser J 2:030
16. Houreld NN, Sekhejane PR, Abrahamse H (2010) Irradiation at 830 nm stimulates nitric oxide production and inhibits pro inflammatory cytokines in diabetic wounded fibroblast cells. Lasers Surg Med 42:494–502
17. Moshkovska T, Mayberry J (2005) It is time to test low level laser therapy in Great Britain. Postgrad Med J 81:436–441
18. Makela AM (2004) Theoretical backgrounds for light application in diabetes. Laser, Florence
19. Makela AM (2005) Role of L-arginine in the biological effects of blue light. Laser Florence 2004. International Society for Optics and Photonics, pp 596805–596813
20. Khamseh ME, Kazemikho N, Aghili R, Forough B, Lajevardi M, Dabaghian FH et al (2011) Diabetic distal symmetric polyneuropathy: effect of low-intensity laser therapy. Lasers Med Sci 26:831–835
21. KazemiKhoo N, Shokrgozar MA, Kashani IR, Amanzadeh A, Mostafavi E, Sanati H et al (2014) In vitro therapeutic effects of low level laser at mRNA level on the release of skin growth factors from fibroblasts in diabetic mice. Avicenna J Med Biotechnol 6:113
22. Brill G, Gasparyan L, Makela AM (2003) editors. Modification in relationships in the system endothelial cell-blood platelet by low level laser radiation. Laser Florence meeting
23. Yudong Y, Zhanhong L, Yong L, Xiaoguang L (2002) Effects of low power semiconductor laser extravascular irradiation of index of blood and hyperlipidemia. Laser J 1:042
24. Ramdawon P (1999) Bioresonance information laser therapy of diabetes mellituse a first clinical experience of the hypoglycemic effect of low level laser therapy and its perspectives. North American Laser Therapy Association Conference
25. Tiedan W (1992) Effects of low-energy He-Ne laser irradiation of extracorporeally circulatory blood on ATPase activities of erythrocyte membrane in patients with IDDM. Laser J 6:011
26. Mittermayr R, Osipov A, Piskernik C, Haindl S, Dungel P, Weber C et al (2007) Blue laser light increases perfusion of a skin flap via release of nitric oxide from hemoglobin. Mol Med 13:22–29
27. Mi X, Chen J, Cen Y, Liang Z, Zhou L (2004) A comparative study of 632.8 and 532 nm laser irradiation on some rheological factors in human blood in vitro. J Photochem Photobiol B: Biol 74:7–12
28. Xiaosen L, Xiaowu N, Shumei G, Ping D (2003) Analysis of fluorescence spectra of blood induced by lights of 530 nm and 632.8 nm. J Nanjing University of Sci Technol 27:73–76
29. Huajiang W, Xiaoyuan L, Xiaoxing L, Dongji W, Runchu T (2001) Scattering and absorbing characteristics of rabbit arteries and veins in Kubelka-Munk model at 488.0 nm wavelength of Ar laser in vitro. Laser Technol 6:014
30. Tong M, Liu Y-F, Zhao X-N, Yan C-Z, Hu Z-R, Zhang Z-X (2000) Effects of different wavelengths of low level laser irradiation on murine immunological activity and intracellular Ca2+ in human lymphocytes and cultured cortical neurogliocytes. Lasers Med Sci 15:201–206