



Research article

Improvement of antibiotics absorption and regulation of tissue oxygenation through blood laser irradiation



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ABSTRACT

A point of this work is to estimate the impact of laser blood irradiation controlled intravenously at the level of an antibiotic. Hundred and twenty grown-up female adult rabbits were utilized in this investigation. They were separated into two equivalent groups relying upon the method for managing of the antibiotic. First group injected with 10 mg/kg b. w of Moxifloxacin antibiotic while second group was given the Moxifloxacin but in a type of a tablet, containing 10 mg/kg.b.w orally. Following, each group was partitioned into four equivalent subgroups; control and treated with laser therapy at different time. Gallium-Arsenide (GaAs) laser device, utilized for treatment, in wavelength 904 nm, power of 5mW, its include a connector by optical fiber with fine cannula fixed at its end. Rabbits of laser subgroup; were treated by presenting needle of cannula into ear-marginal vein for 10, 20 and 30min. Blood samples have been collected from both groups after 1, 2, 3, 4, 5 and 6 h intervals after treatment and had transmitted for analysis via a high-pressure liquid chromatography to determine level of Moxifloxacin in blood. The after-effects' revealed a regular increment in Moxifloxacin level (ng/ml) in two groups until 3 h followed with a rapid decline until the end of the experiment. Blood Irradiation through low-level laser enhances the concentration of Moxifloxacin in the serum whatsoever; was the rout of its performance, besides the irradiation help within quickened clearance of blood beginning the drug.

1. Introduction

During Intravenous Blood Laser Irradiation (IBLI), thin optical fiber technique (laser guide) is inserted inside the lumen of vein through needle or catheter, while other end side of it attached to low level laser system [1]. Through this way, the blood while passing in the vein is exposed to laser beam. Various blood ingredients, including erythrocytes (red blood cells), platelets, neutrophils, eosinophils, and basophils; T cells and B cells, blood proteins such as serum albumin, globulins and so on, absorb laser beam [2]. It is acknowledged, that modification of these cells function following laser irradiation is ending with essential anti-infection immunity, enhanced the microcirculation, and additional benefits for body modifications. The Biological effects vary by means of the wavelength range of radiation [3, 4].

Molecules absorb the radiation in the blood cells for example DNA, as well as protein or certain drugs and these molecules are transformed chemically which, open biochemical responses in cells [5]. Theses biochemical process generates cool oxidants ROS that leads to genetic material transcription then cellular repair plus advance the progress of microcirculation in addition to stimulating lymphatic system, gives

maintenance of high concentrations of drug within blood, lymph. Additionally, Nitric oxides are released back to the system [6]. Nitric oxides help to expand the blood vessels, as well as improve blood circulation and improve the drug absorption [7].

Numerous reports have successful performance of IBLI in the medication of various sicknesses and infections. They had conferred that laser beam can stimulate microcirculation, progress O₂ plus nutrients that provide to tissues, therefore stimulate reparation of damaged tissues or limit it caused by activated ionizing radiation, hypoxiation, bacterial toxins, Microbial toxins or Cytotoxic drugs. Additional mechanisms of action are linked to activation and balancing of the immune system; and this is why IBLI can be utilized together with additional treatment methods in the processing of inflammations, infections, Autoimmune Disorders [8, 9, 10].

Activation of cellular immunity is extra significant action of laser beam. IBLI can stimulate bactericide activity of the blood serum, reduce the levels of c-reactive protein, toxicity plasma levels, levels of circulating immune complexes, and increase the concentration of Immunoglobulin A, M, G in the blood serum. IBLI can excite phagocytosis of macrophages generating more influential amount of bacteria captured over and above

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Table 1. Mean with standard error of Moxifloxacin concentration for the control and laser treatment subgroups within the Oral group.

Time (hours)	Oral Treatment Groups					
	Laser irradiation for 10min		Laser irradiation for 20min		Laser irradiation for 30min	
	Control Subgroup	Laser treat Subgroup	Control Subgroup	Laser treat Subgroup	Control Subgroup	Laser treat Subgroup
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
1	70 ± 1.54*	96 ± 1.54*	74 ± 1.54*	140 ± 1.54*	60 ± 1.54*	155 ± 1.54*
2	85 ± 1.18**	120 ± 1.18**	81 ± 1.18*	160 ± 1.18**	80 ± 1.18**	170 ± 1.18*
3	61 ± 1.08*	98 ± 1.08*	55 ± 1.08**	120 ± 1.08*	79 ± 1.08**	140 ± 1.08*
4	56 ± 1.39*	76 ± 1.37*	48 ± 1.39*	70 ± 1.31*	66 ± 1.39*	90 ± 1.59*
5	39 ± 1.35*	49 ± 1.38*	37 ± 1.38*	40 ± 1.38*	50 ± 1.48*	50 ± 1.38*
6	22 ± 1.54*	39 ± 1.68*	19 ± 1.54*	20 ± 1.38*	29 ± 1.54*	10 ± 1.18*

* P<0.05; ** P<0.01.

destroyed [11, 12, 13]. Moreover, a significant importance of microcirculation in the implementation of the biological influence of the waveband, particularly of that around the Gallium Arsenide (GaAs) laser device, has been confirmed other studies [14, 15].

Immunological consequence of IBLI can be described through normalization of intercellular bonds inside the sub-population of T cells and enhancing the amount of these cells in the blood. Its boosts the function action of B cells, encourages the immune response, reduces the intoxication, and as a result enhances the overall condition of patients [16, 17].

Amounts of assays have confirmed the fact that laser blood irradiation stimulates the development of capillary tubes, reduces vasospasm, discharges stasis, including reverses blood flow. Furthermore, blood irradiation has been conferred to minimize capillary edema moreover to increase the number of functioning capillary tubes [18]. It has been noted that exposure to low levels of laser radiation actively developed a new capillary tubes, whereby augmenting the oxygen delivery to the tissues also optimizing metabolism [19].

IBLI can be effectively applied with traditional methods for antimicrobial therapies. Ihsan, M.F.R [20]. stated regarding significantly greater concentration of Genetamicin in blood plasma of experimental animals after IBLI by using 904nm, with power 10 mW. Moskvina et al. [21] utilized UV-IBLI for processing of diabetes purulent complications. They found faster advancement of general condition, detoxication, enhancement of microcirculation, and fluidity rate. They noticed a blood samples included a smaller volumes of aerobic and anaerobic bacteria following laser therapy.

This study has made due to the importance of overcoming a time of available drug preparations absorption time by suggestion of stimulation of drug by IBLI method, which is being widely used during several past years. We have suggested to use the Moxifloxacin drug in this study since

is utilised to treat a mixture concerning bacterial infections. This medication regards to the class of drugs termed quinolone antibiotics. It achieves through stopping the outgrowth of bacteria [22]. Moxifloxacin diffuses readily in to all body tissues along with fluids. It has a wide spectrum in addition to its bactericidal action; it is administered orally, intramuscular as well as intravascular (IV).

2. Materials and methods

120 female adult, New Zealand, rabbits have been used in this work. They had been divided into two equivalent groups. First was treated with Moxifloxacin (10mg/kgb.w.) and were administered intramuscularly by (Netherlands; H.M.Com.) while; the second group has been received similar dose but were administered orally as a tablets (Ajanta pharma limited, India).

All groups have been subdivided into two subgroups; control and, treated by laser on changed time. Fine cannula fixed within ear-marginal vein towards to obtain the samples. After that, the samples have been transmitted for evaluation of Moxifloxacin level via high-pressure liquid chromatography (Schmsu Analytical Laboratory, Japan, and J-4002).

GaAs laser device, it is emit at 904nm, and power 5mW, its include a connector by optical fiber with fine cannula fixed at its end have been used as an irradiation source.

Animals' of treated subgroups irradiated after administration of antibiotic immediately. Blood samples have been collected from the animals of each one subgroup following 1, 2, 3, 4, 5 and 6 h from the time of antibiotic injecting. Irradiation time has been 10, 20, 30min. Process of blood irradiation has been transmitting from laser beam through a fine fiber optic (outer diameter of 0.8mm) conceded into femoral vein crossways a cannula (AG, D-34209, Vasofix-Germany) fixed to its end.

Table 2. Mean with standard error of Moxifloxacin concentration for the control and laser treatment subgroups within the intramuscular group.

Time (hours)	Intramuscular Treatment Groups					
	Laser irradiation for 10min		Laser irradiation for 20min		Laser irradiation for 30min	
	Control Subgroup	Laser treat Subgroup	Control Subgroup	Laser treat Subgroup	Control Subgroup	Laser treat Subgroup
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
1	80 ± 1.66*	155 ± 1.1*	88 ± 1.36*	170 ± 1.36*	79 ± 1.36*	184 ± 1.36*
2	94 ± 1.31*	174 ± 1.3*	97 ± 1.18*	186 ± 1.21*	88 ± 1.21*	191 ± 1.18*
3	72 ± 1.22*	157 ± 0.92*	81 ± 1.57*	162 ± 1.54*	73 ± 1.18*	178 ± 1.54*
4	54 ± 0.99*	131 ± 1.69*	53 ± 0.99*	137 ± 0.99*	61 ± 0.99*	152 ± 0.99*
5	32 ± 1.38*	115 ± 1.78*	37 ± 1.18*	113 ± 1.78*	40 ± 1.18*	121 ± 1.18*
6	21 ± 1.38*	92 ± 1.18*	18 ± 1.38*	99 ± 1.68*	27 ± 1.38*	80 ± 1.38*

* P<0.05; ** P<0.01.

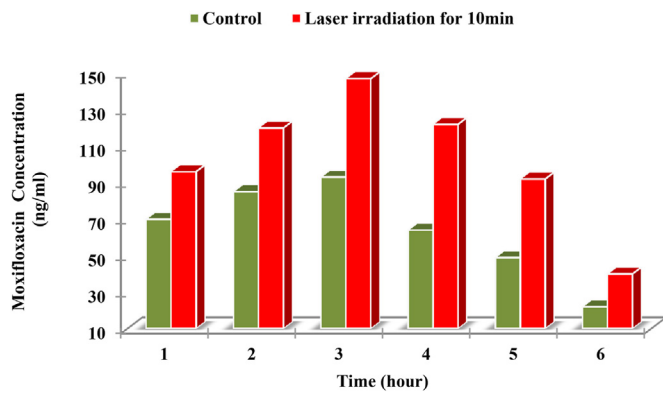


Figure 1. Concentrations of the Moxifloxacin in oral group at laser irradiation for 10 min.

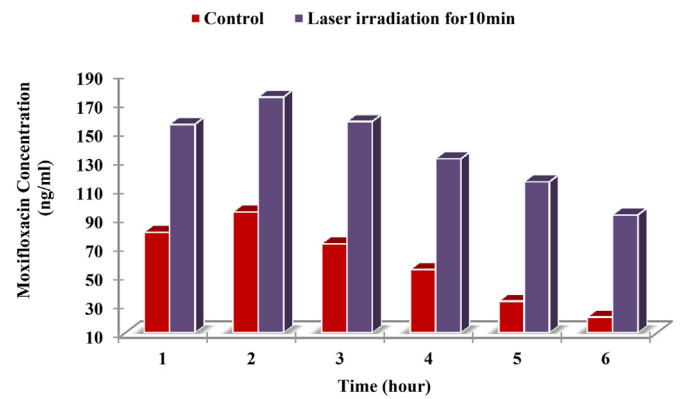


Figure 4. Concentrations of the Moxifloxacin in intramuscular group at laser irradiation for 10 min.

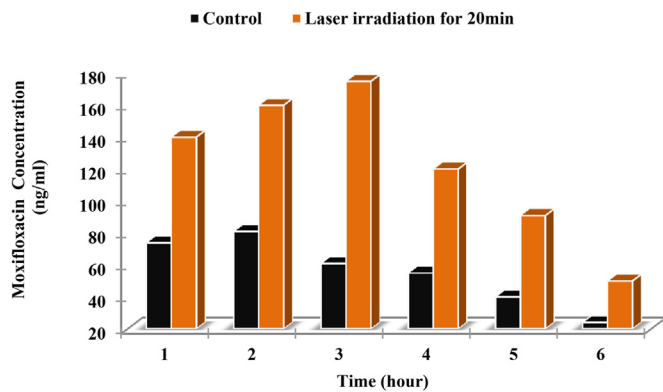


Figure 2. Concentrations of the Moxifloxacin in oral group at laser irradiation for 20 min.

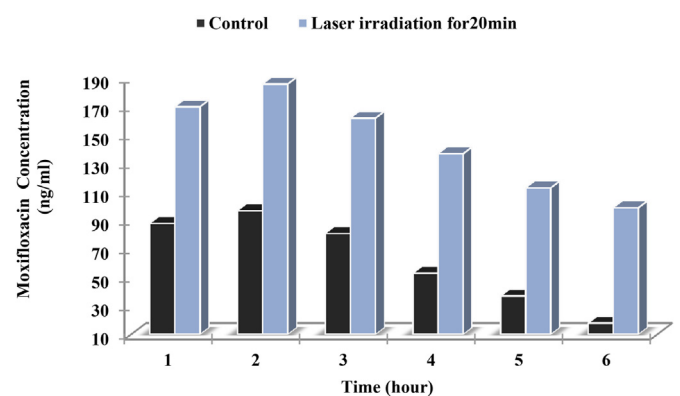


Figure 5. Concentrations of the Moxifloxacin in intramuscular group at laser irradiation for 20min.

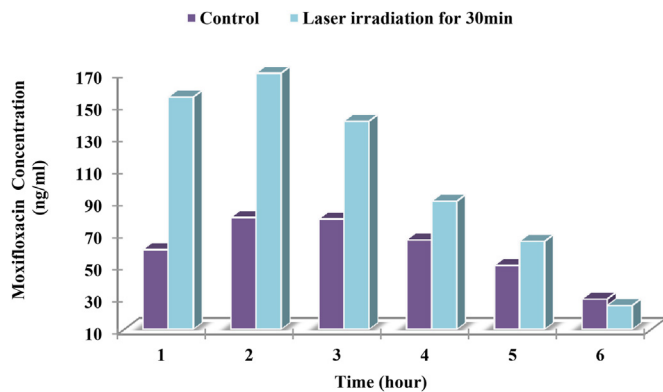


Figure 3. Concentrations of the Moxifloxacin in the oral group at laser irradiation for 30 min.

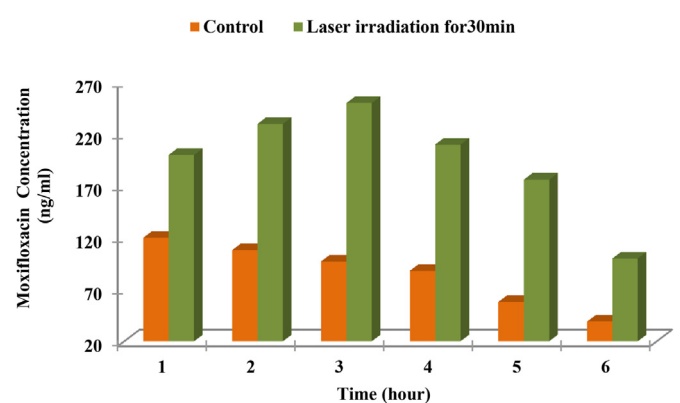


Figure 6. Concentrations of the Moxifloxacin in intramuscular group at laser irradiation for 30 min.

2.1. Statistical analysis

Values obtained from samples have been estimated statistically by means of (ANOVA) to evaluate the responses of each and every one subgroups; control in addition to laser treated. Results of Moxifloxacin Concentrations intended for various groups at changed times of irradiation have been represented like the mean with standard error. IBM SPSS Statistics 27 has been utilised for statistical analysis. Value $P \leq 0.05$ has been set, as a numerical significance.

3. Results

The after-effects of the level of the Moxifloxacin (ng/ml) over the time of all control as well as irradiated groups have been presented in Tables 1 and 2 separately. Gradual increase has been appeared in the results of the samples on all times in both intramuscular along with oral groups. In addition to every one of the subgroups (control along with laser therapy treated) beginning from 1 hour furthermore achieve the peak at the end of 3 hour, after that they lessens slowly in anticipation of the end of the experiment.

The effects of all hours time provided in the subgroup that treated by administered the Moxifloxacin orally showed considerably significant differences; $P < 0.01$ when, compared by means of the control one. While, in the first group that the Moxifloxacin is administered intramuscular, presented significant differences; $P \leq 0.01$ once compared with control one by the side of all hours times are given, except the 2 hour which; presented so greatly significant differences, $P < 0.001$, in the notice to a control one.

Influences of irradiation time on the concentrations of Moxifloxacin which was orally administered are shown in the Figures 1, 2, and 3. The levels of Moxifloxacin have been reaching peak after 3h and had gradually dropping to normal values after time. There was a big increase in levels of Moxifloxacin after 20min of irradiation time.

In addition, the effects of irradiation time in intramuscular administered group have been presented in the Figures 4, 5, and 6. There were increases of Moxifloxacin levels reaching a peak after 3h and had gradually dropping to normal values after time. There were also big increases after 20min of irradiation time.

4. Discussion

The rise in the concentration of Moxifloxacin in the blood of treated subgroup, which intramuscular administered was highly significant when compared with the control subgroups. This observation is attributed to laser radiation that accelerates vasodilatation. Most essential to temporary vasodilatation is an enlargement in the diameter of blood vessels. Vasodilatation is known well as an essential factor boost bioavailability of drugs [23, 24].

Results obtained from treated subgroups that received Moxifloxacin orally; there were a rise in the concentration of Moxifloxacin in the subgroups laser-treated. This could be explained by a laser beam can stimulate and proliferate erythropoiesis as well as differentiate red blood cell precursors because of the activation of caspase-3. In addition to anti-hypoxic activity in blood cells and tissue; also the activation in the microcirculation [25, 26].

Following the influence of IBLI, there are sufficient changes in peripheral blood, a study via Filippidis, G.et.al [27] indicated an increase in red blood cell count, decrease in the erythrocyte sedimentation rate (ESR), and enhanced functions of lymphatic plus macrophage cells. Ananchenko.et.al [28] investigated the outcomes of ILBI on the clinical progression and action of energy enzymes of the peripheral blood lymphocytes in ischemic heart disease patients.

Experimental studies reported significant differences in the morphological structure of peripheral blood based on the influence of ILBI. Following total irradiation of an animal, reticulocytosis was detected together with raise in the erythrocyte count and improved resistance [29, 30].

The performance of low-power laser therapy is connected to the ability of cells to absorb the photon energy and transform it into Adenosine triphosphate (ATP). Commonly ATP is generated by the mitochondria, utilizing O_2 as the principal fuel. Laser therapy stimulation has been bestowed to enhance the generation of ATP through forming dioxide, Reactive oxygen species, or Nitric oxide (NO), all of which affect the production of ATP [31, 32].

In vitro studies by F.R.Mohammed [33] and his group [34] have conferred an increase in production of E and F prostaglandins following low power laser therapy. These produce vasodilatations and play as a synaptic modulation in afferent stimuli transfer.

The rise in antibiotic level had highly significant in all groups for 1h and 2h furthermore then began to lessen through time until reach clearance approximately. Medications for example procaine, certain antibiotics, can be improved their efficiency through laser assist by intensifying their receptor sites [35, 36].

The results of this study agreed with a study via Jin Woong Lee [37] and his group, which examined the efficiency of Methyl 5-aminolevulinate in the treatment of recalcitrant Malassezia folliculitis, they had

found that the inflammatory lesions had been decreased obviously. They had concluded that low power laser therapy increases the absorption of the drug in the treatments of the diseases.

Outcomes obtained from this study should be accredited to the studies of enhancement of blood rheological properties, along with a rise in capillary blood flow. Additionally, it decreases the vascular resistance as well as vascular tone, which guides to support the motion flow of fluids into the lymphatic system. Thus, IBLI allows obtaining upper drug saturation in blood in comparison, by way of intramuscular administration.

5. Conclusion

Blood laser irradiation improved regulation of tissue oxygenation as well as the dynamics of morphofunctional activity of blood. Energetic effects of laser therapy approaching antibiotic activity are the fundamental feature of their therapeutic benefit. Blood laser irradiation when combined through antibiotic oral or intramuscular injection administration allows obtaining elevated drug saturation in blood in comparison by way of intramuscular injection administration alone. Thus, it means that this technique; have been supported the accelerating restoration of functions along with stimulation of the adaptational ability, furthermore stabilization of the hormonal state.

Declarations

Author contribution statement

Zahra Al Timimi: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Declaration of interests statement

The authors declare no conflict of interest.

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No additional information is available for this paper.

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