Correlations between Lymphocytes, Mid-Cell Fractions and Granulocytes with Human Blood Characteristics Using LowPower Carbon Dioxide Laser Radiation

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Abstract

In this research, the subpopulations of human blood parameters including lymphocytes, monocytes, and granulocytes were determined by electronic sizing in the Health Centre of UniversitiSains Malaysia. These parameters have been correlated with human blood characteristics such as age, gender, ethnicity, blood types, body mass index, medical history, number of chronic diseases, and type of chronic diseases; before and after irradiation with 15 W carbon dioxide laser (λ=10,600 nm). The correlations were obtained byfinding patterns in changes of blood parameters using paired non-parametric tests, and an independent non-parametric test using the SPSS version 17. Irradiation of blood samples with carbon dioxide laser showed significant changes in lymphocytes, monocytes, and granulocytes before and after irradiation. These analysis revealed that a significant increase in lymphocyte before and after irradiation among different body mass index (p-value = 0.031). There is significant increase in monocyte before and after irradiation between medical history (p-value = 0.052), and number of chronic diseases (p-value = 0.022). And there is significant decrease in granulocyte before and after irradiation, among different body mass index (p-value = 0.021), and number of chronic diseases (p-value = 0.018). The correlation between changes in human blood parameters and a patient's characteristics were very much correlated and can become a significant indicator for blood analyses. This study considered as a new finding for the increase in lymphocyte, monocyte, and the decrease in granulocyte by using low power Carbon dioxide laser radiation.

Keywords: Carbon dioxide laser radiation, Lymphocyte (LYM), Monocyte (MID), Granulocyte (GRAN)

1. Introduction

The Carbon dioxide laser is widely used by surgeons and is the most commonly used medical lasers, and different from other medical lasers the action of this laser on tissues is clearly seen when it is used (Judy, 1995). Carbon dioxide lasers can be used for a number of soft tissue applications (Research Science & Therapy Committee, 2002) including the following: soft-tissue incision and ablation; gingival troughing; esthetic contouring of gingiva; treatment of oral ulcers; frenectomy and gingivectomy; de-epithelialization of gingival tissue during periodontal regenerative procedures.

The Carbon dioxide laser offers a number of advantages for such applications. It provides excellent hemostasis, offering the dentist a clear operating field and allowing for instant visual feedback. In addition, the Carbon dioxide laser removes tissue efficiently and quickly and causes negligible concern about subsurface tissue damage, as the effect is on the surface only (Fisher, et al., 1983). Postoperative pain usually is minimal to none

(Pick & Colvard, 1993). This laser is absorbed strongly by water that formed > 80% of soft tissues (Oswal, et al., 1988; Apfelberg, et al., 1981a, 1984b; Kaplan & Giler, 1984; LoCicero, et al., 1985). Most of the irradiation energy of a Carbon dioxide laser is absorbed by the tissue surface, and little penetrates to cause damage in deeper tissues (Kumazawa, et al., 1992).

The study of the mechanism of interaction of a low – intensity laser radiation with living organism by various methods for the purpose of widening the field of its medical applications is undoubtedly a pressing problem. The solution of this problem will aid in further development of practical medicine. Although the fact that the response of blood to the action of a low – intensity laser radiation gives important information on the mechanism of interaction of laser radiation with a living organism (Zalesskaya & Sambor, 2005; Korolevich, et al., 1992; Khairullina & Oleinik, 1996) only a small number of works have been devoted to such investigation in living organisms.

Kujawa et al. (2002) have studied the transformations of RBC produced by low-intensity near IR (810 nm). The investigations revealed that low-intensity near IR laser radiation produced AchEase activity changes, reflecting the effect of light on the enzyme due to energy absorption. In humans, the Carbon dioxide laser is used most commonly in oral and maxillofacial soft tissue surgery due to its favorable interactions with oral soft tissue. While the mechanisms of the effects of Carbon dioxide laser on human blood cells are not yet understood, because of lack of the researches in this field. More research needs to be done to understand the respond of this parameter with low level laser radiation. The goals of the present study are to compare the blood parameters of LYM, MID and GRAN before and after irradiation of Carbon dioxide laser and to study correlations between LYM, MID and GRAN with human blood characteristics such as age, gender, ethnicity, blood types, body mass index, medical history, number of chronic diseases, and type of chronic diseases; before and after laser irradiation.

2. Methodology

2.1 Blood Parameter Measurement

Fresh human blood parameter such as LYM, MID, and GRAN before and after laser exposure in each blood sample were analyzed by using automated hematology analyzer sysmex, KX-21N. The analyser measured the blood parameters, in particular the LYM, MID, and GRAN. These fresh human blood samples were collected from the Health Centre of UniversitiSains Malaysia. A total of 240 blood samples from 120 males and 120 females were used in this study. Blood samples were obtained from patients with ages ranging from 10 to 80 years old and were labeled with the coding systems according to age, gender, ethnicity, blood types, body mass index, medical history, number of chronic diseases, and type of chronic diseases.

2.2 Laser Irradiation

The subpopulations of human blood parameters such as white blood cell WBC included LYM, MID, and GRAN for laser irradiation. Every blood sample was divided into two equal parts: laser irradiated and control sample. The sample was irradiated for one second using the 10,600 nm infrared light laser beam from a Carbon dioxide laser (Synrad model j48-1, USA) as a power source. Readings of blood parameter, was recorded before and after irradiation. Experiments were repeated for all blood groups under the same experimental conditions; laser beam power, beam source-sample distance, sample detector distance, beam exposure time, room temperature and humidity.

2.3 Statistical Analysis

After irradiation was performed, non- irradiated and irradiated samples of the blood parameter, LYM, MID, and GRAN, were compared. The paired test was used to determine the differences between the controlled samples and irradiated samples. An Independent test was further conducted to examine the differences in the samples according to the age, gender, ethnicity, blood types, body mass index, medical history, number of chronic diseases, and type of chronic diseases of patients. The SPSS software version 17 was utilized to perform statistical calculations and analyses of the data.

3. Results and Discussion

In this study, the measurements using automated hematology analyzer sysmex, KX-21N showed significant differences between control and irradiated blood samples using Carbon dioxide laser (Table 1). The analyses of white blood cell WBC parameter include: lymphocyte (LYM), monocyte (MID), and granulocyte (GRAN) parameters showed a significant increase in lymphocyte (p-value = 0.000) and in monocyte (p-value = 0.000) whereas a significant decrease in granulocyte (p-value = 0.000).

The difference in blood parameter readings using Carbon dioxide laser was investigated according to respondent's characteristic: age, gender, ethnicity, blood group, body mass index, medical history, number of chronic diseases, and type of chronic diseases. There is significant increase in mean lymphocyte before and after Carbon dioxide laser irradiation among different body mass index (p-value = 0.031), patients with underweight show the highest increase in mean lymphocyte (Table 2). There is no significant increase in mean lymphocyte before and after irradiation using Carbon dioxide laser for age groups (p-value = 0.482), between gender (p-value = 0.581), ethnicity (p-value = 0.117), blood groups (p-value = 0.831), medical history (p-value = 0.517), number of chronic diseases (p-value = 0.504), and type of chronic diseases (p-value = 0.855).

There is significant increase in mean monocyte before and after irradiation using Carbon dioxide laser between medical history (p-value = 0.052), and number of chronic diseases (p-value = 0.022) (Table 3), the mean increase of monocyte is higher for patients with chronic diseases than patients without chronic diseases and for patients with one chronic disease than patients with more than one chronic disease. There is no significant increase in mean monocyte before and after irradiation using Carbon dioxide laser for age groups (p-value = 0.608), between gender (p-value = 0.978), ethnicity (p-value = 0.456), blood groups (p-value = 0.876), body mass index (p-value = 0.157), and type of chronic diseases (p-value = 0.178).

There is significant decrease in mean granulocyte before and after irradiation using Carbon dioxide laser among different body mass index (p-value = 0.021), and number of chronic diseases (p-value = 0.018) (Table 4), the mean decrease of granulocyte is higher for patients with normal weight than patients with underweight and for patients with more than one chronic disease than patients with one chronic disease. There is no significant decrease in mean granulocyte before and after irradiation using Carbon dioxide laser for age groups (p-value = 0.701), between gender (p-value = 0.627), ethnicity (p-value = 0.891), blood groups (p-value = 0.562), medical history (p-value = 0.153), and type of chronic diseases (p-value = 0.520).

Physically, the increase in mean lymphocyte, and monocyte that mean the proliferation and production increase of these cells. These are may be due to the fission of mononuclear cells owing to the effects of low energy Carbon dioxide laser irradiation. While the decreases in mean granulocyte, may be due to dead of this parameter after the low energy Carbon dioxide laser irradiation.

4. Conclusions

The findings from this study indicate that the 10600 nm low levels Carbon dioxide laser irradiation cause: a significant increase in lymphocyte, monocyte, and a significant decrease in granulocyte. Generally the increasing effect on the proliferation and production of lymphocyte, and monocyte may be due to the fission of mononuclear cells owing to the effects of low energy Carbon dioxide laser irradiation. However the decreases in proliferation in granulocyte may be due to dead of this parameter after the low energy Carbon dioxide laser irradiation. These can become a significant indicator for blood analysis.

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Table 1. Blood parameters for controlled and irradiated samples by using CO_2 laser

Blood parameters	LYM	MID	GRAN
Controlled	34.50± .642	10.15± .262	55.33± .676
Irradiation	37.02± .564	11.76±.302	51.44± .637
Difference	2.51± .233	1.61± .240	-3.88± .390
p–value	0.000***	0.000***	0.000***

Blood parameters (mean ± standard error) for 240 irradiated and 240 controlled samples.

Statistical significance:* p<0.10, ** p<0.05, *** p<0.01

Table 2. Comparison of lymphocyte according to characteristic of respondents

Characteristic	Category	CO_2 laser Mean ± Std error	p–value
Age (years)	10 – 24	2.589±.928	0.482
	25 – 40	2.966±.789	
	>40	2.257±.562	
Gender	Male	2.632±.584	0.581
	Female	2.379±.624	
Ethnicity	Malay	2.687±.610	0.117
	Chinese	2.736±.897	
	Indian	1.666±1.029	
	Others	2.570±.956	
Blood Group	A	2.344±.918	0.831
	B	2.388±.714	
	AB	2.780±.987	
	O	2.649±.877	
Body mass index(kg/m^2)	Underweight : <18.5	5.793±1.760^a	0.031**
	Normal weight: 18.5-24.9	2.169±.625^b	
	Overweight: 25-29.9	2.198±.727^b	
	Obesity: ≥ 30	3.070±1.146^b	
Medical history	with chronic disease	2.563±.621	0.517
	without chronic disease	2.473±.566	
Number of chronic diseases	one chronic disease	2.681±.755	0.504
	more than one chronic disease	2.314±1.097	
	without chronic disease	2.473±.567	
Type of chronic diseases	Cardiovascular	2.469±.937	0.855
	metabolic	2.502±1.026	
	other chronic disease	2.895±1.417	
	without chronic disease	2.473±.567	

Statistical significance:* p<0.10, ** p<0.05, *** p<0.01&a, b significant difference between the groups.

Table 3. Comparison of monocyte according to characteristic of respondents

Characteristic	Category	CO_2 laser Mean ± Std error	p–value
Age(years)	10 – 24 25 – 40 >40	0.970±.775 1.617±.659 1.844±.470	0.608
Gender	Male Female	1.512±.491 1.725±.525	0.978
Ethnicity	Malay Chinese Indian Others	1.312±.515 2.288±.757 1.987±.869 1.252±.807	0.456
Blood Group	A B AB O	1.985±.770 1.537±.599 1.633±.828 1.365±.736	0.876
Body mass index(kg/m²)	Underweight : <18.5 Normal weight: 18.5-24.9 Overweight: 25-29.9 Obesity: ≥ 30	3.536±1.481 1.436±.526 1.726±.612 1.100±.964	0.157
Medical history	with chronic disease without chronic disease	2.023±.518[a] 1.269±.473[b]	0.052*
Number of chronic diseases	one chronic disease more than one chronic disease without chronic disease	2.472±.629[a] 1.074±.915[b] 1.269±.473[a,b]	0.022**
Type of chronic diseases	Cardiovascular metabolic other chronic disease without chronic disease	2.283±.784 1.835±.859 1.786±1.185 1.269±.475	0.178

Statistical significance:* p<0.10, ** p<0.05, *** p<0.01& a, b significant difference between the groups.

Table 4. Comparison of granulocyte according to characteristic of respondents

Characteristic	Category	CO_2 laser Mean ± Std error	p–value
Age (years)	10 – 24	-3.766 ± 1.020	0.701
	25 – 40	-4.662±.867	
	>40	-3.535±.618	
Gender	Male	-3.824 ± .635	0.627
	Female	-3.955±.679	
Ethnicity	Malay	-3.651±.691	0.891
	Chinese	-4.680±1.015	
	Indian	-3.653±1.165	
	Others	-3.759±1.082	
Blood Group	A	-3.596±.976	0.562
	B	-4.126±.759	
	AB	-4.413±1.049	
	O	-3.370±.932	
Body mass index(kg/m²)	Underweight : <18.5	-9.329±1.900^{b}	0.021**
	Normal weight: 18.5-24.9	-3.295±.675^{a}	
	Overweight: 25-29.9	-3.700±.785^{a,b}	
	Obesity: ≥ 30	-4.024±1.237^{a,b}	
Medical history	with chronic disease	-4.034±.676	0.153
	without chronic disease	-3.762±.616	
Number of chronic diseases	one chronic disease	-4.603±.820^{b}	0.018**
	more than one chronic disease	-2.831±1.193^{a}	
	without chronic disease	-3.762±.617^{a,b}	
Type of chronic diseases	Cardiovascular	-3.473±1.021	0.520
	metabolic	-4.547±1.118	
	other chronic disease	-4.338±1.543	
	without chronic disease	-3.762±.618	

Statistical significance:* p<0.10, ** p<0.05, *** p<0.01& a, b significant difference between the groups.