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Evaluation of SAR and temperature variation in diabetic blood using different power outputs of 532 nm laser for low level laser therapy.

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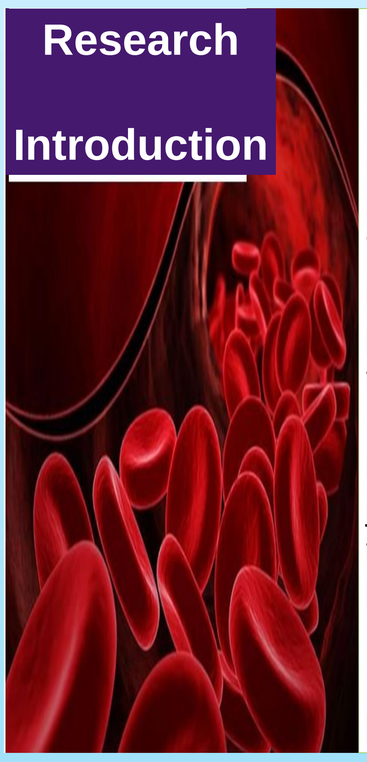
ABSTRACT:

Relationship between specific absorption rate (SAR) and temperature variation during blood laser therapy help in suggesting appropriate laser output power for efficient diabetic patient's treatment. A portable diode-pumped solid state laser of wavelength 532 nm at power of 50- 80 mW was used for blood exposure. Its capacitance and dissipation factor was obtained using Agilent 4294A impedance analyser spectroscopy within frequency range of 40Hz-30 MHz. At average tempt range of $24.2 - 26.0\,℃$ and specific absorption rate of blood range within $0.140 \leq 0.695\,W/Kg$, the condition of the exposed diabetic blood was observed to improve both morphologically and physiologically. Laser power intensity and exposure time are directly proportional to SAR until the diabetic blood attains saturation peak. Therefore laser parameters and material properties influenced the blood cells, the plasma status and general conditions. Within the diabetic blood SAR range of $0.140 - 0.695$ W/kg before saturation absorbance peak, laser therapy can have a robust positive influence on the immune system cells and all blood exchange processes.

Research Introduction



Blood laser treatment has effects like biostimulation, analgesia and stimulation of immune system.

The low level laser therapy (LLLT) has been known for enhanced diabetic cases, proliferation of fibroblast cells, cells of endothelial and the lymphocytes etc.

The proliferation mechanism is believed resulted from the mitochondria photo-stimulation which leads to signalling pathways activation and the up regulation of the transcription factors that affects growth factors increase.

Individual systems and components practices play unique roles in achieving the desired goal therefore have to be justifiable by evaluating the specific absorption rate (SAR) of the diabetic blood and its temperature variation to ensure human safety is fully optimised [2].

It is the amount of energy absorbed by the blood sample/tissue during radiation exposure, expressed in Watts per kilogram of the blood weight.

Significance of Study

- This research work will provide a deep understanding of SAR evaluation for proper blood low level laser therapy. The dielectric study of blood impedance spectroscopy method will help to optimise the use of radiation exposure in laser practice.

Objectives

1. To evaluate SAR for 532 nm wavelength lasers in blood laser therapy for efficient cell stimulation, diabetic diagnosis and treatment.
2. To examine and suggest the proper exposure duration and average temperature that the SAR is achieved.

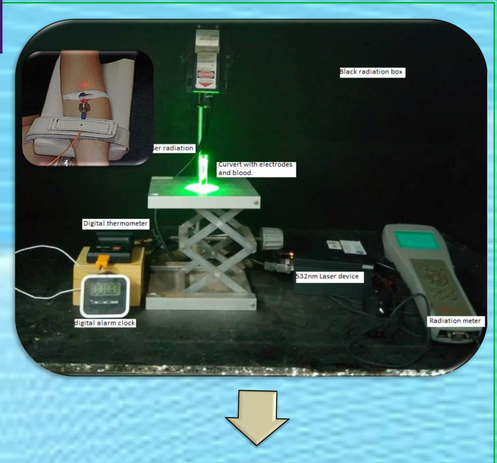
Research Methodology

Ethical approval on clinical data study

Blood Samples collection: 64 (diabetic and non-diabetic) patients involved.

653 nm Laser

- Power- 50, 60, 70 & 80 mW
- Duration: 5,10,15&20 mins



Capacitance & Dissipation factor-Calculate

$$\varepsilon' = \frac{cd}{\varepsilon_o A} \quad 1$$

$$\varepsilon'' = \varepsilon' * D \quad 2$$

$$\sigma = \varepsilon_r'' \omega \varepsilon_o \quad 3$$

Agilent 4294A impedance analyser

SAR EVALUATION

Blood dielectric constant ε' conductivity σ (S/m), conductance G, dielectric loss ε'',impedance Z (real and imaginary)

$$E_o^2 = \frac{2I_{av}}{c\varepsilon_o} \quad 4$$

$$SAR = \frac{\sigma/E/^2}{2\rho}\text{(W/Kg)} \quad 5,$$

ε_o is the permittivity of free space (8.854×10^{-12}F.m^{-1}),

$\omega = 2\pi f$(f is the frequency in Hz), $/E/^2$is the electric field strength (field amplitude) (V^2/m^2), ρ is the density of the blood(Kg/m^3) [2].

Research Results

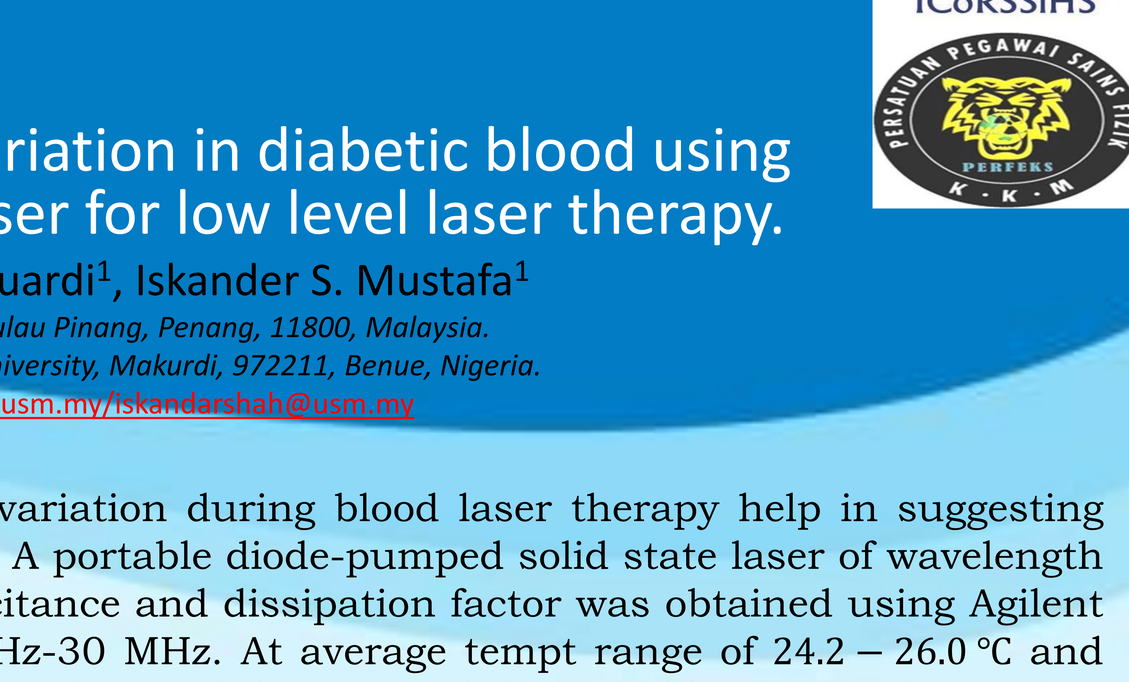


Fig 1. Frequency characteristics of SAR values of non-diabetic blood irradiated using a laser at an output power of 50 mW under different time duration duration.

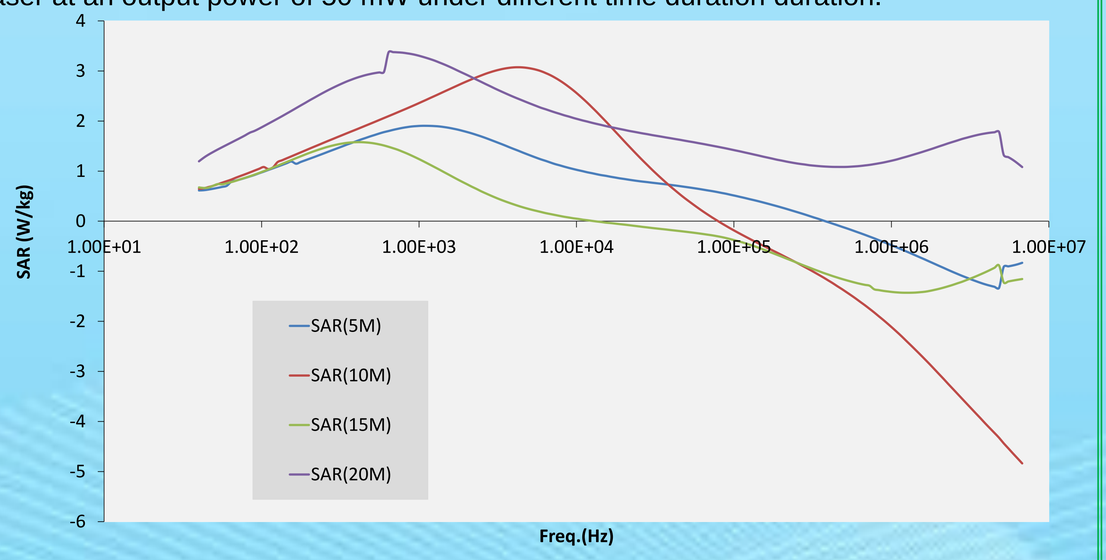
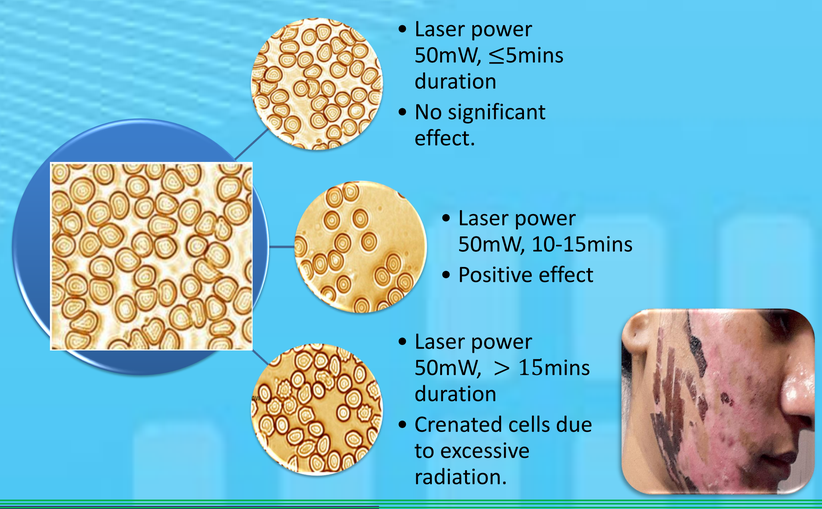


Fig 2. Graph of SAR values of diabetic blood frequency characterization irradiated using a laser at an output power of 50 mW under different time duration.

Table 1 below shows the efficacy /optimization of diabetic patient's blood irradiated and SAR at characterized frequency of 40Hz

Duration (Min)	50mW		60mW		70mW		80mW	
	SAR (W/kg)	Blood Phs.	SAR (W/kg)	Blood Phs	SAR (W/kg)	Blood Phs	SAR (W/kg)	Blood Phs
5	0.615	Stimulate	0.489	Stimulate	0.140	Stimulate	2.064	Not satisfy
10	0.647	Stimulate	0.695	Stimulate	1.666	Not satisfy	2.412	All crenate
15	0.674	Stimulate	0.893	Not satisfy	0.837	All crenate	1.506	Lake & haemolysed
20	1.195	Not satisfy	0.326	crenate	2.060	Lake & haemolysed	1.552	Lake & haemolysed



Conclusion

Within diabetic blood SAR range of $0.140 - 0.695$ W/kg , average tempt range of $24.2 - 26.0\,℃$ before saturation absorbance peak, laser therapy efficiently stimulate the immune system cells and all blood exchange processes at appropriate laser output power of 50 mW for 10-15 mins exposure.

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