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Assessment of the impacts of 830 nm Low Power Laser on Triiodothyronine (T3), Thyroxine (T4) and the Thyroid Stimulating Hormone (TSH) in the Rabbits

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ABSTRACT

This study has designed to research whether there an impact on the thyroid hormone in female rabbits irradiated by low power laser therapy (LPLT) in the thyroid gland region. Thirty female rabbits utilized in this investigation. Ten rabbits used for inspecting the thyroid gland location and dissected to make certain that low power laser source shall be directed to this gland. Twenty female rabbits divided into two equal groups: 10 used as control and the others have exposed to LPLT for three sequential days for five minutes on either side. LPLT irradiation procedures consisted of an infrared diode laser emitting at 830 nm in continuous mode, point manner on the thyroid gland role. Blood collected for secretion assay from the ear vein at 1^{st}, 4^{th}, 7^{th}, 10^{th}, 13^{th}, 16^{th}, 19^{th}, 22^{th}, 25^{th} *and* 30^{th} *days after the last treatment of LPLT.*

The results discovered a gradual decrease in Triiodothyronine (T3) and Tetraiodothyronine (T4) levels. A concomitant increase in Thyroid-Stimulating Hormone (TSH) level, then the normalization of hormone level has taken place to be normal after thirty days. It has concluded that LPLT of the thyroid gland can produce an effect on the thyroid hormone levels. A supplementary work is required on this topic to examine the specific role of LPLT on the glands.

Keywords- *Thyroid Gland, Triiodothyronine, Thyroid-Stimulating Hormone, Triiodothyronine, Low Power Laser Therapy***.**

INTRODUCTION

Low Power Laser Therapy (LPLT) is a type of laser medicine utilized in medical and veterinary treatment, which uses (low power) lasers to alter cellular perform. Alternative names for the therapy embrace low-level laser, non-thermal laser, soft laser, cold laser, low intensity laser, phototherapy, bio-stimulation laser and laser acupuncture. Since high intensity lasers ablate tissue, low intensity lasers can stimulate it, encouraging the cells to function [1, 2].

Low intensity laser radiation is characterized by ability to induce thermic, nondestructive photobiological processes. LPLT is argumentative in alternative medicine with ongoing research to decide whether it is a demonstrable effect. Likewise disputed are the ideal location of treatment, efficient dose or energy density, wavelength, beam penetration, pulsing (peak power and repetition rates) and duration [3, 4].

Thyroid is one among the biggest endocrine glands within the body, it is found in the neck inferior to the thyroid cartilage. The thyroid dominates, but quickly the body burns energy, makes proteins, and the way sensitive the body should be alternative hormones. The thyroid gland participates in the above processes through producing the thyroid hormones, especially Thyroxin (T4) and Triiodothyronine (T3) [5].

Triiodothyronine and Thyroxin hormones organize the rate of metabolism; impress the growth and rate of function of many systems within the body [5, 6]. Iodine is an essential part of both T3 and T4. The thyroid additionally produces calcitonin that plays a role in (Ca^{2+}) homeostasis [6].

Hormone generates from the thyroid gland is regulated by the Thyroid-Stimulating Hormone (TSH) generated by the anterior pituitary, that it is regulated by the Thyrotropin Releasing Hormone (TRH) produced by the hypothalamus [7].

Thyroid hormone production is dominated by the (TSH).The increased production of Tyrosine is very important since it establishes the body to produce levodopa and dopamine, the lack of them give rise to muscle stiffness, tetany, spastic and movements that one better known by the name of (Parkinson's Disease)[8, 9].

An infrared laser therapy applied for irradiating thyroid gland since it absorbed by the skin and hairs provides the underlying tissue, which transmits this new energy to the cell walls by means of protein and calcium [10]. The cell walls, then rework into healthy shapes so the cell will do commonly once again and function at a higher ability [11].

The irradiated tissue activates nitric oxide [12], so increasing blood flow that helps to carry vitamins and nutrients to lacking areas; likewise, toxins and metabolic by-products are withdrawn from the suffering tissue quickly [13]. There are three kinds of photo-biological effects that rely on reasonably interaction between laser and biological tissues:

i. Photo-destructive influence. During this case the hydrodynamic, thermal and photochemical effects of laser cause the tissue destruction [14, 15].
ii. Photo-physical and photo-chemical impresses, when laser absorbed by the

tissues, initiates atoms and molecules in these tissues and as result chemical science and photo-physical reactions are appearing [3, 16].

iii. Zero-influence, which means the biological substance doesn't change its properties throughout and once laser radiation. They're such effects like dispersion and reflection [17].

Increasing of the dynamic activity of biological membranes under the influence of low power infrared laser involves in an exceedingly whereas the changing of bioelectrical procedure, stimulating of substance transferring through a membrane, changes in lipid bilayer so the whole membrane potential [18, 19].

Membranes are necessary targets of photo-modification and so the role of singlet oxygen as a crucial intermediate in several membrane's photosensitization reactions is firmly established [17]. Laser studies show that the laser beam is capable of doubling the size of the lymphatic ducts in the area of radiation and swiftly removing the protein waste [18]. Another important aspect that the LPLT was capable of perfect regeneration of the lymphatic system in the immediate area with no leak and no confused network of ducts [20, 21] .

It is known that, in laser therapy, absorption of the laser should be considered at the surface as well as at a depth, be- cause organs other than those targeted for irradiation might be affected [22]. Early observations of the thyroid gland after direct infrared laser irradiation have demonstrated an increase in the mitotic activity of follicular cells, transitory hyperactivity in the follicles, epithelial necrosis, and lack of cellular masses [23].

One classic mechanism concerned is that the laser energy is absorbed by intracellular chromospheres and converted to metabolic energy, in connection with stimulation of the mitochondrion to raise the production of Adenosine Triphosphate (ATP) and increasing in reactive oxygen species, that influence oxidation reduction signalling, which affecting the intracellular homeostasis or the proliferation of cells [2, 24].

The final accelerator within the production of ATP by the mitochondria, cytochrome c enzyme, will seem to just accept energy from laser therapy[25]. ATP acts via multiple P2 nucleotide receptor subtypes to extend intracellular calcium concentration (Ca^{2+}) [26]. At the same time, ATP regulates protein synthesis, deoxyribonucleic acid synthesis, and expression of immediate-early and delayed-early genes [27].

Although, laser irradiation is now being considered a therapy of choice for many difficult pain management challenges and is becoming a common practice in medicine, there is no clear understanding of its side effects from one side and its physiological actions on endocrine glands from the other side. Otherwise, the available studies lack the effect of LPLT on thyroid gland directly, conjointly to verify the effect of 830 nm.

MATERIALS AND METHODS

The study has been approved by the Committee on the Ethics of Animal Experiments of Veterinary Medicine College, Babylon University, Iraq, and conducted in the Laboratory animal based research in University Saints Malaysia (USM) with the recommendations in the Guide for the Care and Use of Laboratory Animals of the National Institutes of Health. A total number of 30 female rabbits, because the females are more sensitive to thyroid diseases than males [28, 29], with a mean weight of (1.75) Kg and similar ages (6) months old were used in this study. They housed in clean plastic cages and kept in a conditioned room (28 -32^{O}C), nutrition, and day–night cycle to avoid physiological changes.

All animals were left for two weeks for adaptation. Ten female rabbits killed by intramuscular injection of Ketamine hydrochloride at a dose 5ml/rabbit and the thyroid gland exposed and the location was noticed. Twenty female rabbits divided into two groups; Control groups, these rabbits were kept without any medication or treatment.

LPLT group, the thyroid gland of these animals irradiated with the using low power infrared laser in continuous mode, 830 nm wavelength and power 150 mW that directed towards to the gland with a spot size of 8.0 mm and a distance from the laser supply to the gland was 1 cm.

The procedure was applied for quarter-hour continuously, double daily with energy density applied to the thyroid gland was 5J/cm^2 clinical signs and symptoms recorded and noted carefully throughout the experiment which lasted for 30 days.

Blood samples collected and serum isolated at 1st, 4th, 7th, 10th, 13th, 16th, 19th, 22th , 25th and 30th days after the last dose of irradiation. The blood kept in tubes for an hour at a temperature 4^{o}C, then the tubes were put in ultra-refrigerated centrifuge for 15 minutes within rotation speed 13000r/min, then the serum isolated and kept in sterile tubes at a temperature of 18^{o}C.

The hormonal analysis (TSH and T4 and T3) measured using a Mini-VIDAS System by Immune enzymatic analysis and a technique to link radiation enzymatic by Enzyme Linked Fluorescent Assay (ELFA).Results statistically analyzed using Statistical Package Social Science (SPSS) using two way (ANOVA) analysis of variance.

RESULTS

During the time of the experiment, the female rabbits irritated with LPLT 830 nm showed disquiet, coldness, dullness, depression, impairment and fatigue, since no such symptoms observed in the control group.

The mean values of Triiodothyronine (T3), Thyroxine (T4) and Thyroid stimulating hormone (TSH) levels ± standard error of the mean (SEM) during 30 days after LPLT irradiation at an energy density (5J/cm^2) for 3 successive days are represented in tables 1-3 and figures 1-3.

Triiodothyronine (TT3) hormone assay as show in the table 1 produce a significant gradual decrease (P>0.05) as compared to the control group and then it increases gradually, While table 2 shows a significant gradual decrease (P>0.05) in the Thyroxine (TT4) assay. This depression becomes significant after 30 days (figure 2) as compared to control group.

Depending on the results in a table (3), Thyroid stimulating hormone (TSH) assay (mlu/L) obvious that the 830 nm laser with energy density (5J/cm^2)

induced a significant gradual (P>0.05) increase In TSH level. At the meantime, the results write down that the maximal level of TSH is being on the 10th day after the last exposure dose of LPLT (figure 3) in comparison during the time of the experiment.

Table 1: The effect of LPLT 830 nm on the level of the Total Triiodothyronine (TT3) hormone (nmol/l) ± SEM of female rabbits as compared to control group at different times during the experimental period.

Time day	Groups	
	Control Mean ± SEM	LPLT Mean ± SEM
1	152± 0.07	143± 1.70
4	143± 0.08	120± 1.80
7	140± 0.08	110± 1.80
10	136 ± 0.07	108± 2.70
13	130± 0.09	94± 1.40
16	122± 0.05	83± 1.60
19	120±0.14	72±1.02
22	117±0.07	62±2.41
25	110±0.17	53±2.3
30	106±0.05	68±2.04

Table 2: The effect of LPLT 830 nm on the level of the Total Thyroxine (TT4) hormone (nmol/l) ± SEM of female rabbits as compared to control group at different times during the experimental period .

Time (day)	Groups	
	Control Mean ± SEM	LPLT Mean ± SEM
1	3.65±0.03	2.88± 0.02
4	3.52±0.02	2.65± 0.04
7	3.29±0.04	2.43± 0.01
10	3.02±0.05	2.29±0.03
13	3.02±0.02	2.24±0.04
16	2.86±0.01	2.07±0.05
19	2.67±0.04	2±0.03
22	2.49±0.05	1.94±0.04
25	3.05±0.03	1.76±0.05
30	3.59±0.05	1.55±0.03

Table 3: The effect of LPLT 830 nm on the level of the Thyroid stimulating hormone (TSH) (mlu/L) ± SEM of female rabbits as compared to control group at different times during the experimental period.

Time day	Groups	
	Control Mean ± SEM	Laser Therapy Mean ± SEM
1	3.44± 0.15	4.73± 0.23
4	3.24± 0.23	4.89± 0.21
7	3.19± 0.10	5.47± 0.24
10	3.1± 0.22	6.46± 0.25
13	2.86± 0.10	6.28± 0.14
16	2.46± 0.17	5.93± 0.16
19	2.32±0.13	5.22±1.34
22	2.27±1.9	4.32±1.24
25	2.37±1.3	3.19±2.8
30	2.45±1.42	2.73±2.26

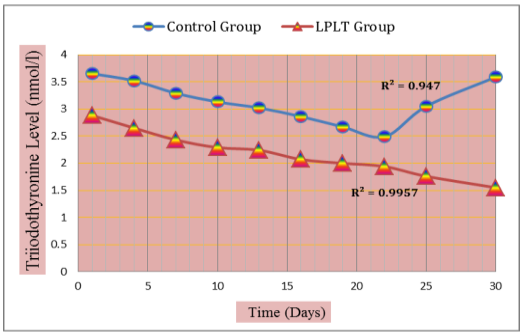

Figure 1: The impact of LPLT 830 nm on T3 (nmol/l) level of female rabbits as compared to control group during the time of the experiment.

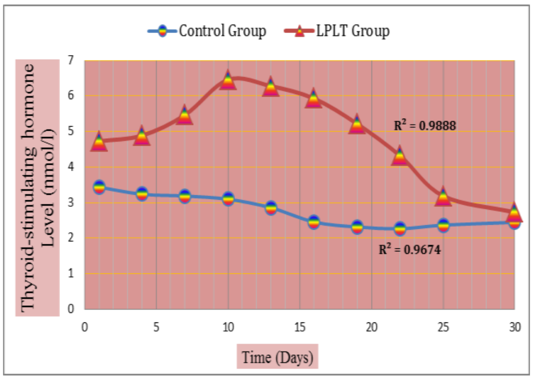

Figure 2: The impact of LPLT 830 nm on T4 (nmol/l) level of normal female rabbits as compared to control group during the time of the experiment.

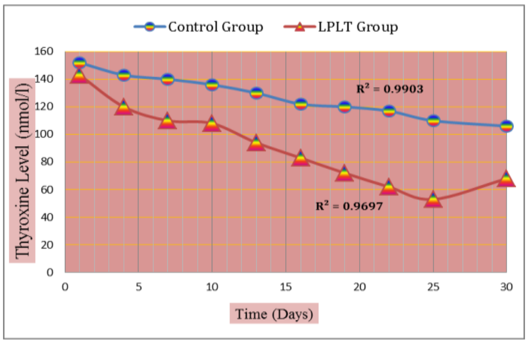

Figure 3: The impact of LPLT 830 nm on serum TSH (mlu/l) level of normal female rabbits as compared to control group during the time of the experiment.

DISCUSSION

Many researchers had reported that measurement of serum TSH is the single best indicator of thyroid function thanks to its sensitivity to any modification in serum T3 and T4 levels [10]. The primary gland disease is manifested by elevated TSH and depression of plasma T3 and T4 [6]. This explains the role of TSH secretion in our experiment. That TSH is the foremost reliable explanation for the normalization of hormone levels is attributable to the function performed by laser irradiation [30]. Recently, Vidal et al. [31] showed that infrared laser irradiation stimulated the growth and maturation of thyroid endothelial cells in young mice, while in adult mice; it could cause thickening of the endothelium and reduction of capillary lumen.

Parrado et al. [32] in an ultra-structural study of the thyroid capillaries showed, by light microscopy, a significant increase of the density of capillary volume in mice irradiated with an infrared laser. Other authors have shown, by electron microscopy, a rise within the luminal area in the capillaries of irradiated mice, in addition to a rise within the thickness of the endothelial cells [30]. It has been accorded that lasers mediate dilation by the histamine nitric oxide, which boosts the transport of nutrients and oxygen to facilitate repair of damaged tissues [11, 13]. It has been clinically documented that lasers will significantly increase the quantity and regeneration of blood and lymphatic vessels [33, 34].

The results of this experiment show that thyroid irradiation by laser reduces hypothyroidism that was characterized by decreasing T3 and T4 levels and increasing TSH secretion from the anterior pituitary gland. However, there is no clear clarification of the impact of a laser on the thyroid gland. The mechanism by which the laser exerts its biological impact remains to be elucidated. The decrease in thyroid hormone secretion in our experiment may well be attributed to some changes in thyroid gland organelles that successively modify thyroid hormone synthesis and secretion processes. A rise in mixture droplets and lysosomes, dilation of rough endoplasmic reticulum and reduction of Golgi apparatus of the thyroid gland are noticed during infrared laser irradiation to rats [10]. It has been reported that laser therapy to hyperthyroid rabbits treated the case of hyperthyroidism by normalizing the levels of hormones and related parameters (cholesterol, total protein, glucose and calcium ions, and inorganic phosphorus in serum) [10, 32].

CONCLUSIONS

Probable alteration in thyroid glands by irradiation with low-intensity infrared emission lasers ought to be investigated, varying the wavelength, energy density and power, with the aim of having the ability to affirm confidently either the deleterious effects or perhaps edges on the thyroid gland.

Finally, our findings function as a proof-of-principle that laser therapy may well be utilized in the treatment of goiter, hyperthyroidism and alternative thyroid diseases.

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REFERENCES

1. Bruch, R. Low Level Laser Therapy (LLLT). in Nevada Health Forum. 2003.
2. Schindl, A., et al., Low-intensity laser therapy: a review. Journal of investigative medicine: the official publication of the American Federation for Clinical Research, 2000. 48(5): p. 312-326.
3. Huang, Y.-Y., et al., Biphasic dose response in low level lighttherapy. Dose-Response, 2009. 7(4): p. 358-383.
4. Tsivunchyk, O.S., Influence of low intensity laser radiation on different biological systems. 2004, Philipps-U niversitأ¤t Marburg.
5. Armigliato, M., et al., Hyperthyroidism as a cause of pulmonary arterial hypertension: a prospective study. Angiology, 2006. 57(5): p. 600-606.
6. Nakamura, T., et al., Association of hyperthyroidism with serum leptin levels. Metabolism, 2000. 49(10): p. 1285-1288.
7. Porazzi, P., et al., Thyroid gland development and function in the zebrafish model. Molecular and cellular endocrinology, 2009. 312(1): p. 14-23.
8. Vos, X.G., et al., Age and stress as determinants of the severity of hyperthyroidism caused by Graves' disease in newly diagnosed patients. European journal of endocrinology, 2009. 160(2): p. 193-199.
9. Cummings, J.L., Depression and Parkinson's disease: a review. The American journal of psychiatry, 1992.
10. Fronza, B., et al., Assessment of the systemic effects of low-level laser therapy (LLLT) on thyroid hormone function in a rabbit model. International journal of oral and maxillofacial surgery. 42(1): p. 26-30.
11. Silveira, P.C.L., et al., Evaluation of mitochondrial respiratory chain activity in muscle healing by low-level laser therapy. Journal of Photochemistry and Photobiology B: Biology, 2009. 95(2): p. 89-92.
12. Aleksic, V., et al., Low-level Er: YAG laser irradiation enhances osteoblast proliferation through activation of MAPK/ERK. Lasers in medical science. 25(4): p. 559-569.
13. Chen, A.C.-H., et al. Role of reactive oxygen species in low level light therapy. in

SPIE BiOS: Biomedical Optics. 2009: International Society for Optics and Photonics.

14. Hawkins, D. and H. Abrahamse, Effect of multiple exposures of low-level laser therapy on the cellular responses of wounded human skin fibroblasts. Photomedicine and Laser Therapy, 2006. 24(6): p. 705-714.
15. Karu, T.I. and S.F. Kolyakov, Exact action spectra for cellular responses relevant to phototherapy. Photomedicine and Laser Therapy, 2005. 23(4): p. 355-361.
16. Karu, T., Mitochondrial mechanisms of photobiomodulation in context of new data about multiple roles of ATP. Photomedicine and laser surgery. 28(2): p. 159-160.
17. Liu, T.C., et al. Membrane mechanism of low-intensity laser biostimulation on a cell. in Optics and Optoelectronic Inspection and Control: Techniques, Applications, and Instruments. 2000: International Society for Optics and Photonics.
18. Liu, T.C.-Y., et al., Microenvironment dependent photo biomodulation on function-specific signal transduction pathways. International Journal of Photoenergy. 2014.
19. Yang, W.گ., et al., Effects of Low Power Laser Irradiation on Intracellular Calcium and Histamine Release in RBLâ€2گH3 Mast Cells. Photochemistry and photobiology, 2007. 83(4): p. 979-984.
20. Lubart, R. and H. Breitbart, Biostimulative effects of lowâ€گenergy lasers and their implications for medicine. Drug development research, 2000. 50(3â€4گ): p. 471-475.
21. Al Ghamdi, K.M., A. Kumar, and N.A. Moussa, Low-level laser therapy: a useful technique for enhancing the proliferation of various cultured cells. Lasers in medical science. 27(1): p. 237-249.
22. Zuk, P.A., The adipose-derived stem cell: looking back and looking ahead. Molecular biology of the cell. 21(11): p. 1783-1787.
23. Schmid, C., et al., Effect of thyroxine replacement on creatinine, insulin-like growth factor 1, acid-labile subunit, and vascular endothelial growth factor. Clinical chemistry, 2004. 50(1): p. 228-231.
24. Torres, C.S., et al., Does the use of laser photobiomodulation, bone morphogenetic proteins, and guided bone regeneration improve the outcome of autologous bone grafts? An in vivo study in a rodent model. Photomedicine and laser surgery, 2008. 26(4): p. 371-377.
25. Tam, G., Low power laser therapy and analgesic action. Journal of clinical laser medicine & surgery, 1999. 17(1): p. 29-33.
26. Albertini, R., et al., Effects of different protocol doses of low power alliumâ€“ aluminumâ€“ arsenate (Gaâ€“Alâ€“As) laser radiation (650 nm) on arrageenan induced rat paw ooedema. Journal of photochemistry and photobiology B: biology, 2004. 74(2): p. 101-107.

27. Houreld, N.N., H. Abrahamse, and J.A. De Villiers, Influence of low intensity laser irradiation on isolated human adipose derived stem cells over 72 hours and their differentiation potential into smooth muscle cells using retinoic acid.
28. Chiovato, L., et al., Thyroid autoimmunity and female gender. Journal of endocrinological investigation, 1993. 16(5): p. 384-391.
29. Bjoro, T., et al., Prevalence of thyroid disease, thyroid dysfunction and thyroid peroxidase antibodies in a large, unselected population. The Health Study of Nord-Trondelag (HUNT). European journal of endocrinology, 2000. 143(5): p. 639-647.
30. Azevedo, L.H., et al., Evaluation of low intensity laser effects on the thyroid gland of male mice. Photomedicine and laser surgery, 2005. 23(6): p. 567-570.
31. Vidal, L., M. Ortiz, and I.P.r. De Vargas, Ultrastructural changes in thyroid perifollicular capillaries during normal postnatal development and after infrared laser radiation. Lasers in medical science, 2002. 17(3): p. 187-197.
32. Parrado, C., et al., A quantitative investigation of microvascular changes in the thyroid gland after infrared (IR) laser radiation. Histology and histopathology, 1999. 14(4): p. 1067-1071.
33. de Lima, F.M., et al., Low-level laser therapy associated to N-acetylcysteine lowers macrophage inflammatory protein-2 (MIP-2) mRNA expression and generation of intracellular reactive oxygen species in alveolar macrophages. Photomedicine and laser surgery. 28(6): p. 763-771.
34. Gao, X. and D. Xing, Molecular mechanisms of cell proliferation induced by low power laser irradiation. J Biomed Sci, 2009. 16(4): p. 1-16.