Rabbit's Triiodothyronine (T_3), Thyroxin (T_4) and the Thyroid Stimulating Hormone (TSH) time depending levels after exposure to laser irradiation and their correlation

Parekhan M. Jaff
College of Science, Sulaimani University.
Kalyan Hama Salih
Technical Institute, Health Department, Sulaimania.
Keywords : Rabbit T_3, T_4, TSH, Laser irradiation.

(NJC)

(Received on 23/9 /2008) **(Accepted for publication 18/3 /2009)**

Abstract

Safe doses of low-intensive visible, class (II) He-Ne laser of λ= 632.8 nm in a dose response of (12-84) J/cm^2 has been used for investigating laser effects on thyroid gland function of rabbits.

Thyroid gland function was examined by monitoring and determining the triiodothyronine (T_3), thyroxin (T_4) and the thyroid stimulating hormone TSH level before (as controls) and after laser irradiation. The activity of Thyroid Glad for (T3) and (T4) production increase directly with laser exposure duration while the rate of TSH production decreases by the same rate.

The correlation of T_3, T_4 and the TSH hormones production during laser irradiation also studied con-firing our data is the closely correlated that obtained for three hormones investigated.

Key Words: He-Ne Laser, Laser interaction with tissues, Thyroide Gland

الخلاصة

لدراسة تأثير عملية تعرض الغدة اللمفاوية في الأرانب الى أشعة الليزر تم استخدام ليزر مرئي بقدرة واطئة (ليزر الهيليوم–نيون من الصنف الثاني و بطول موجي قدرة 632.8 نانوميتر)، وبجرعة أمينة تتراوح ما بين 12 جول/سم^2 الى 84 جول/سم وذلك بفحص نسبة كل من الهرمونات (T_3)، (T_4) و (TSH) في سائل السيروم المسحوب من آذان الأرانب قبل و بعد تعرض الغدة اللمفاوية للأرانب الى أشعة الليزرثم تمت دراسة العلاقة بين التغيير الحادث في نسبة افراز هذه الهرمونات وأظهرت النتائج بان نشاط الغدة اللمفاوية لانتاج هرمون (T_3) و (T_4) تزداد بزيادة فترة التعرض لأشعة الليزربينما يقل نشاط الغدة لافراز هرمون (TSH) بنفس النسبة.

Introduction

The beneficial properties of light employed for medicinal purposes have a long tradition." Light therapy", also called, Phototherapy, was known by the Egyptians, the Indians and the Chinese, and has been applied since 3000 years ago [1].

Thyroid is one of the largest endocrine glands in the body. This gland is found in the neck inferior to (below) the thyroid cartilage. The thyroid controls how quickly the body burns energy, makes proteins, and how sensitive the body should be to other hormones [2].

The thyroid participates in the above processes by producing thyroid hormones, principally thyroxin (T_4) and triiodothyronine (T_3). These hormones regulate the rate of metabolism and affect the growth and rate of function of many other systems in the body. Iodine is an essential component of both T_3 and T_4. The thyroid also produces the hormone calcitonin, which plays a role in calcium homeostasis [2].

Thyroid hormone production is controlled by TSH, the thyroid stimulating hormone. The increased production of Tyrosine is very important since it establishes the body to produce levodopa and dopamine, the lack of them causes muscle stiffness, tetany, spastic movements which one better known by the name of (Parkinson's Disease) [2]. A therapeutic laser of 632.8 nm wavelength used for irradiating this gland in rabbits since it absorbed least by the skin and hairs provides the underlying tissue [3].

Biomedical Optics as an interdisciplinary field of science has been developed during many years and is covering a wide range of optical techniques and methods, utilized for medical therapeutic and diagnostic purposes [4].

Interaction of light with matter can reveal important information about the nature of the matter.

Considering the duality nature of light, the concept of light-tissue interaction can be explained in two ways.

One is as changing electric and magnetic fields, which propagate through space, forming an electromagnetic wave. This wave has amplitude, which is the brightness of the light, wavelength, which is the color of the light, and an angle at which it is vibrating, called polarization angle**.** This was the classical interpretation. In terms of the modern quantum theory, electromagnetic radiation consists of particles called photons, which are packets-quanta, of energy moves at the speed of light, in this particle view of light, the brightness of the light is the number of photons, and the color of the light is the energy contained in each photon.

To describe the wave nature of the electromagnetic radiation, the terms wavelength λ, or frequency ν are used; while in the particle description of the electromagnetic radiation, the energy E, is used. These quantities are connected as:

$$E\,(J) = h.\nu = h.\frac{c}{\lambda} = E\,(ev).q_e \qquad (1.1)$$

where h denotes Planck's constant, c the speed of light, and q_e the electron unit charge. E (J) and E (eV) are energy in joules and energy in electron-volts; respectively.

Interacting different parts of the electromagnetic spectrum with matter have different effects on it. For example, the human body is quite transparent to the low frequency radio waves, while moving to microwaves and infrared to visible light, the body absorbs more and more. In the lower ultraviolet range, all the UV radiation from the sun is absorbed in the thin outer layer of skin, while moving towards the X-ray region of the electromagnetic spectrum, the body becomes transparent again [5].

Materials

a. Chemical

Three kits were used as a tool for determining T_3, T4 and TSH hormone levels. The kits were manufactured by the firm of Bio Tex-France. Kits of T_3 and T_4 hormones were used by Radioimmunoassay. While that for TSH was used adopting Immunoradiometricassay (IRMA) techniques.

b. Instruments

- He-Ne laser source with 632.8 nm wavelength.
- γ- Counter – LKB.
- ERMA – counter – LKB.
- Centrifuge – T5.

c. Samples Collection

1. Animals: 14 rabbits were used and grouped into 9 rabbits 9 month age and 5 rabbits of 2-3 months. Their feeding was as specific supplements. Living with a day-night cycle.

2. Serum collection: Two mills of serum from each rabbits were collected from their ears.

Methods

1. Determination of T3, T4 and TSH as control levels:

The T_3, T_4 and TSH levels were determined before and after irradiation by laser using immunochemical techniques. Two of the most important techniques were applied. A Radioimmunoassay (RIA) was applied in detection levels of both T_3 and T_4 hormones, while another technique called Immunoradiometricassay (IRMA) was applied in detecting TSH hormone [11]. Both, RIA and IRMA techniques are capable of measuring the primary reaction between hormone and a single antibody. in IRMA, the antibody is labeled [12].

$$Ab + Ag \underset{K-1}{\overset{K1}{\rightleftarrows}} Ab - Ag$$

$$K = \frac{[Ab - Ag]}{[Ab][Ag]}$$

Ab- Antibody.
Ag- Antigen (hormone).
Ab-Ag- Boond complex formation.
K_{1-} Association rate constant.
K-1 – Dissociation rate constant.
K – Equilibrium rate constant.

The animals (rabbits) were left for state at their cages for 2-3 hrs before collecting blood samples. Blood sample (5 ml) is collected by a vein puncture using sterilized syringe from rabbit's ear. The blood was left for clouting at room temp, for a period of time between 60-120 minutes. After that, the sera were separated (2 ml) using centrifugation, for 5-10 minutes. (r.p.m. =3000).

2. Exposure of rabbits to irradiation (He-Ne laser 632.8 nm):

Shaving the area surrounded thyroid gland of the rabbits take place before the irradiation. A power of 1 mw of He-Ne laser was directed to thyroid gland. The direction of He-Ne laser takes place by using two- side exposure about 5 cm from the thyroid gland, the doses varied from 12 J/cm^2 to 84 J/cm^2 of laser source this corresponding to exposure duration of 1 to 7 minutes.

3. Determination of T3, T4 and TSH levels after laser irradiation:

Sera of the rabbits were collected using the techniques as previously illustrated (1).
The collection of rabbit's sera has been done after 48 hrs. from the laser irradiation.

4. Determination of T3, T4 and TSH technology:

Two types of techniques were applied in the determination of the hormones T3, T4 and TSH. Radioimmunoassay technique was adopted for T3 and T4 levels determination depending on the technology of an antibody-antigen

(Ab-Ag) analysis in which a dose response is proportional to the counted radioactive tracer, using γ-counter. For determining TSH level, an IRMA technique was adopted. The level of T3, T4 and TSH hormones were determined before and after laser irradiation of the rabbits as it have been illustrated before.

Results

4.1 The effect of thyroid gland irradiation on the Production of T3, T4 and TSH:

Figure (4.1) shows that the production of triiodothyronine (T_3) is increased as a result of laser irradiation nearly by a rate of (2/7 n.mol/L.min) while the production of thyroxin (T_4) is increased nearly by a rate of 55/7 (n.mol/L.min) , if we compare between this value and the ratio of (T_3) production we conclude that this difference is due to the fact that the activity of thyroid gland for(T_4) production is more than its activity for (T_3) production, while the production of thyroid stimulating hormone TSH is decreased nearly by a rate of 2/7u.Mol/L.Min and this is the same rate of increase in triiodothyronine (T_3) production value and this is proves that the production of thyroxin (T_4) and triiodothyronine (T_3) are regulated by thyroid stimulating hormone (TSH).

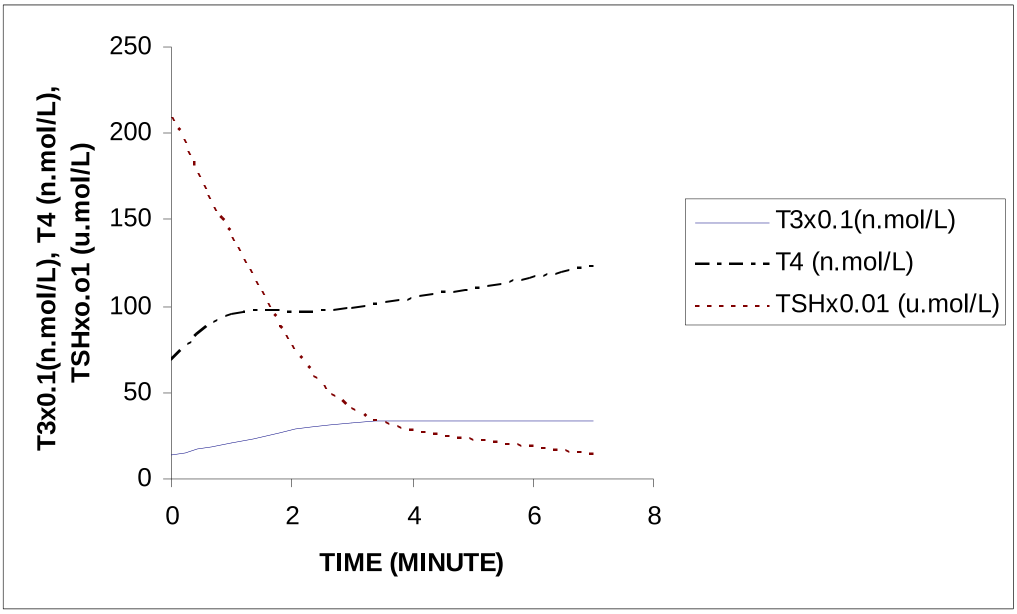

Figure (4.1): The variation of T3, T4 and TSH with time laser exposure.

4.2 The relation between the Production of T3 with T4 and TSH:

Figure (4.2) shows that triiodothyronine (T_3) and thyroxin (T_4) are directly related to each other and increased with time exposure duration, but the (T_4) level is 28.94 times the (T_3) level at the same exposure duration while the production of triiodothyronine (T_3) and thyroid stimulating hormone (TSH) are inversely related to each other, this proves that the production of triiodothyronine (T_3) is regulated by the production of thyroid stimulating hormone (TSH).

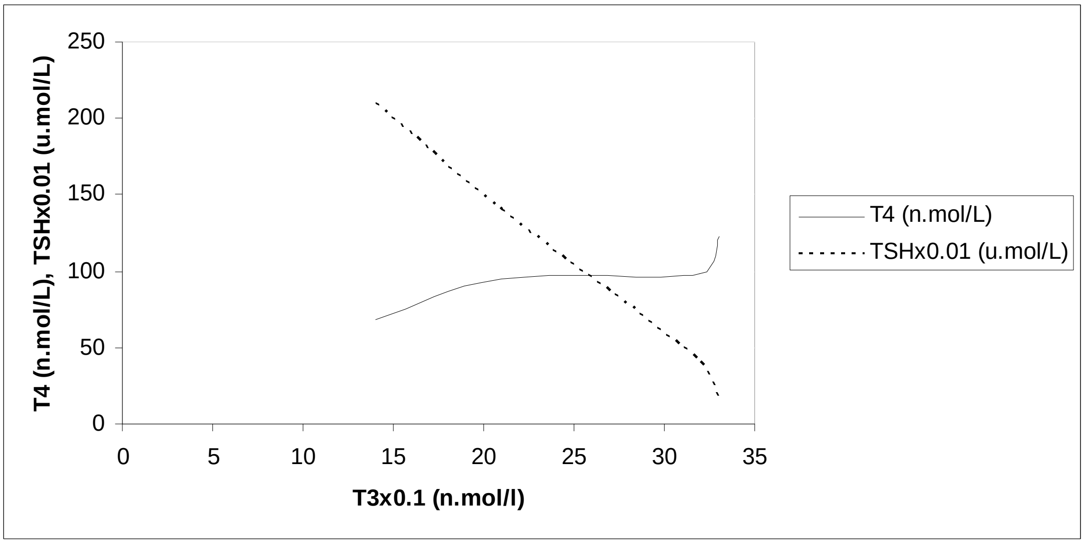

Figure (4.2): The variation of T4 and TSH with T3.

4.3 The relation between the:

4.3.1 Variation of T_3 and T_4 with laser exposure duration:

Figure (4.3) shows that the production of triiodothyronine (T_3) and the production of thyroxin (T_4) is increased with laser exposure duration, but the rate of (T_4) production is 28.94 times that of (T_3) production.

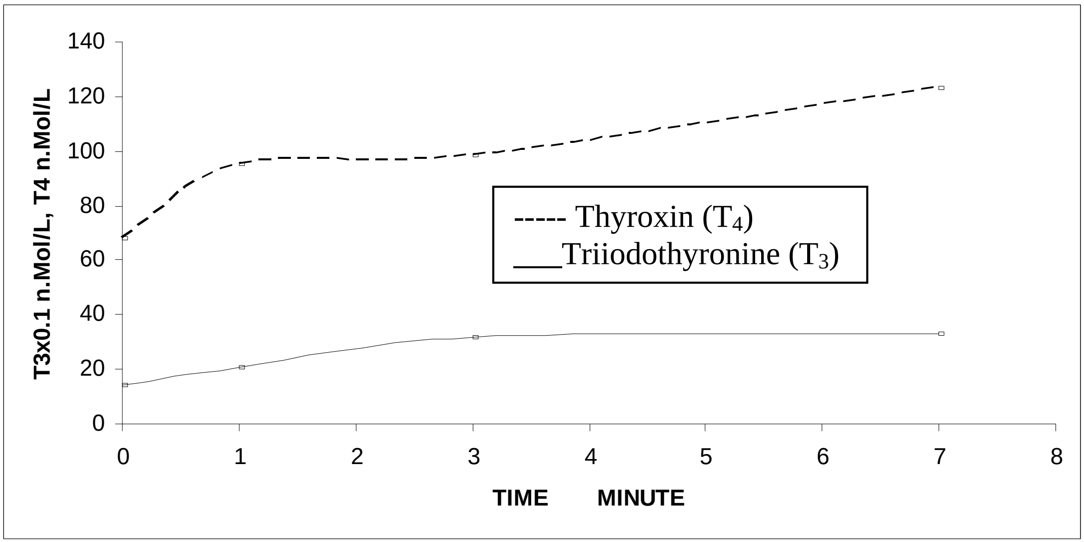

Figure 4.3: T_3 and T_4 levels versus the exposure duration.

4.3.2 Variation of T_3 and TSH with time exposure:

Figure (4.4) shows that after the laser irradiation T_3 level is increased by a rate of 2/7 n.mol/L, while the TSH production is decreased by the same rate and this proves that the production of triiodothyronine T_3 is regulated by thyroid stimulating hormone TSH.

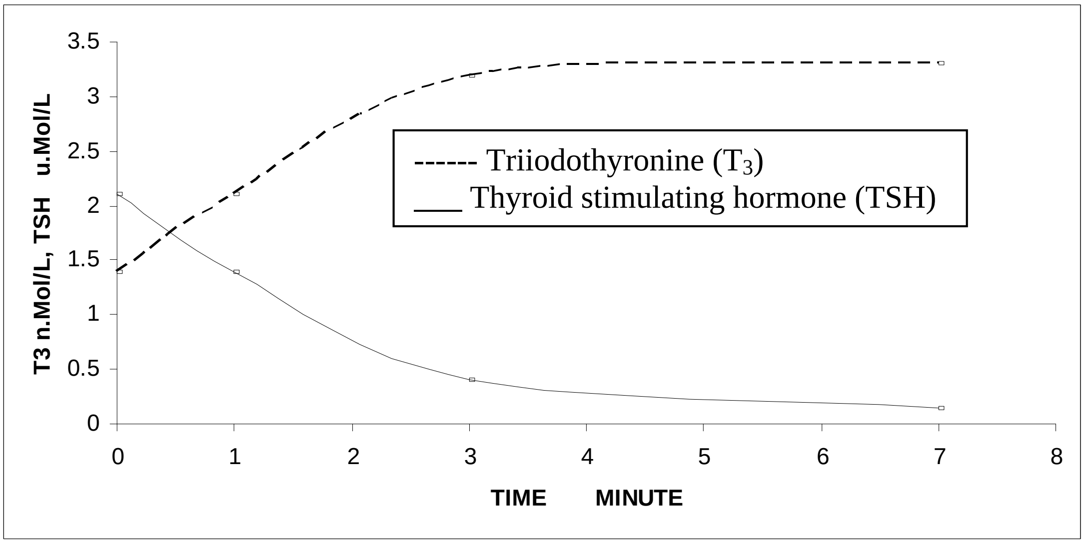

Figure 4.4: The relation between T_3 and TSH production.

4.3.3 The variation of T_4 and TSH with laser exposure duration:

The thyroxin (T_4) production is increased after the laser irradiation by a rate of (55/7 n.mol/L.Min) and this is approximately 28.061 times more than the triiodothyronine (T_3) production due to the same reason written in (4.1.2).

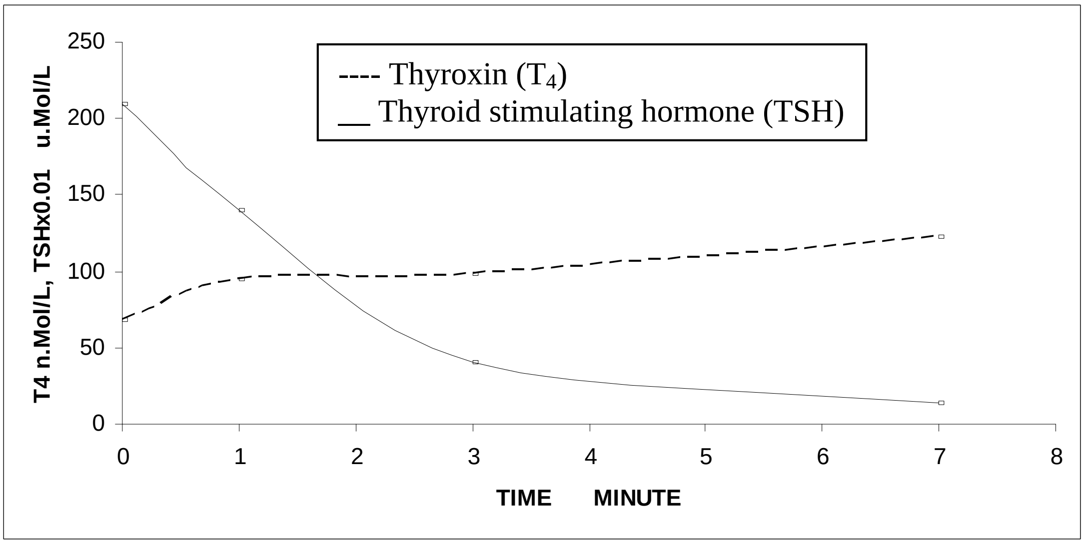

Figure 4.5: The variation of T_4 and TSH with laser exposure duration.

Conclusions

1. The activity of Thyroid gland for (T_3) and (T_4) production increases directly with laser exposure duration by a rate of 2/7 for (T_3) and 55/7 for (T_4).

2. The rate of TSH production decreases by the same rate of increase in (T_3) value that is 2/7.

3. The production of TSH regulates the production of (T_3) and (T_4).

4. Since the increased production of (some hormones) enables the body to produce dopamine and levodopa the lack of which causes muscle stiffness, Thyroid laser irradiation may be helpful for (Parkinson's disease) treatment.

Reference

1. W.M.Steen, Laser material processing, (Springer, 1998).
2. http:// en. wikipedia. org/wiki/ Thyroid, Date modified on 6 April 2008.
3. http://www.laser.nu, international: laser Acupuncture, Date modified: March, 9, 2008
4. J.S.Dam, Optical analysis of biological media - continuous wave diffuse spectroscopy, Dissertation thesis, Lund Institute of Technology, Lund, Sweden, (2000).
5. Optical spectroscopy for tissue diagnostics and treatment control, Nazila Yavari-Doctoral Thesis, Department of Physics and Technology University of Bergen, April 2006.
6. K.M.Case and P.F.Zweifel, Linear transport theory, (Addison-Wesley Publishing Co., Reading, MA, 1967).
7. A.J.Welch and M.J.C.van Gemert, Optical-Thermal Response of Laser-Irradiated Tissue, (Plenum Press, New York, 1995).
8. S.Svanberg, Atomic and molecular spectroscopy- Basic aspects and practical applications, (Springer Verlag, Heidelberg, 2004).
9. S.L.Jacques, L. Wang and A.H.Hielscher, Time-resolved photon propagation in tissues, in Optical-thermal response of laser-irradiated tissue, eds. A.J.Welch and M.J.C.van Gemert, pp. 305-332 (Plenum Press, New York,1995.
10. J.-L.Boulnois, ***Lasers Med. Sci***., 1986, **1**, 47.
11. Tietz, NW ״ Fundamentals of clinical chemistry ״ 3rd. Ed., Published by Sounders, USA, p. 154-155 (1987).
12. Bishop, ML; Duben, JL; and Fody, Ep״ Clinical chemistry‶4th. Ed. Published By Lippincott W. and Wilkins, nsn, p. 375 (2000).