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Evaluation the Effect of Low Level Laser on Sensori-neural Hearing Loss

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Abstract

Low Level Laser Therapy (LLLT) is one of biotechnology its useful as produced treatment for diseases that were previously difficult to treat. Some studies claim that an improvement in hearing threshold and tinnitus symptoms by Low Level Laser therapy and others set no significant effect of laser treatment. The aim of this project was to evaluation effect of low level laser (LLLT) treatment on senserinurail hearing loss. The study including 16 patients divided into two groups each group consists of 8patients (first group consist of 14 ear and second group consist of 16 ears), and each group has λ=650nm+532nm and 2.78mW/cm^2. The result of this project found statistically significant differences in each group (before and after laser application) as well as a significant change in the threshold of pure tone audiometry for patients having hearing degree (40-75)dB in each group.

Keywords: Low Level Laser Therapy, Patient Suffer from Senserinurail Hearing Loss and Pure Tone Audiomrtrey Test.

1 Introduction

Increased cases of internal ear diseases over the last decade in particular. The severe clinical trials of inner ear disease consist of sensation of aural pressure, hearing loss, tinnitus and vertigo. The Low Level Laser might enhance cochlear work[1]. It was supposed that low level laser irradiation enhance cell reproduction, producingof Adenosine Triphosphate (ATP) ,collagen and increase growth factor. Photochemical and photophysical stimulation of mitochondria in hearing hair cells it has been raised local blood flow in the inner ear [2]. The aim of the project is to assess the effect of low level laser therapy on hearing loss and the amount of enhancing the sensor neural hearing loss by using two types of diode laser with wave lengths(650nm 532nm),irradiated power and to evaluate the benefit of combination of two wavelengths of laser.

2-Kindes of Hearing Loss(HL):

There are three basic kinds of HL: conductive, sensorineural, and mixed[3].

3-Degree of Hearing Loss:

Level of hearing loss indicate to the acuity of the loss. The table(1) shows one of the generally used division systems. The numbers were the patient's HL range between in decibels (dB)[4]:

Table(1): Degree of hearing loss and range in (dB)[4].

Degree of hearing Loss	Hearing loss range (dB HL)
Normal	-10 to 15
Slight	16 to 25
Mild	26 to 40
Moderate	41 to 55
Moderately severe	56 to 70
Severe	71 to 90
Profound	91+

4- Materials and Methods:

4.1-The Experimental Setup:

This setup consists of two wavelengths (650nm and 523nm)diode lasers, optical fiber coupler(2×2 optical coupler FBT-MM-5050 and splitting ratio is 50%of each input power for each port.) and hearing mask, as shown in figure(1 and 2).

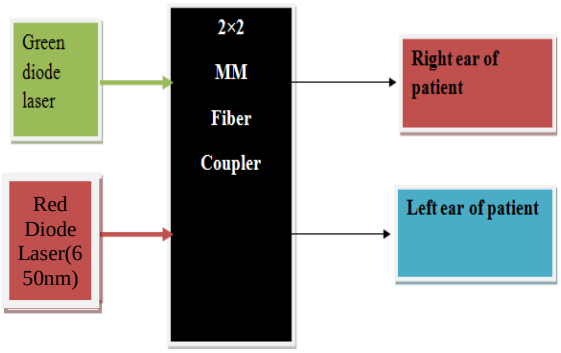


Figure (1):Block diagram of the setup consist of (650nm and532nm) laser and 2×2 optical fiber couple.

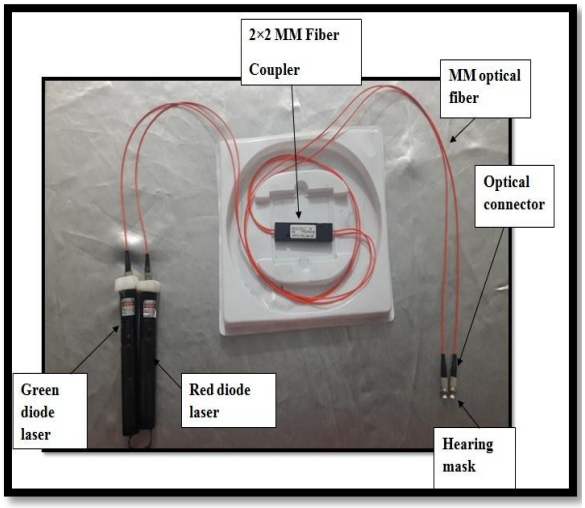
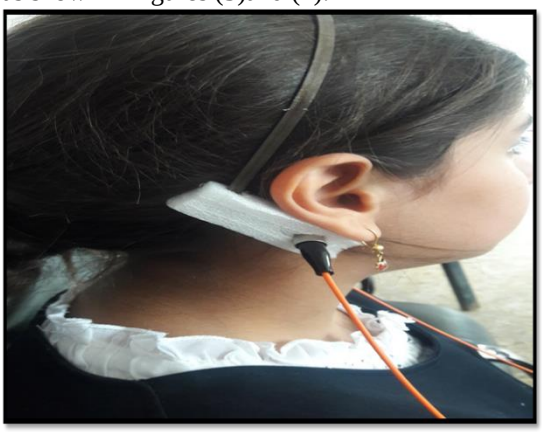


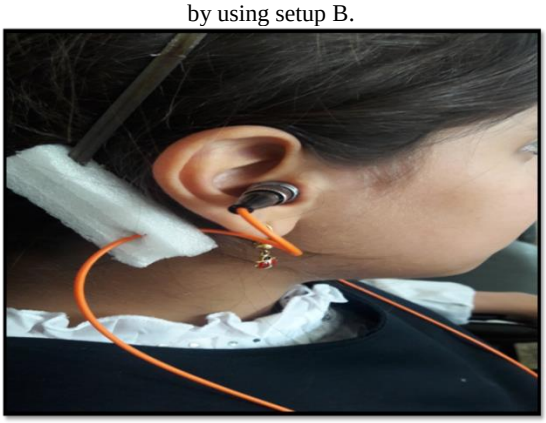
Figure (2): The experimental setup of system.

4.2-Laser Treatment Protocol:

The laser was applied for all patient in both parts by using setup in figure(1) and successive in two areas in mastoid and the ear channel but not in the same time (each place has irradiation time) as shown in figures (3)and (4).



Figure(3): The laser applied on patient in mastoid area by using setup B.



Figure(4): The laser applied on patient in ear channel by using system B.

The irradiation parameters in this protocol for both treated groups in this part of thestudy listed in table(2).

Table (2): Irradiation parameters for two lasers used in this study for first and second group in part two

Groups	No of Patients	Output Power mW	Power Density (mW/cm^2)	Irradiation Time/day (min)	Dose Energy (J/cm^2)
First Part	8	20	2.78	10day for 30min(15 min in mastoid and ear channel)	5.004
Second part	8	20	2.78	5day for 40min(20 min in mastoid and ear channel)	6.672

5- Statistical analysis

Statistical analysis of data was load out employ the obtainable statistical collection of SPSS-24. Data were offered in simple test of frequency, percentage, mean, standard deviation, and range (min-max values).

The significance of variation of different means (quantitative data) were calculated using Students-t-test for variation between two independent means or Paired-t-test for variance of paired comment, The important of variation of different percentages (specific data) were examined by appling Pearson Chi-square circulation (X^2-test) with use of Yate's correction or Fisher perfect, test whenever usable. Analysis significance was contemplate the P value$\leq$ 0.05.

Percentage difference= (pretreatment-post treatment /pretreatment)×100%....(1)

6-Results:

The analysis of the results based on the classification of Audiometric Hearing Impairment. According to the international Bureiar Audio phonology (BAIP) in1997 It is unclouded the following [5]:

- Normal hearing: threshold of pure tone degree is below (20) dB hearing loss.
- Softhearted(Mild) hearing loss: threshold pure tone degree in range(21 and 40) dB HL.
- Modest HL:
  - First level: threshold of pure tone degree in range (41 -55) dB hearing loss.
  - Second level: threshold of pure tone degree in range(56 -70) dB hearing loss.
- Severe hearing loss:
  - First level: threshold of pure tone degree in range(71 - 80) dB hearing loss.
  - Second degree: threshold of pure tone degree in range(81 - 90) dB hearing loss.
- Very sharp(very severe)HL:
  - First level: threshold pure tone degree in range (91 - 101) dB HL

- Second level: threshold pure tone degree in range(102 - 111) dB HL.
- Third level: threshold one degree between(112 - 119) dB HL[5].

6.1- Combine Red 650nm + green 532nm (First part):

First part consists of 8pationt (with 14ear) was treated for 10days with both 650nm and 532nm, dose energy (5.004J/cm^2)for 30min per day. As in figure(5) and (6) ,show different threshold of pure tone audiometry in (dB) before and after laser treatment for patients suffering from Moderate to severe and severe HL respectively .

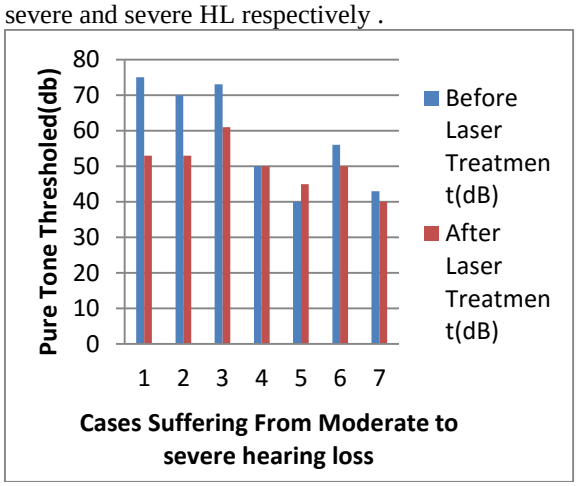
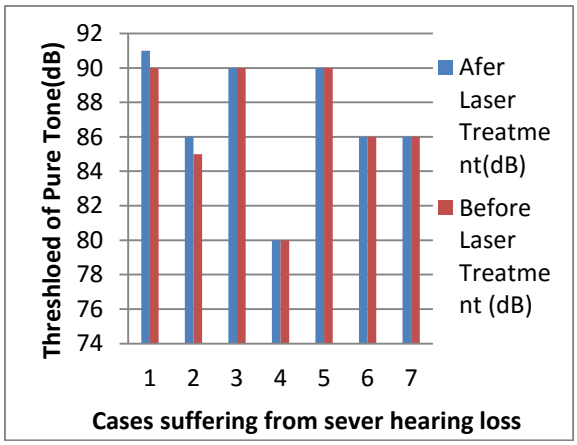


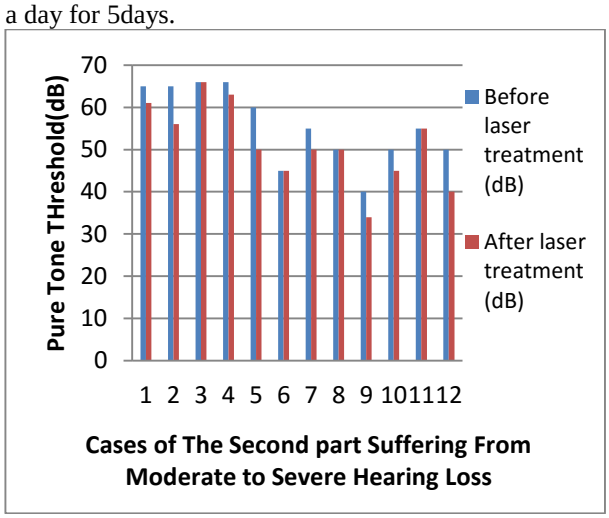
Figure (5): The block diagram of Moderate to Severe cases of HL before and after laser treatment (7(ear) Cases, 650nm+532nm, 30min for10 days) .



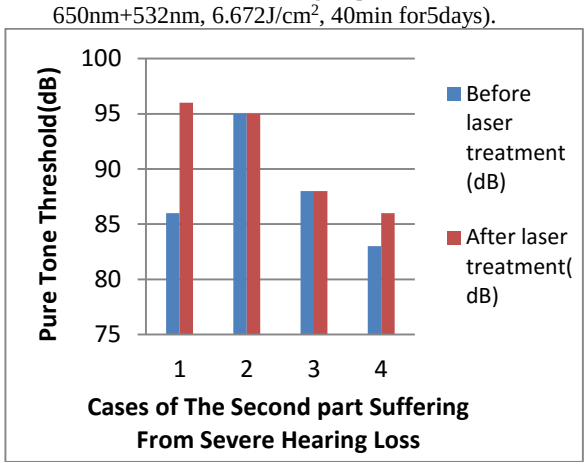
Figure(6): The block diagram of severe cases of HL before and after laser treatment (7(ear) Cases, 650nm+532nm, 30min for10 days).

6.2- Combine Red 650nm with green532nm (Second part):

Figures (7) and (8) show different threshold of pure tone audiometry in(dB) before and after treatment by (650nm+532nm)lasers. This part consist 8patient (16cases 12 of them suffering from Moderate to severe hearing loss and 4 of them have severe hearing loss),and this group exposed to dose energy(6.672J/cm^2)in 40min per a day for 5days.



Figure(7): The block diagram of Moderate to Severe cases in second group before and after laser treatment for second group (12(ear) Cases, 650nm+532nm, 6.672J/cm^2, 40min for5days).



Figure(8): The block diagram of severe cases before and after laser treatment for second group (4(ear) Cases, 650nm+532nm, 6.672J/cm^2, 40min for 5days).

6.3-The statistical analysis of First and Second Parts :

The mean age of patient was 13.0±2.5 (9-14 years) and 11.0± 4.6(3-18 years) for first and second parts, respectively.

As showed in table(3)there was significant decrease in the mean value of the threshold of pure tone audiometry (dB), After treatment (44.8±9.6)with range (45-76) compared with before laser treatment (58.6 ±11.5) so that the P_{value}=0.0001 and percentage difference (23.6 ±7.4) for patient with Moderate and Moderate to severe hearing loss in both groups.

But the patient with severe hearing loss they have mean value before laser treatment was(86.9±3.8) with range(80-93)and after laser treatment (86.4± 3.9)with range(80-91)so that P_{value}=0.056and percentage difference(0.6±1.3), as in figures(9) and(10).

Table (3): The percentage difference between pre and post treatment for both groups by using(650nm and 532nm)with exposure time.

Treatment protocol		Before Laser Treatment (dB)	After Laser Treatment (dB)	P value	Difference%
650nm & 532nm in 30 min for 10 days	Moderate-Severe	58.6±11.5 (45-75)	44.8±9.6 (40-61)	0.0001#	23.6±7.4 (10-33)
	Severe	86.9±3.8 (80-93)	86.4±3.9 (80-91)	0.056	0.6±1.3 (-1 -3)
	P value	0.0001*	0.0001*		0.0001*
650nm & 532nm in 40 min for 5 days	Moderate-Severe	63.6±8.4 (50-75)	55.7±8.6 (40-68)	0.0001#	12.6±4.9 (5-21)
	Severe	84.9±5.9 (76-96)	85.3±6.7 (75-96)	0.609	-0.5±3.7 (-12 -4)
	P value	0.0001*	0.0001*		0.0001*

*Significant variance between two independent means using Student-t-test at 0.05 level

#Significant variation between two dependent means using Paired-t-test at 0.05 level

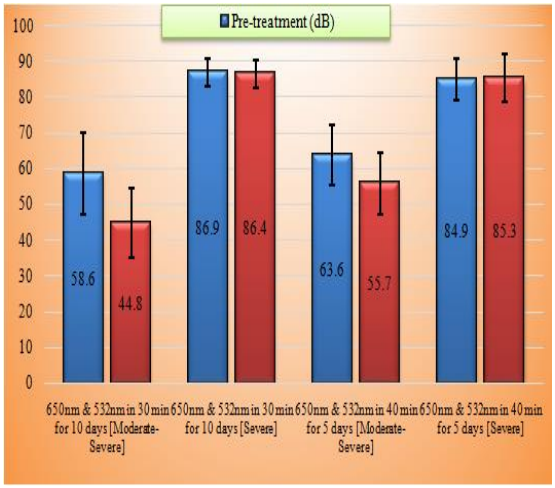


Figure (9): The block diagram for the mean threshold of pure tone audiometer between before and after laser treatment for both parts.

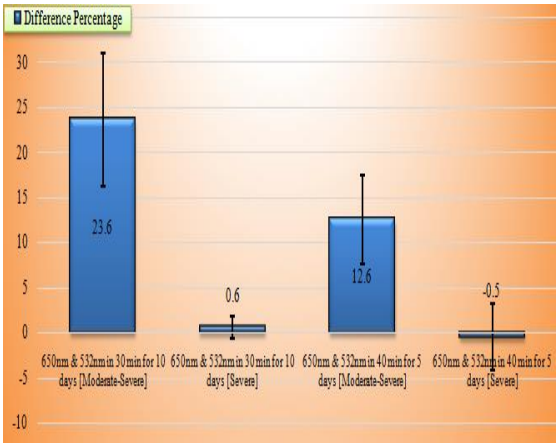


Figure (10): The block diagram the percentage difference of First and second groups divided as Moderates to severe and severe hearing loss.

7-Discussion:

After choose the diodes lasers (red laser650nm and green laser 532nm)with output power 50-100m, but after connected to the optical connectors the output power were decreases due to the attenuation in the optical connecter. Low level laser therapy(LLLT)used as a therapeutic agent to treat the inner ear diseases such as cochlear dysfunction, tinnitus and sensorineural hearing loss. Low level laser irradiation in appointed parameters was important and useful agent for the therapy of Terminal and central nervous system injuries and disorders. The therapeutic effect of the LLL was not totally apparent; a little hypotheses were included growing or cell proliferation, ATP and collagen synthesis, accretion factors, improvement the inner ear blood stream and motivating the heaing hair cell mitochondria[6]. And from a clinical viewpoint threshold of audiometry pure tone modification of 10dB or greater was in general considered significant [7].

The law of the acquired light principle information, the new laser medical system imprimaturs laser stimulate therapy of a known anatomical place within cochlear winding (cochlea area operationally mediating the conceivable of many acoustic frequencies) by a before sets light dose [9]. Our study evaluate the laser treatment(LLLT)for sensorineural hearing loss could just define and quantify the dosage used to the internal ear through the mastoid area and the ear canal, respectively. The protocol of our study design divided for two groups and each group have its procedures. In this project all patient were divided for two parts depending on irradiation time for each part have the same treatment setup ,wavelengths but different in exposure time and dose energy(5.004J/cm^2 and 6.672J/cm^2).The statistical analysis of this part showed significant effect of laser on pure tone threshold for(500,1K,200K)Hz in both groups of patients suffering from Moderate to Severe hearing loss when compared with before laser treatment, but there was no significant effect of laser on patient have severe hearing loss in comparison with their readings before treatment.

8-Conclusions:

1- The results of this project include that low level laser therapy have important effect on sensori-neural hearing loss and this is achieved clear via combination of two wavelengths (650nm+532nm) by using 2×2 optical fiber couplers but this effect was temporary.
2- LLLT could make the probability of for enhancing the regeneration and restoration of inner ear function.

Reference:

[1] wilden L and Dindinger D, (1996)"treatment of chronic diseases of the inner ear with low

level laser therapy (LLLT) pilot project ", laser therapy 8:209 – 312,.
[2] Breugel V and Bär P, (1992) , "Power Density And Exposure time of He-Ne Laser Irradiation are More important Than Total Energy Dose in Photobiomodelation of Human Fibroblast Invitro", Laser Surg.Med,12:528-37.
[3] Rockville M, (2015), " Type, Degree , and Configuration of Hearing Loss ", American speech – Language – Hearing association, audiology in formation series.
[4] Jerger J and Carhart R, (1995), " Preferred Method For Clinical Determination of Pure – Tone Thresholds ", Journal of Speech and Hearing Disorders, Vol.24,330 – 345.
[5] *International Bureau Audio phonology, (2017)*, " Audiometric Classification of Hearing Impairments", *biap.org.*
[6] Schom k, Tauber S., Beyer.W and Baumgartner.R, (2003), "Transmit Cochlear Laser (TCL) Treatment of Cochlear Dysfunction A Feasibility study for chronic tinnitus", lasers medsci, Springer –Verlag London limited.
[7] Schauch. R, (2009), " Pure Tone Evaluation ", Hand book of clinical audiology ,Eds , P30 – 42 Lippincott Williams and Wilkins Baitimore , MEd , USA.
[8] Touber. S, Baumgartner. R, Schorn. K and Beyer W, (2001), " Light Dosimetric Quantitative Analysis of The Human Petrous Bonc Experimental Study for Laser Irradiation of the Cochlea ", Experimental Study for Laser Irradiation of the Cochlea, Laser Surge med, 28:18 – 26.

تأثير التحقق من تأثير الليزر منخفض المستوى على ضعف السمع الحسي

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الخلاصة

العلاج بالليزر أو العلاج بالليزر منخفض المستوى (ل ل ت) هو واحد من التكنولوجيا الحيوية تقنياتها لتوليد العلاج للأمراض التي كانت في السابق من الصعب علاجها. بعض الدراسات تدعي أن تحسنا في عتبة السمع وأعراض الطنين عن طريق العلاج بالليزر منخفض المستوى ، وغيرها من الدراسات لم تحدد أي تأثير كبير من العلاج بالليزر. وكان الهدف من هذا المشروع هو التحقيق في تأثير العلاج بالليزر منخفض المستوى (ل ل ت) على فقدان السمع الحسي العصبي وإذا كان بإمكان العلاج بالليزر منخفض المستوى تحسين حساسية السمعية (تغيير عتبة السمع لهجة نقية). شملت الدراسة16 مريضا. يتكون هذا البحث من جزئين كل جزء يتكون من 8 مرضى الكروب الأول 14 أذنو الكروب الثاني 16 أذن (λ=650نانوميتر +532نانوميتر) وأظهرت النتائج وجود فروق ذات دلالة إحصائية في الاختبارات (بين قبل وبعد العلاج بالليزر) وهناك تغير كبير في عتبة قياس السمع لهجة نقية للمرضى الذين يعانون من درجة السمع (40-75) ديسيبل في كل مجموعة .