The tattoo treatment using different types of lasers

Mithaq M. Mehdy Al-Sultani[1], Wiam A. Abass Al-Shimary[2]
[1, 2]Department of physics, College of Education of Girls, University of Kufa, AL Najaf, Iraq.
Email: Mithaq.alsultani@uokufa.edu.iq

Abstract
A tattoo is a foreign material entered into the dermis by needle or some other trauma that results in a visible mark in the skin. either decorative or cosmetic tattoos or may be traumatic tattoos placed in radiation ports. There are many ways for tattoo removal one of them is laser treatment by Q-Switched Nd:YAG laser. This study was done in clinic medical – Mashhad Holy in Iran, from December 2021 to end Joule 2022. After clinical assessment of skin tattoo color and classification of skin color. (15) patients were divided by color ink. (7) patients with tattoo black, (3) patients with tattoo red, (2) patients with tattoo green, (2) patients blue, and (1) patient with tattoo sky blue. The time of treatment session was from (5-20) mint according to the size of lesion and 3–4-week s interval between session. The distribution of lesions on different part of body, face, hand, forearm, and back. Fifteen patients completed the study. (10) female, and (5) male patients completed the study ages from 20-50 years with variable of volumes. Number of sessions were from 2-4 session according to the color and depth of pigmentation. According to Fitzpatrick classification 8patients were skin type (III), and 7patients were skin type (II). Laser parameter used: Q-switched laser wavelength 532nm for red tattoo patients, Q-switched laser wavelength 585nm for blue and green tattoos patients, Q-switched laser wavelength 650nm for sky blue tattoo patients, and Q-switched laser wavelength 1064nm for black tattoo patients, spot size (5-10) mm, R.R 1-2Hz, fluence 6J/cm2. Clinically good improvement. Physical properties have been studied for tattoo and laser treatment.
Keywords: Laser, tattoo, physical properties.

1. Introduction

The dermatological condition that has to be treated by laser only, is considered one of the hardest cosmetic problems to treat with conventional methods. In the search we will study some laser tattoo treatment and study their physical properties. A tattoo is a permanent mark or design made on the body when pigment is inserted into the dermal layer of the skin through ruptures in the skin's top layer. In 1991, at the border of Austria and Italy in the Alp Mountains, the body of a man was found. Subsequent carbon dating showed that this well-preserved frozen human had died approximately 5300 years earlier of note is the fact that he had 59 purposely placed skin markings making this discovery one of the best-documented cases of tattoo placement in ancient man [2].
Procedure: The procedure Includes preparation of patient before laser, and after laser treatment and the relative and absolute contraindication to laser treatment. Before treatment by laser Complete history from patient taken for blood disease, viral hepatitis.
Take photograph by digital camera to each patient before any session and after completed the study for comparing. Apply a topical anesthetic (EMLA cream) to skin and covered with an occlusive dressing and left for 30 minutes. The treatment session taken from five minutes to twenty minutes according to the size of lesions and 3-4 weeks interval between sessions. Small test done to small area. After treatment by laser, The laser arm putted in perpendicular manner to the lesion and move slowly till all the lesional area hit by laser beam. The laser causes instant whitish "popcorn" frosting over the lesion that last for 10 or 15 minutes. Then the lesion gradually returns to how it looked before the treatment. The difference is that the lesion area is slightly raised and the area around them become a little reddish and warm, much like sunburn. With higher energies you can expect some local swelling and small amounts of bleeding are possible. Healing cream (antibiotic + steroid) is applied locally. Lesion is covered with a protective dressing; mostly after five-day healing occurs. Then, during 21 days, the skin cells and other immune cells will slowly remove the tiny pigmented particles, which have been "broken up" by laser treatment and the lesion will look lighter. The patients were asked to avoid sun exposure every day by using wide spectrum sun-blocking cream[1].

Theory

Physical properties for tattoo treatment
Melanin absorption [5]
The Melanin absorption is calculated from the following equation:

$$\mu_a^{mel}(\lambda) = A \exp\left(-\frac{\lambda - 800}{182}\right)$$

Where: the parameter A is the ratio of the optical density of pigmented skin layers (epidermis and basal membrane) to their thickness. In our model, A = 0.87 cm-1 for epidermis, and 13.5cm-1 for basal membrane.

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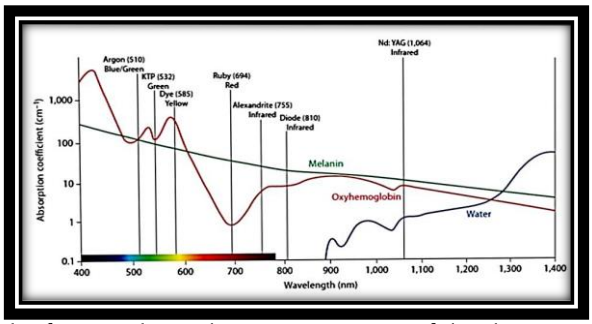

The figure1 show Absorption spectra of the three main skin chromospheres.

Figure (1) Absorption spectra of the three main skin chromospheres [2].

Constant scattering random [5]

The constant scattering random is calculated from the following equation:

$$g^{bg}(\lambda) = 0.7645 + 0.2355\left[1 - \exp\left(-\frac{\lambda - 500}{729.1}\right)\right]$$

Where $g^{bg}(\lambda)$: is the anisotropy scattering factor of the bloodless tissue.

Clearance rate tattoo[6]

The Clearance rate tattoo is calculated from the following equation:

$$C_r = \frac{M_{v0} - M_{v1}}{M_{v0}}$$

Where M_{v0}, M_{v1}: mean the content of tattoo pigment before and after the treatment, respectively.

Experimental apparatus

The site of lesion in body.
Age of patient. *
*Color of lesion.
*Type of ink, Instrument used to make tattoo whether Amateur or professional.
The age of lesion. *
*History of any treatment taken.
*Complete history of drug (steroid, Isotretinoin, anticoagulant).
*Then clean the area.
*Shaving the hair.

Table 1 shows properties the Nd:YAG laser used in tattoo treatment.	
Name	Nd:YAG
The manufacture Company	Lutronic
Model	2020
Country origin	USA

Figure2 shows the laser used in tattoo treatment.

Table (2) shows properties cream EMLA	
The scientific	Lidocaine 5%
Trade Name	Cream emla
The manufacture Company	astrazeneca
Country origin	Sweden, Britain
His duties	Topical anesthetic

Figure 3 Cream EMLA.

2. Result

In this item we will explain Physical properties for tattoo treatment

Table shows laser treatment tattoos.

Table (3) shows laser treatment tattoos.				
S. P	Sex	Age	(nm)λ	P(J/cm2)
P_1	male	29	1064	3
P_2	female	23	532	2.4
P_3	male	21	585	4.5
P_4	female	33	1064	3
P_5	female	31	1064	3
P_6	female	52	585	4.5
P_7	female	23	532	2.4
P_8	female	35	1064	3
P_9	male	27	1064	3
P_{10}	male	23	650	4.5
P_{11}	female	29	1064	3
P_{12}	female	40	1064	2.9
P_{13}	male	16	1064	4
P_{14}	female	22	650	4.5
P_{15}	female	22	1064	2.5

Table 4 shows the results melanin absorption for epidermis, and basal membrane layers.It was found that the absorbance of the dye for the wavelength decreases with the long wavelength.

Table (4) shows the results of melanin absorption.			
	(nm)λ	A(cm-1)	Ma×10-7
Epidermis layer	532	0.87	3.793
	585	0.87	2.835
	650	0.87	1.983
	1064	0.87	0.203
Basal membrane layer	532	13.5	0.588
	585	13.5	0.439
	650	13.5	0.367
	1064	13.5	0.316

Table 5 shows the results of constant scattering random for wavelength (532,585,650,1064). Where it turns out that the direct relationship between the wavelength, and Constant scattering random.

Table (5) shows the results of Constant scattering random.	
(nm)λ	g×10^{-8}(cm)
532	7.746
585	7.904
650	8.082
1064	8.913

Table (6) shows the results of Clearance rate tattoo. It was found that the rate of tattoo clearance depends on the depth of pigmentation, the color of the tattoo and the date of the tattoo.

Table (6) shows the results of Clearance rate tattoo.			
S.P	M_{v0}(ml)	M_{v1}(ml)	C_r
P1	6	4	5.3
P2	7	5	6.2
P3	9	7	8.2
P4	10	8	9.2
P5	12	10	11.1
P6	14	12	13.1
P7	16	13	15.1
P8	1	0.8	0.2
P9	18	15	17.1
P10	20	18	19
P11	1	0.8	0.2
P_{12}	2	1.5	1.2
P_{13}	1.5	0.9	0.9
P_{14}	25	22	24.1
P_{15}	2	1	1.5

Figure 4 shows black tattoo photographs before and after for one session, using a 1064nm wavelength laser. The session took place 10mint.

Figure 4 black tattoo photographs before and after one session.

Figure 5 shows green tattoo photographs before and after for two sessions, using a 532nm wavelength laser. The session took place 5mint.

Figure 5 green tattoo photographs before and after two sessions.

Figure 6 shows sky blue tattoo photographs before and after for one session, using a 650nm wavelength laser. The session took place 20mint.

Figure 6 black tattoo photographs before and after one session.

Figure 4 shows tattoo photographs before and after for three sessions, using a 532nm wavelength laser. The session took place 10mint.

Figure 7 green tattoo photographs before and after three sessions.

3. Discussion

In this study, QS-Nd:YAG laser has been used to treat, remove the tattoo, frame and different wavelengths, and input,. The mechanism of action of the Nd:YAG Q-Switched is through photon absorption by tattoo pigment within fibroblasts, during the short pulse duration, temperature exceeding 1000°C can occur. The reduction in pigmentation of pigment-containing cells probably results from rapid thermal expansion, shock waves, and potentially localized cavitation [3]. With each laser treatment the fragmentation process is

repeated to remove deeper layers of pigment until the tattoo fades completely without damaging the skin [4].

4. Conclusion

The use of Q-Switched lasers offers a low risk, highly effective therapy with minimal side effective because they offer bloodless, low risk, effective treatment, Q-Switched Nd:YAG lasers have replaced others methods and are now considered standard treatment. The Q-Switched Nd:YAG laser have great advantages in removing pigmentation, its longer wavelength (1064nm) would increase dermal penetration and decrease melanin absorption so that it's used in skin type (III,IV,V,VI) without risk of depigmentation or hypopigmentation.

I concluded that a tattoos skin response to laser energy depends on several factor: tattoo color, tattoo depth,tattoo age, and tattoo volume.

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