Wound treatment Q-switched Nd: YAG Laser tattoo removal rat model by Photobiomodulation Therapy PBMT

التئام الجروح باستخدام العلاج الضوئي بعد ليزر إزالة الوشم

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الملخص:

ليزر أزاله الوشم عن طريق العلاج الضوئي (PBMT therapy) لتسريع التئام الجروح عن طريق تحفيز الاوعية الدموية للأنسجة المحيطة . في هدة الدراسة تم تطبيق العلاج الضوئي باستخدام ليزر دايود 808 نانوميتر علي الجلد الموشوم بعد ازالة الوشم . تم اختيار ما مجموعه 35 جرذًا من جرذان ، مقسمة إلى ثلاث مجموعات وموشومة بأحبار سوداء باستخدام مسدس وشم. تلقت المجموعة الضابطة G0 إشعاعاً غير ليزر.

ثم علاج G1 لإزالة الوشم بالليزر في جلسة واحدة بدون علاج الضوئي ((therapy PBMT)) بينما تم علاج G2 بالعلاج الضوئي ((therapy PBMT)) يوميًا باستخدام 808 نانومتر ليزر ديود بعد إزالة الوشم باستخدام ياق ليزر 1064 نانوميتر

بعد جلسة واحده لإزالة الوشم بالليزر . / ا 5)سم 2 ؛ 50 ثانية (. أجريت الملاحظات التجريبية لمدة تسعة (9) أيام. تم تحليل تأثير إزالة الوشم وتقدم الشفاء على الجلد المستهدف باستخدام الكاميرا الرقمية والتحليل النسيجي. أظهرت النتائج أن الصمام الثنائي الليزري 808 نانومتر يعزز عملية الشفاء من خلال تكوين النسيج الظاهري وتعزيز ترسيب الكولاجين. بالإضافة الى حفز العلاج الضوئي الخلايا المناعية لتحسين عملية

البلعمة لإزالة حبر الوشم المتكسر بشكل فعال. أظهرت المجموعة التي تم تطبيقها باستخدام ليزر ديود 808 نانومتر تحسنًا في الشفاء وجودة الجلد بعد عملية إزالة الوشم بالليزر. أظهرت نتائج الدراسة أن العلاج الضوئي يحفز الوظيفة الخلوية ويحسن كفاءة إزالة حبر الوشم من الجلد.

الكلمات المفتاحية: التئام الجروح ، إزالة الوشم ، العلاج الضوئي ، ليزر ديود ، ياق ليزر.

Abstract: The Q-switched laser method is the most effective method of tattoo removal compared to other methods of i.e. chemical, mechanical and surgical. The objective of this study is to investigate the effect of Nd:YAG laser to remove the tattoo and also to utilize 808 nm diode laser to enhance the wound healing at post-treatment. Q-switched Nd: YAG laser with fundamental wavelength of 1064 nm is applied to remove tattoo pigment with different energy fluencies. Additionally, 808 nm diode laser will be applied on wound created after tattoo removal to enhance the healing process. More than 15 Sprague Dawley rats will be involved and tattooed with black inks on their back by a tattoo gun. A single session treatment is use in the energy about 400mj for tattoo removal. The exposure to diode laser treatment will be conducted daily. The experimental observation will be hold for 9 days, and 5 rats from each group will be sacrificed on day 3, 6 and 9 respectively. The skin biopsy will be removed for H&E and Masson's trichrome histology examination. The effect of tattoo removal and healing progress of skin analyzed via photothermal.. The preliminary findings of this study indicate that 1064 nm wavelengths of Q-switched Nd-YAG laser treatment with 400mj pulse energy exhibit significant progress of black tattoo removal.

Keywords: 808nm Diode Laser, Nd:YAG laser wound healing, Tattoo removal, Sprague Dawley rats, Healing process

Introduction

The history of tattooing began over 5000 years ago. Tattoos are established by inserting colored materials beneath the skins surface. The first tattoos probably were made by accident (N. Goldstein, 2007). Someone had a small wound, and rubbed it with a hand that was dirty with soot and ashes from the fire. Once the wound had healed, they saw that a mark stayed permanently(Hart Hansen 1985).The earliest record of tattoos, to date, was found in 1991 on the frozen remains of the Copper Age "Iceman" scientists have named Ötzi. His lower back, ankles, knees, and a foot were marked with a series of small lines, made by rubbing powdered charcoal into vertical cuts. Tattooing has been in existence since the early beginnings of modern civilization. The discovery of selective photothermolysis at last has enabled it to remove tattoos without leaving a scar. Q-switched neodymium: yttrium-aluminum-garnet, alexandrite, and ruby lasers with pulse durations in the nanosecond domain fulfill this need. Argon or cw-CO_2 lasers as well as intense pulsed light sources should be used since they often produce significant scarring (Pfirrmann 2007). Surgical excision of tattoos is a one of the ways to remove a tattoo that results in an incomplete removal process, leaving behind unwanted and unintended scarring (Michael2013). Currently, three common types of lasers are used for tattoo removal: Q-switched ruby laser (694nm), Q-switched Nd: YAG laser (532nm, 1064nm), and Q-switched alexandrite laser (755nm). The Q-switched ruby and alexandrite lasers are useful for removing black, blue and green pigments. The Q-switched 532nm Nd: YAG laser can be used to remove red pigments and the 1064nm Nd: YAG laser is used for removal of black and blue pigments. Q-switch Nd:YAG laser technology has proven to be more efficient in clearing cosmetic tattoos than other laser. The most common side effect is hyper- (darkening) or hypo-pigmentation (lightening) of the skin. Hyperpigmentation is the laser pulse to remove the tattoo ink in skin. It will affect the natural pigment or melanin, which is essentially patches of darkened skin. Conversely, hypopigmentation is where your skin's normal pigmentation has been removed (P .S. Lau, N. Bidin2015).

Material and Methods

In this study, 15 with mixed gender of (male, female) as well as the age of rats is between 10-12 weeks, and the weight of those rats is about 200g-250g. All of rats drawn tattoo and distributed into 3 groups each group of five rats.one group serve as control group (n=5) received non-laser irradiation, another groups serve as laser

treatment group. This groups were treated a single session by 1064nm with energy fluence in range 400 mJ. The procedures are following the policy for care and use of experiment animals by animal ethnics committee with approval project code: UTM/APSI/2015/NORIAH/29-JULY/694-JULY-2015-JULY.-2017. The rats were anesthetized with 2.0 ml of Ketamine mixed with 1.0 ml of Xylazine at 20 mg/ml and add 1.0 ml of distilled water; hence the total volume was 4.0 ml. The amount of drug administered to each animal is based on its body weight. Each animal needs to be weighed on the day of anesthesia. Mixture of ketamine xylazine was given intravenously (0.1 ml/100g) to rat studies.. Furthermore, all the surgical procedures were undertaken in the same conditions to limit variability in the wounding procedure. For tattoo designs, the tattoo gun, 20 turns/second with 2 needles of 0.5cm tips was used which has the capability to inject the black pigment 1.5mm deep into the dermis. Tattoo pigment was true black ink "C.i.77226". A total of 10 wounds for each day tattoos were drawing on the rat's skin in a single session. After four weeks, laser treatment of 1064nm wavelength and 808 diode laser was applied to each animal and observed the differences with microscopic and histopathological observations.

Results and Discussion

Laser treatment of 1064 nm wavelength was applied to each animal. All rats treated with a Q-switched (1064 nm) Nd:YAG laser using a 10 cm distance, 2 mm spot size and a pulse duration of 8-10 ns. The fluencies used were in the range of 3.04 J/cm2 at energy 400mj. The laser parameters are tabulated in table 1.1 which has been used for removal of black ink tattoos.

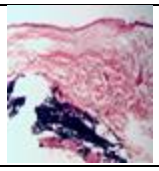
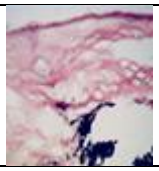
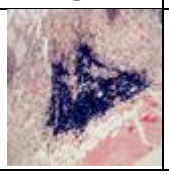
Table 1.1:.Laser parameters

Wavelength (nm)	Energy (mJ)	Laser beam (cm)	Frequency (Hz)	Fluence (J/cm2)
1064	**400**	**10**	**1-5**	**3.04**

Furthermore, the 1064nm wavelength revealed a reduction of black tattoo pigments gradually after laser treatment used 808 diode laser to enhance wound healing in figure (1.1) shows treatment and enhances wound healing from day 1, day 3 .day 6 and day 9.

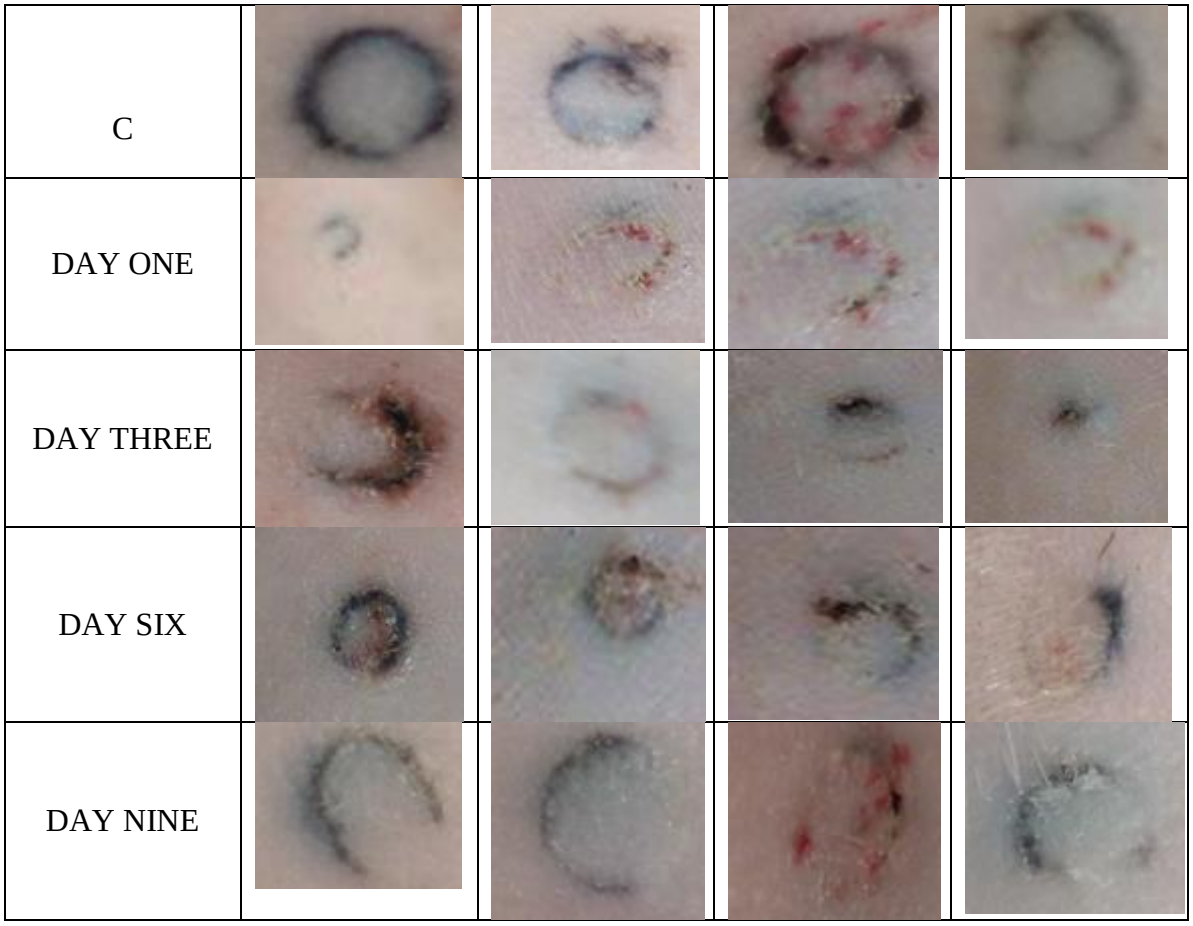
C show tissue has tattoo without treatment.

Figure 1 Histology laser tattoo removal at 1064 nm

DAYS	C	1	3	6	9
TISSUES					

The 1064 nm wavelength revealed a reduction of black tattoo pigments gradually with 400mj pulse energy as shown in Figure 2.in one day for treated and enhanced tattoo ink reduction was observed gradually between day one and three, six, nine.

Figure 2 Black tattooed skin showing epidermis effect after one to nine days of laser treatment with 808 diode to enhance wound healing.



Conclusions

The Q-switched 1064nm wavelength Nd:YAG laser with 2mm spot sizes and a pulse duration of 8-10 ns was used for tattoo removal with efficient laser energy of 400mj to remove black ink spots from the tattoo's skin. From experimental findings, it is observed that 1064nm wavelength with maximum laser fluency 1-5 J/cm2 and 400mj energy pulse have capability to remove the tattoo ink from the rats' skins completely. Therefore,808 diode laser used to enhance the healing process after tattoo removal. it concluded that the laser tattoo removal treatment at the mentioned wavelength with 808 diode is an effective method to remove the tattoos with less skin surface's damages or scars from laser therapy using 808 diode .

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