



系統識別號	U0026-1808201107120500
論文名稱(中文)	探討小光斑與能量密度之二極體雷射系統 應用於除毛的可行性
論文名稱(英文)	Investigate Effects of Small Spot Size & Fluence on Hair Removal Using Diode Laser System
校院名稱	成功大學
系所名稱(中)	醫學工程研究所碩博士班
系所名稱(英)	Institute of Biomedical Engineering
學年度	99
學期	2
出版年	100
研究生(中文)	江昱緯
研究生(英文)	Yu-Wei Chiang
學號	p86984081
學位類別	碩士
語文別	中文
論文頁數	106 頁
口試委員	口試委員-王國照 口試委員-蔡明世 口試委員-簡基憲 指導教授-鍾高基 指導教授-曾盛豪
中文關鍵字	除毛 小光斑 熱傷害 二極體雷射 蘭嶼豬
英文關鍵字	Hair Removal Small Spot Heat Injury Diode Laser Lanyu Pig
中文摘要	<p>近年來科技的進步也帶動了醫學美容發展，而除毛雷射更是目前雷射應用中最常被應用的項目。但市面上的除毛雷射系統，多數以高能量較大光斑(直徑 6~18 mm)進行除毛治療，雖然可縮短除毛療程所需的時間，但對於毛囊週邊組織的熱傷害具有較高的發生率。使得復原的時間拉長，治療時也較具疼痛感。本研究的目的為探討直徑 1mm 小光斑與能量密度(20、30、40 J/cm²) 之二極體雷射系統應用於除毛的可行性。本研究特定目標：(1)蒙地卡羅模擬光子於組織內部的能量分佈；(2) 小光斑二極體雷射除毛系統雛型設計；(3)應用動物皮膚組織實驗驗證系統於除毛的可行性。先運用蒙地卡羅法模擬不同雷射光斑大小在組織間的能量分佈，考量小光斑雷射除毛的臨床需求與功能設計，並進行小光斑二極體雷射除毛系統雛型系統設計及校正，最後以蘭嶼豬為動物模型，將耳翼、頸部腹面部、前肢內側、前肢外側、腹部、後肢鼠蹊外側等部位建立資料庫，並找出與人相近的部位，以直徑 1 mm 小光斑與 20、30、40 J/cm² 能量密度於蘭嶼豬皮膚 3cm × 3cm 標記範圍內，針對單一毛孔進行雷射，以切片染色觀察毛囊形態學的影響，評估小光斑雷射應用於除毛的可行性。</p> <p>結果顯示：(1) 不同光斑的大小進入表皮層的能量衰減均相同，光斑面積大小並不影響能量的穿透率，在表皮層下 2.25mm 處時穿透率皆約為入射能量的 0.87%；(2) 完成小光斑二極體雷射除毛系統雛型，可達到 1.5×1.5cm 毛孔辨識偵測範圍，達到 1mm 小光斑飛點掃描之功能；(3) 部位選用實驗發現蘭嶼豬耳翼皮膚部位的毛囊、汗腺、皮脂腺較具完整性，表皮與真皮層比例約 1:12 與人類最相近，適合進行雷射除毛</p>

實驗；(4) 小光斑二極體雷射除毛動物實驗發現於能量密度 30J/cm² 小光斑雷射照射的耳翼皮膚，切片下可見，表皮層結構、細胞型態完整，毛根處黑色素細胞有部分燒灼壞死，毛髮皮質破壞，毛囊內、外根鞘可見部分融解，顯見當雷射能量高於 30J/cm² 可達到毛囊破壞之效果驗證小光斑雷射系統於除毛的可行性。

本研究未來可改進及持續研究的項目：(1)持續針對 1.5、2mm 光斑直徑參數進行動物實驗並找出合適雷射除毛參數，並建立皮膚膚色及部位資料庫，提高影像辨識度；(2)可針對毛囊破壞程度判讀加入科學量化評分。

英文摘要

In recent years, the improvement of science and technology promote Medicine cosmetology, and laser hair removal is often much more used. In order to achieve the efficacy of Laser hair removal, laser system usually adopt a large spot (Diameter 6~18 mm) for treatment. Although the treatment time could be reduced, big spot will cause unnecessary tissue thermal injury near hair follicle. The purpose of this research is to investigate small spot size on hair removal (Diameter 1、mm) and Fluence (20、30、40 J/cm²). This research utilizes animal testing (Lanyu pig) to probe the feasibility of hair removal by small spot size and laser diode system.

The specific purposes of this research is : (A) Using Monte Carlo photons to simulate energy distribution within the tissue. (B) To design the prototype of small spot size laser diode system. (C) Design the animal test on Lanyu pig. First we use Monte Carlo to simulate different spot size laser energy distribution between tissues. Then we design and calibrate the small-spot diode laser hair removal system prototype system according to clinical needs .Finally, using the Lanyu pig as animal model, a database was created to identify parts that are close to human's. The parts include: the leading edge of the ears, the side of right neck, the interior of forelimb, forelimb lateral, abdomen and groin of limbs outside. Laser with 1 mm diameter small spot and 20,30,40 J/cm² energy density is used to illuminate single pores within a 3cm × 3cm marked area on the skin. After treatment, we biopsy skin tissues Within the marked area, and stain the hair follicle to observe it's morphology, And estimate the feasibility of hair removal using small spot laser system.

The results showed that: (1) The different spot size of the energy attenuation into the epidermis are the same. The spot size does not affect the energy penetration, and the incident energy under 2.25mm of the epidermis penetration are about 0.87%; (2) Completing the small spot diode laser hair removal system prototype can reach the detection of pores identify in the range of 1.5 × 1.5cm, and achieve the function of scanning the small spot in the size of 1mm ; (3) The experiments of selecting sites on Lanyu pig's surface of III its ear skin has found in the hair follicles, sweat glands, and sebaceous glands are more integral. The ratio of epidermis and dermis is about 1:12 is the most similar to humans, and suitable for laser hair removal experiment; (4) Small spot diode laser hair removal in animal experiments irradiated ear skin by biopsy .The results show that when conditions are within 1 mm spot size, fluence 30 J/cm², we can find out the structure of the cuticular layer and cell form is unbroken, some root of melanocytes with necrosis, the damage of crinal cortex, and part melt of the hair follicles and outer root sheath. Therefore, it proves that there is the feasibility of a new treatment of laser hair removal when the laser energy is higher than 30 J/cm².

In this study, future research can improve and sustain the project:(1) continue searching for appropriate animal hair removal laser parameters hair removal parameters using 1.5,2 mm diameter spot sizes and establish database for skin surface color and location to improve the image recognizing system;(2) scientifically quantitative the damage of hair follicle.