Cairo University
Faculty of Veterinary Medicine
Department of Surgery, Anaesthesiology,
and Radiology

Studies on photobiostimulation of soft and hard tissues healing

A thesis presented by

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For Ph.D degree

(Surgery, Anaesthesiology and Radiology)

Under supervision of:

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2017

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Approval Sheet

This is to approve that the dissertation of the thesis entitled:

"Studies on photobiostimulation of soft and hard tissues healing"

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Abstract

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Name: Hosam El Din Mostafa Mohamed Ahmed

Degree: Ph.D
Specification: Surgery, Anesthesiology, and Radiology
Title of the thesis: Photobiostimulation of soft and hard tissues healing
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This study was divided into two studies; Experimental animal study carried out on 135 rats and clinical study carried out on 20 dog of different breed, sex, age, and fresh wound site. The experimental study rats were subdivided into soft tissue part (60 rat)and hard tissue part (75). Sixty rats were subjected to circular skin excision and divided into four groups each group contains fifteen rats. Control group was left without any treatment while the Red laser 650nm group, Infrared laser 906nm group, Red LED group was treated by 4-5 J/Cm^2 on daily basis for 7 sessions. A representing 5 Rats of each group were euthanized at days 3,7,15 post-wounding. Results showed that Red laser was the best tool for soft tissue healing promotion followed by LED. In the hard tissue part, experimental tibial osteotomies fixed with intramedullary pins was biomodulated either by IR laser or red laser. Seventy five rats subjected to tibial diaphysial osteotomies and fixed by intramedullary pins. Rats were divided into 3 groups of twenty five rats each; control group was left without any laser exposure, Infrared laser group treated by infrared laser 1064nm, Red laser group treated by Red laser 650nm. The dose was adjusted to 10 J/Cm^2 on daily basis for one week. All animals were evaluated by x-ray on weekly basis for one month. Low level laser therapy (LLLT) was effective for the stimulation of bone healing. Clinical fresh skin wounds of 20 dogs of different sex breed, age and site of the wound divided into 4 groups 5 each. The control group, was left without light source treatment. The other groups, were treated by red laser 650nm, red LED 630nm and green laser 532nm. Each dog received 5 J/Cm^2. Red laser 650nm, red LED 630nm , and geen laser 532nm showed promising results.

Key words: Photobiostimulation, Laser , Fracture Healing Biostimulation, wound Healing biostimulation, Fracture healing photostimulation, Low Level Laser Therapy.

Acknowledgment

In the name of Allah, the Most Gracious and the Most Merciful Alhamdulillah, all praises to Allah for the strengths, all his grants and His blessing in completing this thesis.

I would like to express my heartfelt gratitude, sincere appreciation and profound regards to

Prof. DR. Hany Mohamed Gohar *Professor of Surgery, Anesthesiology, and Radiology former Dean of Faculty of Veterinary Medicine, Cairo University for his unlimited help, endless advice and cheerful cooperation.*

Prof. Dr. Inas Nabil El-Husseiny *, Professor of Surgery, Anesthesiology, and Radiology, for her support, kind supervision and personal and academic guidance.*

Lecturer. DR Mostafa Sad ElDin Assistant *Professor of Radiology Faculty of Dentistry, Ain Shams University for his assistance and kind effort.*

Prof. Dr.*Khaled Essam Ezzat Professor of Histology Faculty of Medicine, Cairo University, for his support in the histopathological evaluation, his patience, constructive comments, valuable advices that help me in this work.*

Finally, I would like to thank the Faculty of veterinary medicine especially the Surgery, Anesthesiology and Radiology department and the National institute of Laser Enhanced sciences for their hospitality and support.

Last, I would like to thank my family and my parents for giving birth to me at the first place and supporting me spiritually throughout my life. Especially my mother and wife, as they suffered a lot all the time of my thesis.

I dedicate this work to the sole of my father.

Contents

List of Abbreviations

Abbreviation	Meaning
ALP:	Alkaline Phosphatase
Aº:	Angestrom = 10^{-10} meter
Ar laser:	Argon laser
ATP:	Adenosine triphosphate
BMD:	Bone mineral density
BMPs:	Bone Morphogenetic proteins
c:	velocity of light
Cm:	centimeter =10^{-2} meter
Cm^2:	centimeter square =10^{-4} square meter
Co_2 Laser:	Carbon dioxide laser (wave length 10600nm)
CW :	Continuous wave Electromagnetic wave of constant amplitude and frequency .
E:	Energy
EDTA:	Ethylene diamine tetraacetic acid
Er:YAG laser:	Erbium-doped yttrium aluminium garnet
FIR :	The Far Infrared Region of the electromagnetic spectrum extending from about 2500 nm to 10600 nm.
GAALAS:	Gallium Aluminum Arsenide

List of Abbreviations

Ga-As:	Gallium Arsenide
He:Ne laser :	Helium Neon laser (wave length 632nm)
IR:	Infrared
J:	Jole
kHz :	Kilo Hertz
LED:	Light Emitting Diode
LILAB:	low-intensity laser-activated biostimulation
LIPUS :	low-intensity pulsed ultrasound
LLLT:	low-level laser (or light) therapy
LPBM :	Photobiomodulation
mW:	milliwatt
NASA :	National Aeronautics and Space Administration
Nd:YAG laser :	Neodymium: Yttrium Aluminum Garnet laser (wave
NIR :	Near Infra Red Region of the electromagnetic spectrum extending from about 700 nm to 950nm.
nm:	nanometer $=10^{-9}$ m
PBM:	Photobiomodulation
PDT:	photodynamic therapy
Phi: φ	beam diameter

PT :	phototherapy
TGF-β_2:	Tumor Growth Factor β_2
UV:	Ultraviolet
λ:	wave length
μm :	micrometer =10^{-6} m
ν :	Frequency

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