

PROGRESS IN BIOMEDICAL OPTICS AND IMAGING

Vol. 11, No. 5

Mechanisms for Low-Light Therapy V

Michael R. Hamblin

Ronald W. Waynant

Juanita Anders

Editors

23–25 January 2010

San Francisco, California, United States

Sponsored and Published by
SPIE

Volume 7552

Proceedings of SPIE, 1605-7422, v. 7552

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Mechanisms for Low-Light Therapy V*, edited by Michael R. Hamblin, Ronald W. Waynant, Juanita Anders, Proceedings of SPIE Vol. 7552 (SPIE, Bellingham, WA, 2010) Article CID Number.

ISSN 1605-7422

ISBN 9780819479488

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445

SPIE.org

Copyright © 2010, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 1605-7422/10/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

SPIE 
Digital Library

SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

vii	<i>Conference Committee</i>
ix	<i>Introduction</i>

SESSION 1 REVIEWS AND DOSIMETRY

- 7552 03 **The importance of pulsing illumination parameters in LLLT** [7552-02]
D. Barolet, RoseLab Skin Optics Lab. (Canada) and McGill Univ. (Canada)
- 7552 05 **Role of the circulation in the systemic effects of low-light therapy** [7552-04]
M. Dyson, King's College London (United Kingdom)
- 7552 06 **Low level laser therapy for traumatic brain injury** [7552-05]
Q. Wu, Massachusetts General Hospital (United States), Harvard Medical School (United States), and Jinan Central Hospital, Shandong Univ. (China); Y.-Y. Huang, Massachusetts General Hospital (United States), Harvard Medical School (United States), and Guangxi Medical Univ. (China); S. Dhital, Massachusetts General Hospital (United States) and Univ. of Tokyo (Japan); S. K. Sharma, Massachusetts General Hospital (United States); A. C.-H. Chen, Massachusetts General Hospital (United States) and Boston Univ. School of Medicine (United States); M. J. Whalen, Massachusetts General Hospital (United States); M. R. Hamblin, Massachusetts General Hospital (United States), Harvard Medical School (United States), and Harvard-MIT Div. of Health Sciences and Technology (United States)

SESSION 2 IN VITRO STUDIES

- 7552 08 **In-vitro suppression of metabolic activity in malignant human glioblastomas due to pulsed-low frequency electric potential exposures** [7552-07]
A. Schlichting, Marquette Univ. (United States); R. W. Waynant, D. B. Tata, U.S. Food and Drug Administration (United States)
- 7552 0A **Comparison of cellular responses induced by low level light in different cell types** [7552-09]
Y.-Y. Huang, Massachusetts General Hospital (United States), Harvard Medical School (United States), and Guangxi Medical Univ. (China); A. C.-H. Chen, Massachusetts General Hospital (United States) and Boston Univ. School of Medicine (United States); S. K. Sharma, Massachusetts General Hospital (United States) and Harvard Medical School (United States); Q. Wu, Massachusetts General Hospital (United States), Harvard Medical School (United States), and Jinan Central Hospital, Shandong Univ. (China); M. R. Hamblin, Massachusetts General Hospital (United States), Harvard Medical School (United States), and Harvard-MIT Div. of Health Sciences and Technology (United States)
- 7552 0B **Effect of low level laser therapy on hair cell regeneration following gentamicin induced ototoxicity in postnatal organotypic culture of rat cochlea** [7552-10]
C.-K. Rhee, Y. H. Kim, S. H. Kim, P. He, J. C. Ahn, Dankook Univ. College of Medicine (Korea, Republic of)

SESSION 3 ANIMAL STUDIES

- 7552 OE **Low-power light and isolated rat hearts after ischemia of myocardium** [7552-13]
V. A. Monich, O. V. Drugova, V. F. Lazukin, A. B. Bavrina, Nizhny Novgorod State Medical Academy (Russian Federation)
- 7552 OH **The photobiomodulation in the bone repair after radiotherapy: experimental study in rats** [7552-16]
M. R. S. Freire, Federal Univ. of Bahia (Brazil); D. Almeida, Federal Univ. of Reconcavo of Bahia (Brazil); J. N. Santos, V. A. Sarmento, Federal Univ. of Bahia (Brazil)
- 7552 OI **Prevention of bloodstream infections by photodynamic inactivation of multiresistant *Pseudomonas aeruginosa* in burn wounds** [7552-17]
M. C. E. Hashimoto, R. A. Prates, D. J. Toffoli, Instituto de Pesquisas Energéticas e Nucleares (Brazil); L. C. Courrol, Instituto de Pesquisas Energéticas e Nucleares (Brazil) and Unifesp (Brazil); M. S. Ribeiro, Instituto de Pesquisas Energéticas e Nucleares (Brazil)

SESSION 4 CLINICAL STUDIES

- 7552 OJ **Review of technology development and clinical trials of transcranial laser therapy for acute ischemic stroke treatment** [7552-18]
B. E. Catanzaro, CFE Services (United States); J. Streeter, Banyon Biomarkers (United States); L. de Taboada, PhotoThera (United States)
- 7552 OK **Laser therapy for the treatment of arthritic knees: a clinical study** [7552-19]
F. Kahn, R. Liboro, F. Saraga, Meditech Laser Rehabilitation Ctr. (Canada)
- 7552 OL **Transcranial LED therapy for cognitive dysfunction in chronic, mild traumatic brain injury: two case reports** [7552-20]
M. A. Naeser, VA Boston Healthcare System (United States) and Boston Univ. School of Medicine (United States); A. Saltmarche, MedX Health Inc. (Canada); M. H. Krengel, VA Boston Healthcare System (United States) and Boston Univ. School of Medicine (United States); M. R. Hamblin, Massachusetts General Hospital (United States), Harvard Medical School (United States), and Harvard-MIT Div. of Health Sciences and Technology (United States); J. A. Knight, VA Boston Healthcare System (United States) and Boston Univ. School of Medicine (United States)
- 7552 OM **The effects of infrared laser therapy and weightbath traction hydrotherapy as components of complex physical treatment in disorders of the lumbar spine: a controlled pilot study with follow-up** [7552-21]
C. Oláh, Borsod-Abaúj-Zemplén County Hospital and Univ. Teaching Hospital (Hungary); M. Oláh, Hungarospa Health Resort (Hungary); B. Demeter, Borsod-Abaúj-Zemplén County Hospital and Univ. Teaching Hospital (Hungary); Z. Jancsó, Debrecen Medical Univ. (Hungary); V. Páll, Borsod-Abaúj-Zemplén County Hospital and Univ. Teaching Hospital (Hungary); T. Bender, Polyclinic of the Hospitaller Broterhs of St. John of God (Hungary)
- 7552 ON **Syntonics phototherapy** [7552-23]
R. L. Gottlieb, College of Syntonics Optometry (United States)

POSTER SESSION

- 7552 0O **Polarized light improves cutaneous healing on diabetic rats** [7552-24]
L. M. P. Ramalho, P. C. Oliveira, A. M. C. Marques, A. L. Barbosa Pinheiro, Federal Univ. of Bahia (Brazil)
- 7552 0P **Assessment of laser photobiomodulation and polarized light on the healing of cutaneous wounds on euthyroid and hypothyroid induced rats** [7552-25]
L. M. P. Ramalho, B. M. P. Weyll, M. D. M. da Costa Lino, M. J. P. Ramalho, A. L. Barbosa Pinheiro, Univ. Federal da Bahia (Brazil)
- 7552 0Q **The antinociceptive effects of *Monechma ciliatum* and changes in EEG waves following oral and intrathecal administration in rats** [7552-28]
A. B. Meraiyebu, A. B. Adelaiye, Bingham Univ. (Nigeria); O. S. O, Univ. of Jos (Nigeria)
- 7552 0R **Transcranial near infrared laser therapy (NILT) to treat acute ischemic stroke: a review of efficacy, safety and possible mechanism of action derived from rabbit embolic stroke studies** [7552-31]
P. A. Lapchak, Univ. of California, San Diego (United States); J. Streeter, L. De Taboada, PhotoThera, Inc. (United States)

Author Index

Conference Committee

Symposium Chairs

James G. Fujimoto, Massachusetts Institute of Technology (United States)

R. Rox Anderson, Massachusetts General Hospital (United States)

Program Track Chair

Reza S. Malek, Mayo Clinic (United States)

Conference Chairs

Michael R. Hamblin, Massachusetts General Hospital (United States)

Ronald W. Waynant, U.S. Food and Drug Administration (United States)

Juanita Anders, Uniformed Services University of the Health Sciences (United States)

Program Committee

James D. Carroll, THOR Photomedicine Ltd. (United Kingdom)

Luis H. De Taboada, PhotoThera, Inc. (United States)

Mary Dyson, King's College London (United Kingdom)

Tomas L. M. Hode, Irradia USA (United States)

Session Chairs

- 1 Reviews and Dosimetry
Michael R. Hamblin, Massachusetts General Hospital (United States)
- 2 In Vitro Studies
Juanita Anders, Uniformed Services University of the Health Sciences (United States)
- 3 Animal Studies
Ronald W. Waynant, U.S. Food and Drug Administration (United States)
- 4 Clinical Studies
James D. Carroll, THOR Photomedicine Ltd. (United Kingdom)

Introduction

The use of low levels of visible or near infrared light known as low level laser (light) therapy (LLLT) for preventing tissue damage and cell death, reducing pain, inflammation and edema, promoting healing of wounds, deeper tissues and nerves, has been known for almost 40 years since the invention of lasers. Originally thought to be a peculiar property of laser light (soft or cold lasers), the subject has now broadened to include photobiomodulation and photobiostimulation using non-coherent light.

Despite many reports of positive findings from experiments conducted in vitro, in animal models, and in randomized controlled clinical trials, LLLT remains controversial. This likely is due to two main reasons; firstly the biochemical and cellular mechanisms underlying the positive effects are incompletely understood, and secondly the complexity of rationally choosing amongst a large number of illumination parameters such as wavelength, fluence, power density, pulse structure, and treatment timing has led to the publication of a number of negative studies as well as many positive ones. In particular a biphasic dose response has been frequently observed where low levels of light have a much better effect than higher levels.

In 2006 SPIE Photonics West reinstated a conference series on this topic entitled "Mechanisms for Low Light Therapy" and the present volume of the Proceedings of SPIE contains the papers presented in the fifth conference of this series in 2010. These proceedings contain several studies that report on the effects of LLLT on the nervous system and in particular on the brain. Two papers from Photothera discussed the clinical trials of transcranial laser therapy for stroke (7552-18 Catanzaro and 7552-31 Lapchak), while LLLT for traumatic brain injury was covered in mice (7552-5 Wu) and in humans (7552-20, Naeser). Reduction of ototoxicity after gentamycin by LLLT was covered by 7552-10 Rhee. Other studies covered bone healing after radiation damage (7552-116 Freire) and wound healing in rats with polarized light (7552-25 Ramalho).

Michael R. Hamblin
Ronald W. Waynant
Juanita Anders

