Title
Rapid Therapy Evaluation Using Chronic, Wide-Field Optical Imaging of Microvascular Blood Flow Dynamics

ISBN
9781557528469

Authors
Choi, Bernard
Jia, Wangcun
Channual, Jennifer
et al.

Publication Date
2007

DOI
10.1364/fio.2007.fwe5

Rapid Therapy Evaluation Using Chronic, Wide-Field Optical Imaging of Microvascular Blood Flow Dynamics

Bernard Choi, Wangcun Jia, Jennifer Channual, Kristen M. Kelly, Justin Lotfi
Beckman Laser Institute and Medical Clinic, University of California, Irvine, CA
choib@uci.edu

Abstract: We employ speckle imaging and window chamber models to study vascular remodeling processes after light-based therapies. Our data demonstrate that the response involves substantial remodeling over a monitoring period of up to 30 days post-intervention.

OCIS codes: (110.6150) Speckle imaging, (170.1470) Blood/tissue constituent monitoring, (170.3340) Laser Doppler velocimetry, (170.3880) Medical and biological imaging, (170.5180) Photodynamic therapy

1. Introduction

Noninvasive blood flow characterization is essential to assess the health status of biological tissue and to evaluate the efficacy of therapies which target the microvasculature. Optimization of laser therapy for disfiguring vascular birthmarks is one specific clinical application. Current treatment protocols involve the use of high-power pulsed laser irradiation with parameters selected to induce selective photocoagulation of the targeted blood vessels. Protocol design is based largely on results from numerical modeling studies, which have predictive capability of the laser light distribution within the skin and subsequent photothermal response leading towards selective photocoagulation. However, the biological response of the microvasculature to therapeutic laser intervention remains a poorly-researched field.

2. Methods

We hypothesize that the acute photothermal response of the microvasculature is a poor predictor of the chronic response, due to vascular remodeling processes which are not included in current modeling studies. To test this hypothesis, we have developed a wide-field laser speckle imaging (LSI) instrument that acquires reflectance images of an object irradiated with low-power laser light [1]. We have applied this LSI method to quantify blood flow dynamics in the exposed microvascular network of a rodent dorsal skinfold model subjected to therapeutic doses of laser irradiation [2]. The primary advantage of using LSI with our animal model is chronic quantitative evaluation of the microvascular network, minimizing the need for costly biopsies necessary in histology-based studies.

3. Results and Discussion

Our data demonstrate that the biological response is characterized by substantial vascular remodeling and blood flow redistribution over a monitoring period of up to 30 days post-intervention. We have observed several vascular effects, including vasoconstriction, vasodilation, delayed blood flow changes, and tortuous vessel formation. Furthermore, we have observed vessel repair within the same position as the original vessel, suggesting that the vascular remodeling process may be associated with a "memory" [3]. In general, our small animal imaging approach allows us to evaluate rapidly novel therapeutic protocols and to identify strategies for protocol refinement to enhance treatment efficacy.

4. References

[1] B. Choi, J.C. Ramirez-San-Juan, J. Lotfi, J.S. Nelson, "Linear response range characterization and in vivo application of laser speckle imaging of blood flow dynamics," J. Biomed. Optics **11,** 041129 (2006).

[2] T.K. Smith, B. Choi, J.C. Ramirez-San-Juan, J.S. Nelson, K. Osann, K.M. Kelly, "Microvascular blood flow dynamics associated with photodynamic therapy, pulsed dye laser irradiation and combined regimens," Laser. Surg. Med. **38,** 532-539 (2006).

[3] MR. Mancuso *et al.*, "Rapid vascular regrowth in tumors after reversal of VEGF inhibition," J. Clin. Invest. **116,** 2610-2621 (2006).