Journal of Innovative Optical Health Sciences
Vol. 3, No. 3 (2010) v–vi
DOI: 10.1142/S1793545810001076

INTRODUCTION

SPECIAL ISSUE: OPTICAL CLEARING FOR BIOMEDICAL IMAGING

In the visible and near-infrared wavelength range, the majority of tissues are low absorbing but highly scattering media. Scattering defines the penetration depth of light in tissue, and also limits the clinical application of light-based diagnostic and therapeutic techniques. Optical clearing agents (OCAs) have been identified that can reversibly change the light scattering properties of tissues and blood. Recently, optical clearing for biomedical imaging shows a great potential, but the challenge remains to elucidate optical clearing mechanisms and to describe the optical clearing processes which could best contribute to optical clearing for biomedical imaging. This issue includes 10 original papers.

Combining the fluorescence spectroscopy and different optical clearing agents, Valery Tuchin's group investigates dynamical changes in autofluorescence spectra of *in vitro* rat skin for the first time. They not only observed that the autofluorescence signal decreases with reducing of scattering in tissue, but also found differences in the shape of spectral curves under application of different clearing agents. Bernard Choi's group proved that DMSO-mediated optical clearing enables enhanced characterization of subsurface fluorophores in a tissue phantom, and then demonstrated that DMSO is an effective optical clearing agent for improving fluorescence emission quantification by *in vivo* studies. In order to demonstrate the optical clearing method for improving laser speckle contrast imaging (LSCI), Dan Zhu's group quantitatively analyzed the enhancement of image contrast, imaging depth and sensitivity to flow velocity of LSCI by monitoring blood flow in different tissue phantoms. Another critical challenge is to establish optimal amounts that could be applied for maximal (local) clearing effects without serious damage to tissues. The work by Kirill V. Larin's group quantitatively assessed the effect of optical clearing caused by various concentration of glucose using optical coherence tomography and demonstrated that higher glucose concentration has the highest optical clearing effect, and a suitable concentration should be chosen for the purpose of clearing, considering the osmotic stress on the tissue sample. Hui Ma's group compared the penetration dependence of rotating linear polarization imaging and the degree of polarization imaging on the mean free path length and the anisotropic factor, which will help us to understand how optical clearing improves the depth of polarization imaging.

The work by Steven Jacques' group examined the mechanism of optical clearing of skin, using reflectance mode confocal scanning laser microscopy to characterize the changes in the scattering coefficient and anisotropy of scattering of mouse skin *in vitro* caused by different agents. They found that under the action of glycerol, a significant increase of scattering anisotropy is a key point of optical clearing. Xiangqun Xu and co-worker investigated the possible mechanisms of the enhanced skin optical clearing by ultrasound medications. SEM images demonstrated that the higher optical clearing effect may be due to the tight order of the lipid bilayers in the disrupted stratum corneum and the separation of keratinocytes. In order to realize live skin clearing, we need to consider how much OCAs penetrate into skin after topical application. Jingying Jiang and co-workers performed both model experiments in tissue phantom and skin *in vitro* so as to understand the dynamical optical clearing process of skin.

Besides application of OCAs, higher tissue optical transmittance could be provided by Tissue Optical Clearing Devices (TOCDs) which have been shown to increase light transmission through mechanically compressed regions of naturally turbid biological tissues. William Vogt *et al.* demonstrate a novel combined mechanical finite element model and optical Monte Carlo model which simulates TOCD pin compression of *in vitro* porcine skin and modifies spatial photon fluence distributions within the tissue. At opposite poles of optical clearing of tissue, thermal coagulation could induce the increase in scattering of tissue. Zhiyu Qian's group utilized NIRS and Mie theory to investigate the dynamics of this process. The methods are also valid for investigating optical clearing process in tissue.

We thank all the authors for their contributions to this special issue. As we look forward, we believe that optical clearing, based on reversible reduction of tissue scattering, will be of great interest for biomedical optics research and can make significant contributions in the fields of light-based diagnostic and therapeutic techniques.

Valery V. Tuchin
Saratov State University, Russia
Martin Leahy
University of Limerick, Ireland
Dan Zhu
Huazhong University of Science and Technology, China