Photomedicine Lights Up the Future of Fighting Cancer

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The history of light as a therapeutic device can be traced back nearly 2300 years. The ancient Greeks said: “What the drug cannot heal will heal with the knife, what the knife cannot heal will heal with the light (fire), what the light cannot heal can’t be healed.” Using and understanding light and its effect reformed and improved health care and medical science.

Since the first laser equipment was invented in 1960, photomedicine has been developed as one of the most exciting fields in biomedicine, especially in the field of cancer. As an information carrier, light has been developed for use in imaging, which revolutionized our understanding of cancer. As an energy carrier, light has been developed for therapy, which transformed the theranostics of cancer.

This special collection of Technology in Cancer Research & Treatment, “Phototherapy and Optical Imaging of Cancer,” provides researchers and clinicians with a platform to share and discuss developments in the prevention, diagnosis, treatment, and monitoring of cancer, which will improve the development of light in cancer research.

The evolution of optical technologies in medical imaging has revolutionized the way in which cancer is detected. Many novel technologies, such as optical coherence tomography, have become powerful clinical tools; other emerging technologies, such as super-resolved fluorescence microscopy, multiphoton microscopy, photoacoustic scanning microscopy, and confocal micro-Raman spectroscopy, have become irreplaceable tools in cancer research.

Photoacoustic imaging is a noninvasive imaging modality which combines optical and ultrasound techniques. There are 2 types of photoacoustic imaging systems, photoacoustic computed tomography (PAT) and photoacoustic microscopy (PAM). Photoacoustic computed tomography uses an unfocused ultrasonic array to acquire photoacoustic signals, and the image requires a reconstruction algorithm. Meng et al developed compressed sensing with a Gaussian scale mixture model for limited-view PAT in vivo, to improve the imaging quality of PAT. On the other hand, the PAM system uses a focused spherically ultrasound detector without a reconstruction algorithm. A way to improve the imaging quality is reflected in “The Dual-mode Imaging of Nanogold-Labeled Cells by Photoacoustic Microscopy and Fluorescence Optical Microscopy.”

Prof. Wu observed the dermatofibrosarcoma protubersa skin applying multiphoton microscopy. The image results indicate that collagen shape and density can be considered as auxiliary diagnostic parameters to improve the accuracy of diagnosis. Prof. Yu observed the effect of the inhibition of HSP70 on breast cancer cells through a laser scanning microscope combined with a mitochondrial membrane potential fluorescence probe.

Blue laser imaging (BLI) endoscopy is a new endoscopic system equipped with a laser beam emitting 2 different wavelengths. The article entitled “The Characteristics of Blue Laser Imaging and the Application in Diagnosis of Early Digestive Tract Cancer” reviewed the application of BLI in diagnosis of early gastrointestinal carcinoma. Compared to the image-enhanced endoscope, BLI has brighter and higher resolution, which is helpful for the diagnosis of early gastrointestinal cancer and colorectal polyps as well as laterally spreading tumors and the judgment of the invasion depth.

Laser techniques have made profound impacts on modern medicine with numerous laser devices currently being used in clinical practice to treat cancer through photothermal effect, photodynamic effect, and so on. Besides conventional surgery,
radiotherapy, and chemotherapy, photodynamic therapy (PDT) is an alternative cancer treatment modality that induces cell death by the generation of reactive oxygen species. Three papers discuss the application of PDT for the treatment of actinic keratosis (AK), metastatic melanoma, and esophageal cancer.

In the paper entitled “Dermoscopic Monitoring For Treatment and Follow up of Actinic Keratosis With 5-Aminolevulinic Acid Photodynamic Therapy,” patients with AK were treated with 5-aminolevulinic acid PDT. Dermoscopy was applied to determine the end point of the treatment in the experimental group, and the recurrence is lower than that of the control group (2.85% vs 12.5%). This shows that dermoscopy can be a useful tool for monitoring skin lesions in patients with AK during PDT and follow-up.

In Abrahamse’s review article entitled “Photodynamic Therapy for Metastatic Melanoma Treatment: A Review,” various photosynthetic drugs and nanoparticle drug delivery systems specifically targeted for melanoma were analyzed. They speculated that further investigations into developing a more efficient active nano-photosensitizer carrier smart drug may improve PDT efficacy.

The study entitled “Evaluation on Short-term Therapeutic Effect of Two Porphyrin Photosensitizers-Mediated Photodynamic Therapy for Esophageal Cancer” discusses Dr Huilong Liu et al’s work to analyze and study short-term therapeutic effects and main adverse effects of PDT for the treatment of esophageal cancer. The dysphagia scores were significantly reduced after PDT. All patients did not display serious adverse effects.

Recent advances in biomedical optics have enabled increasingly sophisticated technologies—in particular, those that integrate photonics with nanotechnology, biomaterials, and genetic engineering. There has been a great deal of interest devoted to the development of nanomaterials for photothermal therapy that can be used in minimally invasive selective cancer treatment. It is anticipated that optical technology will continue to have a fundamental impact on the advancement of biomedical research.

Photothermal reaction produces hyperthermia and coagulation of tissue; it can be an effective means in tumor tissue destruction due to the sensitivity of tumor cell to temperature elevation. Prof. Chen et al have been focusing on the novel modality combined laser with immunoadjuvant for over 20 years. Their new research in this field is described in the article “An Immunologically Modified Nanosystem Based on Noncovalent Binding Between Single-Walled Carbon Nanotubes and Glycated Chitosan.” Here, they studied how glycated chitosan maximizes treatment efficacy of photothermal therapy.

In summary, this special collection encompasses many rapidly moving research areas and clinical studies of phototherapy and optical imaging of cancer. We hope the reader gets up-to-date with advances in the fields of photomedicine. We also hope that photomedicine may light up the future of fighting cancer.

Authors’ Note
Our study did not require an ethical board approval because it did not contain human or animal trials.

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