Improving Skin Cancer Detection

By: Kunal Mitra, Ph.D. & Gregory Nichols

Skin cancer is one of the most rapidly growing cancers affecting Americans. Nearly 5 million people are treated for skin cancer every year in the United States, and treatment costs were reported in excess of $8 billion from 2007-2011. Risk factors for skin cancer include prolonged and unprotected exposure to sunlight. Recent wars in Iraq and Afghanistan may have contributed to excessive exposures to ultraviolet light from the sun among U.S. service members. Recent statistics (and studies) show a very invasive form of skin cancer, called malignant melanoma, has been on the rise among U.S. military members. Rates for melanoma cases are much higher in service members over the age of 30 and among Caucasians compared with the rest of the U.S. population. Improving the efficiency of skin cancer diagnosis would certainly be an asset to both the Department of Defense and the Department of Veterans Affairs.

Currently, the majority of skin cancers are confirmed using an invasive biopsy. This means that a section of the skin must be removed and then studied in a laboratory. Results can take anywhere from three to 10 days. The ratio of benign biopsies to confirmed melanomas can vary, ranging from 40 to 1 for dermatologists and as high as 50 to 1 for primary care physicians.

In order to reduce this error rate, we are developing a non-invasive, time-resolved optical tomography (TROT) detection system based on ultra-short pulse (USP) lasers that will be used for detecting early cellular changes in suspected skin cancer lesions. Use of short pulse laser for minimally or non-invasive diagnosis and therapeutic treatment has become an indispensable tool in the technological arsenal of modern medicine and biomedical engineering. Time-resolved optical tomography system using USP laser is a novel real-time and non-invasive diagnostic technique providing a complete 3-D view of the scanned area by which one can detect skin cancer and its margins at early stages normally not detected by other techniques (Pal et al., 2006; Sakami et al., 2002). It can differentiate between different types of lesions and improve diagnostic accuracy. Once the tumor’s size and location are known, the tumor can be irradiated killed using a focused beam from USP laser radiation.

Time-resolved optical tomography will provide information with a safer, simpler and cheaper system than other modern imaging techniques. The information gathered is not restricted to a few physical samples, as it is in biopsies. Use of USP lasers will result in greater depth of tissue penetration and will provide high temporal and spatial resolution images compared to a traditionally used continuous wave laser.

In addition to using the USP laser, we are exploring the use of gold nanoparticles as contrast agents for enhanced imaging. Metal nanoparticles, such as gold, are among one of the most promising and exciting new materials for biomedical applications. Engineered nanoparticles can be introduced in order to enhance intrinsic tissue contrast (and therefore imaging sensitivity and resolution). Dr. Mitra has demonstrated the significance of enhanced imaging using specific gold nanoparticles with the TROT system (Sajjadi et al., 2013). Our hope is that use of this TROT system coupled with injection of gold nanoparticles will provide a system that could ultimately save billions of dollars annually in unnecessary biopsies. However, any technique utilizing nanoparticles in a healthcare setting must be evaluated for feasibility and risk before large-scale use can be considered. Often times the development of new technologies does not take into account environmental, health and safety issues. Protocols for the use of new technologies are often haphazard and develop much later out of necessity rather than being an...
Engineered nanomaterials have the potential to revolutionize medicine, but there are some concerns regarding potential organ and genetic toxicity as well as environmental contamination. Further studies and the development of safe methods for the utilization of engineered nanomaterials in medical applications are needed before proceeding to clinical trials. Tackling the introduction of nanotechnology into an applied healthcare environment will be no easy task; therefore, we plan to conduct a series of small-scale studies in conjunction with stakeholder engagement to assess the feasibility of integrating engineered nanomaterials into medical practice while developing possible models for best practices. Although it is not a typical pairing, having a biomedical engineer and a public health professional, both with expertise in nanotechnology, makes for an interesting and innovative partnership.

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References:
