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Optical Techniques Show Continued Promise in Detecting Pancreatic Cancer

Optical technology developed by a Northwestern biomedical engineer has been shown to be effective in detecting the presence of pancreatic cancer.

By Megan Fellman

EVANSTON, Ill. --- Optical technology developed by a Northwestern University professor of biomedical engineering has been shown to be effective in detecting the presence of pancreatic cancer through analysis of neighboring tissue in the duodenum, according to clinical trial results published in the journal Disease Markers.

The promising new technology -- which researchers hope could help raise the extremely low survival rate of pancreatic cancer patients by aiding early detection -- uses novel light-scattering techniques to analyze extremely subtle changes in the cells of the duodenum, part of the small intestine neighboring the pancreas. The cells are obtained through a minimally invasive endoscopy.

The study shows that cells that appear normal using traditional microscopy techniques do show signs of abnormality when examined using the Northwestern technique, which provides cell analysis on the much smaller nanoscale.

The technology was developed by Vadim Backman, professor of biomedical engineering at the McCormick School of Engineering and Applied Science at Northwestern, and Vladimir Turzhitsky, a graduate student in Backman's lab. Clinical trials have been conducted in collaboration with Hemant Roy, M.D., director of gastroenterology research at NorthShore University HealthSystem, and Randall Brand, M.D., a gastroenterologist at the University of Pittsburgh Medical Center.

In the study of 203 patients, the technique accurately discriminated with 95 percent sensitivity between healthy patients and those with differing stages of the disease. (Only 5 percent of patients were found to have been diagnosed with false negatives after testing.) The specificity of the testing group was 71 percent. These results confirm those of an earlier study of 51 patients published in August 2007 in the journal Clinical Cancer Research.

The larger number of patients in the more recent study allowed researchers to calculate the "area under the receiver operator characteristic" (AUROC), which is an analysis of the accuracy of the test in distinguishing healthy samples from diseased samples. While the sensitivity and specificity of tests may vary based on the threshold set by researchers for diagnosis, the AUROC measures the overall efficacy of the diagnostic technique. The analysis showed an 85 percent AUROC for the Northwestern method. (Clinically sound tests typically have an AUROC greater than 70 percent.)

The study in Disease Markers also reports promising results in detecting mucinous cyst lesions, which are a precursor to cancer. If confirmed in further clinical trials, this approach may lead to a method for early diagnosis.

Pancreatic cancer is among the most deadly forms of cancer, with a five-year survival rate of just 5 percent. It is so deadly, in part, because early detection is difficult. There is a high risk of complications if the pancreas is examined directly, so routine inspections for at-risk patients usually are not an option. In fact, only 7 percent of people with pancreatic cancer are diagnosed in the earliest stages of the disease, when the cancer is still confined to its primary site. More than half of all people with the disease are not diagnosed until the cancer has already metastasized.

"Typically, by the time a patient is diagnosed with pancreatic cancer, it is too late for the most successful treatments," says Backman. "Our hope is that this technology will provide a better method for early diagnosis of the disease, which could greatly improve the survival rate."

The technology combines two complementary optical techniques, four-dimensional elastic light-scattering fingerprinting (4D-ELF) and low-coherence enhanced backscattering spectroscopy (LEBS). The researchers found that the two combined work better than one alone in pancreatic cancer screening.

During the test, a xenon lamp shines intense, white light through a series of lenses and filters onto the specimen -- cells from the duodenum. The light refracts through the outermost layer of tissues and scatters into a spectrograph, a device that separates a beam of white light into its component wavelengths and measures them. An image sensor captures the result,

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then a computer analyzes the pattern of light scattering, looking for the "fingerprint" of carcinogenesis in the nanoarchitecture of the cells.

The technology makes use of a biological phenomenon known as the "field effect," a hypothesis that suggests the genetic and environmental milieu that results in a neoplastic lesion in one area of an organ should be detectable throughout the organ and even in neighboring tissue.

If similar results are found when the technique is applied to other organs, the method could have broad impact on the timely treatment of breast cancer, lung cancer and other forms of cancer.

The original technology was supported by the National Science Foundation; clinical trials were supported by the National Institutes of Health and the V Foundation for Cancer Research.

"I'm very excited about the Backman group's work," says Leon Esterowitz, NSF biophotonics program director. "I believe these results are very promising, and the technique has a high probability of success for not just detecting early pancreatic cancer but also pre-cancer, so doctors can go ahead and treat the patient while there's still a chance to defeat the disease. For pancreatic cancer, this could lead to not only an excellent prognosis, but perhaps even a cure."

In a related study published last month in the OSA journal Optics Letters, Backman, Roy and Brand reported promising results for another optical technique called partial wave spectroscopy. That technology measures how light propagates through a cell in a single dimension, allowing researchers to detect nanoscopic changes to the interior architecture of a cell. In this study, researchers examined actual pancreatic cells, gathered using fine needle aspiration.

"We are developing a suite of optical technologies that we hope will transform our ability to detect cancer at its earliest stages," says Backman.

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