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events
contacts
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grads
industry
employment

LIGHT REVEALS BREAST TUMOR OXYGEN STATUS

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DURHAM, N.C. – Light directed at a breast tumor through a needle can provide pathologists with biological specifics of the tumor and help oncologists choose treatment options that would be most effective for that individual patient.

Duke University bioengineers have developed a light-based system that can quickly and easily provide important information about oxygen levels within a tumor while it is still in place. The new system, based on diffuse reflectance spectroscopy, gives researchers important clues about the tumor by interpreting how the light is either reflected back from the tumor or absorbed.

Oxygen status is important, the researchers said, since past studies have shown that low levels of oxygen, or hypoxia, are more often associated with malignant tissue than healthy normal tissue. Tumors that thrive in these low-oxygen environments tend to be more difficult to treat, the researchers said.

“We developed an easy-to-use fiber-optic probe that can provide immediate and non-destructive measurements of tumor oxygenation,” said J. Quincy Brown, a fourth-year post-doctoral fellow in the laboratory of Nirmala Ramanujam, associate professor of biomedical engineering at Duke’s Pratt School of Engineering. The results of the Duke experiments were published April 1 in the journal Cancer Research.

“This new approach could be an important new tool for physicians in determining the aggressiveness of a specific tumor and which therapies might work best against it,” Brown said. “Since this system is compatible with commonly used biopsy needles, we could make oxygen measurements at the time of a needle biopsy, providing immediate feedback about the tumor’s oxygen concentration.”

In their current experiments, the researchers enrolled 35 women who were to undergo surgery for their breast cancer. Before the surgery, the researchers directed normal, UV-visible light directly through a needle at the surface of the tumor while it was still in the breast. Since the system gathers information immediately, researchers are able to take readings at multiple locations in little time.

Their main target was blood and its hemoglobin, a protein which is responsible for carrying oxygen throughout the body, as well as to tumors. While some types of breast cancer thrive in environments low in oxygen, other cancers stimulate the growth of new blood vessels to feed oxygen to the tumor.

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“Our system measured how the light was either absorbed by the hemoglobin, which gave us an optical fingerprint of the oxygen status of the tumor,” Brown explained. “This fingerprint can give clues about which form of therapy – chemo, radiation, surgery – might be the most effective for that particular tumor.”

One interesting finding involved tumors with the gene HER2/neu. It is estimated that one in five breast cancers exhibit over-expression of the HER2/neu gene. A routinely used drug known as Herceptin, which can block HER2/neu over-expression, is only effective in treating tumors with this gene.

“The tumors that over-expressed the HER2/neu gene had significantly higher levels of oxygen,” Brown said. “This is likely due to the fact that the amplification of this gene encourages the formation of tiny new blood vessels, which in turn feed the tumor. Knowing how the Her2/neu status of a tumor is affecting tumor oxygenation at the time of biopsy would be useful information for the oncologist, since over-expression of this gene typically leads to a cancer that is more aggressive and more resistant to treatment.”

The researchers plan future studies of breast cancer patients undergoing chemotherapy by taking regular oxygen measurements to determine how a particular tumor is responding to therapy over time.

The research was supported by National Institutes of Health and the Duke Comprehensive Cancer Center. Other Duke members of the research team were Lee Wilke, Joseph Geradts, Stephanie Kennedy and Gregory Palmer.

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