Novel technique changes lymph node biopsy, reduces radiaiton exposure

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Information obtained from a new application of photoacoustic tomography (PAT) is worth its weight in gold to breast cancer patients.

For the first time, Lihong Wang, Ph.D., Gene K. Beare Distinguished Professor in the Department of Biomedical Engineering, with a joint appointment in Radiology, and Younan Xia, Ph.D., James M. McKelvey Professor in Biomedical Engineering, with a joint appointment in chemistry in Arts & Sciences, both at Washington University in St. Louis, have used gold nanocages to map sentinel lymph nodes (SLN) in a rat noninvasively using PAT. Wang's lab is the largest PAT lab in the world credited with the invention of super-depth photoacoustic microscopy, and Xia's lab invented the gold nanocages.

Their work can minimize invasive surgical lymph node biopsy procedures to determine if breast cancer has metastasized and reduce the patient's exposure to radioactivity. The nanocages also have the potential to serve as an alternative to chemotherapy to kill targeted cancers by heating them up.

From heat, to expansion, to sound and an image

PAT blends optical and ultrasonic imaging to give high-resolution images of the body that contain information about physiology or tissue function. Molecules already present in the body (endogenous molecules, as opposed to exogenous ones that are from outside the body), such as

melanin, hemoglobin, or lipids, can be used as endogenous contrast agents for imaging. When light is shone on the tissue, the contrast agent absorbs the light, converts it to heat, and expands. This expansion is detected as sound and decoded into an image.

"Using pure optical imaging, it is hard to look deep into tissues at high resolution because light scatters. The useful photons run out of juice within 1mm," Wang explained. "PAT improves tissue transparency by 2-3 orders of magnitude because sound scatters less than light. This allows us to see through the tissue by listening to the sound."

Exogenous contrast agents, like the gold nanocages developed by Xia's group, can be used to image parts of the body that even contain endogenous contrast agents. These nanocages are especially attractive because their properties can be tuned to give optimal contrast and gold is non-toxic.

"By controlling the synthesis, we can move the absorption peak for the nanocages to a region that allows them to be imaged deep in tissue. We can also attach biomolecules to the surface of the nanocages so they are targeted to cancer cells," Xia said.

Safe imaging, no radioactivity or surgery

The SLN, the first draining node, is often biopsied in breast cancer patients to determine if the cancer has metastasized. "To find the SLN, doctors inject radioactive particles and a blue dye into the breast. The lymphatic system gobbles up the injected material, treating it as foreign matter and accumulating it in the SLN. The radioactive particles can be detected using a Geiger counter held to the breast to locate the lymph nodes. Then, the doctors surgically open the breast, follow the blue dye, and dissect the SLN," Wang said.

Wang and Xia's technique allows the SLN to be imaged safely without radioactivity or surgery. A piece of tissue can then be removed using a minimally invasive needle biopsy and tested for cancer. "We will convert an invasive surgical procedure into a minimally invasive needle biopsy," Wang said.

Source: Washington University in St. Louis