Progress in ultrasound-guided surgery may improve breast cancer treatment

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When surgeons operate to remove a tumor, determining exactly where to cut can be tricky. Ideally, the entire tumor should be removed while leaving a continuous layer of healthy tissue, but current techniques for locating the tumors during surgery are imprecise. Now a multidisciplinary team from the University of California, San Diego, is developing an alternate means of precisely tagging breast cancer tumors for removal or targeted destruction. They will present the results of their investigations at the AVS 59th International Symposium and Exhibition, held Oct. 28 – Nov. 2 in Tampa, Fla.

Breast cancer is the most common female cancer in the U.S., and the main cause of death in women ages 40-59, according to UptoDate, an information service for clinical physicians. Over a lifetime, 1 in 8 women in the U.S. is expected to develop breast cancer. Despite great strides in survival, there is trauma associated not only with the disease, but also with its treatment. Many women want to avoid a full mastectomy, but conventional breast-conserving approaches, such as lumpectomy, can be arduous. Up to 25 percent of lumpectomies require a second surgery to excise the entire tumor.

The UCSD team is working on a better method for tagging tumors that should reduce the need for follow-up surgeries. The researchers developed iron-doped – and therefore biodegradable – silica micro/nano spheres for implanting into the body as ultrasound contrast markers to guide a surgeon using ultrasound during breast lumpectomy. Additionally, the particles can also be used to destroy tumor tissue with

high intensity focused ultrasound (HIFU) ablative therapy, an approach used elsewhere in the world to treat prostate cancer and used in the U.S. to treat uterine fibroids.

If breast tumors are precisely marked, the number of second surgeries can be decreased by 50 percent, according to published studies using radiative tumor markers. Because the gas-filled nanoparticles that the researchers developed make tumors easier to see, they hold the potential for increasing surgical precision with a safe agent. Once injected into the breast cancer tumor, they stick, rendering the tumor more visible with contrast-enhanced ultrasound.

"We are trying to improve the markers surgeons use so they can pull the tumors out with more precision and ease, while reducing trauma for the patient," explains Alex Liberman, the PhD graduate student in the materials science and engineering program who has taken the concept from test tube to animal models. Adds his advisor, chemical physicist Andrew Kummel, PhD: "We are using these particles for two applications. In the short term we are injecting them into breast tumors to enable surgeons to halve the number of second surgeries by readily locating the tumors in the operating room with low- power ultrasound imaging. In the long term, we want to inject the particles intravenously, have them stick to the tumors, and then ablate the tumors by blowing up the particles with high intensity focus ultrasound which is called HIFU."

As now performed, the lumpectomy requires a surgeon to extract tumors through incisions in the breast with the aid of guide wires that protrude out of the breast to help locate the tumor. The wires are prone to movement, and therefore yield imprecise results. Furthermore, the wires are inserted while the patient is awake, which is unpleasant for the patient.

The next step for the team involves conducting more animal tumor

studies. Those results will determine if the particles are suitable technology to submit to human clinical breast cancer trials as a localizing agent to guide lumpectomy surgery or even for HIFU therapy.

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