Probe to detect spread of breast cancer co-developed by UH scientist

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High-temperature superconductors hold the key to a handheld tool for surgeons that promises to be more accurate, cost-effective and safer than existing methods for staging and treating various cancers, including breast cancer.

Audrius Brazdeikis, research assistant professor of physics in the College of Natural Sciences and Mathematics at the University of Houston, and Quentin Pankhurst, a professor of physics from the University College of London (UCL), have developed a novel detection procedure combining nanotechnology and advanced magnetic sensing based on high-temperature superconductors. Their innovation will enable surgeons to more effectively locate the sentinel lymph node – the first lymph node to which a tumor's metastasizing cancer cells will drain.

The researchers produced an ultrasensitive magnetic probe to detect minuscule magnetic fields in the body. The probe is a supersensitive magnetometer – an instrument used to track the presence of clinically introduced magnetic nanoparticles. During breast cancer surgery, a surgeon will inject a magnetic nanoparticle dye, already approved as an imaging contrast agent by the Food and Drug Administration, into the tumor or into tissues surrounding the tumor.

Receiving a $250,000 grant to be used from 2004 to 2006 from the United Kingdom Department of Trade and Industry under the UK-Texas Bioscience Collaboration Initiative, Brazdeikis and Pankhurst were required to show "proof of concept" by building a device and showing it worked. An ethics committee in the UK since has approved the detection procedure for a clinical trial of women undergoing breast cancer surgery at University College Hospital, London.

Dr. Michael Douek, a London surgeon who specializes in breast surgery and is a senior lecturer at UCL, is overseeing the trial and used the probe for the first time in surgery in December. Douek, who visited Houston recently in preparation for the testing, said that the ethics committee gave the hospital permission to use the probe in 10 surgeries and that after a review of those procedures, the number could increase to 100.

"We expect to start new clinical trials in Japan and Europe before the end of 2007," Brazdeikis said. "Our technology will be extensively validated by different surgeons in various countries."

Brazdeikis, who heads the Biomedical Imaging Group at the Texas Center for Superconductivity at UH (TcSUH), said a goal of the grant was to commercialize biomedical technology developed at universities through collaborative research. He and Pankhurst, deputy director of the London Centre for Nanotechnology, have formed a medical devices company – Endomagnetics Inc. – to bring their technology to the marketplace and patented the probe.

"The company plans to roll out the production of the technology in 2008," Brazdeikis said. "We hope that in the next two to three years practice assisted with our new probe will become more widely adopted by surgeons."

Endomagnetics also already has garnered recognition from such key world figures as England's Prince Andrew, his country's special representative for international trade and investment, who highlighted new technology developed by the nanotechnology industry at the Nano-TX '06 conference in Dallas. He cited the UH-UCL collaboration and

Endomagnetics' as an "exciting example of the early stages of this kind of progress."

"The partnership has resulted in a technology used to locate lymph nodes for the staging and treatment of various forms of cancer, including breast cancers and melanomas, and some of the more disfiguring and demoralizing forms of cancer," he said, according to a transcript of his remarks.

"Although the technology has potential for use in the staging and treatment of other cancers, including lung and prostate cancer, the instrument needs to be customized for the type of surgery," said Douek, who has advised the researchers from the beginning of the probe's development. "We went through a whole series of different probes during the course of a year. I was interested in being part of the project because of my interest in magnetic resonance imaging. This is an extension of that technology."

A surgeon holds the probe, which incorporates two sets of coils connected to a sensor. One set of coils magnetizes the magnetic particles, and the second detects the magnetic response from those particles. The sensor, known as an HTS SQUID (or high-temperature superconducting quantum interference device) is located in a cryogenic vessel on a cart and is submerged in liquid nitrogen that cools the sensor to 77 K, equivalent to -320.5 F. The system uses custom-built electronics and software on a laptop computer to give the surgeon visual and audio feedback while tracking the magnetic nanoparticles in the body.

"When breast cancer is diagnosed, and a tumor has been located, a critically important issue is whether the cancer has spread to other parts of the body – a process that occurs via the transport of metastatic cancer cells through the lymphatic system," Brazdeikis said. "The surgeon looks for lymph nodes close to the cancer. They are not easy to find. The probe is a tool for the surgeon to use during the surgery to locate the sentinel lymph node."

Existing practice calls for a breast cancer patient to receive two preoperative injections – a radioactive isotope and a blue dye – eight to 12 hours before surgery, frequently requiring hospitalization the night before the operation. Later, in the operating room, the surgeon uses a handheld gamma probe, aided by the visual observation of the dye, to locate the lymph node with the highest radioactivity.

"Surgeons have a very small window of opportunity to locate the lymphatic nodes that the cancer drains into," Brazdeikis said. "Our technology offers unprecedented quality and value of care benefits to patients, doctors and hospital administrators over existing procedures."

The UH-UCL technology allows a surgeon to administer one injection – the magnetic dye that takes only 10 to 15 minutes to work – and eliminates the need for a nuclear medicine practitioner to inject the radioactive material. A patient thus may not have to be hospitalized while waiting, and the technology eliminates unnecessary patient and surgeon exposure to radioactivity.

"We introduce a paradigm-shifting new technology for the staging and treatment of breast and other forms of cancer," Brazdeikis said. "It will be very appealing for surgeons to take this technology into their practice."

Source: University of Houston