SQUID may improve breast cancer detection

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November 15, 2011
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An emerging application known as magnetic relaxometry demonstrated 100 times greater sensitivity than mammography imaging in identifying breast tumors. The technology employs tumor-targeted magnetic nanoprobes and superconducting quantum interference device (SQUID) sensors.

As Helen J. Hathaway, PhD, and fellow investigators explained in their report for *Breast Cancer Research* (http://breast-cancer-research.com/content/pdf/bcr3050.pdf), mammography can detect very small (5 mm) tumors early in the course of the disease, but misses 10% to 25% of tumors and cannot distinguish between benign and malignant growths. Magnetic relaxometry is fast and potentially more specific than mammography, particularly when using SQUID sensors, because it is designed to detect tumor-targeted iron-oxide magnetic nanoparticles. The technology may even be more specific than MRI detection, because it detects only the target-bound nanoparticles.

Hathaway, of the University of New Mexico Cancer Center (Albuquerque), and colleagues are developing magnetic nanoparticles targeted to breast cancer cells that can be detected using magnetic relaxometry. They created nanoprobes by attaching iron-oxide magnetic particles to HER2 antibodies. (The HER2 protein is overexpressed in 30% of breast cancers.)

The nanoparticles were able to distinguish between cells with HER2 and those without, and were able to find HER2 cancer cells in biopsies from mice. A synthetic breast was then used to determine the potential sensitivity of this early prototype system. The system accurately pinpointed as few as 1 million labeled cells at a depth of 4.5 cm, approximately 1,000 times fewer cells than the size at which a tumor can be felt in the breast, and 100 times more sensitive than mammography.

“While we do not expect the same level of nanoparticle uptake in the clinic, our system has an advantage in that dense breast tissue, which can mask traditional mammography results, is transparent to the low-frequency magnetic fields detected by the SQUID sensors,” commented Hathaway in a statement describing her group's work.

According to the researchers, the results indicate that SQUID-detected magnetic relaxometry is a viable, rapid, and highly sensitive method for in vitro nanoparticle development and eventual in vivo tumor detection. With further refining, the system may be able to classify tumors according to protein expression (rather than having clinicians wait for biopsy results). This would allow clinicians to predict breast cancer progression and adjust treatment plans to improve patient survival.