Snapshot series may replace breast biopsy

Noninvasive methods for evaluating tumors may one day enable clinicians to distinguish benign from malignant breast cancers without the aid of a biopsy. A new report describes a method for obtaining high-resolution images of tumors that also yields important information about their physiological properties.

When a mammogram shows suspicious masses, physicians usually follow up by taking a biopsy to identify the relatively few tumors that turn out to be malignant. These tests, however, often do not reveal tumor size or whether there is more than one lesion.

To overcome these limitations, clinicians are turning to magnetic resonance imaging (MRI). This approach has the added benefit of working when breast tissue is too dense or scarred for mammography to be useful. MRI can also detect cancers that are neither revealed by mammography nor palpable, says Nola M. Hylton, a medical physicist at the University of California, San Francisco.

In the July Nature Medicine, researchers present high resolution images that distinguish benign from malignant tumors. Hadassa Degani of the Weizmann Institute of Science in Rehovot, Israel, and her colleagues first studied mice implanted with human breast tumor tissue and then assessed their method on patients. The group correctly diagnosed each of 18 women, eight of whom had a benign tumor and ten of whom had cancer.

"We predicted something, and it worked," says Degani. "But how good is it?" To evaluate the technique more carefully, researchers must next perform large-scale clinical trials, she says.

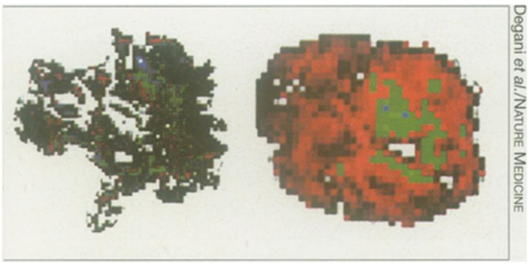
Hylton and her colleagues have already used a similar method in a study of 200 patients. The group finds that their results correlate well with two standard prognostic indicators, blood vessel density and tumor grade, as assessed by a pathologist. The investigators have reported their results from the first 57 patients at several recent meetings.

Normally, MRI signals from tumors and normal tissue differ only slightly. Radiologists enhance this difference by using dyes that increase the signal and accumulate preferentially in tumors (SN: 2/17/96, p. 100).

Early contrast-enhanced MRI scans of the breast showed bright spots for malignant and some benign tumors. Scientists discovered that they could distinguish the types of tumors by taking a series of MRI images—sort of a movie—that reveals how quickly dye flows into and out of the tissue. Malignant tumors, being more densely packed with blood vessels and cells, fill fastest. But because the MRI signal is weak, each movie frame, generated during a short detection period, has less data and lower resolution than a longer scan could provide. The movie therefore blurs details and can miss small tumors.

Researchers have been considering how best to learn about both tumor properties and size. Degani's and Hylton's groups produce three images: one before injecting the dye and two after. For each image, they collect data over several minutes instead of 30 to 60 seconds. Degani says her method provides "almost the same information" about tumor characteristics as the movie.

"People are struggling with how to get enough spatial and temporal resolution," says physicist Robert Weisskoff of Massachusetts General Hospital in Boston. "It's important to find the best compromise, because in the battle against breast cancer, more information is always better." —*E. Strauss*



Degani et al./Nature Medicine

MRI scans of malignant (left) and benign (right) human breast tumors. Red indicates that the dye flows into and out of the tissue slowly, green reflects moderate flow, and blue denotes fast flow.

Computing nuclear crash and burn scenarios

A jet aircraft skids along a runway. Its wing slams into a vertical pole, rupturing a fuel tank. The sprayed fuel ignites to create a giant fireball that engulfs the plane. The flames lick at a cruise missile, heating up critical electronic components in the missile's nuclear warhead.

Thanks to a new computer capable of calculating at a rate of up to 1.8 trillion operations per second, researchers at the Sandia National Laboratories in Albuquerque, N.M., now have a vastly improved tool for simulating various scenarios involving nuclear weapons. Such simulations are designed to reduce the need for full-scale tests of aging nuclear systems (SN: 10/19/96, p. 254).

"It is a very important step in shifting from a test-centered program to a computation-centered program," says Sandia director C. Paul Robinson.

Built at a cost of $55 million as part of the U.S. Department of Energy's Accelerated Strategic Computing Initiative, the so-called teraflops ultracomputer is the fastest computer in the world. Assembled from 9,072 Pentium Pro microprocessors, originally developed by Intel for use in workstations and servers, the computer covers an area roughly equal to the floor space of a modest home.

In a December test at Intel's Beaverton, Ore., plant, this computer became the first to calculate at a rate of 1 trillion operations per second, using just 7,264 of its processors (SN: 1/4/97, p. 7). Installation of the full computer at Sandia was completed late last month.

Even before all the processors had been installed, Sandia researchers were running simulations on the computer. One key effort modeled, in four separate stages, the crash of an airplane carrying a nuclear warhead.

Preliminary results provide insights into such complex phenomena as wind-fanned fires. The simulations reveal, for example, that air rushing past a column of flames spawns vortices that greatly intensify the fire. The temperatures are highest at the fringes of the inferno.

Sandia

Computer simulation of an airplane wing striking a vertical pole. The ruptured wing sprays fuel, shown by red squares representing the fuel's distribution.

"The physics involved is really complicated," says Sandia's Carl W. Peterson, who specializes in fluid mechanics. Even the ultracomputer isn't powerful enough to enable researchers to model the full scenario—from crumpled wing to heated electronics—in one continuous run.

At the same time, researchers are discovering they need experimental data to feed into their models and to validate their findings. In the missile simulation, for example, new experiments had to be performed to determine how the special solid foam in which electronic components are packed responds to heat.

"We're finding we have to increase the amount of experimenting, say, on materials," says Robert K. Thomas, who manages the materials and structural mechanics effort at Sandia.

"You must be willing to bet your paycheck on a simulation," says Sandia's Russell Skocypec. —*I. Peterson*