**Evidence of the Anisotropic Nature of the Mechanical Properties of Breast Tissue**

J Weaver[1,2] (John.B.Weaver@Hitchcock.ORG), M Doyley[1], E Van Houten[2], M Hood[2], Xiaochuan Qin[2], F Kennedy[2], S Poplack[1], K Paulsen[2]
[1]Department of Radiology, Dartmouth-Hitchcock Medical Center, Hanover, NH
[2]Thayer School of Engineering, Dartmouth College, Hanover, NH

Lay language description of paper MO-D-518-6
Monday, July 15, 2002
AAPM/COMP/CCPM Meeting, Montréal, Quebec

This paper presents evidence of a newly discovered mechanical property of breast tissue that might be important in breast cancer detection. Breast cancer remains the most commonly detected cancer in women. Magnetic resonance (MR) elastography, a recent innovation in magnetic resonance imaging, is being developed by several groups of researchers worldwide to help diagnose breast cancer earlier and more accurately in the effort to reduce the mortality and morbidity from this disease. Elastography measures the stiffness of tissue *in vivo*. Breast cancer appears to be stiffer than normal tissue in MR elastography just as cancer feels harder to a woman or physician in the physical examination except that MR elastography is quantitative and more sensitive than the physical examination.

The mechanical properties of breast tissue are proving to be more complex than previously expected. For example, one European group reported that cancer tends to be anisotropic, that is, its stiffness is different depending on in which direction it is pushed and pulled. Rope or string provides a classic example; it is very difficult to stretch rope lengthwise but easy to move it perpendicular to its length. The suggestion that breast cancer is anisotropic and normal breast is not was never confirmed by any of the other groups working in the area.

This study is the first that is able to support the previous findings that breast tissue is anisotropic using an alternative method and it presents evidence that some normal, noncancerous breast tissue may also be anisotropic. Two subjects were studied. Vibration was induced in one direction in the breast tissue and the stiffness of the tissue was calculated. Then, without moving the breast, vibration was induced in a different direction and the stiffness of the tissue was calculated again. The same values of stiffness would be obtained for both directions of vibration in materials with isotropic stiffness, but the values would be different in materials with anisotropic stiffness.

Most tissues within the breasts were found to be isotropic but regions that were clearly anisotropic were also present. These preliminary results suggest that normal breast tissue exhibits anisotropic behavior and that the presence of anisotropic tissue is not in and of itself indicative of cancer. However, it also suggests that mechanical stiffness may be an important property in breast tissue. Our new methods may provide a way to study isotropy and anisotropy in an effort to understand its overall significance for the early detection of breast cancer.