MRI-based Breast Cancer Imaging Device

Case 1543

Background
Great strides have been made in the imaging and diagnosis of breast cancer, but the National Cancer Institute reports the following flaws with each diagnostic method:

- Mammography exposes patients to radiation, has a high false positive rate (70 percent), and cannot capture a tumor’s physiology.
- Sonography can only guide a physician during biopsy or determine whether a mass is fluid filled or solid.
- Magnetic resonance imaging (MRI) cannot distinguish benign breast disease from malignant cancers.
- Positron emission tomography (PET) utilizes radioactive agents; cannot easily detect small, nonaggressive masses; and is dependent on a single marker.

Technology Description
MRI in combination with magnetic resonance spectroscopic imaging (MRSI) is a promising method for breast cancer diagnosis without the limitations of current methods. This technology provides both an anatomic picture of the breast and biochemical and physiologic information. The MRI/MRSI combination may identify key biochemical changes before the tumor becomes detectable by other imaging methods such as PET that rely upon single markers not entirely sensitive or specific for malignant activity. MRI/MRSI is potentially well suited for screening and repeated monitoring as it entails no radiation exposure.

The invention is a combined volume H-1 coil (standard proton coil) and butterfly C-13 coil (carbon proton coil) as a unified breast coil system for the simultaneous detection of both H-1 and C-13 signals from human breast tissue. The combination of these two coils permits imaging of chemicals elevated specifically in breast cancer, which improves breast cancer diagnostic specificity.

Applications
- Breast cancer detection
- Breast cancer treatment efficacy
- Clinical diagnosis and study of other breast diseases

Advantages
- The MRI/MRSI provides both an image of the breast and information about the biochemical activity of the tissue. This has two important implications:
  - Sensitive and accurate diagnosis of breast disease.
  - Monitors the efficacy of a treatment regimen by viewing the biochemical activity of a tumor.
- Coil can be modified to detect other nuclei such as Na-23 and F-19, allowing for detection of different biochemicals.
- Procedure does not expose patients to radiation.

Stage of Development
- Accomplished design, construction, and partial testing of a prototype coil system
- Sixty-patient clinical trial planned

Patent Status
Provisional patent application filed

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Above Figure:
(a) Abnormal PUFA distribution pattern in the breast cancer patient with an invasive ductal carcinoma. (b) A control tissue slice without tumor in the same breast. The tumor also was detected by (c) clinical mammography and (d) ultrasound imaging.
Research Interests

- MRSI of human cancer
- Bacterial-based molecular therapy and imaging of cancer using animal tumor models
- Proteomic electrophoretic nuclear magnetic resonance for structure characterization of biological signaling processes with applications in cancer diagnosis

Publications


HONORS

James A. Shannon Director’s Award, National Institutes of Health (1997–99)
Chancellor’s Research Fellow, University of Connecticut (1997–98)
Outstanding Student Awards, Jilin University (1980–81, 1981–82, 1982–83)