POSSIBLE MISDIAGNOSIS OF SOUND ATTENUATING BREAST MASSES AS DETECTED BY ULTRASOUND VISUALIZATION TECHNIQUES AND SOLUTIONS TO THIS PROBLEM

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Introduction

A number of ultrasound visualization image pattern characteristics are used in distinguishing between benign and malignant breast tumors, but a primary factor is the presence or absence of attenuation (as indicated by "acoustic shadowing") which, when present, is generally considered an indication of a malignant tumor. This paper is concerned with findings on the attenuation of benign breast masses (as indicated by ultrasound visualization) and with the problem of clearly differentiating image patterns of such tumors from those of malignant tissue in order to prevent a misdiagnosis on the basis of "acoustic shadow" phenomena.

Instrumentation and Procedures

Two separate ultrasound visualization systems were used for the studies outlined in this paper; namely, a laboratory-based research instrument and a clinical instrument. The research system is a B-mode linear scan unit (patient supine) which allows easy interchange of transducers, precise placement of the focus of the transducer within the breast, and a choice of water bag or direct fluid coupling. Four transducers, ranging in frequency from 2.25 to 5.0 MHz, were used in the studies discussed in this paper. The clinical instrument, a commercial unit specifically designed for breast examination at a frequency of 5 MHz, has been modified to allow examination of patients at different frequencies and in 1 mm step intervals.[1]

Natural sponges with embedded scattering-type targets (hydrocolloid material with a mixture of dextran microspheres) having attenuation values that are close to those found for benign masses, and others with attenuation values comparable to malignant tumors, were used as breast phantoms and examined by both visualization systems.*

Discussion and Results

It was shown in previous investigations that "acoustic shadowing" image patterns for certain benign breast masses may be indistinguishable from those of malignant masses under the circumstance of examination by focused transducers with frequencies in the general range of 4.4 to 5.0 MHz in instruments with dynamic range and sensitivity values that are presently standard for diagnostic ultrasound.[2] This phenomena may be explained by assuming that the frequency dependent attenuation coefficient for these specific benign masses has a value which, although less than that of the attenuation coefficient of malignant tumors, is sufficiently high to result in a "black shadow" if examined by a pulse-echo system (which involves two passes of the sound beam through the tissue) at frequencies of the order of 4.5 MHz and above. Additional studies of patients using both the laboratory and clinical ultrasound instrumentation mentioned above confirmed this result. To date, benign tumors which exhibit attenuation image patterns that simulate those of malignant tumors have been found in the breasts of six subjects. The benign nature of the tumors was confirmed by surgical biopsy in five of the cases. Mammogram examination of the other case indicated the presence of a benign mass and a pattern of dysplasia. In the five cases biopsied, the pathology diagnosis showed fibrocystic disease for all five subjects. In addition, however, all of these subjects had specific tissue alterations, either epithelial hyperplasia, inflammation, collagen deposits, fibrosis or calcification. Fat necrosis, known to be sound attenuating, was not detected in any of these cases.[3]

In attempting to find a solution to this diagnostic problem, patients were scanned at both low (2.25 MHz) and high (5.0 MHz) frequencies. This approach was based on the presumption that benign tumors, of whatever complexity, probably have attenuation coefficients with values less than that of highly attenuating malignant tumors (i.e., scirrhous carcinoma); therefore, the image patterns of such benign tumors, at lower frequencies, should be different from those of malignant tumors scanned at the same low frequency. This has been shown to be the case in the limited number of patients with this type of benign pathology examined to date.

The validity of this approach was further investigated by visualizing tissue phantoms with embedded scattering-type masses over the same frequency range that was used for the human subjects. It is recommended that patients with tumors that are highly attenuating at 5.0 MHz be scanned at lower frequencies.

References

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