

AbstractID: 5172 Title: Characterization of Breast Calcifications using X-ray Diffraction

Purpose: Coherent scatter imaging has been developed to elucidate the chemical composition of calcifications. Breast calcifications can be divided into two broad categories. Type I are calcium oxalate dehydrate, while Type II are calcium hydroxyapatite. Type II calcifications are known to be associated with carcinoma. It is generally accepted that the exclusive finding of type I calcifications is indicative of benign lesions.

Method and Materials: An imaging system has been built that utilizes a molybdenum target x-ray tube with niobium filtration to isolate the molybdenum K_{α} characteristic radiation. The system is designed to interrogate calcifications in the field with a pencil-beam of radiation. The transmitted beam is attenuated, and the scattered beam is recorded on an x-ray image intensifier optically-coupled to a CCD camera. The system is typically operated at 36 kVp and 25-100 mAs.

Results: Reagent grade calcium oxalate and calcium hydroxyapatite were made into blocks of thickness 42-510 mg/cm². Pinhole sizes varying from 0.3-2.0 mm in diameter were tested to observe the effects of irradiation area on the resolution of the diffraction patterns. All pinhole sizes produced distinctive spectra, but a pinhole size of 0.75 mm appears to be near optimal, as there is sufficient angular resolution and photon fluence to produce distinguishable diffraction patterns. Scattering materials (simulating glandular tissue and fat) were placed upstream and downstream of the calcific material to probe the influence of the surrounding tissue on diffraction. Material thicknesses >1 cm dramatically degraded the measured diffraction patterns. Analysis of diffraction patterns show that calcifications are readily discernable based upon their scattering characteristics. We are able to match these diffraction patterns to calculated theoretical patterns when the later is convolved with a Gaussian-based filter.

Conclusion: We have demonstrated in proof-of-principle that we can discern different types of calcifications using coherent scatter imaging.