Opto-Acoustic Imaging in the Evaluation of BI-RADS 3 Lesions: Findings and Implications

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Objective

Based on the presence of deoxygenated hemoglobin, Opto-Acoustics (OA) delineates metabolically active breast lesions from those with less metabolic activity. BI-RADS 3 ultrasound lesions were evaluated with OA to determine whether this technology has the potential to determine which of these probably benign solid lesions require biopsy. The objective of the study is to identify lesions such as cellular fibroadenomas, phyllodes tumors, and atypical papillary lesions where biopsy would impact subsequent treatment decisions.

Methods

High resolution ultrasound images of breast abnormalities are combined with short pulses of laser energy at two separate wavelengths directed at the solid breast lesion. One laser wavelength interrogates oxygenated hemoglobin while the other wavelength excites the de-oxygenated hemoglobin. The opto-acoustic data, color-coded (green = oxygenated hemoglobin, red = deoxygenated hemoglobin) is co-registered with the B mode ultrasound allowing the reader to not only describe the morphology of the lesion but evaluate the physiologic properties as well. A predominance of oxygenated hemoglobin suggests a benign process and the predominance of de-oxygenated hemoglobin content suggests a malignant process.

We analyzed a subset of BI-RADS 3 solid masses and suspected papillary lesions with OA in order to assess functional heterogeneity within these two groups. All lesions were subsequently biopsied.

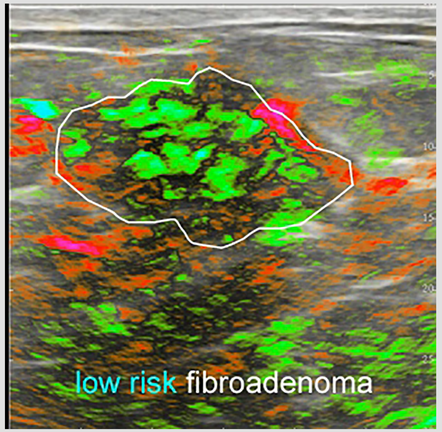

Figure 1. Solid lesion with high oxygenated hemoglobin concentration. Fibroadenoma

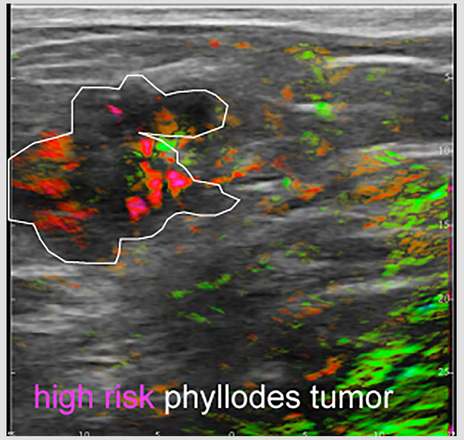

Figure 2. Solid lesion with high deoxygenated hemoglobin concentration. Phyllodes tumor

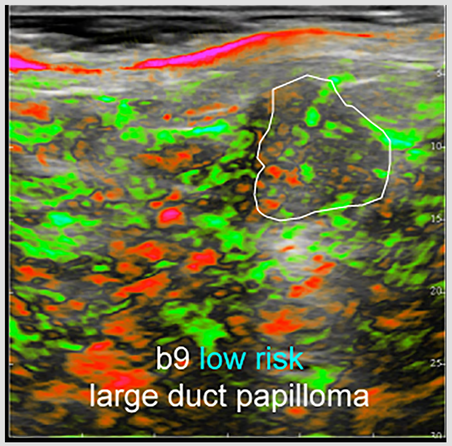

Figure 3. Papilloma with normal oxygen content.

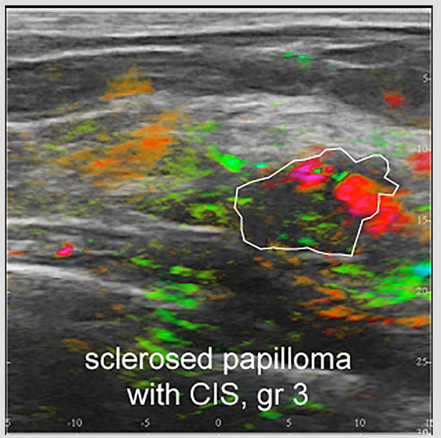

Figure 4. Papilloma with high deoxygenated hemoglobin content with grade 3 CIS

Results

Seven BI-RADS 3 solid lesions were evaluated with OA. Five had minimal internal deoxygenated hemoglobin and were all found to be typical fibroadenomas on biopsy. Two had marked internal deoxygenated hemoglobin and on biopsy one was a benign phyllodes tumor, the other was a fibroadenoma with increased cellular stromal activity (Fig 1, 2). Of the four papillary lesions evaluated with OA, two had normal metabolic activity and were benign on biopsy, while two had increased internal deoxygenated hemoglobin. Of these two, one was a papilloma with DCIS (Fig 3, 4), the other had atypia.

Conclusions

In this small group of lesions OA was able to distinguish biologic differences in lesions that appeared benign on conventional breast ultrasound. This suggests that this technology potentially can be employed to determine which BI-RADS 3 lesions, can be observed and which should undergo more evaluation. In an ongoing multicenter clinical trial, additional cases will be evaluated to assess the efficacy of this hypothesis.