Restriction Spectrum Imaging in the Breast: Evaluating response to Neoadjuvant Chemotherapy

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Motivation
An estimated 250,000 women will be diagnosed with breast cancer in 2017.
An estimated 40,000 women will die of breast cancer in 2017.

MRI can determine early response to chemotherapy.

Goals
Develop a non-invasive imaging technique to determine whether a breast cancer patient will respond to chemotherapy early in the treatment.

Background
Restriction Spectrum Imaging (RSI), is an enhanced MRI diffusion imaging technique which models the signal emanating from cancer cells. Often times, nuclei are enlarged in cancer cells. RSI theoretically detects the signal from these cells, excluding unwanted signal from surrounding edema and tissue.

By determining whether or not a patient will respond to chemotherapy early in the treatment, we can determine to either continue a useful treatment, or change regimens.

Results
Ten women with biopsy proven breast cancer underwent standard breast MRI and RSI before and after neoadjuvant chemotherapy. All 10 patients demonstrated a positive response to chemotherapy detected by RSI.

Standard breast MRI requires an extra contrast agent to see the tumor, while RSI does not require any delivery of contrast to the patient.

Conclusion & Future Directions
We are investigating RSI in a large breast cancer patient cohort with correlation to biopsy results. Preliminary results demonstrate that RSI can better determine response to chemotherapy compared to standard techniques.

Funding
NIH EB-RO1000790
UCSD Clinician Scientist Program in Radiology
RSNA Resident Research Grant

Figure 1. RSI was originally developed for brain imaging. This is an example of a patient with glioblastoma multiforme. The first frame represents the signal from the tumor cells. This is differentiated from frame 8, where surrounding edema and central necrosis are separated from the active cancer cells.

Figure 2. Prior studies in the prostate demonstrated the utility of RSI in improving localization of prostate cancer (Rakow-Penner, PCAN, 2015) and correlating to Gleason score (Liss, Front Oncol, 2015).

Figure 3. Pre and post chemotherapy RSI images on all 10 patients. Note decreased tumor burden on post-chemotherapy RSI images.

Figure 4. Patient with right breast high grade cancer pre and post treatment. Patient has breast implants.