Role of Diffusion Weighted MRI and Positron Emission Tomography for Characterization of Breast Cancer Phenotypes and Aggressiveness: Preliminary Results

Riham El Khouli, MD, PhD; Katarzyna J. Macura, MD, PhD; Michael A. Jacobs, PhD; Richard Wahl, MD

The Russell H. Morgan Department of Radiology and Radiological Science
The Johns Hopkins University School of Medicine
Disclosures

Nothing to disclose
Introduction

- Breast cancer is a heterogeneous disease, not only grossly but also at the histological and molecular levels.

- This heterogeneity presents challenges and difficulties in diagnosing, treating, and following up breast cancer patients.

- Biopsies evaluate a small portion of the tumor, while imaging evaluate the entire tumor and have the potential to guide the biopsy.
Introduction

Breast cancer tumors with the same histological subtypes may carry different prognosis and response to treatment due to differences at the molecular level.

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Introduction

- Diffusion Weighted Imaging (DWI) provides physiologic information about the movement of water in normal versus pathological tissue.
- The quantitative measure of DWI (ADC value) has been reported to be inversely correlated with tissue cellular density.
Introduction

FDG-PET provides information about the metabolic status of the tissue.

FDG uptake has been correlated with tumor size and degree of aggressiveness.
Study Aim

- To describe the DWI and PET characteristics of different breast cancer phenotypes.

- To evaluate the potential value of combining DWI and PET imaging parameters to predict breast cancer phenotypes and nuclear grade.
Patient Population

- We retrospectively reviewed all breast cancer patients presenting for initial staging with PET/CT in the period from 7/1/2013 till 12/31/2013.
- We included patients that had PET/CT studies done prior to surgery and had not received any treatment for their cancer.
- Thirty three patients with 35 breast cancer lesions were scanned with GE PET/CT scanners.
- Both DWI and PET/CT were performed in 21 breast cancer.
Breast Cancer Phenotypes

40% Luminal A $\rightarrow$ ER+ PR+/- & HER2- or low Ki67

11.5% Luminal B $\rightarrow$ ER+ PR+/- & HER2+ or high Ki67

14.3% HER2 enriched $\rightarrow$ ER-, PR- & HER2+

28.5% Triple negative $\rightarrow$ ER-, PR- & HER2-

5.7% DCIS
Diffusion weighted imaging

EPI + SENSE + Fat suppression (SPAIR)

b-values: 0 & 600
TR/TE: 9548/64 msec
Flip angle: 90 degrees
Slice thickness: 3 mm
Band width 1040.8 hz/ pixel
Voxel size: 1.25 x 1.25 mm
PET/CT

Patients fasted for at least 4 hours prior to FDG injection.

Height and Weight of patient is obtained.

Blood glucose is measured and must be < 200 mg/dl.

Oral contrast was administered.

FDG dose is 0.2 mCi/kg.

Patient is seated in a dim room for 60 minutes after IV injection (uptake phase).
All image analysis were performed by a single experienced Radiologist blinded to PET results.

ADC maps were constructed on a pixel-by-pixel basis.

Multiple ROI’s were placed on the lesion avoiding necrotic regions and the average value is recorded.

Multiple ROIs were placed on the remote glandular tissue on the ADC map and the average value was recorded.
Normalized ADC value was calculated as:

\[
\frac{\text{ADC value of lesion}}{\text{ADC value of glandular tissue}}
\]
FDG PET quantitative analysis

Attenuation and decay corrected PET images were created.

ROI’s were placed on the lesion and the lean body mass normalized $SUV_{max}$ values were recorded.
$\text{SUV}_{\text{max}}$ and breast cancer phenotypes.
$SUV_{\text{max}}$ and breast cancer nuclear grades

- Grade 1: Well differentiated
- Grade 2: Moderately differentiated
- Grade 3: Poorly differentiated

Nuclear Grade
Correlation between $SUV_{\text{max}}$ and Proliferative Index (Ki67)

$R = 0.44$

$P$-value = 0.029
Correlation between ADC value and $SUV_{max}$

Lesion ADC

95% CI Fitted values

$R = 0.43$

P-value 0.02
Correlation between Normalizes ADC value and $SUV_{\text{max}}$

- $R = 0.53$
- P-value = 0.003

Normalized ADC value

- 95% CI
- Fitted values
A 38 year old female recently diagnosed with 2.1x1.9 cm Luminal A invasive ductal carcinoma.

**T1 High resolution Subtraction**

**ADC map**

**FDG-PET**

ADC value 1.8
Normalized ADC 0.9

SUV_{max} 3.1
A 72 year old female recently diagnosed with 2.9 x 2.5 cm Triple negative invasive ductal carcinoma.

ADC value 1.4
Normalized ADC  0.58

SUV\text{max}  7.9
Summary

DWI and PET quantitative measures can serve as single modality predictors of breast cancer phenotypes and aggressiveness.
Summary

• We demonstrated that cellular density (measured by DWI) correlates with metabolic activity (measured with FDG SUV).
Limitations

The small sample size, yet this is a work in progress.
Conclusion

A combination of the normalized ADC value as a measure of the movement of water and cellular density with the $SUV_{\text{max}}$ as a measure of metabolic activity of breast cancer tumors has the potential to accurately characterize breast cancer phenotypes.
Thank You