SER volume predicts malignancy in DCE MRI-detected secondary occult breast lesions

V. Arasu[1], R. C-Y. Chen[1], D. C. Newitt[1], B. Chang[1], H. Tso[1], N. M. Hylton[1], and B. N. Joe[1]
[1]Department of Radiology and Biomedical Imaging, University of California, San Francisco, San Francisco, CA, United States

Purpose

Breast MRI, although extremely sensitive for defining known cancer margins or detecting additional occult disease, has been criticized for its use in staging preoperative patients[1]. MRI's variable specificity can lead to unnecessary biopsies and changes in surgical management. Signal enhancement ratio (SER) of contrast-enhanced breast MRI lesions characterizes neoangiogenesis in cancers, with high values predicting malignancy and neoadjuvant response[2,3,4]. We investigated if SER also predicts pathologic outcome in new lesions found secondary to the known primary cancer when staging preoperative patients using DCE MRI.

Methods

A retrospective review was performed of women who were preoperatively staged for known cancer using breast MRI, and had lesions evaluated as BIRADS 4 or 5 in 2008 at UCSF. Secondary lesions were included if they were physically separate from the primary lesion, biopsied separately, and occult to prior mammogram and clinical exam. MR imaging was performed on a 1.5 T imager and dynamic contrast–enhanced high-spatial resolution images were acquired at 3 time points: precontrast (S0), early postcontrast (S1 at 1.5-2 mins), and late postcontrast (S2 at 6-6.5 mins). SER is defined as (S1-S0)/(S2-S0) and maps were generated with in-house software (see figure 1). Bilateral axial studies were imaged as TR/TE= 9/4.4, flip-angle 10°, NEX=1, matrix: 512x320, FOV 29-36 cm, slice thickness 2 mm. Region-of-interest volumes of suspicious lesions were filtered for voxels having high initial enhancement ((S1-S0)/S0 > 70%). SER parameters were predetermined: total SER tumor volume (SER>0.9), washout SER tumor volume (SER > 1.3), peak SER, and peak percent enhancement (PE).
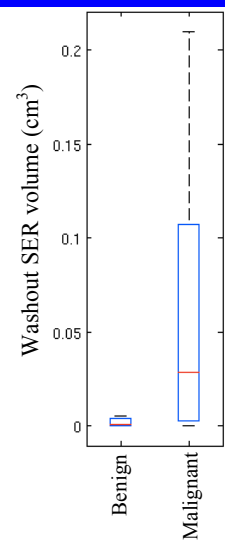
Results

Among patients preoperatively staged for extent of disease of known cancer, a total of 30 secondary lesions in 25 women were suspicious (BIRADS 4 or 5). Of these, 10 new malignant lesions were identified: 1 DCIS, 8 invasive ductal only or mixed with DCIS, and 1 periductal stromal invasive tumor. 5 cancers in 30 suspicious lesions (17%) were found in the contralateral breast. Outcomes were non-normally distributed and compared statistically using the Wilcoxon test, with results presented as median [25th-75th quartile]. Total SER tumor volume was significantly associated with malignancy (0.093 cm^3 [.061-.524] vs. 0.017 cm^3 [0-0.095], p=0.006) as well as washout SER volume (0.028 cm^3 [0.002-0.107] vs. 0.0006 cm^3 [0-0.0042], p=0.026) and peak SER (1.76 [1.28-2.13] vs. 1.08 [0.78-1.39], p=0.022). Peak PE was not significantly associated with malignancy (104% [93-121] vs. 96% [88-114], p= 0.242).

Significance

Lesions with high total tumor SER volume, washout SER volume, and high peak SER significantly predict secondary malignant lesions in the setting of preoperative staging for additional ipsilateral or contralateral disease occult to mammography and clinical exam. Notably, peak percent enhancement (PE) was not significantly associated with malignancy. Finally, the rate of contralateral cancer among suspicious lesions is comparable to previously published results of 25%[5]. These results further validate the utility of SER in predicting breast malignancy and potentially improve the efficacy of preoperative MRI for surgical management.

Figure 1

a. Benign

b. Malignant

c. SER COLOR RANGE

Total Tumor Vol.

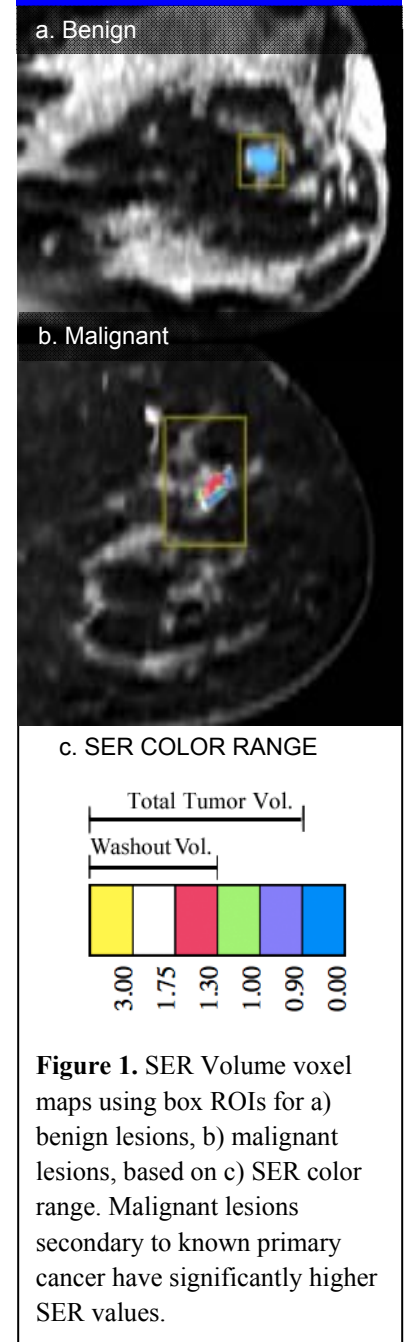Washout Vol.

3.00 1.75 1.30 1.00 0.90 0.00

Figure 1. SER Volume voxel maps using box ROIs for a) benign lesions, b) malignant lesions, based on c) SER color range. Malignant lesions secondary to known primary cancer have significantly higher SER values.

Figure 2

Washout SER volume (cm^3)

Figure 2. Washout SER volume was significantly higher in malignant lesions (p = 0.026).

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