

Statistical Analysis of Two Dimensional MR Spectroscopy Combined with Dynamic Contrast Enhanced MRI in Breast Cancer Detection

X. Liu<sup>1</sup>, S. Lipnick<sup>1</sup>, J. Sayre<sup>1</sup>, N. Debruhl<sup>1</sup>, A. Singhal<sup>1</sup>, and A. Thomas<sup>1</sup>

<sup>1</sup>Radiology, University of California, Los Angeles, David Geffen School of Medicine, Los Angeles, CA, United States

Introduction:

DCE MRI has been combined with 2D L-COSY to increase breast cancer detection sensitivity, because 2D L-COSY can detect the appearance of Choline which was used as a biomarker to differentiate between malignant and benign tumors (1). 2D L- COSY of breast tissues showed that in addition to Choline, several other metabolite ratios are significantly different between malignant tumor and healthy fatty breast tissues and can be classified by classification and regression (CART) analysis (2). A major goal of this work was to investigate the feasibility of using statistical analysis of 2D L-COSY combining DCE MRI to classify malignant and benign breast tumors.

Methods:

A total of 18 patients with breast tumors were scanned on a 1.5T Avanto Siemens whole body MRI scanner, including 9 subjects with malignant tumors (mean age 51 years old), 9 women with benign tumors (mean age 38 years old). DCE-MRI was acquired by using the dynamic T1W 3-D FLASH sequence with fat saturation. 2D L- COSY data were acquired by using the 2D L-COSY pulse sequence. The size of each VOI was 1x1x1cm<sup>3</sup> for each acquisition; the total scan time is 12 minutes. DCE MRI were processed by Siemens post processing software, the dynamic curves were generated using CADstream software Version4.1 (Conforma, Bellevue, WA). All 2D MRS data files were processed using Felix2000 software package (Felix NMR Inc., San Diego, CA). The data were zero-filled to 2048 x 96 points, filtered and Fourier-transformed along both dimensions. The 2D L-COSY spectral peaks were displayed using contour plots in the magnitude mode, which were used to evaluate the spectra and to calculate the volume under each detectable peak. Each 2D spectrum contains contributions from the following diagonal peaks: Water (WAT) (4.8, 4.8) ppm; Fat (FAT) (1.4, 1.4) ppm ; Methyl Fat (FMETD) (0.9, 0.9) ppm ; Olefinic Fat (UFD) (5.4, 5.4)ppm ; Choline (CHO) (3.3, 3.3)ppm ; the cross peaks are: UFR (2.1, 5.4)ppm ; UFL (2.9, 5.4) ppm; Triglyceryl fat cross peak (TGFR) (4.3, 5.3)ppm; 9 diagonal peak metabolite ratios and 9 diagonal and cross peak ratios are calculated and inputted into two statistical analysis software packages for classification: Fisher’s Linear Discriminant Analysis (BMDP Statistical Software, Inc. Version 7.0) and the Classification and Regression Tree (CART) analysis (CART Version 6.0 ) (3) .

Results:

Figure 1 A shows a benign lesion processed by CADstream, B is the enhancement curve. Figure 2 A shows a malignant lesion processed by CADstream, B is the enhancement curve. Both curves are type 2 enhancement curves which can not be classified . Totally there are 4 out of 18 type 2 curves which need to be further investigated. Here we use 18 metabolite ratios to do statistical classification analysis, Table 1 is the linear discriminant analysis result, and Table 2 is CART analysis result.

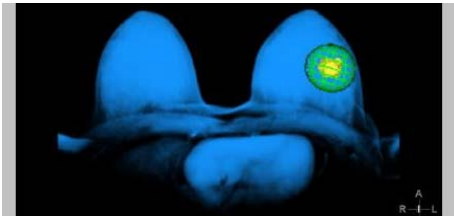


Figure 1 A) CADstream processed benign lesion ;

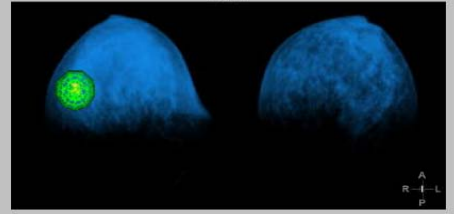
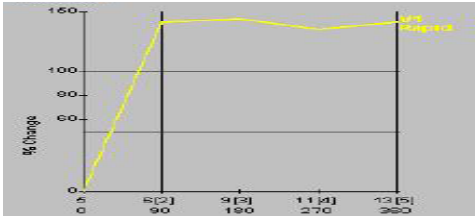
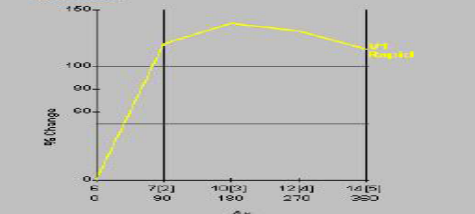


Figure 2 A) CADstream processed malignant lesion



B) The created type 2 enhancement curve



B) The created type 2 enhancement curve

Table1. Linear Discriminant Analysis Result: Classification Features: WAT/UFD, CHO/FAT, CHO/UFD, FAT/FMETD  
Total=24, Overall % Correct=95.8%

	Predicted Benign	Predicated Malignant	Total
Actual Benign	11 (100%)	0	11
Actual Malignant	1(7.7%)	12(92.3%)	13

Table2. CART Analysis Result: Classification Feature: FAT/FMETD; Total=24, Overall % Correct=95.8%

	Predicated Benign	Predicated Malignant	Total
Actual Benign	10 (90.9%)	1 (9.1%)	11
Actual Malignant	0	13(100%)	13

Conclusion:

Two statistical analysis methods: Linear discriminant functions and CART analysis were used for statistical classification respectively. Both statistical analyses resulted in an overall detection accuracy of 95.83%. Results showed that using statistical analysis of 2D COSY combined with DCE-MRI improved breast cancer detection accuracy compared to DCE-MRI alone. These pilot findings need to be evaluated using a large cohort of breast cancer patients

References:

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