Knight Cancer Institute
at Oregon Health & Science University

CLINICALLY PRACTICAL MAGNETIC RESONANCE PROTOCOL FOR IMPROVED SPECIFICITY IN BREAST CANCER DIAGNOSIS

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Introduction

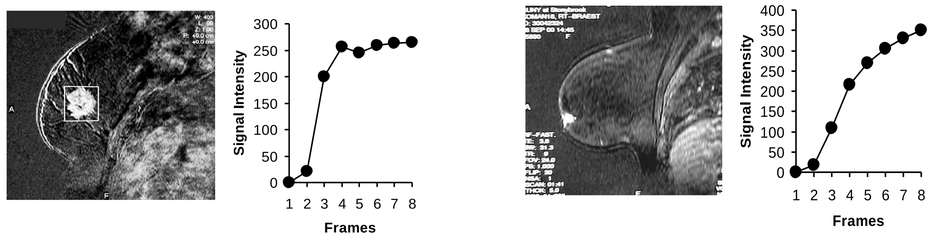
- X-ray mammography
  - limited sensitivity (especially dense breast), high false positive rate (60-80%), resulting in unnecessary (benign) biopsies.
- Conventional Dynamic Contrast-Enhanced (DCE) T1-weighted MRI
  - Excellent sensitivity (88-100%)
  - Rather variable (37-97%) and limited specificity, leading to unnecessary (benign) biopsies as well
- MR techniques to improve specificity
  - ^{1}H MRS (Bartella et al. 2006;Huang et al. 2004; Jacobs et al. 2004; Bolan et al. 2003; Yeung et al. 2001; Gribbestad et al. 1998; Roebuck et al. 1998) ----- Cho as marker of viable tumor.
  - T2*-weighted Perfusion MRI (Huang et al. 2004; Kvistad et al. 1999; Kuhl et al. 1997) ----- increased tumor vascularity and perfusion, typical in malignancy
- In this study DCE MRI, ^{1}H MRS, and perfusion MRI performed on patients with suspicious breast lesions prior to biopsy. MR results were correlated with pathology
- Goals: 1) determine if the combined MRI/MRS protocol improves specificity; 2) establish clinically practical breast cancer diagnostic MR protocol with high sensitivity and specificity

Methods

- 124 patients with positive mammography findings scheduled for biopsies, consented under IRB-approved Protocol.
  - BIRADS (Breast Imaging Reporting AND Data System) scores 4 (suspicious abnormality) or 5 (high probability of malignancy)
- MRI/MRS protocol performed on a 1.5T Philips Intera and a 1.5T Marconi Edge scanners, both equipped with 4-channel phased array breast coils.
- Biopsy usually performed within a week following MR examination.
- **DCE MRI**
  - 3D sagittal acquisition (SPGR sequence, flip/TE/TR: 30^o/3.8/9 ms, 5mm slice thickness, 24 cm FOV) covering one whole breast with positive mammographic findings
  - 8 frames of 3D images, ~15 sec per frame
  - 0.1 mmol/kg Gd contrast agent, IV injection at 2 cc/sec at the beginning of 2nd frame acquisition
  - 1st frame of images subtracted from each following frames.
  - Subjective analysis of DCE MRI signal time-course
  - **Positive Findings:** fast enhancement, reaching plateau by 4th frame.
  - **Negative Findings:** no enhancement or continuous signal rising
- DCE MRI findings
  - **Positive** → Proton MRS and perfusion MRI
  - **Negative** → End of study
- **Single-voxel ^{1}H MRS**
  - PRESS sequence
  - TE/TR: 135/2000 ms; 128 scan averages
  - MRS voxel encompassing enhanced lesion
  - **Positive Findings:** an apparent Cho peak at 3.23 ppm, S/N ≥ 2)
  - **Negative Findings:** no apparent Cho peak at 3.23 ppm or S/N < 2
- **Perfusion MRI**
  - single slice (10 mm thickness) at lesion location
  - T2*-weighted FLASH sequence (flip/TE/TR 10^o/35/54 ms), 24 cm FOV
  - 0.1 mmol/kg Gd contrast agent, IV injection at 4 cc/sec, 40 frames
  - Relative blood volume map reconstruction
  - **Positive Findings:** striking enhancement in lesion area compared with normal tissue area on relative blood volume map
  - **Negative Findings:** no obvious enhancement in lesion compared with normal tissue area on relative blood volume map

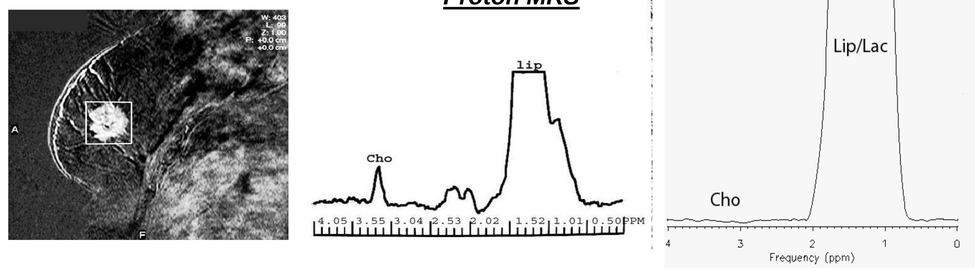
Results

DCE MRI



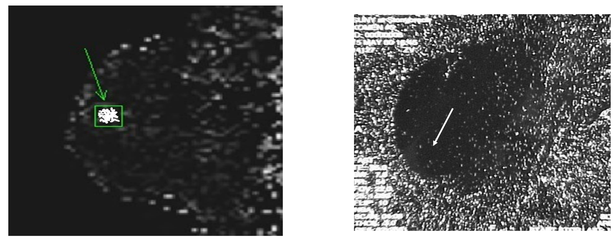
Positive Finding — Negative Finding

Proton MRS



Positive Finding — Negative Finding

T2* Perfusion MRI



* arrows point to locations of contrast enhanced lesions

Positive Finding — Negative Finding

Table MRI/MRS and Pathology Findings of Patients with Suspicious Breast Lesions

Patient No.	DCE MRI	MRS	Perfusion MRI	Pathology
13	+	*	*	Malignant
44	-	*	*	benign
39	+	+	+	malignant
14	+	-	-	benign
7	+	+	-	benign
5	+	-	+	benign
2	+	+	*	benign

+ = positive findings; - = negative findings; * = MR scan discontinued due to negative DCE MRI findings or at patient's request.

- DCE MRI:
  - 100% sensitivity, 61% specificity
- DCE MRI + MRS:
  - 100% sensitivity, 88% specificity
- DCE MRI + MRS + perfusion MRI:
  - 100% sensitivity, 100% specificity (excluding two patients without perfusion MRI data)

Discussions

- Addition of ^{1}H MRS and perfusion MRI to DCE MRI protocol substantially improves specificity
- The improvement in the specificity of MR examination protocol may help to reduce unnecessary (benign) biopsies due to false positive conventional mammographic findings
- The MRI/MRS protocol is easy for implementation at any clinical imaging site, scan duration (45 min maximum) tolerable to most patients
- Qualitative data analysis, easy data interpretation for radiologists

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