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Case Report

Noncontrast MRI with advanced diffusion weighted imaging for breast cancer detection in a lactating woman ☆,☆☆

Ana E. Rodríguez-Soto, PhD[a,†], Claire H. Meriwether, MD[b,†], Andrew J. Park, MD[c], Dennis W. Adams Jr, MD[c], Anne Wallace, MD[d], Haydee Ojeda-Fournier, MD[a], Anders M. Dale, PhD[a], Rebecca Rakow-Penner, MD, PhD[a,]*

[a] *Department of Radiology, University of California, San Diego. La Jolla, CA, USA*
[b] *School of Medicine, University of California, San Diego. La Jolla, CA, USA*
[c] *Department of Pathology, University of California, San Diego. La Jolla, CA, USA*
[d] *Department of Surgery, University of California, San Diego. La Jolla, CA, USA*

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ABSTRACT

Magnetic resonance imaging (MRI) is used for preoperative evaluation, high-risk screening, and other select indications for breast cancer. However, the interpretation of breast MR images in pregnant and lactating women is complicated by physiologic changes of the breast that may result in marked background enhancement. Breast MRI with contrast administration is contraindicated in pregnancy. Restriction spectrum imaging (RSI) is an advanced diffusion-weighted (DW)-MRI method that theoretically reflects signal from cells with high nuclear-to-cytoplasm ratio without gadolinium-based contrast. This report describes a case in which RSI notably increased tumor conspicuity in a lactating woman, compared to contrast-enhanced (CE)-MRI and conventional DW-MRI.

Introduction

Pregnancy-associated breast cancer (PABC) is defined as breast cancer diagnosed during pregnancy or within year following delivery. While standard MRI plays a role in preoperative evaluation, high-risk screening, and other indications such as monitoring response to neoadjuvant chemotherapy, PABC poses a unique challenge [1]. Firstly, standard breast MRI protocols rely on intravenous contrast administration which

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* Corresponding author.
E-mail addresses: a6rodriguezsoto@health.ucsd.edu (A.E. Rodríguez-Soto), cmeriwet@health.ucsd.edu (C.H. Meriwether), andrewjpark@ucsd.edu (A.J. Park), dennis.adams@hhs.sccgov.org (D.W.A. Jr), amwallace@ucsd.edu (A. Wallace), hojeda@health.ucsd.edu (H. Ojeda-Fournier), andersmdale@gmail.com (A.M. Dale), rrakowpenner@health.ucsd.edu (R. Rakow-Penner).
† Co-first authors.
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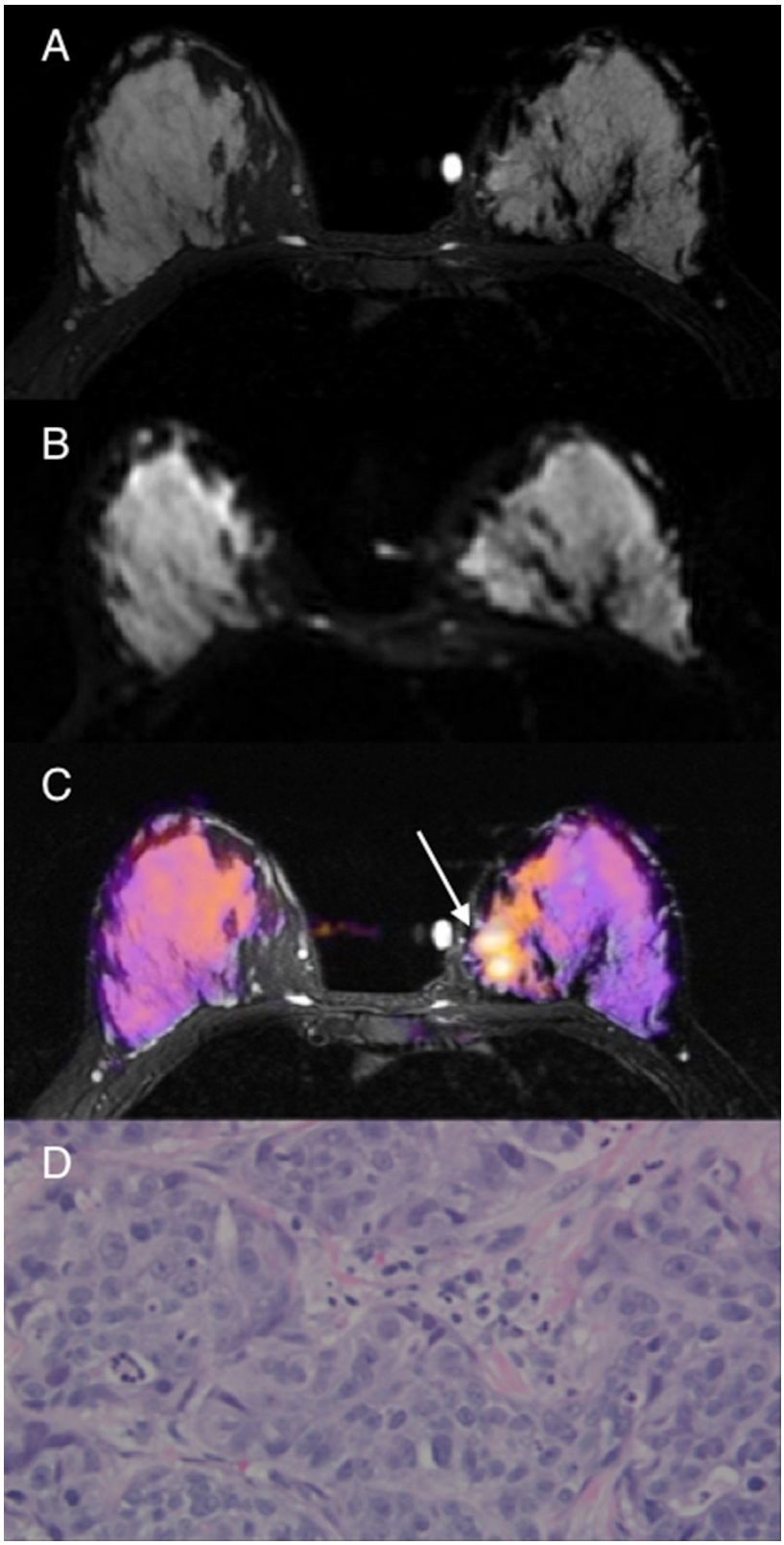

Fig. 1 – Bilateral MRI and biopsy pathology images of a 41-year-old female patient with PABC. Comparison of patient's (A) CE-MRI, (B) standard DWI (b = 800 s/mm^2), (C) RSI-derived cellularity index map overlaid on T_2-weighted image, and D) pathology (hematoxylin and eosin stain, × 400 magnification). The white arrow indicates the tumor, which is easily visualized on the RSI-derived cellularity index map.

is contraindicated in pregnant patients. Secondly, the physiologic increase in proliferative breast tissue during pregnancy and lactation results in marked background enhancement, limiting the interpretation of conventional MRI studies [2,3].

Diffusion-weighted imaging (DW-MRI) is a noncontrast MRI technique that has shown promise in the detection of PABC [4]. Restriction spectrum imaging (RSI) is an advanced DW-MRI technique that theoretically differentiates among isotropic restricted (intracellular), anisotropic hindered (extracellular), and free water diffusion compartments utilizing multishell DW-MRI data (eg, multiple b-values and diffusion directions) [5]. Here, we report a case in which RSI significantly increased tumor conspicuity in a lactating woman compared to contrast-enhanced (CE)-MRI and conventional DW-MRI.

Case

A 41-year-old gravida 2, para 2 female presented for a second opinion regarding a left breast cancer. The patient had detected a mass in her left breast while breastfeeding her 7-month-old infant. On initial outside workup, ultrasound revealed a 2.8 cm mass and biopsy confirmed a high-grade triple negative invasive ductal carcinoma (IDC).

Contrast-enhanced MRI, conventional DWI, and RSI sequences were obtained for this patient. Imaging parameters: Contrast-enhanced (CE) *Gradient Echo*— Echo/repetition times (TE/TR) = 4.25/7.7 msec, field-of-view (FOV) = 340 × 340 mm^2, voxel size = 0.66 × 0.66 × 1.4 mm^3; *Conventional diffusion-weighted imaging (DWI)*— TE/TR = 65.7/4000 msec, b-values 0 and 800 s/mm^2, 3 orthogonal diffusion directions, FOV=340 × 340 mm^2, voxel size=1.33 × 1.33 × 5 mm^3; *Multi-shell DWI* — TE/TR=96.7/12000 ms, b-values (number of diffusion directions) 0, 500(6), 1500(6), 4000(15) s/mm^2, FOV=340 × 340 mm^2, voxel size=2.66 × 2.66 × 5 mm^3. The RSI processing pipeline corrects the geometric distortions that affect DW-MRI. The RSI framework allows for the estimation of a cellularity index statistically classified with a Z-score that represents the discrepancy of the restricted diffusion signal in standard deviations between tumor and healthy tissues [6]. The main output of the RSI processing pipeline is the cellularity index map overlaid and color-coded on structural images [5].

In this patient, conventional CE-MRI indicated segmental nonmass enhancement with heterogeneous internal enhancement that corresponded to the site of the known malignancy, but further characterization was limited by marked background enhancement consistent with active breastfeeding (Fig. 1 A and B). Conventional DW-MRI did not differentiate the tumor region from background signal variation. In contrast, the RSI cellularity index facilitated accurate visualization of the tumor without intravenous contrast (Fig. 1C).

The patient was treated with neoadjuvant therapy based on 4 cycles of carboplatin and paclitaxel, followed by 4 cycles of dose-dense doxorubicin and cyclophosphamide (ddAC). After completion of neoadjuvant chemotherapy, the patient underwent a bilateral mastectomy with subsequent reconstruction after a deleterious PALB2 mutation was detected on genetic testing. Surgical pathology revealed high grade DCIS with lobular extension in the left breast, a benign right breast, and no positive lymph nodes.

Discussion

Evidence suggests that delayed diagnosis may contribute to the poorer prognosis and reduced survival rates in women with PABC compared to nonpregnant women [7,8,9]. There is an urgent need for a noncontrast imaging modality that is more sensitive in detecting and characterizing PABC in the context of the physiologically-altered breast tissue during pregnancy and lactation.

Restriction spectrum imaging, RSI, spares the patient exposure to ionizing radiation, does not require intravenous contrast, and has proven diagnostic value in the brain [5], the prostate [6], and the nonlactating breast [10]. This report describes a case in which there was increased tumor conspicuity with RSI in the setting of marked lactation-associated background enhancement, suggesting that RSI may have an important role in PABC imaging. Further research is needed to investigate the utility of RSI in detecting and characterizing PABC.

Patient Consent Statement

A waiver of consent was granted by the Institutional Review Board at the author's institute to perform a retrospective study of breast MRI exams.

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