

# Contrast-Enhanced MRI for Assessing the Response of Invasive Breast Cancer to Neoadjuvant Chemotherapy

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**Purpose:** Neoadjuvant chemotherapy (CTX) is used to down-stage locally advanced breast cancers prior to mastectomy or lumpectomy. Physical examination and mammography have limited efficacy for assessing tumor response. Previous studies have suggested a role for contrast-enhanced MRI. The purpose of this retrospective study was to assess the performance of contrast-enhanced MRI for evaluating the response of invasive breast cancers to neoadjuvant CTX.

**Methods:** We reviewed 291 contrast-enhanced breast MRI studies performed at our institution. The study group consisted of 48 MRI studies on 19 women (age range: 37-72 yrs) with 20 biopsy-proven invasive breast cancers who had at least two MRI studies performed during neoadjuvant CTX (1 patient had bilateral cancers). 10 patients had 2 MRI scans and 9 patients had  $\geq 3$  scans. Tumor histology was IDC (n=10), ILC (n=4), poorly differentiated invasive CA (n=4), invasive papillary CA (n=1) and microinvasive DCIS (n=1). 11 patients had malignant ipsilateral axillary lymph nodes. The CTX regimens were anthracycline and cytoxan (AC, n=6), AC and taxane (n=8), AC, taxane and 5-FU, Herceptin or carboplatin (n=3), or taxane alone (n=2). Among patients who had  $>2$  MRI scans, 8 had their CTX regimen changed after MRI scan #2. Surgical pathologic correlation was available for 14 cancers (13 mastectomies and 1 lumpectomy).

MRI was performed on a Siemens Avanto (1.5T, n=27) or Trio (3.0T, n=21) scanner using a four-element breast coil with compression (MRI Devices). Fat suppressed 3D FLASH images were acquired once pre-contrast and 4x post-contrast at 2 min intervals using 20 cc IV gadolinium. Interpolated voxel resolution varied from 0.4-0.7 x 0.5-0.9 x 0.9-1.2 mm. Bilateral exams (n=13) were performed using an axial 3D volume with iPAT factor 2, and unilateral exams (n=35) were performed using a sagittal 3D volume. 4 sets of subtraction images were created for each study.

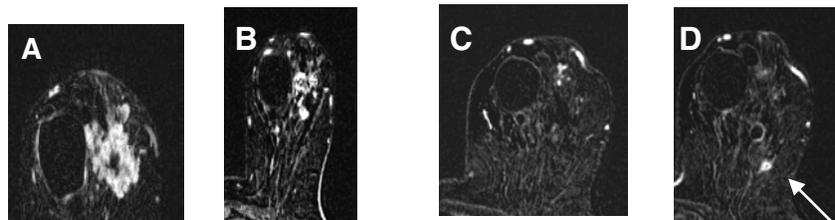
Studies were reviewed offline on a computer workstation by a mammographer and a body MR radiologist. Response to CTX was assessed as change in tumor size on consecutive MR scans. The 48 MRI scans included 31 "intervals" (on a "per lesion" basis) between consecutive scans on the same patient. There were three kinds of "intervals": initial CTX (n=16), continuation of the same CTX regimen (n=7), and change to another CTX regimen (n=8). The mean time between consecutive MR scans was 72d (range: 28-174 d). Tumor response was scored by consensus from MR subtraction images as follows: 1= progression, 2= stable or minimal disease, 3=  $<50\%$  partial response, 4=  $>50\%$  partial response, and 5= complete or near-complete response. Agreement between surgical pathology and the final post-CTX MRI was considered good if the measurements of residual tumor size were within 5 mm.

**Results:** MR image quality was uniformly excellent. MRI scores of tumor response were "1" in 2 cases, "2" in 11 cases, "3" in 4 cases, "4" in 6 cases, and "5" in 8 cases. Four of these cancers also demonstrated a fragmentation or "swiss cheese" pattern of response (Fig. 1A-B). In two patients, the dominant lesion showed near-complete response, but a new cancer appeared elsewhere in the breast (Fig. 1C-D). In 2/8 patients, MRI showed an improved tumor response score after a change in CTX. Agreement between MRI and surgical pathology was good in 11 cases, including all four cases with score "5"; however, MRI overestimated residual cancer in the other three cases (all with scores  $<5$ ).

**Conclusions:** Our data suggest that contrast-enhanced MRI is a promising technique for serial assessment of the response of invasive breast cancers to neoadjuvant chemotherapy. In particular, complete or near-complete tumor response on MRI accurately predicts little or no residual cancer at mastectomy.

## References:

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**Fig. 1.** Axial contrast-enhanced MRI of left breast showing a poorly differentiated invasive CA before CTX (A) and after 2-cycles (B) and 5-cycles (C, D) of taxane. B shows lesion fragmentation, and C shows near-complete response. Note the new enhancing lesion elsewhere in the breast (arrow, D).