# Single site breast DCE-MRI data and segmentations from patients undergoing neoadjuvant chemotherapy (Breast-MRI-NACT-Pilot)

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# Summary

This collection contains longitudinal DCE MRI studies of 64 patients undergoing neoadjuvant chemotherapy (NACT) for invasive breast cancer.

## *Patient population*

This pilot study to investigate the use of serial DCE MRI examinations during neoadjuvant chemotherapy for invasive breast cancer recruited 68 patients with stage II or III locally advanced breast cancer enrolled between 1995 and 2002 in an institutional review board (IRB)-approved research protocol. All patients gave written informed consent to participate. All patients had confirmed breast cancer diagnoses based on histopathology of biopsy or surgical excision, and none had prior treatment with chemotherapy, surgery or radiation. All patients received pre-operative chemotherapy with four cycles of adriamycin-cytoxan administered every three weeks. A subset of 17 patients received additional weekly treatment with taxane after the Anthracycline regimen was completed. Three DCE-MRI scans were scheduled for all patients: $MRI_1$ before treatment; $MRI_2$ after one cycle of chemotherapy; $MRI_3$ after completion of Anthracycline treatment and before surgery or further treatment. Subjects receiving Taxane were scheduled for an additional exam, $MRI_4$, after completion of all chemotherapy treatment and before surgery.




**Figure 1.** UCSF Pilot NACT study schema. Only an N=17 subset of patients received Taxane and $MRI_4$ as a result of changes in standard of care during the course of the study. Note: Not all patients received core biopsies as indicated in this schema.

Exclusions: Of the 68 patients, four have been excluded from this collection: one did not undergo surgery, one did not have a pre-surgery time-point MRI, one was rejected due to unanalyzable MR images, and one had metastatic disease prior to the completion of treatment. None of the excluded patients were from the 17 subject Taxane group. Three patients are included here but may be excluded at researchers' discretion due to treatment anomalies: a) Two subjects in the Taxane group (UCSF_BR_30 and UCSF_BR_53) did not complete the Taxane treatment, but were moved directly to surgery early and did not have the final $MRI_4$ examination, and b) Patient UCSF_BR_27 declined standard-of-care post-surgery radiation and hormonal treatments. These cases are noted in the accompanying clinical information workbook.

Endpoint data: Recurrence-free survival (RFS) was assessed for each patient at 6-month or 1-year intervals following surgery. For patients that recurred, length of RFS was defined as the time from initial surgery to either local or distant recurrence. Other clinical and endpoint data includes patient age, lesion characteristics including pretreatment tumor size, histologic type, pathologic size, tumor subtype, and lymph node involvement. These data are included as supplemental information for the collection in the accompanying clinical information workbook.

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## *MRI acquisition*

Breast MRI was acquired on a 1.5-T scanner (Signa, GE Healthcare, Milwaukee, WI) using a bilateral phased array breast coil. The MR imaging protocol included a 3D localizer and a unilateral sagittal DCE acquisition. The DCE acquisition utilized a high spatial resolution, low temporal resolution, T1-weighted, fat-suppressed 3D fast gradient-recalled echo sequence developed for pre-surgical staging (TR/TE 8/4.2; flip angle 20 degrees; field of view 18-20 cm; acquisition matrix 256 x 192 x 60, section thickness 2 mm; spatial resolution 0.7 x 0.94 x 2.0 $mm^3$). A minimum of three time points were acquired during each contrast-enhanced MRI protocol: a pre-contrast scan ($t_0$), followed by 2 consecutive post-contrast time points: early ($t_1$) and late ($t_2$) phases. The gadopentetate dimeglumine contrast agent (Magnevist, Bayer HealthCare, Berlin, Germany), was injected at a dose of 0.1 mmol/kg of body weight (injection rate = 1.2 mL per second) followed by a 10 mL saline flush, with injection starting coincident with the start of the early $t_1$ phase acquisition. Imaging time was approximately 5 minutes per acquisition, resulting in effective early and late post-contrast time points of 2.5 minutes and 7.5 minutes from the start of the contrast injection, respectively, using standard k-space sampling. Fat suppression was performed using a frequency-selective inversion recovery preparatory pulse.

This shared data set was provided by David Newitt, PhD and Nola Hylton, PhD from the Breast Imaging Research Program at UCSF.

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- National Institute of Health/National Cancer Institute: IUO1CA151235; RO1CA132870
- Susan G Komen: SAC110017

**Data Access**

## Data Access

| Data Type | Download all or Query/Filter | License |
|---|---|---|
| Images and Segmentations (DICOM, 19.5 GB) | *Download* *Search*<br><br>(Download requires the NBIA Data Retriever) | CC BY 3.0 |
| Clinical and DFS Metadata (XLS, 103 kB) | *Download* | CC BY 3.0 |
| ISPY-1 DCE MRI Data Sharing Dictionary_v2 (PDF, 254 kB) | *Download* | CC BY 3.0 |

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## Additional Resources for this Dataset

The NCI Cancer Research Data Commons (CRDC) provides access to additional data and a cloud-based data science infrastructure that connects data sets with analytics tools to allow users to share, integrate, analyze, and visualize cancer research data.

- Imaging Data Commons (IDC) (Imaging Data)

## Third Party Analyses of this Dataset

TCIA encourages the community to publish your analyses of our datasets. Below is a list of such third party analyses published using this Collection:

- SDTM datasets of clinical data and measurements for selected cancer collections to TCIA (DI-Cubed-Reports)
- DICOM SR of clinical data and measurement for breast cancer collections to TCIA (DICOM-SR-Breast-Clinical)

**Detailed Description**

## Detailed Description

| Collection Statistics | |
|---|---|
| Modalities | MR, SEG |
| Number of Participants | 64 |
| Number of Studies | 189 |
| Number of Series | 2602 |
| Number of Images | 99314 |
| Image Size (GB) | 19.5 |

## QIN BMMR Challenge

Subsets of this collection are being used as the training data set for the NCI Quantitative Imaging Network (QIN) Breast MRI Metrics of Response (BMMR) challenge. To download these subsets use the following links:

| Download Link | Description |
|---|---|
| QIN_BMMR_Training DCE_Derived_HRknown | n=47 subject training set for bMMR Challenge, DCE series and derived maps and segmentations |
| QIN_BMMR_Training DCEonly_HRknown | n=47 subject training set for BMMR Challenge, primary DCE series only |
| QIN_BMMR_Training AllSeries_HRknown | n=47 subject training set for BMMR Challenge, all acquired and derived series |

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| | |
|---|---|
| QIN_BMMR_Training AllSeries_AllSubjects_n64 | n=64 training set for BMMR Challenge, all series all patients |
| QIN_BMMR_Training DCEonly_AllSubjects_n64 | n=64 training set for BMMR Challenge, Original DCE series only, all patients |
| QIN_BMMR_Training DCE_Derived_AllSubjects_n64 | n=64 training set for BMMR Challenge, DCE series and derived maps and segmentati, all patients |
| BMMR_Training_Tissue_DSO_AllSubjects | Breast tissue segmentations for all studies in Breast-MRI-NACT-Pilot collection |
| BMMR_Training_Tumor_DSO_AllSubjects | Breast enhancing tumor segmentations for all studies in Breast-MRI-NACT-Pilot collection |

## Included image data

### Original and time-of-scan derived images.

Original DCE images are contained in a single series for each study. For the majority of studies (174 of 198) this series contains only the 3 time-points described above. 12 studies have 1 additional post-contrast acquisition for a total of 4 phases, while 2 studies, UCSF_BR_36, visit 1, and UCSF_BR_42, visit 1, have 4 and 6 post-injection phases respectively.

**NOTE: Study UCSF_BR_18, Visit 1, has two pre-contrast acquisitions and two post-contrast phases**. Use of the 2nd pre-contrast phase for time-point $t_0$ is recommended. All other studies have a single pre-contrast phase.

Other original image series present in the collection include 3-plane scout images for each study, and for some studies T2 weighted images and diffusion weighted images. In addition, some studies may contain derived images from the DCE series including subtraction images and projection images.

### Tumor volumetric analysis images.

The primary predictor variable for the original study, functional tumor volume (FTV), was measured from contrast-enhanced images using the signal enhancement ratio (SER) method. Four derived series per study from this analysis are included in this collection:

| **Series ID**<br><br>**(x=original DCE series ID)** | **Object Type** | **Series description** |
|---|---|---|
| x1000 | MR | SER*1000 map[1] |
| x1001 | MR | $PE_{early}$ map |
| x2000 | Segmentation | $PE_{early}$ segmentation for SER map calculation[2] |
| x2001 | Segmentation | Breast tissue segmentation for $PE_{early}$ map calculation[3] |

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1. SER true values range from 0.0 to 3.0. These are scaled by 1000 in order to store in integer format. DICOM viewers utilizing the rescale-slope field (0028,1053) will display the true SER values.
2. The $PE_{early}$ segmentation is based on both the breast tissue segmentation (background level threshold, see next footnote) and an early percent enhancement threshold of 70%.
3. The breast tissue segmentation is based on an intensity threshold applied to the pre-contrast image. Threshold was set to 60% of the 95% percentile intensity within the tumor region volume-of-interest. Coordinates of the VOI are stored in all derived DICOM images using private fields (0117, 10a1) and (0117, 10a2) for the starting and ending voxel coordinates respectively.

## Further information on later NACT Breast Cancer MRI studies can be found at:

- ACRIN 6657 Protocol http://www.acrin.org/6657_protocol.aspx
- I-SPY TRIAL http://ncicb.nci.nih.gov/tools/translation_research/ispy (archive.org recovered deprecated page PDF per May 2023)
- CALGB 150007 http://www.cancer.gov/clinicaltrials/search/view?cdrid=69280&version=HealthProfessional (archive.org recovered deprecated page PDF per May 2023)

## Metadata

**Excel workbook with clinical data and disease free survival (DFS) data for the 64 patients in this study:**

**Clinical and DFS Data (xls)**

**DICOM data dictionary defining fields included in the 0x0117 private group for PE/SER calculation parameters and results, and deduced DCE scan timing information. NOTE: Dictionary contains sections for attributes from the I-SPY 1 TRIAL which are not included in this pilot study.:**

**ISPY-1 DCE MRI Data Sharing Dictionary_v2**

**Citations & Data Usage Policy**

## Citations & Data Usage Policy

Users must abide by the TCIA Data Usage Policy and Restrictions. Attribution should include references to the following citations:

**Data Citation**

Newitt, D., & Hylton, N. (2016). **Single site breast DCE-MRI data and segmentations from patients undergoing neoadjuvant chemotherapy (Version 3) [Data set]**. The Cancer Imaging Archive. https://doi.org/10.7937/K9/TCIA.2016.QHsyhJKy

**TCIA Citation**

Clark, K., Vendt, B., Smith, K., Freymann, J., Kirby, J., Koppel, P., Moore, S., Phillips, S., Maffitt, D., Pringle, M., Tarbox, L., & Prior, F. (2013). **The Cancer Imaging Archive (TCIA): Maintaining and Operating a Public Information Repository.** In Journal of Digital Imaging (Vol. 26, Issue 6, pp. 1045–1057). Springer Science and Business Media LLC. https://doi.org/10.1007/s10278-013-9622-7 PMCID: PMC3824915

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## Additional Publication Resources

The Collection authors suggest the below will give context to this dataset:


1. Partridge SC, Gibbs JE, Lu Y, Esserman LJ, Tripathy D, Wolverton DS, Rugo HS, Hwang ES, Ewing CA, Hylton NM. **MRI measurements of breast tumor volume predict response to neoadjuvant chemotherapy and recurrence-free survival**. AJR Am J Roentgenol. 2005 Jun;184(6):1774-81. PubMed PMID: 15908529. doi: 10.2214/ajr.184.6.01841774
2. Li KL, Partridge SC, Joe BN, Gibbs JE, Lu Y, Esserman LJ, Hylton NM. **Invasive breast cancer: predicting disease recurrence by using high-spatial-resolution signal enhancement ratio imaging**. Radiology. 2008 Jul; 248(1):79-87. PMID: 18566170. doi: 10.1148/radiol.2481070846
3. Hattangadi J, Park C, Rembert J, Klifa C, Hwang J, Gibbs J, Hylton N. **Breast stromal enhancement on MRI is associated with response to neoadjuvant chemotherapy**. AJR Am J Roentgenol. 2008 Jun;190(6):1630-6. PubMed PMID: 18492917. doi: 10.2214/AJR.07.2533
4. Li KL, Henry RG, Wilmes LJ, Gibbs J, Zhu X, Lu Y, Hylton NM. **Kinetic assessment of breast tumors using high spatial resolution signal enhancement ratio (SER) imaging**. Magn Reson Med. 2007 Sep;58(3):572-81. PubMed PMID: 17685424; PubMed Central PMCID: PMC4508009. doi: 10.1002/mrm.21361
5. Jones EF, Sinha SP, Newitt DC, Klifa C, Kornak J, Park CC, Hylton NM. **MRI enhancement in stromal tissue surrounding breast tumors: association with recurrence free survival following neoadjuvant chemotherapy**. PLoS One. 2013 May 7;8(5):e61969. Print 2013. PMCID: PMC3646993. doi: 10.1371/journal.pone.0061969


## Other Publications Using This Data

TCIA maintains a list of publications which leverage TCIA data. If you have a manuscript you'd like to add please contact TCIA's Helpdesk.


- Boehm, K. M., Khosravi, P., Vanguri, R., Gao, J., & Shah, S. P. (2022). Harnessing multimodal data integration to advance precision oncology. Nature Reviews Cancer, 22(2), 114-126. doi:10.1038/s41568-021-00408-3
- Chui, K. T., Arya, V., Band, S. S., Alhalabi, M., Liu, R. W., & Chi, H. R. (2023). Facilitating innovation and knowledge transfer between homogeneous and heterogeneous datasets: Generic incremental transfer learning approach and multidisciplinary studies. Journal of Innovation & Knowledge, 8(2). doi:https://doi.org/10.1016/j.jik.2023.100313
- Du, R., & Vardhanabhuti, V. (2020, 06-08 July 2020). 3D-RADNet: Extracting labels from DICOM metadata for training general medical domain deep 3D convolution neural networks. Paper presented at the Third Conference on Medical Imaging with Deep Learning (MIDL 2020), Montréal, QC, Canada.
- Kosareva, A. A., Paulenka, D. A., Snezhko, E. V., Bratchenko, I. A., & Kovalev, V. A. (2022). Examining the Validity of Input Lung CT Images Submitted to the AI-Based Computerized Diagnosis. Journal of Biomedical Photonics & Engineering, 8(3). doi:https://doi.org/10.18287/JBPE22.08.030307
- Lo, W.-C., Li, W., Jones, E. F., Newitt, D. C., Kornak, J., Wilmes, L. J., . . . Hylton, N. M. (2016). Effect of Imaging Parameter Thresholds on MRI Prediction of Neoadjuvant Chemotherapy Response in Breast Cancer Subtypes. PLoS One, 11(2), e0142047. doi:10.1371/journal.pone.0142047
- Natsheh, Q., Li, B., & Gale, A. (2016). Security of Multi-frame DICOM Images Using XOR Encryption Approach. Procedia Computer Science, 90, 175-181. doi:10.1016/j.procs.2016.07.018
- Nave, O. (2020). Adding features from the mathematical model of breast cancer to predict the tumour size. International Journal of Computer Mathematics: Computer Systems Theory, 5(3), 159-174. doi:https://doi.org/10.1080/23799927.2020.1792552
- Tianxu Lv, Xiang Pan, & Li, L. (2020). DCE-MRI based Breast Intratumor Heterogeneity Analysis via Dual Attention Deep Clustering Network and its Application in Molecular Typing. IEEE International Conference on Bioinformatics and Biomedicine (BIBM), Seoul, Korea (South).


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- Wu, Y., Wang, Y., Sun, H., Jiang, C., Li, B., Li, L., & Pan, X. (2022). Joint model- and immunohistochemistry-driven few-shot learning scheme for breast cancer segmentation on 4D DCE-MRI. Applied Intelligence. doi:https://doi.org/10.1007/s10489-022-04272-y

**Versions**

## Version 3 (Current): Updated 2023/08/07

Repaired a DICOM tag(0008,0005) to value "ISO_IR 100" in 79 series, affected ID: UCSF-BR-06, UCSF-BR-26, UCSF-BR-41, UCSF-BR-43, UCSF-BR-45, UCSF-BR-54, UCSF-BR-59, UCSF-BR-68.

| Data Type | Download all or Query/Filter |
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| Images (DICOM, 19.5 GB) | *Download* *Search* (Download requires the NBIA Data Retriever) |
| Clinical and DFS Metadata (XLS) | *Download* |
| ISPY-1 DCE MRI Data Sharing Dictionary_v2 (PDF) | *Download* |

## Version 2: Updated 2016/04/16

deleted 4 duplicate DICOM series:

1.3.6.1.4.1.14519.5.2.1.7695.2311.274969196687715738621052447111

1.3.6.1.4.1.14519.5.2.1.7695.2311.790802609328661944330528970451

1.3.6.1.4.1.14519.5.2.1.7695.2311.869262000688001356814712906748

1.3.6.1.4.1.14519.5.2.1.7695.2311.914480028549654883806586724682

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| ISPY-1 DCE MRI Data Sharing Dictionary_v2 (PDF) | *Download* |

## Version 1: Updated 2016/01/30

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