

BREAST DCIS: PART 2

Breast ductal carcinoma in situ (DCIS) encompasses a range of pathology with pronounced heterogeneity. Part 1 of this two-part *WCC Note* series on DCIS reviewed the epidemiology, pathology, mammography appearance, and some recent scientific developments of DCIS. This issue reviews the MRI findings of DCIS.

MORPHOLOGY ON MRI

What morphology does DCIS display on MRI?

1. Clumped non-mass-like enhancement in a ductal, linear, segmental, or regional distribution is the most commonly reported MRI appearance of DCIS. (1)
2. While pure DCIS typically appears as non-mass-like enhancement on dynamic contrast enhanced MRI, it can appear as a mass. (2)
3. Segmental enhancement shows triangular or conical shape with a radial orientation pointing toward the nipple and corresponds to a single duct system. Less common distributions of pure DCIS include regional enhancement, implying that it is not confined to a single duct system; and focal enhancement. (2)
4. Occasional confluent areas, heterogeneous or “nonuniform enhancement in a random pattern” can occur. (3)
5. DCIS, like invasive carcinoma, can show hyperintensity on diffusion-weighted imaging, with lower apparent diffusion coefficient (ADC) values than benign lesions and normal tissue. (4)
6. A review of the worldwide experience of MRI of DCIS includes the following:
 - a. A retrospective review of 39 patients with pure DCIS found the hallmark was unilateral segmental enhancement, most commonly with a granular dotted morphology. (5)
 - b. A 2010 MRI study reported that of 31 known DCIS cases, the morphology appeared as mass type or non-mass lesions with nearly equal frequency. For masses, the most common morphology was irregular shape (50%), irregular margin (50%), and heterogeneous enhancement (67%). The non-mass lesions most commonly displayed clumped enhancement (64%). (6)
 - c. Tumors that had extensive intraductal component accompanying invasive ductal carcinoma underwent evaluation in 50 cases by authors from Belgium. The ductal spread appeared as ductal or linear enhancement, long spicules, or a regional enhancing area or nodules adjacent to a mass. (7)

Why does DCIS enhance on MRI?

1. Current MRI techniques with temporal resolution of 120 seconds do not image lesion perfusion but instead reflect contrast diffusion. (3)
2. Providing insight into why DCIS lesions enhance, a study of DCIS used dynamic contrast enhanced (DCE) MRI and x-ray fluorescence microscopy in a mouse model. The authors preface their study with the statement that DCIS is not always associated with dense vasculature, particularly in the early setting. The study showed that gadolinium penetrated and collected inside neoplastic ducts was present in high concentrations inside and along mammary ducts and that there was a high extravascular extracellular space fraction in DCIS. The authors hypothesize that the mechanism of enhancement relates to gadolinium diffusing out of capillaries into the extraductal space, encountering leaky duct basement membranes and accumulating and distributing within the largely unobstructed ductal lumen. They further state that a number of factors could affect the kinetic curve: the distance between the vessels and duct, the permeability of the basement membranes, and the volume of the duct lumen. (8)

RIGHT:

- **History: Bloody nipple discharge.**
- **Mammography (magnification view) (Figure A) shows large area of clustered microcalcification in left lower outer breast.**

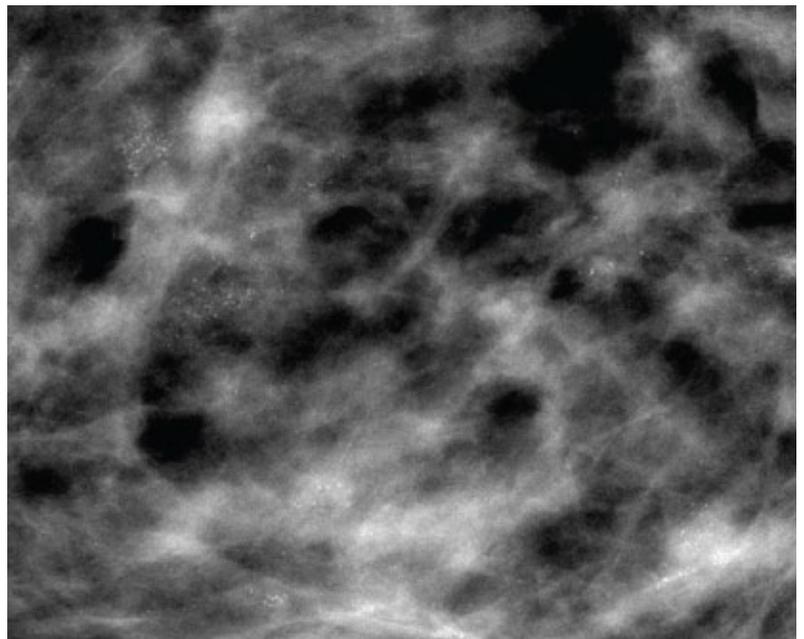


Figure A

RIGHT:

- **MRI (Figure B) shows large area of non-mass type enhancement, skin thickening, and enhancement.**
- **Pathology: DCIS, high grade.**

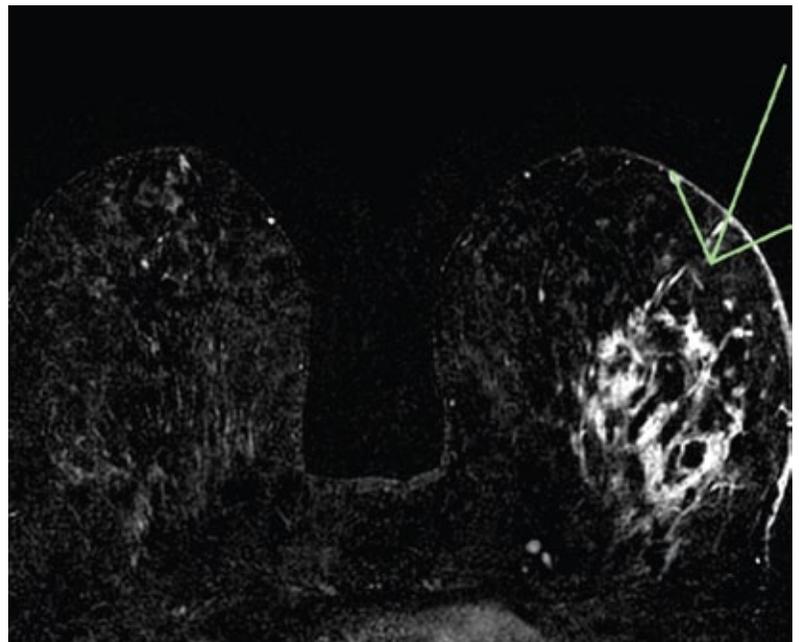


Figure B

What kinetic patterns does DCIS display on MRI?

1. The kinetic curve of DCIS shows a range of appearances in both initial contrast uptake slopes and in the delayed phase. Plateau, persistent, or washout kinetics all can occur. (2)
2. Since DCIS may show persistent enhancement, recommendations should be based on morphology rather than kinetics. (3)
3. Of 31 known DCIS cases, Chan et al. reported suspicious kinetics in 78%. (6)
4. However, it is important to note that kinetic curves of malignant lesions have been reported to vary depending on the MRI system used to evaluate them. (9)

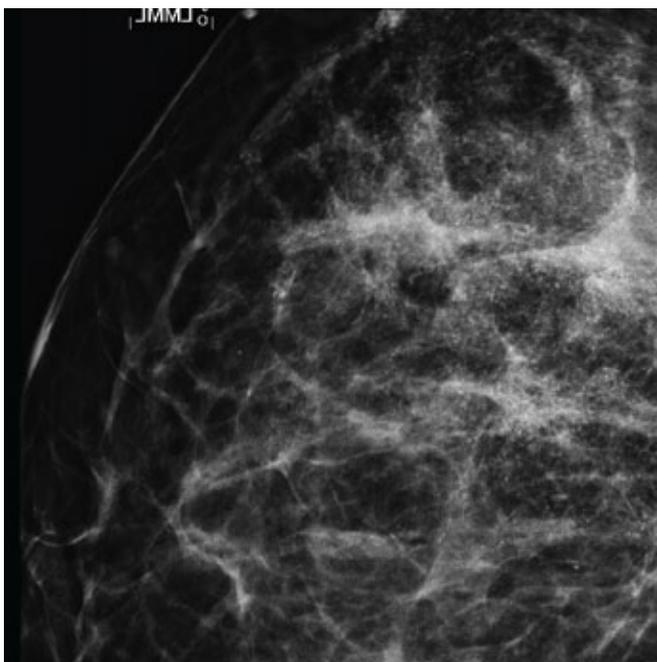


Figure C

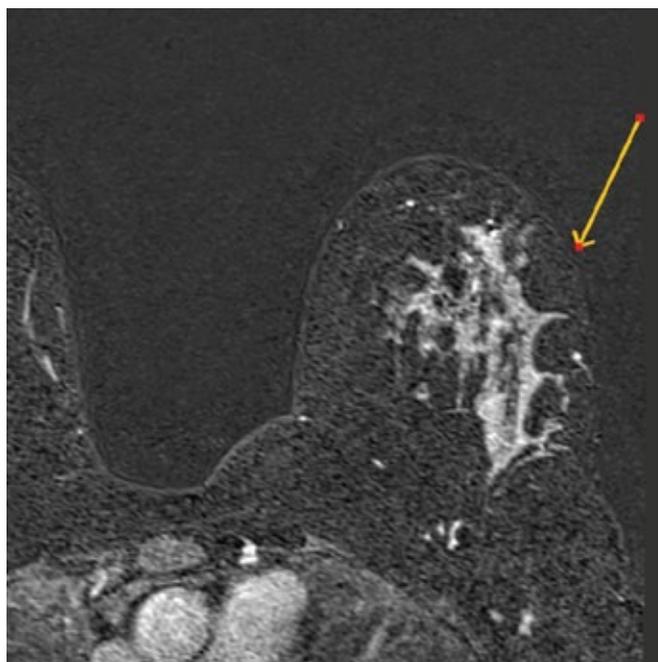


Figure D

Above:

- **History:** Left breast pain.
- **Mammography (Figure C)** shows numerous pleomorphic microcalcifications
- **Post-contrast subtracted axial MRI image (Figure D)** shows extensive non-mass type enhancement.
- **Pathology:** DCIS, intermediate to high grade, cribriform.

How does the MRI appearance of DCIS reflect its biobehavior?

1. According to Yamada et al. no MRI kinetic pattern is pathognomonic of a DCIS nuclear grade. (10)
2. Chan et al. reported no significant MRI difference was found in morphology, size, and kinetics between lower grade (I and II) and high-grade (III) pure DCIS. (6)
3. Of 79 pure DCIS lesions, Jansen et al. reported kinetics showing a variety of curves – washout, plateau, and persistent. In this cohort, 25% showed plateau kinetic, 44% washout. No significant difference occurred in kinetics across the nuclear grades, and MR lesion morphology did not vary significantly with either nuclear grade or mammographic appearance. (11)

Continued on next page

4. According to a study from Liu et al., when including cases of DCIS with microinvasion, whether a lesion showed mass type versus non-mass type DCIS morphology on MRI reflected different biological behavior. A retrospective analysis of 41 cases of DCIS evaluated by MRI (3 pure DCIS and 18 DCIS with microinvasion) revealed that high grade lesions were more likely non-mass lesions than mass type. The average size of DCIS was larger in the high grade, negative ER, positive c-erbB2 (HER-2/neu) expression cases than in the non-high grade, positive ER, negative c-erbB2 (HER-2/neu) expression tumors. The average size of DCIS with microinvasion was also larger than in pure DCIS tumors. (12)

MRI SENSITIVITY

How sensitive is MRI to diagnose DCIS?

Studies within the past five years report the MRI sensitivity for DCIS from 68% to 97%. These studies include the following:

1. A 2010 MRI study from Taiwan reported that of 31 known DCIS cases, MRI showed the DCIS in 29 (94%). (6)
2. Of 167 women with pure DCIS who had undergone both mammography and MRI tests preoperatively, 56% were diagnosed by mammography and 92% by MRI ($p < 0.0001$). Of those with high-grade DCIS, 48% were missed by mammography, but diagnosed by MRI alone; all 43 cases missed by mammography were detected by MRI. By contrast, MRI detected 98% of these lesions; the two cases missed by MRI were detected by mammography. The authors concluded that MRI could help improve the ability to diagnose DCIS, especially DCIS with high nuclear grade. (13)
3. A study of false-negative MRI for breast cancer revealed the sensitivity for DCIS was 90.2%. (14)
4. MRI may underestimate DCIS when mammography shows microcalcifications. A study of 112 patients with calcifications detected by mammography who were evaluated with MRI revealed that of 33 lesions of DCIS, the sensitivity of MRI for diagnosing the DCIS was 79%. Four lesions did not enhance; 29 lesions enhanced, but three were interpreted as benign. (15)
5. In patients showing no invasive cancer after preoperative chemotherapy, MRI helps distinguish between lesions with and without residual DCIS, per authors from Seoul, Korea. (16)
6. MRI assessed the size of DCIS better than mammography in 33 patients with DCIS proven by needle biopsy who subsequently underwent surgery. (17) MRI detected the lesion in 97%, appearing as non-mass in 78%. The DCIS distribution proved ductal or segmental in over 50% and the kinetic enhancement curve was persistent. Lesion size received correct estimation (± 5 mm) in 60%, under-estimated by < 5 mm in 19%, and overestimated by > 5 mm in 21% (compared to mammography: 38%, 31%, and 31%).
7. In tumors that had extensive intraductal component accompanying invasive ductal carcinoma, MRI predicted the intraductal disease in 68%, surpassing its diagnosis by mammography (48.5%) and ultrasound (34.2%). (7)
8. MRI holds higher sensitivity than mammography for detecting DCIS and greater accuracy depicting its extent. (10)
9. The ability to detect DCIS on MRI improves significantly with experience, according to a 2011 Canadian report. The authors examined their ability to detect DCIS when screening very high-risk women before and after acquiring expertise in its MRI detection. Improved image quality also occurred due to technical improvements. (18)

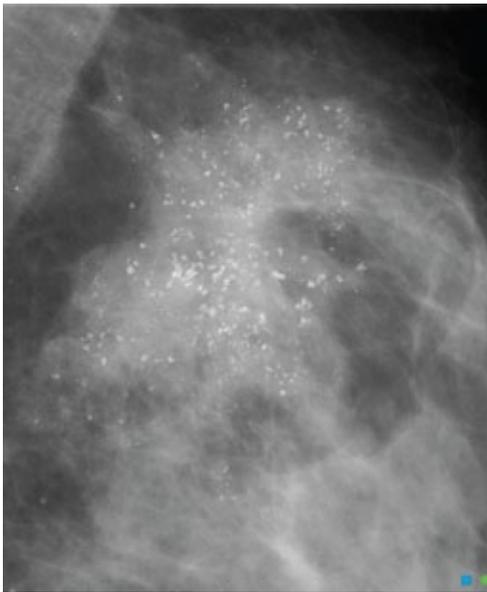


Figure E

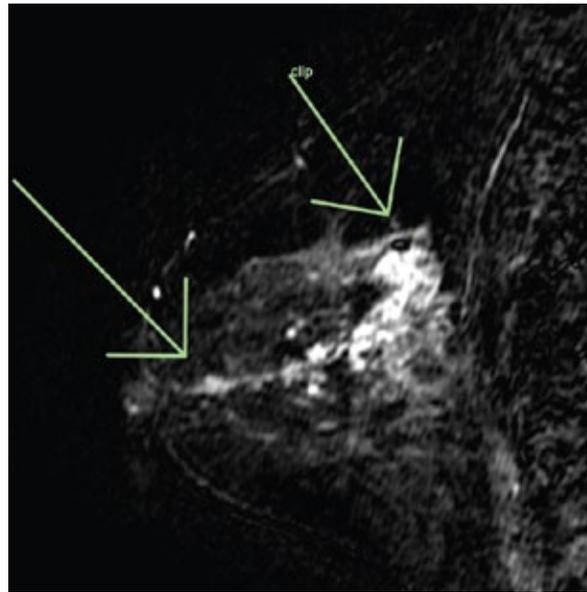


Figure F

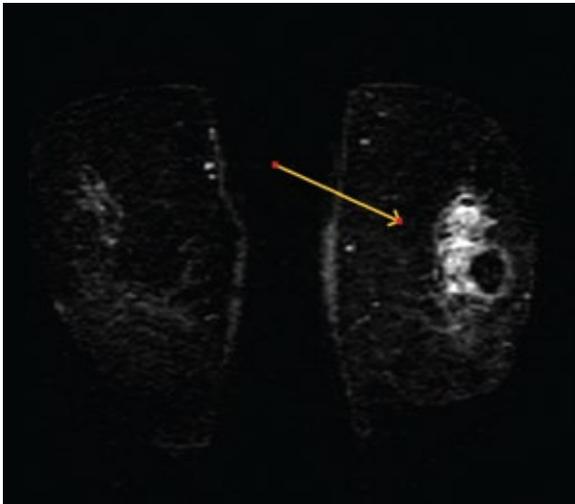


Figure G

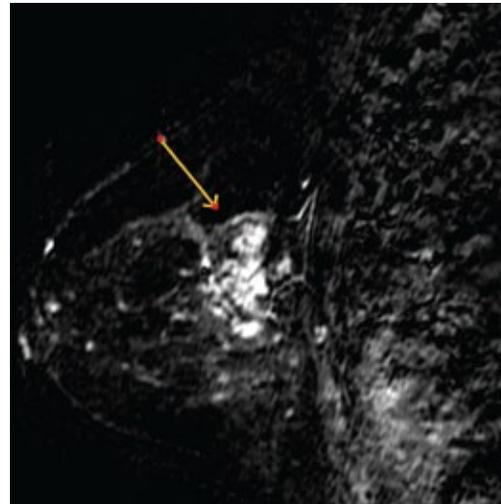


Figure H

Above:

- **History:** Palpable mass left 2 o'clock.
- **Mammography (Figure E)** shows abnormal asymmetric density superolateral with large amount of pleomorphic branching calcifications. Area corresponds to clinically palpable abnormality
- **Post-contrast subtracted sagittal MRI image (Figure F)** shows enhancement concordant with the microcalcifications and biopsy clips seen on mammography, clumped stippled intense enhancement with plateau kinetic in the posterior outer to central breast extending from the equator to upper breast, but associated with an enhancing beaded duct that courses to the retroareolar region, which has a contiguous 4 mm nodular region.
- **Coronal subtraction MRI (Figure G)**
- **Sagittal subtraction MRI (Figure H)** shows clumped stippled intense enhancement.
- **Pathology:** DCIS high grade.

CONCLUSION

Conclusion: The most frequent MRI appearance of DCIS displays non-mass type clumped enhancement with ductal or segmental distribution and variable kinetics. More recent literature reports a 68% to 97% MRI sensitivity for diagnosing DCIS.

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- *Research and Reporting:* Margaret D. Phillips, M.D. (newsletter@wccclinical.com)
- *Reviewer and Publisher:* Stephen J. Pomeranz, M.D. (newsletter@wccclinical.com)
- *Managing Editor:* Shannon Hemsink
- *WorldCare Clinical Editorial Advisor:* Richard C. Walovitch, Ph.D.
- *Graphic Designer:* Tom Anneken