63. Breast Neoplasia

Due to its high sensitivity (approaching 100%) breast MRI is indicated for the screening of patients who are genetically positive for BRCA1 or BRCA2 gene mutations (or other rarer gene mutations) or alternatively have first degree relatives meeting this criteria, have received radiation to the chest between the ages of 10 and 30, or have a calculated lifetime risk greater than 20% using standard risk models.

Imaging protocols for MR mammography have in recent years become more standardized, typically including the acquisition of pre-contrast T1WI, FS T2WI and DWI followed by dynamic post-contrast scans (DCE-MRI), with these performed about every minute for 5-8 minutes. Using this conventional approach, the latter (dynamic post-contrast scans) is felt to improve further the sensitivity and specificity for breast cancer. Elimination of the signal intensity from fat is important for dynamic imaging, and can be easily achieved using newer innovative techniques or by subtraction of pre- from post-contrast T1WI. Maximum intensity projections, whereby the greatest SI pixels from three-dimensional space are projected to create a two-dimensional image, are often used for image interpretation of the dynamic post-contrast scans. Slice thickness is critical with 2D techniques, as is voxel size for 3D imaging (with the aim being to achieve the highest possible spatial resolution with each technique). High spatial resolution is required for improving the assessment of lesion architecture whereas high temporal resolution provides information on lesion enhancement kinetics. In dynamic imaging, a balance must be struck between requirements of high spatial resolution and adequate temporal resolution—a conflict eased by the advent of high field (3T), parallel imaging and compressed sensing. An important technical consideration, to be noted, is that breast MR should be performed between days 7 and 14 of the menstrual cycle, when background enhancement is minimized.

Enhancing lesions of the breast are divided into three main categories: mass, focus and non-mass enhancement. A mass is a 3-D, space occupying lesion. Kinetic curves, constructed from post-contrast scans, depicting SI evolution of a mass are helpful in its characterization. Breast MRI enhancement curves are divided into three types. With type I, there is progressive enhancement – with > 90% of these lesions being benign. Type II is a plateau pattern, with initial uptake followed by a plateau, a finding concerning for malignancy. With type III, there is relatively rapid uptake followed by a reduction in enhancement (washout), a pattern strongly suggestive of malignancy. In terms of the appearance of a mass, on non-dynamic scans, masses with irregular margins (for example spiculated) are likely neoplastic, while those with smooth or lobulated borders are more likely benign. A focus is a nonspecific singular enhancing dot usually smaller than 5 mm,

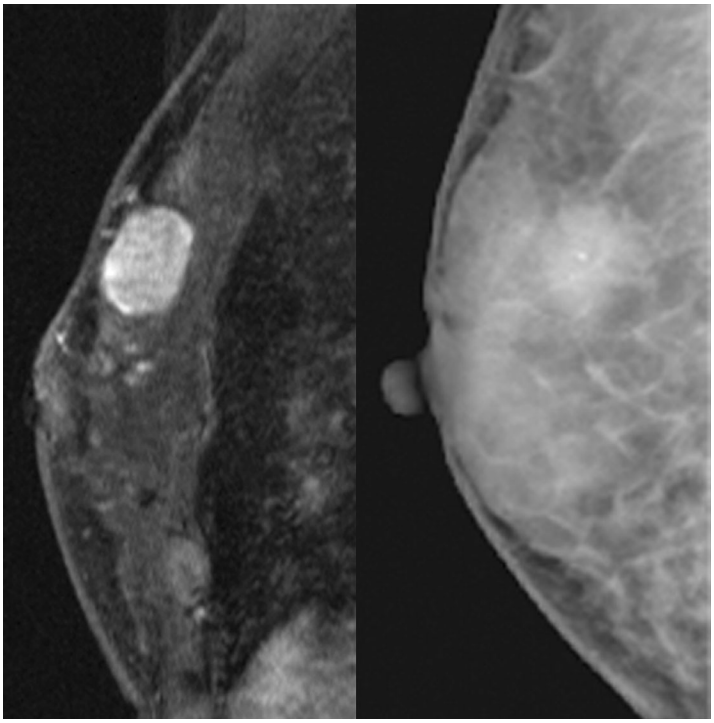

Fig. 63.1

too small to be characterized morphologically and without a corresponding finding on the pre-contrast acquisition. Non-mass enhancement is neither a focus nor a mass, and is classified according to its distribution and internal enhancement pattern.

Figure 63.1 illustrates an invasive breast cancer with rapid prominent enhancement (A) that was difficult to detect on mammography due to the presence of dense breast tissue (B). Breast density is well known to decrease the sensitivity of screening mammography. In terms of MR field strength, 3 T offers the advantage of higher spatial and temporal resolution (together with improved fat suppression) when compared to 1.5 T, although clear benefits in terms of clinical outcome have not been proved. Figure 63.2 shows the difference in SNR, presenting a comparison with similar imaging parameters of (A) 1.5 and (B) 3 T in a woman with a large breast carcinoma, specifically subtraction images from the first post-contrast scan in the dynamic series. An invasive cancer is illustrated in Fig. 63.3, with both a single sagittal slice from the dynamic post-contrast exam and the 3D MIP reconstruction. This invasive cancer (large arrow) is well seen, together with the associated intraductal extent (small arrows).

In the last few years, several important new discussions/sequence innovations have emerged that involve clinical breast imaging, which may lead to major changes in study protocols. Diffusion (DWI) has great value in the characterization of breast lesions, and as previously noted is now part of a standard evaluation. However, in a head-to-head

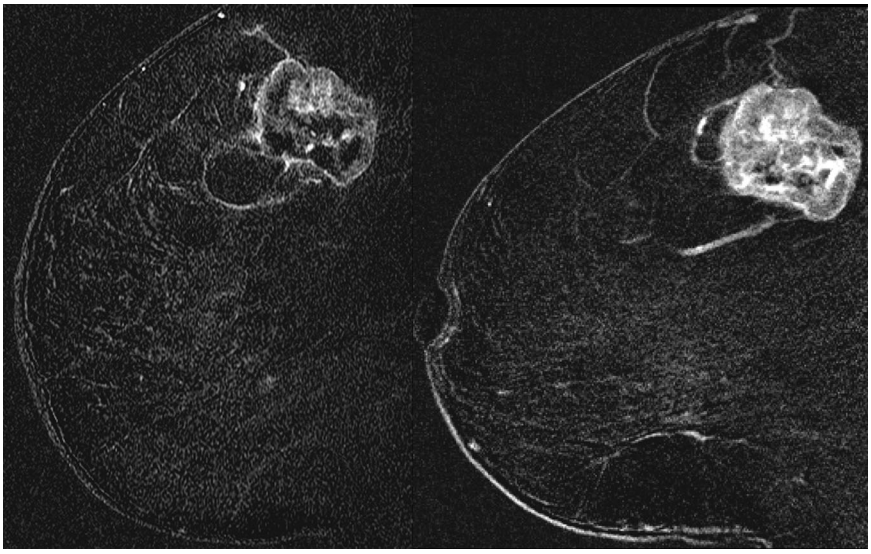

Fig. 63.2

comparison with DCE-MRI, DWI has inferior sensitivity and its use as a stand-alone parameter cannot be justified. Compressed sensing is now reaching the clinic for breast applications, allowing an increase in through-plane spatial resolution (with CS-VIBE), enabling 3D ultrafast dynamic contrast-enhanced MRI for morphologic assessment of lesions. Dixon-RAVE (radial volumetric encoding) which combines radial sampling, compressed sensing and fat/water separation has also been recently similarly advocated for robust dynamic contrast enhanced imaging with excellent fat suppression and high spatial and temporal resolution. This sequence also enables extraction, from the same data set, of non-fat suppressed images pre-contrast images, offering a one-stop-shop approach for DCE breast imaging. A separate discussion, but potentially benefiting and part of this scan and acquisition time optimization, has been that of ultrafast breast MRI and its diagnostic accuracy and potential for breast cancer screening. Bilateral whole breast dynamic imaging is performed for the first one to two minutes only following intravenous contrast administration, with a temporal resolution of 5 seconds or less. This approach has been shown to be noninferior for screening when compared with a full multiparametric diagnostic MRI protocol, offering potentially higher screening specificity and lower cost, with reduced magnet time and shorter reading time.

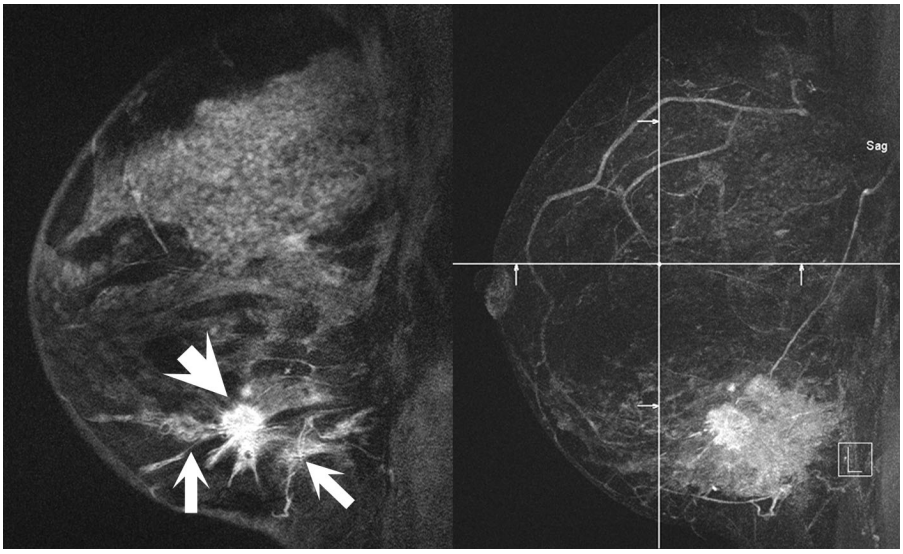

Fig. 63.3

Figures courtesy of Mitchell D. Schnall