Radial MIP Imaging Protocol For Improved MR Visualization Of Intraductal Breast Cancer

H. Schultze-Haakh[1], B. A. Porter[2]

[1]Siemens Medical Solutions, Malvern, PA, United States, [2]First Hill Diagnostic Imaging, Seattle, WA, United States

MR is increasingly used for breast cancer diagnosis, staging and management. Two primary and previously rather mutually exclusive approaches have been employed: high-resolution 3 dimensional, fat-suppressed acquisition techniques, and dynamic contrast enhanced acquisitions. Each approach has merits and limitations, both for invasive and non-invasive, intraductal tumors. With recent advances in MR technology, both methods can now be incorporated into one rapid, bilateral clinical exam.

Our current techniques incorporate both approaches and begin with a dynamic 3 dimensional 60-90 second bilateral axial acquisition with fat-suppression (dynaVIEWS: dynamic **V**olume **I**maging with **E**nhanced **W**ater **S**ignal) before and after bolus contrast injection. This generally T1-weighted spoiled gradient echo (FLASH) sequence produces close to iso-tropic sub-millimeter voxels. This is followed (at 5-6 minutes) by an even higher-resolution with yet smaller voxels, centrically reordered k-space 3 dimensional acquisition, also with fat-suppression, using either a binomial water excitation or a quick fat-saturation scheme. Both protocols incorporate parallel acquisition techniques to achieve these high resolutions in short scan times.

Most aggressive lesions, e.g. invasive malignancies, enhance markedly on the early post-contrast images, but may wash out later. On the other hand, intraductal malignant or pre-malignant processes such as ductal carcinoma in situ (DCIS) are often best seen on more delayed images, reflecting the slower time course of their enhancement. As DCIS may be a precursor to or marker for invasive cancer, its detection has become an important challenge to breast MR. Typically, DCIS presents with a pattern of linear or clumped enhancement following the ductal pathways of the breast - the ductal or "string-of-pearls" appearance. Since DCIS often does not show rapid enhancement, initial dynamic post-contrast measurements may fail to display its intraductal extent, particularly with lower grade tumors. Therefore, the delayed higher-resolution acquisition presented here, and termed "delayed VIEWS" was developed for the identification of the extent and distribution of intraductal tumors (Figure1). This is typically axial.

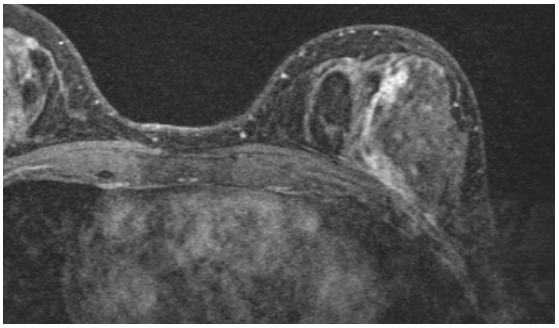

Figure 1: axial bilateral delayed VIEWS acquisition image showing a portion of the DCIS within the left breast.

The very high spatial resolution provided by sub-millimeter (0.6 to 0.8 side length) voxels allows reconstruction (Multi-Planar-Reconstruction) of the 3 D data in any orientation without appreciable loss in resolution or detail. Small enhancing structures, such as DCIS or other intraductal tumors, are visualized with high signal and therefore Maximum Intensity Projections (MIP) can depict tumor spread along the ductal pathways. To further improve the visualization of the often linear, obliquely oriented DCIS a post-processing tool called RADIANT MIP (**RAD**ial Maximum Intensity Projection **I**maging **A**round **N**ipple or **T**umor) was developed.

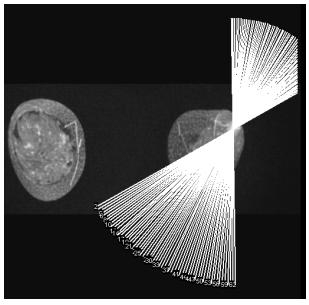

Figure 2: Planning set-up of radial thin MIP reconstructions.

Since the anatomy of the breast is radial, not orthogonal, reconstructing thin (1-5mm.) MIPs, radially from the 3 dimensional data, centered on the nipple or lesion, shows the extent and the location of DCIS in a unique manner that can rarely be as well appreciated from conventional orthogonal imaging. These thin-MIPs are reconstructed every 3 to 5 degrees, depending on the extent of the abnormality (see figure 2). This produces an anatomically understandable image (Figure 3) that is unique for its ability to demonstrate the 3D sub-gross anatomy and extent of intraductal cancers. This may facilitate not only surgical planning and patient communication, but may also aid diagnosis of DCIS based upon the improved display of its characteristic morphological features.

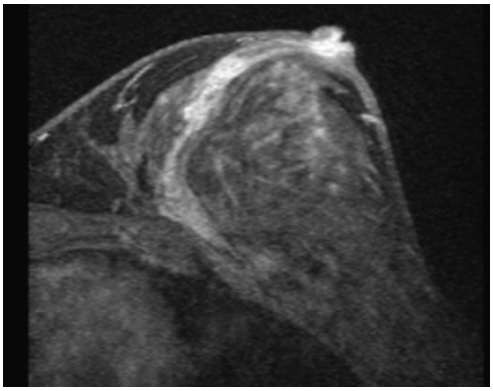

Figure 3: Oblique nipple-centric thin MIP along the ductal path of DCIS. 2 mm RADIANT MIP; one of 62 images.