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Acquisition of High Quality MRI

연세의대 영상의학과

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1. The role of Breast MR Imaging

- Breast MRI was highly sensitive, noninvasive technique for the detection of breast cancer.
- The absence of enhancement on breast MR imaging had an 88% negative predictive value for any cancer, with a 94% negative predictive value for invasive breast cancer.
- Indications of breast MRI
 - 1) MRI to detect multifocal and multicentric disease that was previously unsuspected facilitates, accurate staging
 - 2) Evaluation of contralateral breast in patients with known cancer
 - 3) Detect residual disease
 - 4) Assess response to neoadjuvant chemotherapy
 - 5) Suspected recurrence can be confirmed with MRI
 - 6) Axillary node metastases with unknown primary
 - 7) Screening in certain high-risk patients

2. Principles of Dynamic Contrast-Enhanced MR Imaging

- Two major imaging features: appearance and enhancement pattern
 - 1) **Appearance** - assessed on high-spatial-resolution T1 postcontrast, though T2-weighted images may also be useful
 - 2) **Enhancement characteristics** are based on observing changes in signal intensity (SI) on precontrast and multiple postcontrast images
- Analysis can be qualitative or quantitative

- Principles of contrast enhancement are based on tumor angiogenesis
- Angiogenesis is a key step in breast cancer growth, local invasion, and progression to metastasis
- The goal of a DCE-MR imaging protocol is to image rapidly enough to detect differential enhancement, but also at a high enough spatial resolution to enable characterization based on size, shape, margins, and internal features.
- Requires rapid acquisition of high-spatial and high-temporal-resolution images
- Initial enhancement is described as slow, medium, or rapid
- The enhancement pattern is described as progressive, plateau, or washout

3) Technical Parameters for Dynamic Contrast-Enhanced MR Imaging of the Breast

- Spatial resolution and temporal resolution represented competing goals
- Early studies of very high-temporal-resolution scanning, covering only a few slices through a suspicious lesion, showed an increased specificity for diagnosing malignancy
- According to Dr. Kuhl (2005, Radiology)- Trade-off between Spatial and Temporal Resolution
 - High spatial and high temporal resolution, there are not enough data available that would substantiate how and where this compromise should be set
 - 30 patients (mean age, 53 years; age range, 27-70 years) with a total of 54 enhancing lesions (28 benign and 26 malignant) who underwent dynamic MR imaging of the breast twice

- Once with a standard dynamic protocol (256 _ 256 matrix, 69 seconds per acquisition) and once on a separate day with a modified dynamic protocol (400 _ 512 matrix, 116 seconds per acquisition)
- Modified dynamic protocol does in fact lead to a loss of kinetic information
- Washout time course was identified with the same sensitivity for both dynamic protocols
- The modified dynamic protocol, lesion morphologic details became detectable, which significantly improved
- High-spatial-resolution images are required for detection of small lesions and for assessment of lesion morphology
- High a spatial resolution as possible while keeping the temporal resolution for each data set below 2 minutes
- Fat-suppression and subtraction techniques are not mutually exclusive
- Subtractions of fat suppressed images can improve conspicuity of enhancing structures

4) Magnetic Field Strength

- Compared with DCE-MR imaging of the breast at 1.5 T, at 3.0 T there is greater SNR
- Greater susceptibility artifacts and dielectric effects, which might compromise uniform enhancement throughout the breast

5) Use of Gadolinium-Based Contrast Agents

- Potential advantage for gadobenate dimeglumine for breast MR imaging
- Increase in sensitivity (94.7% versus 76.3%) and negative predictive value (80.0% versus 47.1%) with the gadobenate dimeglumine, particularly for lesions less than 5 mm in size

6) Choice of Pulse Sequence Type: 2D GRE or 3D GRE?

- Three dimensional imaging indicates that phase encoding, frequency encoding, and section encoding are all achieved by applying suitable gradients during image acquisition.
- 2D imaging, section encoding is achieved by means of selective excitation.
- Compared with 2D imaging, 3D imaging has the inherent advantage of stronger T1 contrast
- 3D imaging has a higher inherent signal-to-noise

ratio

- 3D imaging allows thinner sections (or partitions) to be acquired
- 3D acquisition mode, phase errors can accumulate in all three dimensions, which can cause in-plane blurring
- Difficult-to-read artifacts on subtracted images

7) Choice of Imaging Plane: Sagittal, Transverse, or Coronal?

- The sagittal plane is the most natural way to image the breast and will be intuitively familiar to breast surgeons
- The technical advantage of the sagittal plane is that a relatively small FOV will be sufficient to cover the breast, which will improve the spatial resolution
- Small FOV is used, the magnetic field is relatively homogeneous
- Active fat suppression works nicely and relatively reliably for sagittal plane protocols
- The only disadvantage of the sagittal plane is too many sections would be needed to cover both breasts
- Sagittal imaging protocols have almost always been used only for single-breast imaging
- Compared with transverse images, coronal images have the theoretical advantage that they can be acquired with a 50% reduction in acquisition time
- Many more sections are needed to cover the entire breast in coronal section
- Coronal imaging suffers more from motion artifacts, breathing motions
- Clinically the coronal plane is not helpful in delineating or excluding nipple or chest wall invasion
- The transverse plane is preferable if bilateral imaging is desired or required

References

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