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## **Ultrafast MRI in Breast Imaging**

**Suhyung Park**

Chonnam National University, Korea

Breast magnetic resonance imaging (MRI) represents the gold standard for breast cancer detection, offering unparalleled sensitivity exceeding 95% and comprehensive multi-contrast capabilities without ionizing radiation exposure. However, conventional dynamic contrast-enhanced (DCE) breast MRI protocols face significant clinical limitations, including prolonged acquisition times of 15-20 minutes, substantial patient discomfort, limited daily throughput, and high operational costs that restrict widespread accessibility.

Traditional time-reduction strategies have focused on abbreviated MRI protocols, which eliminate non-essential sequences to achieve 3-5 minute scan times while maintaining first post-contrast enhancement information. While abbreviated protocols demonstrate preserved sensitivity and improved workflow efficiency, they sacrifice crucial kinetic information, particularly washout characteristics that provide valuable diagnostic insights, resulting in reduced specificity and limited problem-solving capabilities.

Ultrafast breast MRI emerges as a superior alternative, capturing comprehensive kinetic information within the first 60-90 seconds after contrast injection using high temporal resolution of 3-10 seconds per volume. This paradigm shift from washout-based analysis to detailed wash-in characterization leverages tumor vascularity and permeability as malignancy indicators.

Technical implementation utilizes two complementary approaches: advanced acquisition techniques and sophisticated reconstruction methods. Acquisition-side innovations include view-sharing techniques (TWIST, DISCO) and compressed sensing protocols (CS-VIBE), while reconstruction advances encompass parallel imaging, compressed sensing, and deep learning algorithms. These technologies enable extreme acceleration factors of 4-16x while maintaining diagnostic image quality and spatial resolution.

Integration with artificial intelligence and radiomics facilitates automated quantitative analysis and clinical decision support, supporting personalized medicine approaches. Current limitations include spatial resolution trade-offs for some applications and requirements for advanced scanner technology and technical expertise. Future directions encompass standardization efforts, multi-parametric protocol integration, and continued AI development. Ultrafast breast MRI represents a transformative technology that addresses fundamental clinical needs while maintaining diagnostic excellence, positioning breast MRI for broader clinical adoption and improved patient outcomes in the era of precision medicine.

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