

Bringing AIR Recon DL to multi-shot diffusion

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AIR™ Recon DL, GE HealthCare's pioneering deep-learning-based reconstruction algorithm, has reshaped the paradigm in MR imaging by challenging the inherent compromise between SNR, scan time and resolution. Today, five years after its initial commercial introduction, more than 90% of GE HealthCare MR sequences are compatible with the deep-learning-based reconstruction technology. GE HealthCare

MR is committed to extending this novel technology across all sequences with the quality, resolution and speed required for different clinical applications.

In diffusion-weighted imaging, AIR Recon DL is compatible with single-shot methods. DWI has inherently low SNR, especially at higher b-values, and suffers from distortion. Multi-shot methods, such as GE HealthCare's **Multiplexed Sensitivity**

Encoding (MUSE), were initially developed to minimize distortion in EPI images by acquiring *k*-space data in multiple shots to reduce the effective echo spacing time. MUSE enables the acquisition of ultra-high spatial resolution data with sufficient SNR, opening up new opportunities for analyzing structural, connectivity and tissue microstructure, particularly in the brain and spine. However, the technique also increases scan time. A conventional MUSE acquisition would take approximately 1.5- to 2-times longer than a single-shot DWI acquisition. The scan time scales linearly with the number of shots; however, the more shots acquired, then the less distortion. So, there is an inherent trade-off between scan time and distortion with the conventional MUSE acquisition. And, even with multi-shot techniques, DWI still had lower SNR.

Now, the addition of AIR Recon DL to MUSE provides a boost in SNR by making use of the raw data to remove image noise and ringing to produce high-quality images with fewer averages, and thus shorter scan

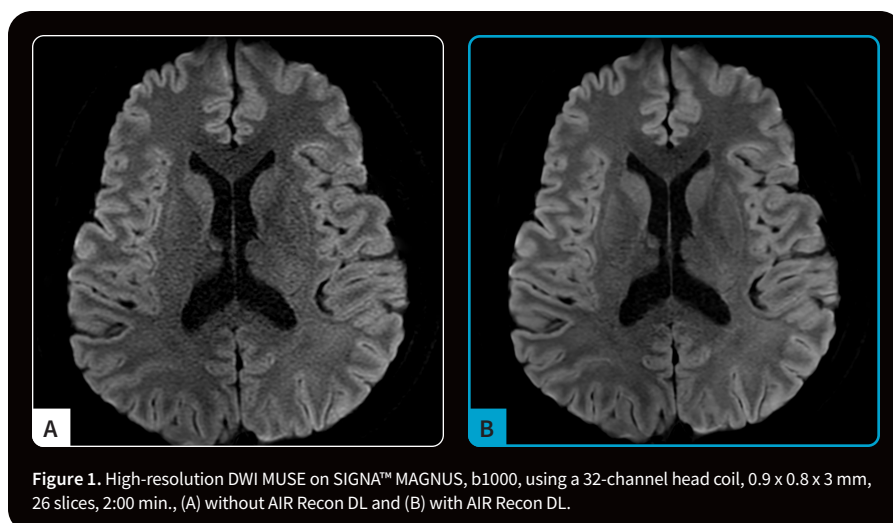


Figure 1. High-resolution DWI MUSE on SIGNA™ MAGNUS, b1000, using a 32-channel head coil, 0.9 x 0.8 x 3 mm, 26 slices, 2:00 min., (A) without AIR Recon DL and (B) with AIR Recon DL.

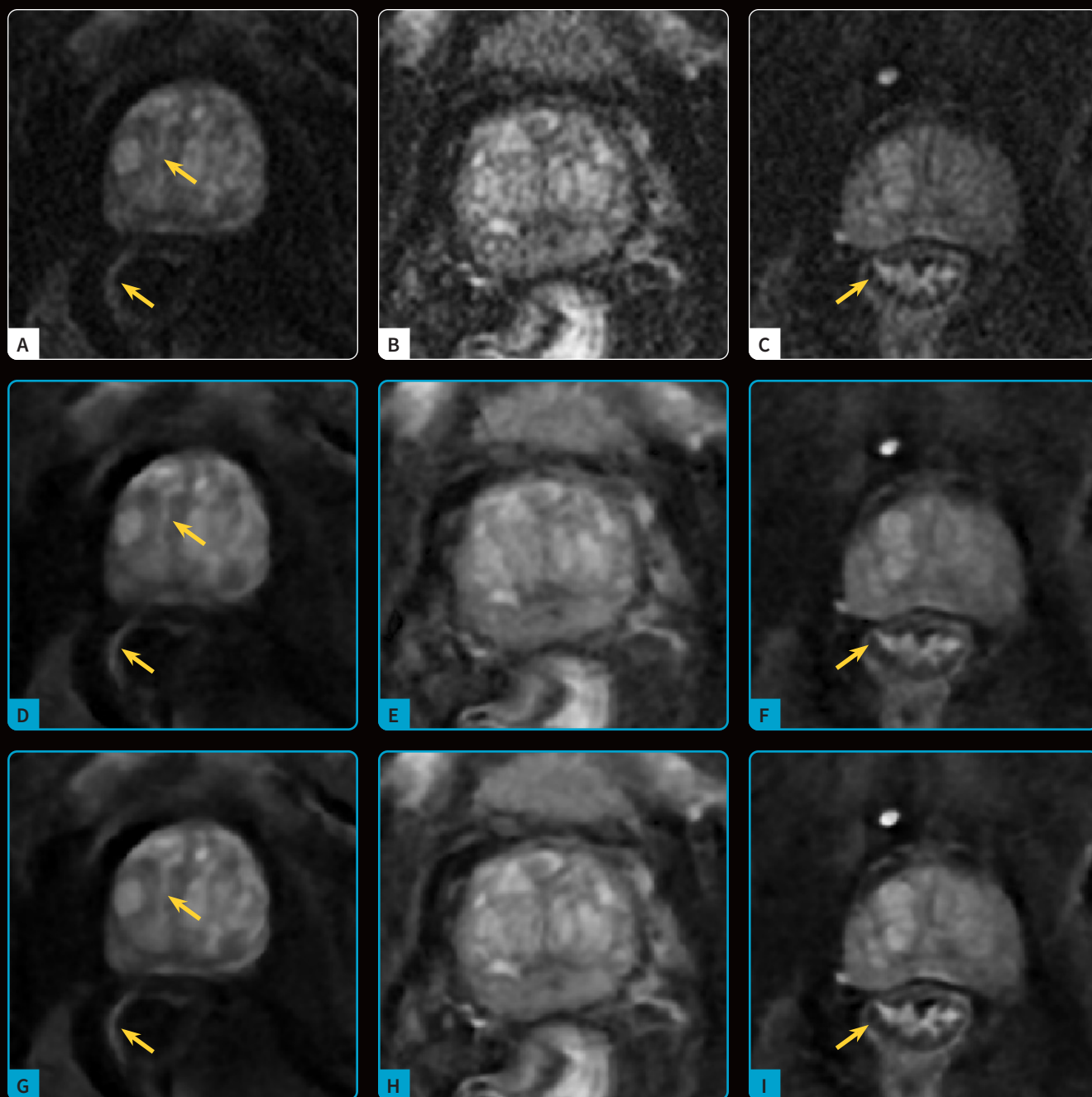


Figure 2. MUSE with AIR Recon DL images of the prostate, b1200, in three subjects with (A-C) all NEX and without AIR Recon DL (conventional MUSE), (D-F) half NEX with AIR Recon DL and (G-I) all NEX MUSE with AIR Recon DL. SNR is improved with AIR Recon DL for both all NEX and half NEX cases when compared with the images acquired without it. Yellow arrows indicate regions where AIR Recon DL increases sharpness.

times – potentially by a factor of 2 – or higher b-values. Alternatively, the inclusion of AIR Recon DL will afford an increase in the acquisition matrix sizes up to 512.

In tandem with the addition of AIR Recon DL, the latest software release also features enhancements made to the MUSE reconstruction pipeline. This algorithm was designed to reduce image reconstruction time by using a specific, calculated matrix size for inversion. These changes were made compatible with AIR Recon DL, and together, these throughput improvement

technologies deliver reduced acquisition and reconstruction times for a more efficient multi-shot diffusion imaging capability. Users can also opt to keep the acquisition time constant and utilize AIR Recon DL for MUSE to increase resolution while maintaining SNR.

The addition of AIR Recon DL to MUSE offers multiple clinical benefits. More immediately, this opens the use of higher b-values for diffusion imaging, especially on 1.5T MR systems. The robustness to distortion will give the user more freedom to use diffusion imaging in regions otherwise prone to distortion artifacts.

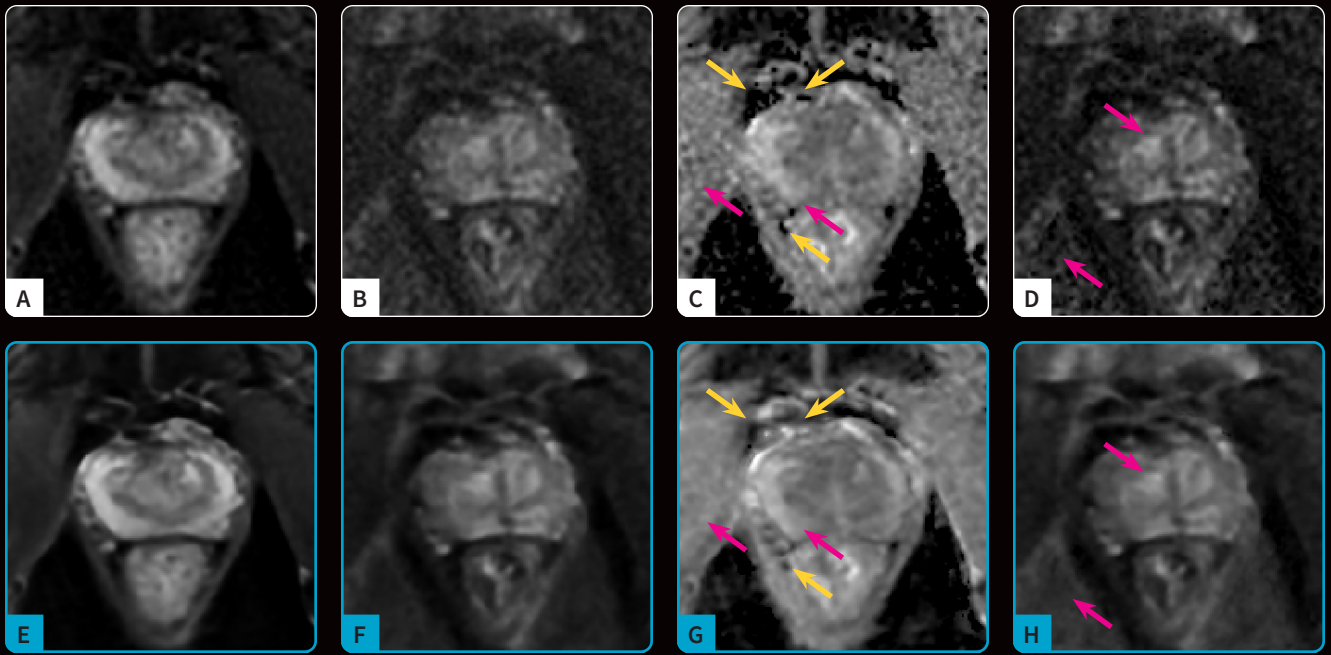


Figure 3. Sample case of (C, G) ADC maps and (D, H) synthetic b1400 generated from pixel-by-pixel fitting using (A, E) b50 and (B, F) b1200 images. (A-D) Without AIR Recon DL and (E-H) with AIR Recon DL. Yellow arrows indicate the wormhole artifacts that are reduced by acquiring MUSE with AIR Recon DL. Pink arrows indicate regions with more homogeneous appearance after reconstructing MUSE with AIR Recon DL.

For example, in prostate cancers within the peripheral zone, the presence of gas or a hip prosthesis could heavily distort that region of interest. AIR Recon DL for MUSE reduces distortion and enables the user to acquire multiple shots – potentially up to four shots – and obtain quality, diagnostic scans in a reasonable scan time. The pelvis and breast are also two anatomies where diffusion is historically more susceptible to distortion. Diffusion is not incorporated into BI-RADS, however, there is growing interest to integrate DWI, particularly for downgrading suspicious lesions to reduce false positives and avoid unnecessary biopsies. The pancreas is another anatomy that is very susceptible to distortion artifacts and could also benefit from higher b-values to more accurately characterize pancreatic lesions. Currently, b-values of 2000 or higher are being explored in pancreatic imaging and it is expected that this next-generation MUSE may help reduce distortion from the anatomy and high b-value acquisition.

In neuro imaging, diffusion is often utilized to examine white matter tracts and connectivity between different brain regions in neurodegenerative disease, such as Alzheimer’s disease, and traumatic brain injuries. Diffusion tensor imaging (DTI) is an adaptation of DWI that allows for the interrogation of the brain microstructure and white matter fibers to aid in diagnosing and monitoring various neurological and oncological conditions such as brain tumors, epilepsy, multiple sclerosis, stroke and more. The increase in SNR provided by AIR Recon DL in the next-generation MUSE application will allow for high-resolution imaging and advanced diffusion modeling in the brain.

As more institutions explore tissue microstructure and function in the body and the brain for oncology and neuroscience applications, AIR Recon DL for MUSE diffusion will provide the capabilities for less distortion and higher resolution multi-shot diffusion imaging. **S**