MR / Case Study

Vantage Galan 3T / Supreme Edition opens up new possibilities in diagnostic imaging

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Canon Medical Systems' new 3T MRI, "Vantage Galan 3T / Supreme Edition," features improved magnetic field uniformity thanks to the incorporation of the in-house magnet, and installed new V10.0 software. In this presentation, we will focus on the benefits of the in-house magnet, the expanded application range of resolution-enhancing image reconstruction technology "Precise IQ Engine (PIQE)" in the new software, and the features of "Zoom DWI," which enables high-resolution diffusion-weighted imaging (DWI) with a narrowed field of view (FOV).

Improved magnetic field uniformity with in-house magnets

The in-house 3T static-magnetic-field magnet has improved magnetic field uniformity, with a typical 30 cm DSV (diameter of spherical volume) improving from 0.2 ppm to 0.05 ppm, and a typical 40 cm DSV improving from 1.2 ppm to 0.49 ppm.

Additionally, the maximum FOV has been expanded from the previous 50 × 50 × 45 cm to 55 × 55 × 50 cm. This has enabled some users to image within the same range using just 3 stations, previously doing so with 4 stations. Furthermore, the gradient coils and platform have been completely redesigned. By changing the arrangement of the components supporting the gradient coils from a parallel pattern to a cross pattern, vibration of the patient table has been reduced. As a result, even under the same imaging conditions and imaging time as previous models, Vantage Galan 3T / Supreme Edition produces clearer images.

Expansion of PIQE Application Range

1. PIQE Principle

PIQE is a technology that enhances resolution of the original images. Using deep learning, training is performed in two stages: denoise and resolution enhancement. In the resolution enhancement stage, by optimizing the blurring and ringing artifacts that were issues in the zero-fill interpolation (ZIP) processing, it enables the output of high SNR, high-resolution images.

Figure 1 shows a case of Rattke's cyst of the pituitary gland. Compared with the original image (a), the image (b) processed with PIQE shows a significant improvement in image quality, with the structure of the pituitary gland, the pituitary stalk, and the edges of the cyst becoming clearer by increasing the matrix from 256 × 256 to 768 × 768.

2. Expansion of the scope of application in 2D imaging

In software version 10.0, the scope of application of PIQE in 2D imaging has been expanded. Previously, it was only compatible with FSE, but now it is compatible with almost all 2D sequences, including fast advanced spin echo (FASE) and echo planar imaging (EPI).

Generally, EPI is used for diffusion-weighted imaging (DWI), but EPI is prone to image distortion in the phase encoding (PE) direction. A technique to correct this distortion is called "Reverse encoding Distortion Correction DWI (RDC DWI)." RDC DWI is a technique that estimates shift maps from forward and reverse b0 images, and then uses the b0 shift map as an initial value to estimate shift maps from each forward and reverse MPG image, thereby correcting distortion caused by b0 inhomogeneity and eddy current generated by the MPG pulse. It is now possible to apply PIQE to RDC DWI. Figure 2 shows a case of prostate cancer. Compared with conventional DWI (Figure 2a), RDC DWI with PIQE (Figure 2b) has less distortion and improved spatial resolution, resulting in images that are easier to diagnose.

Next, we present an example of applying PIQE to FASE. Figure 3 shows a case of multiple liver metastases after surgery for transverse colon cancer. In respiratory-gated, FSE, T2-weighted images (T2WI), motion artifacts occur when respiratory conditions are poor (Figure 3a). By applying PIQE, high-resolution imaging is possible while maintaining the time-saving advantage of FASE, resulting in clear images without motion artifacts (Figure 3b).

Zoom DWI enables small FOV imaging in DWI

Zoom DWI is a technique that rotates the excitation pulse by a specific angle relative to the refocusing pulse to perform imaging without aliasing artifacts in the PE direction and reduces EPI-induced distortion by narrowing the FOV. This enables the acquisition of high-resolution DWI with a narrowed FOV.

Figure 4 shows a case of cancer in the pancreatic head. Compared with conventional DWI (Figure 4a), Zoom DWI with PIQE (Figure 4b) improves spatial resolution from 1 mm to 0.3 mm, enabling clear depiction of the structure of the pancreas and hypertrophy of the gallbladder wall.

Figure 5 shows a case of stage I endometrial cancer. Compared with conventional DWI, the spatial resolution of Zoom DWI with PIQE has improved from 0.5 mm to 0.3 mm, distortion has been also significantly corrected, and the muscular layer is clearly depicted (Figures 5a and 5b left). In addition, the image quality of the ADC map has improved, making it easier to evaluate invasion into the uterine muscular layer (Figures 5a and 5b right).

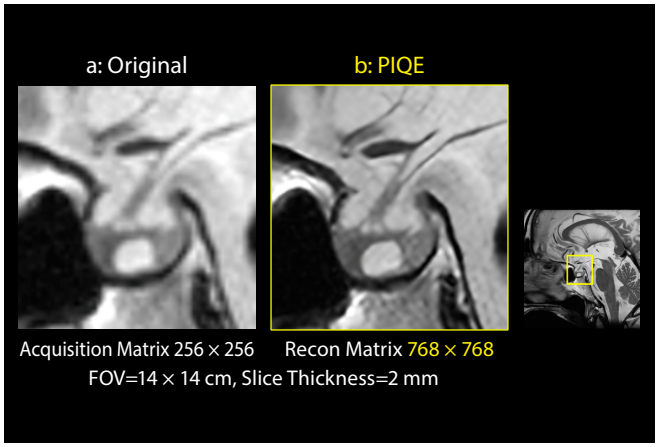

Figure 1 Improvement in image quality of fast spin echo (FSE) 2D images using PIQE (Rattke's cyst)

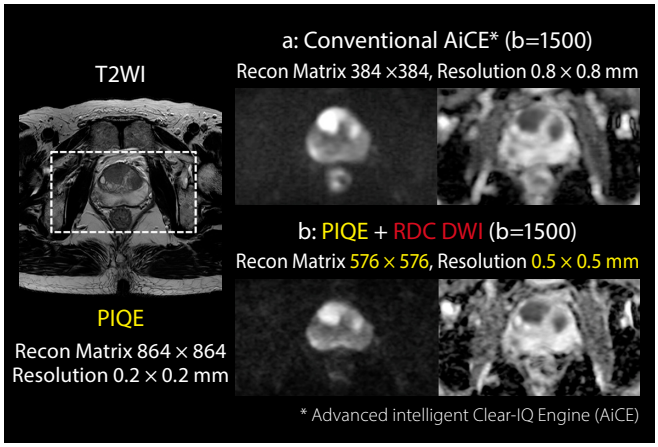

Figure 2 Expanded application of PIQE: Improved image quality of RDC DWI (prostate cancer)

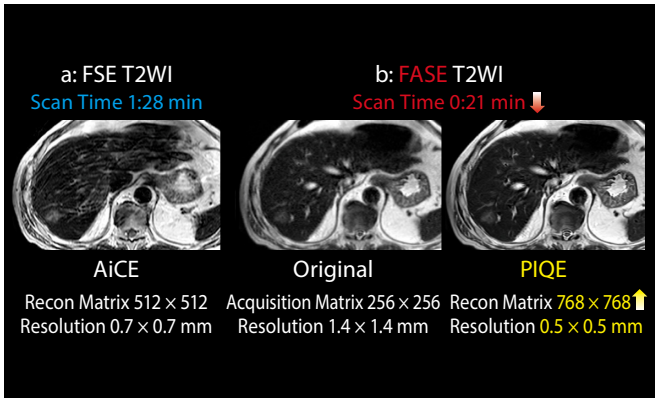

Figure 3 Expanded application of PIQE: Improved image quality with FASE (Multiple liver metastases after transverse colon cancer surgery)

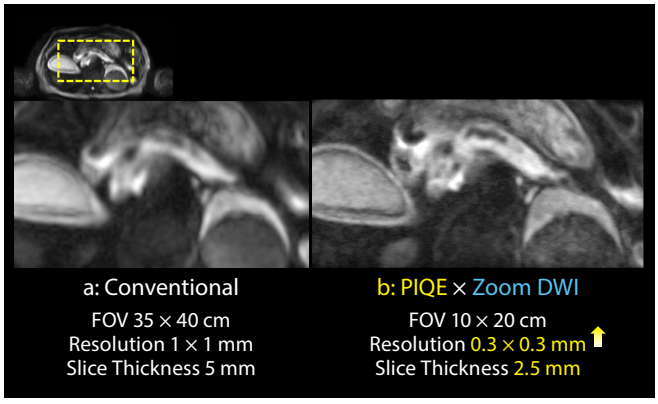

Figure 4 Example of PIQE × Zoom DWI application (pancreatic head cancer)

Various imaging techniques in chest MRI

1. Usefulness of FASE and Zoom DWI with PIQE

Figure 6 shows STIR, T2WI, and T1-weighted images (T1WI) using the Black-Blood method of FASE in a case of thymic cancer.

Compared with the original image (Figure 6a), the image with PIQE (Figure 6b) clearly shows the margins and internal characteristics of the tumor. In mediastinal tumors, assessing infiltration into adjacent structures such as the pericardium and lungs is crucial; therefore, the high-resolution imaging provided by PIQE is particularly valuable. Additionally, in Figure 7 that shows the same case as Figure 6, Zoom DWI with PIQE (Figure 7b) demonstrates improved distortion correction and clearer images.

2. Usefulness of UTE CG Recon

"Conjugate Gradient method-based Reconstruction (CG Recon)" is a technique in radial sampling UTE for time saving imaging, while maintaining SNR and resolution of the images. CG Recon overcomes the challenge in the estimation of the missing data in radial sampling, and has been preferred over Grid-Recon in some cases in the context of imaging performance.

Figure 8 shows UTE images of a case of interstitial pneumonia, with ground-glass opacities predominantly in the lower lobes of both lungs. In the image reconstructed with CG Recon (Figure 8c), interstitial pneumonia is depicted more clearly despite a 50% reduction in the number of spokes and imaging time.

Summary

Vantage Galan 3T / Supreme Edition features improved magnetic field uniformity thanks to in-house magnets, contributing to improved base image quality and expanded FOV. Additionally, the application sequence of PIQE has been expanded, and numerous useful technologies such as Zoom DWI are incorporated. These advancements are expected to enable reduced patient burden through shorter MRI examination times, improved examination efficiency, and smoother diagnostic assessment through advanced technologies in Vantage Galan 3T / Supreme Edition.

Acknowledgement

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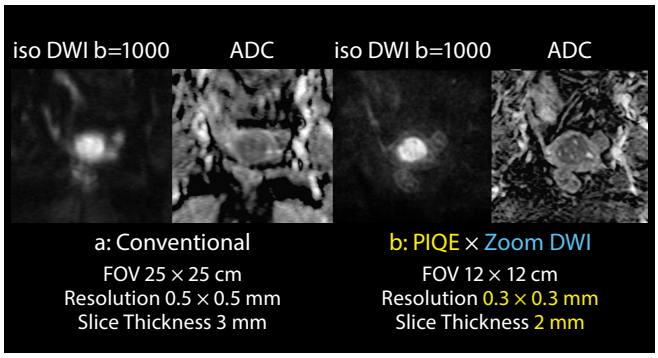

Figure 5 Example of PIQE × Zoom DWI application (stage I endometrial cancer)

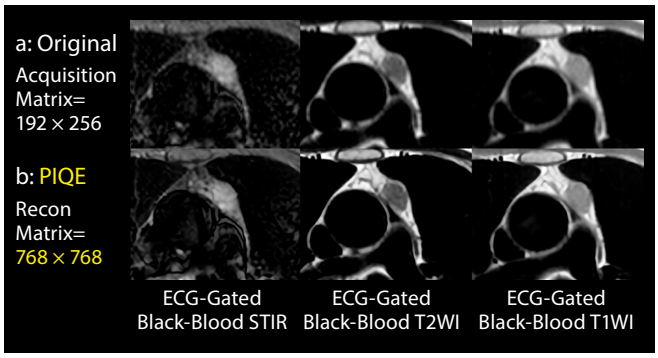

Figure 6 Depiction of thymic cancer using PIQE × FASE

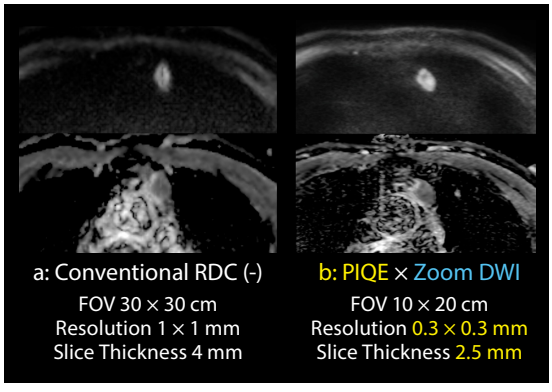

Figure 7 Depiction of thymic cancer using PIQE × Zoom DWI (same case as Figure 6)

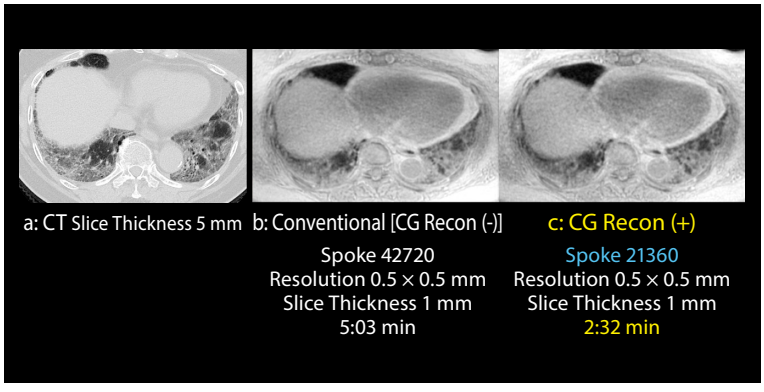

Figure 8 Depiction of interstitial pneumonia using UTE CG Recon

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