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An upgrade that redefines MR excellence

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In February 2024, our institution upgraded its SIGNA™ HDxt 1.5T system to the 70 cm SIGNA™ Artist Evo 1.5T and MR 30 for SIGNA™ software featuring AIR™ Recon DL and PROPELLER for motion-insensitive and distortion-free imaging. The SIGNA Artist Evo widens the bore on legacy 1.5T MR systems to 70 cm, while improving system performance to be on par with a state-of-the-art premium MR system. In the first eight months, we performed approximately 4,000 examinations on the MR system.

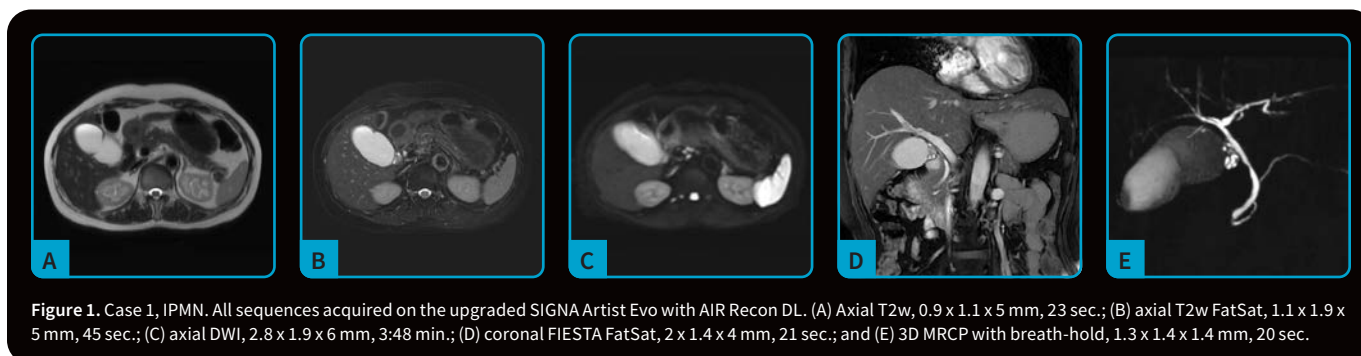
With this upgrade, we can now use AIR Recon DL for 3D imaging. Even with breath-hold 3D magnetic resonance cholangiopancreatography (MRCP), AIR Recon DL 3D ensures sufficient SNR and provides sharper MRCP images due to its ability to increase sharpness. Additionally, the new system enables the use of FOCUS for 3D MRCP, allowing high-resolution imaging within a breath-hold duration. The reduced acquisition time for 3D MRCP

has significantly shortened MR examination times, particularly in pancreatic studies. In fact, we've had patients who have undergone follow-up examinations remark that the examination time was shorter compared to previous exams.

The upgrade also enables high-resolution imaging with small FOV and thin slices. This has a significant impact on ankle joint diagnoses. Previously, achieving these imaging conditions required extending the scan time. With AIR Recon DL, it's now possible to reduce scan time compared to conventional methods, even with thin slices and high resolution.

Case 1: Pancreas

While conventional systems don't experience significant challenges in the interpretation of pancreatic and biliary tract examinations



SIGNA Artist Evo 1.5T					
Case 1: IPMN follow up	T2w SSFSE	T2w FatSat	DWI	FIESTA FatSat	3D MRCP breath-hold
TR (ms):	100	88.1	99	1.7	700
TE (ms):	566	4500	9026	3.7	1726
FOV (cm):	36	36	36	34	36
Slice thickness (mm):	5	5	6	4	1.4
Frequency:	400	320	128	172	288
Phase:	320	192	192	240	256
NEX:	0.6	1	6	1	0.8
Scan time (min.):	0:23	0:45	3:48	0:21	0:20
Options/other:	Acc, TRF, AIR Recon DL	Acc, Z1024, AIR Recon DL	Acc, b-100, AIR Recon DL	Acc, AIR Recon DL	Acc, FOCUS, AIR Recon DL

for most patients, we've encountered cases where the examination was hindered by motion artifacts in patients unable to hold their breath. Improving the success rate of these examinations is crucial. By performing short-duration, motion-robust imaging with our upgrade to SIGNA Artist Evo, we can reduce patient burden and decrease the number of examinations and diagnoses that are difficult to obtain.

Patient history

The patient was referred for a follow up on intraductal papillary mucinous neoplasms (IPMNs)—tumors that grow in pancreatic ducts that transport fluids to the bowel—that can progress to invasive cancer if left untreated.

Results

We use a FOCUS diffusion sequence and AIR Recon DL applied to 3D sequences to achieve high-quality, motion-insensitive imaging of the upper abdomen in a significantly shorter acquisition time. Moreover, for patients capable of breath-holding, AIR Recon DL enables substantial image quality improvements in conventional fast spin-echo sequences, which are more susceptible to motion artifacts.

Discussion

The significant improvement in single-shot FSE (SSFSE) image quality during upper abdominal examinations has provided a substantial diagnostic benefit. Given the inevitable presence of patients unable to hold their breath, a motion-robust SSFSE sequence enables us to conduct stable examinations, even in patients with unstable respiratory conditions.

We believe the most significant advancement over previous systems is the remarkable clarity achieved in SSFSE images through AIR Recon DL. Despite enhancing spatial resolution, the acquisition time remains virtually unchanged. We are experiencing the transformation from noisy images to now having much sharper images with less noise as a result of AIR Recon DL.

The T1-weighted image quality has also improved, particularly in the out-of-phase images, where margins are now more distinct.

MRCP is a highly accurate, non-invasive diagnostic test used to assess the hepatobiliary and pancreatic systems. A challenge is that patient compliance is required for respiratory-triggered and breath-hold sequences to achieve diagnostic-quality images. In these studies, conventional systems rely on respiratory gating, which has the disadvantage of image quality and scan time being dependent on the patient's respiratory status. To address this, 3D MRCP with breath-hold was attempted on our previous system, but SNR and spatial resolution were insufficient, resulting in suboptimal image quality, such as interrupted pancreatic ducts that were not of diagnostic quality.

AIR Recon DL has also significantly reduced noise across all contrast levels. By eliminating noise, the algorithm improves image quality, facilitating more confident diagnoses.

When evaluating the pancreas, confirming normal variations and anomalies such as the confluence of the bile duct and pancreatic duct, the course of the cystic duct, and the presence or absence of an accessory hepatic duct is crucial. While 3D MRCP is a vital imaging technique for this diagnosis, visualization of the bile duct and pancreatic duct can be challenging in certain patients due to various factors.

With the recent upgrade, the image quality of SSFSE has been significantly improved. As a result, even in cases where the bile duct and pancreatic duct are difficult to visualize on 3D MRCP, high-resolution SSFSE and FIESTA images can be used as reference to facilitate the assessment of their morphology. We have observed that this upgrade enables clearer delineation and easier detection of small lesions, such as microcysts in the pancreatobiliary system.

Case 2: Orthopedic

In orthopedic imaging, MR is indispensable for detecting signal alterations in soft tissues, such as ligaments and muscles, as well as bony pathologies. The new SIGNA Artist Evo has helped our institution enhance our diagnosis of traumatic injuries by providing superior image quality.

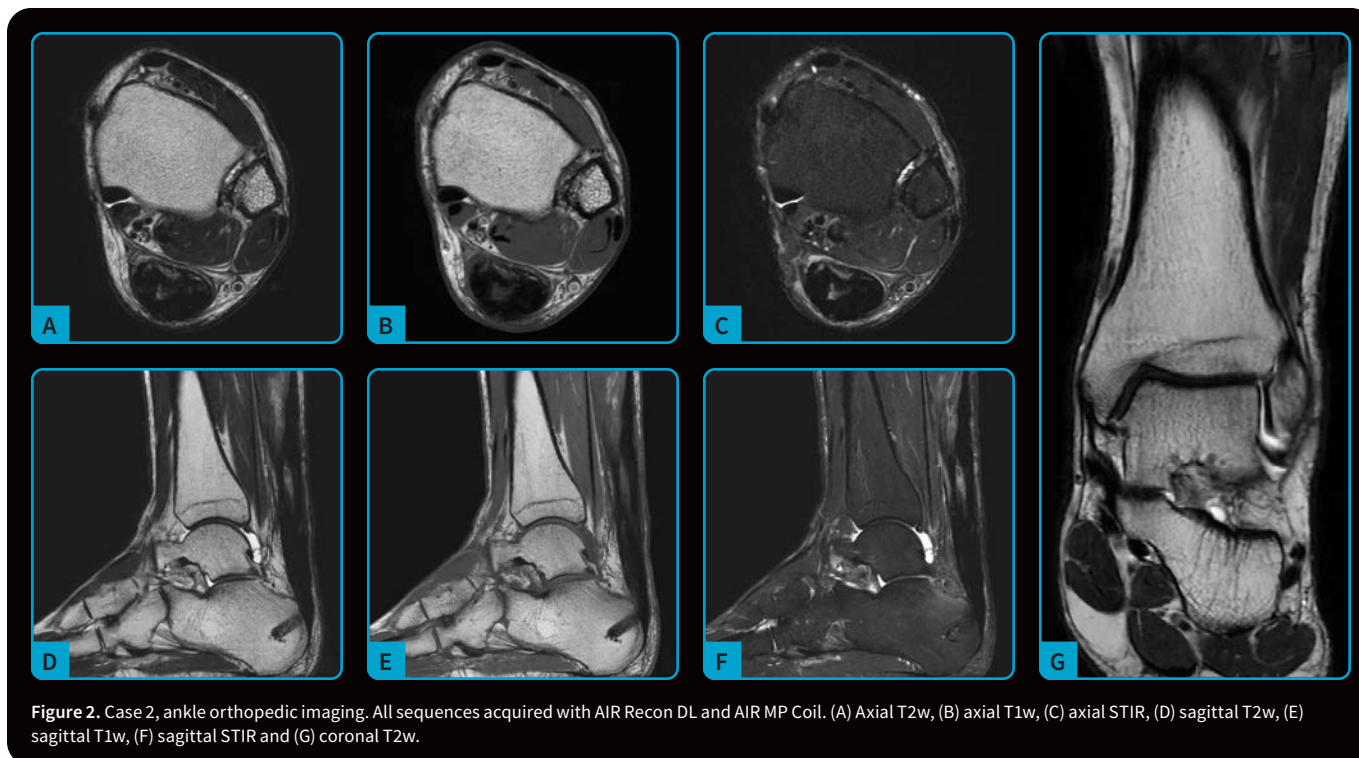


Figure 2. Case 2, ankle orthopedic imaging. All sequences acquired with AIR Recon DL and AIR MP Coil. (A) Axial T2w, (B) axial T1w, (C) axial STIR, (D) sagittal T2w, (E) sagittal T1w, (F) sagittal STIR and (G) coronal T2w.

Prior to upgrading to SIGNA Artist Evo, we used GE HealthCare’s IDEAL sequence for T2 fat suppression in ankle imaging to achieve robust fat suppression. Since this imaging method is based on the three-point Dixon technique to separate water and fat signals in the body, it requires a reduction in echo train length (ETL) and a wide receiver bandwidth setting to reduce blurring. These imaging conditions, along with the extended acquisition time, previously made it difficult to ensure a sufficient SNR.

Patient history

The patient was referred for MR assessment of post-operative outcomes following Achilles tendon rupture repair.

Results

AIR Recon DL was used to capture images of the ankle joint with exceptional clarity. To obtain a robust fat suppression effect, we replaced the IDEAL sequence with STIR.

Case 2: ankle orthopedic	T2w	T2w	T2w FatSat
SIGNA HDxt:	288 x 192 Th 2.5 mm	288 x 224 Th 2.5 mm	288 x 192 Th 2.5 mm
	2:43 min.	3:20 min.	5:32 min.
	0.4 x 0.6 x 2 mm	0.4 x 0.6 x 2 mm	0.4 x 0.7 x 2 mm
SIGNA Artist Evo:	1:56 min.	3:01 min.	3:35 min.
Time (after upgrade):	-47 sec.	-19 sec.	-1:57 min.
Voxel size (after upgrade):	-46%	-45%	-52%

SIGNA Artist Evo							
Case 2: ankle orthopedic	Axial T2w	Axial T1w	Axial STIR	Coronal T2w	Sagittal T1w	Sagittal T2w	Sagittal STIR
TR (ms):	86	8.8	63.1	89.2	10.2	87	61.3
TE (ms):	4112	473	6067	4564	686	3918	5108
FOV (cm):	14	14	14	17	17	17	17
Slice thickness (mm):	3	3	3	2.5	2	2	2
Frequency:	416	300	384	512	400	400	416
Phase:	288	256	300	288	300	288	256
NEX:	1.5	1	1	2	1	1.5	2
Scan time (min.):	2:12	1:50	2:38	3:12	1:56	3:01	3:35
Options/other:	Acc, AIR Recon DL	Acc, Z1024, AIR Recon DL	Acc, Z1024, AIR Recon DL	Acc, AIR Recon DL	Acc, Z1024, AIR Recon DL	Acc, AIR Recon DL	Acc, Z1024, AIR Recon DL

Discussion

In our previous system, IDEAL helped ensure sufficient SNR for high-resolution and thin-slice imaging. However, with the availability of AIR Recon DL, sufficient SNR can now be obtained with STIR, resulting in images with good contrast and reduced blurring, along with a robust fat suppression effect.

Additionally, the use of AIR Recon DL enables high bandwidth scanning, which can help reduce metal artifacts caused by postoperative MR-Conditional implants in the ankle. With conventional systems, it is not possible to ensure sufficient SNR under similar conditions. Therefore, we have to compromise and either reduce scan time or spatial resolution. However, with the availability of AIR Recon DL, we can now flexibly set imaging parameters to improve image quality while tailoring imaging parameters to the patient.

Given the low signal intensity of ligaments in MR imaging, it is imperative to obtain images with sufficient SNR. Furthermore, the ankle joint's complex ligamentous structures demand high-resolution imaging with thin slices for precise delineation.

The upgrade to SIGNA Artist Evo has enabled high-resolution imaging with small FOV and thin slices, significantly impacting ankle joint diagnoses. Previously, achieving these imaging conditions required extending the scan time. However, with the use of AIR Recon DL, it is now possible to reduce scan time compared to conventional methods, and obtain thin slices with high resolution.

Case 3: Female pelvis

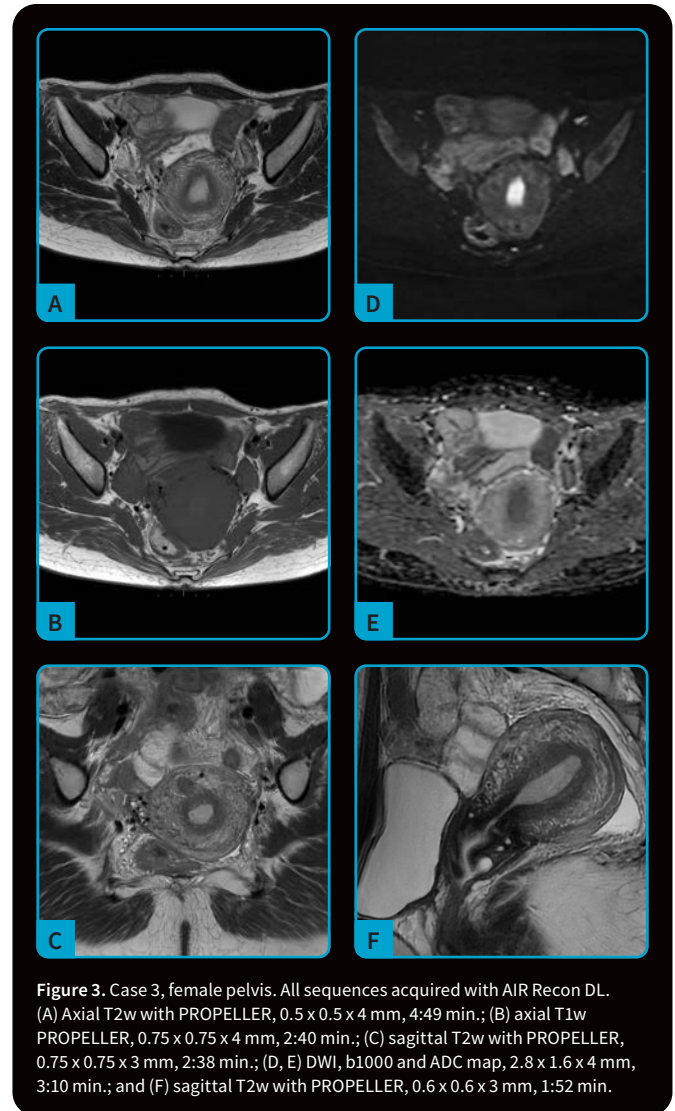
Kitasato Institute Hospital conducts a large number of prostate and female pelvis examinations each year. In these pelvis exams, controlling motion artifacts caused by respiration and gastrointestinal peristalsis is crucial.

Before the upgrade to SIGNA Artist Evo with PROPELLER, we controlled respiration by tightly fixing the lower abdomen during positioning. However, this workaround increased the burden on the patient due to the strong compression of the lower abdomen. Another method we used to control respiration was respiratory gating during the scan. However, this approach can make scheduling difficult, as scan time depends on respiratory rate.

To suppress gastrointestinal peristalsis, we also administered an antispasmodic drug to reduce involuntary muscle contractions in the digestive tract. While this doesn't pose significant risks, administering medication increases the invasiveness of the procedure.

Patient history

The female patient was referred for MR evaluation of the endometrium, including assessing a polyp and following up on a previous fibroid diagnosis.



Results

PROPELLER MB is highly effective for pelvis MR examinations. We used it to confirm the presence of myoma uteri (uterine fibroids) and nabothian cysts, which are small, benign, mucous-filled bumps that form when skin cells trap mucus inside the endocervical glands in the cervix.

PROPELLER MB is GE HealthCare's latest PROPELLER enhancement. It's a multi-shot approach that preserves tissue contrast regardless of weighting while also reducing motion artifacts. It corrects body motion, allowing us to obtain pelvis images without respiratory synchronization. Additionally, by using PROPELLER MB it is possible to suppress gastrointestinal peristalsis without using an antispasmodic drug, thereby reducing any associated risks.

We also use AIR Recon DL to reduce scan time, which also helps decrease the risk of patient motion.

SIGNA Artist Evo					
Case 3: female pelvis	Axial T2w PROPELLER	Axial T1w PROPELLER	DWI	Sagittal T2w PROPELLER	Sagittal T2w PROPELLER
TR (ms):	3202	486	8805	7869	3820
TE (ms):	87	14	111	85.9	88.5
FOV (cm):	24	24	36	24	24
Slice thickness (mm):	4	4	4	3	3
Frequency:	512	320	128	320	384
Phase:	512	320	224	320	384
NEX:	2.06	2	5	1.56	2.06
Scan time (min.):	4:49	2:40	3:19	2:38	1:52
Options/other:	Acc, AIR Recon DL	Acc, AIR Recon DL	Acc, b-100, AIR Recon DL	Acc, AIR Recon DL	Acc, AIR Recon DL

Discussion

The biggest advantage over the previous SIGNA HDxt 1.5T system is the ability to use PROPELLER with AIR Recon DL. With PROPELLER and PROPELLER MB, the contrast of uterine structures in T2-weighted images is significantly improved compared to previous images. In the case of Cartesian trajectory imaging, uterine structures such as the myometrium, endometrium and junctional zone may sometimes appear blurred due to the effects of peristalsis. With PROPELLER, these uterine structures are now clearly visible and the image quality of DWI has improved.

The motion correction effect of PROPELLER MB produces images that are not affected by respiration, without the need to administer drugs that suppress gastrointestinal peristalsis. We can now consistently capture motion-free pelvis images without the need for strong compression of the lower abdomen during positioning and without drug administration. **S**