Seiji Shiotani, MD, PhD
Seirei Fuji Hospital in Fuji City, Shizuoka, Japan

Masayoshi Sugimura
Seirei Fuji Hospital in Fuji City, Shizuoka, Japan

SIGNA Explorer Lift revives our MR

The clinical usefulness and economic advantage of SIGNA™ Explorer Lift

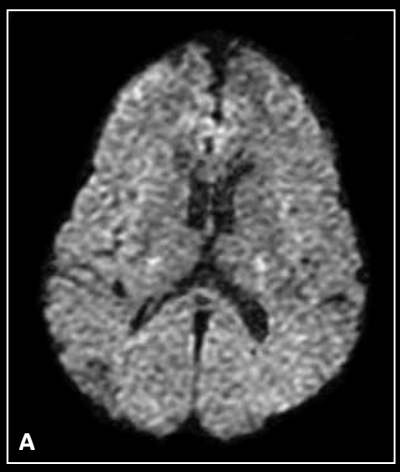
By Seiji Shiotani, MD, PhD, Chief Radiologist, Department of Radiology, and Masayoshi Sugimura, Chief Radiation Technologist, Keiaikai General Incorporated Foundation, Seirei Fuji Hospital, Fuji City, Shizuoka, Japan

In 2025, it is predicted that one in three Japanese citizens will be over 65 years old and one in five will be over 75 years old. This age shift will drastically change the medical environment for our 151-bed hospital. While small in size, Seirei Fuji Hospital contributes significantly to regional medical care by enhancing advanced capabilities and strengthening cooperation with other regional medical facilities.

Although our hospital is advanced in many areas across the prefecture, our 2001 MR system was somewhat obsolete. Due to the system's age, we often had breathing artifacts around the chest area due to long scan times and the lack of motion correction techniques, which hampered our diagnosis. We also could not perform upper abdominal scans (Liver, MRCP) in a wide range, so we had to scan the abdomen separately in three stations: upper, middle and lower. This made it very difficult to interpret the images for a diagnosis because each series was reconstructed separately, and this was most pronounced when the radiologist was reading remotely. Particularly problematic were patients with unstable breathing as the breath-hold would appear completely different in each series, making it very difficult to ascertain the continuity of each station.

The system had additional shortcomings as well. MR brain and spine exams did not have sufficient image quality for our referring physicians (Figures 1 and 2). Finally, our radiology staff would attend academic meetings and sessions to learn the latest techniques, but could not utilize that learning back at the hospital due to our system's outdated technology.

We were convinced that the above issues could be solved by investing in a new MR system. On the other hand, we were concerned about the cost. Fortunately, we learned it was possible to upgrade[1] our MR to the latest model, SIGNA Explorer, by replacing all components other than the magnet with SIGNA Explorer Lift.



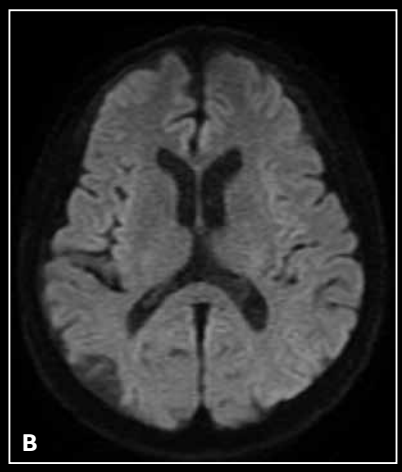


Figure 1. A 70-year-old suffering from transient ischemic attack. Comparison of brain DWI images (A) before and (B) after SIGNA Explorer Lift. In Figure 1B, the SNR is significantly improved and brain structures are more clearly visualized than Figure 1A.

Figure 2. An 80-year-old with back pain. Comparing the lumber spine T2w images (A) before SIGNA Explorer Lift and (B) after SIGNA Explorer Lift, it is clear the vertebral body structures are distinctly visualized. The upgrade contributed to image quality improvement and motion artifact reduction as a result of shortened scan times and higher SNR through the Posterior Array Coil improvement.

The main objective of upgrading our MR was to improve image quality. We visited another site that had recently upgraded and compared images to another recently installed (new) SIGNA Explorer and found them to be comparable. We therefore chose the SIGNA Explorer Lift with confidence. The cost was also lower since the magnet did not need to be replaced, making the downtime for the upgrade significantly less.

After the upgrade

SIGNA Explorer Lift significantly improved the performance and image quality of our MR exams and shortened exam times. We could now provide a patient-friendly MR scan and immediately accept emergency patients. The scan time reduction enabled an increase in the number of patients in a day, providing an economic benefit to our hospital.

Before the upgrade, we performed an average of 240 exams/month operating five days each week; now we increased that number to approximately 300 exams/month in the same operating time. A key reason for the increase in the number of examinations is the system's image quality and clinical capability, further increasing referrals from local physicians.

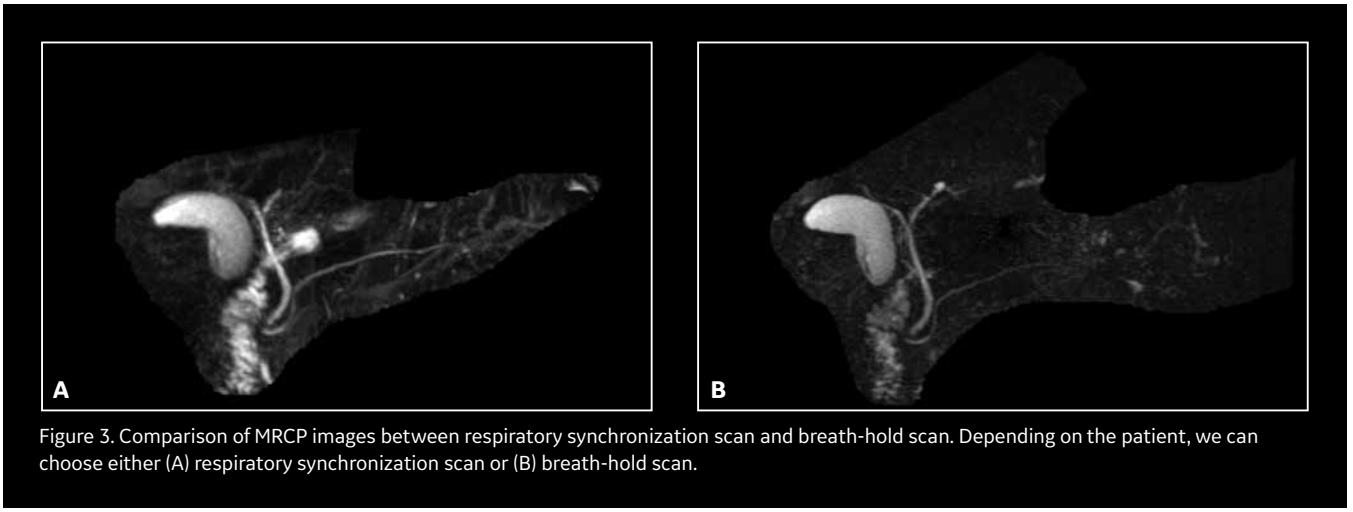


Figure 3. Comparison of MRCP images between respiratory synchronization scan and breath-hold scan. Depending on the patient, we can choose either (A) respiratory synchronization scan or (B) breath-hold scan.

In our case, we expect to realize a return on our investment within three years, including human resources and maintenance expenses. With the broader range of clinical capabilities, our staff is now motivated to improve their knowledge and skills.

Advanced clinical capabilities

With the prior system, we scanned MRCP using 2D Fast Spin Echo (FSE). The newly upgraded SIGNA Explorer allows us to perform 3D Fast Recovery FSE (frFSE) combined with ASSET parallel imaging.

We reviewed 40 MRCP cases: 20 gallstone cholecystitis, 11 pancreatic neoplastic lesion and 9 other cases. The 18 male and 22 female patients were an average age of 65.8 years (maximum 85 and minimum 36 years). All cases were scanned with respiratory synchronization, although MRCP can be acquired with diaphragm synchronization. The use of Auto Navigator was reported to improve the image quality.

Using the 3D frFSE acquisition, it is possible to acquire higher signal with shorter TRs due to Fast Recovery. By using ASSET, it is possible to reduce the echo train of FSE, which helps to reduce blurring due to T2 attenuation. In addition, with 3D imaging we can view the data in various planes and angles. Furthermore, both respiratory synchronization and diaphragm synchronization are available.

Our evaluation reported 27 cases as "very good," 10 cases were "rescan not necessary," and only three cases required rescans. For the cases rescanned, 3D frFSE was again used under breath-hold but with increased slice thickness. Since 3D frFSE collects in-phase data with single shot, it is necessary to decrease the number of slices or shorten TR to achieve scan time reduction. Increasing slice thickness will lower the resolution but improve SNR. Shortening TR causes lower SNR even if fast recovery is used. Considering these points, our hospital optimizes the protocols based on slice thickness, the number of slices and TR to keep breath-hold times less than 25 seconds (Figure 3).

Figure 4. Image comparison of T1w (A) before and (B, C) after upgrade. (A) Prior to upgrade, breath-hold T1w 2D FSPGR FatSat. After the upgrade, we are using a (B) breath-hold T1w LAVA Flex FatSat. (Water) and (C) breath-hold T1w LAVA Flex (in-phase). We can make the slices thinner using LAVA Flex, so the vessels in the liver can be observed without partial volume effect.

LAVA Flex

With the upgrade, we can now use LAVA Flex for T1-weighted (T1w) imaging. LAVA Flex, a 3D acquisition, uses a 2-point Dixon method. After collecting data in-phase and out-of-phase, the sequence estimates whether the signals are water dominant or fat dominant with reference to certain pixel data. It then calculates magnetic field inhomogeneity of all pixels from neighboring pixels. By identifying the signal intensity of each pixel from the results, it is possible to calculate a uniform water image (fat separation image) and fat image (water separation image).

There are several advantages to using LAVA Flex, including thinner slices with 3D imaging, robust fat separation and acquiring both with/without fat separation images in one acquisition. We can scan the same area on the patient with gapless 3.2 mm slice thickness in one breath-hold using LAVA Flex and obtain both with/without fat separation images (Figure 4).

Most importantly, these sequences help us address the problem of a patient who cannot hold their breath to acquire the imaging data. In these cases with the prior scanner, we often sacrificed image resolution to shorten breath-hold time by optimizing slice thickness or using phase-encoding to shorten breath-hold time. However, SIGNA Explorer is compatible with Auto Navigator and includes Auto Navigator-gating, which enables the acquisition of 3D T1-weighted images with free breathing. By performing LAVA Flex in conjunction with Auto Navigator-gating, it is possible to scan 3D T1-weighted images both with and without fat separation on patients who cannot hold their breath (Figure 5).

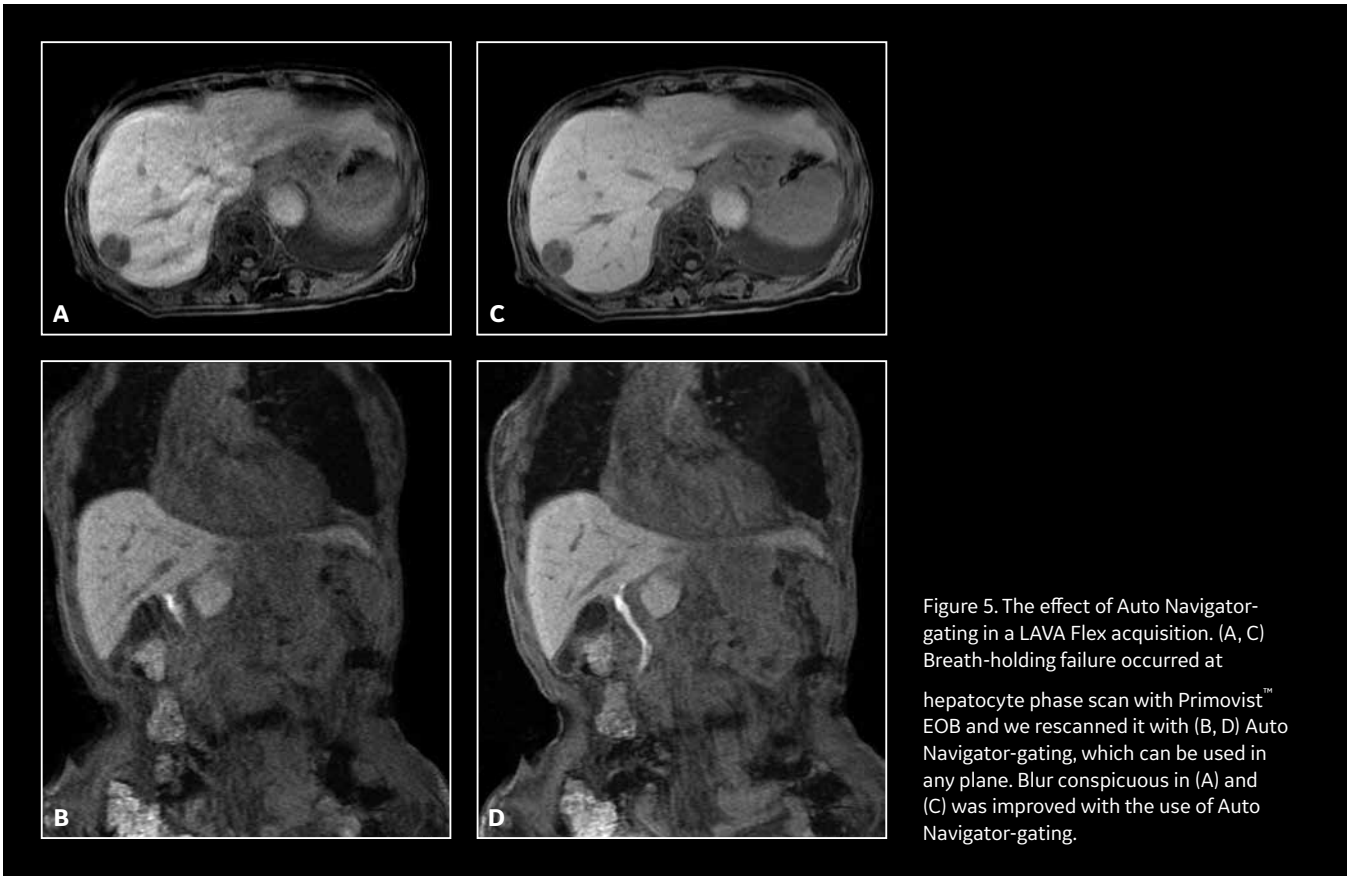


Figure 5. The effect of Auto Navigator-gating in a LAVA Flex acquisition. (A, C) Breath-holding failure occurred at hepatocyte phase scan with Primovist™ EOB and we rescanned it with (B, D) Auto Navigator-gating, which can be used in any plane. Blur conspicuous in (A) and (C) was improved with the use of Auto Navigator-gating.

Parallel imaging

Conventionally, the ASSET parallel imaging method has been used to shorten scan time. It can also be used to reduce aliasing artifacts. Theoretically, it is a parallel imaging method that reduces the acquisition time by decimating the amount of data sampling. Typically, if the data sampling amount is decimated then aliasing artifacts appear. But with ASSET we can obtain images without aliasing artifacts due to the signal strength of the wrapped-around part by calculation.

If we utilize this calculation to the general aliasing artifact images (smaller FOV scan than subject), we can obtain non-aliasing artifact images by setting the ASSET reduction factor to one. Generally we utilize No-phase Wrap (NPW) to eliminate aliasing artifacts. NPW is a technique used to solve the artifact by oversampling so the scan time gets longer. Even in such cases, it is possible to acquire non-aliasing artifact images without extending scan time by using ASSET. Using LAVA Flex, it is possible to acquire a higher quality image without non-aliasing artifact and without a penalty in scan time.

Conclusion

Just one month after the upgrade, our hospital recorded its highest patient volume for MR imaging. With SIGNA Explorer Lift, we have the latest imaging techniques at a fraction of the cost. A key clinical benefit for our patients and economic advantage for our hospital is that we can improve image quality without extending scan time. SIGNA Explorer Lift is a good solution for facilities seeking to improve clinical image quality in an economic way.

Footnotes

1. In the upgrade process, the existing magnet remains and all other components are replaced. After upgrading, the regulatory name and the number of the product will be changed.