



Case Study

**Improving productivity
and image quality with
AIR™ Recon DL and
AIR™ Multi-Purpose Coil**

MAÇKA EMAR, Istanbul, Turkey



Maçka EMAR improving productivity and image quality with AIR™ Technology empowered by AIR™ Recon DL and AIR™ Multi-Purpose Coil

Historically in MR imaging, there has been a trade-off between scan time and signal-to-noise ratio (SNR)/ image resolution. Longer scan times improved SNR/ image resolution while shorter scan times decreased them. Operators often had to find the right balance between productivity (scan time) and quality (resolution).

What if MR imaging operators no longer had to compromise one for the other? The implications could be significant: shorter scan times may enable higher patient throughput and the ability to handle urgent exams; higher quality images could increase diagnostic confidence and enable more advanced post-processing and image interpretation.

Now, with the latest innovations in MR technology from GE Healthcare, the compromise between scan time and resolution is much less limiting. SIGNA™Works AIR™ IQ Edition with AIR™ Recon DL delivers simply better clinical confidence with improved signal-to-noise ratio (SNR) and image resolution along with shorter MR scan times.

The AIR™ Multi-Purpose Coil is the next generation coil technology that allows flexibility in any direction to conform to the patient's anatomy. Based on the innovative technologies behind the INCA conductor and the E-mode module, AIR™ Multi-Purpose Coil provides superb SNR and acceleration performance, while improving the overall patient and user experience. The coil has been designed to adapt to various patient shapes and sizes, with an ultra-lightweight distribution of less than 0.5 grams/cm²

Conventional challenges in MR imaging

In MR, image resolution is determined by scan time, signal-to-noise-ratio (SNR), physical properties of the scanner (e.g. 1.5T or 3.0T) and the sampling rate. Improving MR image resolution has been a well-established goal with numerous approaches over the years, including hardware or scanner-based technologies.¹

Scanner-based technologies include improvements to slice-selection pulse, pulse sequence timing, sampling and hardware (gradients, RF coils, etc.). Post-processing approaches can be generally categorized as Bayesian and non-local formulations. Bayesian is a method of statistical inference based on Bayes' theorem, which is a mathematical model used for calculating conditional probability. Non-local typically refers to learning paradigms wherein an imaging model is trained, such as in the use of deep-learning (DL).¹

MR spatial resolution is determined by the gradient field strength, digital imaging filter bandwidth, the number of readout points and phase encoding steps. MR resolution along the third dimension (Z) in 2-D pulse sequences is determined by the slice selection pulse. Enhancement of the spatial resolution may be achieved by (a) shifting the frame of reference in steps smaller than the pixel or voxel size (this can be done along one, two and three dimensions) and (b) carrying out complementary measurements at several fields of view (FOVs).²

A new DL-based approach to MR image reconstruction

AIR™ Recon DL changes the paradigm in post-processing and removes the compromise in MR imaging. Unlike conventional post processing-based approaches that can obscure image detail, it takes a different approach with a DL-based reconstruction engine making full use of raw data for maximum image quality.

AIR™ Recon DL uses a DL-based neural network to remove noise and Gibbs ringing artifact. This technology features a unique intelligent ringing suppression that preserves fine image details, helping address two common pain points for radiologists and technologists—image noise and ringing.³

This pioneering technology, developed on GE Healthcare's Edison intelligence platform, seamlessly integrates into the clinical workflow to generate AIR™ Recon DL images in real-time at the operator's console. The result is an improved patient experience through shorter scan times along with increased diagnostic confidence due to better image quality across all anatomies. It's a win for patients and service providers, alike.

This paper demonstrates the increase in spatial resolution and productivity enhancements provided by AIR™ Recon DL and AIR™ Multi-Purpose Coils at Maçka EMAR Diagnostic Center (Istanbul, Turkey) after upgrading to SIGNA™ Works AIR™ IQ Edition featuring GE's AIR™ Technology. Using a comparative model, the baseline conventional imaging methodology prior to the system upgrade was examined, including; dedicated coil setup, sequential acquisition and conventional image reconstruction cycle. After the upgrade, the new imaging methodology was also measured, including; new AIR™ Multi-Purpose Coil setup, sequential or bilateral simultaneous acquisition and AIR™ Recon DL image reconstruction.

Also, an observational approach was utilized to compare the workflow steps and times of the conventional workflow to the post-upgrade workflow, including radiology department staff testimonials regarding the impact of the upgrade. iCenter™ utilization data helped assess the utilization of the MR system before and after the upgrade.



Maçka EMAR is one of the leading diagnostic centers in Istanbul, Turkey. Since its opening in 1988, the center has remained on the cutting edge of medical technology innovation to benefit its patients and has become one of the most advanced radiology centers with sub-specialized physicians in Turkey. Outpatient services are also provided in cooperation with some of Turkey's most respected clinicians and surgeons.

As part of its commitment to early adoption of new technology and its history as a long-time user of GE MR systems, Maçka EMAR became a development partner for the first generation 3.0T SIGNA™ Pioneer system. The center replaced its 10+ year-old 1.5T SIGNA™ HDxt system in 2015, becoming one of the first global installations for this new breakthrough clinical technology.

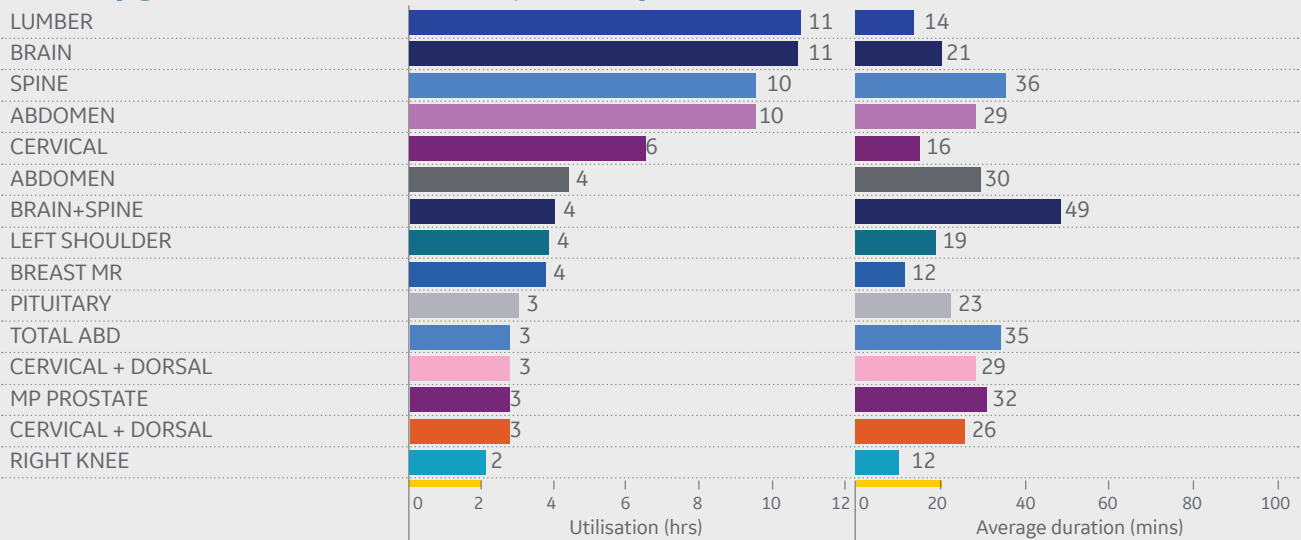
After a successful 5.5 years of service, the 3.0T SIGNA™ Pioneer was upgraded in April 2021 to another breakthrough technology, SIGNA™ Works AIR™ IQ Edition software release featuring AIR™ Recon DL. This upgrade has led to a significant leap in image quality and clinical productivity for Maçka EMAR.

With minimal interruption to the center's daily clinical routine, the entire upgrade process was completed in 1.5 days over a weekend.

According to technologist Mehmet Fatih Çapan, "Despite our confidence and experience with GE, change can be difficult to adapt. However, our first day with the new upgrade was easier than we expected. I had the chance to be the first technologist to operate the new software, with guidance from GE's clinical training team, and was amazed at the image quality we acquired with significantly reduced scan times."

He adds, "With a wide variety of patients and exam types, exam delays can often be unavoidable. Now with AIR™ Recon DL, we can complete the exams in a shorter time and obtain excellent quality with high-resolution images."

Post-upgrade exam duration by description | cumulative and average exam duration



Source: GE iCenter data for Maçka EMAR.

Impact on patient throughput

At Maçka EMAR, exam times for all anatomies have been reduced on average by 15-18 minutes, from 45 to 28 minutes. Spine contrast exams have been shortened by 50%, from 1 hour to 30 minutes*. As important, with the decreased scan times, motion artifacts are also reduced which has a further impact on minimizing scan repeats.

“Following the upgrade, we observed average of 40-50% scan time reduction for all anatomies and furthermore inherently longer studies where we need multi-anatomy coverage, such as brain & whole spine or abdomen & pelvis, are now much more comfortable for patients and the results are really appreciated too,” says Dr Ismail Çerezci, Head of Radiology at Maçka EMAR.

*iCenter™ data represents post upgrade utilizations, comparisons obtained by random pre-upgrade samplings from PACS

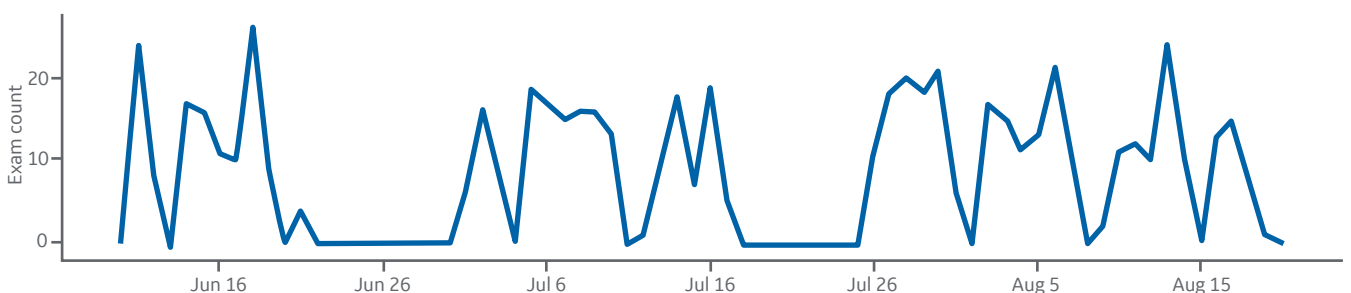
Meeting peak demand

During certain days each week, Maçka EMAR has to accommodate increased demand for MR imaging due to visiting physicians that increase the number of radiological consultations and imaging referrals. In many instances, the patients require same-day imaging as their clinical appointment and often will meet with their physician after the imaging study to discuss their treatment plan. This type of care pathway requires a well synchronized flow across modalities and image reading, therefore there is no room for any delay. Not surprisingly, MR was the imponderable factor due to relatively longer scan times that also requires more patient compliance.

Having the capability to improve productivity and efficiency with shorter scan times helps the center meet this peak demand by opening up additional time slots that can be used to accommodate more patients and manage delays.

“The reduction in scan times also leads to fewer appointments being moved to the next day,” says Dr. Çerezci. “We can accommodate these urgent clinical examinations during any gaps in our system schedule.”

EXAMS | Trend over selected period



Exam trends between June 10 to August 20 based on iCenter™ data. Graph demonstrating peak demand times.

Improved diagnostic confidence

Following the SIGNA™Works AIR™ IQ Edition upgrade and the utilization of AIR™ Recon DL, the ability to consistently acquire high-resolution images has facilitated diagnosis and clinical confidence. Now, radiologists can detect small pathologies and technologists can acquire more sequences quickly when needed. Referring physicians have commented very positively on the image quality.

Dr. Çerezci states, “Our clinicians consistently state that the quality of the scan has increased. Patients also reported their satisfaction with the shorter exam time to their clinicians.”

“Unequivocally, AIR™ Recon DL meets the expectation of Maçka for MR. It is highly recommended for other centers, especially high throughput centers like ours that would benefit from the improved scan time and image quality,” Dr Çerezci adds.

Cases:

Case 1: Knee scan

Figure 1

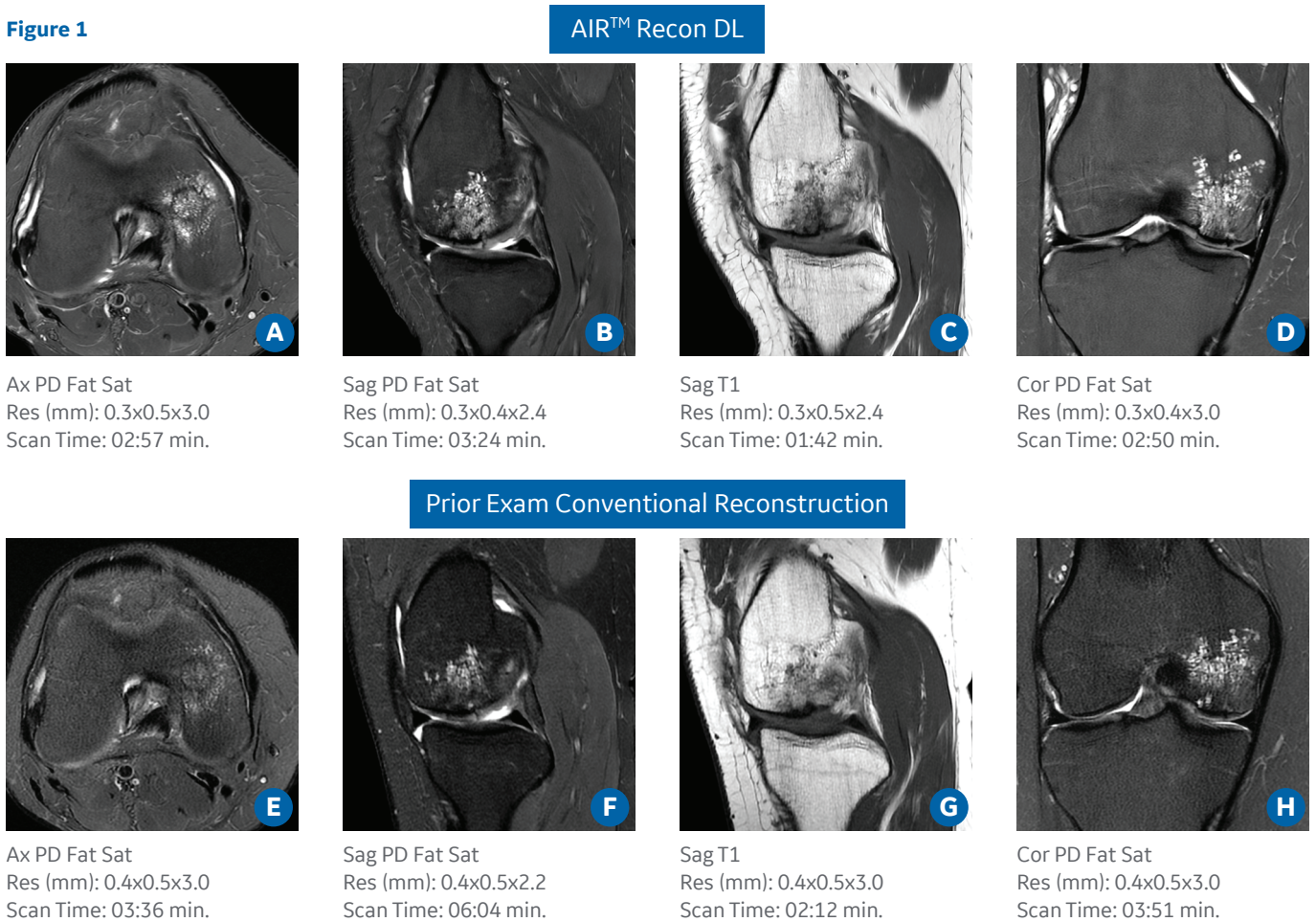


Figure 1. Comparison of a 42-year-old patient with AIR™ Recon DL and AIR™ Multi-Purpose Coil. E-H scanned pre-upgrade. Note the higher resolution, smaller FOV imaging and shorter scan time provided post-upgrade.

Figure 2

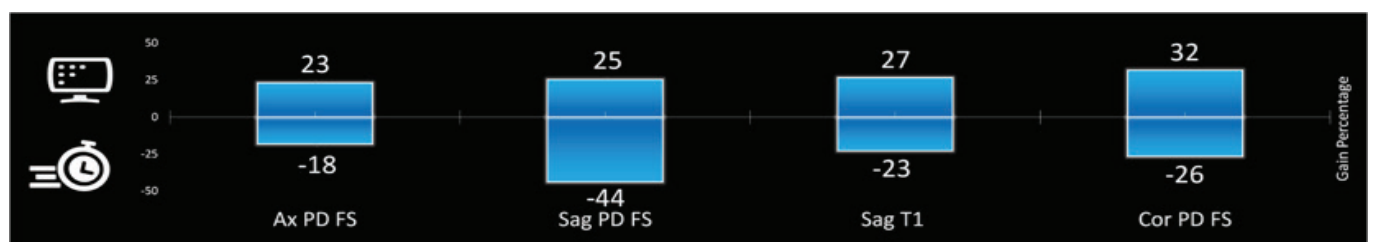


Figure 2. The graph demonstrates resolution and scan time gain percentages for each sequence. Total scan time gain 29%, Average resolution improvement 27%

Case 2 : Hip scan

Figure 3

AIR™ Recon DL



Cor PD FatSat
Res(mm): 0.3x0.5x4.0
Scan Time: 02:38 min.



Cor T1
Res(mm): 0.4x0.5x3.5
Scan Time: 01:54 min.



Sag PD FatSat
Res(mm): 0.3x0.4x4.0
Scan Time: 03:15 min.

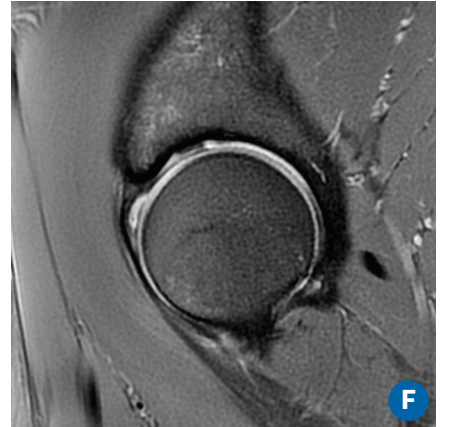
Prior Exam Conventional Reconstruction



Cor PD FatSat
Res(mm): 0.6x0.6x4.0
Scan Time: 04:21 min.



Cor T1
Res(mm): 0.5x0.7x3.5
Scan Time: 02:37 min.



Sag PD FatSat
Res(mm): 0.55x0.55x4.0
Scan Time: 03:52 min.

Figure 3: Comparison of a 32-year-old patient with Labral Stricture between a prior and a follow-up exam. A-C scanned with post-upgrade, which includes AIR™ Recon DL and AIR™ MP Coil. D-F scanned pre-upgrade. Note the higher resolution and shorter scan time provided with AIR™ Recon DL.

Figure 4

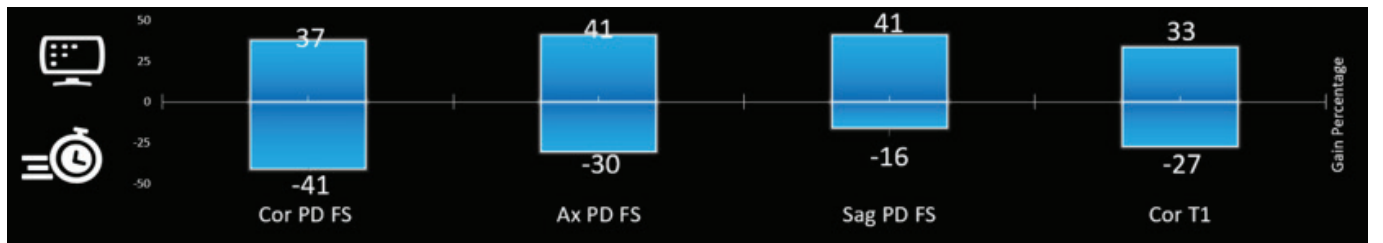


Figure 4. The graph demonstrates resolution and scan time gain percentages for each sequence. Total 37% improvement in resolution, 41 % reduction in scan time.

Spine Scan

Improved patient comfort and reduced rescans

The reduction in scan times has improved patient comfort and reduced rescans due to patient discomfort and movement. With AIR™ Multi-Purpose Coils, the patient stabilization is even easier and enabled scanning while providing added comfort to the patient.

“As the scan times are shortened, the duration of time the patient is inside the MR bore has decreased, which automatically increases patient comfort. This is particularly important for exams of oncology or other patients who are in pain. We’ve also noticed that motion artifacts and rescans are minimized” adds. Dr. Çerezci.

The improved patient satisfaction may contribute expected loyalty both from clinicians and their patients to prefer Maçka EMAR for their imaging needs. Furthermore, increase patient volume and throughput.

Another challenge for the technicians is patient positioning. With the AIR™ Coils, the patients are more comfortable, and the technician no longer needs to use a hard shell and heavy coil for difficult patients.

“With the shortening of the scan times, the increase in patient comfort and image quality, our work-related stress has been minimized, and now we work in a more comfortable and harmonious manner,” says. Mr. Çapan.

A more efficient workflow

AIR™ Coils enable a simplified, faster workflow that maintains image quality. It can fit a variety of sizes and its shape no longer defines what can be imaged with it. For example, an AIR™ Coil can be wrapped around the knee or arm, or draped over the torso. Because it is ultra-light and flexible, it can be used to scan complex anatomies and complicated conditions. It is the closest that users can get to total positioning freedom with 360-degree coverage.

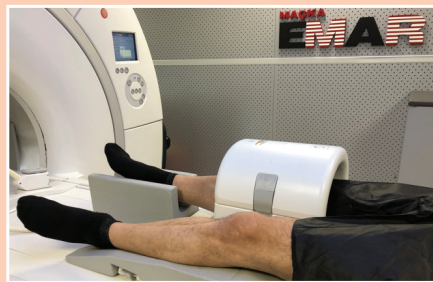
At Maçka EMAR, the new AIR™ Multi-Purpose Coils have improved the workflow in sequential knee MR scanning by 33%. Between right and left knee scanning, patient preparation and scout steps have been eliminated. Due to their flexible design, AIR™ Coils make the patient positioning easier for the technician.



Knee MR scanning workflow comparisons

Pre-upgrade

Bilateral knee exam | Dedicated coil setup | Sequential acquisition method



Dedicated knee coil setup.

Post-upgrade

Sequential acquisition

AIR™ Recon DL | AIR™ Multi-Purpose Coil | AIR x™ Knee

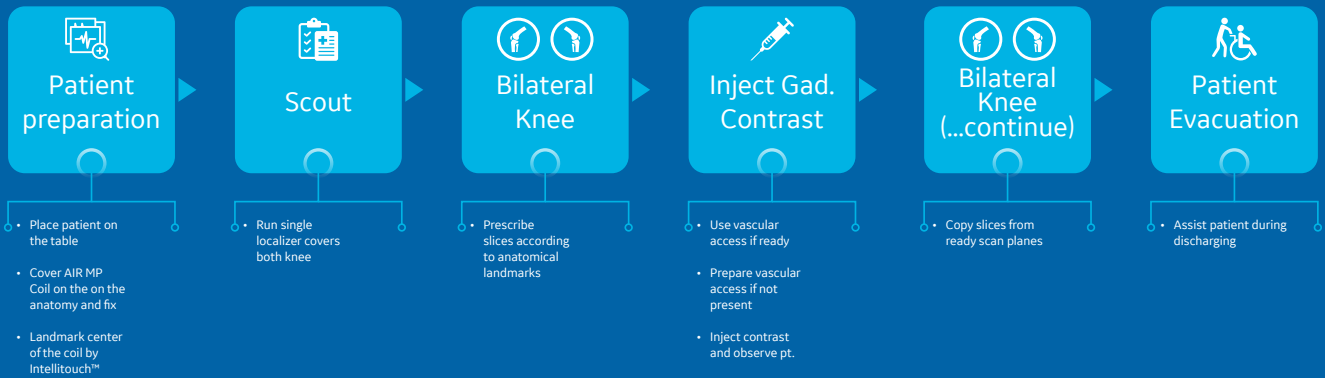


AIR™ Multi-Purpose Coil setup

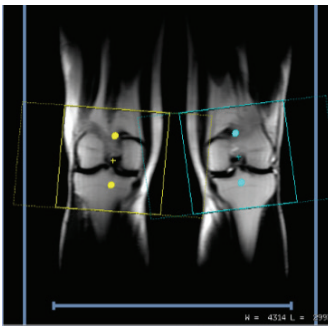
Post-upgrade

Simultaneous acquisition

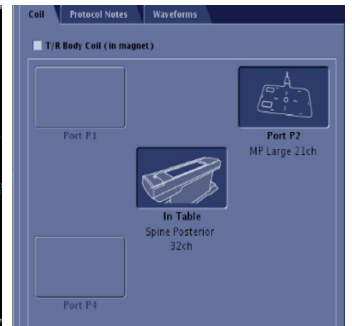
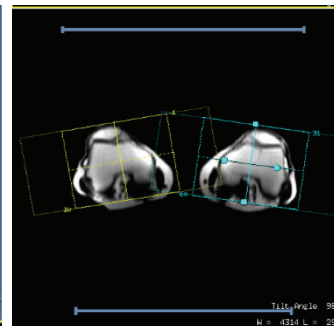
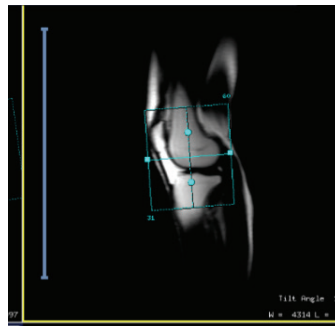
Post-upgrade bilateral Knee AIR™ Multi-purpose Coil set-up (simultaneous acquisition)



AIR™ Coil technology enables simultaneous acquisition of right and left knee, which improves the workflow and productivity even further, reducing the number of steps from 11 to 6, representing a decrease of 45%.



Bilateral knee slice prescription screen.



AIR Touch™ coil screen

Reduced task durations & operational idle time

After the upgrade with AIR™ Recon DL and AIR™ Multi-Purpose Coil for the same bilateral knee exam, now takes less than 41 minutes to complete, a 34% reduction in scan time or 21:10 min. shorter. Furthermore, simultaneous acquisition for the same exam takes around 37 minutes which counts to 40% less scan time*.

	Pre-upgrade	Post-upgrade	
	Conventional reconstruction with dedicated coil	AIR™ Recon DL AIR™ Multi-Purpose Coil AIR x™ Knee Sequential acquisition	AIR™ Recon DL AIR™ Multi-Purpose Coil AIR x™ Knee Simultaneous acquisition
	Procedure, Duration min:sec	Procedure, Duration (min:sec)	Procedure, Duration (min:sec)
Patient preparation	4:00	4:00	Patient preparation 4:00
Scout	0:20	0:30	Scout 0:26
Right knee	15:50	9:58	Right and left simultaneous acquisition 16:20
Patient preparation	4:00	0	
Scout	0:20	0	Right and left simultaneous acquisition (continue) 08:42
Left knee	15:50	9:58	
Inject gad. contrast	5:00	5:00	05:00
Left knee (continue)	4:44	4:16	Right and left simultaneous acquisition (continue) 08:42
Patient preparation	4:00	0	
Scout	0:20	0	Right and left simultaneous acquisition (continue) 08:42
Right knee (continue)	4:44	4:16	
Patient evacuation	3:00	3:00	03:00
Total time	62:08 min.	40:58 min.	37:28 min.
		34% scan time reduction (21:10 min. shorter)	40% scan time reduction (24:40 min. shorter)

*Based on observational time-stamp data on file collected at customer site.

Conclusion

Until now, there has been an inherent compromise in MR between image quality and scan time. Acquiring higher SNR and/or spatial resolution to depict anatomical detail necessitated longer scan times. Shorter scans, aimed to improve patient comfort and productivity, compromised image quality and diagnostic confidence. Now with AIR™ Recon DL and AIR™ Coils, clinicians and technologists will no longer have to choose between image quality and scan time. AIR™ Recon DL changes the paradigm in MR imaging by improving SNR to enable fine image details, helping address two common pain points for radiologists and technologists—image noise and resolution.³

References

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