FieldStrength

8-minute acquisitions for five common MRI exams

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Acquisition in less than 8 minutes for five most common MRI exams

Tim Leiner, MD, PhD, is cardiovascular radiologist and Associate Professor of Radiology at the University Medical Center Utrecht since 2010. Previously he was Assistant Professor of Radiology at Maastricht University Medical Center. He is the current President of the International Working Group on MR Angiography.

University Medical Center Utrecht (UMCU) uses Ingenia 1.5T to design significantly faster imaging while maintaining diagnostic quality

The UMCU team recently developed fast Ingenia 1.5T ExamCards for the five most common exams, each of which require less than 8 minutes scan time. This is a scan time reduction of more than 50% compared to their standard protocols, and still satisfies the image quality criteria defined by the ACR Clinical Image Quality Guide[1].

Faster imaging that still supports diagnosis

UMCU, in the Netherlands, installed Philips Ingenia 1.5T in 2010. Since then, Tim Leiner, MD, PhD, cardiovascular radiologist and Associate Professor of Radiology at UMCU, has built up considerable expertise in working with this system. The team developed five exams with scan times of less than 8 minutes for brain, cervical spine, knee, foot/ankle and liver. Together these exam types make up 85% of clinical exams performed in typical MRI practices today. Compared to UMCU's standard clinical MR exams, the number of sequences was reduced and individual sequences were adjusted to meet the recommendations by the American College of Radiology (ACR).

"Our starting point was the ACR minimum requirements for sequence types, image contrast, anatomic coverage, imaging planes and spatial resolution, which we incorporated into the scan protocols," says Dr. Leiner. "We wanted to produce images that sufficiently support the clinical decision process but without adding more sequences than necessary. This resulted in the five exams taking less than 8 minutes."

"Radiology is ultimately not about making images, it's about supporting clinical decision-making."
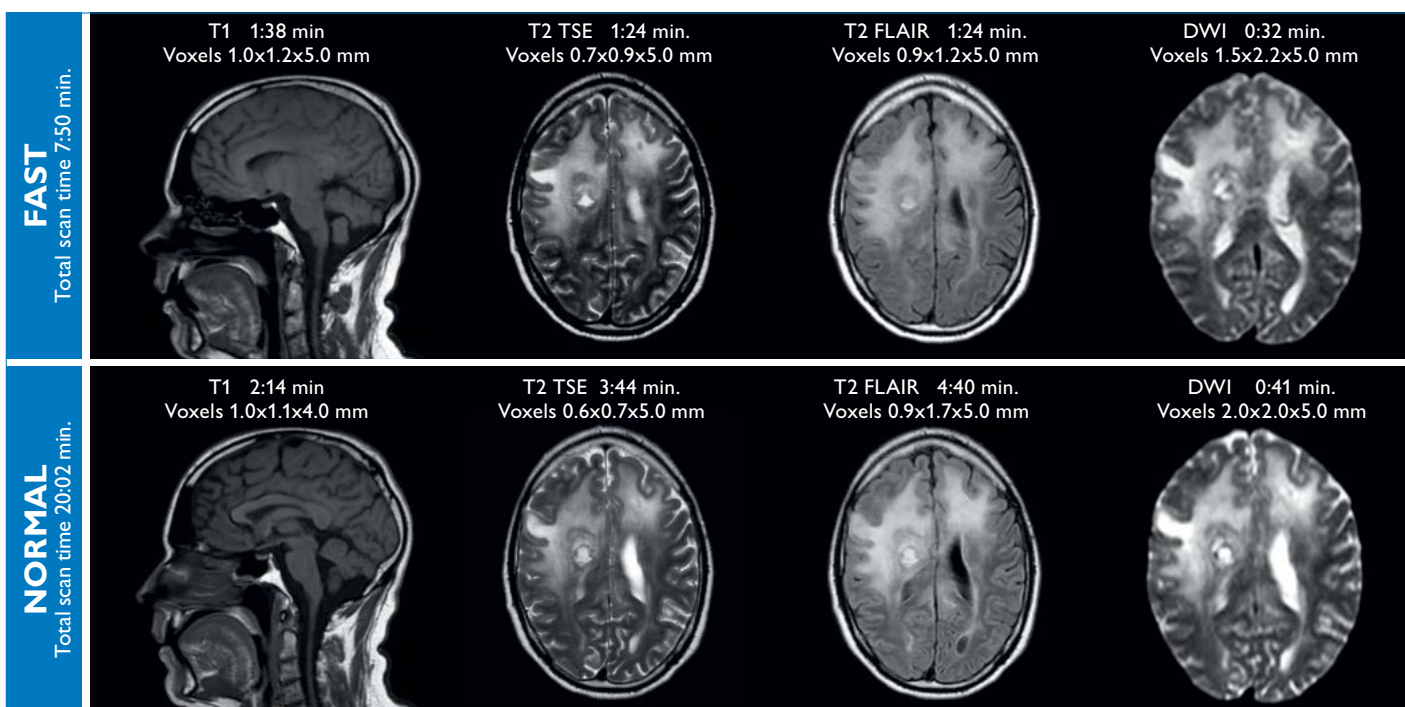
To assess the image quality of the newly optimized fast ExamCards, 40 patients were scanned with both the new and existing protocols for brain, cervical spine, knee or foot/ankle. Results of a blind test[2] showed that the image quality, SNR and artifact presence were not significantly different ($p > 0.05$) although the mean perceived image quality was slightly lower for the fast ExamCards. The UMCU team is now assessing the diagnostic quality of the new optimized ExamCard images. "Before we share these new protocols with others, we want to be sure that their diagnostic values are as good as those of the longer exams."

How Ingenia contributes to reducing scan time

"Thanks to Ingenia we have been able to reduce scan time so much," says Dr. Leiner. "That's because Ingenia is a digital broadband MR system that digitizes the signal at the source in the coil. Thanks to this dStream platform it provides up to 40% higher SNR than our analog system. In addition, Ingenia has dS SENSE next generation parallel imaging that allows us to use higher acceleration factors."

"With Ingenia we also got access to the mDIXON technique that can really modify the way MR is done," says Dr. Leiner. "With mDIXON multiple contrasts can be acquired at the same time. Acquiring both water and fat images in one scan has interesting implications, as often both a T1-weighted sequence and a fat-suppressed T1 sequence are needed. Now with mDIXON, both fat-suppressed and non-fat suppressed images are acquired together in just one scan, so imaging time is substantially reduced. In addition, mDIXON also provides in-phase and out-phase images. I think the mDIXON technology is really a game changer. This Philips implementation is, in my opinion, very elegant, because it is compatible with very fast imaging."

"Ingenia is capable of producing very high image quality, but instead of pursuing ever-sharper images, we wanted to see how much image quality we could tradeoff for speed, and still produce clinically relevant images. After all, radiology is ultimately not about making images, it's about supporting clinical decision-making. We managed to halve the imaging time and still get the key information that influences clinical management."

FAST — Total scan time 7:50 min.

| T1   1:38 min | T2 TSE   1:24 min. | T2 FLAIR   1:24 min. | DWI   0:32 min. |
| Voxels 1.0x1.2x5.0 mm | Voxels 0.7x0.9x5.0 mm | Voxels 0.9x1.2x5.0 mm | Voxels 1.5x2.2x5.0 mm |

NORMAL — Total scan time 20:02 min.

| T1   2:14 min | T2 TSE   3:44 min. | T2 FLAIR   4:40 min. | DWI   0:41 min. |
| Voxels 1.0x1.1x4.0 mm | Voxels 0.6x0.7x5.0 mm | Voxels 0.9x1.7x5.0 mm | Voxels 2.0x2.0x5.0 mm |

Comparing fast and normal brain images
Ingenia 1.5T fast and standard MR brain images show nearly identical appearance of image contrast and lesion conspicuity in right cerebral hemisphere.

More than short scan times: faster workflow

In addition to optimizing ExamCards for speed, the UMCU team takes full advantage of the Ingenia's workflow acceleration features. The posterior coil integrated in the table eliminates coil handling from a significant portion of all exams. The wide bore and lightweight coils are designed for easy patient handling and to enhance patient comfort. "A comfortable patient is less likely to move, which will benefit image quality," says Dr. Leiner.

SmartAssist reduces the number of manual actions as it automatically positions the table and starts the scanning, automatically plans the scan, reduces the number of processing steps, and automates coil element selection.

All of this can help reduce total patient examination time by up to 30%.

Will faster scanning change the role of MR?

"Traditionally, the aim was to image everything, but that is simply not necessary for many patients," says Dr. Leiner. "The fast protocols are designed, for instance in new patients with pain, to determine what the problem is. For complex disease or very specific clinical questions more extended exams will still be needed."

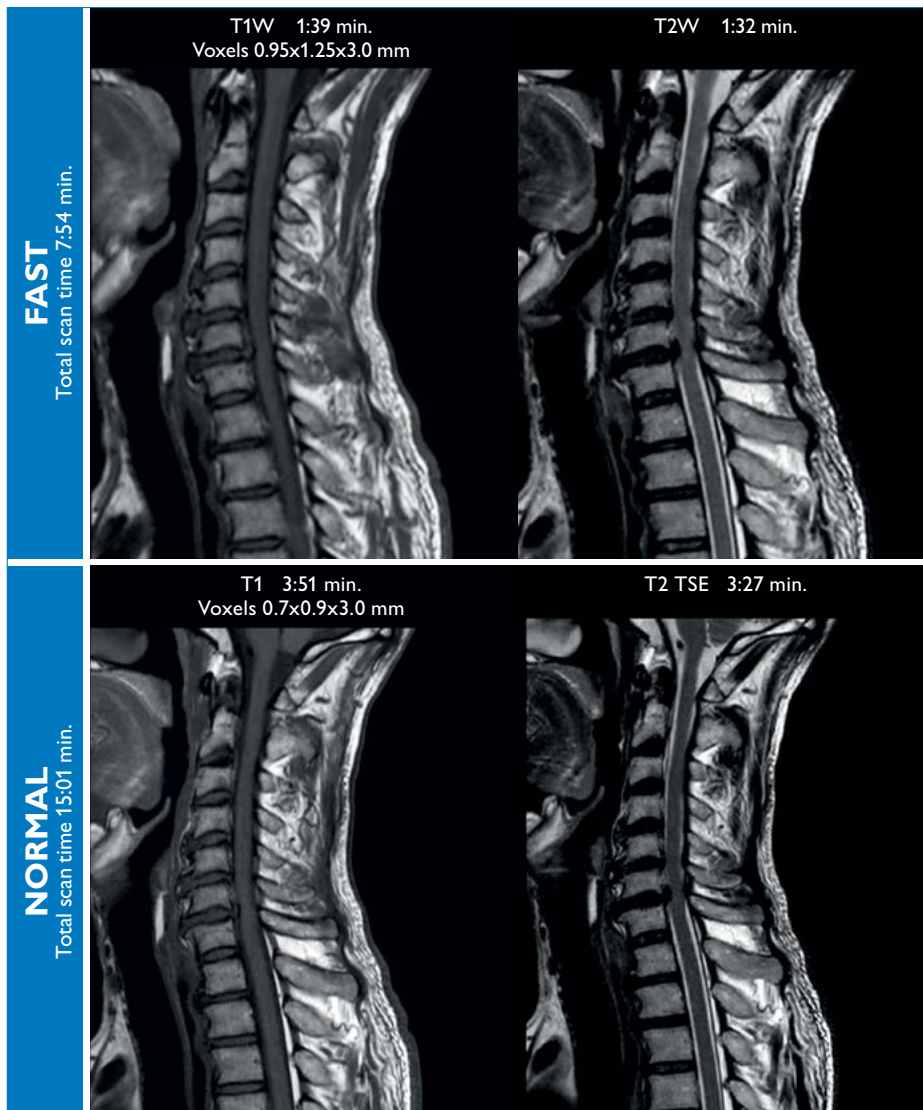### Fast Ingenia 1.5T ExamCards developed at UMC Utrecht

Brain	
T1_SE sag SENSE	1:38 min
T2W TSE tra SENSE	1:24 min
DWI SENSE	0:32 min
T2 FLAIR SENSE	1:24 min
T2W FFE SENSE	1:48 min
T1 IR cor SENSE	1:04 min
	7:50 min

Cervical spine	
T2W sag SENSE	1:32 min
T1W sag SENSE	1:39 min
T2DRIVE 3D SENSE	2:09 min
T1W tra CLEAR	2:18 min
	7:38 min

Foot/Ankle	
T1 cor CLEAR	1:10 min
PD cor SENSE	0:47 min
T2 SPAIR sag CLEAR	1:55 min
PD sag CLEAR	1:16 min
T2W TRA CLEAR	1:20 min
PD tra SENSE	0:54 min
	7:22 min

Knee	
PDW SPAIR CLEAR	1:26 min
T2W TSE sag CLEAR	2:01 min
T2W SPIR SENSE	1:10 min
T1W TSE cor SENSE	0:38 min
T2W tra SENSE	1:42 min
	6:57 min

Liver	
T2 cor	
3D mDIXON (IP, OP, water, fat)	
DWI	
T2 tra	
T2 tra fat sup	
3D arterial, portal, venous	
	7:40 min

FAST Total scan time 7:54 min.

T1W 1:39 min. Voxels 0.95x1.25x3.0 mm

T2W 1:32 min.

NORMAL Total scan time 15:01 min.

T1 3:51 min. Voxels 0.7x0.9x3.0 mm

T2 TSE 3:27 min.

Comparing fast and normal imaging in cervical spine

In cervical spine the total scan time in the ExamCard is reduced from 15:01 min. in the normal protocol to 7:54 min. in the fast exam.
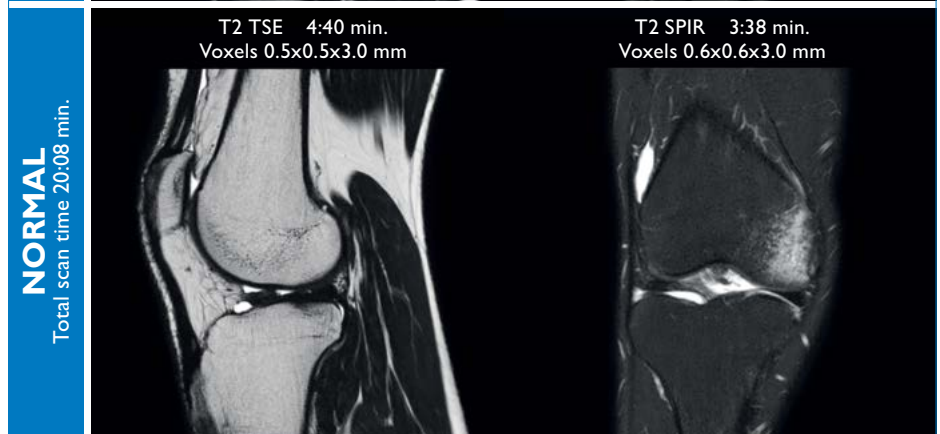
"Thanks to Ingenia we have been able to reduce scan time so much."

"We don't know exactly how healthcare institutes will take advantage of the faster scanning," says Dr. Leiner. "However we may expect that MR use will continue to grow rapidly. The two main drawbacks of MRI today are the long waiting lists and the relatively high cost. If faster scanning can help to reduce exam time slots and increase patient turnover, this will make MR more cost-effective and help to reduce waiting times. Our waiting times with these fast protocols are now approximately one day only. Another consequence could be that MR may become the preferred first exam for some patient groups, for instance, patients with knee pain or chronic headaches."
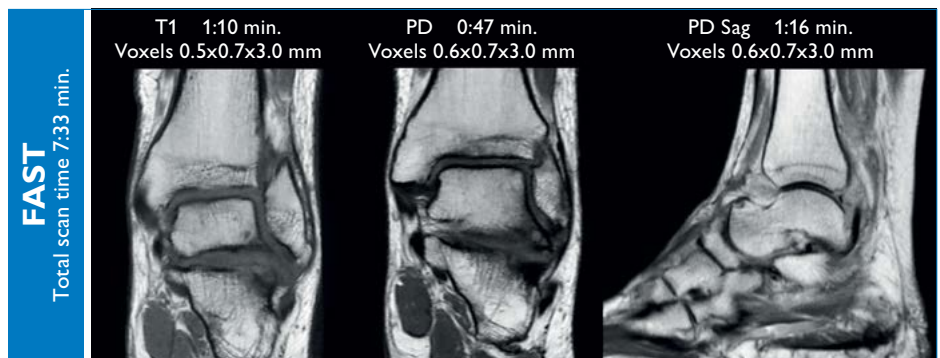
A true paradigm shift for users and patients

"Often when significant improvements are made in hardware or software, there may not automatically be a high impact on the users or the patients," says Dr. Leiner. "But here we are seeing a synergistic convergence of several innovations. We have the Ingenia with powerful hardware and software. We have the new fast protocols. And we have the patient-friendly wide bore and the dStream coils. It is this convergence that is creating a truly radical change for users and patients." ◼

FAST — Total scan time 7:10 min.

T2 TSE   2:01 min.
Voxels 0.7x0.9x3.0 mm

T2 SPIR   1:10 min.
0.8x1.1x3.5 mm

NORMAL — Total scan time 20:08 min.

T2 TSE   4:40 min.
Voxels 0.5x0.5x3.0 mm
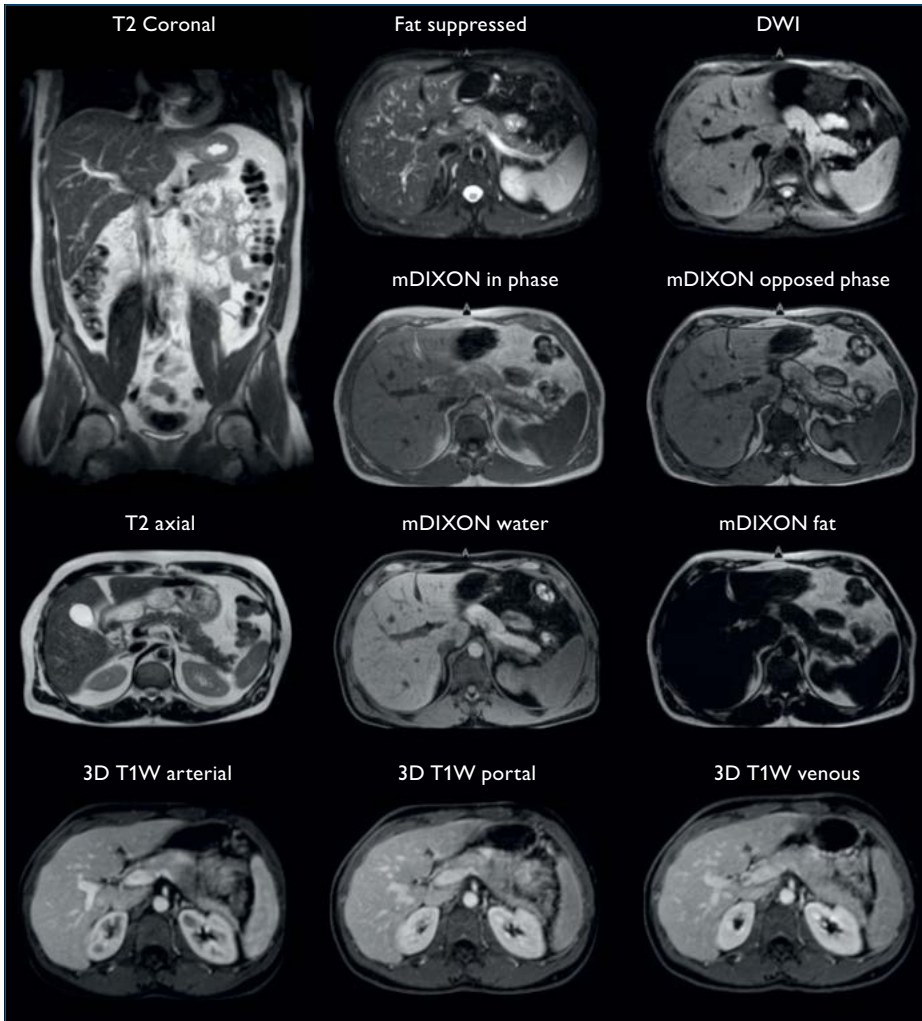
T2 SPIR   3:38 min.
Voxels 0.6x0.6x3.0 mm

Comparing fast and normal imaging in the knee
In the fast exam, T2-weighting and spatial resolution are both slightly decreased. Despite this, the area of bone marrow edema in the medial femoral condyle is clearly visible and of similar extent as in the normal imaging protocol. Total scan time is reduced by 65% in the fast exam.

FAST — Total scan time 7:33 min.

T1   1:10 min.
Voxels 0.5x0.7x3.0 mm

PD   0:47 min.
Voxels 0.6x0.7x3.0 mm

PD Sag   1:16 min.
Voxels 0.6x0.7x3.0 mm

NORMAL — Total scan time 26:34 min.

T1   2:31 min.
Voxels 0.5x0.6x3.0 mm

PD   2:31 min.
Voxels 0.5x0.7x3.0 mm

PD Sag   3:31 min.
Voxels 0.5x0.6x3.0 mm

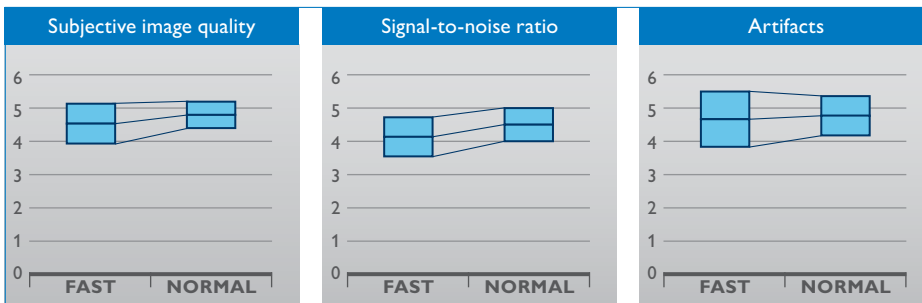**Comparing fast and normal imaging in foot/ankle**
In the fast exam, total scan time is reduced by 70%. In the example images shown scan times have significantly dropped, while voxel sizes have only slightly increased.

T2 Coronal — Fat suppressed — DWI — mDIXON in phase — mDIXON opposed phase — T2 axial — mDIXON water — mDIXON fat — 3D T1W arterial — 3D T1W portal — 3D T1W venous

Complete Ingenia 1.5T liver exam in 7.5 minutes

The exam starts with coronal T2W, in-phase and out-of-phase T1W*, DWI, axial T2W and fat suppressed T2W. For functional evaluation three 3D volume T1W acquisitions are done for arterial, portal and venous. Because mDIXON is used, 3D water images and fat images are obtained as well, without adding acquisition time.

I think mDIXON is really a game changer as it is compatible with very fast imaging."

Comparing image quality of fast and normal exams

Images of 32 patients from the fast ExamCards and the normal UMCU ExamCards for brain, cervical spine, knee and foot/ankle were assessed by an experienced radiologist, who was blinded to acquisition type. Each image was rated for image quality, perceived SNR, and artifact presence. The results show no significant differences, i.e. $p > 0.05$.

NetForum
www.philips.com/netforum

Visit NetForum to view more MRI contributions by UMC Utrecht, for instance by typing Utrecht in the Search box.

References

1 ACR MRI Accreditation Clinical Image Quality Guide v2.1 (2008)
www.acr.org/~/media/ACR/Documents/Accreditation/MRI/ClinicalGuide.pdf

2 T Leiner, E Alberts, N Blanken, M Stoesz, M Hartjes, J Hendrikse
MR Examination Times of Less than 8 Minutes for 4 Common Indications
ISMRM 2013

Results from case studies are not predictive of results in other cases. Results in other cases may vary.

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