

Publication for the Philips MRI Community **Issue 54 – 2017/1**

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MRI Magazine

FieldStrength

Elevate **neuro** **diagnostics**

MRI in Emergency Department
for fast, confident decisions

Brain protocols upgraded
with latest methods

Black Blood imaging case study

Expanding **whole body MRI** use
in **oncology** patients



Dear Friends,

At Philips, we believe MR still has huge untapped potential. Potential to make an even bigger difference to healthcare. Potential to touch far more lives than it does today. Exploring these possibilities is our mission – and by collaborating with our users, we can create meaningful innovations. Together, we can make the technology more accessible to patients, through consistent imaging. By empowering you with our leading-edge technologies for image acquisition and visualization, we can help you deliver personalized, more definitive answers to even the most complex diagnostic questions. And our MR-based tools and applications let you extend the benefits beyond diagnostics.*

This issue of FieldStrength highlights some of the great work done by our users and its impact in these institutes. Read how introducing MRI into the Neuro Emergency Department at St. Joseph's Hospital in Phoenix has helped image more emergent patients immediately, with their preferred modality.

The University of Vermont article shows how recent neuro methods helped them improve their imaging and raise their diagnostic confidence. Apart from that, UVM researchers talk about the benefits of our methods in advancing their neuroscience program.

For MRI of oncology patients, the team of Kawasaki Saiwai Hospital has shortened their whole body exam for monitoring oncology patients and at the same time enriched the information it provides. As a result, they have seen a significant increase in the referrals they get.

We're passionate about enabling our users to tap the huge potential in MR and touch far more lives – as described in these stories. Our team is looking forward to talking to you at ISMRM or other occasions.

Enjoy reading!

A stylized, handwritten signature in blue ink, belonging to Louise Verheij van Wijk.

Louise Verheij van Wijk
VP Commercial & Clinical Innovation, Philips MR

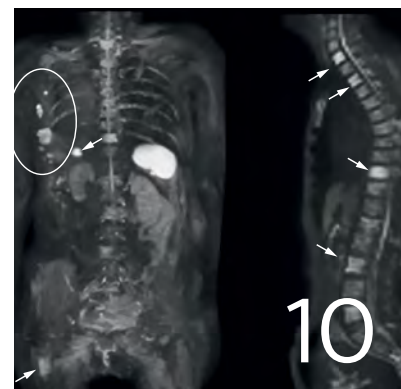
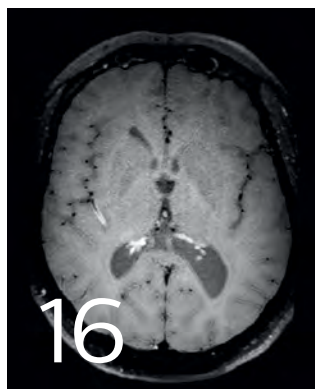
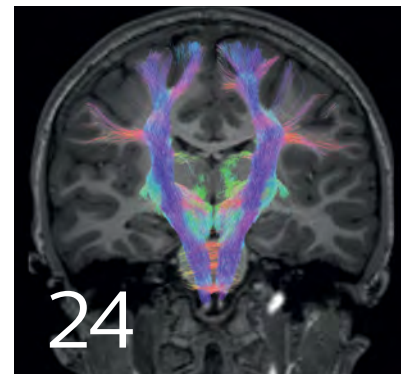
*Definitive refers to features that are expected to deliver alternative contrasts, functional or quantitative images.



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Elevate neuro diagnostics



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MRI enters Emergency Department for fast, confident decisions

When MRI is the preferred choice, ED patients can get fast MRI and fast diagnosis

When neurological emergencies require diagnostic imaging, common practice in the ED has been to perform CT rather than MRI, even when MRI could potentially produce more informative diagnostic images of spinal cord damage, disc protrusions, soft tissue injuries, and stroke pre-cursors. [1,2] The main reason is that timing is essential in emergency cases, and CT is generally faster than MRI. The St. Joseph's Hospital and Medical Center is now challenging this paradigm by offering rapid MRI scans within its Neurologic ED and seeing that it helps them make a richer diagnosis – a finding that supports our first time right philosophy.



John Karis, MD, is a neuroradiologist and has been director of MRI and brain imaging at Barrow Neurological Institute at St. Joseph's Hospital & Medical Center in Phoenix, Arizona since the early 2000's. Dr. Karis completed his residency at the Duke University School of Medicine.

“MRI is a better test for identifying soft tissue abnormalities in the brain.”

Introducing MRI in the ED: why the change?

Since 2012, St. Joseph's Hospital and Medical Center in Phoenix, Arizona, USA, has had an ED dedicated to neurological patients. In 2015, John Karis, MD, of the Barrow Neurological Institute at St. Joseph's spearheaded a project to place an MRI system in the Neuro ED. He stressed the added prognostic value of having an emergency MRI, and the importance of reducing radiation doses, particularly in patients for whom a CT scan was not the optimal test.

“In the past, CT scans were performed because of their availability and rapid turnaround time,” Dr. Karis argues, “but if an MRI could be as efficient as CT for referring physicians, then physicians would probably prefer MRI over CT in part of the cases. Reducing the number of CT scans for patients less than 40 years of age without significant acute findings, such as acute stroke, was also a main reason for introducing MRI into the ED.”

“MRI is a better test for identifying soft tissue abnormalities in the brain. What really influenced the decision on the administrative side, was the total radiation dose received by ED patients, and how this could be reduced by introducing MRI into the ED.”

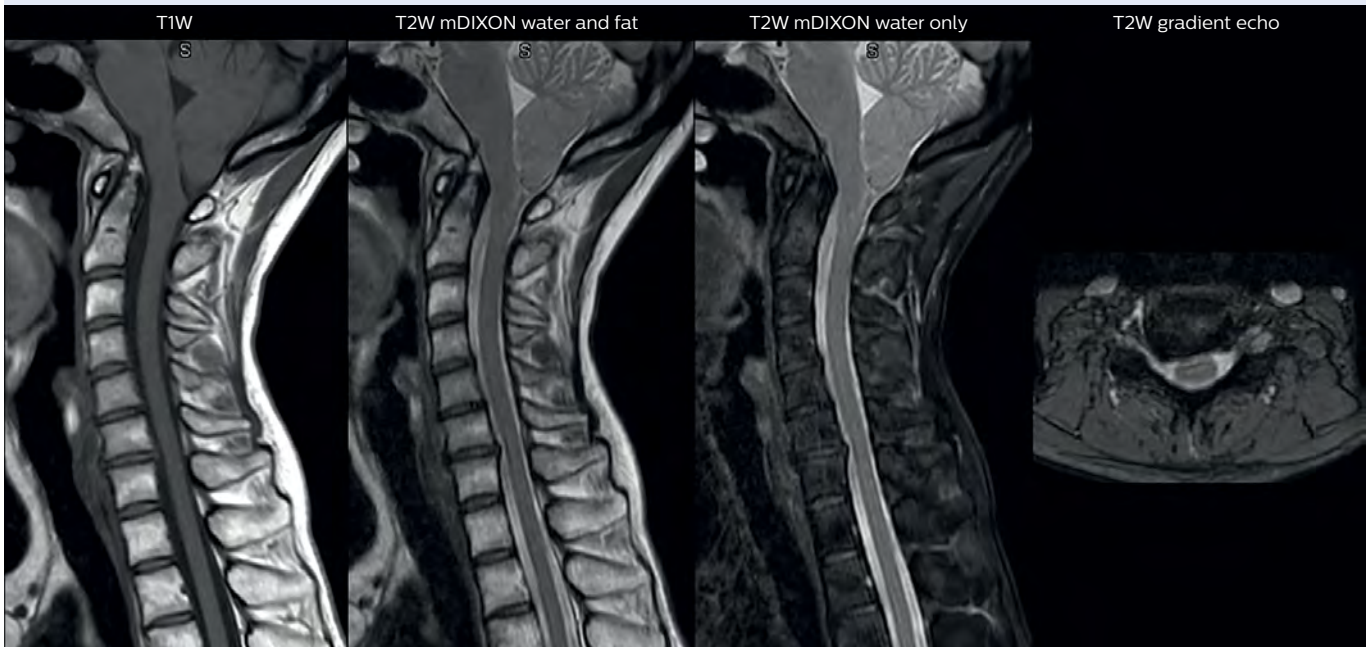
Towards routine scan times of about 10 minutes

In order to address efficiency, matched with state-of-the-art capabilities to support a rich diagnosis, the decision was made to include a Philips Ingenia 1.5T MRI scanner with wide bore in the new setup of the ED to enable scanning of virtually all patients.

To minimize the time taken to perform scans, rapid MRI examination protocols (ExamCards) were developed, shortening the total scanning time to less than 10 minutes in some exams. Techniques like mDIXON (modified DIXON) are used for robust capturing of fat-free MRI images in a hectic ED environment.

Cervical spine routine exam using mDIXON

This patient presented with headache that was worse with neck flexion and we see a Chiari 1 malformation with low-lying cerebellar tonsils as well as some degenerative cervical thrombotic change.



“mDIXON is robust with regard to susceptibility type of problems that would come up with traditional spectral fat-saturated images.”

Including mDIXON TSE for robust fat suppression

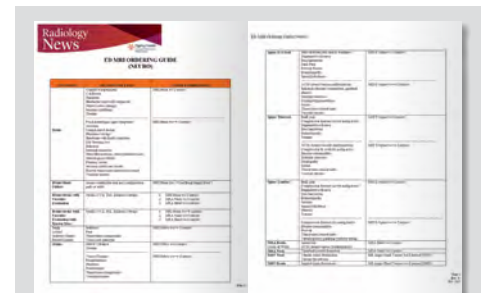
“We use mDIXON TSE extensively in our spine imaging in the emergency room,” says Dr. Karis. “It’s particularly nice in that it is very robust with regard to susceptibility type of problems that would come up with traditional spectral fat-saturated images. These problems are essentially eliminated with the mDIXON technique. In our ED environment it’s really nice to have the fat-free imaging that goes along with the mDIXON technique.”

“For the thoracic and cervical spine routine non-contrast exam, for example, we perform one mDIXON T2 TSE sequence, which provides us with two outputs: the fat-and-water-together T2-weighted images, as well as the water-only sagittal T2-weighted images. And then we also perform an axial gradient echo exam.”

Guidance on appropriate use of MRI

A range of protocol sheets was developed to help ensure that referring physicians order the most appropriate MRI exam. The optimized MRI protocols also include 3D contrast-enhanced imaging, allowing neurosurgeons to comfortably use the isotropic data in the operating room while performing stereotaxic surgery.

After the MRI scanning, the preliminary reports are made available to referring physicians more quickly than before,



Download the SJHMC ED MRI ordering guide for referring physicians on www.philips.com/fieldstrength

because physicians require fast reports to make their decision on what to do with patient. Using a redesigned reporting process results in total turnaround times that are similar to those of CT. Another of the changes introduced is that MRI safety screening data is retrieved from the hospital information system, saving approximately 30 minutes.

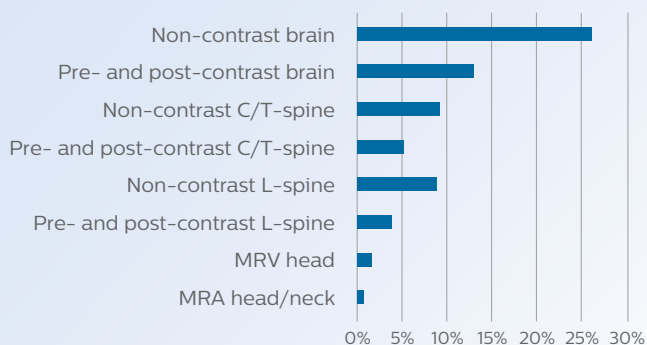
Changing established behaviors

The transition away from a predominantly CT-based ED began by educating physicians about the advantages of MRI in the emergency setting, when to use MRI, and the importance of targeted exams instead of broader, non-targeted exams.

Some resistance to the change was anticipated, as it was disrupting established routines. So a reasonable amount of time was planned for educating referrers, neuroradiologists and neurosurgeons, as well as residents and fellows. However, less time than anticipated was needed as all involved were already familiar with MRI and, more importantly, they were easily persuaded to learn about the 10-minute exam duration with MRI. >>

“The MRI scanner is available for targeted exams only. This requires referrers to think clearly about what they want to test.”

MRI exams in Neuro Emergency Department



Find more details on protocols on www.philips.com/fieldstrength

“We bring forward that the MRI exam time is similar to CT, which is very important to physicians”, says Dr. Karis. “One of the other points to stress is that the MRI scanner is available for targeted exams only. This requires referrers to think clearly about what they want to test. There must be a true commitment to the shorter time frame, otherwise the process won’t work.”

“Experienced neuroradiologists adapted fairly instantly – they knew the value of MRI and as such, quite quickly learned to use just the three or four sequences for their diagnosis. In fact, one came to me and asked ‘why don’t we do this for all of our patients, all the time?’ This is not realistic in our center, of course (e.g. because of issues relating to demand, availability, and the range of conditions dealt with) but it illustrates the confidence in the approach.”

The high value of a negative MRI scan

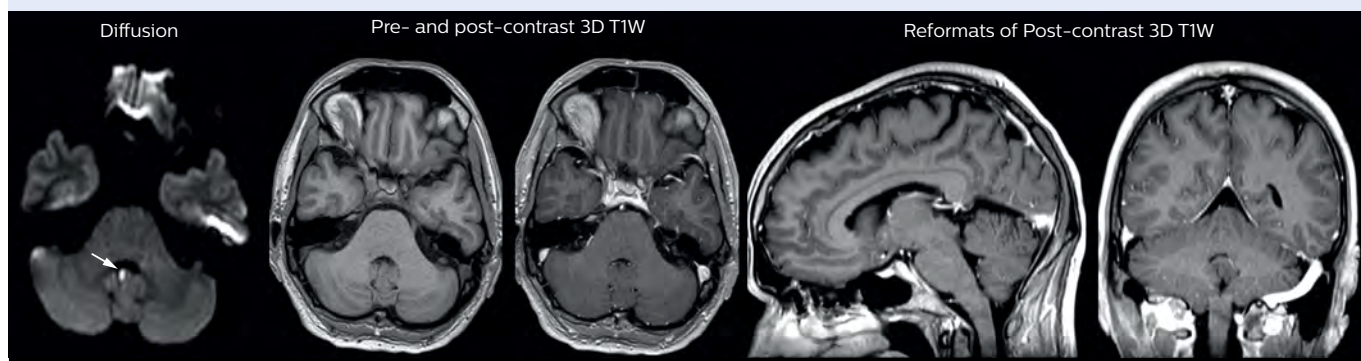
“One of the most important decisions an ED physician has to make is to admit or discharge their patient. So a physician who is better informed by an MRI exam can make this decision with more confidence. By converting to a test that has a far better potential to identify issues, physicians get a better and more certain diagnosis.”

MR angiography of head/neck

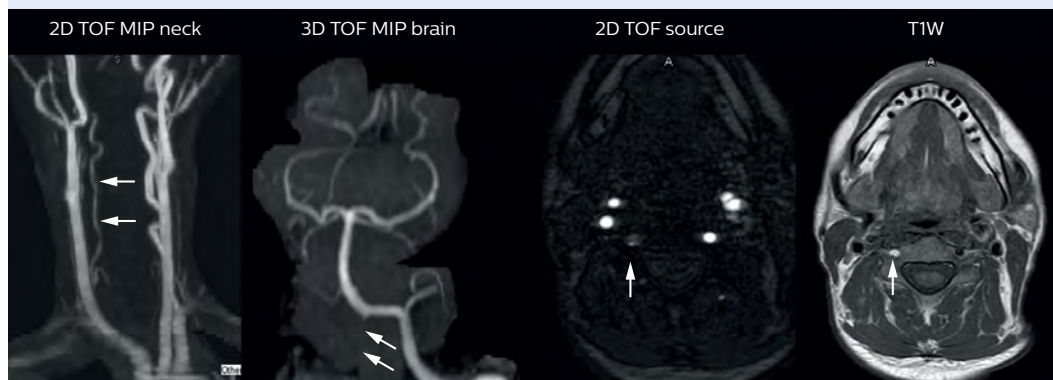
This patient, with complaints of transient weakness, presented at the ED. Pre- and post-contrast MRI on Ingenia 1.5T showed unremarkable results, except for one small diffusion abnormality focus in the posterior fossa, which was concerning for acute stroke. However, there were no additional findings in the pre- and post 3D T1W or the sagittal and coronal reformats. So, additional MR angiography of the head/neck was recommended.

A small right vertebral artery with only minimal flow is visualized on the 2D TOF image that is highly sensitive to flow and there is non-visualization of flow within the distal vertebral artery on the 3D TOF image. The axial source images of the neck show dissection of the right vertebral artery, with small residual lumen and reduced flow.

Pre- and post-contrast brain exam



MR angiography of head/neck



"In my experience a negative MRI, because it is so sensitive to abnormality, far exceeds the value of a negative CT. A negative MRI can allow physicians to be more confident about making discharge decisions, potentially reducing the number of admissions in cases of doubt, and offering cost savings for the institute."

"There are far more decisions being made to send people home than to admit. And in terms of making that decision, I believe there's no more valuable exam than a negative MRI for neurologic disorders."

"The only unforeseen challenge," says Dr. Karis, "was the tendency to still perform non-targeted exams, particularly among less experienced staff and new neurology or neurosurgery residents. Since MRI image quality is so excellent, it's just easier to ask for a number of tests, and then your exam goes from in-and-out in 10 minutes to much longer."

Targeted scanning is important

The ED physicians can only request exams from a selected set, represented on the protocol sheet, of exam protocols minimizing the time necessary for the MRI scan. The sheet contains advice as

to which scan to order (i.e. MRI vs. CT, contrast vs. non-contrast) depending on the situation, and encourages physicians to order targeted scans.

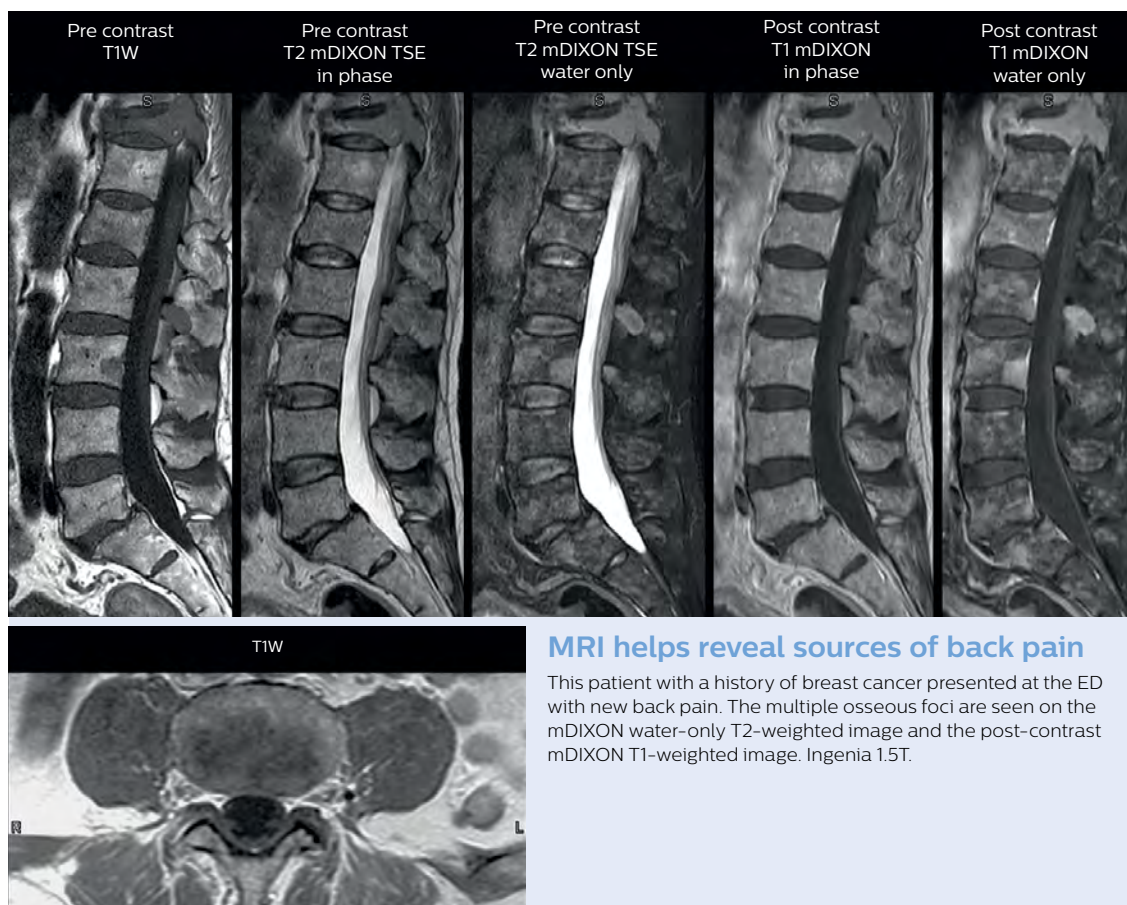
Even though the process has now been implemented, education still remains important. New neurology residents, for example, are informed as to the use of the ED MRI scanner, how it's being utilized, and the importance of targeted scanning.

"In my opinion, education has been crucial to establish the MRI exam as an ED test," says Dr. Karis. "This is really key. If you can't establish this concept, then you can't convert everyone to the mindset that this is an ED test."

Patient turnaround times on par with CT

"Our results show that a dedicated MRI in the ED can be effectively implemented; patient turnaround times with MRI are on par with CT. Interestingly, even though the MRI exam protocols are shortened, this robust yet rapid scanning still yields good quality images, further improving our workflow and almost eliminating the need for repeat scans or follow-up scans. So, we're heading towards first time right imaging," says Dr. Karis. >>

***"We're heading towards
first time right imaging"***

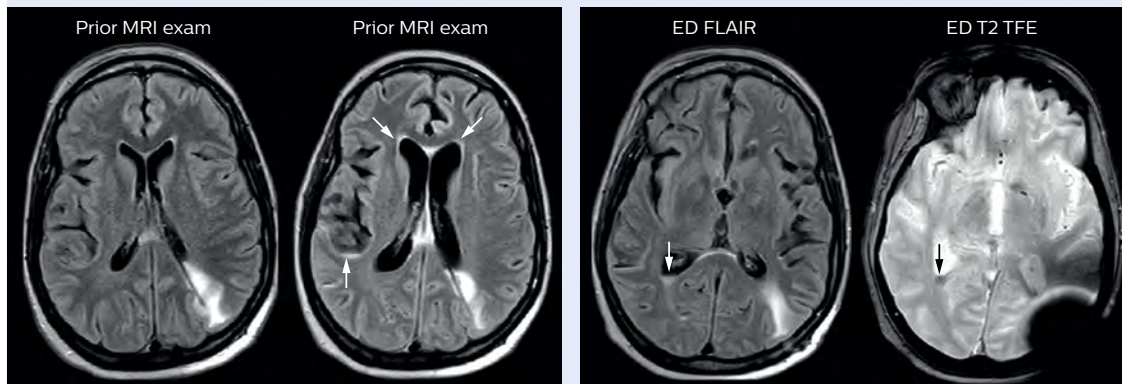


MRI helps uncover signs of meningeal carcinomatosis

A patient with previously resected metastatic focus from the posterior fossa, presented to the ED with new symptoms of meningismus and headache. The MRI exam done in the ED is compared to images from a previous standard, longer time, clinical MRI study with a higher resolution. The ED image shows interval increases in ventricular size and a new abnormal signal within the subarachnoid spaces (arrows), indicative of an underlying process that is either infectious or hemorrhagic. In this patient it turned out to be related to meningeal carcinomatosis.

The axial T2 gradient echo image shows a component of blood layering in the trigone of the right lateral ventricle. The FLAIR image also shows the layering as well as abnormal signal in the subarachnoid spaces.

The ED non-contrast brain exam includes sagittal T1W, axial DWI, FLAIR, T2 TFE, total scan time under 9 minutes on Ingenia 1.5T.



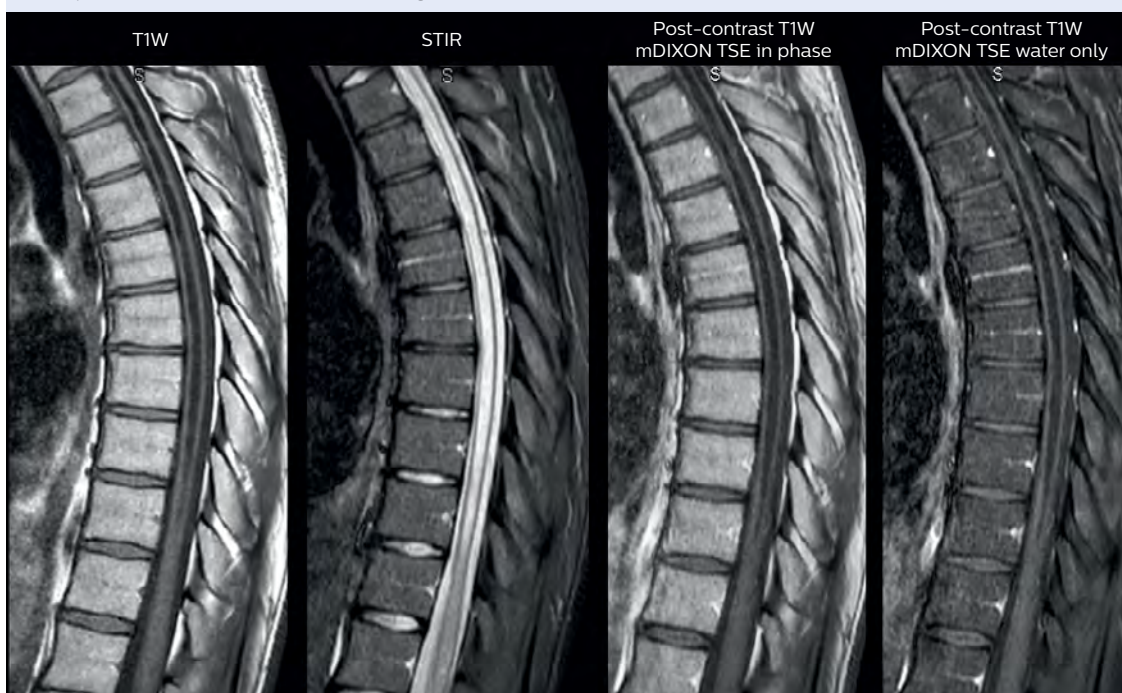
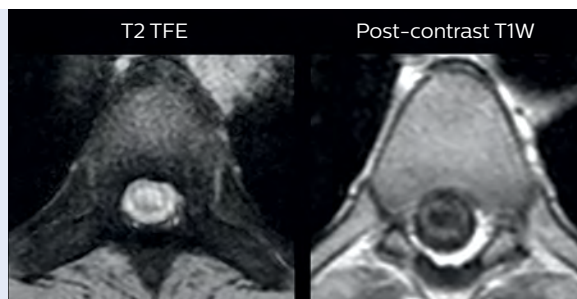
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Myelopathy imaging: the role of mDIXON

A patient with previously resected metastatic focus from the posterior fossa, presented to the ED with new symptoms of meningismus. Patients with myelopathy are recommended to get a contrast-enhanced study of the cervical or thoracic spine, depending on the level of finding. In case of myelopathy, a more traditional STIR exam is used instead of T2W mDIXON because of the slightly improved contrast within the cord. mDIXON is used for post-contrast T1-weighted imaging so that water-only and fat-plus-water post-contrast T1-weighted imaging is available.

Post-contrast axial T1W and axial T2W gradient echo is then performed, targeted to areas where the tech sees a clear finding in the patient, in order to keep the scan time short. Performed on Ingenia 1.5T.



“Before, when patients received CT in the ED, it was quite common that they would need an MRI afterwards. However, in the four months that I have logged data for this study, I have not become aware of a single patient that underwent MRI in the ED and had to come back for repeat imaging, probably because the protocols are so robust. Patients with complicated cases requiring specialty acquisition types are the most common reason for recalls at our institution.”

How to achieve a successful transition?

The successful incorporation of MRI into the ED is dependent on several factors, according to Dr. Karis.

“First, it is necessary to have the MRI in close proximity to the ED, bypassing the need for hospital staff to leave the ED for extended periods in order to accompany patients to other departments. Also, exams must be streamlined, so that they can be performed in about 10 minutes or less. Targeted scans should be ordered for the specific issue at hand, and non-targeted exams should be discouraged. In particular, neurology and neurosurgery residents who work overnight shifts should understand the shortened protocols, in the effort to avoid ordering extra scans that could extend exam times and hinder workflow.”

Dr. Karis recommends that a global view should be considered before the change can be implemented. “You need to look at everything, from metal screening and nursing, to transport and proximity to the ED, if you’re really going to make this transition successfully.”

Future plans: expansion to stroke and TIA patients

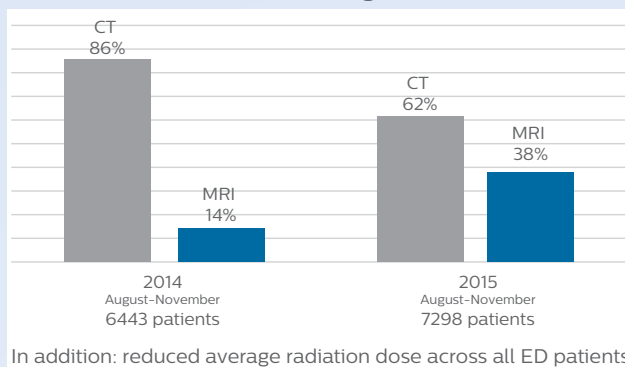
At St. Joseph’s Hospital and Medical Center, the dedicated MRI system in the ED has been shown to efficiently provide high quality MR images that assist physicians in making informed decisions on patient diagnoses and take a more definitive decision on follow-up. The decision to have a dedicated ED MRI has resulted in rapid patient turnaround, efficient patient management, and substantial reductions in radiation dose.

For Dr. Karis, the next goals for the neuro ED include converting the exams for acute stroke and TIA patients from CT to MRI, offering an alternative management option for these patients. Also, collaboration between other departments is currently underway, encouraging the performance of targeted exams with the ED MRI. These improvements in workflow and faster turnaround times may result in further reductions in scanning time. <<

“In the four months that I have logged data for this study, I have not become aware of a single patient that underwent MRI in the ED and had to come back for repeat imaging.”

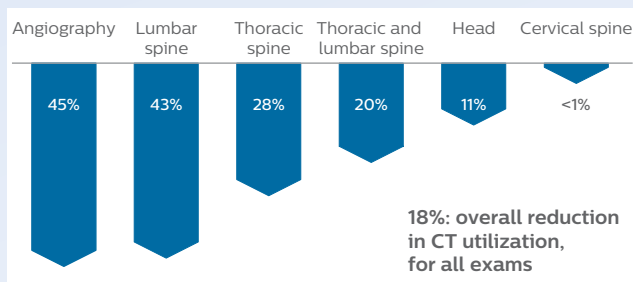
Growth of MRI in the Neuro Emergency Department

Distribution between MRI and CT before and after adding MRI in the ED



In addition: reduced average radiation dose across all ED patients

Reduced use of CT



Throughput and financials of MRI in Emergency Department

Analysis by St. Joseph’s Hospital and Medical Center

Throughput	Financials
1199 MR examinations in August 2016	All exams reimbursable
39 patients/day on average	\$453.71 average hospital reimbursement per patient, which equates to
Highest day: 62 exams in 24 hours	\$554,000 MR revenue for August 2016.
Scanner operation	>1.5 million coded reimbursement over 3 months (June – August 2016)
7 days a week	This reimbursement does not include the professional fee the radiologists get on top of the hospital coded reimbursement.
99.2% uptime (June-August 2016)	

References

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2. Grimm JM, Schindler A, Schwarz F, Cyran CC, Bayer-Karpinska A, Freilinger T, Yuan C, Linn J, Trelles M, Reiser MF, Nikolaou K, Saam T. Computed tomography angiography vs 3 T black-blood cardiovascular magnetic resonance for identification of symptomatic carotid plaques. J Cardiovasc Magn Reson. 2014;16:84.

Expanding **whole body MRI** use in oncology patients

Improved coronal DWIBS whole body protocol shortens exam time and increases referrals at Kawasaki Saiwai Hospital

Recognizing the clinical utility of whole body MR imaging, radiologists at Kawasaki Saiwai Hospital (Kasawaki, Japan) began offering whole body diffusion weighted imaging (DWI) in 2009 for oncology patients. In 2012, the hospital installed a Philips scanner, the Ingenia 1.5T. The dStream digital architecture and highly linear gradients of Ingenia allowed them to switch to coronal – rather than axial – whole body DWI, and were key to developing a fast, high quality protocol that has led to increased referrals and decreased dependence on nuclear medicine imaging.



Hiroshi Nobusawa, MD, PhD, Radiologist at Kawasaki Saiwai Hospital, Japan



Takanori Naka, MR technologist at Kawasaki Saiwai Hospital, Japan

High contrast between lesions and background is beneficial in oncology patients

Radiologist Hiroshi Nobusawa, MD, PhD, explains that the coronal DWIBS protocol for whole body DWI is excellent for visualizing lesions in oncology patients. “About 90% of the DWIBS exams are done in this type of patients. The remainder of DWIBS exams are performed to gain information in cases of fevers of unknown origin,” he says.

“The DWIBS sequence’s value in oncology cases is due to the high contrast it creates between lesions and surrounding tissue. Whole body DWI is requested by physicians who need to clarify TNM staging or determine therapeutic strategies, oncologists in need of diagnosis or follow-up scans, surgeons who need to see the presence of distant lesions that are sometimes difficult to detect by CT before surgery, and urologists for the evaluation of bone lesions, and the effect of chemotherapy and radiotherapy.”

Shorter exam time needed for improving patient acceptance

“Before we had Ingenia, clinical adoption was hindered because the exam length of the whole body DWI protocol on our old system was difficult for many patients to tolerate,” says Takanori Naka, MR technologist.

“The value of DWIBS in oncology cases is due to the high contrast it creates between lesions and surrounding tissue”

“The Ingenia 1.5T allowed us to improve our whole body DWI scan and make the exam time more tolerable for patients”

“In our initial whole body DWI, we scanned from the top of the head to the toe in axial orientation. Because that took a lot of time, it constrained the examination to performing only coronal TSE and the axial whole body DWI scans. So, we had to compromise on clinical information to keep the exam to a reasonable length.”

“Fortunately, the Ingenia 1.5T system allowed us to improve our whole body DWI scan and make the exam time more tolerable for patients,” says Mr. Naka.

More clinical information in much shorter exam time

“Once Ingenia was available, our first goal was to shorten the exam time of our scan,” says Mr. Naka. “The next goal was to create a protocol that provided more clinical information.”

“When we limited the scan coverage to the area from neck to femur, we could fit more clinical information in approximately the same scan time. So, we added coronal mDIXON, sagittal T1-weighted, and sagittal STIR sequences to our examination, instead of performing only axial DWIBS and coronal single-shot TSE scans.”

The single shot T2-weighted TSE images are used for morphology and compared to DWIBS images to identify T2 shine-through. Sagittal STIR images are used in patients with inflammation or bone metastasis.

Coronal DWIBS is faster and improves image quality

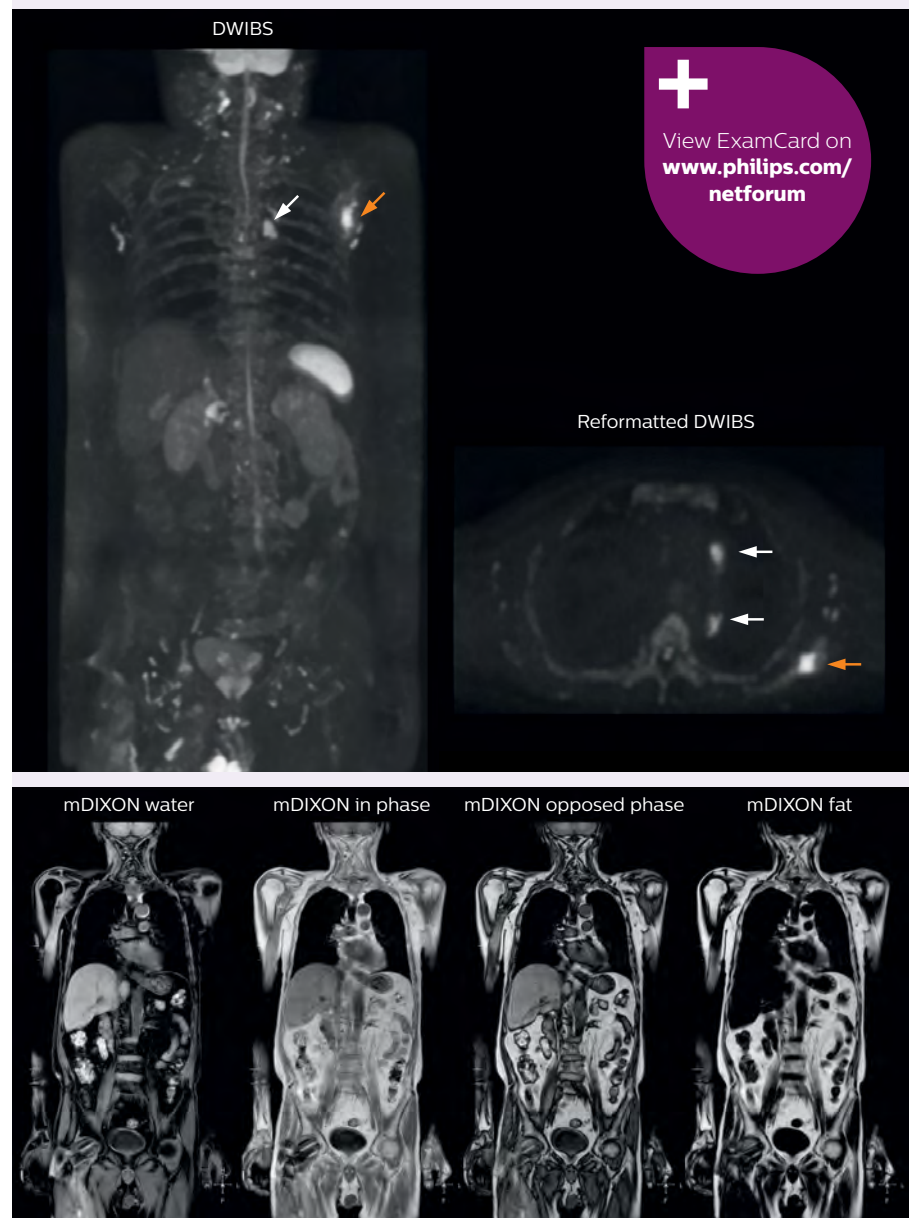
“Switching to coronal DWIBS – rather than axial – further shortens scan time,” says Mr. Naka. “Important is that a dS SENSE factor of 5 shortens exam time, while high SNR can be maintained, thanks to Ingenia’s dStream architecture.” He adds that the coronal orientation also avoids artifacts that are specific to combining axial images. >>

DWIBS helps discover lesions

For this 74-year-old male patient diagnosis seemed difficult based on the patient’s complaint, but a pathological fracture was suspected. It was decided to send the patient to MRI for a whole body DWIBS exam. Abnormalities were discovered on the DWIBS images and reformats (arrows).

The final diagnosis turned out to be left superior lobe cancer, mediastinal lymph node metastasis.

The ExamCard used is Ingenia 1.5T Whole body with DWIBS for oncology follow-up.



View ExamCard on
[www.philips.com/
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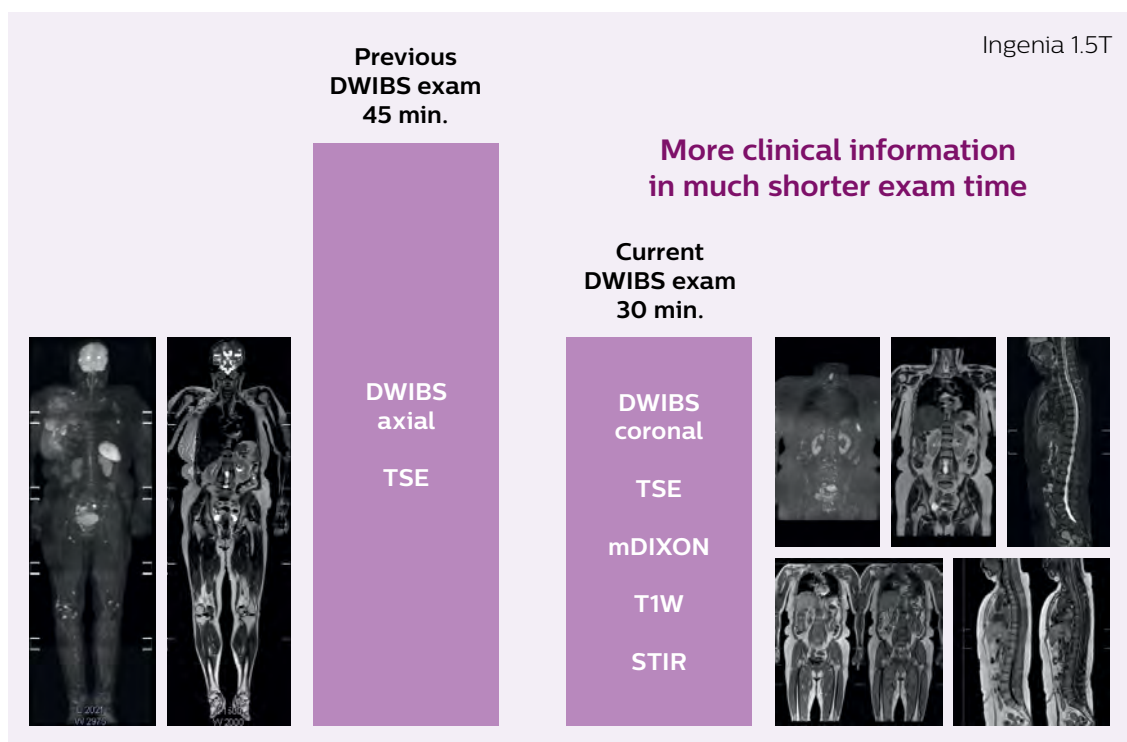
Reformatted DWIBS

mDIXON water

mDIXON in phase

mDIXON opposed phase

mDIXON fat



“We added three sequences to our examination, instead of performing only axial DWIBS and coronal TSE”

“When we use a coronal DWIBS acquisition, we can perform a full whole body examination, including other required sequences, within 30 minutes,” Mr. Naka says.

“This is considerably faster than the previously used exam with axial whole body DWI, which took more than 45 minutes,” he notes. “A shorter exam is more patient-friendly and allows us to also use it on patients in poor health who would have difficulty tolerating a long exam. Limiting the exam time is also helpful for scheduling, because it fits in a normal single exam timeslot.”

mDIXON FFE enriches the whole body exam without scan time penalty

Kawasaki Sawai Hospital’s whole body protocol also includes an mDIXON FFE sequence. Because mDIXON provides images for four contrast types – water only, fat only, in-phase and out-of-phase – from a single acquisition, it is useful in many ways.

“mDIXON FFE allows us to quickly get information we need to assess the presence of fat. That gives us more information when we need to diagnose bone lesions, and when we are asked to judge the degree of hepatocellular carcinoma,” Dr. Nobusawa says.

“The mDIXON fat images can help us to differentiate fatty bone marrow from bone lesions. This is especially useful in elderly people, who tend to have fattier bone marrow. The water images

provide a high signal-to-noise ratio in the intestinal canal, which is valuable for visualizing lesions in the colon,” he says.

“In-phase and out-phase sagittal T1-weighted FFE images help us to visualize and further characterize bone lesions such as metastasis and bone marrow hyperplasia that have high signal on DWI. These images are also used throughout radiotherapy, to monitor changes in the fatty bone marrow.”

Active education of referring physicians helped increase referrals

After implementing the improved whole body protocol, the radiology team initially did not see a large increase in referrals, although Dr. Nobusawa saw clinical cases where the DWIBS images provided him valuable information for diagnosis. This is why Dr. Nobusawa and Mr. Naka started to actively educate referring physicians about the value of whole body DWIBS. They organized several presentations for physicians in the hospital, where they explained how DWIBS can be of value for oncology patients. The information it provides can be useful for physicians when staging cancer, as well as when determining or adjusting treatment strategy.

As oncologists and surgeons have learned more about DWIBS, referrals for the exams have increased. In 2015, the 326-bed hospital’s radiology department doubled their number of whole body DWIBS exams compared to 2014. >>

Whole body MRI of bone lesions in spine

This oncology patient received a diagnosis of EOD grade 2 after bone scintigraphy. The lesions in the spine (red ellipse) were thought to be age-related bone marrow effects. When the patient was sent to MRI one month later, he was scanned with the whole body oncology protocol. Many bright bone lesions were seen (yellow ellipse) on the DWIBS images.

The Dual FFE in-phase and opposed-phase images can help the physician to further characterize the lesions. Fatty bone marrow would be expected to appear bright on both in-phase and opposed phase images. Hematopoietic bone marrow would be expected to appear mid-gray on in-phase and dark on opposed phase images. The lesions in this patient are mid-gray on both in-phase and opposed-phase images.

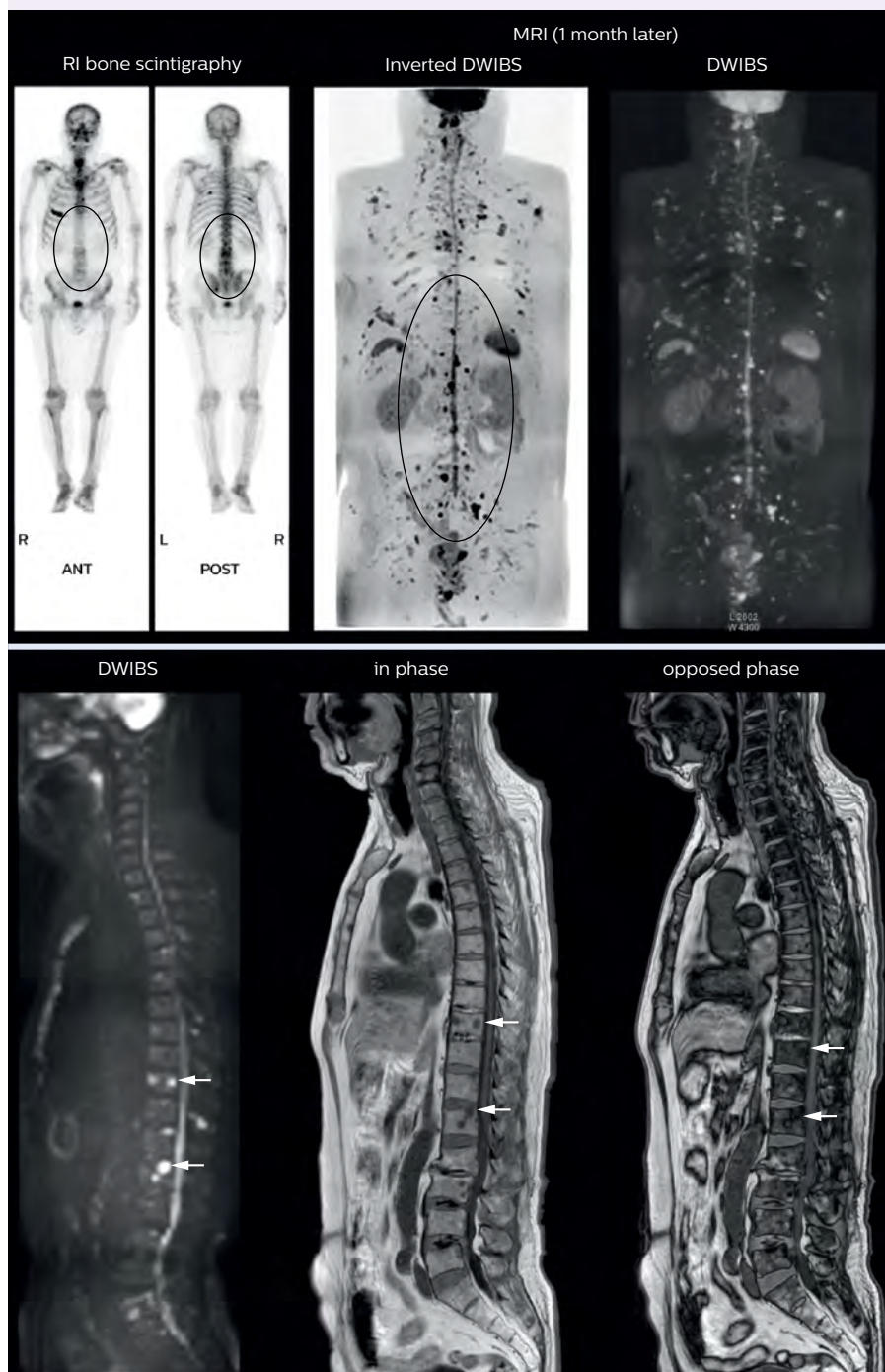
The therapy plan for this patient was changed from radiotherapy to pain relief in line with EOD grade 4.

The ExamCard used is Ingenia 1.5T Whole body with DWIBS for oncology follow-up.

“When we use coronal DWIBS, we can perform a full whole body examination, including other required sequences, within 30 minutes”



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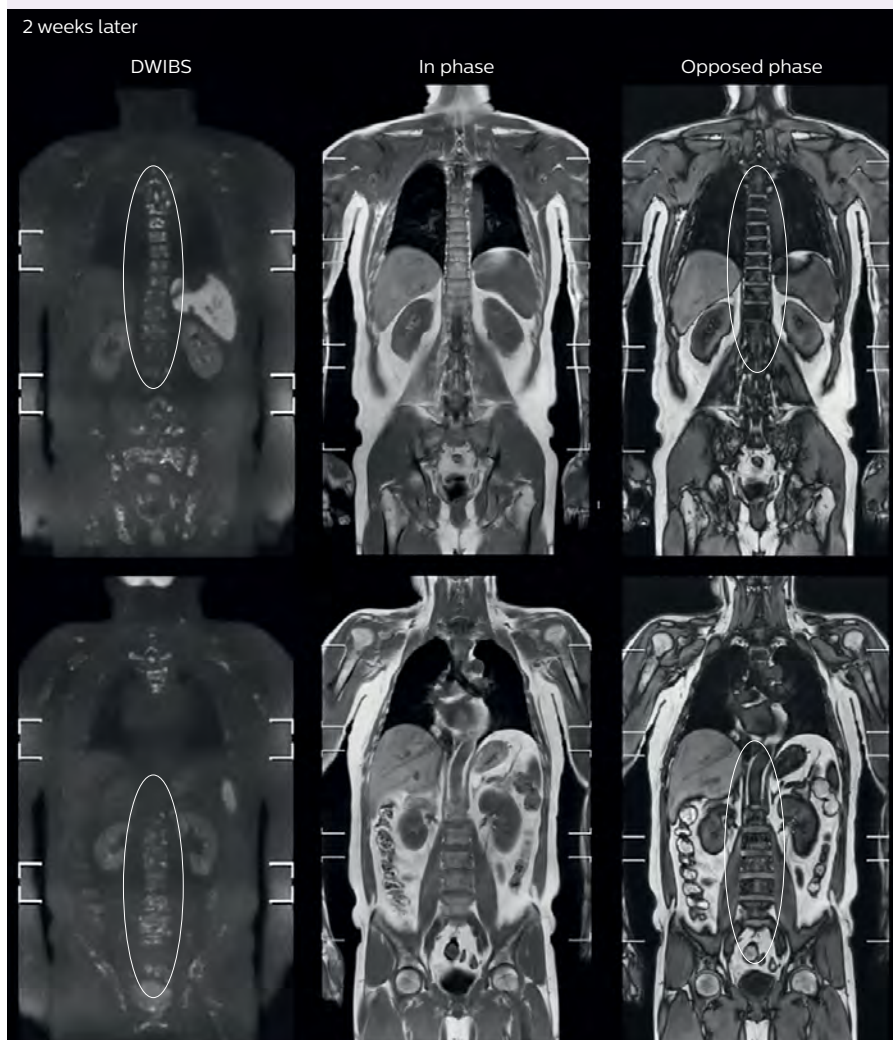
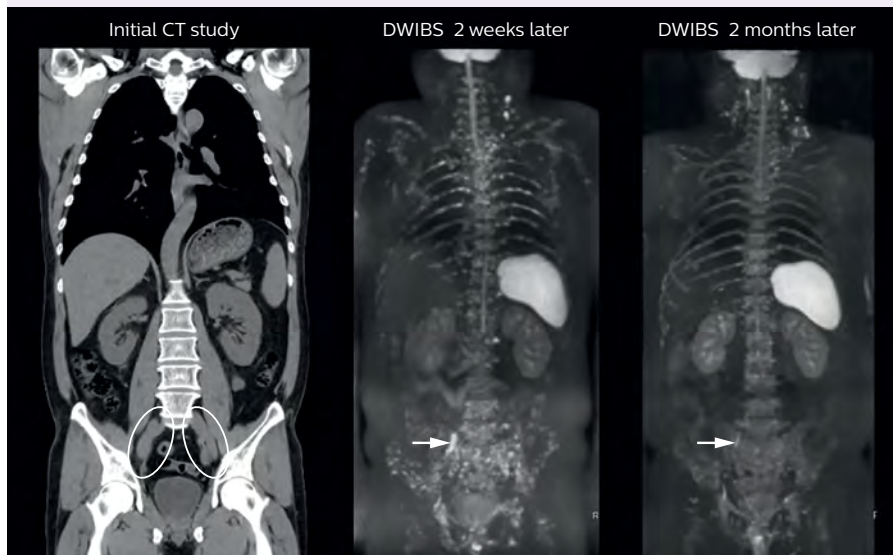
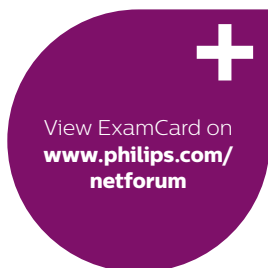
	In phase	opposed phase
Fatty bone marrow	●	●
Hematopoietic bone marrow	●	●
Bone metastasis	●	●

MRI of patient with unknown fever

A 62-year-old male patient with fever of unknown origin and a normal appearance on CT was referred to MRI. Abnormalities are seen on whole body DWIBS images (ellipse), which could be compatible with bone marrow hyperplasia or metastases. Lesions show diffuse low signal on the opposed-phase images, which is consistent with bone marrow hyperplasia.

Diagnosis is right iliopsoas muscle cellulitis and diffuse bone-marrow hyperplasia.

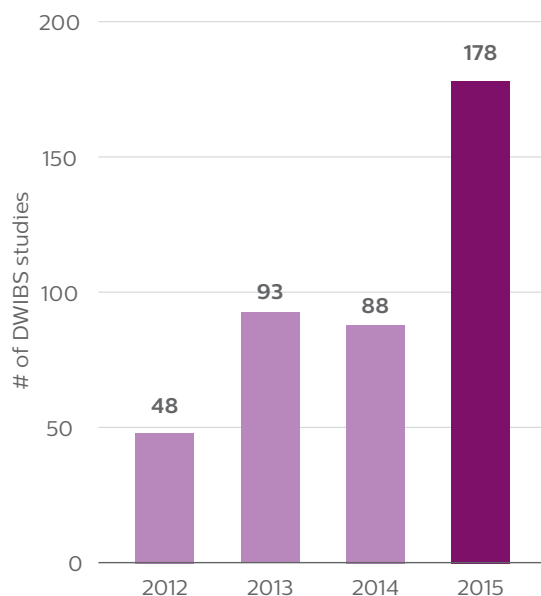
The ExamCard used was Ingenia 1.5T Whole body with DWIBS for patients with fever of unknown origin



“mDIXON FFE allows us to quickly get information we need to assess the presence of fat and to diagnose bone lesions”

	in phase	opposed phase
Fatty bone marrow	●	●
Hematopoietic bone marrow	●	●
Bone metastasis	●	●

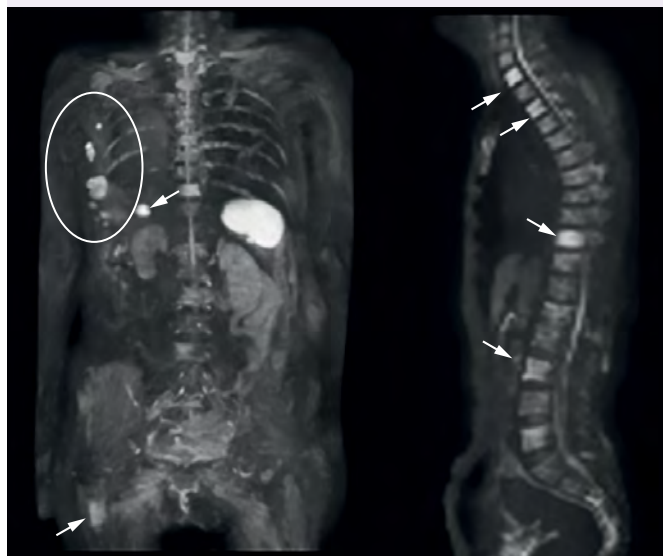
Increased referrals



DWIBS of metastasized breast cancer

A patient with metastasized breast cancer underwent MRI. Many abnormalities are easily seen on the DWIBS images. Abnormalities in bone are believed to be due to hypercellular bone marrow.

The ExamCard used is Ingenia 1.5T Whole body with DWIBS for oncology follow-up.



“As oncologists and surgeons have learned more about DWIBS, referrals for the exams have increased”

Mr. Naka remembers some cases where DWIBS provided remarkable information. “In one example, DWIBS visualized bone lesions that could not be seen on PET or SPECT. In another case we found a bone lesion when a normal L-spine scan for narrowing of the disk space was done. One extra DWIBS scan (2 stations, 8 minutes) demonstrated a lesion that later was confirmed to be the primary region of cancer.”

Ingenia 1.5T and physician education accelerate acceptance

Dr. Nobusawa notes that acceptance of whole body DWI accelerated after the hospital installed the Ingenia 1.5T which allowed them to optimize the protocol to their needs. “The Philips system helped us promote the technique, because the DWIBS image quality was so high with Ingenia. It provides high quality in the coronal images, and a short acquisition time plus high SNR thanks to the dStream technology,” he says.

In certain cases, radiologists now choose DWIBS to make diagnoses that used to depend on nuclear medicine studies. “We don’t have SPECT or PET in our hospital, so for instance for visualizing metastasis and monitoring the effect of treatments such as chemotherapy or radiotherapy, we used to refer patients outside the hospital. Now, these patients are sent to MRI for our whole body protocol with DWIBS,” Mr. Naka says. “Our radiologists are confident when using our current exam with DWIBS and appreciate that it provides more information

than nuclear medicine. The number of referrals is increasing, including referrals from other hospitals that cannot provide DWIBS. And because the scan time is short, we immediately choose DWIBS when oncology patients are referred.”

Finally Dr. Nobusawa concludes, “As soon as you understand the usefulness of DWIBS exams with the Ingenia system, surely you would like to use it. We hope that DWIBS one day will be adopted as a gold standard in the care for oncology patients.” <<

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Black Blood imaging of HIV patient with **brain vasculitis**

helped in suggesting the diagnosis and choosing treatment



Niloufar Sadeghi MD, PhD, is neuroradiologist at Erasme Hospital in Brussels, Belgium since 2000. She completed her PhD in 2010 and has been recently nominated as professor.

In a patient with HIV and cardiovascular risk factors, MRI with Black Blood imaging helped to diagnose brain vasculitis. The same MRI protocol was later also used to noninvasively confirm treatment response. Dr. Sadeghi presents this case below.

Patient history

A 56-year-old patient presented in the Emergency Room at Erasme Hospital in Brussels, Belgium, with recurrent left leg weakness that had been occurring over a period of 24 hours. The patient was known to have been HIV infected for four years, but was not treated for this infection. The patient had multiple cardiovascular risk factors such as obesity, glucose intolerance, arterial hypertension and hypercholesterolemia. The neurological examination showed left leg hemiparesis.

MRI examination

After a conventional routine MR imaging examination, the suspicion of vasculitis arose, therefore we performed an MRI including Black Blood imaging in a separate session. The dedicated ExamCard includes diffusion, FLAIR, MR angiography using TOF, and 3D T1 MRA with bolus injection. This ExamCard also includes Black Blood imaging before and after contrast. The examination was performed on our Ingenia 3.0T.

Findings of the exam with Black Blood imaging

On the routine MR sequences that we did, we could see acute ischemic lesions. We typically see them very well on the diffusion images, where acute ischemic lesions usually appear with high signal intensity and restricted diffusion. However, the etiology of these lesions cannot be derived from these images.

An area of restricted diffusion was seen in the anterior cerebral artery territory and we concluded it was an ischemic lesion. On MR angiography we can just see if there is stenosis or

vessel occlusion, but it does not provide us information on the etiology of this kind of lesion.

So, we decided to perform Black Blood imaging. The presence and the pattern of vessel wall enhancement on Black Blood imaging, can help us to determine the etiology of the lesion.

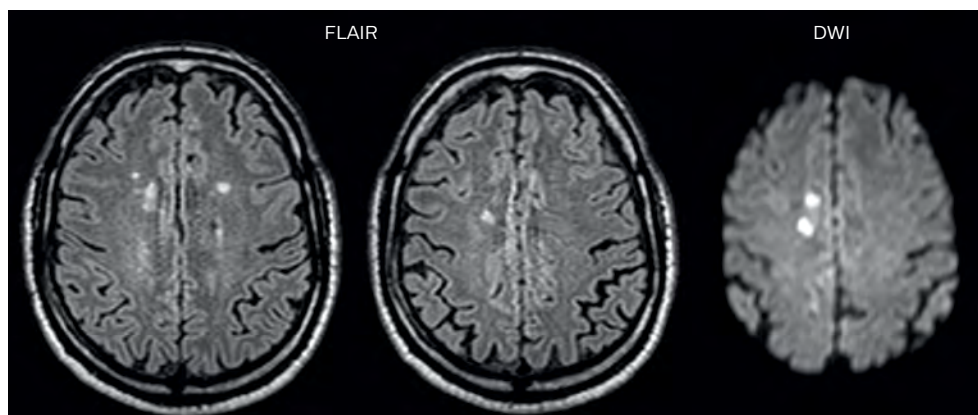
Many studies have shown that Black Blood imaging can help differentiate vasculitis from other causes of vasculopathy, such as atherosclerosis, with a high specificity [1-3]. In an atherosclerotic lesion, vessel wall thickening and enhancement are usually eccentric, while in vasculitis the wall thickening and enhancement are usually concentric, homogenous, and in a long portion of the vessel.

Furthermore, this imaging can also be used for the follow-up of patients whenever their treatment is established in order to determine the efficacy of a particular treatment.

In this case the Black Blood imaging helped us to suggest the diagnosis of HIV-related brain vasculitis.

Impact of Black Blood imaging for this patient

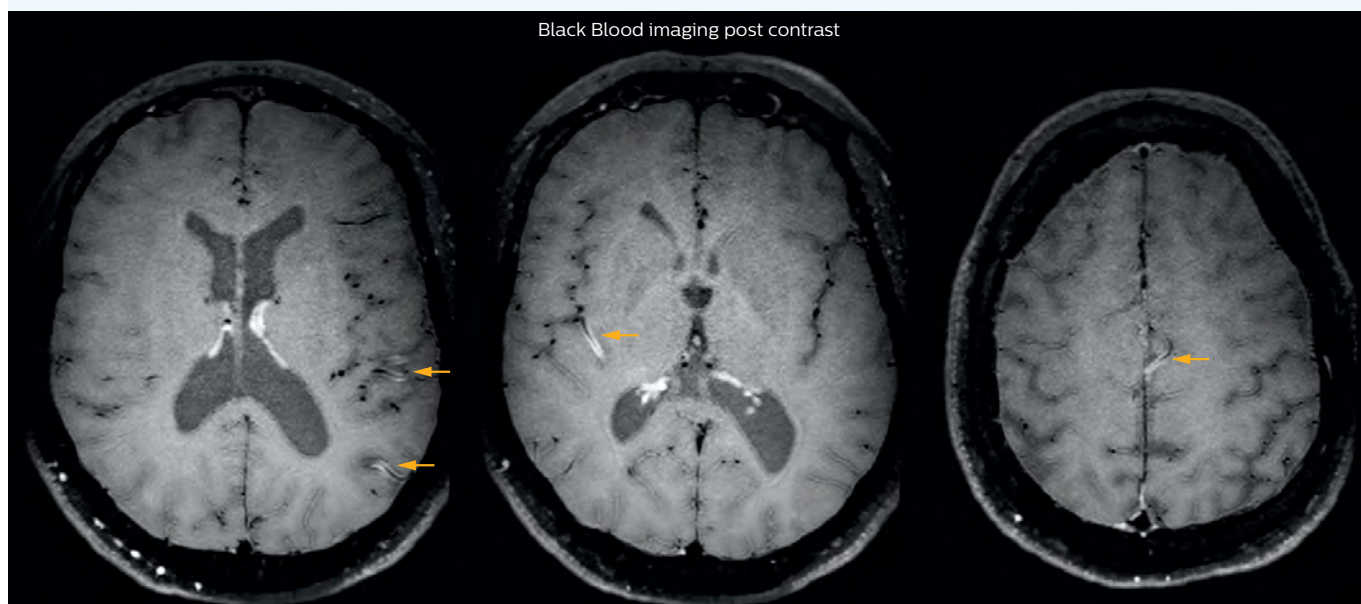
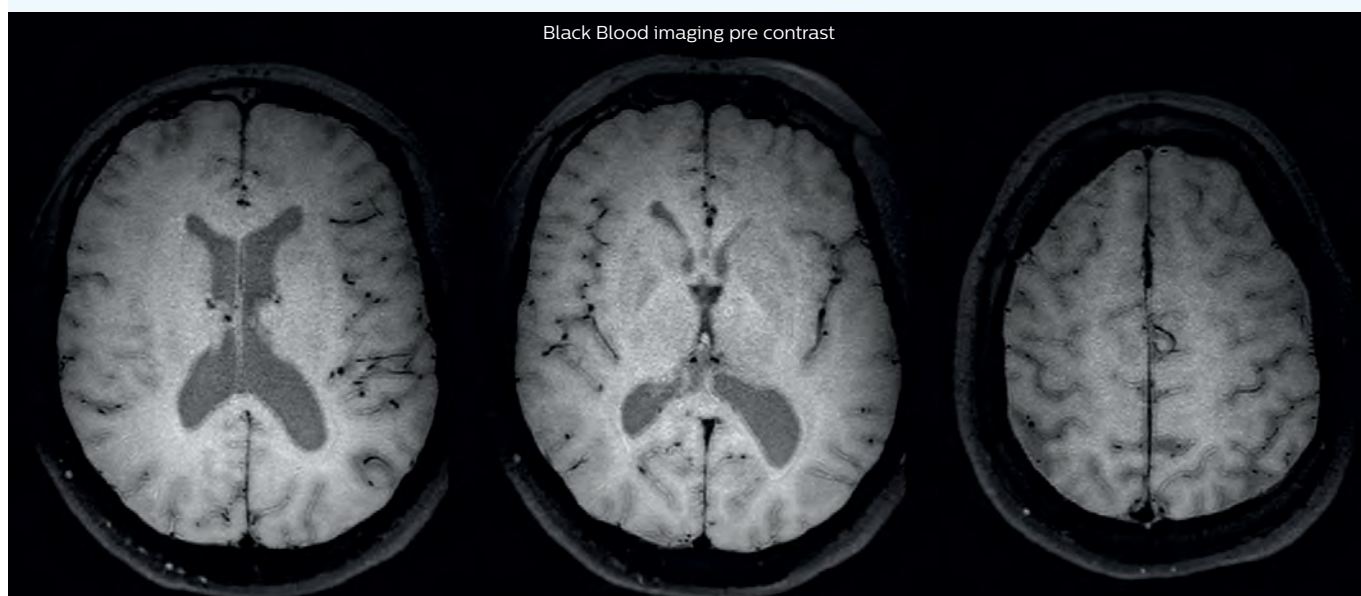
With the multiple cardiovascular risk factors this patient had, such as glucose intolerance, arterial hypertension and hypocholesterolemia, his lesions could be atherosclerotic lesions or vasculitis, conditions which require different treatment. Especially in this patient with HIV infection causing the vasculitis, treatment of the two conditions is different. >>



MRI with Black Blood imaging

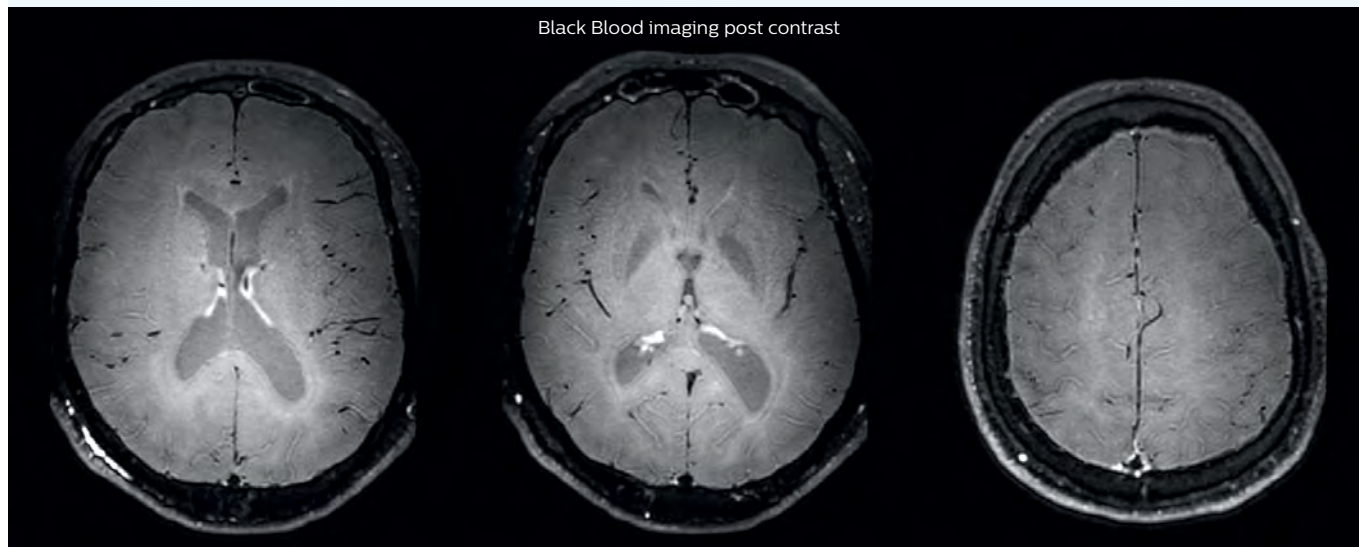
On FLAIR images we can see some nonspecific high signal abnormalities in frontal white matter bilaterally. On DWI we can see acute ischemic lesions which appear with high signal intensity. Arrows show vessel wall enhancement which appears concentric and homogeneous in different cerebral territories.

Black Blood scan time 4:39 min, acquired voxel size 0.75 x 0.75 x 1.0 mm, 21 slices, Ingenia 3.0T.



Black Blood imaging after one month

After one month of treatment, post-contrast Black Blood images at the exact same levels as in the first exam show disappearance of the vessel wall enhancements which were seen on the previous examination.



The results of MRI with Black Blood imaging, helped us to choose the preferred treatment for this patient, which was based on antiviral medication rather than an antiaggregant or anticoagulation treatment, which is usually given to patients with risk of ischemia based on atherosclerotic lesions.

One month after beginning the antiviral treatment, the same MRI examination was repeated, and again 8 months after the beginning of treatment. On follow-up images, we see the enhancements have almost disappeared.

So in case of this patient, the MRI exam with Black Blood imaging helped us to give the patient the appropriate treatment and also allowed us to noninvasively confirm the treatment response.

The importance of Black Blood imaging

Black Blood imaging can help us to noninvasively visualize vessel wall thickening and enhancement patterns that occur in vasculitis, and help us distinguish it from atherosclerotic lesions. Imaging techniques such as time-of-flight (TOF) MR angiography are not very sensitive or specific for this kind of lesions. Other possible diagnostic methods are intra-arterial angiography or brain biopsies, both of which are invasive.

Recommendations for using Black Blood imaging

We do not perform this examination with Black Blood imaging on all patients with ischemic lesions in the brain, because in most patients the lesion origin is embolic or atherosclerotic. We typically use it in young patients (less than 60 years old) or those patients without cardiovascular risk factors. We find it important to use Black Blood imaging in such cases, because treatment is different for a patient with vasculitis. ««

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Black Blood imaging

Philips Black Blood imaging is 3D brain imaging with reduced intraluminal blood signal¹ over the complete imaging volume in the brain.

It helps you to better differentiate intraluminal blood signal from other signal, which can enhance diagnostic confidence.

The Black Blood sequence allows fast², isotropic 3D imaging, higher spatial resolution³ and reformatting in any plane without loss of resolution.

1. Compared to our 3D T1W scan without MSE prepulse
2. Compared to our 2D double inversion recovery methods with same full brain coverage
3. Compared to our 2D double inversion recovery methods with same brain coverage and scan time

UVM upgraded brain MRI protocols with latest methods

UVM appreciates latest neuro MR methods for diagnosing and workflow

The MRI staff at UVM Medical Center has evaluated recent methods to identify how their brain protocols can be improved. In these studies, they saw the latest methods for susceptibility weighted imaging, motion reduction and perfusion imaging provide significant differences that benefit diagnostic confidence and are favorable for workflow. Their evaluation convinced them to incorporate SWIp, MultiVane XD and pCASL into their standard MR exams, which also helps them contribute to a first time right approach for their patients.

Leading the way for neuro diagnostic imaging into a broader framework

As the University of Vermont (UVM) Medical Center in Burlington, Vermont, strives to provide a high level of patient care, the MRI team is always watchful for ways to increase diagnostic value. The team is driven to explore the added value of new methods, provided these help improve their exams and broaden the diagnostic scope of MRI. When additional methods for brain MRI became available to them, they systematically compared these methods with their previous standards to investigate the benefits and determine how these could help them expand their capabilities or improve their way of working. »

“We switched over entirely. SWIp is now included in all our routine brain exams”



Joshua Nickerson, MD, is the Medical Director of the University of Vermont MRI Research Center. His research interests include novel MRI-based perfusion techniques for functional brain imaging, high resolution MR imaging of the orbit, and new methods for using MRI to evaluate multiple sclerosis. He is also involved in several interdisciplinary studies in the UVM research community.

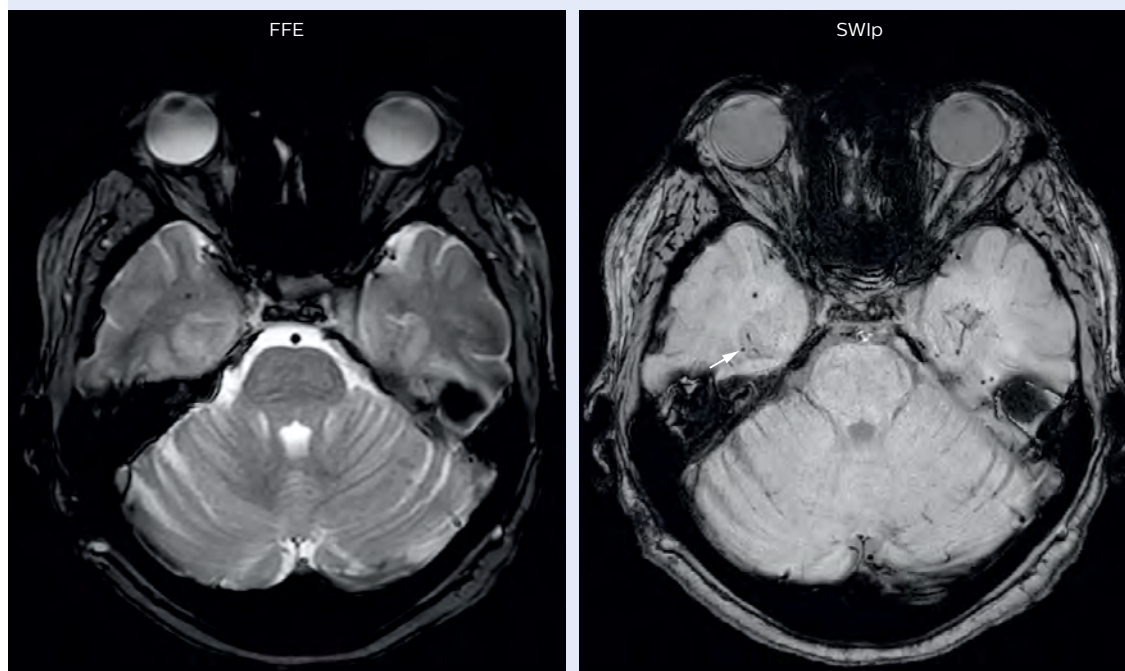


Richard Watts, PhD, is Co-Director of the University of Vermont MRI Center for Biomedical Imaging, and an Associate Professor in the Department of Radiology. His academic interests include T1-weighted imaging in multiple sclerosis, Alzheimer's disease, brain tumors, multimodal imaging of mild traumatic brain injury (mTBI), therapeutic hypothermia, and imaging connectomes using high b-value diffusion imaging.

“For us, SWIp use has resulted in more diagnostic confidence when small lesions need to be detected”

Hemosiderin foci in brain

Gradient echo imaging and SWIp are compared in a patient with radiation-induced foci of hemosiderin deposition. A greater number of small foci is seen on the SWIp image. Ingenia 3.0T



SWIp in patients with hypertension, amyloid angiopathy, trauma

The SWIp sequence offers high resolution 3D susceptibility weighted brain imaging, which helps to visualize deoxygenated blood or calcium deposits. In combination with other clinical information, it may help in the diagnosis of various neurological pathologies.

Neuroradiologist Joshua Nickerson, MD, discusses their findings in comparing SWIp versus T2*-weighted imaging in different types of patients. “With SWIp we are basically looking for blood byproducts. It is a sensitive method for visualizing small lesions containing deoxygenated blood. In our comparison study, SWIp images are vastly better than gradient echo imaging, there’s no question of that anymore.”

“We find the SWIp images very useful in three areas in particular. In patients with a history of hypertension, it offers clear

visualization of hemosiderin deposition from hypertensive hemorrhages. We certainly see a greater number of foci of hemosiderin deposition on the SWIp images than on the T2* gradient echo images. In addition, it also helps us visualize amyloid depositions in patients with amyloid angiopathy.”

Dr. Nickerson mentions trauma patients are the third large area where SWIp is useful. “We benefit from SWIp in trauma patients, certainly in cases with diffuse axonal injury and shearing injuries. Our study shows that SWIp usually provides better visualization,” he says.

“Apart from these three, SWIp also helps us to beautifully depict the normal venous anatomy in patients with venous outflow issues or vascular congestion. In some cases, we have seen downstream effects of arterial problems. And in patients with vascular malformations we have seen deposition of blood products associated with those.”



University of Vermont MRI Center

“Motion artifacts can obscure subtle findings”

UVM incorporates SWIp in all of their brain exam protocols

“We switched over entirely. SWIp is now included in all our routine brain exams. We developed two different SWIp sequences: a high spatial resolution (0.5 x 0.5 mm) version that takes 5.5 minutes and our fast SWIp that takes just three minutes. Only in patients that are moving tremendously do we occasionally still acquire a gradient echo sequence.”

“For us, SWIp use has resulted in more diagnostic confidence when small lesions, such as small shear injuries, vascular malformations, or minute amounts of calcification, need to be detected,” says Dr. Nickerson. “Our physicians greatly value the SWIp images. When we get patients transferred from other facilities with SWIp missing from their exam, we have several neurologists and neurosurgeons who order a new MRI exam because they want to see the SWIp images.”

Diagnostic imaging in presence of motion

“Motion artifacts can obscure subtle findings, make image interpretation more difficult and decrease diagnosis confidence. For example, when imaging the cerebellum or brain stem, or when looking for subtle multiple sclerosis (MS) lesions, motion can be problematic,” says Dr. Nickerson.

MultiVane XD motion-free imaging delivers diagnostic images even in the case of severe patient motion. A more relevant patient group is one with typical small artifacts related to moderate motion like an occasional cough. The absence of those artifacts

brings forth better day-to-day diagnostic confidence. MultiVane XD works in multiple orientations and for various contrasts, such as T1-weighted, T2-weighted and FLAIR.

Trevor Andrews, PhD, explains that the team compared motion artifacts seen in the brain with MultiVane XD and with T2-weighted TSE. “In nine out of the ten datasets in our study, we saw clear improvements with MultiVane XD, while in the tenth dataset image quality was comparable. The MultiVane XD sequence is now used in the majority of patients that present at UVM for brain MRI.”

Motion-free imaging of white matter changes with MultiVane XD

“We saw MultiVane XD provide remarkable improvement, not only for artifacts caused by patient motion, but also for the extent of pulsation artifacts in the basal cisterns. Based on these results, we have added the MultiVane XD sequence to our brain studies,” says Dr. Nickerson.

“MultiVane XD is especially useful when imaging patients with diseases that cause white matter changes on T2-weighted images, such as MS, small vessel disease, vasculitis and sarcoidosis,” says Dr. Nickerson. “Many of these are only visible on T2-weighted or FLAIR images, and sometimes aren’t even seen with FLAIR images. However, when using MultiVane XD and we don’t see any motion on the rest of the scan, but still do see a signal abnormality, we can probably attribute that to a real disease process, rather than an artifact.” >>

If patient motion would not hamper workflow

As workflow can suffer significantly from patient motion, a good motion reduction technique is also desirable from that perspective. According to UVM technologist Sarah Comtois, technologists used to spend much time on communicating with patients who tended to move, supplying extra padding for the head, re-running sequences, and consulting with radiologists to ensure that the results were acceptable.

For Dr. Nickerson, MultiVane XD adds substantial value: “It’s not just time being saved on the technologist’s side,” he says. “If the use of MultiVane XD would result in fewer calls back to the reading room to evaluate images of questionable diagnostic value, there are significant time savings there, too.”

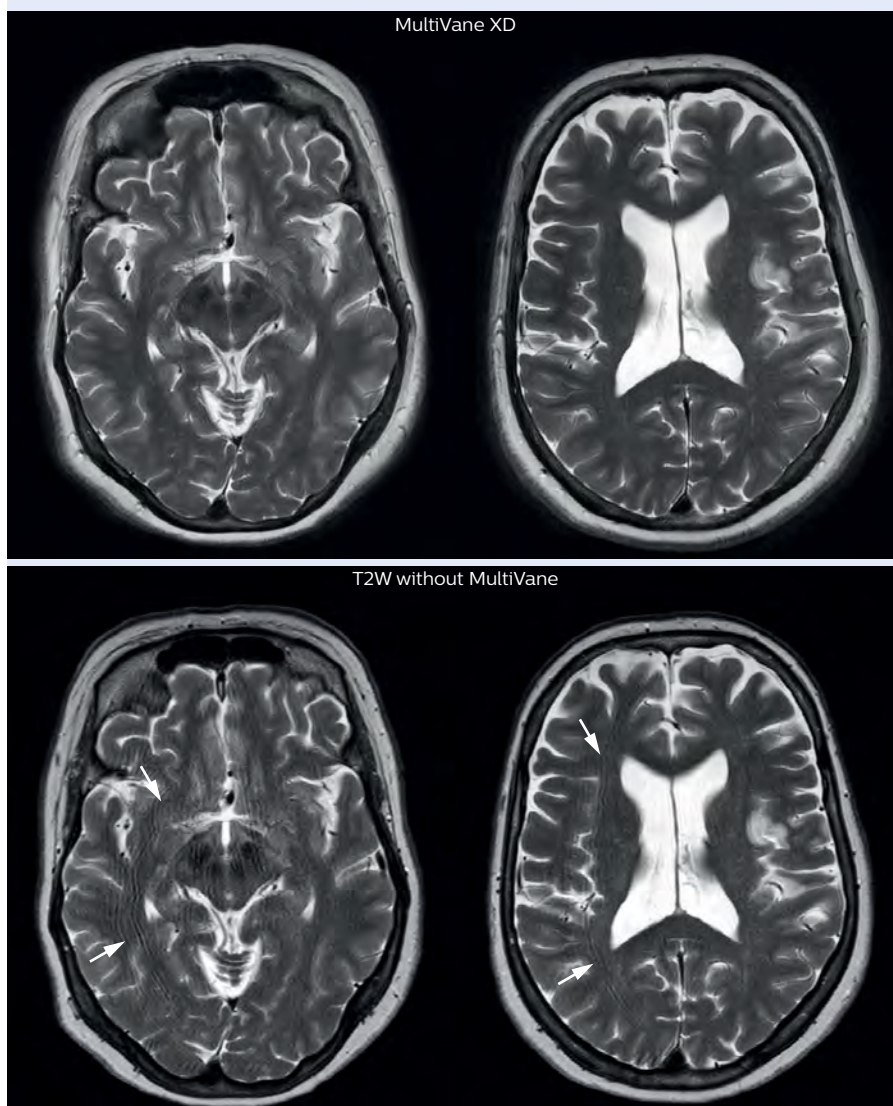
Dr. Nickerson suggests that MultiVane XD may have the potential to help them shorten time slots for pediatric patients. “That population is particularly prone to motion, so sometimes larger gaps are planned between slots with the understanding that sequences may have to be repeated and the study may take longer than it would in an adult. There may be a significant impact on time saving if we didn’t have to take that into consideration”

“It’s not just time being saved on the technologist’s side”

“MultiVane XD is especially useful for imaging patients with diseases that cause white matter changes on T2-weighted images”

MRI motion artifact reduction in brain

The images made with MultiVane XD show significant reduction in motion artifact compared to the T2-weighted images without MultiVane below them.



“If a patient moves during pCASL perfusion imaging, we can simply repeat the scan because there’s no contrast injection involved”

Fast brain perfusion imaging without contrast agent

Brain perfusion imaging is typically performed using a contrast agent. However, pCASL allows visualization of brain perfusion and physiology without contrast agent injection. This fast sequence can be an alternative for perfusion imaging in patients who are contraindicated for use of gadolinium based contrast agents.

“We have compared pCASL to T2*-weighted perfusion imaging with contrast agent in patients with brain tumors”, says Dr. Nickerson. “In the cases included in our study, pCASL was at least as representative as perfusion with contrast agent. It’s a pretty big improvement if we’re avoiding giving gadolinium and we’re getting a quite equivalent dataset.”

pCASL broadly used in brain tumor patients

The pCASL method is now broadly used at UVM. “It’s a short sequence, and is ideal for use in patients where motion is a concern. pCASL is currently included in all our MRI exams for patients with a known tumor, either initial or post-operative and all follow-ups. Additionally, it can also be used when we examine for stroke. And of course, pCASL is an alternative allowing perfusion imaging in patients with compromised renal systems, for whom contrast agent is contraindicated.”

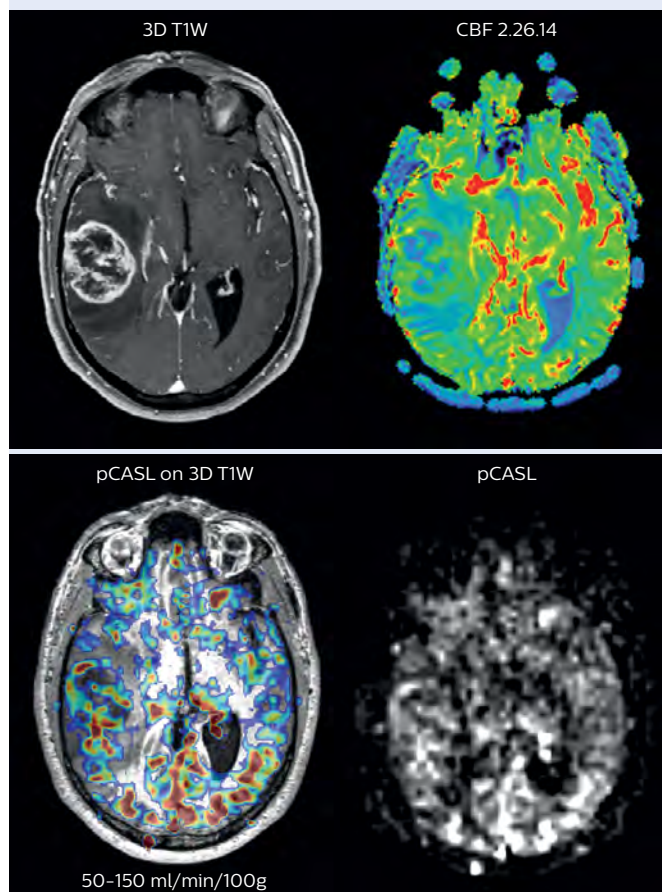
“Furthermore, we image a fair number of pediatric tumors here and the repeatability of pCASL is a great benefit when scanning pediatric patients with brain tumors. If the patient moves during the acquisition of a DSC perfusion scan, we missed our shot. However, if a patient moves during pCASL, we can simply repeat the scan because there’s no contrast injection involved,” says Dr. Nickerson

Richard Watts, PhD, brings forward another aspect. Quantification with pCASL does not have the issue of selecting an arterial input function. In the brain tumor studies that we’ve been running, we feel it’s not sufficient just to ascertain it’s got more blood flow than the other side. In the future, we want to move towards quantitative comparisons between subjects.”

Cerebral blood flow in glioblastoma

The pCASL perfusion map overlaid on the 3D T1 image demonstrates a peripheral rim of elevated cerebral blood flow corresponding to the centrally necrotic glioblastoma.

The pCASL-generated CBF closely approximates the rim of elevated rCBV obtained with DSC contrast-enhanced perfusion imaging.



A boost in diagnostic confidence

The MRI staff at UVM feels that the adopted methods not only boost their diagnostic confidence, but also contribute to improving workflow. Two of the methods, SWI_p and MultiVane XD, are now used in virtually all brain MRI scans performed at the institute. Additionally, pCASL is considered a robust addition for brain perfusion imaging, providing an option for fast and easy repeat scanning if patient movement occurs, and offering an alternative for patients who do not tolerate contrast agent use.

“Our experience is that these methods help us in obtaining the best possible scans for our patients. I would recommend to anyone to use these methods if they have them at their disposal,” says Dr. Nickerson. «

“I would recommend to anyone to use these methods if they have them at their disposal”

Studying connectivity between brain regions

The need for large amount of diffusion directions and high b-values

“From a research perspective, the bottom line is that we want to use diffusion MRI to study connectivity between brain regions,” says Richard Watts, PhD, University of Vermont MRI Center for Biomedical Imaging. “Previous diffusion methods, using a diffusion tensor imaging (DTI) model with a limited number of directions and typical b-values of 1000 s/mm², are not able to support these kinds of quantitative connectome studies.”

“Overcoming these limitations requires us to use high b-values to give us a couple of advantages. One is that we suppress extracellular water, so the signal has a much more specific interpretation, representing the highly anisotropic intra-axonal water content. Another advantage is that we get much higher angular resolution at higher b-values so we can determine a more accurate fiber orientation distribution within a voxel. The higher angular resolution requires us to sample more directions so that we can be sure to capture signals from directions where the fibers are close to perpendicular to the diffusion encoding gradient. And in more complex geometry with multiple fiber populations, we can better separate those individual fiber populations.”

“There is a close analogy with digital camera technology; using **high b-values** is like having a higher quality lens, it produces a sharper image. But, to make the most of that sharpness, you need a higher resolution sensor, or, in the case of MRI, to measure **more directions**”.

“While a minimum of 6 directions, and a single b-value was sufficient for fitting the diffusion tensor model, measuring a much greater number of directions and a range of b-values opens up the ability to apply more sophisticated and biologically realistic models.”

According to Dr. Watts, the institute is currently acquiring data for a multicenter study focusing on Adolescent Brain Cognitive Development (ABCD)*, using diffusion and functional MRI to examine the development of brain regions associated with reward and risk-taking behavior in children and adolescents. [1]

“We now employ a fairly sophisticated diffusion sequence with a total of 104 acquisitions at a range of b-values. We are now

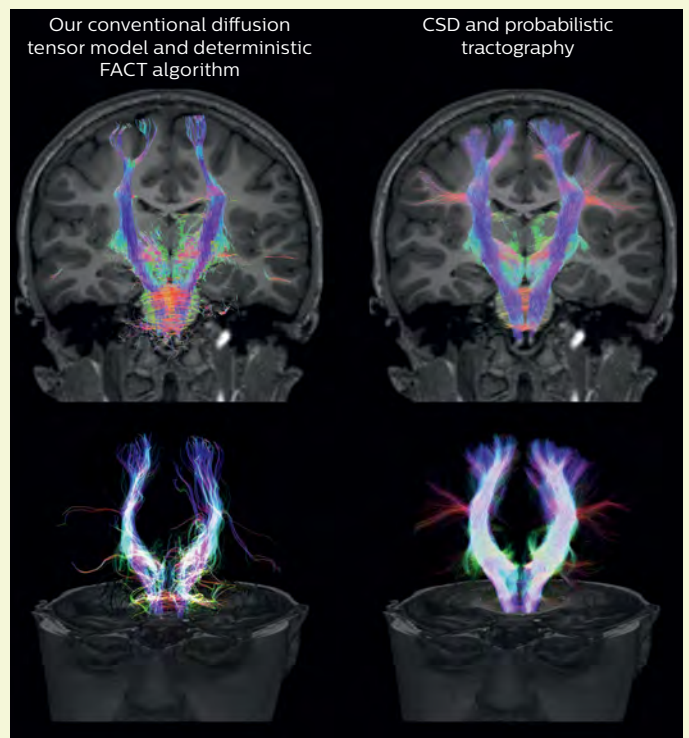
able to run this study with more directions and at a higher spatial resolution than our previous protocol, that we used in a study focusing on Alzheimer's, while maintaining the same scan time of about 10 minutes.” <<

Reference

1. ABCD Study* <https://addictionresearch.nih.gov/abcd-study>

Comparison of fiber tractography methods

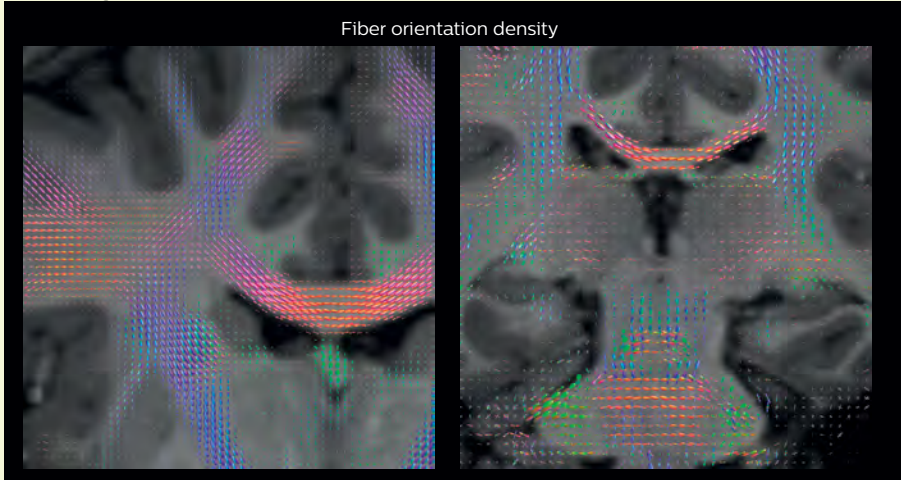
Fiber tractography of the corticospinal tract with seed region of the posterior limb of the internal capsule. Different processing based on the same data.



* Philips is not sponsoring this study

"A greater number of directions and range of b-values opens up the ability to apply more sophisticated and biologically realistic models"

CSD of multishell DWI results in the white matter FOD at each voxel. Unlike the conventional diffusion tensor model, this approach enables accurate modeling of multiple fiber populations within a single voxel.



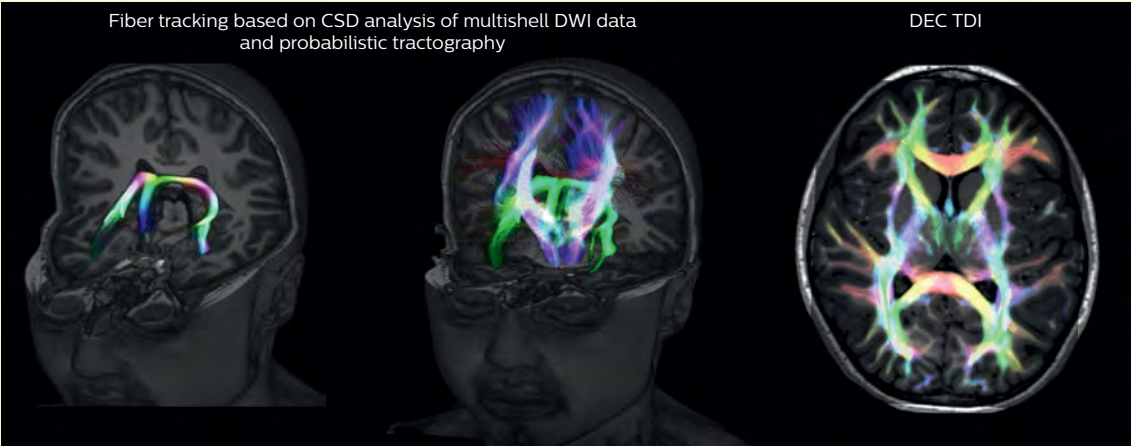
Crossings of the corpus callosum, corticospinal tracts, and the superior longitudinal fasciculus are shown.

Crossing fibers of the corpus callosum bordered by the superior longitudinal fasciculus as well as within in the pons.

All images were created from the same acquisition in a child using Ingenia 3.0T CX and 32-channel dS Head coil. Diffusion data was acquired at b-values 0, 500, 1000, 2000, 3000. The use of high b-values (3000 s/mm²) effectively suppresses extra-axonal water signal and provides high angular resolution.

- Legend of acronyms**
- CSD:** constrained spherical deconvolution
 - DEC TDI:** directionally encoded color track-density imaging
 - DTI:** diffusion tensor imaging
 - DWI:** diffusion-weighted imaging
 - FOD:** fiber orientation density

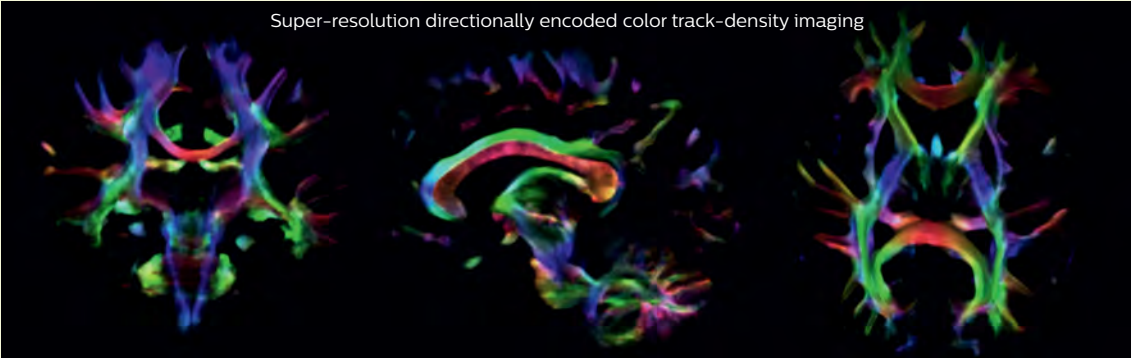
Data processing was performed using open source software. Fiber tracking was performed using the MRtrix package (J-D Tournier, Brain Research Institute, Melbourne, Australia, <https://github.com/MRtrix3/mrtrix3>), Tournier et al. 2012. DEC TDI based on F Calamante et al 2010.



Fiber tracking from the left and right hippocampi to the fornix.

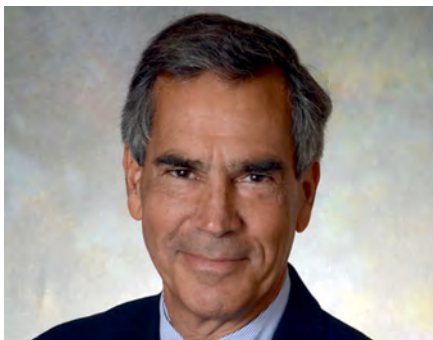
Fiber tracking from the left and right hippocampi to the fornix (green), and the corticospinal track based on a seed region of the posterior limb of the internal capsule.

Super-resolution directionally encoded color track-density imaging overlaid on T1-weighted structural MRI.



Take your **next step in MRI** don't miss the must haves

Experts evaluate the recent technological innovations



Chip Truwit, MD, is Chief of Radiology and Chief Innovation Officer of Upstream Health Innovations at Hennepin County Medical Center, Minnesota, USA, and Professor Emeritus of Radiology at the University of Minnesota. Specialist in neuroradiology with clinical interests in pediatric neuroradiology and intraoperative MR-guided therapy.

Recent technological innovations in MRI, such as the next wave in parallel imaging and motion correction techniques, have reduced scans times further and improved imaging quality. There has also been a re-imaging of the ambient environment of the imaging suite. Jim Pipe, PhD, of Barrow Neurological Institute (Arizona, USA), and Chip Truwit, MD, of Hennepin County Medical Center (Minnesota, USA), discuss how these changes are transforming clinical practice and the patient experience.



Jim Pipe, PhD, is Director of Neuroimaging Research at Barrow Neurological Institute, Saint Joseph's Hospital and Medical Center, Phoenix, Arizona, USA. Wide professional and research interests, including novel acquisition and reconstruction methods, fast scanning, and improving MR value.

"There have been a host of technological transformations, but the biggest change is that radiology has justly moved forward towards the value proposition of putting the patient at the center of care," says Dr. Chip Truwit, Chief of Radiology and Chief Innovation Officer at Hennepin County Medical Center. "And that applies to the entire experience that a patient undergoes, from the thought of planning an MRI, to the preparation of having MRI, to how they undergo the MRI, to how we deliver the message of the results of the MRI."

In recent years, changes in healthcare systems and the constantly shifting economic situation have increased the emphasis on healthcare costs and have influenced purchasing and operating models in MRI.

"We have witnessed the transformation of 3.0T imaging from niche to mainstream"



High resolution MRI of foot.
PDW TSE, voxels 0.3 x 0.4 x 2.8 mm, scan time 3:50 min, Ingenia 3.0T.



High resolution and excellent fat suppression in elbow.
mDIXON XD TSE water only, voxels 0.4 x 0.6 x 2.5 mm, scan time 3:05 min, Achieva 3.0T dStream.

Turning innovations into clinical benefits

When discussing the expansion of the range of procedures and diagnostic applications of MRI, Dr. Truwit points out, “The technological developments during recent years have been dramatic. For example, we have witnessed the transformation of 3.0T imaging from niche to mainstream. Initially, people weren’t sure if it would be worth the investment. The initial expectation was that 3.0T would be great for neuroimaging, MR angiography, MR spectroscopy, advanced fMRI and DTI applications. However, SENSE matured, 3.0T pulse sequences improved, mDIXON and motion correction were introduced, and the range of applications started to ramp up. We knew neuro would be better, but in addition the strength of 3.0T really resides in musculoskeletal and body applications. What 3.0T has brought to these areas is nothing short of unbelievable. The detail we see now on wrist exams, elbow exams, ankle exams at 3.0T is stunning.”

The power of parallel imaging

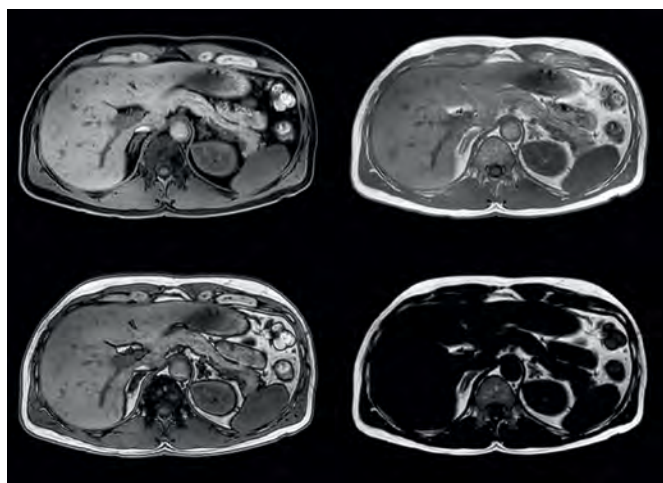
A milestone in the advancement of MRI came with parallel imaging. The sensitivity encoding (SENSE) parallel imaging technique enables a reduction in scan times by a factor of two or more.[1] Since its original implementation, continuous improvement of the technique has increased its performance, and now dS SENSE* allows greatly increased speed in the routine clinical setting. Faster image acquisition can also help decrease breath-hold times, resulting in reduction of motion artifacts and fewer motion-corrupted images. [2]

“Parallel imaging makes a huge difference in how well we can image the abdomen and parts of the body where there is a lot of motion,” says Dr. Jim Pipe, Director of Neuroimaging Research at Barrow Neurological Institute. “So I think for the clinician it really has helped to extend the scope of MRI. And it makes a difference for the patient experience; in the distant past a lot of abdominal imaging would require a patient to hold breath for a very long period of time. I think just being able to image faster, and maybe image more intelligently over a few respiratory cycles, has made the imaging exam easier on the patient.” >>

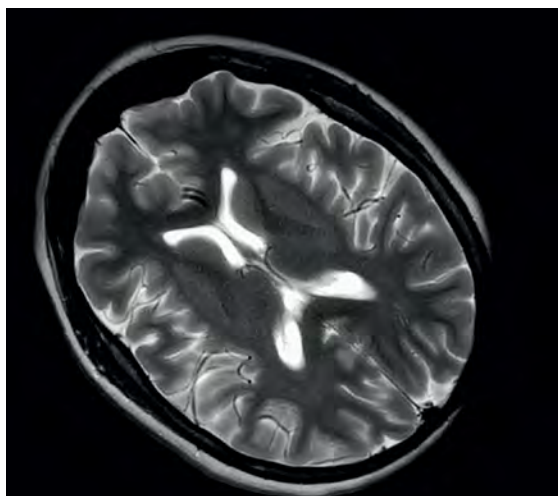
“Parallel imaging, we couldn’t conceive of living without it now”



Axial mDIXON, voxels 1.6 x 1.6 x 2.5 mm, scan time 0:11 min, Ingenia 3.0T.



Axial mDIXON: water only, in phase, out phase, fat only.
Voxels 1.5 x 1.8 x 4.0 mm, scan time 0:15 min, Ingenia 3.0T.



Head with T2W MultiVane XD for motion reduction, voxels 0.6 x 0.6 x 4.0 mm, scan time 2:00 min, Ingenia 3.0T.



Neck with T2W MultiVane XD motion reduction, voxels 0.7 x 0.7 x 3.0 mm, scan time 3:37 min, Ingenia 3.0T.

Overcoming artifacts due to patient motion

Parallel imaging is not the only improvement that has pushed the boundaries, aiming to further shorten scan times without trade-off in terms of image quality. As Dr. Truwit notes, "A second important innovation is Jim Pipe's development of propeller imaging. Now many vendors have a propeller type of method, such as MultiVane XD** from Philips. The method is based on constructing parts of images at a time, and running the scan so quickly that the second time you run it you acquire another part of the exam, and third time another part of the exam. Then you speed it up like a propeller blade, going so fast you can't see the cumulative addition of the individual blades or vanes of an exam. So it looks like we are acquiring a single picture – a full picture at one moment in time. And it reduces the amount of time exposure for each part of the image. It almost looks like we are freezing human motion."

Has the expansion in MRI tools actually had a positive effect in driving improved patient care? "I think that's an important question," says Dr. Pipe. "As we advance MRI, do the patients get better? My feeling is that it's true. But I think our field needs to do a better job of really assessing this. I do think certainly that the volume of information that we can give to a clinician continues to increase based on advancements that have been made in MRI."

Keeping pace with shifting demands

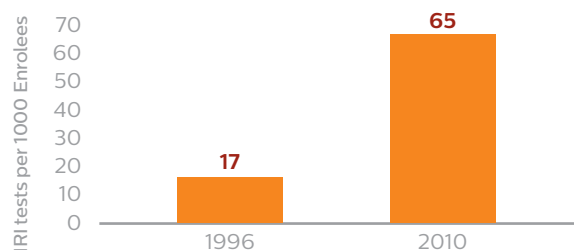
The volume of MRI scans performed has increased dramatically during the last decade. A study performed within large integrated healthcare systems in the USA revealed a 10% annual increase in the use of MRI during the period 1996–2010. [3]

In addition to increased patient numbers, there have also been pressures from the changing patient demographics within society.

A recent survey has suggested that the prevalence of obesity in the USA increased by more than two percentage points between 2008 and 2014, to 27.4%. [4] In an already aging population, the greatest obesity rise was seen in people over the age of 65.

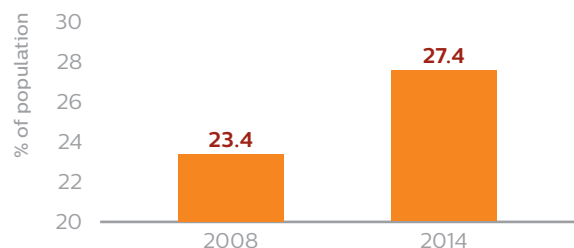
"We have the good fortune that although we are being asked to take care of more and more patients, the scanners have made that a realistic possibility," says Dr. Truwit. "Certainly with the more obese patients, having the wider bore scanners has been important," says Dr. Pipe. "Just getting a patient in and out of a scanner can be a challenge with certain body types. Having wider bore scanners does facilitate that quite a bit."

The use of MRI in an integrated healthcare system in the USA between 1996 and 2010



Data from Smith-Bindman R, et al. JAMA. 2012;307:2400-9 [3]

Obesity rates in the USA over-65 population for 2008 and 2014



Data from Levy, J., Gallup US Obesity Rate 2014 [4]

“Simply increasing efficiency has been a major focus area in the last decade”



“The changes in scanner technology have been significant,” adds Dr. Truwit. “The reality is that we handle a lot more work than we used to and we handle it with much better throughput and less obstacles than we used to. The goal is to be efficient, to be effective, and to do so with the patient’s goals, comfort and safety all foremost in our minds.”

Getting more from your scanner

“Simply increasing efficiency has been one of the major focus areas in the last decade,” Dr. Pipe explains. “A lot of the advances that I see are not just new applications but rather aiming to make applications more robust and collect data more cost-effectively. So, things like faster scanning have, in my mind, been some of the more substantial advances that we have seen in MRI.”

Are there efficiency gains from getting more information from a single scan? For instance, the mDIXON method that allows to get four contrast types from a single scan? “If you need two to four contrast types, then the ability to collect them all in one scan can lead to huge gains,” says Dr. Pipe. “You can shorten scanning time, and you can have the two pieces of information collected at the exact same time. That allows you to compare images side-by-side and be certain that the different features correspond to each other across the different types of contrast because there can’t be any motion in-between. I think that can be very helpful. Also, isotropic scanning is a way that allows us to view this information in multiple planes.”

Revolutionizing the imaging suite

“Technological advances in the modern imaging suite have also led to efficiency gains,” says Dr. Truwit. “With the conversion to PACS-based Radiology departments, we have seen a dramatic increase in the volume of scans that we can read in a day. Just by not having to physically hang a film but simply clicking on the next one saves time; having the prior studies immediately available saves time and helps to deliver quality in radiology care. Coupling these changes with communication tools to enhance critical

results reporting, image sharing for second opinions ‘on the fly’, and regular peer reviews have all raised the bar in radiology.”

“Likewise MRI scanners have allowed for improved throughput. Because of parallel imaging and other changes, such as MultiVane XD** for motion-free imaging, we can perform scans in a shorter period of time. This frees up time to deal with the patient experience. But it also means that we can scan more patients while giving everybody the attention they need.”

Total cost of ownership can overshadow initial purchase cost

“The fast pace of technological development also has a potential impact on the decision-making process surrounding MRI equipment purchase,” says Dr. Pipe, “Scanners are a bit like computers in the sense that they don’t stay state-of-the-art for very long after buying them. I think the total cost of ownership is becoming a big driver these days. So, having the long-term view is important and upgradability is certainly an important factor.”

“The length of time that hospitals keep MRI scanners has stretched a bit,” says Dr. Truwit. “Upgrading a scanner – as opposed to buying a new scanner – is of great appeal to many facilities, especially when one factors in the siting costs related to replacement. Upgrades provide the latest technology without having to buy a whole new scanner. Fewer dollars over a longer period of time, rather than recapitalizing. I think the question of total cost of ownership should be present in everybody’s mind when making these purchases.” >>

“I think the total cost of ownership is becoming a much bigger driver these days.”

Putting the patient first

“For a patient who is trying to heal, we want to offer a healing environment,” says Dr. Pipe. “I think having an MRI exam is one of the more stressful experiences for a patient while in hospital. Anything we can do to reduce that stress is really good. I see an increasing awareness of the importance of the patient experience.”

For patients who experience feelings of helplessness, entering the bore of the scanner can be a quite stressful moment. This has led vendors to investigate solutions to make the patient more physically and emotionally comfortable when entering the scanner room and while inside the scanner. These range from reducing the distressing level of noise, to providing in-bore entertainment to distract the patient while the scan is proceeding.

Enhancing the patient experience with shorter scans

“The increased speed of imaging has also had definite benefits for the overall patient experience, and particularly in scanning difficult patients,” Dr. Truwit says. “There are very few patients that we can’t scan successfully with our very short sequences now. It might not always be a perfect scan in the very difficult patients, but it’s diagnostic.”

“I think for the patient, the experience of being in that MR scanner for a much shorter period of time is a big deal,” says Dr. Pipe. “And just anecdotally, I would say that the faster we can get a patient in and out of the scanner, the less chances there are that the patient is going to become agitated or worried and starts moving around and becoming less compliant. We are interested in looking at how we can get the patient in and out of the scanner in a fast enough time so that they will lie still and we can collect high quality data.” <<

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4. Levy, J. *U.S. obesity rate inches up to 27.7% in 2014*. <http://www.gallup.com/poll/181271/obesity-rate-inches-2014.aspx>

“There are very few patients that we can’t scan successfully with our very short sequences now.”



*dS SENSE provides superior speed performance compared to first generation SENSE (internal bench test comparing dS SENSE to SENSE. Data on file)

**MultiVane XD provides improved motion correction (motion-free) compared to standard TSE and shorter scan times compared to MultiVane thanks to the compatibility with dS SENSE.

Automatic adjustment of **scan settings** for **MR Conditional implants**

We offer you a key to confidence when scanning patients with MR Conditional implants

The dedicated user interface of ScanWise Implant [1] guides you through the few simple steps needed to set up an MRI exam for a patient with an MR Conditional implant.

Simplifying scanning of patients with MR Conditional implants

With the ScanWise Implant user interface, you simply enter the value of each MR Conditional parameter as specified by the implant manufacturer. The scanner then automatically adjusts the scan parameters for all scans and pre-scans in the patient's exam. It's an easy way to meet the implant's condition values throughout the whole examination.

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ScanWise Implant enhances user confidence when scanning patients with MR Conditional implants when guided by ScanWise Implant. [3]

Let ScanWise Implant guide you

The simplified scanning workflow offered by ScanWise Implant can help you to serve a growing population of patients with MR Conditional implants. It allows you to increase your referrals.

ScanWise Implant can be operated with confidence by well-trained radiographers or technologists of all experience levels. Philips ScanWise Implant is available on our 1.5T and 3.0T MRI scanners. >>



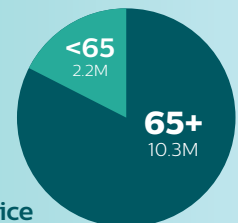
Why would you need ScanWise Implant?

- The population of patients with implant is rapidly growing around the globe. By 2020 the number of patients with implants in the USA will have grown by 71%. [4]
- The majority of people with an implant are older adults. [4]
- For many medical conditions prevalent among older adults [5] MRI is a modality of choice.

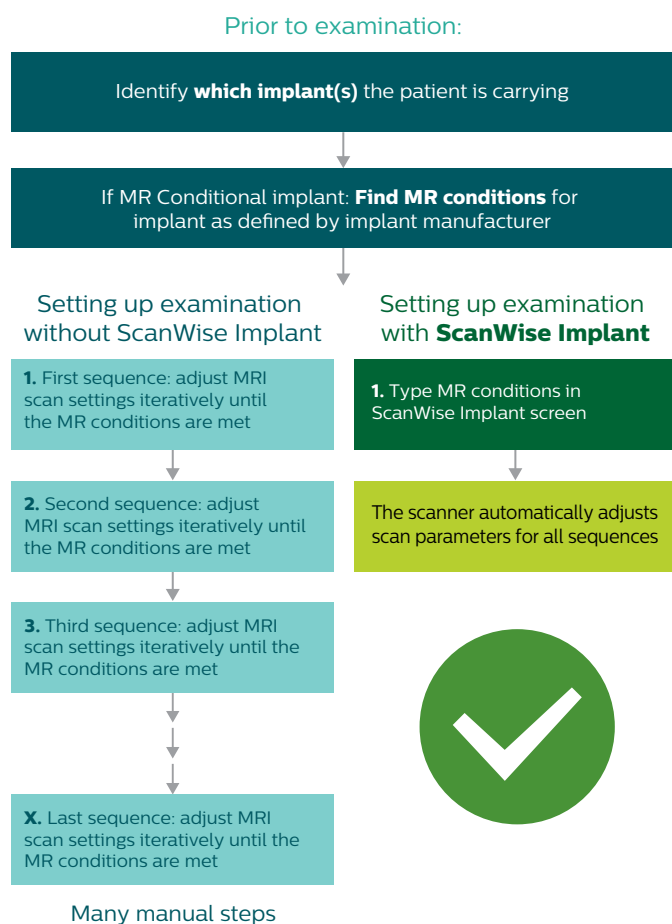
Today's facts

Device implant statistics^[6]

There are about **12.5 million people with an implanted device in the USA** and this number is growing



When a patient with MR Conditional implant is referred for MRI



Example of
MRI scan conditions
provided by implant
manufacturer

- Static magnetic field of 1.5 Tesla and 3 Tesla
- Maximum spatial gradient magnetic field of 3000 Gauss/cm or less
- Maximum whole body average specific absorption rate (SAR) of 2.0 W/kg or less under Normal Operating Mode, for 15 minutes of scanning per pulse sequence.



The simplified scanning workflow offered by ScanWise Implant can help you serve a growing population of patients with MR Conditional implants

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1. Only for use with MR Safe or MR Conditional Implants by strictly following the Instructions For Use.
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Early user of **ScanWise Implant** shares experiences



Scott G. Hipko, BSRT(R)(MR)(CT) MRSO, University of Vermont Medical Center, Burlington (Vermont, USA) was one of the first MR technologists to experience ScanWise Implant.

“This smart technology of the scanner makes it easy for a technologist”

Using the ScanWise Implant **smart technology**

“Once you know what conditions are associated with the implant of your patient, ScanWise Implant helps speed up the process of parameter setting. This smart technology of the scanner makes it easy for a technologist: after entering the MR conditions as specified by the implant manufacturer only once, the scanner will meet the conditions of the implant throughout the whole examination; rather than the tech trying to bumble around in every sequence to meet the conditions laid out by the MR Conditional implant.”

“Clearly ScanWise Implant can help better meet implant conditions by allowing the parameter value as specified by the implant manufacturer to be entered only once, and then the system automatically adjusts all scan and pre-scans parameters to meet the implant conditions entered by the user.”

Guiding technologists through a **myriad of choices**

“Not every tech may know as much as needed for adjusting the scanner to meet the implant’s conditions, so ScanWise Implant helps guide you. Philips is the first MRI vendor to create this.”

“With ScanWise Implant I experience this as a smart scanner. It helps me through this myriad of choices. For instance, when a patient has a deep brain stimulator, ScanWise Implant guides me as it automatically adjusts all scan and pre-scan parameters to meet the implant conditions that I entered.”

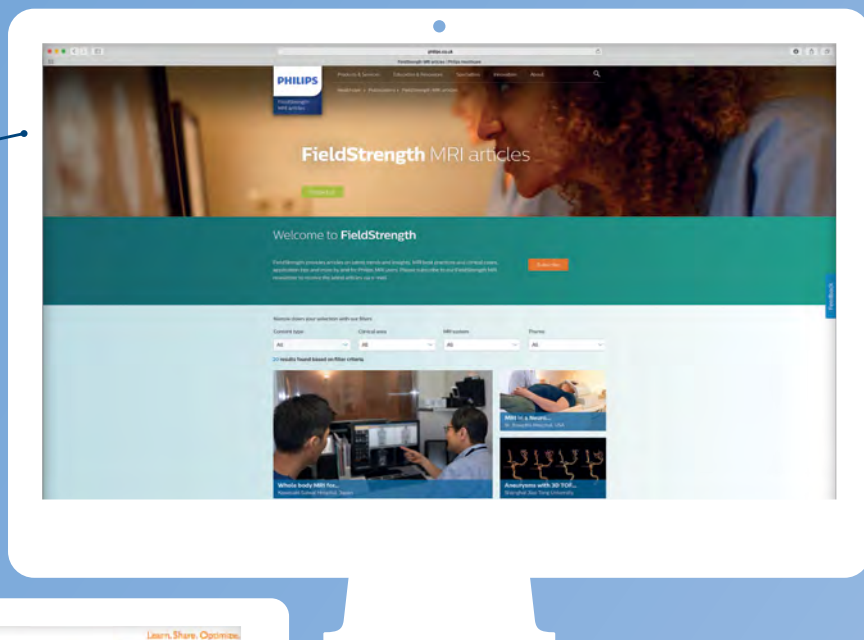
“Some patients with active MR Conditional implants used to be denied by the radiology department, although clinicians want us to scan them. Questions that come up are: what are the implications of not doing an exam when you could? What if that one exam changed the outcome of the patient’s disease? If you could have done an exam and said no, what are the costs of saying no when you could have said yes?” <<

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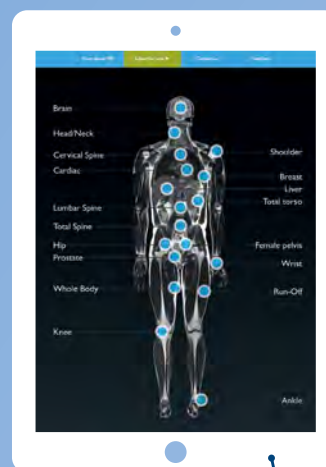
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Editor-in-chief

Karen Janssen

Editorial team

Annemarie Blotwijk, Paul Folkers (PhD),
Liesbeth Geerts (PhD), Karen Janssen,
Marc Van Cauteren (PhD).

Contributors

Faiza Admiraal (PhD), Trevor Andrews (PhD), Megan Breuer (PhD), Sarah Comtois, Scott Hipko, Akihiro Hirao, Karen Janssen, John Karis (MD), Stephan Mercier, Takanori Naka, Joshua Nickerson (MD), Hiroshi Nobusawa (MD, PhD), Jim Pipe (PhD), Niloufar Sadeghi (MD, PhD), Polly Schmidt, Richard Sherry, Chip Truweit (MD), Louise Verheij van Wijk, Richard Watts (PhD).

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Please subscribe on www.philips.com/fieldstrength

Correspondence

FieldStrength@philips.com or

FieldStrength, Philips Healthcare, Building QR 0119
P.O. Box 10 000, 5680 DA Best, The Netherlands

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