Publication for the Philips MRI Community **Issue 2015/2**

PHILIPS

MRI Magazine

FieldStrength

Designed for first-time-right MRI

Users explain the importance of fast and robust imaging and overcoming motion challenges

Neuroscientists

use benefits of MR tools

Dear Friends,

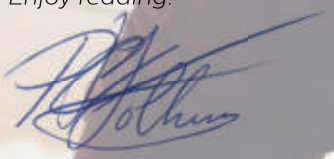
At ISMRM 2015 we showed our MR innovations and illustrated how we collaborate with our users on research that drives future clinical applications. As your collaborative partner, we are dedicated to giving you access to key capabilities on our systems such as reconstruction tools like recon 2.0, so you can stretch the limits of your MR research and help speed the translation from discovery to clinical practice.

Our system architecture is designed to be the launch pad for possible future MR evolvements: the digital RF system with dStream allows for new coil concepts, and dSync brings fast loopback times and high resolution wave form shaping to facilitate the development of new MR methods and applications, including therapy delivery methods using MR guidance.

This issue of FieldStrength contains interesting content in the field of neuroscience. Our Neuroscience package provides a robust set of tools for neuroscientists, including high-end DTI, fMRI and quality assurance tools. At ISMRM, our booth showed you a broad range of tools and capabilities.

To underline the importance of pushing the boundaries to progress MRI, I recommend the articles that demonstrate how recent innovations help boost clinical practice, such as the dStream digital RF system enabling speed combined with Premium IQ, MultiVane XD motion correction, and the Philips-unique mDIXON TSE for robust fat suppression. And don't miss the success story on how the Patient In-bore Solution, that was introduced together with our Ingenia S system, helps improve efficiency at Herlev University.*

Enjoy reading!

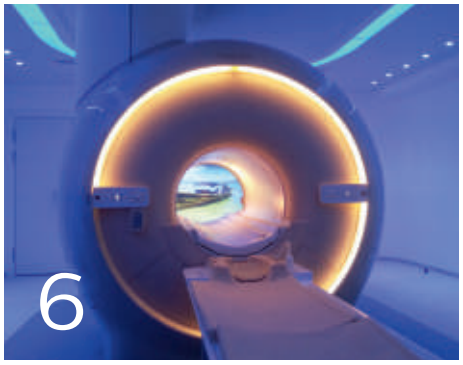


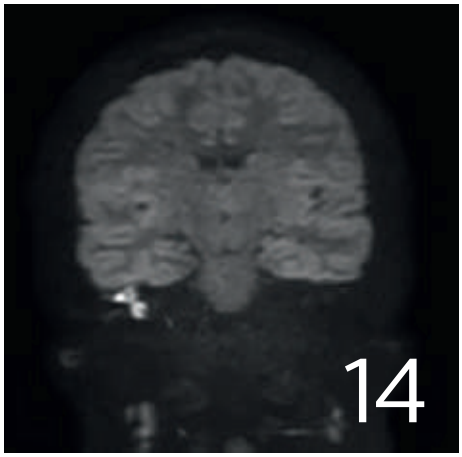
Paul Folkers, PhD
Head of Global MRI Clinical Science and Applications, Philips Healthcare

*Premium IQ defined as image quality obtained with dStream compared to Achieva

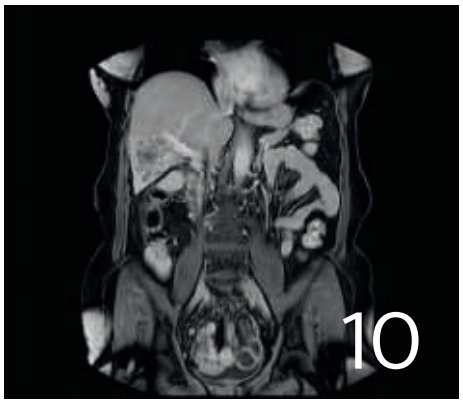
NetForum
www.philips.com/netforum

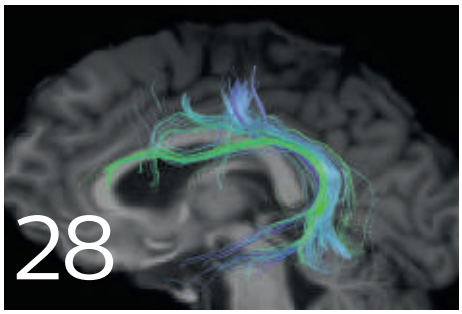
Visit the NetForum online community to download ExamCards and view application tips, case studies, online training and more. Scan the QR code with your smartphone or use www.philips.com/netforum.

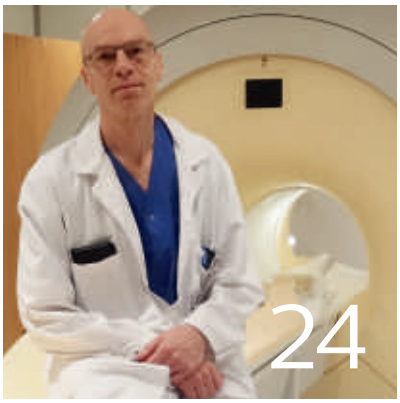




Read about MRI designed for **first-time-right** imaging







First-time-right imaging

Research

MR news

Results from case studies are not predictive of results in other cases. Results in other cases may vary.
Results obtained by facilities described in this issue may not be typical for all facilities.

Ingenia 1.5T S MR system for **first-time-right imaging**

Designed for fast workflow, robust scanning and enhancing the patient's experience during MRI examinations.

The need to repeat even one scan can put you behind schedule, increasing patient wait times and staff overtime. Today more than ever, first-time-right imaging is key. Ingenia 1.5T S delivers fast, robust scanning methods based on dStream digital quality and speed, along with Premium IQ* for more information in the same time slot. With our Patient In-bore Solution we have innovated patient experience during the MRI exam.

Fast and robust capabilities

Ingenia S features Premium IQ*, which helps clinicians obtain more information in an available timeslot. This is thanks to up to 40% higher SNR with dStream, increased scanning speed with the high acceleration factors of dS SENSE, motion-corrected imaging with MultiVane XD – even in challenging patients – and superb fat-suppressed imaging with mDIXON.

Patient in-bore experience

Philips has brought innovation where it's most needed: into the bore. Choosing the In-bore Solution allows your patients to design their own relaxing scan experience, with immersive visual and audio features that help to calm and relax them for a smooth scan. With ComforTone for noise reduction and AutoVoice to help guide the patient through the scan, the in-bore experience can be successful for patients of virtually any age or condition.

Operators are in control

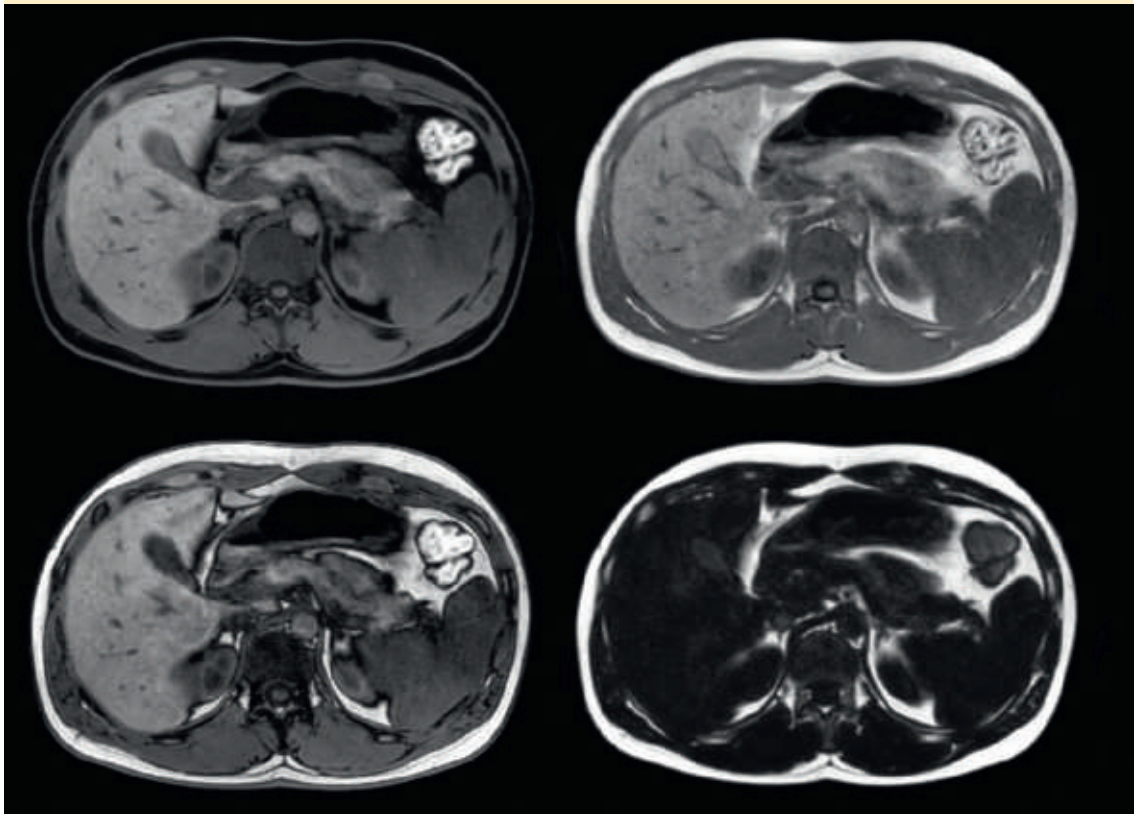
iPatient, a fast and comfortable patient setup, uses integrated and lightweight coils with simple connections to smooth and enhance the scanning process. iPatient also incorporates automated imaging with a personal touch, such as ExamCards, SmartExam and SmartSelect, that allow technologists to spend more time with the patient.

«

*Premium IQ is defined as image quality obtained with dStream compared to Achieva

Four different contrasts in one breathhold

mDIXON provides four different contrasts in one scan: water, fat, in-phase and out-phase images.
Voxels 1.3 x 1.5 x 2.5 mm, high dS SENSE acceleration factor, breathhold 16 seconds.



Patient comfort leads to first-time-right imaging

Having a clear vision on the importance of patient experience, Herlev Hospital acquired the differentiating Philips In-bore Solution to benefit their department efficiency.

Patient experience is a crucial factor for the successful operation of a radiology department. To that end, Herlev Gentofte University Hospital (Denmark) has added the Patient In-bore Solution to its Ingenia 3.0T system. Patients are positive and the MRI staff sees these features help calm patients, reducing motion-related problems and providing excellent images.

Focus on the patient's experience to benefit robust imaging

Michel Christian Nèmery, MD, is chairman of the Department of Radiology at Herlev Hospital. "Patient satisfaction is very important to us. In our country discussions on including patient experience into reimbursement models are currently ongoing. We're trying to move away from being a 'disease repair shop' to being a 'temple of health' as I sometimes call it. The MR suite with the Ambient Experience and the In-bore Solution is a substantial element in that change."

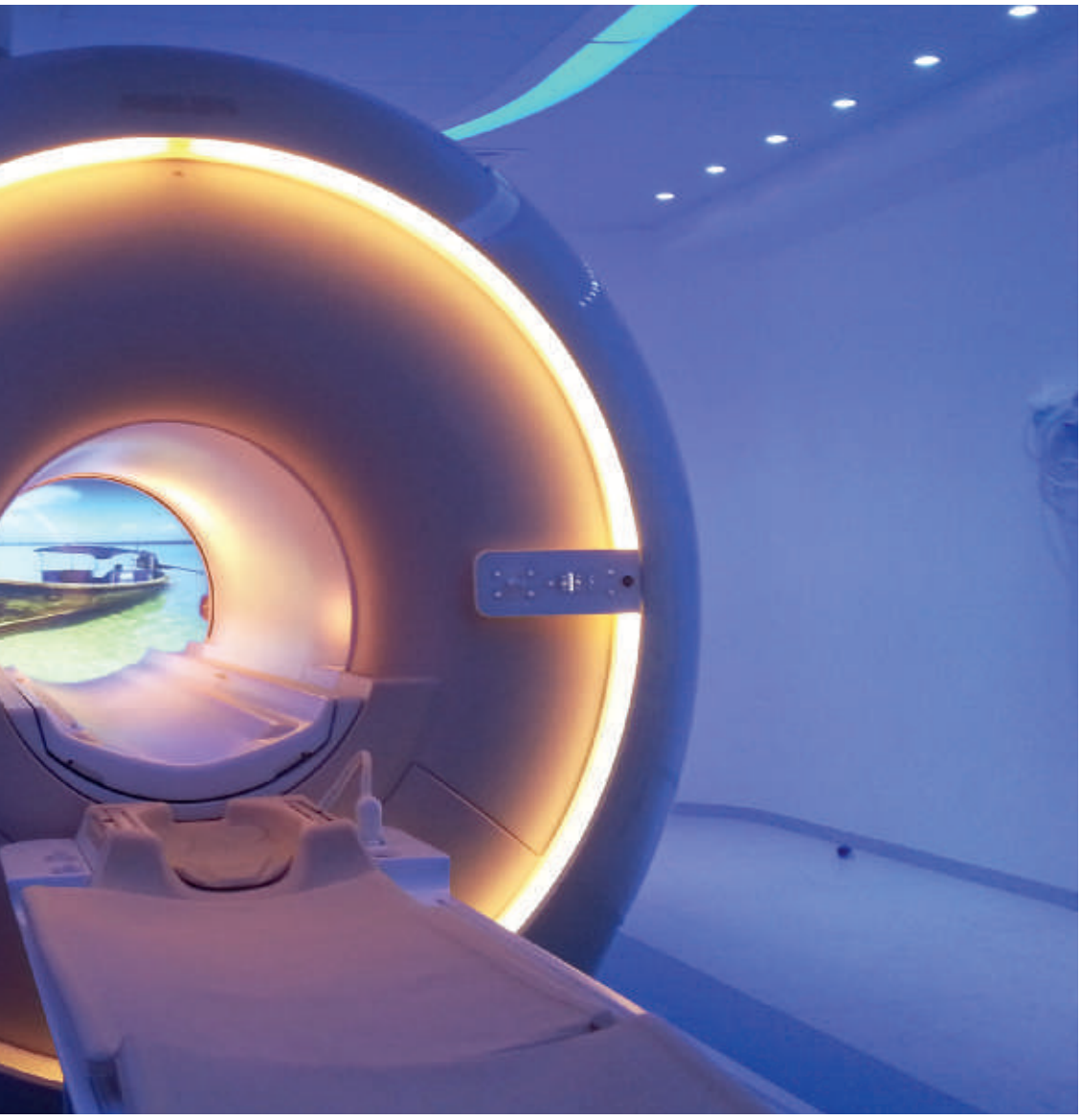
"We have the full Ambient Experience and Patient In-bore Solution on our Ingenia 3.0T. We're also trying to improve waiting areas and the reception area. We've asked our patients to choose wall pictures, and we're doing a fairly extensive remake with special lighting and the Luminous Textiles technology from Philips, and we are in the process of asking our patients what else they'd like to see there."

Dr. Nèmery says the staff members feel good doing their job in this appealing environment. "They understand that it's important for patients to be treated with respect and attention. Most important, they realize that a comfortable patient is key for a successful scan. An uncomfortable patient is likely to move and cause artifacts in MR images, so that a scan needs to be repeated. So our attention for patient experience is also meant to benefit image quality and even our efficiency."

Helping patients feel comfortable in MRI

Dr. Nèmery describes what a patient experiences in their Ingenia 3.0T suite: "Already in the preparation room, MRI patients design their own scan experience. Via an iPad mounted on the wall, the patient can choose a theme for the Ambient and In-bore experience. Then as the door opens they enter the scanner room,

"Our staff members understand that a comfortable patient is key for a successful scan."



Michel Christian Nèmery, MD, is neuroradiologist and chairman of the Department of Radiology at Herlev Gentofte University Hospital, the largest emergency hospital in Denmark. He is an innovator, founder of the CT-innovation unit for user driven innovation in clinical practice, and chair of the Radiology Council of Region Hovedstaden.

Jeanette Brus Mortensen is department radiographer and leader for the MRI Department.

which shows, for example, an underwater theme. Patients are typically surprised and our techs are pretty clear that this gives them something to talk about while handling the patient; it often is a 'concern-breaker'."

"We are often able to bring patients into the scanner feet first, which adds to their comfort level. However, when patients have to be scanned head first, the In-bore Solution provides this special audiovisual experience to a patient lying in the bore. I've tried it myself and it's quite impressive: your focus is really filled up with what's on the screen." »

"This reduces the amount of times we have to retake shaken sequences."

"Our attention for patient experience is also meant to benefit image quality and even our efficiency."

"We've been using this for about five months now, and it's very effective. For patients, it's a great experience and at the same time a distraction if they're nervous or feeling a little claustrophobic or just impatient."

Patient experience and department efficiency go together. Dr. Nèmery and his team conducted a survey of patients who were scanned with the In-bore Solution. "They said it's lovely, calming and a positive distraction. About 30% said time went by quickly. One said peaceful. One patient said fairy-tale-like! So patients are very positive and ask for this scanner when they need to come back. And in the short time we've been using the In-bore Solution, our patients who underwent scanning before on other systems have said adding the In-bore Solution gave them a positive experience."

"My sincere impression is that we do reduce patient motion, we reduce cancellations, and we do reduce repeat sequences and non-completed studies. So you could say it also improves on our efficiency," says Dr Nèmery.

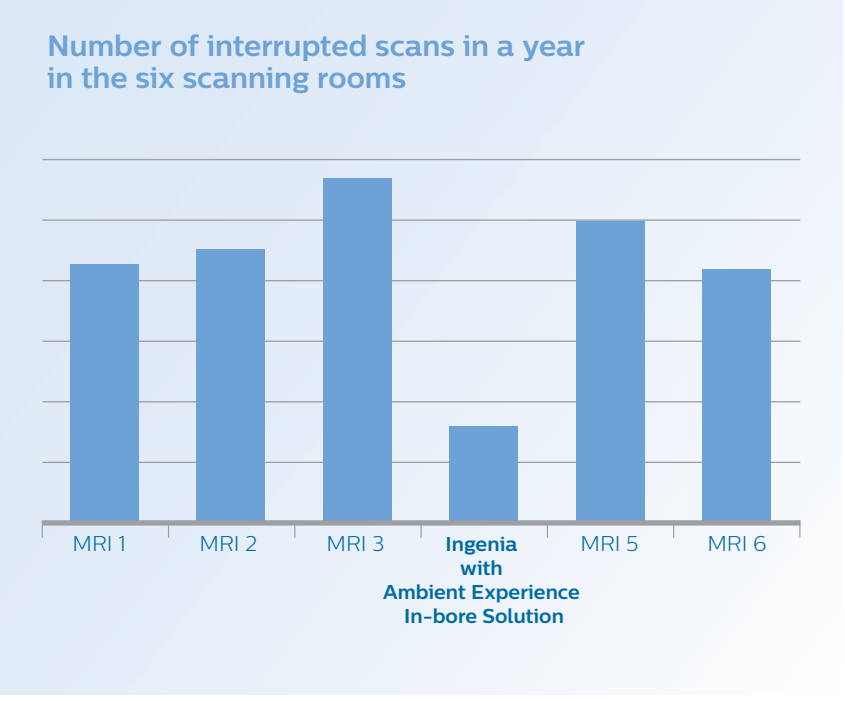
Studies show fantastic results

Radiographer Jeanette Brus Mortensen confirms these findings. "We get very positive feedback from our patients. They say that it is calming and has a relaxing effect. Our patients feeling somewhat anxious become focused on something other than the fact that they are lying in a scanner. Our patient survey shows that over 90% of the patients indicated to have a better or much better comfort level with their in-bore experience."

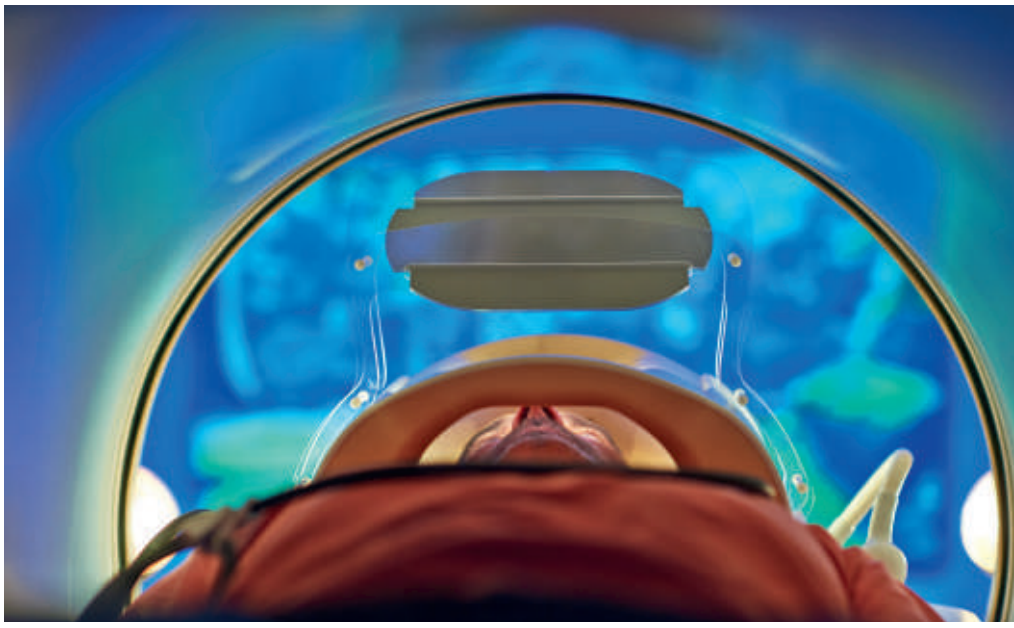
"Most important, feeling relaxed helps patients lie still during the scanning, which helps reduce motion in images," she says. "This helps in diagnosis and reduces the amount of times we have to retake shaken sequences. Our data demonstrate a significantly reduced number of interrupted scans (rescans) in the scanner room where the Patient In-bore Solution is installed – which directly contributes to a more predictable throughput."

"We compared the number of interrupted examinations before and after installation of the In-bore Solution and between the six scanners. These data show a significant reduction of interrupted exams from the Ingenia 3.0T scanner with the In-bore Solution."

"By reducing patient motion, we also reduce repeat scans, waiting times, rescheduling and staff overtime."



“When the patients feel relaxed, they lie still during the scanning.”



Changing our patient approach

Dr. Nèmery says, “Before we had Ambient Experience and the In-bore Solution, we could choose medication or human coaching to try to calm patients and also children who needed that. Or sometimes we would invite a patient to see the scanner some days before their exam, or we would offer a scan in our open scanner, the Panorama HFO.”

“Some patients turn out to be not able to complete the scan in the open system. We have had a few examples of such patients who were then invited for a relaxed conversation and a look at the Ingenia with Ambient Experience and the In-bore Solution. Although it may not work for every patient, most of these patients did actually manage to get scanned there.”

A differentiator for the hospital

The focus on patient experience has helped the Herlev Hospital Department of Radiology to differentiate itself from others in the region. “We do get patients who ask to be referred to us, and who are very explicit about having recommendations from family or friends or have heard about it on TV or Facebook or other media – we try to get it out there, because it looks beautiful and it represents that we take patient experience seriously.”

“For us, there’s no question that it adds value,” Dr. Nèmery concludes. “Previously we could only try to comfort patients and cut down exams to go quickly. Now, the In-bore Solution introduces an element of surprise that generates an opportunity to break a train of thoughts, to distract patients in a good way, and help the techs handle the patients with care and give them a good experience. It enables patients to be active participants in their imaging by empowering them to design their own scan experience.”

“This has a huge effect on our department. If we manage to reduce patient motion with the In-bore Solution, we also reduce repeat scans, waiting times, rescheduling and staff overtime. It helps us be more efficient while getting the high quality images we need.”

«

Results from this facility are not predictive of results in other facilities. Results in other facilities may vary

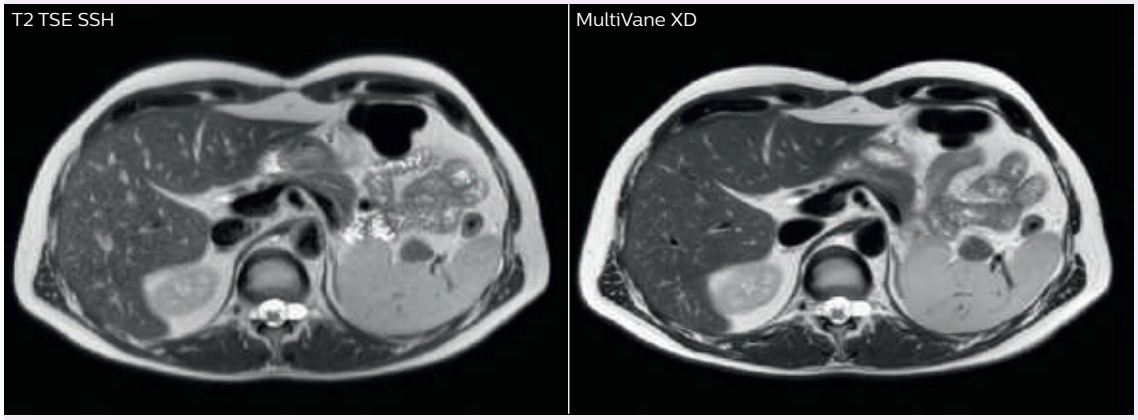
Overcoming motion challenges for first-time-right MR imaging

Bowel or respiratory motion can lead to difficulties in making a diagnosis, a need for rescanning or a loss of diagnostic confidence. MultiVane XD helps to get first-time-right image quality in the presence of motion.

Motion can be a challenge, especially when imaging the abdominal area. MultiVane XD is helping clinicians at Radiologie am St Joseph Stift to get abdominal imaging right the first time, with an extended reconstruction algorithm that reduces motion-related artifacts. It is a key component in the fast liver exam that the site routinely uses.

Radiologie am St. Joseph Stift

Comparison of liver with and without MultiVane XD



In this example the image quality of the MultiVane XD images is evidently better than quality of the images without MultiVane XD. Ingenia 1.5T with dS Torso coil solution.

Voxels 1.2 x 1.5 x 5.0 mm

Voxels 1.0 x 1.0 x 5.0 mm, 2:27 min.

Motion can hamper MRI quality and efficiency

Radiologie am St Joseph Stift (Bremen, Germany) is a private institution, connected to a 500-bed hospital. Using two Ingenia 1.5T MRI systems, the site performs mainly musculoskeletal, neuro and abdomen/liver studies.

Radiologist Peter Baumann, MD, says motion can be a challenge in MR imaging. "Artifacts can appear in our images due to respiratory motion and bowel motion, as well as in patients who cannot hold their breath or lie still long enough. As a consequence, our diagnostic confidence decreases, or sequences may have to be repeated, resulting in a longer examination time, or sometimes we even have to reschedule the patient to do a rescan."

Correcting motion while you scan

Dr. Baumann then implemented MultiVane XD for motion correction. It uses an extended reconstruction algorithm for imaging that is virtually motion free.

"With MultiVane XD we get excellent motion-corrected images with high spatial resolution. We typically first optimize our scan for high image quality, and when satisfied with that, we try to reduce the scan time. So, we combined MultiVane XD with dS SENSE, which allows us to shorten the scan time," he explains. "The performance of MultiVane XD in liver imaging is outstanding. MultiVane XD with dS SENSE is a powerful development in improving liver image quality."

"As we use breathhold imaging for T2-weighted liver scans, we depend on the patient's ability to cooperate with the exam. This can present a real challenge when we are looking for small lesions, such as in our oncological patients. However, with MultiVane XD motion correction, we get excellent images. This is important for our surgeons, because they want to know exactly where the lesions are."

Successful brain imaging even when patient can't lie still

Sometimes Dr. Baumann also uses MultiVane XD in other anatomy. "In brain imaging, we use it when we anticipate the patient moving, such as for severely ill patients who can't lie still, or we add it when a sequence is not good enough because of motion. We are happy with the good image quality. We've also started to examine patients with lung and heart problems, which of course have moving parts, and we're developing protocols there that seem to work quite well."

»

Peter Baumann, MD, completed his medical studies at RWTH Aachen in 1994. His residency was done in the Radiology department at Bremen-Nord Clinic, and he became a radiologist in 2001 at Radiologie am St. Joseph Stift Bremen, specializing in MRI and CT.

"There's no rescanning necessary, because there are very few or virtually no artifacts."

More confidence in difficult patients

"Our way of working has changed since we implemented MultiVane XD. For instance, in consulting with other clinicians, we are confident to recommend more often MRI instead of CT for liver examinations in difficult patients who cannot cooperate properly. Before using MultiVane XD, we used to do CT scans with a short breathhold, but we prefer good liver MRI with different contrasts over a CT scan."

"The robust performance of the MultiVane XD protocol also makes a difference for our staff. With high image quality results our technologists don't need to ask the radiologist if they have to repeat a scan or use other sequences."

"With MultiVane XD motion correction, we get excellent images."

An efficient comprehensive liver exam

"Our liver exams are quite fast," says Dr. Baumann. "If the patient tolerates it, we use an arms-up position to reduce the FOV and speed up the exam with dS SENSE."

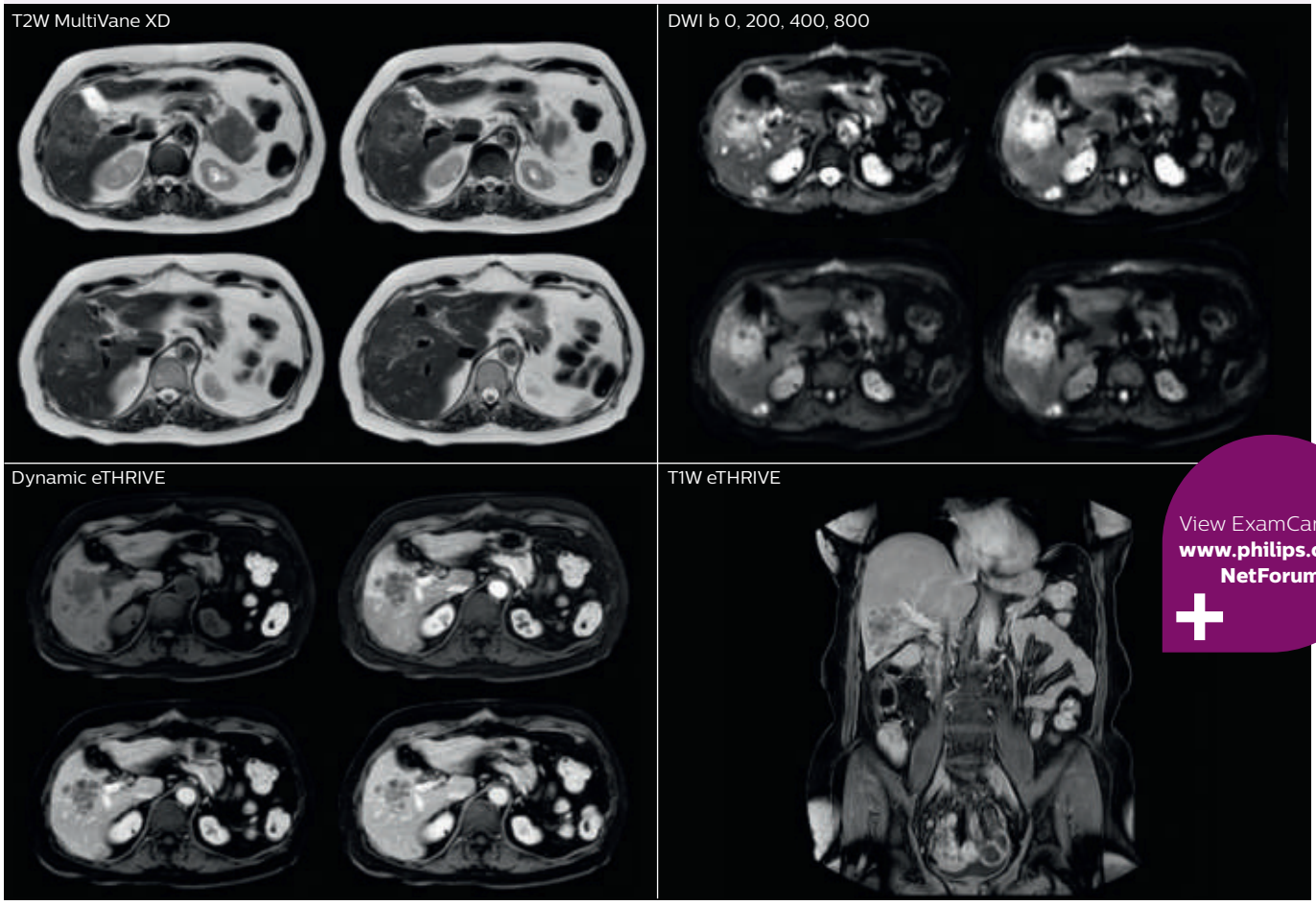
"We acquire one transversal high resolution T2-weighted sequence with 3 mm slice thickness, for example for pancreas or liver lesions. Then we also add a T2 fat suppressed MultiVane XD SPIR sequence. We perform these two routinely in our liver imaging. We use high dS SENSE factors to significantly shorten scan times to 2-4 minutes, which can improve our protocol; it's a very robust scan."

"We include mDIXON for the dynamic sequences because of the robust and homogeneous fat suppression we get with that. We had been using eTHRIVE, but we are now quite happy with

Liver MRI of patient with rectum cancer

A 74-year-old male with rectum cancer and known hepatic metastases underwent chemotherapy and liver resection. MRI with MultiVane XD motion correction was performed for staging. Liver images show the known large metastasis, but also new small lesions are seen. Such small lesions are difficult to detect using ultrasound, so being able to apply motion correction to MRI was important for diagnosing this patient.

MRI on Ingenia 1.5T with dS Torso coil solution. T2W MultiVane XD with voxel size 1.0 x 1.0 x 5.0 mm and scan time 2:27 min.



View ExamCard on **www.philips.com/NetForum**

mDIXON. Sometimes we use a medication to calm the bowels, to further improve the image quality."

First-time-right scanning

"MultiVane XD contributes to getting the images right the first time. Usually there's no rescanning necessary, because there are very few or virtually no artifacts from movement."

"We are more confident in our diagnosis if we don't have to rescan the patient and compare it to other studies; this liver exam gives us good image quality in a faster time than the default system's approach with arms down. That makes a difference for the patients, too. The shorter scan times, especially with the high dS SENSE factors, shorten the duration of the total examination. At the same time it's more comfortable for the patient, to rest normally without holding the breath, just relaxing."

A must-have for everyone?

"I would absolutely recommend to other sites to implement MultiVane XD with dS SENSE in their abdominal cases, as it's brilliant for robust, motion-corrected abdominal imaging. It provides us with excellent image quality with high resolution in a short time," says Dr. Baumann. "I would advise using MultiVane XD for T2 and T2 fat suppressed high quality imaging for almost every liver case."

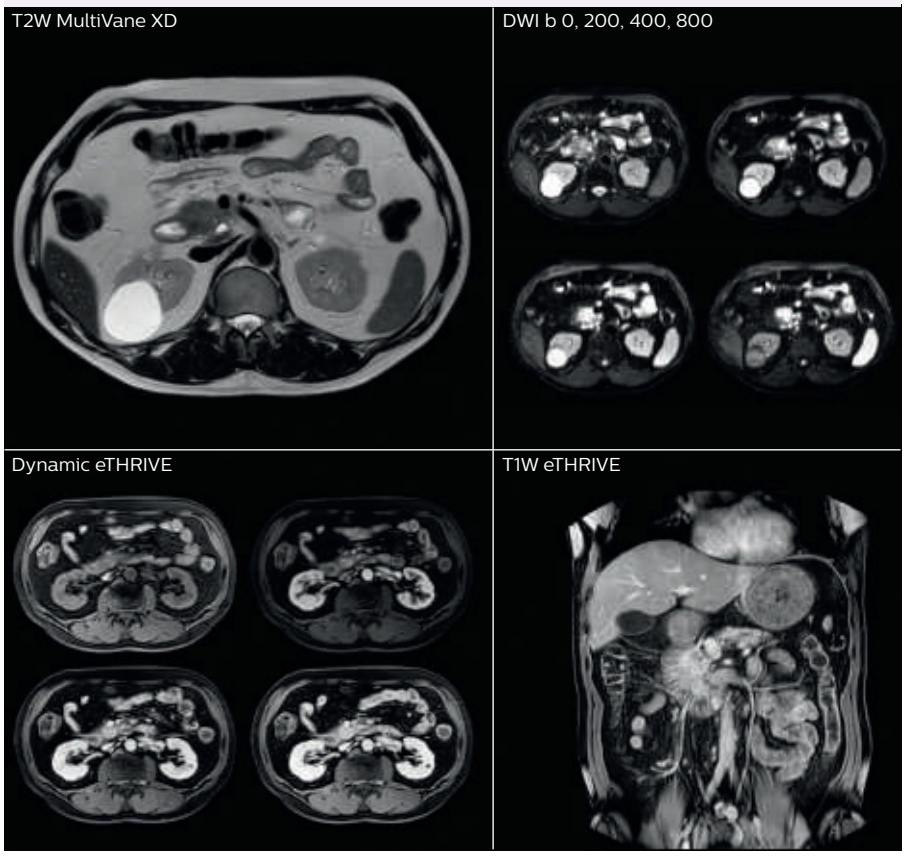
«

"We are more confident in our diagnosis if we don't have to rescan the patient."

Pancreas tumor with metastases

A 61-year-old patient with pancreas cancer and lymph node and liver metastases underwent MRI for first staging after chemotherapy. The tumor is visualized in the head of the pancreas, surrounded by the lymph node metastases and one liver metastasis. T2-weighted MultiVane XD images and T2W SPIR show the size of the tumor regression. Together with diffusion and dynamic imaging this exam provides excellent image quality and gives us a confident measurement for staging.

MRI on Ingenia 1.5T with dS Torso coil solution. T2W MultiVane XD with voxel size 1.0 x 1.0 x 5.0 mm and scan time 2:37 min.



"On Philips NetForum we shared an ExamCard that provides a quite extended version of our examination. We don't examine all patients this way. There are several sequences we don't need for every single case. It does include our MultiVane XD sequences."

+

View ExamCard on **www.philips.com/netforum**

Ben Heggelman, MD, was trained as a radiologist at the Erasmus University Hospital Rotterdam. He has worked for 27 years at Meander Medical Center.

Meander Medical Center (Amersfoort, the Netherlands) is a 600-bed community hospital. Since last year the hospital is concentrated in a beautiful new building, with only single-patient rooms, on the outskirts of Amersfoort. The Radiology Department employs 13 radiologists, 3 nuclear medicine physicians and in total 13 residents. The department operates three 1.5T Philips MRI systems, including Ingenia 1.5T and Achieva 1.5T dStream. (www.meandermc.nl)

Meander Medical Center **raises its standard** in MRI

After introducing the latest methods, radiologists get more information in the same time, making them more confident in their diagnoses.

Since the installation of Ingenia 1.5T in the new building of Meander Medical Center, the MRI team has enjoyed many successes in improving their MRI scanning by implementing the latest techniques available to them, such as Diffusion TSE for distortion-free images, mDIXON TSE for adding fat-free imaging without adding time, and motion correction with MultiVane XD.

Gradual transformation to a new standard

Obtaining high quality MR imaging in the head and neck area can be quite demanding, because the susceptibility changes at the many (curved) interfaces between air, tissue and bone may lower the quality of fat suppression, in diffusion weighted imaging in particular. In addition, the area is prone to motion, which also affects image quality.

Driven by the desire for artifact-free imaging that facilitates easy and confident diagnoses, radiologist Ben Heggelman, MD, and his team have implemented some of the latest techniques. Because of the heavy patient load at the department the changes were gradual to allow for fine-tuning the sequences to their preferences. This process went together with a growing diagnostic confidence among the radiologists. After a few months, the team is passionate about the improvements they achieved.

Excellent cholesteatoma imaging with Diffusion TSE

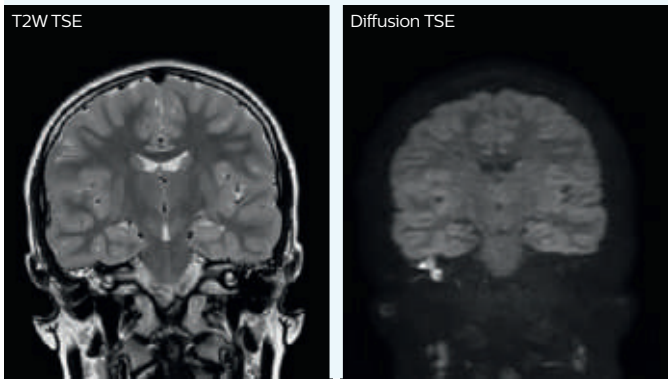
“Imaging cholesteatoma, benign tumors of the middle ear, has been a huge challenge,” says Dr. Heggelman. “We used to do CT, but then we were unsure if we were looking at an inflammation or a cholesteatoma. Also determining if residual cholesteatoma exist after surgery or visualizing recurrence used to be very difficult. Adding Diffusion TSE in our MRI protocol now effectively addresses this.”

“Diffusion TSE is far less sensitive to susceptibility differences than previously used EPI sequences. We appreciate the high resolution and the robustness of the sequence. The quality is so good that our confidence has increased. Also our ENT (ear, nose, throat) physicians are excited about the high resolution, the excellent lesion delineation and the sensitivity and specificity.”

»

MRI of large cholesteatoma of the right ear

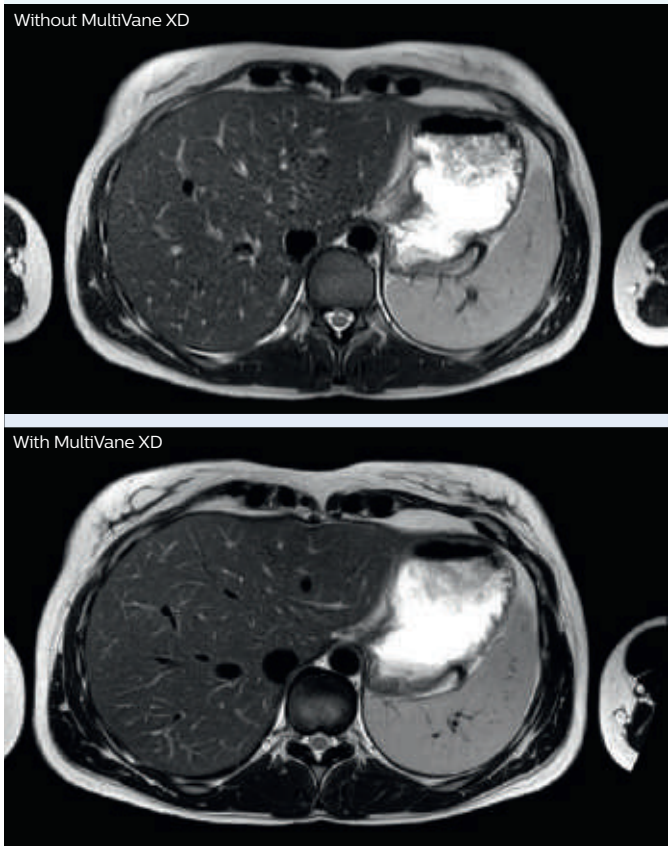
On the diffusion TSE images of this patient a large cholesteatoma is easily seen in the right middle ear. In our experience, looking only at the high signal on Diffusion TSE images may lead to some false positives, but correlation with a low ADC improves the specificity.



"We have high sensitivity and specificity for cholesteatoma acquisition with Diffusion TSE."

MRI motion correction with MultiVane XD

Comparison of T2-weighted TSE imaging with and without MultiVane XD motion correction in a normal upper abdomen demonstrates the spectacular quality of the MultiVane XD images.
Ingenia 1.5T with Anterior and integrated Posterior coil.

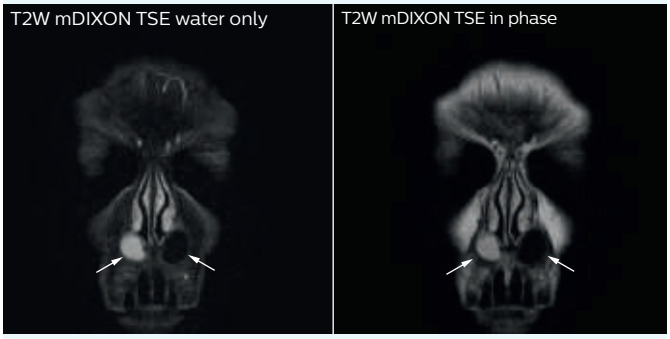


MRI of bilateral nasolabial cyst

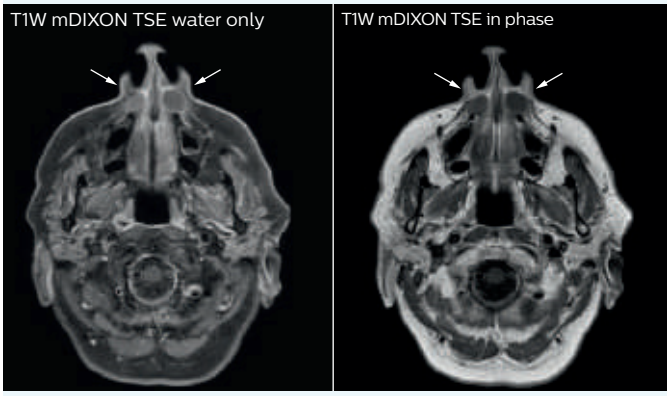
Patient with bulge on the left base of the nose since several months underwent MRI on Ingenia 1.5T using the dS HeadNeck coil.

T2-weighted mDIXON TSE provides both water-only and in-phase image series in one scan with high quality and excellent homogenous fat suppression. Images show the bilateral nasolabial cyst. The cyst on the left is dark on T2-weighted imaging, probably because of high protein level or blood products.

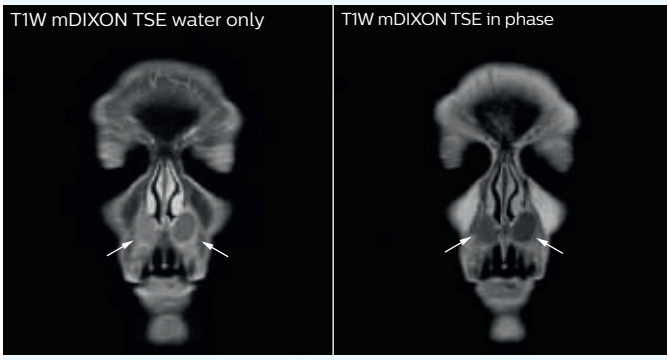
Also post-contrast T1-weighted mDIXON TSE produces high quality water-only as well as in-phase images in one scan with excellent homogeneous fat suppression.



Voxel size 0.48 x 0.48 x 3.5 mm, scan time 4:22 min.



Voxel size 0.47 x 0.47 x 4 mm, scan time 2:27 min.



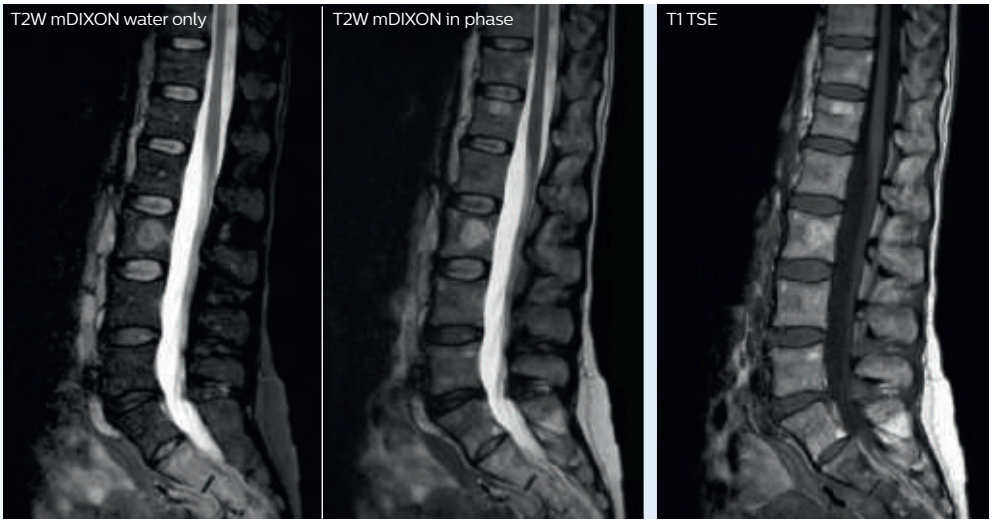
Voxel size 0.55 x 0.55 x 3.5 mm, scan time 2:31 min.

"These methods save time and produce beautiful images."

Low-grade osteomyelitis of the sacrum

This patient underwent rectum amputation and radiotherapy three years before because of rectal cancer. She presented with lower back pain and was examined on Ingenia 1.5T using the integrated Posterior coil.

Edema in the sacrum is easily seen on the water-only reconstruction of the T2W mDIXON TSE. This was less obvious to recognize on the T2W without fat suppression and T1-weighted TSE images. Reactive prevertebral lymph nodes are seen. Diagnosis is low-grade osteomyelitis of the sacrum.

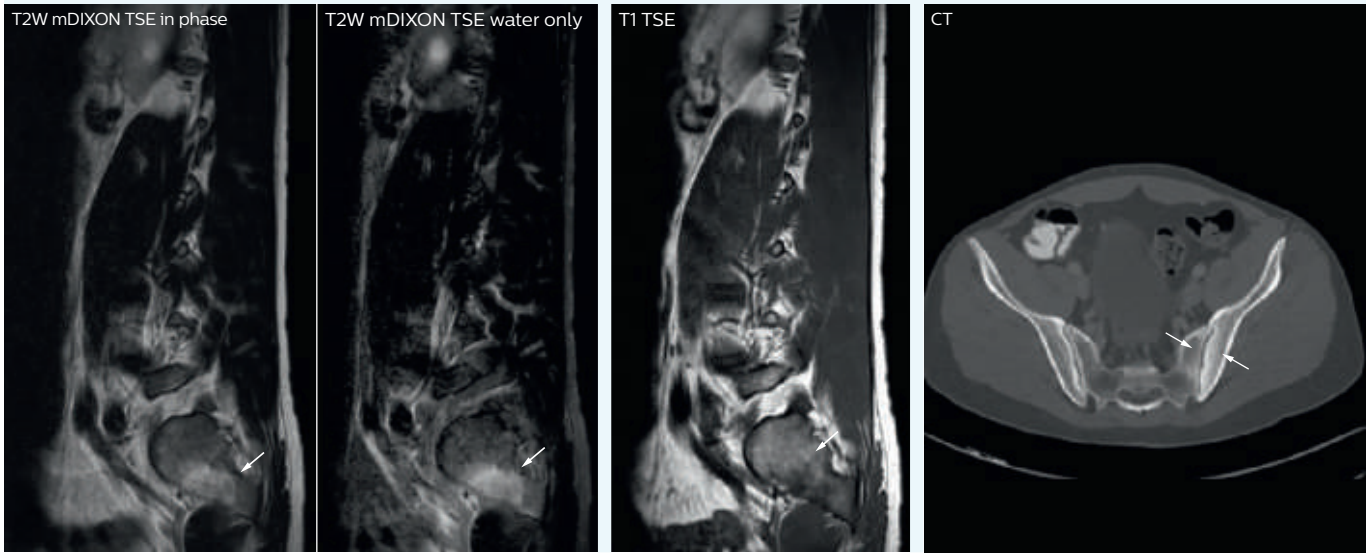


MRI of sacroiliitis

The neurologist referred a patient who was experiencing irradiating pain in the left leg for several months for MRI of the lumbosacral region. Ingenia 1.5T with integrated Posterior coil was used.

The water-only image from the T2W mDIXON TSE scan shows edema in the region of the left sacroiliac joint, which was hard to see on the sagittal T2- and T1-weighted images. The edema was only seen on the outermost slice on the left side. No other abnormalities. CT confirms the left sided sacroiliitis, which turned out to be the first clinical presentation of Crohn's disease in this patient.

T2W mDIXON TSE voxel size 0.52 x 0.52 x 4.0 mm, scan time 4:41 min.



"With mDIXON, we not only get T2 images but we also get a T2 with fat suppression 'for free' in the same scan."

mDIXON TSE boosts homogeneity and efficiency

Dr. Heggelman raves about mDIXON TSE because it provides him an extra image series without having to add another scan.

"With mDIXON TSE, we not only get a T2-weighted series, but we also get the T2 fat suppressed images 'for free' in the same scan. I feel much more confident with the homogeneous fat suppression that mDIXON TSE provides under virtually all conditions, even in this challenging anatomy. SPAIR and SPIR weren't good enough due to the susceptibility problems in the air cavities, so that fat suppression was not homogeneous over the whole field of view. That made it difficult to see whether something was enhancing or the fat suppression was not good enough."

"To me the most remarkable fact is that mDIXON TSE provides us T2-weighted images with and without fat suppression at the same time. In the past we needed two separate sequences for that, so it does save some time."

Value of mDIXON TSE image quality

"The excellent image quality of mDIXON helps us a lot. We can, for instance, see the foramina in the skull base very well. Also our confidence in imaging of the facial nerve and the trigeminal nerve is highly improved. Visualizing these nerves properly used to be difficult because they run very close to the air cavities. However, it is very important to know if there are abnormalities or not. I'm very satisfied with the possibilities of mDIXON TSE."

mDIXON TSE in MRI of orbits

mDIXON TSE also benefits MR imaging of orbits, according to Dr. Heggelman. "Using mDIXON TSE helps us reduce fat suppression problems due to susceptibility. The mDIXON TSE orbital images look outstanding. So, also here I get excellent fat suppressed images, and on top of that, the in-phase images as well in the same time."

"We can also use mDIXON TSE for post-contrast imaging and choose to have T1-weighted both with and without fat suppression at the same time. In the past, it took us two scans to get the same information!"

Motion reduction

"We also love MultiVane XD for motion reduction in imaging. We find this a huge step forward. We use it in the head, and of course in the upper abdomen, and the images are outstanding most of the time. And it can be combined with dS SENSE parallel imaging for speed."

From left to right: MRI technologists Gerrit Kooiker, Jane van Straelen, Natasja van Bree, radiologist Ben Heggelman

"We have compared image quality of FLAIR with MultiVane XD versus FLAIR without MultiVane XD. In 15 of the 40 patients studied, we saw motion artifacts on plain FLAIR brain images. The FLAIR images with MultiVane XD were motion-free in 39 of 40 patients and showed slight motion artifacts in only one patient."

More information without extending time slot

"In our lumbar spine MRI, the value of mDIXON TSE is so obvious. Normally we perform T1 and T2 scans in sagittal and transverse orientation. It used to take too much time to add a sagittal T2 with good fat suppression. But now, using mDIXON TSE, we get the sagittal T2 fat suppressed images 'for free', that is: without adding time."

"Diagnostically that is a great benefit. I sometimes see abnormalities in the fat suppressed sagittal T2 that would be quite challenging to notice in the T2 without fat suppression. There have been several diagnoses that I could make easier because of our exam setup with mDIXON TSE, such as sacrum insufficiency fractures and sacroiliitis; these were more challenging with our previous exam setup."

A boost for efficiency

"The described techniques have taken us a big step forward," concludes Dr. Heggelman. "Especially in more challenging regions, these methods save time and produce beautiful images. I feel much more confident with the high image quality and fewer artifacts."

«

Guillaume Lefebvre, MD is an MSK Radiologist at Lille University Hospital (Pr. A. Cotten 's Department). Dr. Lefebvre is a member of French Society of Radiology (SFR), Society of Musculoskeletal Imaging (SIMS), European Society of Musculoskeletal Radiology (ESSR), European Society of Radiology (ESR), and Radiological Society of North America (RSNA).

"Radiologists no longer need to choose between fat suppression or not."

Used in most of its MSK exams, mDIXON TSE shines at CHRU Lille

One sequence, many benefits in musculoskeletal MRI

The musculoskeletal imaging department at Lille University Hospital (CHRU, Lille, France) manages to get more information in the same time slot after integrating mDIXON TSE in many exams. mDIXON can provide four different contrasts from a single acquisition and its fat suppression is robust, helping us reduce additional scans.

The Hospital's musculoskeletal imaging department, led by Prof. Anne Cotten, scans patients referred from various departments including emergency, orthopedics, neurosurgery and rheumatology using its Ingenia 3.0T system.

According to Guillaume Lefebvre, MD, the MRI team has recently changed its way of working by integrating mDIXON TSE into most MR exams of peripheral joints and spine. Using mDIXON TSE has contributed to detailed diagnoses and diagnostic confidence, he says.

A way to get more information within the available time

"In MSK imaging, we generally need T1-, T2-, PD-weighted, and sometimes post-contrast sequences, with or without fat suppression, in different orientations. The goal is to have enough information to see abnormalities in signal and morphology, but we can't fit all orientations, all weightings and all contrasts into an exam, so we must make a choice."

"With previous exam protocols, we sometimes missed information because we didn't choose the right acquisitions, with or without fat suppression for example. Adding sequences in our exam could help, but lengthens the examination time and thus reduces the availability of MRI. A long exam is also a source of patient motion, which degrades the image quality."

"mDIXON TSE helped us find a solution here, as it provides four different contrasts in just one acquisition – an important reason why we prefer using it. mDIXON TSE is now added to most joint MRI protocols at our hospital."

Bone assessment with confidence

"For bone assessment near joints, mDIXON TSE provides the visualization and multiple contrasts to describe abnormalities within a limited number of acquisitions. Bone marrow signal abnormalities are common MRI findings that can represent various underlying causes, from normal variance to malignancy. So, it is important for us to notice and characterize these findings. With different contrasts, both with and without fat signal as mDIXON TSE efficiently provides, we can make a confident diagnosis."

"Other examples in bone are the signal description of a necrotic fragment in osteonecrosis, the signal description of tumoral matrix that has different components (necrosis, hemorrhage,

cartilage, bone formation). These are all possible thanks to in-phase and water images from a single mDIXON acquisition."

Add fat suppressed imaging without time penalty for peripheral joints

"In peripheral joints, mDIXON TSE imaging aids in diagnosing injuries in ligaments or tendons, for imaging degenerative and inflammatory pathologies such as osteoarthritis and rheumatologic disorders and for oncological exploration."

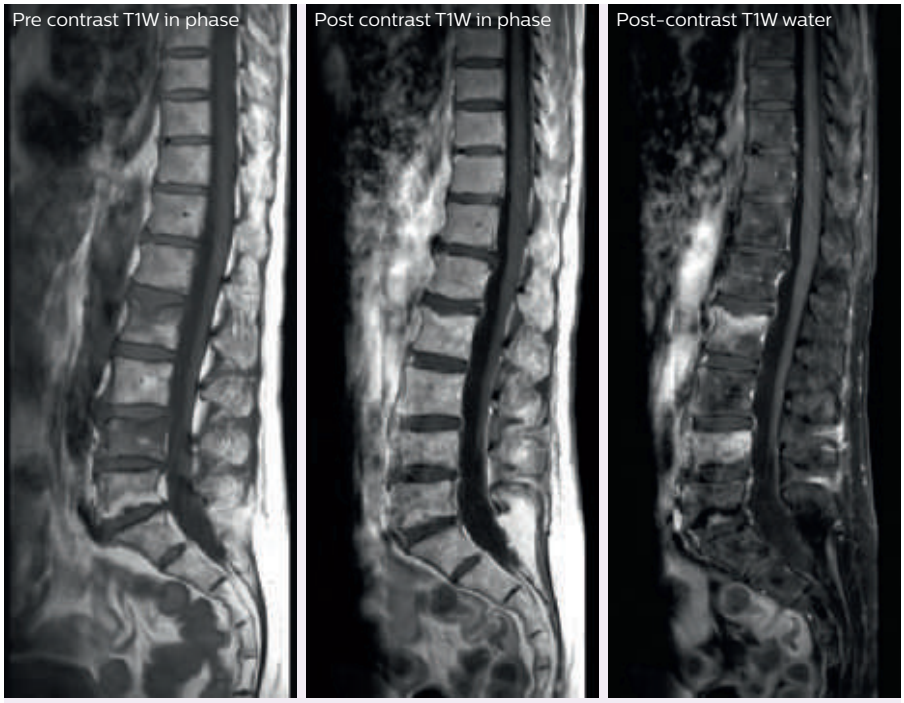
"For tendon and ligament assessment around knee, ankle, hip and elbow, mDIXON TSE contributes to diagnostic confidence thanks to having images both with and without fat suppression – and without time penalty. This is possible because 2-point mDIXON is faster than the common 3-point Dixon method. It can also increase efficiency as it helps avoid having to add scans during the exam."

Amazing quality of fat suppression

"In peripheral joints, we get good image quality in difficult areas with mDIXON TSE. Fat suppressed images appear homogeneous over the entire image, even with large coverage at 3.0T – for instance in scapular or hip girdles – or in the bearing areas or around metal prostheses*, where fat suppression is often deficient with STIR or spectral fat suppression, causing diagnostic difficulties. If diagnostic images are right the first time, we don't need to repeat or add a sequence."

"mDIXON TSE sequences allow simultaneous characterization of morphological changes from the in-phase T2-weighted images and visualization of edematous changes, thanks to the water T2-weighted images from the same acquisition. Anatomical and morphological considerations could be a partial or complete ligament tear, a bony avulsion or hematoma."

"For soft tissue assessment mDIXON brings similar benefits. For example in one T2-weighted mDIXON TSE acquisition, having the multiple contrasts helps us assess abnormalities in peripheral nerves fascicles, which may be due to anatomical or inflammatory changes."



Vertebral fracture characterization with mDIXON TSE

A 63-year-old patient with breast cancer in remission and a recent lumbar back pain was referred for MRI on Ingenia 3.0T. On the mDIXON TSE water images the edematous changes into vertebral bodies related to recent fractures and inter spinous edema related to new biomechanical constraints are seen. Fat suppression is homogeneous, also of the subcutaneous fat.

Both post-contrast images, with and without fat suppression, are obtained from the same acquisition. No focal lesion is seen on T1W pre-contrast in-phase or post-contrast water images. The addition of post-contrast in-phase images allows visualization of homogenization of the bone marrow, suggestive of no malignancy. Diagnosis is recent osteoporotic vertebral fractures, seen at L2 and L4 levels.

mDIXON TSE provides the images with and without fat suppression simultaneously and without time penalty. Ingenia 3.0T, pixels 0.63 x 0.63 mm.

These mDIXON TSE sequences appear useful thanks to the homogeneity of the fat suppression obtained with extended fields of view at 3.0T.

View extended case on **www.philips.com/fieldstrength**

Improving efficiency in musculoskeletal MRI

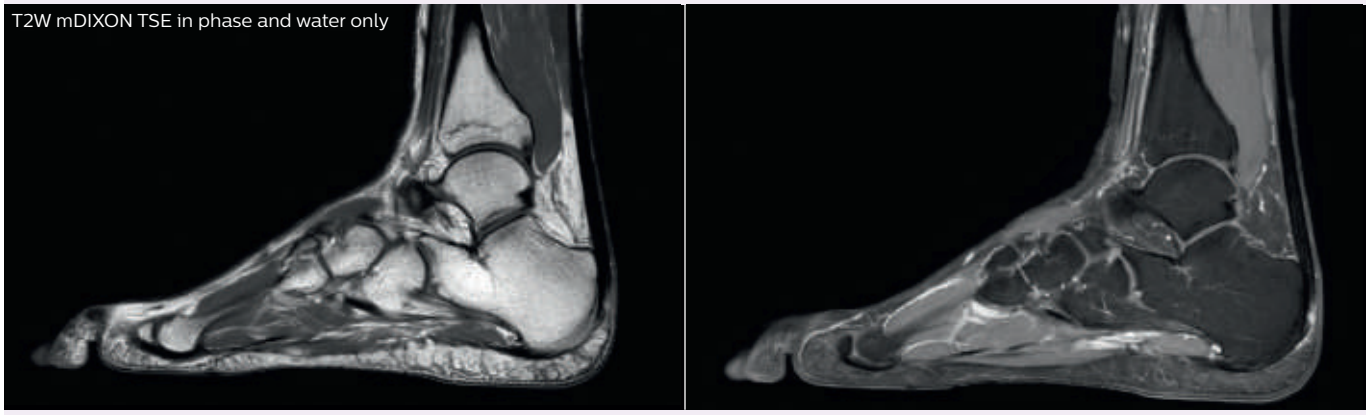
Dr. Lefebvre appreciates the efficiency of mDIXON TSE. "Using mDIXON TSE we can reduce the number of sequences scanned, without reducing the number of contrast types provided. In addition, we also value the reduction we see in repeats because of artifacts (as frequently found in other fat suppressed sequences as SPAIR and SPIR), making the acquisition non-diagnostic. Imaging right the first time is the most efficient way for us, and also for the patient."

»

"Fat suppressed images appear homogeneous over the entire image, even at 3.0T."

* Metal implants are a contraindication for MRI, unless the MR compatibility for the implant is stated by the implant manufacturer.

Ankle with mDIXON TSE on Ingenia 3.0T



A 30-year-old patient with clinical presumption of chronic inflammatory disease was referred to MRI to explore talalgia. Homogeneous fat suppression is seen on the post-contrast T1W mDIXON TSE images, including the peripheral and bearing areas. In-phase images provide visualization of anatomical abnormalities: small calcaneal enthesophyte and fiber disruption of the Achilles' tendon, which is often difficult to see. Water images allow to see edematous changes of the tendon and surrounding soft tissue adjacent to the tear. No bone edema is found. Diagnosis is focal partial tear of distal Achilles tendon.

Ingenia 3.0T is used with dS FootAnkle coil. Pixels 0.42 x 0.53 mm acq, 0.40 x 0.40 mm rec.

With mDIXON TSE sequences, images with and without fat suppression can be obtained simultaneously without time penalty. Fat suppression is homogeneous over the entire field of view, even when examining a peripheral joint at 3.0T. The bearing area, as imaged in this case, can be a usual source of artifacts and diagnostic difficulty.

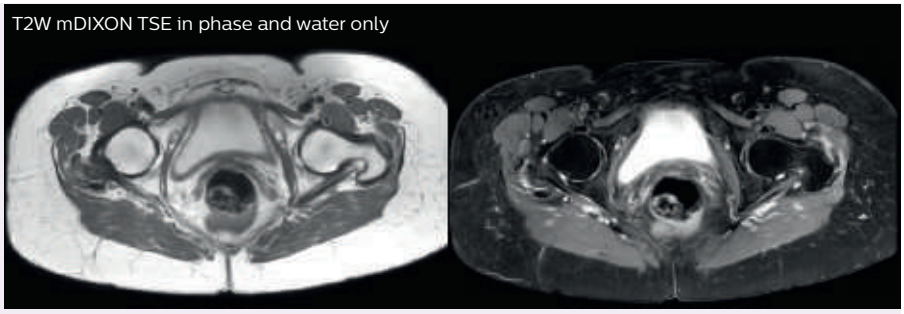
mDIXON TSE sequences allow simultaneous finding and characterization. The distinction of the relevant structures (cortical and spongious bone, tendon, fat, skin) is helped by the direct match between the different contrasts obtained from the same acquisition.

Hip MRI with mDIXON TSE

A 67-year-old patient with chronic painful hip without history of trauma underwent an MRI examination to find articular or periarticular lesions.

Homogeneous fat suppression is seen on the T2W mDIXON TSE images over the whole large field of view, even in the peripheral subcutaneous fat. Image series with and without fat suppression are obtained from the same acquisition. In-phase images allow detailed analysis of entheses and tendon structures. Water images provide visualization of edematous changes predominant into the distal left gluteal tendon. Diagnosis is gluteal enthesopathy.

Ingenia 3.0T with dS Torso coil solution. Pixels in axial images 0.90 x 0.84 mm acq, 0.77 x 0.76 mm rec. Pixels in coronal images 1.07 x 1.06 mm acq, 0.67 x 0.67 mm rec.



"We prefer using mDIXON TSE, which provides four different contrasts in the same acquisition."

What Dr. Lefebvre likes about **mDIXON TSE**

- The quality, robustness and homogeneity of fat suppression.
- Getting images both with and without fat in the same scan time, so without time penalty.
- The good correlation between images with different contrast: misregistration is avoided as images are obtained from the same acquisition avoiding movement between scans.
- The simplified ExamCards are easy for technologists.

"Using mDIXON TSE gives us homogeneous fat suppression in a reduced scan time, as well as good correlation between different images. In addition, we have a direct match between different contrasts because they are obtained from the same acquisition."

Spine scans must be fast and complete

"In our spine cases, we use mDIXON TSE for patients with degenerative and inflammatory spine issues, vertebral fractures and vertebral and paravertebral tumor characterization," says Dr. Lefebvre. "It provides, in a single acquisition, different contrasts so we can both visualize and characterize spinal, focal or diffuse spine lesions."

"mDIXON TSE makes real a difference in cases of acute and traumatic spinal injuries, where it allows us to reduce the scan time by only using a limited number of sequences. For patients in pain, who come from the emergency unit and need surgery, for example, MRI must be very fast. With a single T2-weighted acquisition we can assess spinal cord, vertebral disc and ligament wholeness with in-phase images, as well as trabecular fracture and edematous changes with water images."

Dr. Lefebvre cites other frequent examples of spinal diseases that benefit from the mDIXON technique. "In cases of vertebral disc herniation or degenerative discs, for example, we don't have to choose between fat or no fat images. We can assess morphological changes in the endplate with in-phase images from T2-weighted sequences and in the water image from the same acquisition we will see inflammatory changes into endplates."

Improvements in the way of working

Dr. Lefebvre says, "Our radiologists no longer need to choose between fat suppression or not during the examination; they have both. In addition they appreciate mDIXON TSE for exceptional image quality and homogeneous fat suppression. Using mDIXON TSE can even help make diagnoses that were difficult or not possible with our older fat suppression methods. In joints, for example, we now get excellent image quality in difficult areas where the fat removal used to be usually deficient."

"Our referring physicians also appreciate the high quality images for confident diagnosis and optimal care. For technologists, using mDIXON TSE helps reduce errors related to the positioning of fat saturation bands, normally used with fat sat acquisitions. Our department managers like to see short scan times, which lead to increased MRI availability."

Easy to use and highly recommended

Overall, Dr. Lefebvre reports, "I would definitely recommend mDIXON TSE for MSK imaging. It's an easy way to get a major improvement of an MRI examination, with simultaneous images for visualization and characterization without time penalty."

«

Read more on **www.philips.com/fieldstrength**

References

1. Del Grande F, Santini F, Herzka DA, Aro MR, Dean CW, Gold GE, et al.. *Fat-suppression techniques for 3-T MR imaging of the musculoskeletal system* Radiographics. Feb 2014;34(1):217-233.

Motion correction in shoulder imaging

Ben Kennedy, chief MRI technologist at Qscan Radiology Clinic (Brisbane, Australia) explains how MultiVane XD helps them in dealing with respiratory motion in MRI of shoulder and elbow.

Ben Kennedy, chief MRI technologist at Qscan Radiology Clinic in Brisbane, Australia

When motion affects MRI of upper limbs

"As upper limb joints are in direct connection to the chest, MR imaging of these joints is susceptible to breathing artifacts, particularly when scanning in axial orientation. Routine MR imaging of the shoulder and elbow regions benefits greatly from motion correction with MultiVane XD.

In our experience, particularly the first sequence of an exam is likely to suffer from respiratory motion as patients are settling into the magnet environment. However, some patients naturally have a lot of respiratory motion, for instance athletes carrying a higher muscle bulk or obese patients. For such cases we have optimized MultiVane XD for all directions with all TSE sequences of the shoulder and elbow."

Integrating MultiVane XD in the exam

"MultiVane XD has been easy to implement and allows me to stick to my basic sequence optimization steps for obtaining high image quality. Compared to the previous version of MultiVane that we used, we find MultiVane XD providing some significant improvements[1] in flexibility and confidence in our imaging outcomes."

"Using MultiVane XD our non-fat-saturated sequences show high definition of the trabecular pattern, which is important in high detail musculoskeletal imaging."

Different sequences, different approaches

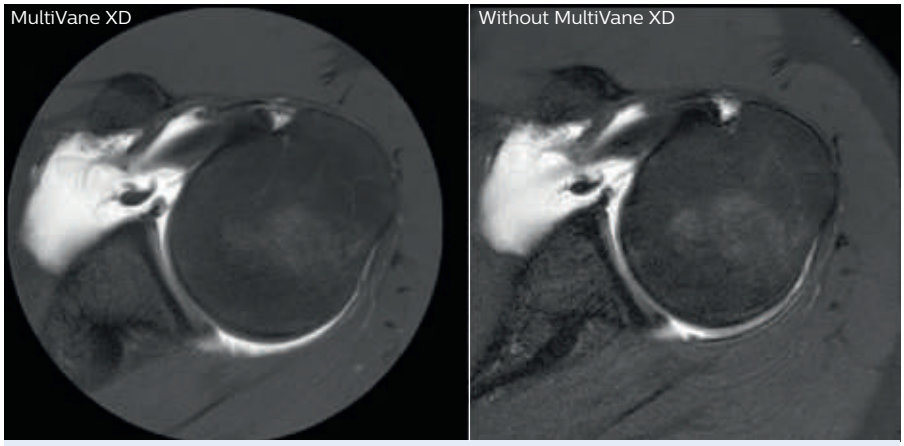
"For PD and T2 fat suppressed imaging, I prefer the asymmetric k-space sampling that gives me great flexibility in tailoring each sequence to enhance image quality and speed. It allows me to increase SNR without compromising voxel size, so that I maintain the same high resolution, and maintain the preferred TE position within the shot length for the desired image quality. Using asymmetric sampling also helps maximize image contrast, which is paramount in musculoskeletal imaging."

"For T1 and T1 fat suppressed imaging, we can still use low-high k-space sampling and stick to the same maximum shot length rule as in our standard TSE version. We are using multiple shots per blade to widen the width of the phase sampling blade. At 3.0T, we have the ability to keep TE spacing much shorter, which requires a smaller water fat shift, whilst maintaining good SNR thanks to dStream."

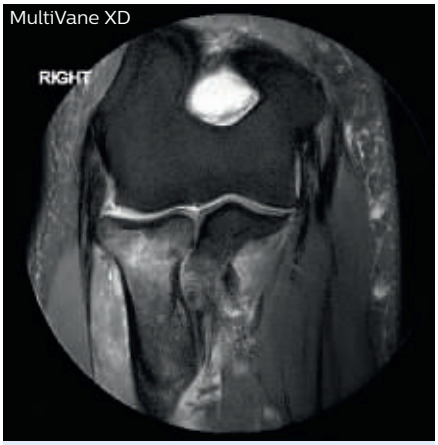
Final considerations

"For blade percentage, I start at minimum 200% and reduce any multiple NSA to 1, as multiple NSA will overlay multiple corrected image data samples, which may

with MultiVane XD



Comparison of axial fat suppressed PD-weighted imaging with and without MultiVane XD in the left shoulder demonstrates that the imaging with MultiVane XD provides excellent image quality, even in presence of motion.



Imaging with MultiVane XD provides excellent image quality, even in presence of motion.

not correct the same. By choosing the MultiVane percentage as NSA (e.g. 4 NSA would be the same as 400%) for keeping SNR equivalent, all data will be corrected to the same image correction. For data at minimum 200%, which started at 1 NSA, dS SENSE can be used for reducing the scan time back where it started."

"After optimizing the contrast parameters, it is important to recognize that often a slightly larger field of view is needed to cover the desired anatomy when converting from a square or rectangular FOV to a circular FOV in order. Increasing FOV can also be a simple solution to get rid of a wrap artifact from a larger size patient."
«

Concluding remarks

"The ability to use dS SENSE can be a great benefit for speed where required. Its sampling pattern preserves SNR even in higher SENSE reduction values. In other sequences, we take advantage of the SENSE unwrapping algorithm at the reduction value of 1, which I commonly leave on."

"Thanks to the homogeneous wide bore magnet of Ingenia, standard SPAIR and SPIR fat saturation is still very robust on these protocols, which use supine patient positioning with arm by the side."

"The MultiVane XD technique is a savior in clinical diagnostic quality in our most challenging patients. You can have the best equipment available but capturing a moving target requires this next step of innovation."

[1] Pipe et al., Magn Reson Med. 2014;72(2):430-7

Results obtained at this facility may not be typical for other facilities

Researchers at Sahlgrenska University are studying the usefulness of synthetic MRI for brain volume quantification in MS patients.

Investigating the potential of for brain quantification

Lars Jonsson, MD, is senior consultant neuroradiologist at Sahlgrenska University Hospital, Gothenburg, Sweden. He had joined the Neuroradiology department in 1991, where he fulfilled the position of department head from 1997 to 2002. He worked in the Radiology department from 1989 to 1991.

Synthetic MR

Synthetic MR is an interesting research topic for quantitative imaging. It combines a special MR imaging sequence with dedicated software to generate synthetic images with different contrast types. The study of the Sahlgrenska team is exploring if synthetic MR could be of use for quantification purposes in MS patients.

What is synthetic MR imaging?

Lars Jonsson, MD, is a neuroradiologist at Sahlgrenska University Hospital (Gothenburg, Sweden) and is involved in a research project on whether and how Synthetic MRI could become of use for clinical purposes.

"Synthetic MRI starts with a special MR sequence that provides multi-dynamic, multi-echo (MDME) imaging in about six minutes," says Dr. Jonsson. "This scan is used to calculate longitudinal (T1) and transverse (T2) relaxation times and proton density for every voxel. These parameters are tissue characteristics and from this data, we can calculate T1 images, T2 images, proton density images and FLAIR images."

Relevance for quantitative imaging

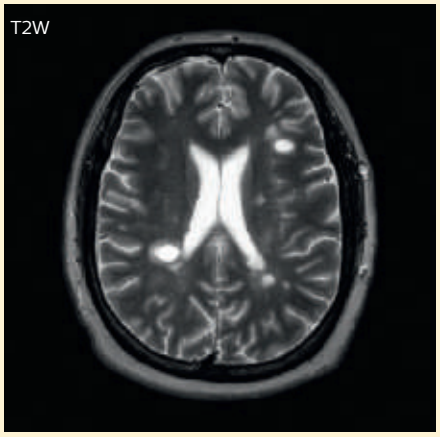
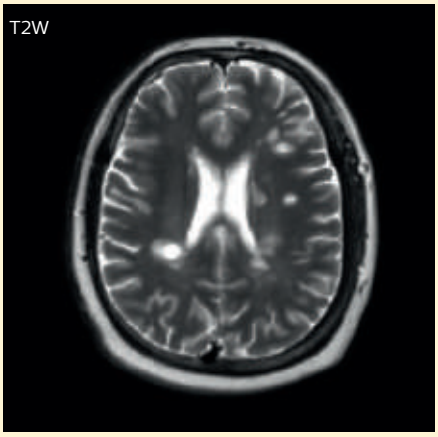
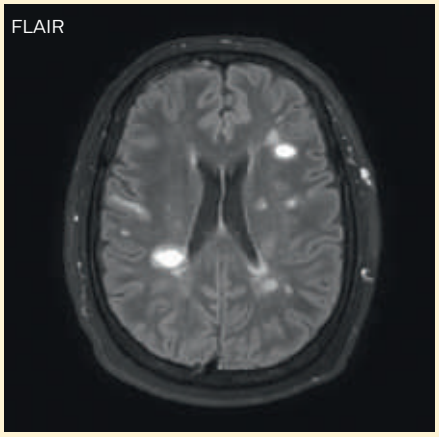
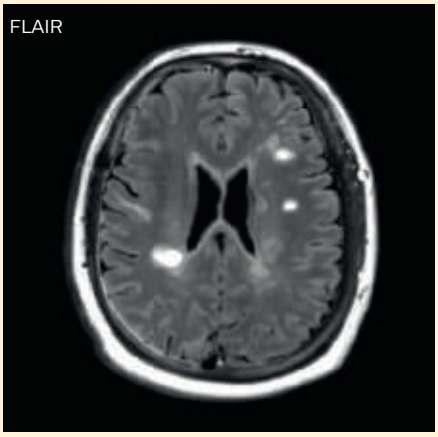
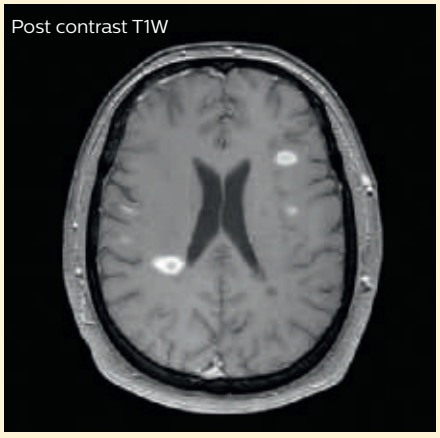
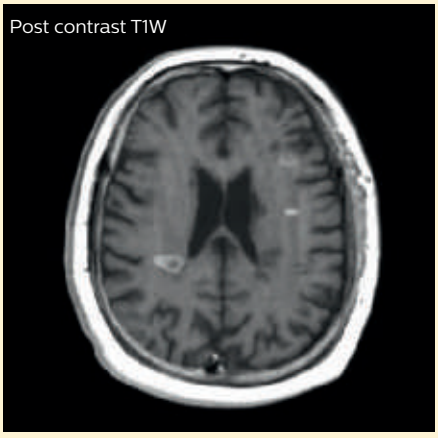
"Once we have those values, it's easier to perform automatic segmentation, for example, of gray matter, white matter, brain volume and brain liquid. So we can get volume measurements that are clinically relevant, and they are quite easy to get – this is a real benefit. We are currently using this approach in a research environment for calculating brain volumes in MS patients."

"For our study, we are using an Ingenia 3.0T with dStream and with the Neuroscience package that enables the dedicated MDME sequence, along with a computer and dedicated software that processes the images and generates simulated images."

Study on quantifying MS brain volumes

In collaboration with MS-specialized neurologists, Dr. Jonsson and his team are studying the potential relevance of Synthetic MRI in patients who have, or are suspected to have, multiple sclerosis (MS), by scanning this synthetic MRI sequence in addition to their regular examination that they undergo anyway. »

"We can produce synthetic T1, T2, PD and FLAIR images from one synthetic MR sequence."

	Separate sequences	Synthetic MR
In the T2 and FLAIR images the active demyelinating lesions with intense high signal and small surrounding edema are seen, together with some smaller, older lesions without edema.		
		
The T1 images show enhancing active lesions.		

"When you need quantitative volume measurements this is a good sequence."

CAUTION - Exclusively for clinical investigations

Slice	WM	GM	CSF	NON
1	0.0	0.0	0.0	0.0
2	0.1	5.5	1.7	0.1
3	0.2	12.2	1.5	0.2
4	1.0	16.1	1.7	0.2
5	3.1	17.0	2.6	0.1
6	6.5	17.1	2.4	0.7
7	4.9	23.5	2.7	0.6
8	3.6	30.2	3.3	0.8
9	6.1	39.7	3.1	0.7
10	13.2	39.5	4.7	0.6
11	18.4	40.7	5.6	1.0
12	21.8	40.4	6.1	1.5
13	29.0	40.0	4.8	1.2
14	28.7	43.6	5.0	0.8
15	33.2	37.7	6.2	1.7
16	26.1	42.3	6.1	2.0
17	28.2	36.7	10.2	2.3
18	28.0	36.4	9.9	2.0
19	31.0	31.9	9.1	2.1
20	30.9	32.6	5.9	1.7
21	27.8	32.9	6.9	0.6
22	21.6	32.9	7.3	0.6
23	19.2	28.9	7.7	0.6
24	15.1	26.1	7.9	0.8
25	11.9	22.6	6.9	1.2
26	9.5	15.7	6.8	2.0
27	4.5	12.2	6.1	1.8
28	1.3	7.1	5.0	1.1
29	0.2	1.5	1.7	0.4
30	0.0	0.0	0.0	0.0
Sum	425.2	763.2	150.1	29.2
% BPV	34.9 %	62.7 %	N/A	2.4 %
% ICV	31.1 %	55.8 %	11.0 %	2.1 %

(BPF: 89.0 % (BPV / ICV = 1218 ml / 1368 ml))
Intracranial mask generated by SyMRI NEURO

The table shows calculated volumes of white matter (WM), gray matter (GM) and CSF for every single slice in the synthetic MR sequence. In the last column (NON) are the values that don't fit in the first three categories.

Below are the slice sums for the different categories (WM, GM, CSF and NON).

% BPV (brain parenchyma fraction) shows the fractions of WM and GM respectively. % ICV (intracranial volume) shows the fractions of WM, GM and CSF. Finally, BPF (brain parenchyma fraction) in percentage of intracranial volume, as well as the brain parenchyma volume and the intracranial volume in mm (BPV/ICV).

"It is known that the brain volume in MS patients is diminishing, even if there is no visible progression in the disease. The purpose of our study using synthetic MR is to see if we can calculate brain volumes and see brain volume diminish when following patients for a couple of years. We hope to learn if this can help us track how the disease is affecting brain volume, and how the brain atrophy progresses. It's quite an interesting area."

"For patients in the study, we start with performing one initial scan as a baseline, followed by another scan after six months, and then every year after. By comparing the measurements from one year to the next, we expect to be able to calculate the speed of brain volume diminishing. We've only started recently, but we hope that in the future we can perhaps study the brain volumes together with lesion volumes."

Further development is ongoing

"Our future goal could be to use just the one sequence providing the synthetic MR images to replace several separate scans. In MS patients, we might then be able to use this one sequence instead of separate T1, T2 and FLAIR, together with, for instance a sagittal T2 sequence. In that case, we would save time because we can replace three scans with this one six-minute scan, and still get the required information. But we are not there yet."

"Some hurdles remain before Synthetic MRI could be of clinical value. For instance, lesion contrast on synthetic images is sometimes not completely identical to the normal images. I think contrast in the T1 and T2 images is already quite good. However, we still want to increase the spatial resolution, we need to get to thinner slices."

Looking ahead

"It might be a few years before these methods are ready for clinical implementation," says Dr. Jonsson. "Only when it's adequately proven that it's possible to replace multiple other sequences with just this one, will people want to consider using it routinely. At that point it can potentially save a great deal of time on different types of patients and different conditions. When you need quantitative volume measurements this is a very good sequence. I think it could be interesting to investigate usefulness in dementia, Alzheimer's, contrast-enhancing tumors and hydrocephalus. You can get some very exact measurements in an easy way with just this sequence, and that is a big advantage."

«

Maxime Descoteaux, PhD, professor of computer science, director of the Imaging and Visualization Platform (PAVI) (http://pavi.dinf.usherbrooke.ca/) and director of the Sherbrooke Connectivity Imaging Laboratory (SCIL) (http://scil.dinf.usherbrooke.ca/), is a leader in medical image analysis and image processing and an expert in diffusion magnetic resonance imaging acquisition, processing and visualization to infer white matter connectivity of the brain.

Kevin Whittingstall, PhD, is an assistant professor in the department of Radiology at the Université de Sherbrooke in Québec, Canada and a Canada Research Chair in Neurovascular Coupling. His main research interests are in the development of non-invasive tools for measuring and interpreting brain function and structure in humans and animal models. In particular, his lab focuses on the balance between neural activity and cerebral blood supply (neurovascular coupling) and how disruptions in this balance are related to diseases of the brain (e.g. brain tumors).

New insights for neuroscience

Sherbrooke researchers investigate **Diffusion MRI** and **fMRI**

Researchers at Université de Sherbrooke (Sherbrooke, Quebec, Canada) are using techniques like denoising, advanced tractography, and simultaneous EEG-fMRI to better understand basic brain function in health and disease.

Local and global challenge

Maxime Descoteaux, PhD, director of the Sherbrooke Connectivity Imaging Laboratory (SCIL), focuses on neuro connectivity, including algorithm development, modeling, and the processing pipeline. He notes two major challenges for neural imaging: understanding white matter microstructure and understanding the large scale connections in the brain.

"At the local level, the challenge is to understand what the MR signal in a single voxel represents, especially in white matter. We have thousands of axons, blood vessels, and other types of cells such as glial cells, and all of this is averaged out in one MR signal, so there is a lot of room for local modeling to extract meaningful features from these signals," Dr. Descoteaux notes. "The ultimate goal is to find new biomarkers for certain diseases such as neurodegenerative diseases, autism and psychiatric diseases."

"At a more global level, one of the biggest challenges is mapping the human connectome. As we map the connections of the brain, it brings so much data that we need new algorithms to analyze that data."

Fast, high resolution DWI

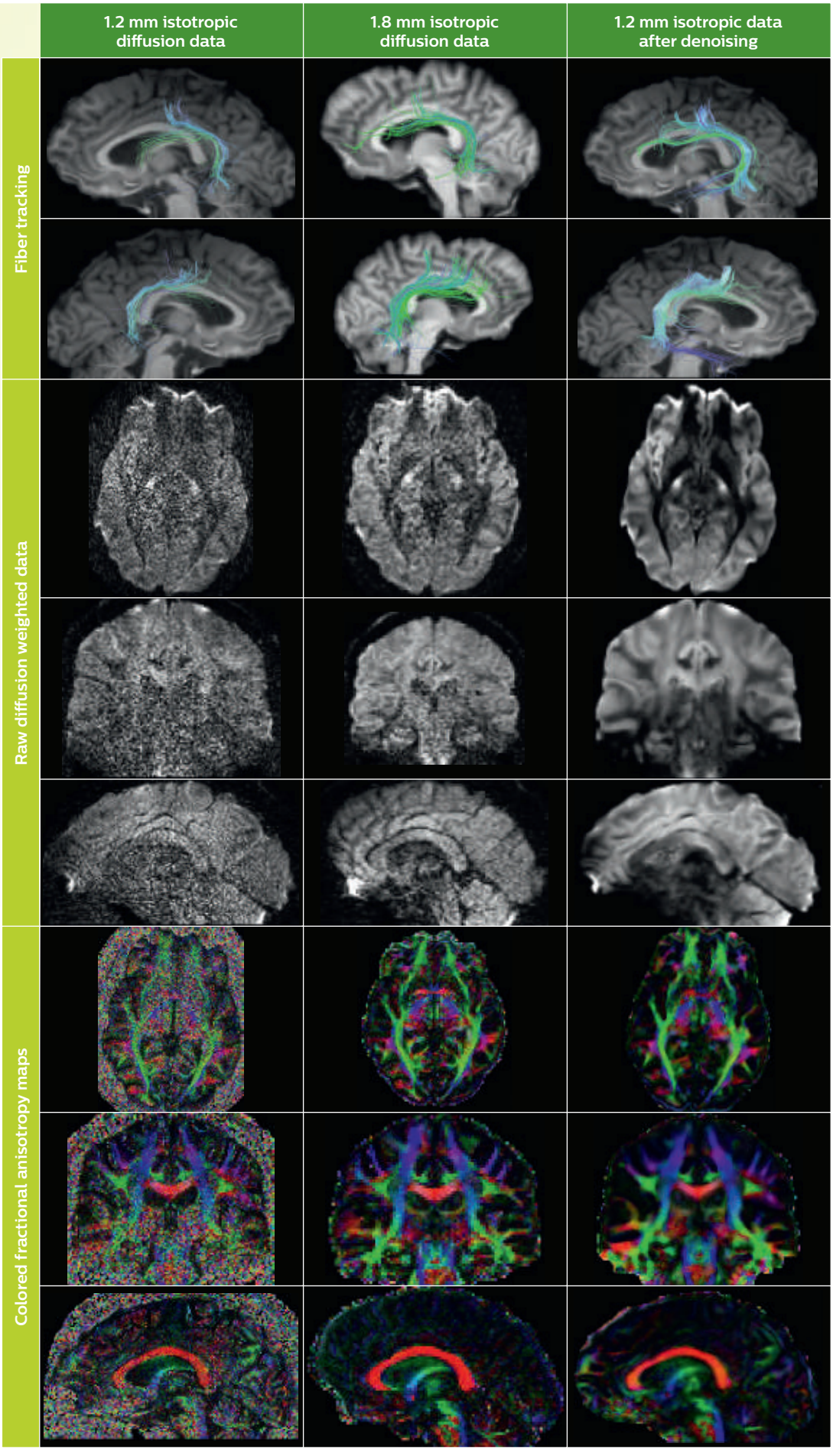
One of Dr. Descoteaux's current projects involves using mathematical modeling and smart algorithms to optimize diffusion weighted images (DWI). He explains that in DWI, as in all MR techniques, SNR decreases and acquisition time increases as the voxel size is reduced, forcing DWI acquisitions at a spatial resolution that can't provide the desired high specificity of reconstructed tracts and diffusion features. Dr. Descoteaux and his colleagues have published a scientific paper at the ISMRM (2015) that concludes that applying his denoising techniques can produce acquisition of high resolution DWIs comparable to those

»

Denoising to improve quality

Using a non-local spatial and angular block matching technique to denoise raw diffusion weighted images. allows to push acquisition to lower spatial resolution and read human-connectome-project-like resolution from standard Philips Ingenia 3.0T MRI scanner.

The data were acquired with spatial resolution of 1.2 x 1.2 x 1.2 mm in 13 minutes for 40 full brain DWI with b 1000 and one with b 0



acquired in the Human Connectome Project. "The difference is that our dataset was acquired in 13 minutes on a clinical 3.0T scanner without expensive, specialized hardware, as opposed to about an hour and a half on the Connectome Project systems," he points out.

Vasculature affects BOLD response

Dr. Descoteaux's colleague, Kevin Whittingstall, PhD, focuses his research efforts on fMRI. An assistant professor in the Department of Diagnostic Radiology and an affiliate in the Department of Radiobiology and Medical Imaging, as well as an adjunct professor in computer science, Dr. Whittingstall is investigating how brain structure affects fMRI response.

He explains that while there is a connection between neural and vascular response, the magnitude of the response may be significantly influenced by the underlying venous architecture of the brain. "fMRI activation maps, as pretty as they are, can be misleading," he says. "More or bigger veins will inherently produce bigger BOLD responses. So you have to be careful when comparing two activation sites in a subject or among subjects, because the amplitude of the response may be a result of highly vascularized tissue, rather than a difference in neural activity. Likewise, an area of the brain with little vasculature can produce a poor BOLD response, even if neural activity is normal."

To address this concern, Dr. Whittingstall and his team use susceptibility weighted imaging with phase difference (SWIp) and compute venous diameter and venous density. "When we take that into consideration, we can reduce the number of false positives and false negatives in fMRI," he says. "Now, we're developing a simultaneous SWI time-of-flight acquisition, which allows us to discriminate arteries from veins, so we can further differentiate structural and neural response."

Simultaneous EEG fMRI

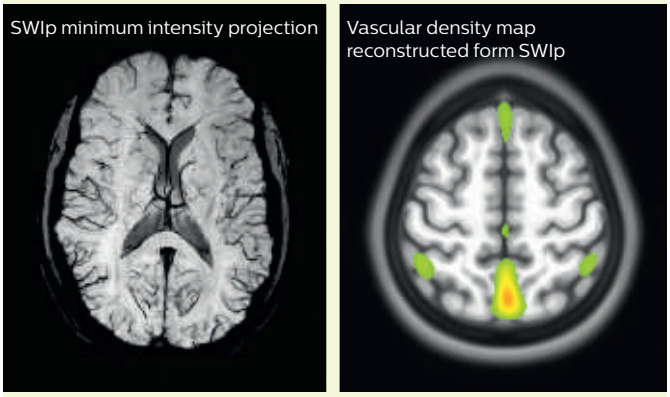
Dr. Whittingstall is also interested in how EEG correlates with fMRI. "We're investigating if changes in a certain EEG frequency band better explain the changes that we're seeing in the BOLD response, or if it is some combination of multiple frequency bands from different brain areas," he says.

Neuroscience tools aid research

Dr. Whittingstall uses iViewBold to map functional areas and connectivity. "iViewBold enables us to see immediately if a subject is properly doing a task, or if the subject is a worthy BOLD responder," he explains. "The prospective motion correction is also very helpful. Usually, online fMRI analysis packages don't always take online registration into account, but the Philips system does online correcting, which helps make fMRI maps more reliable." In addition, together with Philips, the team is evaluating a new tool to display – in real time – the motion of the subject during the fMRI acquisition.

The team uses the 32-channel dS Head coil for its studies. "With a very short TR of just below two seconds, we're getting beautiful signal-to-noise ratio in the visual cortex using fairly subtle visual stimuli," Dr. Whittingstall notes.

Correcting for vascular density



A SWIp image (left) is used to visualize veins in cortical and sub-cortical areas. Using in-house reconstruction techniques, a vascular density map is obtained in individual subjects and averaged over a population (right). Areas in red/green represent areas with dense venous vascularization. The lab uses such images to correct fMRI (BOLD) activation maps in order to minimize false positives.

Both Dr. Whittingstall and Dr. Descoteaux appreciate that the neuroscience package makes it easy to convert DICOM images to a NIfTI format. "There are many DICOM to NIfTI converters," Dr. Whittingstall says, "but it is convenient to have it done at the console."

Through a research agreement with Philips, the researchers also have access to the Paradise pulse programming environment and sequence simulator. "It's like a virtual scanner," Dr. Descoteaux explains. "I can prepare my protocols from home and then I'm set up and ready as soon as I get to the scanner."

Reproducibility impresses

Drs. Descoteaux and Whittingstall chose a digital Philips Ingenia MR system after downloading and analyzing the source data from scans on different systems. "It's great to publish your findings, but ultimately, you want to make sure that they're reproducible, and access to the source data is the only way we can see exactly what is happening," Dr. Whittingstall says. Dr. Descoteaux adds that they preferred Philips performance in the categories reviewed, including SNR, fMRI stability, and the angular resolution for diffusion data.

«

References

1. St-Jean S, Gilbert F, Descoteaux M
Connectome-like quality diffusion MRI in 13 minutes - Improving diffusion MRI spatial resolution with denoising
ISMRM 2015

2. Vigneau-Roy N, Bernier M, Descoteaux M, Whittingstall K
Regional variations in vascular density correlate with resting-state and task-evoked blood oxygen level-dependent signal amplitude
Human Brain Mapping 2014, 35 (5), 1906-192

Ingenia 3.0T CX and neuroscience package enhance studies

Designed to support both clinical investigation and advanced clinical imaging, our neuroscience package offers a suite of exceptional tools for neuroscience and neurofunctional studies.

High-end diffusion techniques

Diffusion imaging benefits from up to 128 directions and up to 32 b-values, for high definition fiber track imaging and multi-shell acquisitions. You can also define your own matrix of diffusion directions per b-value, for imaging that meets your specific needs in neuroscience.

fMRI capabilities

fMRI tools include algorithms that reduce and stabilize Nyquist ghosting. The B0 mapping tool measures both magnitude and phase images, which can help you correct for EPI distortion.

The scanner console provides real-time feedback and results during fMRI studies, and an integrated quality assurance tool helps you measure fMRI stability and analyze fBIRN metrics. The extended data storage holds up to 64k images, accommodating long fMRI sessions.

In addition, the neuroscience package includes an export tool to easily export images in formats such as NIfTI, which you may need in your neuroscience projects.

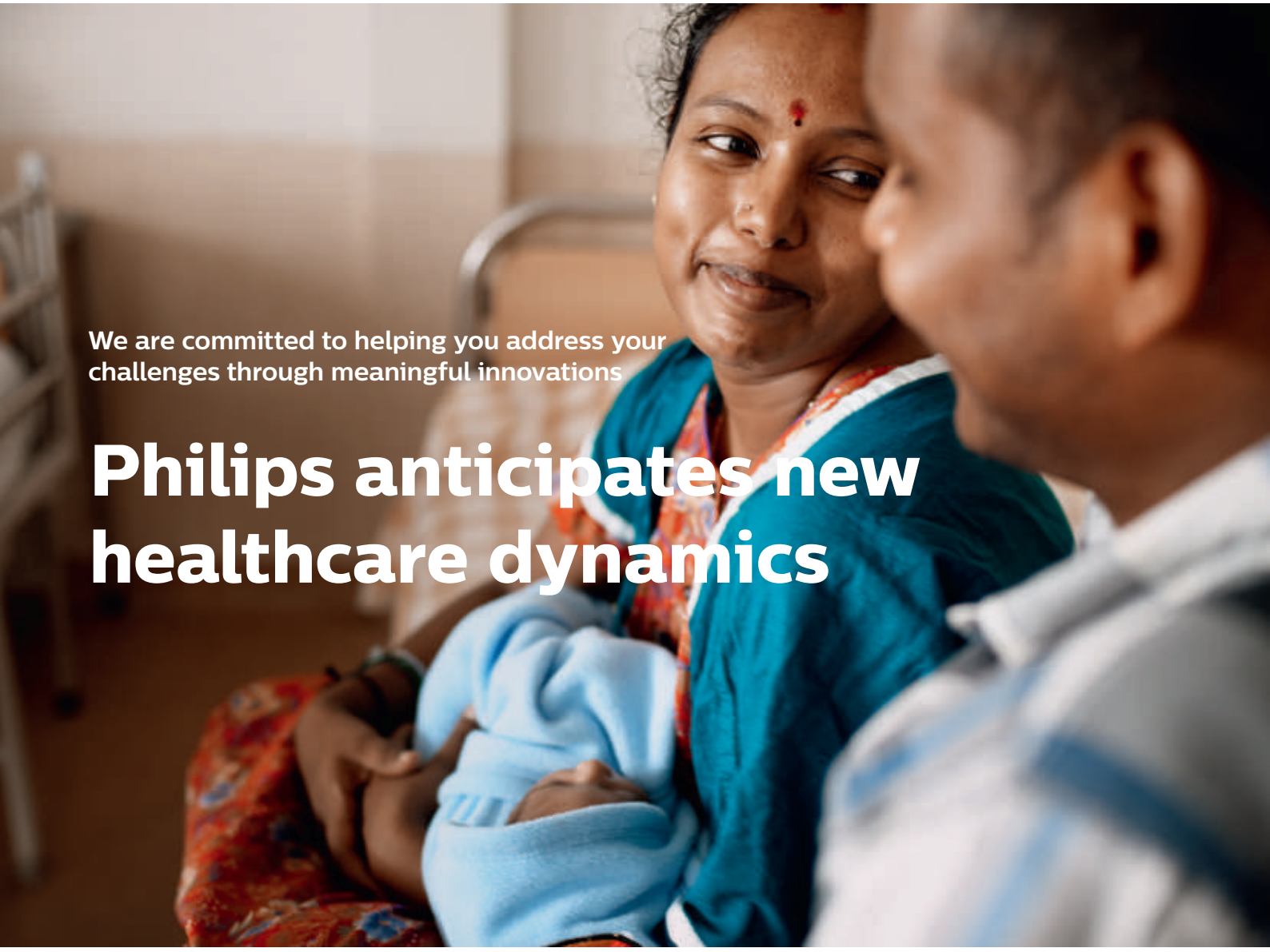
Excellent hardware

The Ingenia 3.0T CX features a high performance gradient with 80 T/m/s slew rate and a maximal amplitude of 200 mT/m. Its balanced design and the digital RF chain with the dS SENSE parallel imaging capabilities bring excellent image quality and stability to your neuroscience exams.

Other tools for neuroscience include:

- Digital 32-element dS Head coil
- SensaVue paradigm generation workstations
- IntelliSpace Portal advanced visualization and analysis

«



We are committed to helping you address your challenges through meaningful innovations

Philips anticipates new healthcare dynamics

Sharpening its strategic focus, Philips has combined its professional Healthcare and Consumer Lifestyle businesses into a new entity called HealthTech.

Building on this strong foundation, Philips will be able to capitalize on the convergence of professional health care and consumer end-markets across the health continuum, from healthy living and prevention, to diagnosis, treatment, recovery and home care. This is illustrated by the rising engagement of consumers to proactively monitor and manage their health, and by increasing pressures on the healthcare system to create new models of care along the health continuum to deliver better and affordable care.

Creating a healthier tomorrow

Philips wants to be more than just a vendor. We are partnering with our customers to develop solutions that span the health

Consumers increasingly engaged in their health journey

Increased emphasis on population health

Ongoing focus on total quality and cost of care

Care shifting to lower cost settings and homes

The health continuum

continuum, from hospital to home. With HealthTech we are delivering innovation in ways that provide better care to more people at a lower cost, as well as advocating for changes in healthcare models to benefit both our customers and consumers.

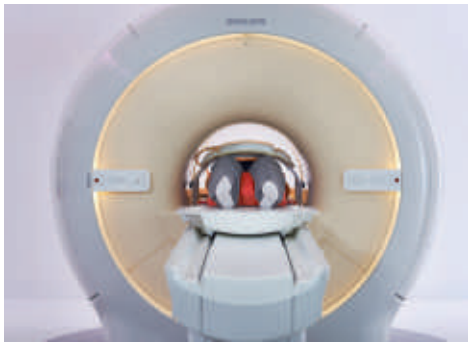
With leading positions in such sectors as oral healthcare, healthcare informatics, ultrasound diagnostics, cardiac care and home healthcare, Philips is uniquely positioned to help shape the future of the healthcare industry as it evolves.

Philips MRI in the health continuum

At Philips, we want to deliver innovation that matters to you. We want to help drive better care for more people at a lower cost. For Philips MRI this means that we strive to make diagnostic MRI available to more people by making MRI faster, more robust and patient friendly, to enable more definitive diagnosis through quantifiable results and advanced visualization and to help improve patient care with MRI-guidance in therapy.

«

We look beyond technology to the experiences of consumers, patients, clinicians and caregivers across the patient journey.



Philips **MRI online**

More FieldStrength articles

The online FieldStrength pages provide you with more articles, news and application tips. You can also download PDF files of all articles.
www.philips.com/fieldstrength

Learn from others

Visit NetForum to find or share case studies, ExamCards and best practices. Use the application tips to help you optimize your system's performance. NetForum has new content every week.
www.philips.com/netforum

Explore clinical cases

Have you seen the latest cases added to the MR Clinical Case Map? These cases demonstrate what you can achieve with our latest products and methods.
www.philips.com/mrclinicalcases

More about our products

With a wide variety of patients and large range of clinical indications, you need MRI that can perform with digital clarity and speed in many clinical circumstances. With our MRI solutions, you can meet today's healthcare challenges.
www.philips.com/mri

Stay in touch
with Philips MRI

FieldStrength is a professional magazine for users of Philips MR systems. It provides results of MR studies performed by Philips users.

Be the first to see new articles

And don't miss an issue. Register now for your personal email subscription at:
www.philips.com/fieldstrength

Colophon

Printed in Belgium.
4522 991 10941

FieldStrength is also available via the Internet:
www.philips.com/fieldstrength
www.philips.com/mri
www.philips.com/netforum

Editor-in-chief
Karen Janssen

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

Contributors
Peter Baumann (MD), Jeanette Brus Mortensen, Maxime Descoteaux (PhD), PJ Early, Liesbeth Geerts (PhD), Ben Heggelman (MD), Karen Janssen, Lars Jönsson (MD), Christoph Katemann, Ben Kennedy, Simon Krijnen, Guillaume Lefebvre (MD), Michel Christian Nèmery (MD), Gerard O'Leary, Polly Schmidt, Natasja van Bree, Kim van de Ven (PhD), Kevin Wittingstall (PhD).

Subscriptions
Please subcribe 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

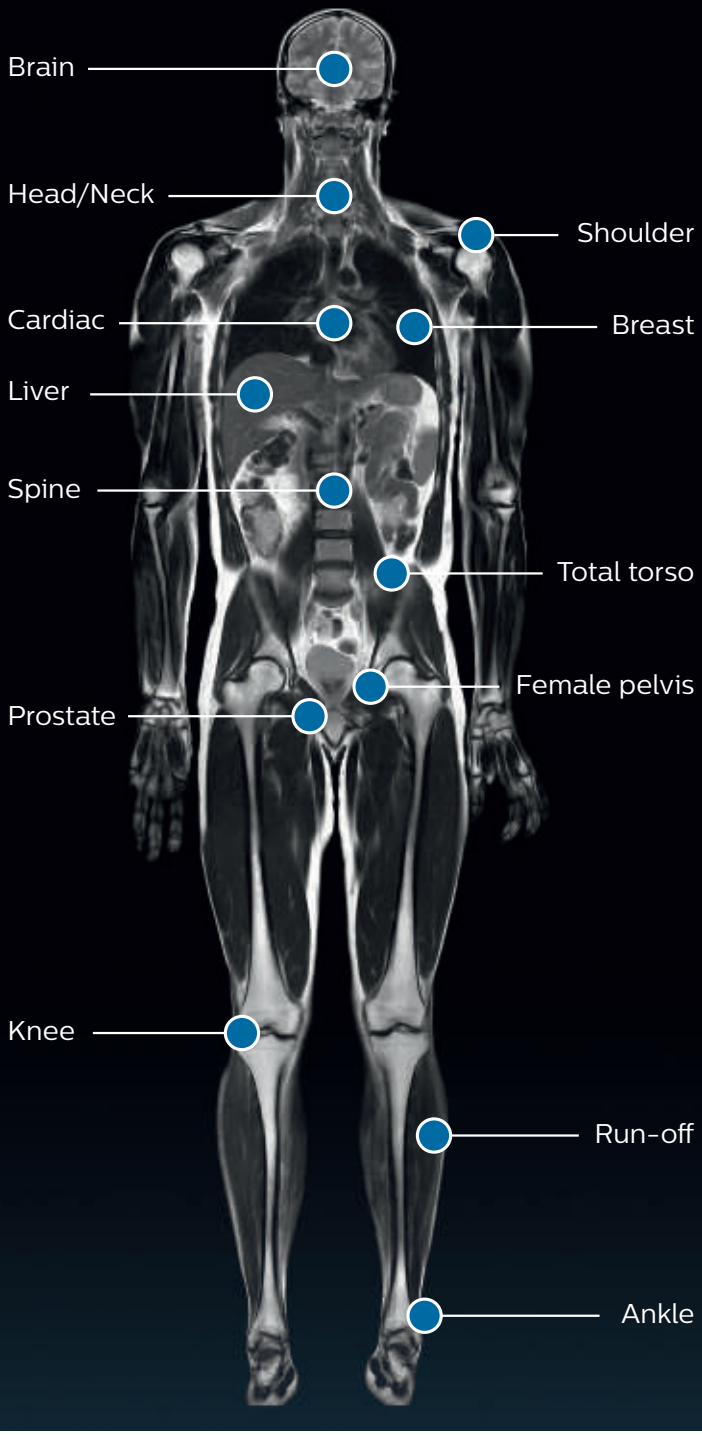
Notice
FieldStrength is created for users of Philips MRI systems. It is a professional magazine for users of Philips medical equipment. It provides the healthcare community with results of studies performed by colleagues. Some articles in this magazine may describe research conducted outside the USA on equipment not yet available for commercial distribution in the USA. Some products referenced may not be licensed for sale in Canada.

Results from case studies are not predictive of results in other cases. Results in other cases may vary. Results obtained by facilities described in this issue may not be typical for all facilities. Images that are not part of User experiences articles and that are not labeled otherwise are created by Philips.

MR clinical case map

www.philips.com/mrclinicalcase

Meet me online to explore MRI clinical cases and much more



PHILIPS