Publication for the Philips MRI Community **Issue 51 – winter 2014/2015**

PHILIPS

MRI Magazine

FieldStrength

Confident diagnoses in an efficient practice

Busy MRI practice at DuPage Medical Group
Bonn University boosts liver MRI

Ingenia 1.5T S is designed for **first-time-right MRI**

Advanced neuro MR

Users tell their stories

FieldStrength looks different

Welcome to this issue of FieldStrength. Regular readers probably notice that it looks different. The adaption aligns FieldStrength with the style of all communication supporting the Philips brand. From now you 'innovation and you' brand line expresses our dedication to innovation that makes a meaningful difference to people's lives.

Printed and digital
When using both the digital and the printed version of FieldStrength, you were accustomed to these two being very similar. However, you will see these two diverge and digital articles will appear more frequently, usually ahead of hardcopy versions.

As the FieldStrength team, we aim to serve you better with every change we introduce. Please let us know what you like or what you miss, or share any other ideas.

We like to listen to you.
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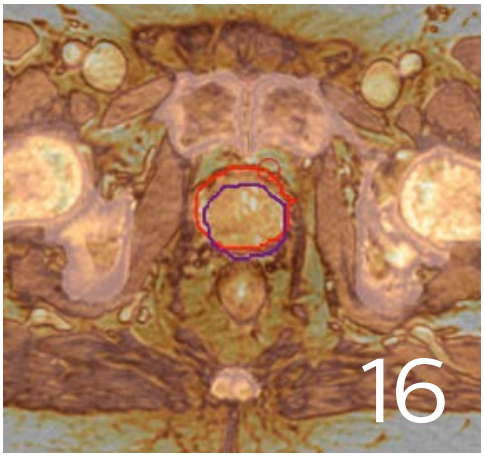
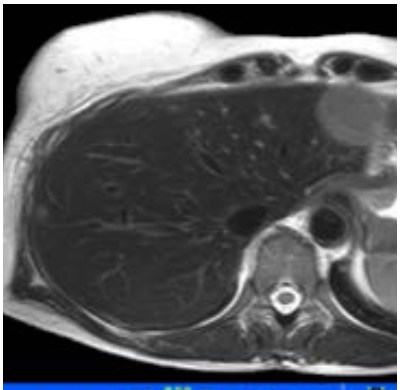
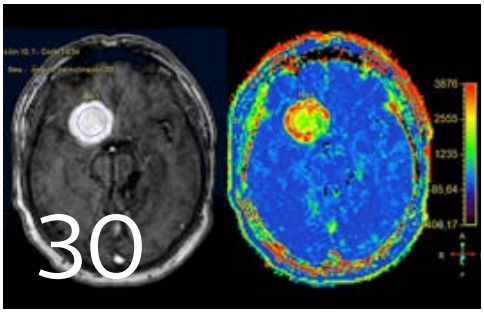
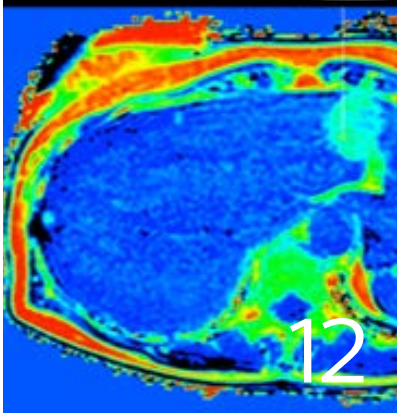
Find out how our users work with our MR scanners and methods in making **confident diagnoses** and run an **efficient practice** at the same time.









Confident diagnoses in an efficient practice

MR-guided therapy

Advanced Neuro MR

MR news

Calendars

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.

Philips introduces **Ingenia 1.5T S**, a robust MRI scanner designed for first-time-right imaging

At Philips, we look beyond technology to the experiences of those at the center of it all, to unlock insights that inspire our innovation. We strive for MRI advances that contribute to delivering better care at lower cost.

In control of a fast workflow with Ingenia 1.5T S

Ingenia 1.5T S is a fast and robust workhorse that can help you stick to your tight schedule, while providing consistent, high quality information for confident diagnosis. Similar to other Ingenia models, it excels in fat suppressed and motion suppressed MRI. Designed for first-time-right imaging, it can enhance throughput up to 30%* with fast and robust procedures powered by dStream technology. Ingenia 1.5T S can drive clinical performance by providing more information in a given time slot to support your diagnosis.

An amazing patient experience

As the innovator of patient experience we now bring innovation into the bore. Ingenia 1.5T S offers an amazing, immersive in-bore audiovisual experience designed to distract patients from their anxiety and give patients control over what they will see. ComforTone will reduce noise during the entire exam and a flexible AutoVoice feature helps to coach the patient through the exam.

More diagnostic information in your time slot

On Ingenia 1.5T S, the dStream digital architecture empowers Premium IQ** that offers high SNR and image quality as well as fast and robust imaging.

Philips dS SENSE provides fast scanning for clinical routine. You can now have stunningly high acceleration factors, and even combine that with high resolution. MultiVane XD offers motion-free imaging, even for challenging patients, using robust motion correction. Combining it with dS SENSE allows for a high-speed exam with high spatial resolution.

The mDIXON technique has demonstrated its consistent quality in fat-free imaging, even with large FOV and in challenging patients. mDIXON can be used with FFE and TSE for enhanced performance. With robust imaging and high resolution, mDIXON simultaneously provides four contrasts (in-phase, out-of-phase, water and fat). In other words, it produces fat-free and normal images in one scan.

iPatient helps you stay in control when patients vary

All patients are different, but consistent quality is desired in all patients. The iPatient platform allows you to automatically store and adjust imaging settings for specific cases, giving you more time to focus on your patient's specific needs.

An uncomfortable patient can mean a long or repeated scan and wasted time. Using the Posterior coil integrated in the table, as well as conforming Anterior coils, a comfortable and fast exam is possible. Combined with a streamlined user interface and automated planning and coil element selection, scanning is now a smooth experience for both patient and clinician.

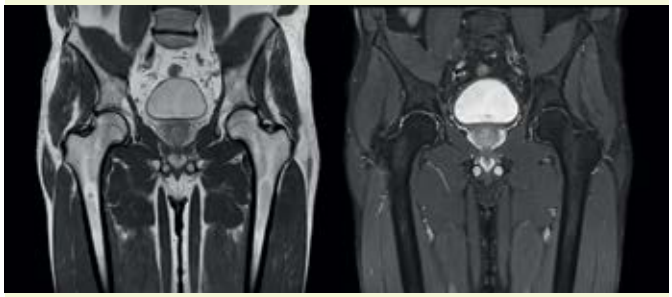
Ensure economic value

Philips Applications Support is known for its helpful support in day-to-day and long-term needs of our customers. But we can also help with consultancy and financial solutions for business outcomes, and radiology informatics solutions that enhance department productivity through data integration, data analysis and instant collaboration. With these and more services available to our users, Philips truly provides innovation that matters to you. «

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

Robust and fast fat-free imaging

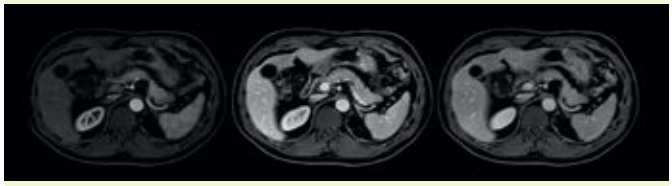
PDW images with and without fat suppression acquired in one scan of 4:23 min. on Ingenia 1.5T S.



mDIXON TSE in-phase mDIXON TSE water

Fast mDIXON in abdomen

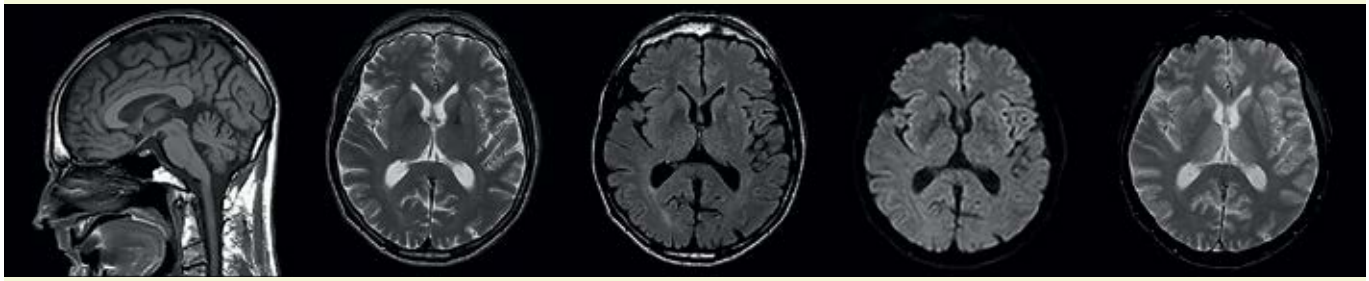
Ingenia 1.5T. Images courtesy of Radiologie am St Joseph-Stift, Bremen



Dynamic mDIXON TSE with dS SENSE factor 4.5, 10-second breathhold.

Routine brain exam in less than 8 minutes

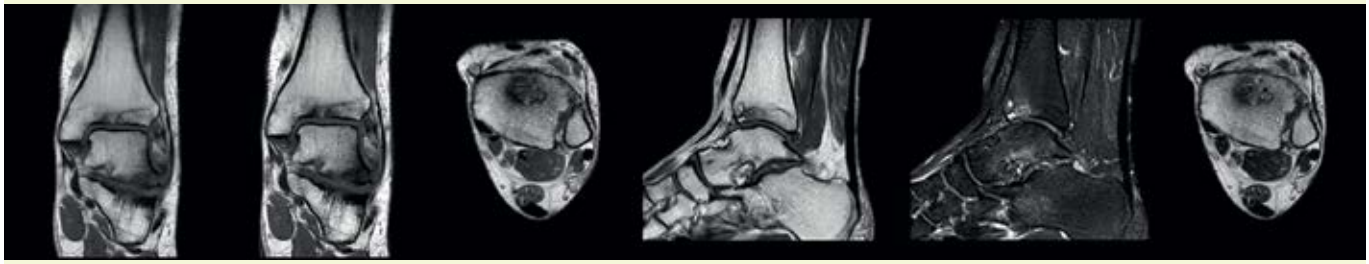
Ingenia 1.5T



T1W TSE 2:03 min. T2W TSE 1:24 min. FLAIR 1:12 min. DWI 0:36 min. T2* FFE 1:48 min.

Complete ankle exam in 8 minutes

Ingenia 1.5T. Images courtesy of University Medical Center Utrecht



PDW TSE cor 0:47 min. T1W TSE cor 1:10 min. PDW TSE ax 0:53 min. PDW sag 1:16 min. PDW SPAIR sag 1:55 min. T2W TSE ax 1:20 min.

Advanced MR imaging and advanced

To provide you with more data to support your diagnosis

We are expanding capabilities for obtaining quantitative and functional information with our MR scanning. This may also allow you to broaden your application areas.

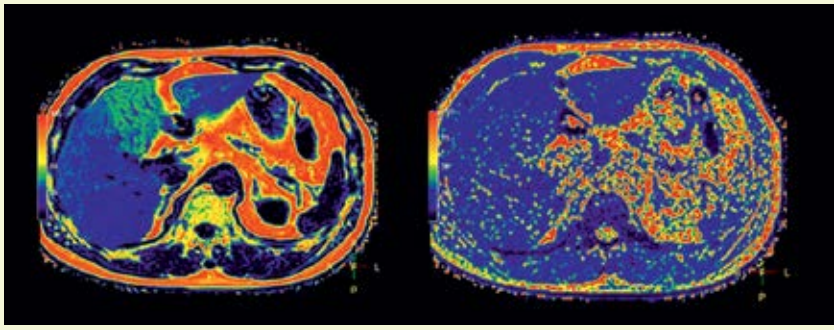
Body

In Body MRI, quantitative liver imaging is ready for mainstream use: a one-breathhold scan can provide a quantitative fat fraction map as well as a T2* map.

For oncology patients we offer a comprehensive imaging and processing solution by combining MRI with multi-modality tumor tracking on IntelliSpace Portal.

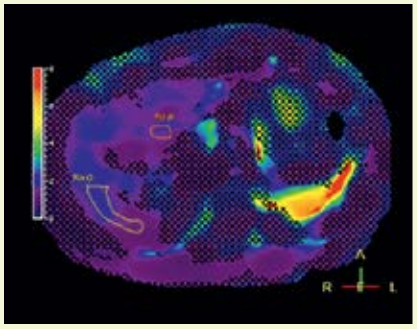
New is MR elastography for non-invasive, quantitative assessment of differences in tissue stiffness.

Ingenia 1.5T, courtesy of Kurashiki Central Hospital

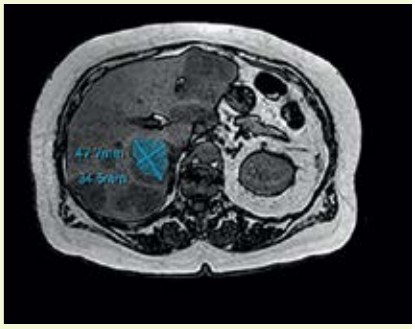


Fat fraction map

T2* map



MR elastography Ingenia 1.5T



Tumor tracking on IntelliSpace Portal Ingenia 3.0T image courtesy of Fondation Rothschild, Paris

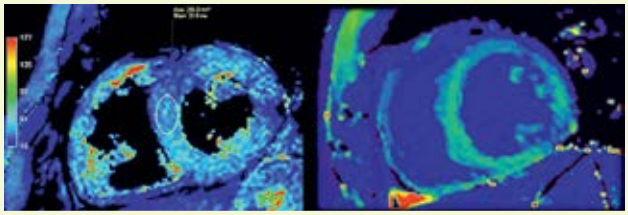
Cardiovascular

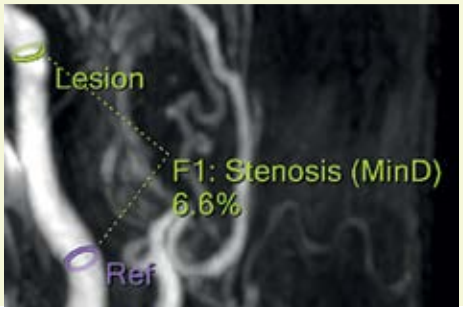
In Cardiovascular MR quantitative T2 and T2* maps can be created using StarQuant for assessing myocardial tissue characteristics, including iron overload an edema. Pixel-based quantitative T1 maps are generated from a one-breathhold scan.

Vascular quantification on IntelliSpace Portal offers ergonomic and efficient vascular quantification.

T2* map, Ingenia 3.0T

T1 map, Ingenia 3.0T





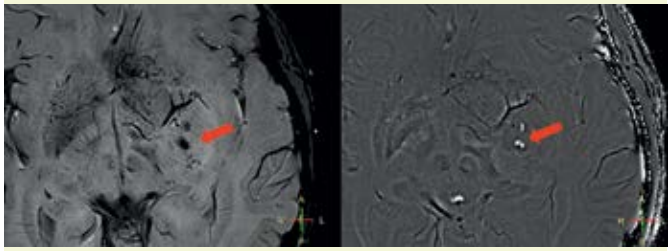
Advanced vessel analysis on IntelliSpace Portal. Ingenia 3.0T image courtesy of Cleveland Clinic Foundation.

visualization

Neuro

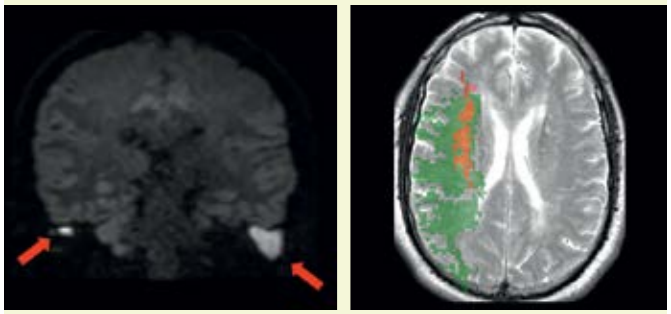
Some recent additions to our broad range of functional assessment tools in Neuro MR are ready for use in routine practice.

SWIp offers high sensitivity for blood products in a routine scan time. Diffusion TSE provides uniform DWI results even in challenging areas by addressing distortion artifacts. IntelliSpace Portal presents semi-automated segmentation of hypo diffusion and hypo perfusion for visualizing perfusion-diffusion mismatch in stroke patients, which helps physicians in diagnosing these patients.



SWIp magnitude | SWIp phase

Ingenia 3.0T, courtesy of Barmherzigen Bruder Hospital, Trier



Diffusion TSE of steatosis

Ingenia 3.0T, courtesy of AZ St.Jan Bruges

Perfusion-diffusion mismatch

IntelliSpace Portal Courtesy of GK Bonn

Enhancing therapeutic decision making with **MR guidance**

Our MR-guided therapy solutions enable clinicians to include advanced MR imaging information in treatment procedures to help them in therapeutic decision making and delivery of therapy.

By offering fast and smooth patient transfer between OR and MR the **Ingenia MR-OR** enables neurosurgeons to verify the result of tumor resection during the procedure with real-time, high quality MR imaging.

In radiotherapy, MRI's excellent soft-tissue contrast and functional imaging capabilities can help define tumors and critical structures for targeted radiation therapy, treatment adaptation and response monitoring. The **Ingenia MR-RT Oncology Configuration** provides a comprehensive solution to integrate MR imaging into radiation therapy treatment planning workflows.

Dedicated MR-RT accessories, including an Anterior coil support and flat tabletop, allow for imaging patients in the radiotherapy treatment position.

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Ingenia 3.0T delivers high MRI to the busy practice

High image quality in a limited time slot and robustness to stay within schedule

DuPage Medical Group (DMG) values Ingenia 3.0T for its versatility in high quality scanning of its wide variety of patients. The design of scanner and room is aimed at soothing patients. Techniques for enhancing performance and robustness contribute to the outstanding image quality that DMG consistently achieves. At the same time, DMG has increased throughput on its Ingenia.

Ingenia helps surmount challenges of a busy practice

DuPage Medical Group (Downers Grove, Illinois, USA) is a physician-owned group outside Chicago that performs about 2,000 MRI exams per month. The radiology department in Lisle, Illinois is using a Philips Ingenia 3.0T in addition to MRI scanners from other vendors.

"We have to scan a wide range of patients and we want to emphasize both image quality and speed. Taking into account these challenges we also need to maintain our time slots at 30 minutes. For routine MR, we maximize acquisition speed for workflow efficiency," says Yazan Kaakaji, MD, radiologist at DMG. "Ingenia 3.0T is a comprehensive scanner that performs according to these needs."

"Patient experience is another important factor. We don't have a sedation policy, so we wanted a fast scanner and a soothing experience for our patients, particularly for those who are relatively claustrophobic. Ingenia 3.0T with the wide bore and Ambient cove lighting provides the patient experience that we desired. We get positive comments from patients on it."

Image quality is 'excellent,' 'phenomenal,' 'stellar'

Patrick Duffy BS, RT (R) MR is Lead Technologist at DMG. "We are getting phenomenal image quality on all types of exams," he says. "Our MSK is stellar, and so is our abdominal work. Ingenia excels at feet, hands and fingers. We do enterographies with great results. With the combination of the 3.0T magnet and the digital coils, we are able to scan prostates without an endorectal coil while still obtaining high quality results. This is a comforting experience for our male patients. We scan many obese patients, and the Ingenia does a tremendous job because of MultiTransmit, which reduces dielectric shading for more confident diagnosis. Our technologists really enjoy scanning on the Ingenia. We also have ordering physicians who specifically want their patients scanned on the Ingenia because of the results of our imaging."

"Obviously, the diagnostic capability is most important," says Dr. Kaakaji. "Ingenia's image quality is excellent and in follow-up studies, Ingenia provides good consistency between scans."

"Without using an endorectal coil we do our prostate MR at 0.5 mm resolution, following the European Society of Urology protocol [1]. For certain joints we use a virtual arthroscopy protocol with 1 mm pixel size and 2 mm slice thickness. Ingenia really excels in our neurography, brachial plexus and prostate scans. Our neurologists insist on using our 3.0T for those," Dr. Kaakaji adds.

"The image quality is phenomenal. Robust, clear, homogeneous, not obscured by dielectric shading," adds technologist Ryan Sybesma, RT (R) MR. "Ingenia is a high performance workhorse."

mDIXON TSE fat suppression helps DMG reduce repeats and supports diagnostic confidence

"DMG includes a cancer center, so soft tissue neck scans, brachial plexus scans, and prostate scans are common. For these exams, mDIXON TSE provides excellent images with and without fat suppression, all while helping us work more efficiently and reduce repeats," Mr. Duffy says.

»

performance at DMG

"mDIXON TSE raises our diagnostic confidence with its homogeneous fat suppression."

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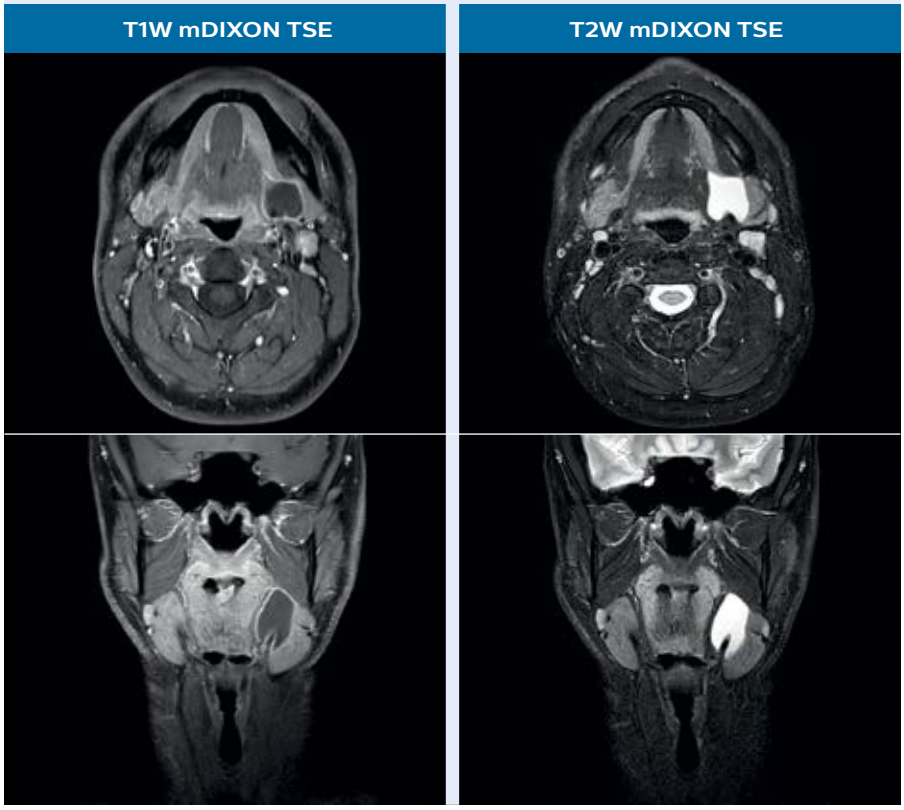
MRI of palpable lump on left side of neck

A 32-year-old male presents with a left-sided neck mass and an intraoral mass that has been present for 4 days. He underwent MRI on Ingenia 3.0T with the dS HeadNeck coil. Excellent fat suppression is obtained with mDIXON TSE.

There is a cystic structure between the sublingual and submandibular spaces with a thin rim of enhancement. Findings are most likely consistent with a plunging ranula extending from the sublingual space into the submandibular space. Multiple bilateral level 2A and level 2B lymph nodes are seen. A few submandibular lymph nodes are also noted.



Yazan Kaakaji, MD has been a radiologist for 16 years. He was educated at St. Louis University School of Medicine and performed his residency at Louisiana State University School of Medicine, with fellowships at University of Virginia School of Medicine and University of Washington School of Medicine.

Patrick Duffy, BS RT(R)(MR) received his BS from Southern Illinois University at Carbondale. Upon graduation he completed an internship and three years of employment at Northwestern Memorial Hospital. He has been with DuPage Medical Group for twelve years and is now the Lead MRI Technologist, where he oversees five magnets with 18 MRI technologists.

Ryan M Sybesma, RT (R)(MR) received his AS in radiography from Ferris State University. He has worked with MRI since graduation, beginning his career at KNI/Southwest Imaging Michigan and was a dedicated Philips MRI user. Prior to joining DuPage Medical Group in 2006, he worked at an outpatient facility in North Carolina.

Multi-parametric MR of the prostate

A 60-year-old male with elevated PSA and weak urinary stream underwent MRI on Ingenia 3.0T. The exam includes high resolution DWI and ADC mapping, as well as dynamic imaging.

Heterogeneous nodular hypertrophy is seen along the central transitional zone, with hypointense pseudo capsule, indicative of BPH, without dominant T2-hypointense nodules. Patchy T2-hypointense foci are noted throughout the peripheral zone bilaterally at the base, mid-gland and apex, with total PI-RADS score 6, so probably benign. No dominant nodular areas of restricted diffusion are evident. A geographic T2-hyperintense focus in the peripheral zone at the right base to mid-gland, paramidline shows asymmetric restricted diffusion, total PI-RADS score 10. No dominant lesions greater than 1 cm. Clinical correlation and follow-up are advised.

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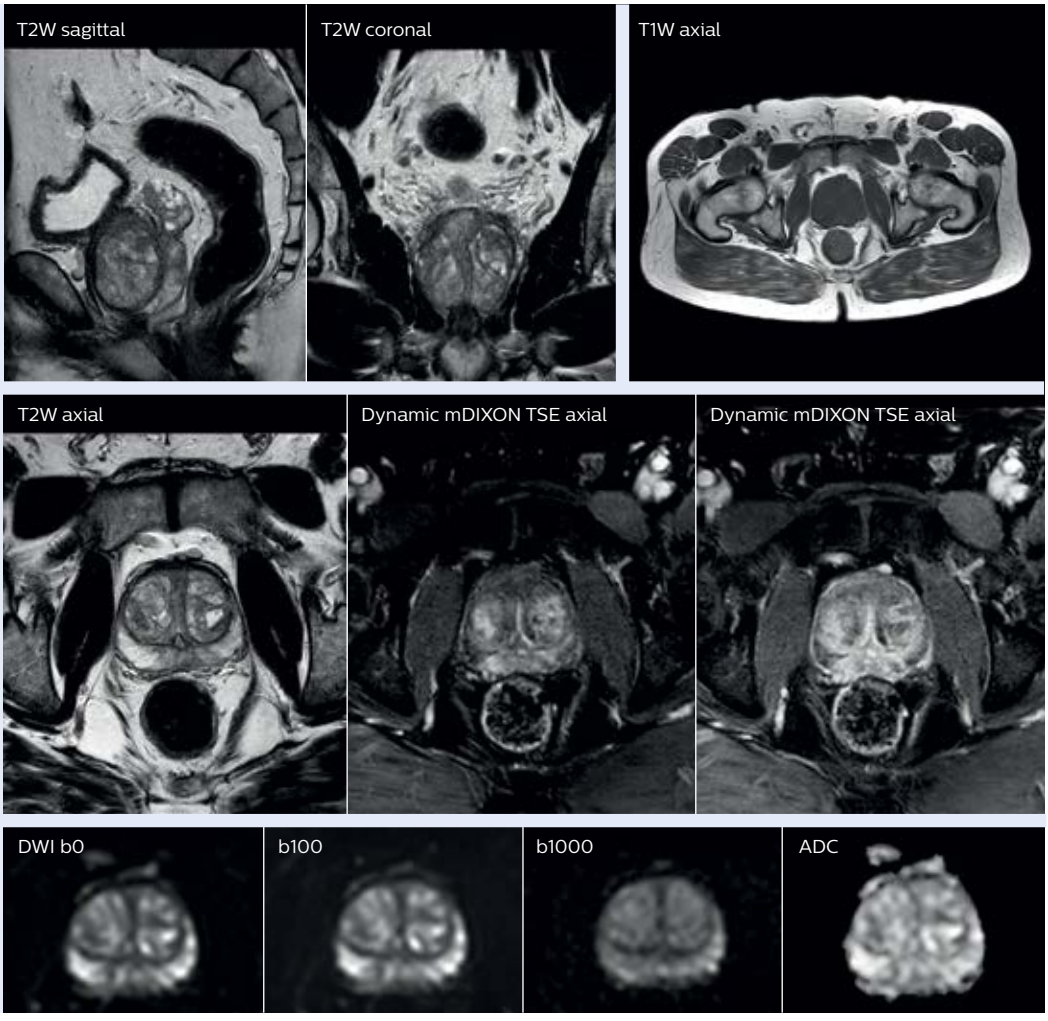


"Since we work in fixed time slots, not having to repeat scans is key for us. With mDIXON TSE we get high quality results the first time – unless of course the patient absolutely jumps off the table. For us, that's significant, because just a single repeat scan could put us behind schedule."

"mDIXON TSE raises our diagnostic confidence with its homogeneous fat suppression. Neck exams and rheumatology patients are two examples where mDIXON TSE is especially useful," Dr. Kaakaji says. "For us it's also an efficiency boost in exams where we need pre and post T1-weighted images with great fat suppression."

MultiVane XD helps eliminate motion for first-time-right scanning

DMG recognizes that MultiVane XD motion compensation is another Philips technique that contributes to image quality and scan efficiency. "We run MultiVane XD for motion-free imaging on almost all our T2-weighted brain scans, just to reduce any repeats we might get. We know our non-contrast brain scans are going to take 20 minutes almost every time," Mr. Duffy says.

"Using MultiVane XD still allows us to turn on dS SENSE, which significantly cuts scan time compared to what we were doing before," he adds. "We went from a 2.5- or 3-minute scan to a 1.5-minute scan with no loss in image quality. So, it not only reduces the motion, but also reduces scan time. That gives us a little bit of extra time to speak to our patients and explain the exam a little more."

Workflow benefits help increase throughput

The workflow benefits of Ingenia 3.0T are indisputable. "We especially like it in spine," says Dr. Kaakaji. "We have a 12-minute spine protocol for non-contrast lumbar and cervical. We perform our lumbar spines feet first, just using the Posterior coil integrated in the table. With the tiltable head coil Ingenia makes it easy to image elderly or kyphotic patients because we can raise their head. We can do spines in about 10 minutes if we have to, and there's no contrast involved."

"MultiVane XD not only reduces the motion, but also reduces scan time."

"We've added two daily slots to the schedule after experiencing Ingenia's performance."

"I think it's also a comfortable scanner for patients – they are in there for sometimes less than 15 minutes. That absolutely helps with throughput. We've added two daily slots to the schedule after experiencing Ingenia's performance."

Techs like working with Ingenia

"The technologists enjoy Ingenia's user interface and easy scanning," says Mr. Duffy. "I have techs at different levels who all do a great job on Ingenia. I think it's an easy scanner to learn, yet at the same time it's one of the most advanced scanners."

Mr. Sybesma agrees. "Ingenia is so versatile. I love the integrated Posterior coil in the table; the long field of view is really helpful, and we can help patients by having them go in feet first instead of head first. The coils are easy to use, and just give us phenomenal images. Radiologists and referring physicians compliment us all the time on our phenomenal knee images."

"Ingenia is also my preferred scanner to do breast imaging. Using the breast coil, we haven't had inhomogeneity issues at all. We also use SmartExam for our breast patients, for consistent, reproducible scans. Our breast images look just remarkable," he adds.

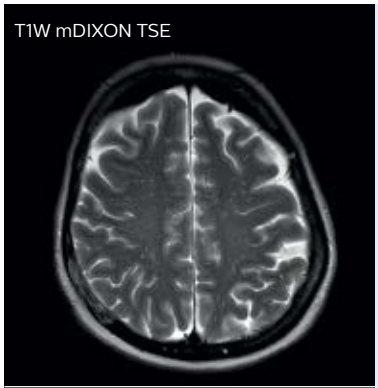
Patients appreciate Ingenia design

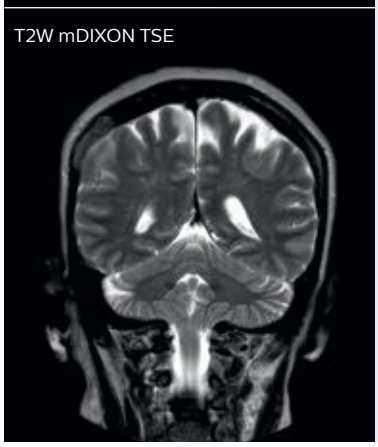
"Of course, patient satisfaction is vital to a successful practice," Mr. Duffy says. "I believe the Ingenia looks very soothing to most people. I get comments from patients as soon as they enter the magnet room. Compliments range anywhere from the aesthetics of the wide bore scanner to how cool the room looks with the special LED cove lighting. I believe it really puts patients at ease, especially if they're apprehensive of the scan to start with."

Summarizing how Ingenia excels at DMG

"When recommending Ingenia to other users, I would highlight the image quality, the consistency of all exams and the overall appearance of the machine," says Mr. Duffy. "Ingenia is an excellent MRI scanner that will perform to the level of every user – from basic MSK to advanced scanning. It's easy to run and produces quality images. We run a tight ship, and that's all we can ask for."

Dr. Kakaaji adds: "In our institution we see MR utilization expanding at the expense of other diagnostic imaging and within MR we see body and oncology applications expanding. I think Ingenia 3.0T is tailored to both. We are ready to move forward." «





Re-evaluation of sella and cranial lesions

A 65-year-old female with a history of lung cancer was sent to MRI for re-evaluation of right parietal calvarial lesion and a hypo-enhancing lesion on the right side of the sella that were seen in a previous exam. MRI was performed on Ingenia 3.0T. MultiVane XD was used to reduce motion in the T2-weighted sequences. Axial and coronal T2W MultiVane XD takes 1:28 min.

Since the prior study, previously noted right parietal calvarial lesion has significantly decreased in size. Enhancement is noted along the right parietal calvarium. Previously noted soft tissue component has nearly completely resolved. No additional intracranial lesions noted. A hypo-enhancing lesion is again noted within the right side of the sella. Leftward deviation of the infundibulum is again noted.

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http://dupagemedicalgroup.com/health-topics/Diagnostic-Testing

Reference

1. Barentsz JO, Richenberg J, Clements R, Choyke P, Verma S, Villeirs G, Rouviere O, Logager V, Fütterer JJ
ESUR prostate MR guidelines 2012
Eur Radiol (2012) 22:746–757

University of Bonn is implementing recent techniques in routine in liver imaging after evaluating the added value

Boosting liver MRI with latest methods

University of Bonn strives for liver imaging that is right the first time and provides sufficient and high quality information for confident diagnosis. Using their Ingenia systems, the team benefits from the dStream digital platform and recently started to use MultiVane XD for robust motion correction and high spatial resolution, as well as mDIXON Quant for non-invasive liver fat quantification in just one breath hold.

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

Ingenia helps improve efficiency and image quality for liver scans

The Department of Radiology at University of Bonn (Bonn, Germany) has two 3.0T and two 1.5T Philips MRI systems. The department performs about 60 liver MRI exams per month, including exams in oncology patients to inform intervention planning and follow-up, scanning of transplant and surgery patients, and outpatient imaging for the department of hepatology. Radiologist Guido M. Kukuk, MD, says the team prefers to use the Ingenia 3.0T and 1.5T systems because of the excellent image quality they provide.

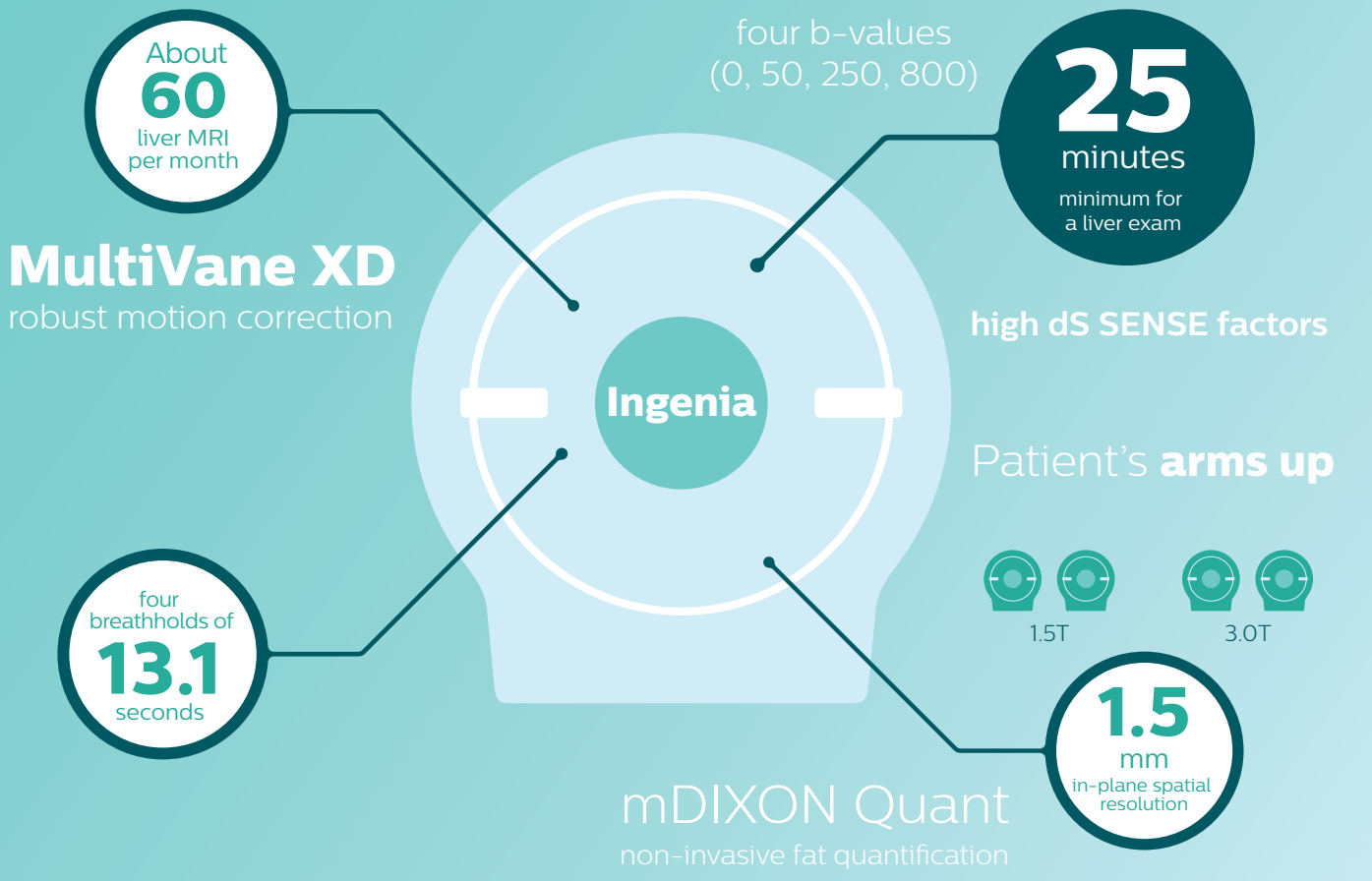
"The Ingenia system helped us to improve the efficiency and image quality of liver exams. Ingenia's dStream digital coil technology provides increased signal compared to analog Achieva systems, which we see translate to better image quality," says Dr. Kukuk. "The MultiTransmit technology of Ingenia 3.0T adds the advantage of reducing dielectric shading, which is especially valuable in abdominal imaging."

"The Posterior coil integrated in the Ingenia patient table is a time-saver," says Dr. Kukuk. "It allows easy patient positioning and planning and provides high quality imaging. We can obtain

Guido M. Kukuk, MD is senior radiologist in the Department of Radiology at University of Bonn. He joined the department in 2003 and received his board certification in radiology in 2010. His clinical specialties are abdominal and urogenital imaging.

"The Ingenia system helped us improve the efficiency and image quality of liver exams."

Liver MRI at University of Bonn



a large field of view with both 1.5T and 3.0T systems, which allows us to extend the anatomic coverage when we notice pathology on the first images."

The need for speed in liver imaging

"Speed is helpful in patients who cannot hold their breath adequately, so it's desirable to have very fast T1-weighted images. The most important sequence to be fast is the arterial phase, as this sequence cannot be repeated. It has to be first-time-right, really fast and sharp to be diagnostic. I would recommend carefully explaining to the patient before acquisition of this sequence."

"Because we use liver-specific contrast agents, the minimum time we need for a liver exam is about 25 minutes," adds Dr. Kukuk.

A smart examination design

Dr. Kukuk's liver exam begins with T2-weighted imaging, single shot and with fat suppression. "We always perform diffusion weighted imaging (DWI) with four b-values (0, 50, 250, 800) for lesion characterization, for monitoring after therapies, and for visualization of small lesions. Before giving contrast we routinely use the mDIXON Quant fat quantification sequence. Then we use dynamic e-THRIVE with an in-plane spatial resolution of 1.5 mm and high temporal resolution in just four breathholds of 13.1 seconds."

"We get fast images, less distortion in DWI and less blurring on T2-weighted images."

"Contrast enhancement is important to help us characterize lesions, for follow up in oncology patients and to inform clinicians when deciding on possible changes in the therapeutic regimen," Dr. Kukuk explains. "Because we use liver-specific contrast agents we can obtain the T2-weighted images after the dynamic, to bridge the waiting time needed with these contrast agents. Just before the patient leaves the scanner we acquire another e-THRIVE in the axial plane and one or two coronals."

Imaging with arms up means faster, better imaging

Dr. Kukuk scans an increasing number of liver patients in an arms-up position using the integrated Posterior coil and a special positioning device. "By placing the patient's arms up, the field of view in the right-left direction can be smaller so that a right-left preparation direction can be used to cut down the scan time," he explains. "We can use high dS SENSE factors for TSE imaging, so we can shorten the echo train length. This results in a faster scan than arms-down T2 TSE and the images show high anatomical detail."

»

"For DWI, the high dS SENSE factor allows using a shorter TE so we get higher signal and fewer susceptibility artifacts, which means less distortion of diffusion weighted images. Of course, with higher dS SENSE factors and the shortening of the TSE factor in T2-weighted imaging, we can drastically cut down the complete examination time. So, with arms-up we get faster images, less distortion in DWI and less blurring on T2-weighted images. Almost all patients tolerate the arms-up scanning well."

Robust motion correction and high spatial resolution with MultiVane XD

"Using MultiVane XD motion correction, we are now able to acquire high spatial resolution T2-weighted images without seeing relevant motion," says Dr. Kukuk. "It's a great technique to obtain high spatial resolution images of the pancreas or the liver, as well as the surrounding organs and tissues. MultiVane XD can be combined with dS SENSE parallel imaging, allowing us to reduce specific absorption rates (SAR), acquire high spatial resolution in short acquisition times, and at the same time reduce artifacts caused by motion in adjacent tissues and organs."

"With the patient's arms up, we get faster scanning and better image quality."

"In comparison to single shot T2-weighted TSE, this approach with MultiVane XD motion suppression provides higher spatial resolution. In addition, it is especially valuable in patients who cannot hold their breath or have some disabilities. My impression is that this sequence has the potential to substitute for, or even replace, the T2-weighted single shot sequence in our liver exams, because of good and consistent delineation of small lesions."

Non-invasive liver fat quantification in a breathhold with mDIXON Quant

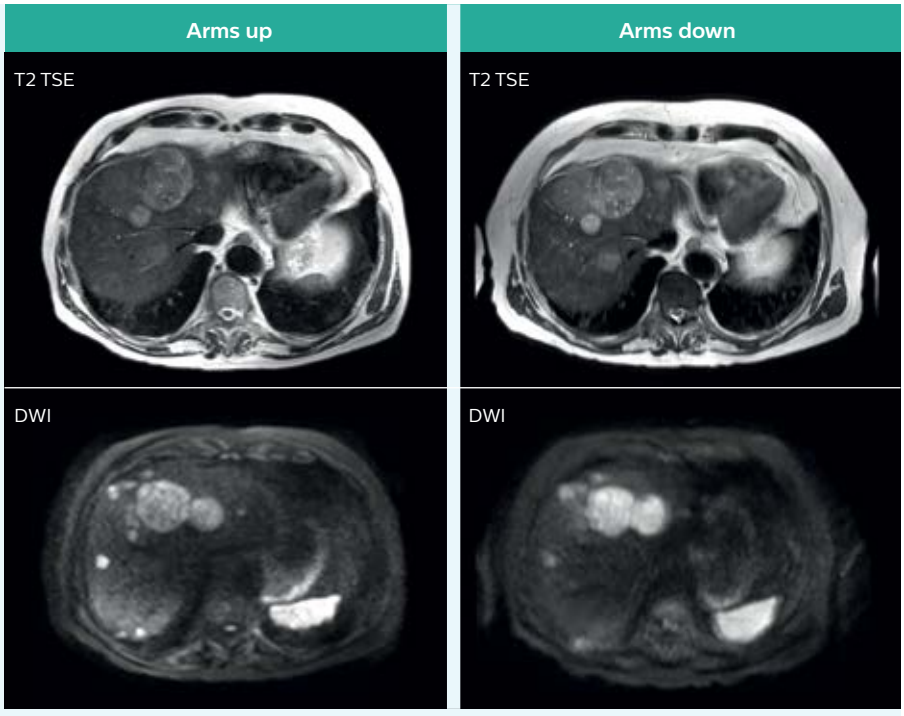
"Fatty liver disease is a common condition. Studies found a prevalence of non-alcoholic fatty liver disease in up to 44% in the general European population [1]. Liver fat cannot be quantified by ultrasound or CT, so biopsy has been the way to quantify fatty liver disease so far," says Dr. Kukuk. "mDIXON Quant now allows non-invasive quantification of liver fat, which is valuable for both diagnosis and follow-up during dietary changes or therapy, for instance in hepatitis C."

"The mDIXON Quant fat fraction maps provide quantitative information and also anatomical detail. The sequence is fast, usually taking about 16 seconds, which is just a breathhold for most patients. It definitely improves our efficiency."

Arms-up imaging of HCC in liver

A 78-year-old male patient with multifocal hepatocellular carcinoma underwent MRI. A special support is used for arms-up imaging. With the patient's arms elevated higher SENSE factors can be used.

Images obtained with arms up and arms down are scanned for comparison. The arms-up T2 TSE images are acquired faster and show less blurring thanks to the shorter echo train lengths. The arms-up DWI images (b=800 mm/s2) show less distortion and increased lesion conspicuity.



T2 TSE arms up: 2 x 11.4 s breathhold, dS SENSE 4, voxels 1.34 x 1.67 x 5.0 mm.
T2 TSE arms down: 2:00 min. resp. trig., dS SENSE 2, voxels 1.35 x 1.69 x 5.0 mm.

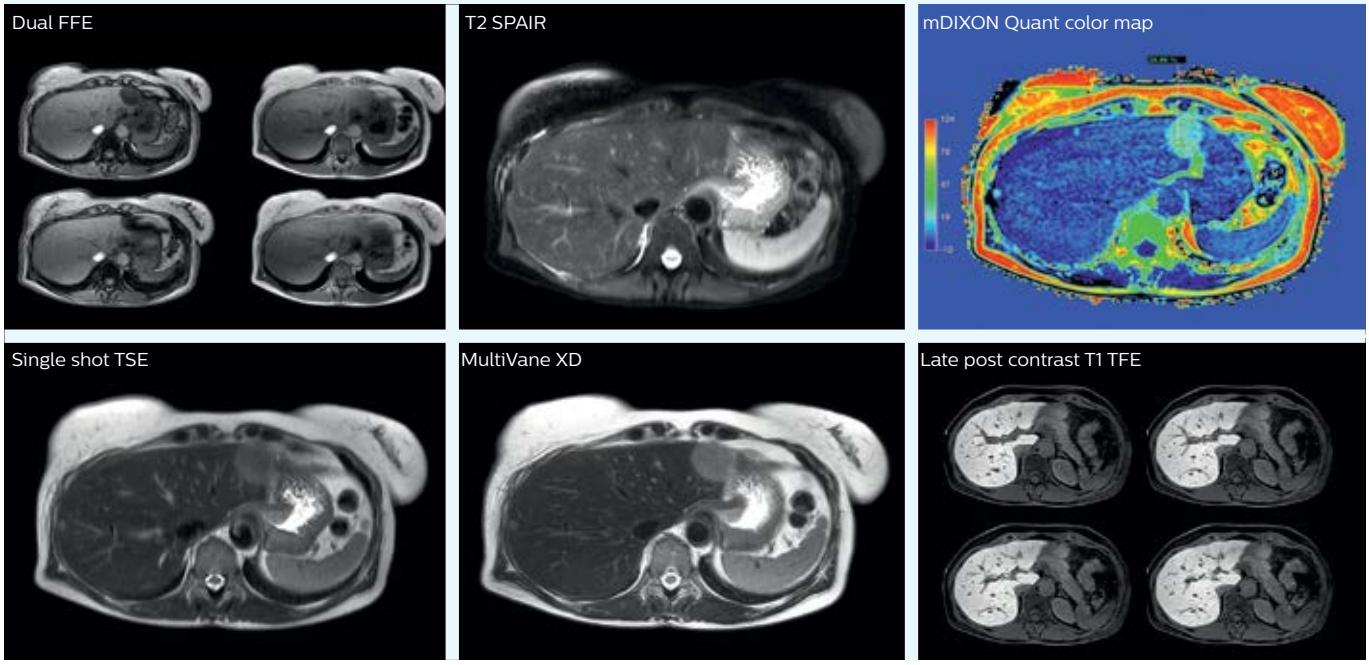
DWI arms up: scan time 2:42 min, voxels 3.03 x 3.15 x 7.0 mm.
DWI arms down: scan time 2:42 min, voxels 3.03 x 3.10 x 7.0 mm.

Ingenia 3.0T with the dS Torso coil solution.

Comprehensive liver exam of focal liver lesions

Patient with multiple liver lesions showing up hyperintense on T2-weighted images. The high spatial resolution of **MultiVane XD** can be appreciated by comparing the images demonstrating the two hyperintense focal liver lesions.

mDIXON Quant was performed for quantification of intralesional and hepatic parenchymal fat content. The fat content in the liver parenchyma was normal. The lesion has a fat fraction of 25-30%. Histopathologic diagnosis was hepatocellular adenoma. Ingenia 3.0T using the dS Torso coil solution.



mDIXON Quant is a simple sequence to include in routine liver MRI

"We have performed a study comparing mDIXON Quant fat percentages with results from histopathology. The correlation with different histologic methods was very good and also the correlation with MR spectroscopy was far above 0.9 – a nearly perfect correlation," says Dr. Kukuk.

"So, this fast mDIXON Quant sequence allows us to diagnose, quantify, and follow up – that's the real advantage. Our gastroenterologists were easily convinced, as they are well aware of the limitations of ultrasound and the risks of liver biopsy."

"Also patients appreciate receiving the quantitative diagnosis and changes seen in follow-up exams during therapy."

"I would recommend acquiring mDIXON Quant routinely in liver MRI exams. It is fast, easy to use, and has been well evaluated [2,3]. The time investment is low and the benefit is high."

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"MultiVane XD is a great technique to obtain high spatial resolution T2-weighted images of the liver without relevant motion."

References

1. Blachier M, Leleu H, Peck-Radosavljevic M, Valla DC, Roudot-Thoraval F *The burden of liver disease in Europe: a review of available epidemiological data*
J Hepatol 2013; 58: 593-608

2. Reeder SB, Cruite I, Hamilton G, Sirlin CB *Quantitative assessment of liver fat with magnetic resonance imaging and spectroscopy*
J Magn Reson Imaging 2011; 34(4): 729-49

3. Yokoo T, Browning JD
Fat and iron quantification in the liver: past, present, and future
Top Magn Reson Imaging 2014;3(2):3-94

Beaumont Health System brought MRI into its radiation therapy routine practice by implementing the comprehensive Ingenia 3.0T MR-RT Oncology Configuration.

Ingenia solution enhances delineation for **RT planning**

The potential benefits of using MR in radiation therapy planning are obvious: with its excellent soft tissue contrast, MR images can help to define lesions for well-targeted radiation therapy (RT) planning. During treatment, MR can visualize changes in patient anatomy and tumor biology to help adapt the treatment plan to these changes. Post-treatment MRI is used to monitor treatment response.

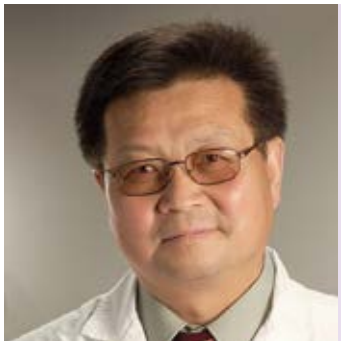
MRI integrated in radiation oncology department

Beaumont Health System (Royal Oak, Michigan, USA) is one of the largest health systems in the USA, with eight hospitals and 153 outpatient sites, a medical school and a research institute. The Radiation Oncology (RO) department houses a dedicated Ingenia MR-RT solution that is routinely used for clinical and research MR-RT activities.

"The main reason to integrate MR imaging in RT planning is the superb soft tissue contrast that allows detailed delineation of tumors and healthy organs, which is crucial for RT planning," says Craig W. Stevens MD, PhD. "The good visualization is why a lot of cancer treatments can benefit from MR based treatment planning, because if we can localize a tumor better, we can aim the radiation beam at it better. This potentially allows us to shrink our margins and spare more healthy tissue."

"MR also provides information on functional and biological activities in tumors, background tissue and normal organs, which may also be used in RT planning," says physicist Di Yan, DSc, FAAPM.

"We currently use MR-RT mainly in the abdomen and pelvis region: prostate, colorectal, pancreatic, cervical, and liver. Also in the brain, we are starting to use it," says Dr. Yan. »



Di Yan, D.Sc., FAAPM is Chief Physicist, Radiation Oncology, Beaumont Health System and Professor, Oakland University William Beaumont School of Medicine. His current research interests include image guided/adaptive radiotherapy, treatment response assessment and outcome modeling, and motion management, dynamic delivery and simultaneous imaging.

Craig W. Stevens MD, PhD is the System Chair of Radiation Oncology for the Beaumont Health System. He is the former Chair of Radiation Oncology at the Moffitt Cancer Center in Tampa, Florida and was a Professor in the Department of Oncologic Sciences at the University of South Florida. He earned his PhD in cancer biology, and his MD from Northwestern University after a BS in biology from MIT.

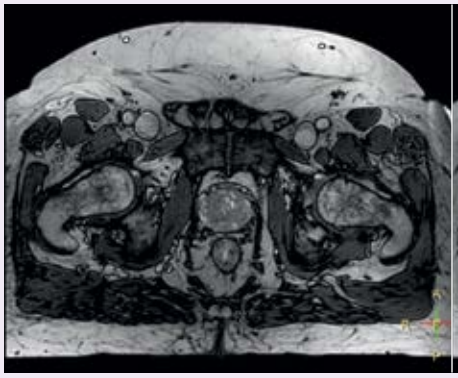
Planning RT treatment of Gleason 7 adenocarcinoma in prostate

After prostate biopsy demonstrating 4/12 cores positive for adenocarcinoma with Gleason 7 (3+4) this 76-year-old male was referred to the RT department.

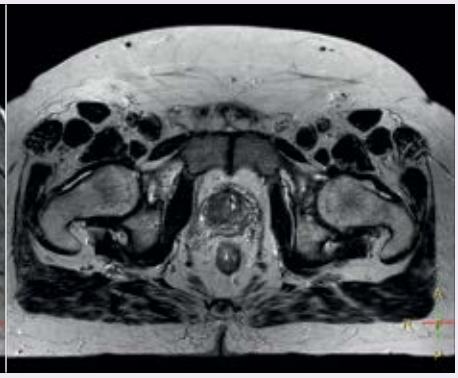
CT and axial MRI images are included in the treatment planning workflow for the delineation of the prostate and visualization of the nerve bundle and other critical structures. Rigid body registration was used to register the MRI image to CT using Syntegra, part of our Pinnacle³ treatment planning system.

The image fusion of CT and BTFE shows the difference in contouring based on MRI and CT.

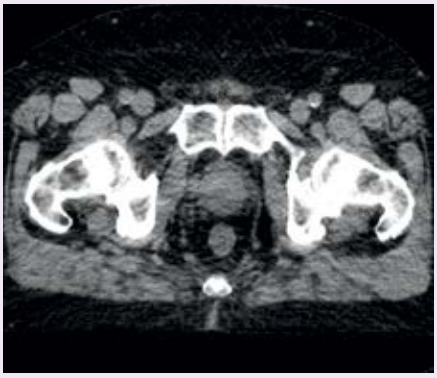
BTFE

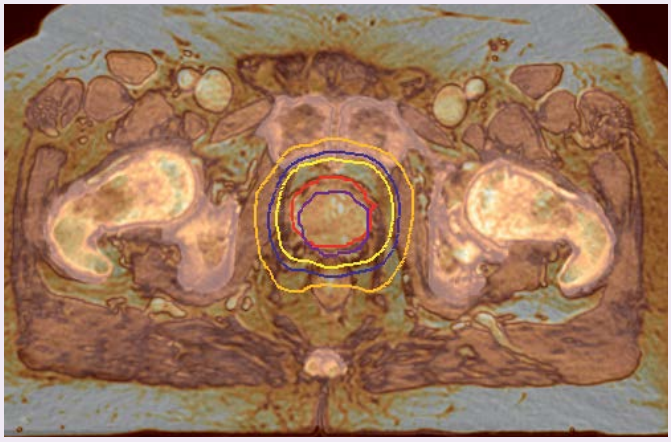


T2W



CT





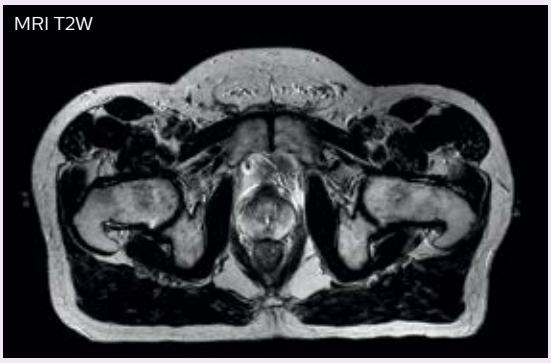
Dose on CT and BTFE fusion with prostate contoured on MRI (red) and on CT (purple)

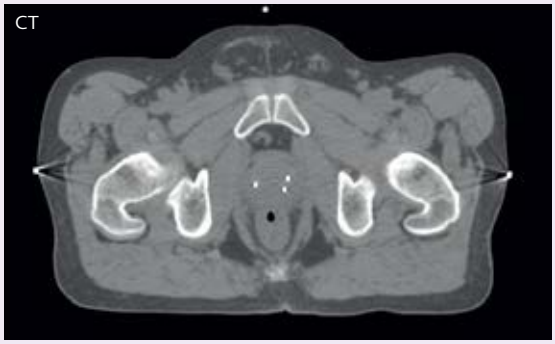
For the MR exam the patient is positioned supine on the flat table of Ingenia MR-RT with a large angle and pillow under his head, a cushion under his knees and a cushion under his feet. The arms are on the chest in a comfortable position. No medication or sedation given for MRI. The coil bridge is positioned over the patient without touching the patient. The FlexCoverage Anterior coil was used. No contrast agent was used. The scan time was 13:34 min.

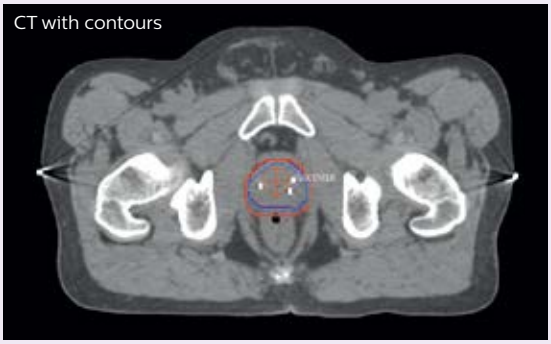
"The superb soft tissue contrast allows detailed delineation of tumors and healthy organs, which is crucial for RT planning."

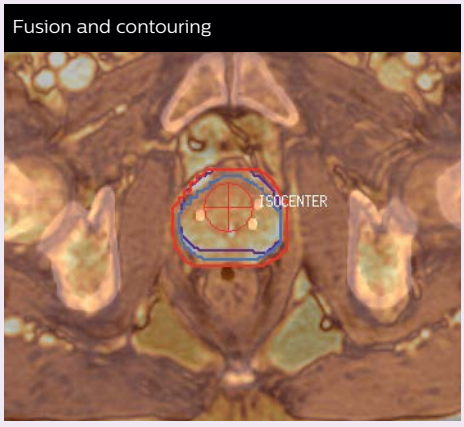
Planning RT treatment of Gleason 6 adenocarcinoma in hypoprostate

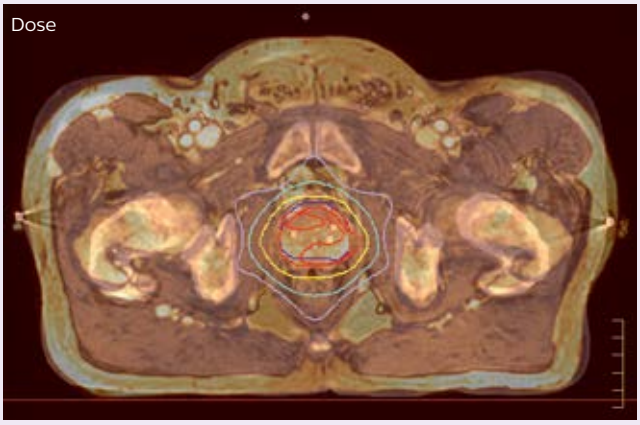
In this 57-year-old male, prostate biopsy demonstrated Gleason 6 (3+3) adenocarcinoma of the prostate involving 5 of 12 cores. A CT scan and Clarity ultrasound were used for treatment planning and the MR imaging was fused to these scans for treatment volume contouring.











Blue contour is prostate on MRI, purple contour is prostate on CT, red contour is PTV (planning target volume)

Impressive clinical benefits for prostate

"The biggest problem for CT-based planning, especially in prostate, is you can't see the cancer very well," says Dr. Stevens. "On CT it can be quite challenging to see the edge of the prostate especially at the apex. When the edge of the prostate can't be delineated well on CT, radiation oncologists will increase their margins a little bit so they don't miss it, but that can also increase toxicity."

"Using MR, the prostate is well delineated. We quickly see the edges of cancerous tumors like in prostate cancer, and as normal structures can be defined, we can optimize the treatment plan to protect these organs and their normal function. This can potentially improve the outcome. And it improves workflow as well. We can contour more quickly, confident that the tumor is going to be in the field."

"The Ingenia 3.0T MR scanner provides high resolution allowing us to make scans fast for the patients. It also gives the potential to include methods like MR spectroscopy and diffusion weighted imaging, which we're in the process of doing right now," Dr. Stevens adds.

Special requirements for MRI in RT planning

"There are some general challenges in RT imaging – even with CT – such as imaging geometry and positioning accuracy. Positioning is extremely important in RT, because we need reproducibility between imaging and treatment position. We also need accurate geometry so we can be sure our treatment plan is properly delivered during the treatment," says Dr Yan.

"The Ingenia MR-RT configuration includes an external laser positioning system for patient alignment and a flat tabletop for imaging the patient in treatment position. Ingenia MR-RT also came with a special QA package for regular monitoring of precision. Our Ingenia 3.0T scanner achieves good geometric accuracy – within a millimeter for most patients – and the phantom measurement is even better," he adds.

"Ingenia's wide 70 cm bore is valuable to easily accommodate immobilization devices needed in RT," says Dr. Stevens. "With a small bore MR scanner you can't get the RT immobilization devices into the scanner properly; the large bore makes it easy to image patients in their immobilization device."

Implementing MR-RT in the department

"Our staff was quite ready to take on the new way of working with MR-RT. After MR-RT was introduced, most of our clinicians said it made their lives easier," says Dr. Yan.

"When a patient registers, first CT simulation and MR simulation are done, followed by CT-MR registration on Pinnacle[3]. Then the target and normal organ delineation is performed on MR images. Meanwhile we create a reference CT image for online treatment and localization correction. During the treatment phase we can perform additional MRI scans to visualize the anatomy changes and create an adaptive plan. This plan basically adapts the treatment plan to the changes."

"Along with its great benefits, MR has introduced some new challenges," Dr. Stevens says. "Radiation therapy teams generally have no experience with MR. The Philips training helped us to implement fully the things we can do with the Ingenia MR-RT system. So the training, as well as having a good MR physicist, is critical."

MR imaging for brain treatment planning

"Also in brain tumor treatment planning the MRI soft tissue contrast offers a great advantage for seeing the target boundary. Brain tumors often involve edema, and CT cannot show this. Besides, MR also provides diffusion and perfusion information on background tissue," says Dr. Yan.

"MR is a powerful method for imaging brain tumors. I think we should never treat a brain tumor without having good MR imaging we can trust," Dr. Stevens says.

Future outlook

"I think that in the future functional information from MRI is going to become much more important, both for prognostic and predictive measures, as well as for treatment response measures," Dr. Stevens concludes. "With Ingenia MR-RT we will have the ability in our department to make decisions based on, for instance, changes in blood flow and diffusion at the beginning, middle and end of treatment. I believe that over time, every large cancer center will need to have an MR scanner in their radiation oncology department."

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"A lot of cancer treatments can benefit from MR based treatment planning, because if we can localize a tumor better, we can aim the radiation beam at it better."

Recently adopted methods for neuro MR improve **efficiency** and **confidence**

Jeffrey H. Miller, MD, is Pediatric Neuroradiologist and Director of MRI at Phoenix Children's Hospital. His current research interests are functional MRI, MR connectomics, and brain PET-CT. Dr. Miller has lectured extensively on advanced pediatric MR imaging.

"We rely on high resolution and robust imaging capabilities of our Ingenia systems."

Efficiency and diagnostic confidence drive adoption of three recent imaging techniques in pediatric neuro exams at Phoenix Children's Hospital

At PCH, fast, high resolution susceptibility weighted imaging with **SWIp** is now routine for traumatic brain injury imaging. Fast contrast-free perfusion imaging with **pCASL** is used in all patients with acute cerebrovascular accidents or abnormalities such as acute stroke. The excellent fat suppression of **mDIXON TSE** has become the standard at PCH for fat suppression in the spine and extremities, for imaging lesions in the soft tissues of face and neck, and for contrast enhancing abnormalities that are mostly visible with fat suppression.

Advanced MRI for challenging cases

Phoenix Children's Hospital (PCH, Phoenix, Arizona, USA) is the primary referral children's hospital for the state of Arizona, serving patients with the most complicated cases. The hospital is using two Ingenia 3.0T systems and two 1.5T systems. "We're a referral center for complex diseases affecting neurological systems, especially traumatic brain injury, brain tumors, epilepsy, and vascular diseases including stoke," says PCH neuroradiologist Jeffrey H. Miller, MD. Along with Lead MRI Technologist Amber Pokorney, Dr. Miller utilizes advanced MRI techniques in some of the hospital's most challenging imaging cases.

More referrals thanks to powerful techniques

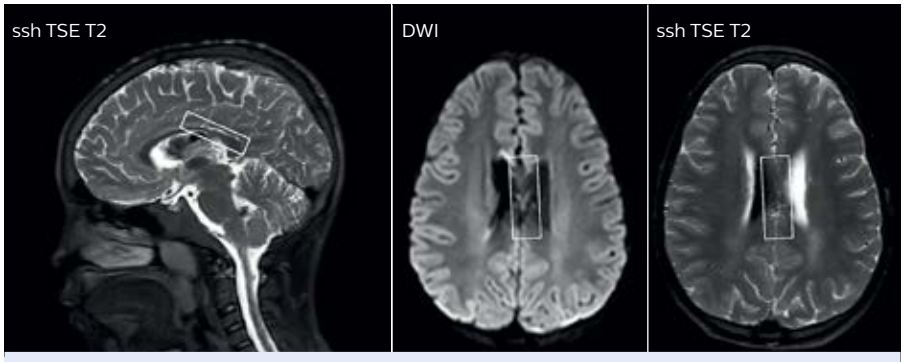
Is using these techniques a good way to attract patients and referrals? Absolutely, says Dr. Miller. "Our neurosurgeons ask to have patients examined on the scanners with SWIp capability, so they can be imaged with highly sensitive techniques. We've had a number of neurosurgical cases for children with sickle cell disease come to us to have pCASL imaging specifically. And the robust fat suppression of mDIXON TSE is critical to a number of diagnoses, not only in pediatrics but also for adults, and having a reliable method of fat suppression is definitely a benefit to radiologists and clinicians."

SWIp supports diagnostic confidence in traumatic brain injury

The value of susceptibility weighted imaging in visualizing brain injury is well documented. The Philips multi-echo SWIp technique provides fast susceptibility weighted imaging with enhanced susceptibility contrast and high resolution.

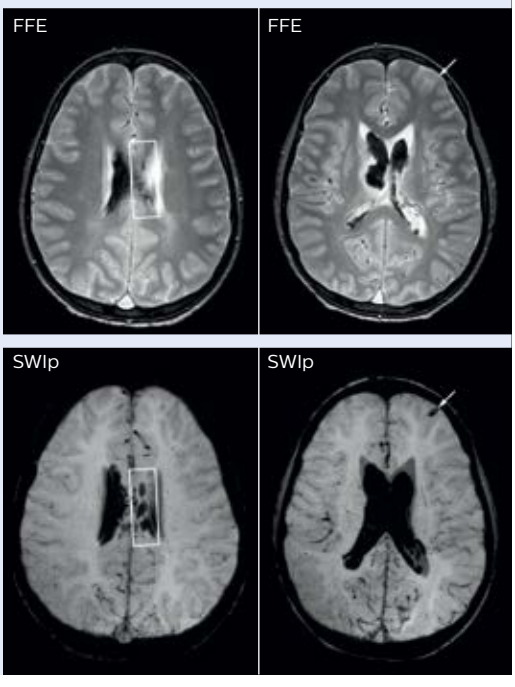
"Pediatric imaging is not without its challenges," Dr. Miller says. "Since our patients are often very small, we need very high-resolution imaging. In cases of brain injury, we need to obtain information quickly so the treating clinicians can make decisions on care. We rely on high resolution and robust imaging capabilities, and SWIp provides that."

"SWIp helps us identify blood or blood products, calcification, and diseases that affect the vascular system," says Dr. Miller. "In children with traumatic brain injuries, it highlights areas that are injured, better than some of the previous techniques that we were using. These children often have micro-injuries that cause small amounts of blood or tissue damage. Adding SWIp helps us to better characterize the extent and nature of the injury. Having characterized an injury to the extent of what's possible supports our diagnostic confidence."



SWIp in traumatic brain injury

In this 10-year-old girl thrown from a horse the SWIp images provide increased visibility of the corpus callosum injury compared to the T2-weighted, diffusion weighted and gradient echo images (box). SWIp also provides increased visibility of the cortical contusion (arrows) compared to gradient echo imaging. In this case, SWIp helps to characterize the extent of the patient's injury, which is important to know for short term care and longer term prognosis and rehabilitation.



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Full adoption of SWIp after initial comparison

"I would definitely recommend other users to implement SWIp. We initially added the SWIp sequence following a lot of support for its utility in the literature. Then we directly compared SWIp to the 2D gradient echo sequences that we were using. After a good amount of clinical experience in seeing its benefits, we were confident to replace the old sequences with SWIp. It gives us a better assessment of the physiological processes of the brain that were less apparent on our previous imaging sequences," says Dr. Miller. "SWIp is now a routine sequence for imaging traumatic brain injury patients at PCH, and it's episodically added for patients who have intracranial vascular abnormalities."

"I believe SWIp is rapidly becoming the standard in imaging traumatic brain injury, because of its high sensitivity to venous blood products. SWIp may even help attract patients; our neurosurgeons often ask to have the patients imaged on our scanners with highly sensitive techniques like SWIp. There's also a growing application of SWI sequences in other vascular abnormalities because of the possibilities around physiological assessment of the brain than just a standard structural imaging."

"SWIp helps us to better characterize the extent and nature of the injury."

pCASL helps assess brain perfusion without contrast

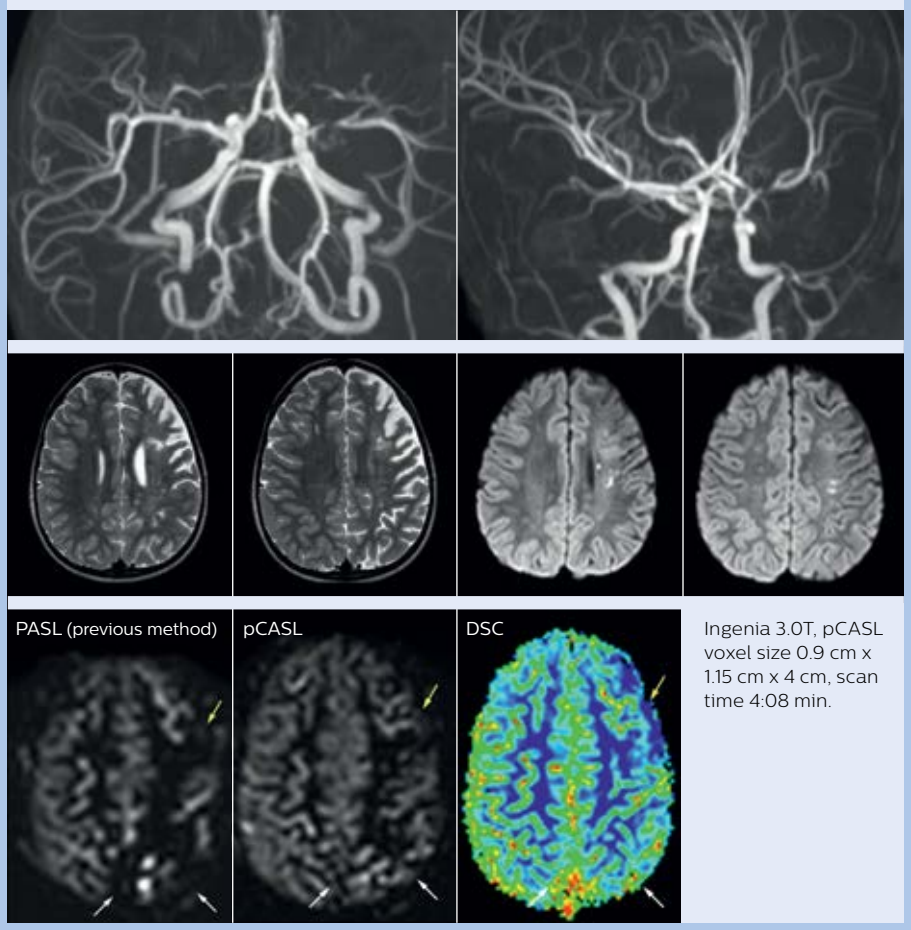
Pseudo-continuous arterial spin labeling (pCASL) was developed for brain perfusion imaging without contrast agent. "This is very desirable in pediatric patients where the general trend is to limit the administration of contrast," says Dr. Miller.

Dr. Miller uses pCASL for all patients who present with chronic and acute cerebrovascular abnormalities such as acute stroke, as well as patients who present with signs of acute inflammation in the brain, and occasionally in patients with tumors, to assess the perfusion status of their tumor.

"In combination with diffusion weighted imaging, it can help give a more extended assessment of the degree of perfusion abnormality in a patient who is suffering acute ischemia. We have a number of patients who have chronic arterial insufficiency due to prior arterial abnormalities or acquired arterial abnormalities such as sickle cell disease or neurofibromatosis. Sometimes the child's first manifestation of disease progression is a reduction in brain perfusion before stroke symptoms manifest clinically or in diffusion weighted imaging. We use pCASL to help delineate the perfusion abnormality."

pCASL in child with sickle cell disease

An 11-year-old boy with sickle cell disease and chronic left MCA stenosis and arterial insufficiency underwent an MRI exam. Comparison demonstrates that pCASL and DSC CBF are equivalent in showing the perfusion deficit anteriorly (yellow arrows) and the mild perfusion deficiency posteriorly (white arrows). However, the older pulsed ASL (PASL) overestimates the extent of perfusion deficiency, see white arrows posteriorly.



Ingenia 3.0T, pCASL voxel size 0.9 cm x 1.15 cm x 4 cm, scan time 4:08 min.

Growing confidence in specific applications

"We built up confidence in pCASL by comparing it to contrast-based perfusion imaging. Once we had confidence that it was representing what the contrast perfusions were representing, we increased our diagnostic confidence by serial imaging in either the acute stage or the long term stages in a number of patients with arterial abnormalities. To other new users I would recommend to also start to interpret the pCASL images in comparison with other standard imaging – T2 and FLAIR and DWI – until users gain confidence in interpreting these images by themselves."

"A powerful use of pCASL is in patients with chronic cerebrovascular stenosis, where clinicians desire information on how compensatory mechanisms of the brain are performing to enable perfusion to the brain. Often clinicians take into account how the compensatory mechanisms appear to help to provide adequate perfusion to the patient's brain, and they may intervene surgically or make some other management decision."

Efficiencies gained with pCASL

"pCASL has now become more of a first-line scan for assessing perfusion for us, as opposed to DSC-based perfusion imaging with contrast agent. And in patients who were not planned to have contrast, we can perform pCASL for perfusion imaging without need to stop the exam, pull the patient out, and put in an IV. It also negates the postprocessing that's necessary for dynamic susceptibility contrasts. And it allows us to repeat perfusion imaging in the same patient at the same imaging time, which is helpful in terms of patient motion, or in a situation where a scan needs to be done before pharmacological perfusion imaging."

"We use pCASL to help delineate the perfusion abnormality."

Routinely obtaining homogeneous fat suppression under virtually all conditions with **mDIXON TSE**

Philips mDIXON TSE is a two-point DIXON technique that separates water and fat signals, for time-efficient fat-free imaging, even in challenging neuro anatomy.

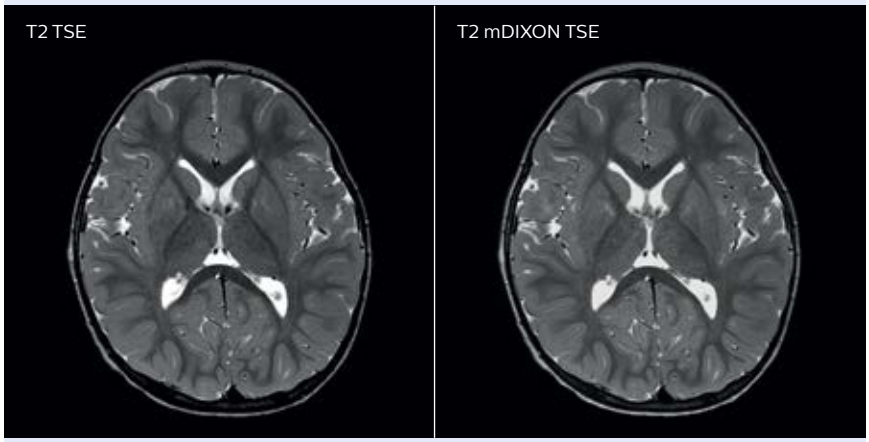
"mDIXON TSE has been one of the most significant improvements in imaging sequences that we have utilized to date at PCH," says Dr. Miller. "Its multi-parametric acquisition allows us to obtain fat suppressed images and equivalent non-fat suppressed T2 images all in the same sequence. In addition, prior methods of fat suppression could be artifactually corrupted by poor patient anatomy or poor operator application, but with mDIXON we now have a robust and reliable method of fat suppression."

Fat saturation is historically challenging at the ends of fields of view, especially in total spine imaging and in difficult patient anatomy such as the lower regions of the neck. "Due to the unique fat suppression capabilities of mDIXON, however, these challenges no long apply," says Dr. Miller. "We routinely obtain homogeneous fat suppression under virtually all conditions. It has also led to some efficiencies by not having to repeat sequences because of that technical failure." »

"We routinely obtain homogeneous fat suppression under virtually all conditions."

mDIXON TSE for T2-weighted imaging

mDIXON TSE can be used for multiple types of acquisitions. This is a comparison of standard T2 TSE and T2 mDIXON in-phase images. The image contrast and quality of the T2 TSE and the T2 mDIXON in-phase image are basically indistinguishable.



Ingenia 3.0T, mDIXON TSE with pixels 0.55 x 0.5 mm, matrix 400 x 400, scan time 5:09 min. T2 TSE with pixels 0.6 x 0.6 mm, matrix 386 x 386, scan time 4:48 min.

mDIXON TSE in metastatic leukemia

In this 5-year-old with metastatic leukemia mDIXON TSE is compared to T1-weighted SPIR. Both demonstrate deposits within the vertebral bone marrow (box) and deposits coating the surface of the spinal cord and nerve roots (arrow). All of the lesions seen on standard SPIR are also seen on mDIXON TSE. Evaluating many cases like this contributes to my diagnostic confidence that mDIXON has equal sensitivity in visualizing these important lesions. With this confidence, we can therefore use mDIXON TSE instead of SPIR to benefit from the reliable fat suppression of mDIXON TSE without being concerned to miss abnormalities like these because of the changed method.

mDIXON TSE with voxels 0.6 x 0.9 x 3 mm, scan time 6:22 min.
T1W SPIR with voxels 0.6 x 0.9 x 3 mm, scan time 5:52 mm
Ingenia 3.0T with dS Torso coil solution.

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mDIXON TSE makes a difference

"mDIXON TSE is most useful in patients with lesions or abnormalities in the soft tissues such as the face and neck, and for patients with contrast enhancing abnormalities that are mostly visible with fat suppression," says Dr. Miller. "All our spine imaging now routinely contains mDIXON water-only T2 images, and this allows us to identify pathology that may be obscured by non-fat suppressed imaging such as injuries of the bone. And it's not necessary to obtain additional standard TSE T2 images because the in-phase mDIXON images are equivalent to standard TSE T2 images."

"mDIXON TSE has increased our diagnostic confidence in ruling in or ruling out abnormalities in which fat suppression is critical to diagnosis, such as metastatic disease or osseous abnormalities."
«

"mDIXON TSE has been a significant improvement compared to imaging sequences that we have utilized to date."

References

1. Goetti R, O'Gorman R, Khan N, Kellenberger CJ, Scheer I.
Arterial spin labelling MRI for assessment of cerebral perfusion in children with moyamoya disease: comparison with dynamic susceptibility contrast MRI.
Neuroradiology. 2013 May;55(5):639-47
www.ncbi.nlm.nih.gov/pubmed/23404242

2. Miller JH, Pokorney A, Naidu P, Eggers H, Shar M, Perkins T.
Improved Fat Suppression and Field Homogeneity of mDixon TSE Total Spine Imaging compared to SPIR Fat Saturation for Post-Contrast T1-weighted Imaging
Proc. ISMRM-ESMRB. Milan, Italy 2014.

Foundation Rothschild, a hospital specialized in head and neck care, exploits the power of Ingenia 3.0T to excel in advanced neuro imaging.

High quality imaging in **MS, stroke** and **brain tumor**

In any type of neurological MRI, it's crucial to gather as much information as possible to increase diagnostic confidence. So, scanning must be fast and efficient, and images must provide high detail.

Ingenia 3.0T is ideal for demanding brain imaging due to its high SNR, good spatial resolution, and flexibility to accommodate many different protocols.

Fondation Rothschild (Paris, France) is a tertiary care hospital that specializes in head and neck care. Neuroradiologist Julien Savatovsky, MD, has been using Ingenia 3.0T since 2012 to optimize image quality and examination times for a broad range of neuro applications.

32-channel dS head coil a high-resolution solution

The hospital uses the 32-channel dS Head coil for every examination type that doesn't include the lower neck. "This coil's biggest advantage is the exceptional SNR. This allows us to use higher acceleration factors than with the standard coil."

"In some cases, the high resolution that this coil provides is really necessary. For example, in a head and neck case when we look for a small lesion or small vascular conflict, or in IAC imaging or fifth cranial nerve imaging, we want to achieve very good spatial resolution. In brain disease it's always better to get more details than less. We gain more diagnostic confidence when we have more information."

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"Every center is different, but for me the ideal stroke protocol includes diffusion, FLAIR, fast susceptibility imaging and MR angiography."

"The challenges of brain imaging are many, but we are very satisfied with the capabilities of Ingenia 3.0T."

Julien Savatovsky, MD, is neuroradiologist at Fondation Rothschild (Paris, France). His clinical interests include brain tumor imaging, inflammatory diseases, HIV-associated brain disease, head and neck vascular CT, and neuro-ophthalmology. He was educated and performed his residency and subspecialty qualification at Université Pierre et Marie Curie, Paris and a fellowship at Pitié-Salpêtrière hospital.

Multiple sclerosis imaging requires precision, speed

When multiple sclerosis (MS) is suspected, clinicians need a diagnosis early on, so treatment can begin as soon as possible. "A challenge for imaging is that MS lesions in the brain and spine may be very small," says Dr. Savatovsky. "We need precise imaging to tell exactly where the lesion is, so we need high quality, very high resolution images, preferably in 3D[1]. We need to know if a high T2 signal intensity is suggestive of MS or just aspecific. And we want to visualize active lesions very well."

"Ingenia 3.0T provides us very good image quality with high SNR, even if we push the resolution. For example, in FLAIR images we may have an isotropic resolution of 0.9 mm. Ingenia allows us to use 3D T1 TSE with BrainView, which has a better sensitivity than 2D spin echo imaging[2] and 3D gradient echo imaging. Ingenia also provides highly reproducible exams, which is important in MS imaging so that follow-up exams at different time points are done the same way."

Imaging MS in brain

For MS imaging in the brain, Dr. Savatovsky uses 3D FLAIR as the basic sequence to visualize the lesions and assess the situation and lesion load. "We count the lesions in each location to determine if the criteria of the disease are fulfilled. We use a T2-weighted sequence because our neurologists are used to it. We compare the lesion load on FLAIR with a 3D T1 post-contrast sequence to help us determine whether lesions are old or new. We typically administer the contrast before the patient enters the machine because it shortens the examination time and allows us to visualize active lesions that tend to be more visible after several minutes. When a differential diagnosis is difficult, we add sequences such as susceptibility imaging, because some focal MS lesions have a small vein in the center[3]."

MS imaging in spine is more complicated

"For MS imaging in the spine, the basic examination includes a sagittal T2 and a post-contrast sagittal T1-weighted sequence in the whole spine. These are done in two stacks and using thin slices, for example 2 mm, without gap. As in the brain, the T2-weighted sequence visualizes the overall lesion load and helps determine if lesions are old or new. The post-contrast T1-weighted sequence helps in assessing if a lesion is new. We will sometimes add a T1 inversion recovery sequence, which has very good sensitivity, if we don't find any lesions on T2 additionally, if there is contrast enhancement outside the spine, it's usually not MS but another kind of inflammation."

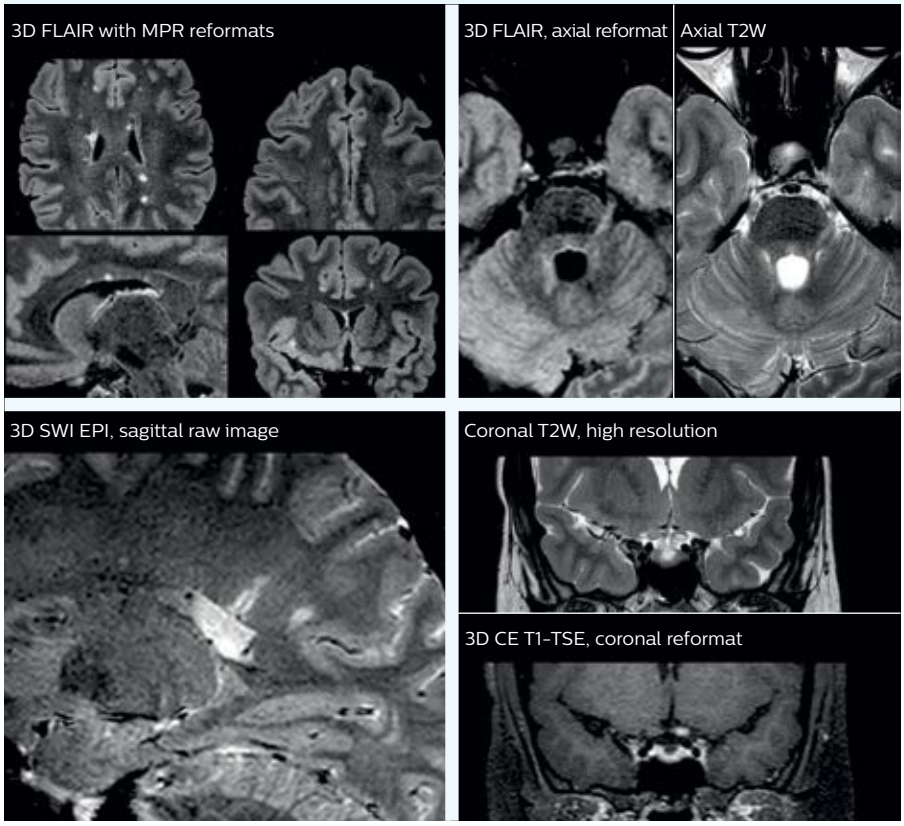
Multiple sclerosis with acute optic neuritis

This 23-year-old female has left visual loss for 3 days and a past history of transient left facial paresthesias. The 3D FLAIR and MPR reformats show multiple T2 FLAIR high signal intensity lesions, including in paraventricular regions and juxtacortical white matter. The axial 3D FLAIR reformat and axial T2-weighted image show two lesions in the brainstem and one in the right superior cerebellar peduncule.

On the 3D SWI EPI image the medullary vein (linear low signal intensity) is seen in the center of a periventricular inflammatory lesion. The coronal high resolution T2-weighted and reformatted 3D CE T1-TSE demonstrate the left optic nerve acute inflammatory lesion in high T2 signal intensity. The diagnosis is multiple sclerosis fulfilling spatial dissemination criteria and acute left optic neuritis.

The powerful combination of dStream and dS SENSE provides high spatial resolution, SNR and good contrast of lesions on FLAIR images, which allows a good identification of lesions and therefore helps to diagnose MS early in the course of the disease. Such high image quality can be achieved in a short acquisition time, thanks to the possibility to use high dS SENSE factors. Being able to use short sequences allows to invest more time during the same exam session for higher resolution and more specific acquisitions, such as the high-resolution optic nerve imaging in this patient.

Brain MS exam on Ingenia 3.0T with 32-channel dS Head coil in 18:04 min.



"Ingenia provides us highly reproducible exams, which is important in MS imaging so that follow-up exams at different time points are done the same way."

Every minute counts in **stroke** imaging

"In France, stroke is usually imaged with MRI, not CT, even for emergency treatment. This is because MRI helps us directly visualize ischemia in the acute phase, but can also help rule out differentials such as MS and hematoma. In addition, we can assess the intracranial and extracranial vessels during the same examination," says Dr. Savatovsky.

The first challenge in MRI of stroke is speed. The patient typically arrives from an ambulance in the MRI preparation room and the installation is done on a separate dock outside the scanner room. "The venous access is placed during the neurological examination. If the delay from the first symptoms allows the patient to receive thrombolysis we do a very fast examination that typically lasts about 11 minutes including the pre-scans. In the case of transient ischemic stroke we usually add ASL perfusion because in some symptoms with negative diffusion, ASL sometimes indicates a vascular origin."

"Ingenia provides great flexibility in the parameters setting. We can tune a sequence the way we want," says Dr. Savatovsky. "For example, in a stroke exam we use a FLAIR sequence of about two minutes instead of the four-minute FLAIR we use for MS. The diffusion is 30 seconds, the T2*-weighted scan is 30 seconds, the angiography scan time is less than one minute. Ingenia is a great scanner in that situation; even with these fast sequences we can achieve good images with good SNR. When the first sequence tells us that it's not an ischemic stroke but a hemorrhagic stroke, we may switch to a time-resolved angiography to look for vascular malformations and venous thrombosis.

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The ideal stroke protocol?

"Every center is different, but for me the ideal protocol for stroke includes diffusion weighted imaging, FLAIR, and fast susceptibility imaging," says Dr. Savatovsky. "Our fast susceptibility weighted imaging takes 50 seconds, so it's as fast as T2*-weighted imaging. It visualizes hemorrhage but also the clots. We also do 3D MR angiography that provides information on cervical and brain vessels. If the patient does not need immediate treatment, or if additional information is needed to decide on treatment, we might also add perfusion imaging and post-contrast T1-weighted imaging."

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"In France, every stroke is usually imaged with MRI, not CT, even for emergency treatment."

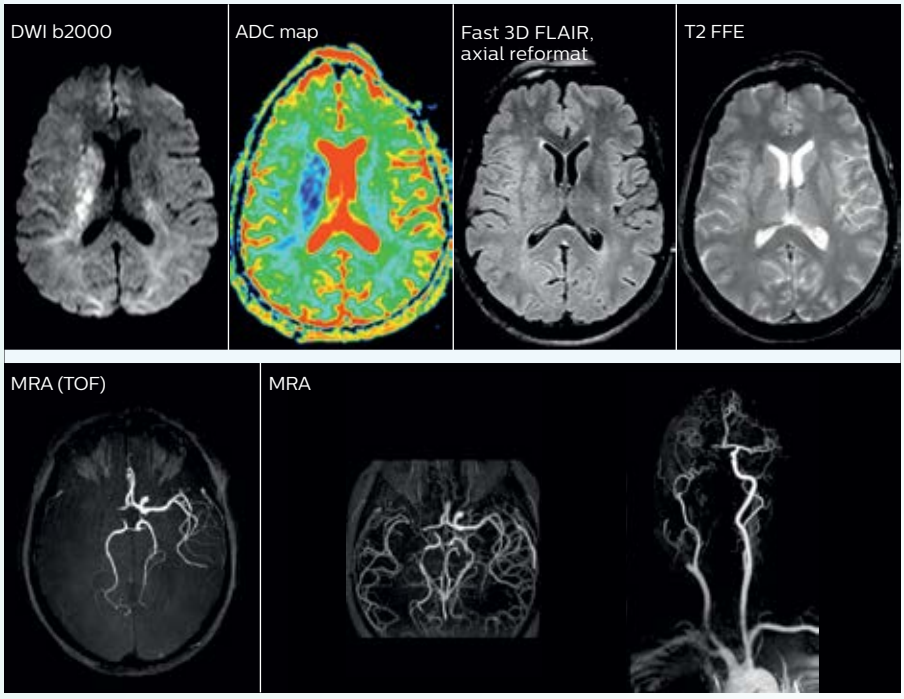
Acute ischemic stroke with ICA and MCA occlusion

A 67-year-old female with contraindication of IV thombolytic therapy underwent an MRI exam 1:35 hours after acute onset of left hemiplegia. NIH stroke scale = 10.

In the right deep MCA territory high signal is seen on the DWI images (b2000) with low ADC. No obvious abnormality (except subtle asymmetry of the right putamen) is seen on the FLAIR images, which rules out differential diagnoses and subacute stroke. No hematoma or blood products are seen on T2-weighted FFE. TOF MRA suggests right carotid and proximal MCA occlusion. On MRA of the supra-aortic vessels and cerebral arteries a right internal carotid bulbar occlusion is seen. Note that right MCA distal branches are visible from cortical collaterals and therefore that thrombus length can be estimated, unlike with the TOF sequence. The diagnosis is acute right deep MCA territory ischemic stroke associated with right carotid and MCA occlusion.

A stroke exam benefits from the fast imaging capacities of the system. The mobile docking table helps to speed up patient installation in an emergency setting. Our comprehensive but short stroke protocol allows the evaluation of both ischemic core extent and arterial clot. Simultaneous assessment of the supra-aortic vessels provides a "roadmap" for neuro-interventionalists and can help reduce the procedure time.

Acute stroke exam on Ingenia 3.0T with dS HeadNeck coil in 7:21 min.



Left frontal glioblastoma multiforme

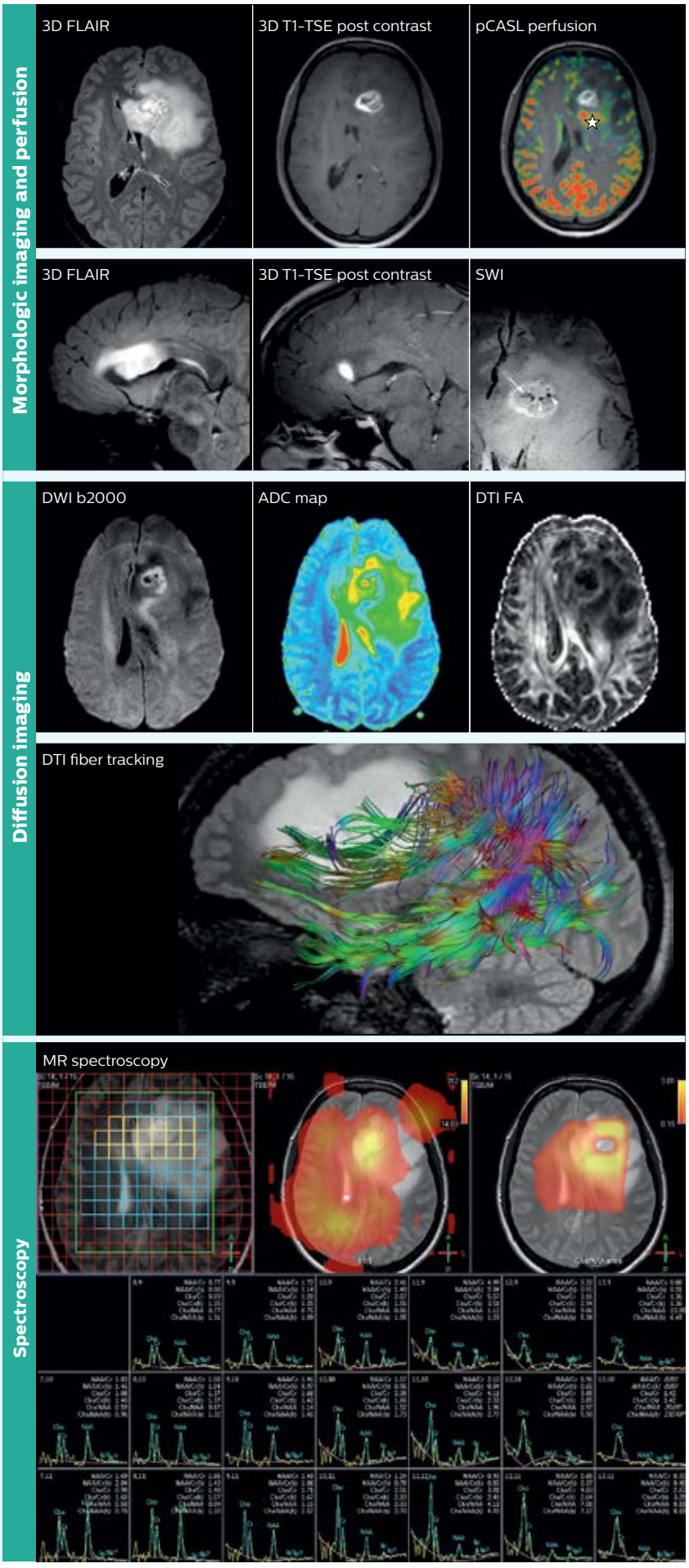
A 27-year-old female with recent onset of seizures and headaches underwent MRI. 3D FLAIR and post-contrast T1-weighted reformats (axial and sagittal) depict an intraaxial mass with a contrast-enhanced component and a non-enhancing, high T2 signal intensity infiltrative component. pCASL perfusion, overlaid on the post-contrast T1W images, displays a highly perfused zone (star) outside the enhanced lesion. Susceptibility weighted imaging demonstrates abnormal vessels (arrow) and small foci of intratumoral susceptibility signal intensities (arrowheads) inside the contrast-enhancing and necrotic component.

The contrast-enhancing component is high in DWI signal intensity with heterogeneous apparent diffusion coefficient (ADC), and low fractional anisotropy (FA). Left arcuate fasciculus tracking demonstrates displaced fibers within the non-enhancing component of the lesion.

Multi-voxel MR spectroscopy (MRS) is performed with TE 135 ms. High choline (membrane proliferation) and low N-acetyl-aspartate (neuronal loss) are seen in both contrast-enhancing and non-enhancing parts of the lesion. Elevated lipids and lactate in areas are seen close to the contrast-enhancing lesion (necrosis).

The diagnosis is left frontal glioblastoma multiforme (WHO grade 4).

Using Ingenia 3.0T with the 32-channel dS Head coil allows both high SNR and high acceleration factors to keep duration of each sequence short and thus allows to perform a comprehensive examination in an acceptable time.



Comprehensive exam answers **complex brain** tumor questions

Dr. Savatovsky uses five or six different ExamCards for imaging a mass or a known tumor in the brain. “If there is a mass in the brain we try to characterize it to inform the neurologist for determining next steps or to help the neurosurgeon prepare for a surgery or biopsy. For follow-up after treatment we have different protocols for different treatments and we adapt for intra- or extra-axial tumors.”

“The biggest challenges are properly characterizing the lesion and giving the surgeon all the information needed, such as the location of vessels and functional areas. Sometimes a very comprehensive exam is necessary, such as when a mass has been discovered at another hospital after which the patient is referred to us. We then do both lesion characterization and preoperative imaging in one exam, so both morphologic and functional assessment. For morphologic assessment we will use pre- and post-contrast T1-weighted imaging, FLAIR to assess infiltration, and diffusion. For functional characterization we will perform perfusion, spectroscopy, and susceptibility weighted imaging to look for micro vessels or micro hemorrhage inside the lesion[4].
For preoperative imaging we perform specific morphologic imaging that is compatible with the navigation system; depending on the location of the tumor, we would do fMRI or DTI.”

“That is the most comprehensive exam we would do. Ingenia has the good spatial resolution and high SNR to provide all this information, and the flexibility to use shorter sequences, so we can do a very comprehensive examination in a limited time.” «

View extended explanation in article on **www.philips.com/fieldstrength**

References

1. Mills RJ, Young CA, Smith ET
3D MRI in multiple sclerosis: a study of three sequences at 3 T.
Br J Radiol. 2007 May;80(953):307-20

2. Hodel J, Outteryck O, Ryo E, et al.
Accuracy of postcontrast 3D turbo spin-echo MR sequence for the detection of enhanced inflammatory lesions in patients with multiple sclerosis.
Am J Neuroradiol. 2014 Mar;35(3):519-23

3. Sati P, George IC, Shea CD, Gaitán MI, Reich DS.
FLAIR: a combined MR contrast technique for visualizing white matter lesions and parenchymal veins.*
Radiology. 2012 Dec;265(3):926-32

4. Kickingereder P, Wiestler B, Sahm F, et al..
Primary Central Nervous System Lymphoma and Atypical Glioblastoma: Multiparametric Differentiation by Using Diffusion-, Perfusion-, and Susceptibility-weighted MR Imaging.
Radiology. 2014 May 3:132740.

Advanced neuro MRI methods get boost from **IntelliSpace Portal**

With less time, bigger workloads, and more data than ever before, how can you perform advanced MRI with faster postprocessing and improved workflow?

Visualization and analysis of advanced MRI data may seem in conflict with efficient workflow. IntelliSpace Portal (ISP) changes that with applications that make postprocessing, analysis and collaboration fast and easy. Clinicians at Gregorio Marañon Hospital routinely combine IntelliSpace with advanced MR for confident diagnoses.

Hospital General Universitario Gregorio Marañon (Madrid, Spain) is a tertiary hospital that serves a population of 300,000 people, with specialties that include neurology, oncology, otolaryngology and oral maxillofacial surgery. Among its 51 radiologists, three neuroradiologists perform around 60 MRI cases a week, mainly for neuro-oncology purposes.

Advanced MR techniques add information for diagnosis

"In complex neuro cases, it's important to have as much information as possible," says radiologist Juan Guzman De Villoria, MD, PhD. "Our neuro-oncology focus means that virtually all our MRI scans involve advanced MRI techniques. We commonly perform perfusion, diffusion, permeability, fiber tracking and spectroscopy for different cases. Advanced MR methods can provide functional information in addition to morphologic information."

"For example, before surgery our neurosurgeons demand perfusion information to look at the tumor's relationship with functional areas seen on fMRI, such as eloquent areas. Fiber tracking informs them on the location of nerve tracts relative to the tumor," says Dr. Guzman.

"In follow-up patients we perform MRI to check progression or response to treatment. When the challenge is to differentiate pseudo-progression from real tumor recurrence, it's important to have all the information we obtained with advanced MR. Spectroscopy is mostly used for low-degree gliomas."

IntelliSpace Portal helps busy radiologists

"A concern in using advanced MR methods is that we need to process and analyze a lot of data," says Dr. Guzman. "We have a lot of patients and we don't have much time for postprocessing. IntelliSpace Portal helps tremendously as it provides user-friendly software that allows us to efficiently extract a lot of useful parameters and information from our MR data."

"We need to obtain a lot of information in a short time."

"We also need to have confidence in the IntelliSpace Portal data outcomes. Therefore, we need to understand the basics of the postprocessing methods, as well as the significance and reliability of the results. The task-guided setup of IntelliSpace Portal clearly shows processing steps and we can control how calculations are performed."

Easy viewing and processing of advanced MR data

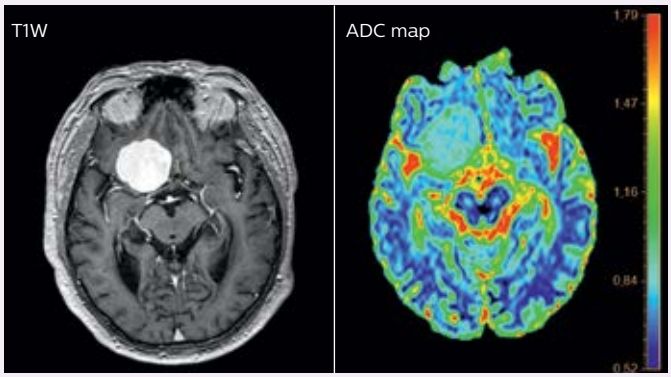
"With IntelliSpace Portal we can quickly perform different types of advanced MR processing. We can easily select the most appropriate area for measurements in a tumor. The mirror line then automatically generates a ROI in the normal area for comparison, so we obtain the necessary information in fewer steps and in a consistent way."

»

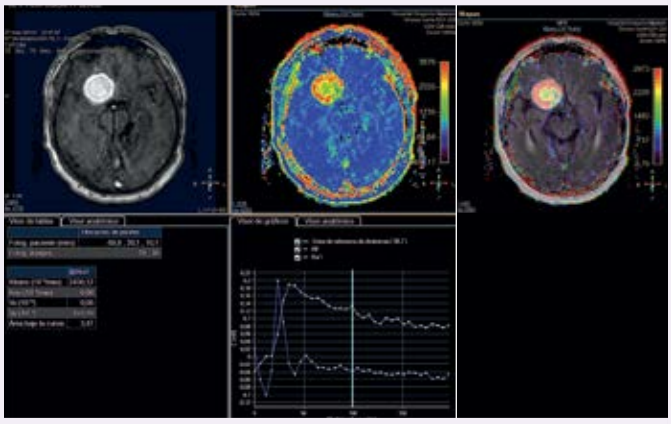
Juan A. Guzman de Villoria, MD, PhD is neuroradiologist at Hospital General Universitario Gregorio Marañon (Madrid, Spain) since 2003. He received his degree in medicine in 1998 from Salamanca University, Spain, and his PhD (2010) from Complutense University of Madrid, Spain. His research interests are in the areas of pre- and post-operative imaging in brain tumors and assessment of advanced MRI in neurodegenerative disorders.

"IntelliSpace Portal is a very powerful and user-friendly tool to analyze very different advanced MRI techniques."

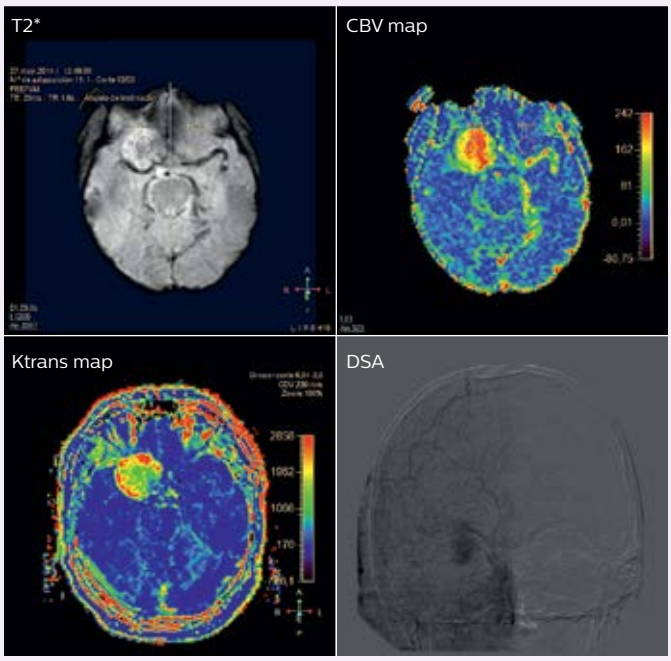
Clinoid meningioma evaluation on IntelliSpace Portal



The **ADC map** is generated based on DWI with b-value 2500 s/mm2) with an appropriate mask definition.



Color-coded **Ktrans maps** are automatically generated. Arterial input function and Ktrans *curves* within the ROI are also shown at the same time, together with a tableof calculated parameters.
The color map can be fused with an anatomic image.



CBV color maps are automatically generated from T2* DSC imaging. The color CBV map shows high CBV values in the mass, most pronounced in the central area. After placing a ROI in the mass, a contralateral ROI is automatically generated. Time-signal curves and a calculated parameter table appear immediately.

Increased Ktrans values are seen in the mass, particularly in the lateral aspect (in red). Cerebral angiography shows a high vascularity of these peripheral areas.

This 64-year-old male with anterior clinoid meningioma experiences progressive loss of vision in the right eye. Post-contrast axial T1W imaging shows an intensely enhancing extra-axial mass centered in the posteroinferior right frontal region. Intera 1.5T.

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IntelliSpace Portal is used for further evaluation.

Brain meningiomas are an example of benign lesions with high vascularization. The blood supply comes from external and internal carotid branches. These vessel types show a different pattern in perfusion parametric maps.

DSC perfusion (T2*) shows high CBV (cerebral blood volume) values, most pronounced in the central part of the mass. Cerebral angiography demonstrates an intense blood supply to the mass.

DCE (T1W) shows abnormal high Ktrans values in the lateral aspect of the mass (red color) which corresponds to the area of blood supply from the external carotid via dural branches as is revealed in selective external carotid cerebral angiography. These vessels do not contain a blood brain barrier and thus are quite permeable.

Perfusion MRI can provide useful information of cerebral supply of meningioma. Benign meningiomas show a blood supply from the external carotid via dural branches. The absence of blood brain barrier of these vessels explains an increase of parameters related to permeability, such as Ktrans. Depending on size or localization of the tumor, it may be fed by pial branches from internal carotid branches. This will elevate cerebral blood volume but Ktrans will be less elevated because the blood brain barrier is more preserved.

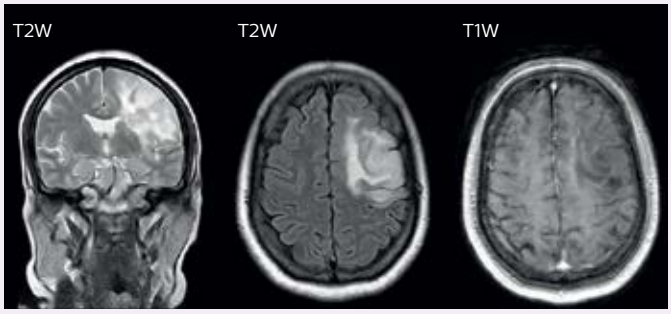
Grade II oligodendroglioma evaluation on IntelliSpace Portal

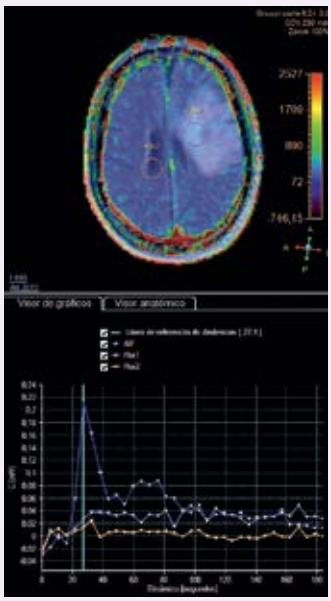
This 56-year-old male with a Grade II oligodendroglioma with 1p/19q co-deletion suffers from episodic headache, facial paresthesia and disarthria.

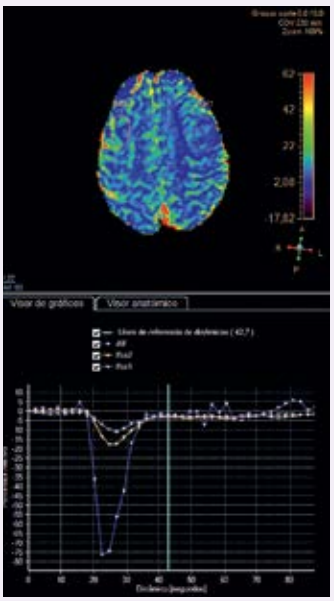
FLAIR images demonstrate the diffuse cortical neoplasm located in the left cortical lobe involving precentral and middle frontal gyrus. The T2W images show that moderate edema is associated. No enhancement is seen on the post-contrast T1W image. Achieva 1.5T.

IntelliSpace Portal is used for further evaluation.

"These types of advanced MRI give us different information, in addition to plain MRI."







MR permeability application

The color-coded parametric map of Ktrans shows a slight increase in the lesion compared to contralateral normal area. This is overlaid on the T1-weighted DCE images for localization.
The graph shows curves for lesion and normal Ktrans, as well as arterial input function.

MR neuro perfusion application

For evaluation of dynamic susceptibility weighted DSC T2*-weighted imaging a ROI is placed in the lesion area and a contralateral ROI is automatically generated. A table with calculated values for both ROIs is presented at the same time, as well as time-intensity curves. The results show no significant changes of cerebral blood volume in the lesion.

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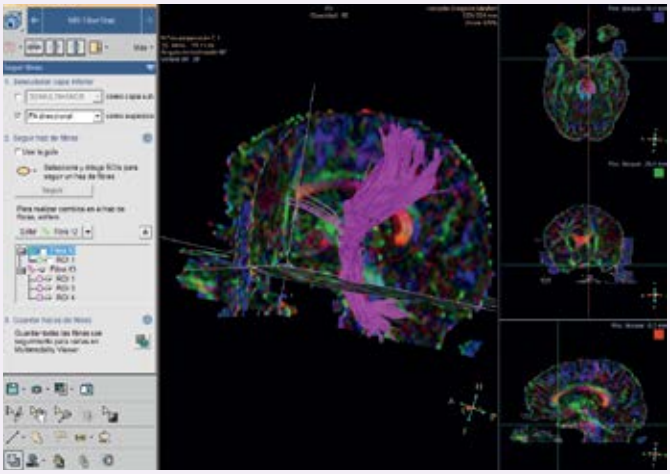
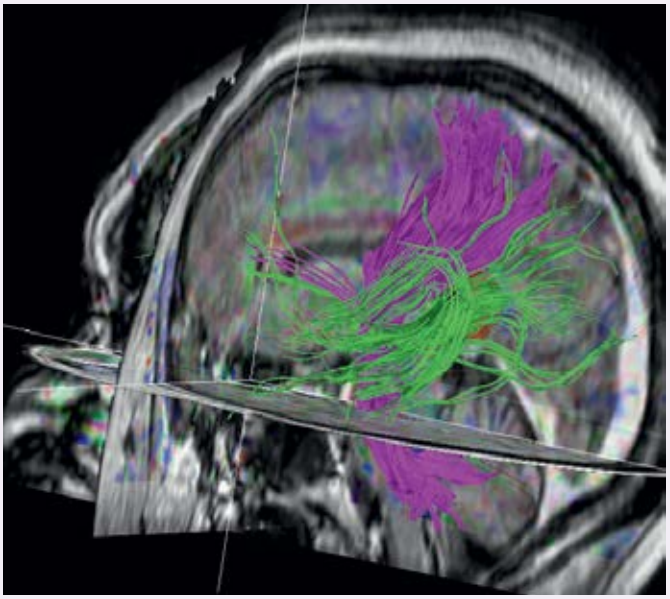


IntelliSpace Portal screen showing diffusion tensor tractography. The corticospinal tract is represented with the ROIs. The anterior portion of the corona radiata is not visualized due to lesion infiltration.



Diffusion tensor tractography. The corticospinal tract (purple) and arcuate tract (green) are fused to multiplanar 3D T1W.

IntelliSpace Portal is used for evaluating the images. A moderate increase of permeability constants (Ktrans and Kep) and volumes (Ve and Vp) is found. DSC T2* images show no significant changes in CBV and CBF. Diffusion tensor tractography shows a disruption of the anterior frontal projection of the arcuate fasciculus and the anterior portion of the corona radiate.

“I don’t need go to another workstation for analysis of advanced MR data.”

“3D reconstructions (MPR) are automatically performed very quickly and we can easily adjust these if we want. These views in different orientations are very useful for neurosurgery. The bookmark feature allows closing a session and continuing again later from the same point with the same patient. That’s another great advantage.”

“The packages that we use – MR Permeability, T1 and T2* Perfusion, FiberTrak, and IViewBOLD – provide a wealth of calculated parameters and parameter maps. We like the output parameters of T1 perfusion, the T2* parameters, relative blood volume (rCBV), relative blood flow (rCBF) and fiber tracking in diffusion. Calculated parameters like Ktrans and Kep give information about histology and processes within tissues that are helpful for diagnosis.”

Flexibility and versatility in many ways

Dr. Guzman and his staff utilize the flexibility of IntelliSpace Portal to work in different locations. “We work in a hospital with different buildings and, obviously, separate work spots. Before, we had to stay close to our workstations to be able to do our analyses, so we were like a slave to our workstation. Now location is not an issue anymore and that’s a big advantage.”

“IntelliSpace Portal saves time, and we obtain more productivity.”

“We usually view cases on the PACS system and one of the most important advantages of IntelliSpace Portal is that we can access it from the same computer. I don’t need to go to another workstation; I can recover cases from PACS and analyze them on the same computer. IntelliSpace complements the PACS system,” says Dr. Guzman.

“With IntelliSpace we have a very powerful and user-friendly tool to analyze different advanced MRI techniques, more than we could do before. It’s compatible with both multi-modality and multi-vendor data. In the many cases where we perform CT in the Emergency Room and later also perform MRI, we can view both the MRI and CT images, and compare or fuse with PET images. We can even use images from different vendors and they work together with IntelliSpace Portal.”

Easy to learn

“IntelliSpace Portal was easy for all of us to learn and it was fast to make the change. We could quickly understand all the steps in postprocessing, supported by help information available within the tool explaining the different choices and the consecutive steps. It also contains, for instance, a quite extensive tutorial on fiber tracking.”

Dr. Guzman also collects and studies data from multiple patients to determine sensitivity and specificity of methods. “This helps us to appreciate the real value of the parameters that we can now determine, for instance with the permeability package.”

“It’s important to know the possibilities and limitations of these techniques. For example, when we analyze a patient after neurosurgery, blood products in the tumor can make it more difficult to analyze the data,” he adds.

Collaboration and reporting improved

Dr. Guzman uses IntelliSpace Portal to collaborate in multidisciplinary sessions between clinicians. “Neurosurgeons can see images such as DTI or functional MRI to help plan surgery. Neurooncologists can ask us questions about treatment response or tumor recurrence. In otolaryngology we may review pathology in detail and help plan surgery.”

IntelliSpace Portal has changed the way of making case reports, as well. “I can choose the best image or view, capture it, and send it to the PACS,” says Dr. Guzman. “It’s easy to exchange information. Before IntelliSpace, a clinician had to come to the radiology department to see certain postprocessed images. Now we just select an image and send it to the clinician.”

Productivity and diagnostic confidence ultimately benefit patients. Dr. Guzman says IntelliSpace Portal has changed the way of working with images at the hospital. “IntelliSpace Portal saves time; it’s easy and fast and our productivity increases. In addition, IntelliSpace contributes to diagnostic confidence because we have more complementary data in addition to basic MRI. We not only have morphological information but also functional information.”

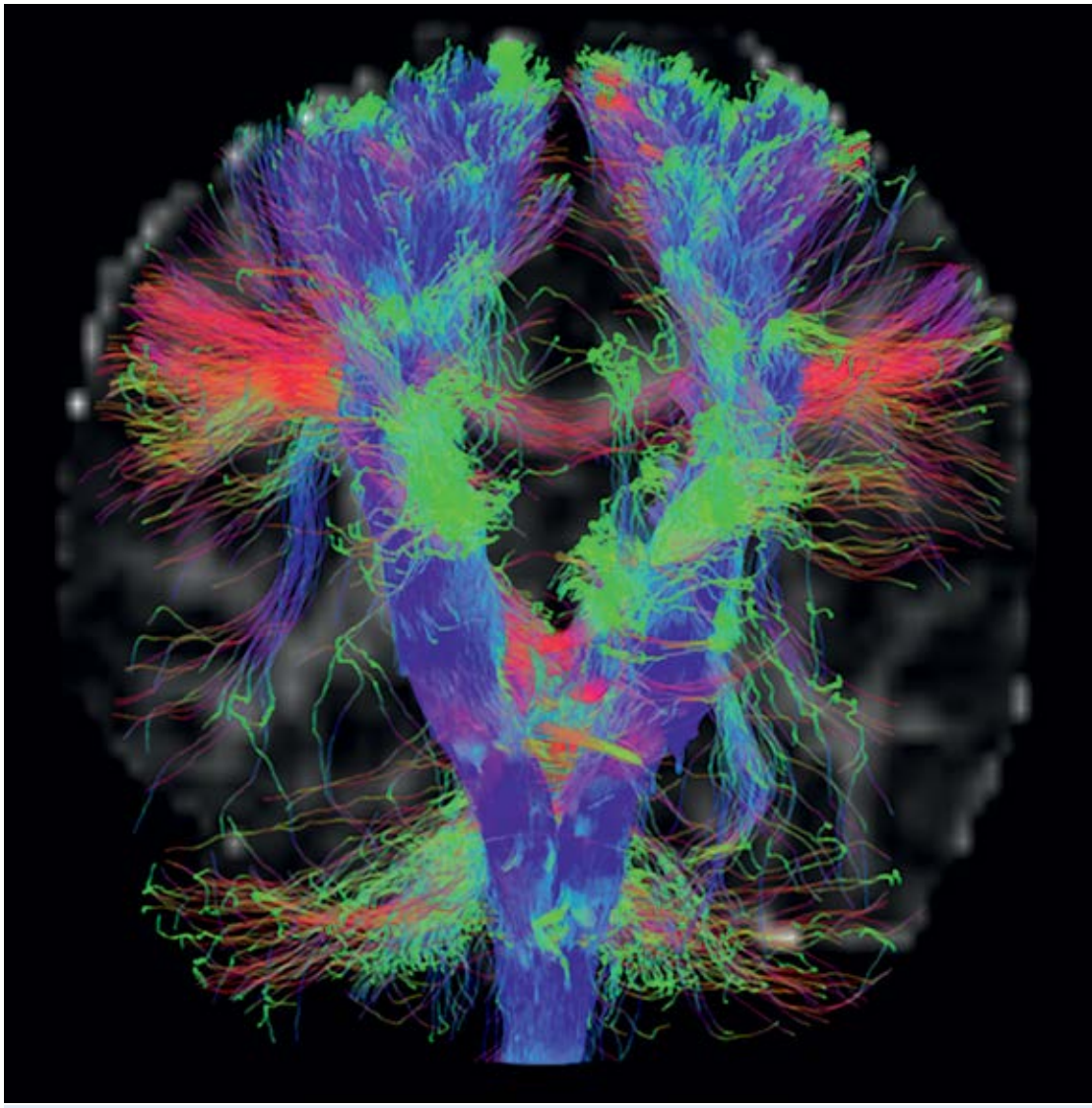
«

“We are faster and more confident with our results, and that is a direct benefit to the patient.”

Diffusion tensor imaging for assessment

Kalev Freeman, MD, PhD, is assistant professor of surgery and pharmacology at University of Vermont College of Medicine, and director of emergency medicine research and an emergency medicine physician at UVM Medical Center Hospital.

Richard Watts is an associate professor in the Department of Radiology at the University of Vermont College of Medicine and co-director of the UVM MRI Center. His interests include applying new data acquisition and analysis techniques such as high b-value diffusion, quantitative susceptibility mapping, and T1rho MRI to clinical studies, including traumatic brain injury and neurodegenerative diseases.



MR diffusion tractography of the corticospinal tract

MR diffusion tractography of the corticospinal tract. Using high b-value diffusion (b=3000 s/mm^2, 64 directions) and analysis using constrained spherical deconvolution (CSD) enables fiber tracking through regions of crossing fibers, such as the superior longitudinal fasciculus, where conventional diffusion tensor tractography fails. The data acquisition time was less than 10 minutes.

Data processed using MRtrix (J-D Tournier, Brain Research Institute, Melbourne, Australia).

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# of mTBI

Researchers at the University of Vermont Medical Center (UVM Medical Center) are using diffusion tensor imaging (DTI) to study mild traumatic brain injury (mTBI). In a longitudinal study of mTBI patients, they concluded that fractional anisotropy changes between images taken less than 72 hours after injury and those taken after an additional week are more sensitive to the effects of mTBI than the values at either individual time point.

What is mild traumatic brain injury

For the purposes of this study, mild traumatic brain injury (mTBI) was defined as: acute head injury, a Glasgow Coma Scale score of 13-15, and two or more concussive symptoms (loss of consciousness, blurred vision, confusion, dizziness, memory problems and poor balance).

ED visits for mTBI are growing

Kalev Freeman, MD, PhD, assistant professor of surgery and pharmacology at University of Vermont College of Medicine (UVM), director of emergency medicine research, and an emergency medicine physician at UVM Medical Center Hospital, says that the number of people visiting emergency departments for mTBI is increasing. He cites a study that found a 30% increase in visits to the emergency department for traumatic brain injury between 2006 and 2010 in the USA[1]. Recent Centers for Disease Control and Prevention data shows that in the United States alone, an estimated 1.7 million people are treated in emergency departments annually for head injury, and 75% of those have mTBI[2].

"In the emergency department, we are very good at identifying patients with potential lethal brain trauma and treating them," Dr. Freeman says. "But the majority of people do not have lethal injuries, and we can't predict who is going to need rehabilitation. That's where we think MRI may be able to help."

Dr. Freeman is part of an interdisciplinary team of researchers at UVM Medical Center who are trying to establish objective biomarkers of mTBI. The group's recent study focused on assessing brain trauma by identifying areas of low fractional anisotropy using diffusion tensor imaging (DTI).

"In the USA, an estimated 1.7 million people are treated in emergency departments annually for head injury, and 75% of those have mTBI."

Their diffusion imaging protocol uses 46 directions at a b-value of 1000, and a scan time of nine minutes. The protocol also includes high-resolution T1-weighted imaging, which is used for morphometry and cortical thickness measurements, as well as FLAIR, non-contrast brain perfusion using pCASL, and functional MRI.

Spatial heterogeneity and inter-subject variability present challenges

Any method for assessing mTBI has to overcome two challenges. The first is spatial heterogeneity; the injuries can be anywhere in the brain, making it difficult to pinpoint where to look for signs of trauma. The second is inter-subject variability - because every brain looks different, it can be difficult to distinguish the difference between signs of trauma and normal variability.

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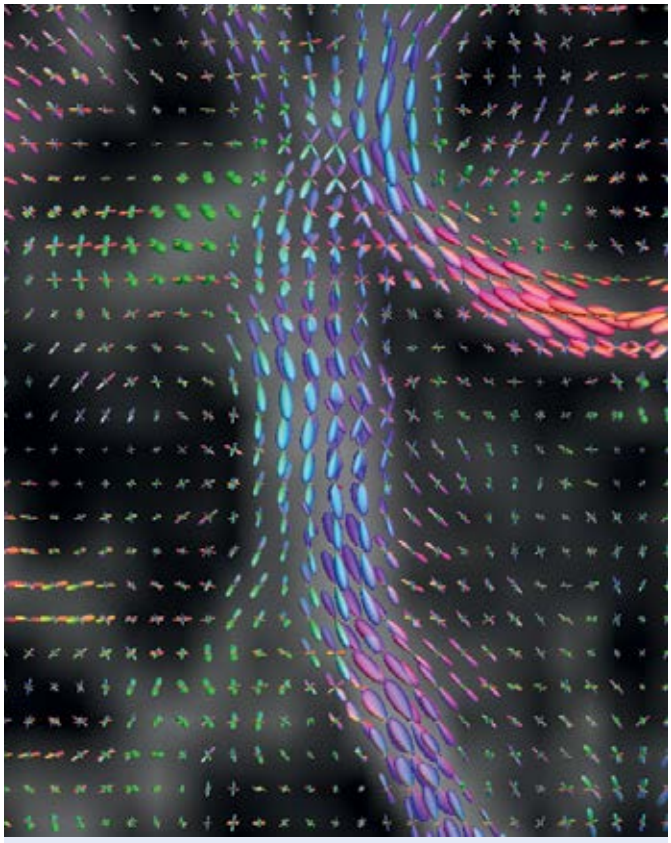


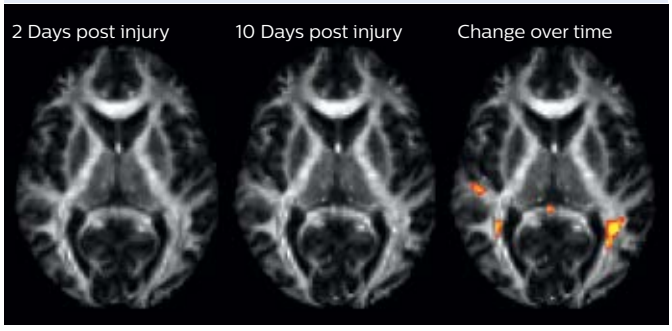
Fiber orientation distribution

The image represents the fiber orientation distribution obtained from high b-value diffusion weighted images (b=3000 s/mm^2, 64 directions). Unlike conventional diffusion tensor imaging, constrained spherical deconvolution (CSD) accurately maps crossing fibers and can generate quantitative measures for each fiber population within a voxel. This may help to clarify some of the apparent discrepancies in the current TBI literature relating to increases and decreases in fractional anisotropy.

Data processed using MRtrix (J-D Tournier, Brain Research Institute, Melbourne, Australia).

Fractional anisotropy maps

Fractional anisotropy (FA) maps from a patient with mild traumatic brain injury imaged 2 days (left) and 10 days (center) post-injury. Compared to a control population, the imaging at either time point was unremarkable. However, the change in FA over this period of time (right image, red-orange areas) may indicate the sites of damage.



Pothole analysis quantifies lesions

Richard Watts, PhD, research associate professor of physics in radiology, co-director of the UVM MRI Center for Biomedical Imaging, and director of radiology research for the Department of Radiology, explains that Z-score analysis, also called pothole analysis, quantifies white matter lesions throughout the brain, making it useful when dealing with a heterogeneous spatial distribution of lesions.

While this method demonstrated a difference between concussed patients and the control group, when the team used leave-one-out cross validation on the data, the difference in the number of potholes between groups was less apparent.

In fact, the team concluded that, "The pothole approach to neuroimaging data may introduce bias. This bias is sufficient to call into question the previously reported diagnostic performance of diffusion tensor imaging for mTBI[3]."

Longitudinal study discriminates between control subjects and concussed patients

The team hypothesized that a longitudinal approach that focused on intra-subject differences might make DTI a more valuable tool for assessing mTBI. They conducted MRI exams on 21 concussed patients within 72 hours of injury, and again a week later. Likewise, a control group consisting of 16 healthy individuals also underwent two exams.

In the longitudinal study, the differences were more apparent. Patients with mTBI displayed larger changes in fractional anisotropy between images taken less than 72 hours after injury and after an additional week, thus discriminating concussed patients from controls better than measurements at either individual time point.

Corpus callosum shows sensitivity

One interesting additional finding is that the corpus callosum may be a vulnerable region for injury. The magnitude of change in fractional anisotropy in that region correlated with post-concussive symptoms, despite variability in how the head trauma occurred.

Achieva system stability increases confidence

The research was performed on an Achieva 3.0T TX MRI system. Dr. Watts says that the exceptional stability of the system was critical to fostering confidence in the study results. "The high stability of our system was such that in our control subjects, we saw very little variability between scan sessions, which suggests that we should be able to detect small variations in our metrics," he says. "Most studies of mTBI are cross-sectional, and we have shown that for such studies the inter-subject variability is much larger than the measurement error. This fundamentally limits the sensitivity of conventional DTI in mTBI." Dr. Watts is currently investigating more sophisticated models of diffusion, which may provide more specific measures of the damage relating to mTBI.

dStream upgrade enhances structural imaging

The Achieva 3.0T TX system at University of Vermont was recently upgraded with dStream. Richard Watts, PhD, says, "When we are looking at particularly thin structures, the higher resolution made possible by dStream is a substantial advantage. We are interested in assessing cortical thickness, which is typically around 3 mm. Previously without dStream, our standard structural scan had a resolution of 1 mm. Our standard scan now is 0.8 mm, and we've shortened the scan time by about 15-20%. The images are better quantitatively, and they look qualitatively better than before the dStream upgrade.

"When we are looking at particularly thin structures, the higher resolution made possible by dStream is a substantial advantage."

"Achieva with dStream is a very good platform for diffusion imaging," he adds. "The combination of dStream hardware, the 32-channel head coil and the strong Quasar Dual gradients is excellent for diffusion imaging."

UVM has defined three areas – or Spires of Excellence – in which it has particular research strength, and one of them is neuroscience, notes Kalev Freeman, MD, PhD. "Part of what makes this an excellent research institution for neuroscience is having a high quality Philips magnet for our research," he says.

"The combination of dStream hardware, the 32-channel head coil and the strong Quasar Dual gradients is excellent for diffusion imaging."

The team has applied for a grant to expand the study to include more subjects, and to investigate multiple methods to help them improve their diagnostic accuracy of imaging for mTBI.

"The ultimate goal is to generate a map that identifies all the weak links in the brain where people are likely to have injuries, and then match those areas with related symptoms," Dr. Freeman says. "We'd like to be able to say, 'If you have an injury in this particular area, you are likely to have memory problems. If your injury is in this area, your issue is likely to be reaction time. If your injury is in this area, you're likely to have anxiety. That would be a real value for physicians."

«

References

1. Marin JR, Weaver MD, Yealy DM, Mannix RC
Trends in visits for traumatic brain injury to emergency departments in the United States.
JAMA. 2014 May 14;311(18):1917-9

2. Faul M, Xu L, Wald MM, Coronado VG.
Traumatic Brain Injury in the United States: Emergency Department Visits, Hospitalizations and Deaths 2002–2006.
Atlanta (GA): Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2010.

3. Watts R, Thomas A, Filippi C, Nickerson J, Freeman K.
Potholes and molehills: bias in the diagnostic performance of diffusion-tensor imaging in concussion.
Radiology. Epub 2014 Mar 14.

MRI innovations that matter to you, a rich Philips history

35 years of innovation in Magnetic resonance

After the foundation of Philips in 1891, the brothers Gerard and Anton Philips expanded the company and in a few years Philips belonged to the largest producers of light bulbs in the world.

Stimulated by the Industrial Revolution in Europe, Philips' first research laboratory was established in 1914 – that's 100 years ago – and the company started introducing its first innovations in x-ray and radio technology. Over the years, the list of inventions has only been growing, and now includes countless breakthroughs that have continued to enrich people's everyday lives.

First Philips MRI system in 1980

Our first MRI system, called Proton, was introduced in 1980. Since then, we've been privileged to work with clinical partners from all over the globe who share our vision of a healthier world. The year 2014 marks 35 years of Philips innovations in MRI.

Pioneering MRI advances were realized over the years in collaboration with our partners. Examples are listed in the wheel of innovation below and there have been many more fruitful innovative projects. To mention an example, ISMRM members recently selected the 2003 paper Transmit SENSE[1] by Philips employees Ulrich Katscher, Peter Börnert, Christoph Leussler and Johan S. van den Brink, as one of the 30 most influential papers that shaped MRI.

Together, we have made many groundbreaking advances that are well recognized. We owe our thanks to you for making every one of them possible. We look forward to many more years of exciting collaboration.

Reference

1. U Katscher, P Börnert, C Leussler, JS van den Brink
Transmit SENSE
Magnetic Resonance in Medicine 49:144–150 (2003)

The Philips cardiac MR expert panel

The ExamCards were developed in collaboration with:

- Cleveland Clinic (USA)
- King's College London (UK)
- MedStar Washington Hospital Center (USA)
- German Heart Center Berlin (Germany)
- ETH Zürich (Switzerland)
- Leiden University Medical Center (Netherlands)
- University Medical Center Utrecht (Netherlands)
- University of Leeds (UK)

Expert users collaborate to develop cardiac MR protocol

The 30-minute Function and Fibrosis ExamCard represents the best practices of eight leading institutes in cardiac MR

Comprehensive cardiac examination in 30 minutes

A close collaboration between eight prominent cardiac imaging centers worldwide has resulted in an ExamCard for 30-minute MR examination of cardiac function and fibrosis, vouched for by a group of key cardiac MR users. The ExamCard was developed in 1.5T and 3.0T versions for Ingenia and Achieva dStream systems.

Cross-fertilization in CMR expert panel

This project started in 2011 during the 12th Philips Cardiac MR Network Meeting in Brussels. Attendees recognized that speed and standardization are critical for the acceptance and growth of clinical cardiac MR. The assembly voted that the development of a fast Function and Fibrosis ExamCard, based on the best experiences of expert panel members, would be the best strategy to drive the increase of Cardiac MR use.

A cardiac MR expert panel was formed. Then, collaboration and cross-fertilization via meetings, emails, phone conversations, ExamCard exchange, patient studies and site visits led to the development of ExamCards for both 1.5T and 3.0T. These two ExamCards, combining experiences and best practices of eight leading institutes in the field of cardiac MR, can support other users of cardiac MR and may help new users to take the CMR threshold.

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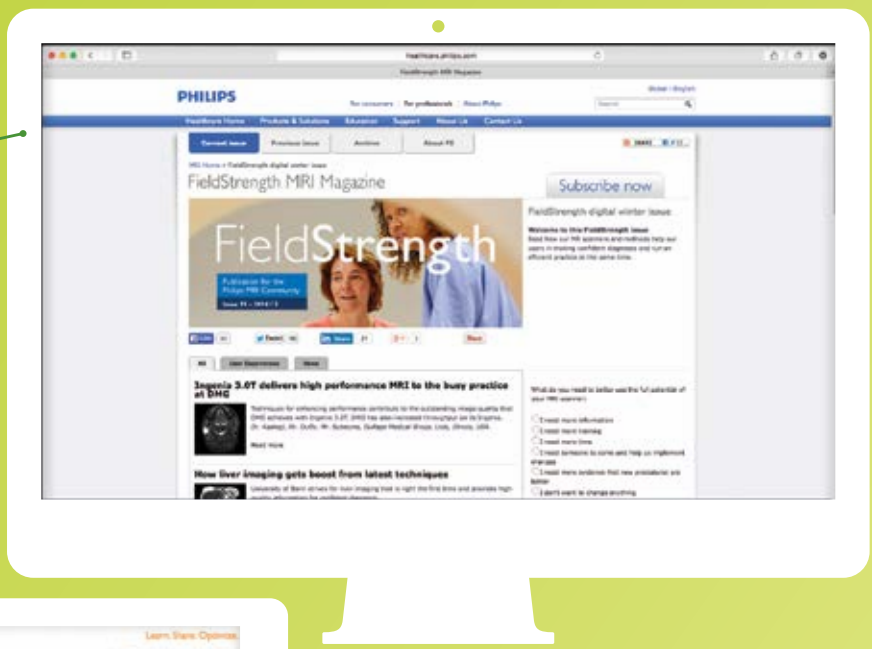

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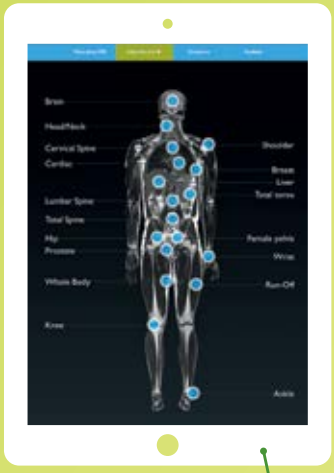

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Education calendar 2015

Course	Date	Location	More information
General MR			
Essential Guide to Philips in MRI Designed for Philips users. Includes 2 days on basics of MR physics and 2 days on advanced concepts. The course can be attended for 2-4 days.	May 11-14; June 15-18; October 5-8; Nov. 30 - Dec. 3	Cheltenham, UK	www.cobalthealth.co.uk/education
Breast MR			
Breast MR with guided biopsy This 100-case course is designed to provide practicing radiologists with an intensive, hands-on experience in reading breast MRI.	April 20-21; September 10-11; November 16-17	Reston, VA, USA	www.acr.org
Breast MRI course: Case Based Review	June 11-13	Enschede, Netherlands	BreastMRIcourse.info
Musculoskeletal MR			
Current issues of MRI in orthopaedics and sports medicine	October 22-24	Las Vegas, NV, USA	www.stollerscourse.com
Cardiac MR			
CMR Academy Complete course Level 2 fellowship including hands-on training at the German Heart Institute, and reading and partially quantifying over 250 cases.	Oct. 16 – Dec. 4 + home study Dec 5 – Jan 15	German Heart Institute, Berlin, Germany	www.cmr-academy.com
CMR Academy Compact course CMR diagnostics in theory and practice, including performing examinations and case interpretation	June 15-19; October 26-30	German Heart Institute, Berlin, Germany	www.cmr-academy.com
CMR Academy technologist course	July 4-6	German Heart Institute, Berlin, Germany	See News on www.cmr-academy.com

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Events
calendar 2015

Date	Event	Location	More information
March 14-16	**American College of Cardiology – ACC**	San Diego, CA, USA	www.cardiosource.org
March 18-20	**American Society of Functional Neuroradiology – ASFNR**	Tucson, AZ, USA	www.asfnr.org
March 26-28	**International Medical Instruments and Equipment Exhibition – China Med**	Shanghai, China	www.chinaexhibition.com
Apr 25-30	**American Society of Neuroradiology – ASNR**	Chicago, IL, USA	www.asnr.org
Apr 28 - May 1	**Charing Cross Symposium – CX**	London, UK	www.cxsymposium.com
May 2-6	**American Association of Neurological Surgeons – AANS**	Washington, DC, USA	www.aans.org
May 13-16	**Deutschen Röntgenkongress – Röko**	Hamburg, Germany	www.roentgenkongress.de
May 30 - June 5	**International Society for Magnetic Resonance in Medicine**	Toronto, Canada	www.ismrm.org/15/
June 2-6	**European Society of Pediatric Radiology – ESPR**	Graz, Austria	www.espr.org
June 9-12	**European Society of GastroIntestinal and Abdominal Radiology – ESGAR**	Paris, France	www.esgar.org
June 29 - July 1	**UK Radiological Congress – UKRC**	Liverpool, UK	www.ukrc.org.uk
Nov 29 - Dec 4	**Radiological Society of North America – RSNA**	Chicago, IL, USA	www.rsna.org

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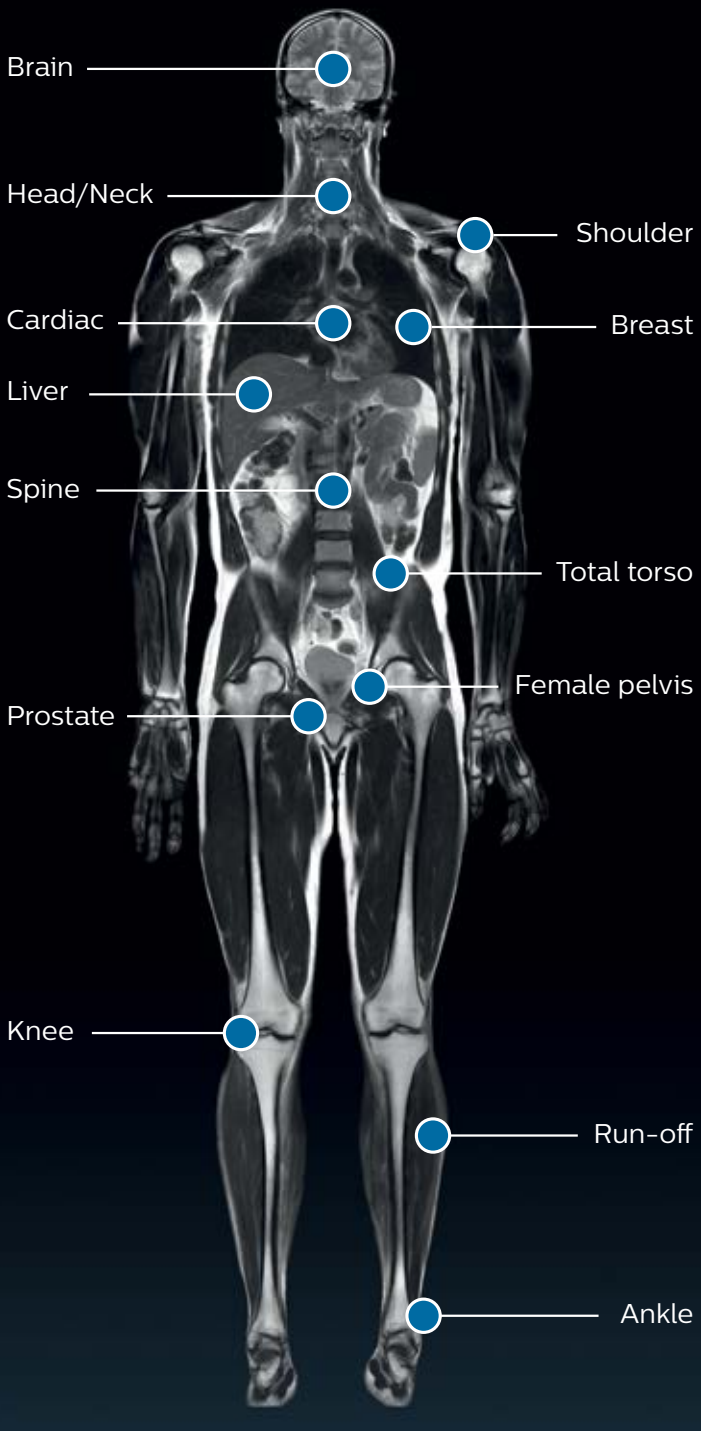

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