Clinical excellence

High performance 3.0T spine imaging with Ingenia at AZ Sint-Jan

University of Michigan uses MR Enterography in IBD patients

Qscan optimizes Ingenia 3.0T protocols for MSK imaging

Productivity and efficiency

Five common MRI exams at less than 8 minutes in UMC Utrecht
Dear Friends,

At Philips, we recognize your need to accommodate a larger number and variety of patients each day, while at the same time dealing with the increased diversification of MRI procedures. Our exhibition at ISMRM displayed solutions designed to accelerate patient management, enhance patient imaging and simplify case reporting – so that you can increase the efficiency and quality of care to your patients.

In this issue you can read how UMC Utrecht has reduced acquisition times for five main MRI exams to less than 8 minutes. The article on Elkerliek Hospital in Helmond shows which other measures can help to actually increase patient throughput.

Henry Ford Health System sees advantages for patients as well as benefits for the hospital by using intraoperative MR during neurosurgery virtually every day.

Ingenia with dStream delivers imaging strategies once thought unattainable to the routine, but now made possible through close collaboration with our clinical partners. This issue of FieldStrength provides great examples from the clinical practice of our users. At AZ St.-Jan in Bruges, Belgium, spine imaging is moved to Ingenia 3.0T. Qscan Radiology, Australia, achieves excellent musculoskeletal imaging with Ingenia 3.0T. University of Michigan uses MR enterography to evaluate bowel wall and surrounding tissues in IBD patients.

Don’t miss the articles on early users testing some of our recent clinical innovations, such as mDIXON TSE used by AZ St.-Jan Bruges and on pCASL high performance brain perfusion imaging without contrast agent, used by CHC Saint Joseph Hospital, Liege.

This is how we transform care, together. I hope you enjoy reading this issue of FieldStrength.

Paul Folkers, PhD
Head of MRI Marketing, Philips Healthcare
Clinical excellence
High performance MRI in spine, musculoskeletal, brain, bowel and liver imaging

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Qscan optimizes Ingenia 3.0T protocols for MSK imaging

Ingenia 3.0T delivers robustness and high image quality

Qscan Radiology Clinics, headquartered in Brisbane, Australia, operates 14 imaging centers with five MRI systems, including two 3.0T systems. Its latest acquisition, an Ingenia 3.0T, was purchased in early 2012 for a clinic in Southport. Because Qscan is competing with five other imaging centers in a one-block radius, it chose to differentiate its offering with a wide bore 3.0T system.

“The thing that strikes me – over and over again – is just how robust the Ingenia 3.0T system is.”
**MultiTransmit is deciding factor**

Ben Kennedy, chief MR technologist at Qscan, says that predictability and robustness were primary reasons for choosing Ingenia 3.0T. “We wanted a system that could give us exactly what we expected each time, with no surprises,” he says. “And now that we are using Ingenia 3.0T, the thing that strikes me – over and over again – is just how robust the system is.”

Because Kennedy highly values reproducibility and consistency, Philips MultiTransmit 4D technology was particularly attractive. MultiTransmit uses multiple RF sources to reduce dielectric shading effects, resulting in better image uniformity and reproducibility in follow-up exams and between patients.

“When we host site visits, we scan with adaptive shimming using MultiTransmit on and off to demonstrate how great the difference in image quality actually is,” Kennedy says. “MultiTransmit also makes scanning more time efficient.”

**dStream benefits and throughput**

The center scans up to 20 patients each day, and about 50% of the caseload is musculoskeletal imaging. Kennedy says that the high SNR provided by dStream makes it possible for him to achieve the image quality he wants without sacrificing throughput. “Even in musculoskeletal imaging, dStream brings an increase in signal. I see a genuine leap in image quality using dStream, with exactly the same coils. In all joints, I now run smaller voxel sizes than I used to, and we do it in reasonable time. Most of our sequences are around 3, sometimes 4 minutes,” he says.

“Qscan’s Ingenia 3.0T system is not government-funded, and the price of an MR exam is under pressure, making it important to leverage dStream for speed, as well as image quality,” Kennedy notes. “We scan the most important views with the highest detail using thinner slices, and then run the others with our routine number of slices and shorter times.”

The center’s efficient patient management also aids throughput, as does having dedicated MSK radiologists. Kennedy explains, “When radiologists clearly know what they want, they don’t waste scanning time with sequences they don’t need, so we can spend more time keeping the quality high on the sequences that they do need.”

Another factor that aids workflow is patient comfort. “The way Philips integrated Ingenia’s dStream coil system is the best move they could have made,” he says. “The homogeneity and linearity of the system allow me to put patients in positions where they are comfortable, and we can still get a quality scan. For example, for wrist and elbow scanning, the patients lie with their hands at their sides. There are not many scanners where you can actually do that consistently, and get full field of view fat saturation.”

**Coils bring flexibility, long field-of-views**

Kennedy is pleased with the flexibility of Ingenia’s MSK coils. “The 16-channel dS Knee coil provides an extra-long field of view without signal drop-off, that can also be used to image other structures, such as imaging down the calf or into the Achilles tendon. Similarly, the 8-channel dS Small Extremity coil also provides a longer field of view, and works well for elbows, whole hands and biceps.”

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**Degenerative changes in cervical spine**

Images of a 41-year-old male show degenerative changes at C5/6 and C6/7 with loss of disc space height and osteophytic ridging impressing on the anterior thecal sac. In addition, central spinal canal stenosis results in flattening of the spinal cord without cord edema or myelomalacia. Degenerative osteophytic narrowing of the right C5/6 and left C6/7 neural foramen can be seen at the sites of C5 and C6 nerve roots respectively. dStream’s high SNR allows exceptional resolution in images of the C-spine, e.g. ax 3D TSE DRIVE 0.45 x 0.5 x 1.5 mm at 8 cm FOV. Sensitized flow compensation is used in standard T1 spine imaging, and an optimized refocusing angle allows high contrast between spinal cord and dark CSF. This had been a challenge in early 3T spinal imaging, leading to the requirement of using T1 FLAIR for these images.

“The posterior spine coil is phenomenal. The T1 contrast is so good that we don’t need to use T1 FLAIR.”
User experiences

**Olecranon bursitis**

A 35-year-old presented with swelling and pain in the elbow. MR imaging revealed a 33x16 mm olecranon bursitis. The imaging was performed with the patient in a supine position with arms by the sides, using the 8-channel dS Small Extremity coil. This patient position, which offers greater comfort, is possible because of the high quality fat saturation throughout the region, even during off-center imaging, due to outstanding homogeneity and linearity of the Ingenia 3.0T.

“Even in musculoskeletal imaging, dStream brings an increase in signal. I see a genuine leap in image quality using dStream, with exactly the same coils.”

**Shoulder injury**

Images of a 57-year-old male with a recent anterior shoulder dislocation. Sagittal images reveal an acute Hill-Sachs impaction fracture. Axial images show a near circumferential labral tear with a bony Bankart fracture, and a full thickness tear of the anterior supraspinatus tendon.
“The integrated posterior spine coil is phenomenal,” he adds. “The T1 contrast is so good that we don’t need to use T1 FLAIR, which may otherwise be a popular choice at 3T. The sensitized flow compensation is excellent for CSF suppression. Also, the ability to accurately optimize the refocusing pulse is very useful. The field of view that we are using for axial C-spine is about 8 cm, with 0.5 mm in-plane resolution. We use a 2D TSE and a 3D TSE DRIVE sequence, which we find to be exceptionally high quality.”

Achieving consistency across systems
In addition to performing patient exams, Kennedy is responsible for developing protocols for all five MR systems at Qscan. “My goal is to obtain reproducibility not just on a single system, but also across field strengths and manufacturers. Anyone who has an exam on any of our systems at any site should expect the same imaging result for the same body part: the same sequences, the same quality, the same orientation. So if I change the parameters on one system, we change it across the fleet. That can be tricky, because it depends on the capabilities of the systems.”

Kennedy notes that this task is made easier because he has worked on systems from three major manufacturers, and understands what the differences are. “I keep a constant eye on how we can improve protocols. For general use, I don’t expect the other radiographers to tinker with sequences. The user interface on the Philips system, in particular, is conveniently designed to be able to drag and drop an ExamCard and run it.”

Parameter options appreciated
Kennedy calls himself an “MR enthusiast,” and as such, he particularly appreciates the many parameters that he can fine tune on the Philips Ingenia 3.0T. “These all have a balance in each sequence type to maximize the image quality and accuracy of the data, and to allow your voxel size to demonstrate its true potential.”

“When I like having control over many aspects of the system, I have confidence in SmartSelect, which automatically determines which coil elements to activate to produce the highest SNR for the selected area,” he says. “SmartSelect has never let me down in regards to choosing elements.”

High resolution and fine detail
Kennedy strives to take full advantage of what 3.0T offers for MSK imaging. “3.0T offers the possibility of higher resolution and finer detail. When imaging fine structures like fingers, toes, hands and shoulders, you are looking at very subtle areas where there is a lot of debate. You need higher detail, finer cuts, and fewer gaps to give the radiologists a lot more confidence in what they are looking at.”

“I see it like this,” he concludes. “I have been handed the keys to a Formula One racecar, rather than a stock car. Why not drive it the way it should be driven?”

More cases and ExamCards are in preparation for the Philips online NetForum community. Sign up for NetForum email updates to receive a message when these appear.
MR enterography stands out in evaluation of the bowel wall and extra-enteric findings in IBD patients

The University of Michigan uses MRI to evaluate the bowel wall and surrounding tissues in Crohn’s disease

The University of Michigan Health System (Ann Arbor, Michigan, USA) is a large tertiary health care center. Philips MR systems Ingenia 3.0T, and two Achieva 1.5T are installed at the hospital’s adult center; and Ingenia 3.0T, Ingenia 1.5T and a Panorama HFO at the pediatric hospital. There are a high number of referrals of patients with IBD to the University Inflammatory Bowel Disease program, with a high percentage of these patients undergoing cross-sectional imaging at the Health System.
"We have excellent visualization of pathology in the bowel wall and surrounding mesentery on MRE examinations."

Most MR enterography (MRE) exams at UHMS, about 60-70 per month on the adult and pediatric side, are done to evaluate patients with known inflammatory bowel diseases (IBD), mainly Crohn’s disease. A small percentage of cases are scanned for other indications such as evaluation of suspected bowel masses and other non-specific gastrointestinal symptoms to exclude IBD or other GI related diseases.

Radiologist Mahmoud Al-Hawary, MD, says, “Crohn’s disease is the main indication for MRE. There are three forms of Crohn’s disease. These include inflammatory, strictureing (stenosing) and penetrating disease. Our main goal when managing patients with Crohn’s disease is to try to differentiate patients with active inflammatory disease from those with stenosing disease (with rigid fibrotic bowel). Patients with active inflammation of the bowel wall will benefit from medical therapy, whereas patients with stenosing disease and fibrotic bowel wall require surgical resection of the diseased segment.”

“Other Crohn’s disease complications, including penetrating disease with abscesses and fistulae, definitely require medical and/or surgical treatment and such complications can be well seen on MRE as well. Often the bowel inflammation, fibrosis or associated penetrating complications are not readily apparent with physical exams and lab tests. However, imaging tests such as MRE can readily provide this information to help the referring clinician in determining the appropriate treatment. It is for these reasons that we use MRE so frequently.”
Advantages of MR enterography over other methods

“Characteristically, Crohn’s disease involvement is transmural; the disease process extends across the bowel wall and can involve the tissues surrounding the bowel,” explains Dr. Al-Hawary. “While optical endoscopy, one of the most commonly used clinical tools for assessing IBD, only visualizes the inside of the bowel, MR and CT imaging can help evaluate the entire thickness of the bowel wall and the surrounding tissue. Thus, optical endoscopy and cross-sectional imaging with CT or MR examinations are complementary and often used in combination to manage IBD patients.”

“Because of the lack of ionizing radiation in MR, we have been moving more towards MR enterography as our primary imaging modality for patients with Crohn’s disease, in particular in younger patients and patients who require frequent follow-up examinations, to reduce the cumulative radiation dose acquired from multiple CT examinations. MR enterography is a dedicated examination of the bowel and is used to evaluate for inflammation, strictures, abscesses or fistulae. It is also used to evaluate the effect of treatment and to monitor development of new disease sites or complications.”

“MR offers several advantages over CT. In addition to the lack of radiation, there are other driving forces toward MR enterography,” says Dr. Al-Hawary. “The multiple biophysical contrast types obtainable with MR enable multiple prospects of the same pathology that help reveal the different disease characteristics, such as edema, inflammation and fibrosis, as opposed to CT.”

“All these advantages of MRE outweigh the minor disadvantages of a slightly longer examination, possible higher cost and limited availability of MR compared to CT.”

Bowel imaging requires large coverage

“Challenges in MRE include bowel motion from peristalsis, inadequate bowel distension, and the large coverage area needed across the abdomen and pelvis,” says Dr. Al-Hawary. “For bowel motion, we use anti-peristaltic agents which can be given at the beginning and/or during the exam to slow down bowel peristalsis and decrease resultant motion artifacts. Bowel distension is improved by administering a non-absorbable oral contrast agent that the patient starts drinking an hour prior to the examination. MRE examinations are performed with the patient in the supine position. We perform most of our adult MRE exams on the Achieva 1.5T scanner with the SENSE Torso XL coil, which covers the small and large bowel area in most patients. Pediatric patients are scanned on an Achieva or on Ingenia systems using the Posterior coil integrated in the table, and an Anterior coil, and because of their small size, we do not have issues with coverage. The MRE exam typically takes about 45 minutes. The image quality on the Ingenia is spectacular, especially the T1-weighted gradient echo fat suppressed images, which have high spatial and contrast resolution.”

Imaging focuses on bowel wall and mesentery

“When we scan the entire abdomen and pelvis, we usually acquire several dynamic series in the coronal and axial planes, and we aim for limiting the breath hold for these sequences not to exceed a tolerable 20 or 25 seconds,” says Dr. Al-Hawary. “The imaging sequences include breath hold single shot T2-weighted sequence, which is used to assess the degree of bowel dilatation, thickness of the bowel wall, and the presence of wall edema, as well as adjacent inflammation fistulae or inflammatory processes. Breath hold Balanced TFE images provide an excellent view of the surrounding mesenteric changes. Breath hold T1-weighted gradient echo sequences with fat saturation obtained in the coronal plane allow evaluation of the entire bowel for active inflammation. 3D gradient echo sequences in the axial and coronal planes are obtained to look for bowel distension and extra-enteric findings such as fluid collections or other complications of the disease.”

“Although it’s not yet a widely established practice, we routinely use diffusion weighted imaging (DWI) through the abdomen and pelvis, which takes about 3-4 minutes to acquire. DWI can help improve the radiologist’s confidence in identifying diseased bowel segments by showing high signal and impeded diffusion in the affected bowel segments.”
MRE is nice tool for providing important information

“MR enterography is a diagnostic tool that does not involve the use of radiation and provides the clinicians with a great deal of important information. The Ingenia 3.0T scanner provides spectacular images and I would prefer to use it more,” says Dr. Al-Hawary. “It provides excellent visualization of bowel pathology in question, especially the degree of bowel wall thickening, edema and other abnormalities in the bowel wall, as well as inflammatory changes in the surrounding mesentery. It offers quick scanning, high signal- and contrast-to-noise ratio, and high spatial resolution images.”

Clinical research on MRE

“The main reason for doing most of our adult MRE exams on the Achieva 1.5T scanner is a special sequence called magnetization transfer, which is currently predominantly used for research purposes. This sequence is currently only available on our Achieva scanner. This sequence has been shown in an animal study to predict bowel fibrosis and we currently are working on translating the use of this sequence to humans. Several professional radiology organizations are currently working on establishing standardized guidelines for the acquisition and interpretation of MRE examinations. These guidelines will hopefully be published in the near future.”

References


User experiences

Jan Casselman, MD, PhD, is a radiologist and Chairman of the Department of Radiology at AZ St.-Jan Brugge-Oostende AV. His special interests include MR Head and Neck radiology and MR neuroradiology.

High performance 3.0T spine imaging with Ingenia

AZ St.-Jan moves all cervical, thoracic, lumbar and total spine MRI to Ingenia 3.0T because of consistent high quality

AZ St.-Jan Brugge-Oostende AV (Belgium) is now doing all its spine work at 3.0T. With Ingenia’s dStream architecture for digitized high performance, efficient workflow and excellent image quality, 3.0T spine imaging is no longer a challenge.
High resolution and excellent fat suppression
Jan W. Casselman, MD, PhD, says, “Spine work used to be one of the weakest points of 3.0T in the past, but currently all our spine MRI is done on Ingenia 3.0T and we get excellent examinations. We get very good fat suppression from the cervical spine down to the lumbar spine. Also total spine imaging is outstanding; we get very homogeneous images with few artifacts over these large fields of view. We also obtain good results in patients who have metal implants from previous surgery.”

“We use the high signal-to-noise ratio (SNR) provided by the 3.0T field strength and dStream for improving image quality and resolution in order to see more detail than was possible on 1.5T in a similar examination time. Therefore, since we have Ingenia 3.0T, we confidently moved all our spine MRI exams from 1.5T to Ingenia 3.0T.”

“We can also easily perform good quality diffusion weighted imaging (DWI) in the spine. We add that when we see suspicious lesions in the spine, in case of medullar compression or for patients with potential medullar infarctions. In the latter, axial DWI is used with good results although it is known that this is difficult in the neck and thoracic area due to motion of the nearby structures.”

“Spinal vascular malformation
A nidus is seen in the cauda equina at level L3 and feeding and draining vessels can be seen along the surface of the conus up to level Th11. The nidus has a lower signal intensity than the CSF on the T2W image and is hyperintense on the T1W image. The Ingenia 3.0T system and its high SNR allow high spatial and contrast resolution imaging (thin slices) in a short time.

“We can acquire very beautiful MR angiography of the spine. We use the power of Ingenia 3.0T to make thinner slices or more slices in the same time, giving us better resolution.”
Disclaimer: Metal implants are a contraindication for MRI, unless the MR compatibility for the implant is stated by the implant manufacturer. MR healthcare professionals are advised to contact the respective implant manufacturer in order to obtain the latest safety information to ensure patient safety relative to the use of an MR procedure.

Hernia patient with tiltable dS HeadNeckSpine coil

The patient was unable to extend the cervical spine. Therefore the posterior part of the dS HeadNeckSpine coil was tilted, resulting in excellent signal intensity at C1-C2 level on the sagittal T2W image even though these structures are several centimeters away from the tabletop. A hernia is seen at level C5-C6 and the high signal intensity of the hernia, the narrowing of the entrance of the left neuroforamen and the medullar compression on the left side with distortion of the grey matter inside the medulla can be appreciated on this transverse mFFE image.

Post-surgery MR with metal fixation of L3-L4

Metal screws can be seen in the pedicles of L3 and L4 and a metal cage is visible in the intervertebral space L3-L4 on the sagittal T2W image. Note that the roots inside the neuroforamina L3-L4 and L4-L5 are still visible despite the presence of metal screws. The screws and cage are also visible on the transverse T2W image and do not disturb the visualization of the dural sac. Although artifacts produced by the fixation material may be expected to be higher on 3.0T than on 1.5T, the metal artifacts are limited in this Ingenia 3.0T case.
“We use the high SNR provided by the 3.0T field strength and dStream for improving image quality and resolution in order to see more detail.”

Dr. Casselman is also performing spine angiography now, which was problematic on other systems. “We were never satisfied with the results,” he says. “But now with Ingenia 3.0T we can acquire very beautiful MR angiography of the spine. We use the power of 3.0T to make thinner slices or more slices in the same time, giving us better resolution. And together with fewer artifacts, that opens the door to excellent MR angiography.”

dStream coils streamline workflow

“In terms of workflow, Ingenia’s integrated Posterior coil provides a huge improvement,” says Dr. Casselman. “This coil is integrated in the table, so it’s always there for spine and abdomen. The techs love it, as they don’t have to change coils all the time, and the system automatically uses the right part of the coil. It makes life so much easier for them. We can now do all of our spine scans in high resolution using this integrated Posterior coil. We do not add the Anterior coils as the little extra signal does not outweigh the extra effort to put on these extra coils. For cervical spine, we just add the dS HeadNeckSpine coil.”

“The tiltable dS HeadNeckSpine coil is very helpful, especially for patients with thoracic kyphosis who cannot lie down flat. In elderly patients we see that regularly. This coil enables such patients to comfortably stay close to the coil. If routine non-tiltable coils are used, the coil stays down and when the neck goes up, farther away from the coil, this will cause a drop in SNR, resulting in longer sequences and exam times in order to recover some of the lost signal.”

High performance spine imaging becomes simple

SmartSelect automatically chooses which elements to use for highest signal intensity, which enhances workflow and benefits quality. “In the past, if the techs didn’t specify the proper coil elements, images became dark at the edge, or at the interface between the thoracic and lumbar spine segments due to too low signal,” says Dr. Casselman. “Now it’s automatic, which speeds up the examination, and that means our patients aren’t on the table for as long.”

“For us, Ingenia 3.0T is crucial,” concludes Dr. Casselman. “Our spine work can be done in the same way, but better or faster than we did at 1.5T. As in many institutions, spine constitutes 30% to 40% of the workload, and we could not afford to move that to a 3.0T system if the spine is not consistently good. And that is where Ingenia has really made a difference.”

“Tuberculous spondylitis

Two-stage spinal T2W and T1W image with fat suppression in a patient with tuberculous spondylitis and involvement and collapse of vertebra Th11 and Th12. Note the homogeneous signal intensity throughout the images without any signal drop at the upper or lower end of the images and at the interface between the upper and lower image. Also notice that this could be achieved without the use of anterior saturation slabs and that the fat saturation remains perfect throughout the image. Enhancing subcutaneous soft tissues are seen at the level of the spondylitis.

“We get very homogeneous spine images with few artifacts.”
mDIXON TSE provides imaging with and without fat suppression in a single sequence

Excellent images, robust fat suppression in a time-efficient way

mDIXON provides imaging with and without fat suppression in a single sequence. It provides excellent images with robust fat suppression in a time-efficient way.

mDIXON provides four image types in just one scan: water, fat, in-phase and opposed-phase images. In body imaging, the 2-point mDIXON technique based on FFE provides great image quality and speed. In a more challenging area like the head and neck, the use of TSE sequences is usually preferred, which is why AZ St.-Jan looked at using mDIXON TSE in that area.

“We always want a T2-weighted sequence and a T1-weighted sequence, but we need to decide whether to do them with or without fat suppression. With the mDIXON sequence, we get both in the same sequence, in the same time, and we get in-phase and opposed-phase images as well,” Dr. Casselman explains.

“mDIXON TSE imaging is excellent for visualizing pathology,” says Dr. Casselman. “For instance, for lesions in the orbit behind the globe it can be difficult to detect the lesions on T2 and T1 without fatsat. But with fat suppression, we can easily visualize the lesion and/or the edema – everything becomes clear.”

“Similarly, we want imaging with and without fat suppression in the skull base; fat suppression will make the bone marrow disappear, which helps to see lesions in the bone very well, while the normal anatomy, the foramina and cranial nerves are better seen on the images without fat suppression. And mDIXON TSE provides both automatically, without having to make up our mind before the scan, with the risk of making a wrong decision and choosing only sequences without or with fat suppression.”

Dr. Casselman says, “mDIXON is fantastic in the areas above the mandible – the oral cavity, the face, the nasopharynx, the skull base, the orbit, the parotid gland. It provides robust fat suppression and saves us time. It’s most useful in areas where a lot of fat is present. That does also include arms, legs and breast.”

“In general, if we acquire T1W, T2W and post-contrast T1W images with mDIXON TSE, we have all we need for our diagnosis with excellent image quality, which is why we changed from using standard sequences to mDIXON TSE in our head and neck imaging. When previously doing only single contrast sequences we sometimes missed some information, or needed more sequences – and more time,” concludes Dr. Casselman.
**Ingenia 1.5T enters at #1 in latest KLAS MR report**

**Phillips Ingenia 1.5T:**
- **Rank:** 1
- **Score:** 92.2%
- **Evangelism:** 80%

**Ingenia 1.5T tops in all Special Report Categories**
- Along with achieving top spot for the KLAS top score and the KLAS evangelism, the Ingenia also received highest ratings in all measured categories of Body Imaging*, Breast Imaging, Non-Contrast Imaging, Fat Saturation, OEM Coils (Quality and Availability), Scanning Speed, Workflow/Patient Throughput (outside of scan time)*, Delivery of New Technology, Money’s Worth* and Average Hours Lost per Service Incident.

* indicates where Ingenia tied with one other vendor for top place

**For more information, see:**
MR 2012: Broadening your Field of View
November 2012
www.KLASresearch.com
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**Some quotes from the report**

“Philips setting the bar high with Ingenia. Though late to the wide-bore party with the Ingenia, Philips did it right. …”

“… Digital coils offer a better upgrade path and better images with less noise. …”

In the section “Which vendors have the best service?” the report states:

“Philips’ efforts with their new Ingenia 1.5T have absolutely made a difference for their customers. …”

“… Their renewed dedication to support with their new scanner has their Ingenia customers singing their praise.”

“When asked if they would buy it again, 100% of participants with Ingenia 1.5T responded that they would.”

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Philips Ingenia 1.5T was ranked as number 1 in the latest KLAS performance report MRI 2012 released in November. Ingenia 1.5T was also highest in both Score and Evangelism. Particularly in Evangelism, the distance from the number 2 was quite significant (66% versus 80% for Philips Ingenia 1.5T). Evangelism indicates how likely users are to recommend the scanner to others. The score is based on surveying organizations using MR scanners.

Ingenia 3.0T did not have enough customer interviews to meet minimum KLAS Confidence levels. However, from interviews that did take place it was given a Score of 90.2.
Lieve hospital studying pCASL for brain perfusion without contrast

pCASL is an arterial spin labeling technique showing high SNR and good sensitivity to whole brain perfusion.

CHC Saint Joseph Hospital (Lieve, Belgium) is using Pseudo-Continuous Arterial Spin Labeling (pCASL) for high performance brain perfusion imaging without contrast. The pCASL technique combines advantages from continuous ASL and pulsed ASL, such as high SNR and high labeling efficiency. Benedicte Martin, MD, and Pierre Reginster, MD, demonstrate the strengths of pCASL.

Pierre Reginster, MD

“pCASL performs as a high SNR method for ASL, with good sensitivity to perfusion. We compared imaging of contrast-enhancing brain tumors with pCASL and DSC (Dynamic Susceptibility Contrast imaging). In 38 exams of 28 patients we found a significant correlation between measured pCASL and DSC signal ratios and between visual scores of enhancement, and significantly lower artifact scores with pCASL than with DSC.”

“pCASL may be a good alternative to DSC and presents two advantages: the absence of injection of a contrast agent, which allows us to increase the frequency of controls in patients with renal failure; and the reduction of artifacts, contributing to good quality exams of some tumors near the skull base.”

Bénédicte Martin, MD

“Using the neurovascular 16-channel coil and a 3.0T system, we have evaluated pCASL in about 100 patients that presented with brain tumor or suspicion of brain tumor, and in follow-up after treatment.”

“pCASL is a good alternative for patients with contraindications for contrast media, especially for patients with renal failure.”
**Post contrast 3D T1W FFE**

**T2* DSC perfusion**

**pCASL of right frontal glioblastoma**

As pCASL does not need any contrast agent, it may be a patient-friendly and economic alternative for dynamic susceptibility contrast imaging. Whole brain pCASL was acquired using Achieva 3.0T TX, 16-channel NeuroVascular coil, 13 slices, voxels 2.73 x 2.73 x 7 mm, scan time 4:08 min. The overlay is created on IntelliSpace Portal.

**pCASL**

**pCASL overlay on anatomic image**

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**Post contrast 3D T1W FFE**

**T2* DSC perfusion**

**eADC**

**pCASL of left frontal metastasis**

Whole brain pCASL was acquired using Achieva 3.0T TX. The overlay is created on IntelliSpace Portal.
pCASL for highly sensitive non-contrast brain perfusion

pCASL (Pseudo-Continuous Arterial Spin Labeling) is designed to provide high performance brain perfusion imaging at 1.5T and 3.0T without using contrast agent. It uses Arterial Spin Labeling (ASL, a subtraction technique) and may be used, for instance, in vascular and oncology exams in the brain. pCASL aims to be an alternative with better SNR – roughly 50% higher – than the pulsed ASL method used before.

**Pulsed Arterial Spin Labeling – STAR**
In the pulsed ASL method STAR, a slab is inverted before image acquisition to label blood over a short period of time and create the perfusion contrast in the brain. In the control situation no inversion is used. Subtraction of images with and without label yields perfusion images.

![Prepulse inverts (labels) the arterial blood in a large volume.](image)

![Delay time to let blood flow to brain.](image)

![Readout when labeled blood is in brain.](image)

Subtraction of images with and without label yields perfusion images.

**Different labeling in pCASL**
pCASL is a pseudo-continuous ASL technique where blood is inverted for a longer period of time. This allows efficient inversion of the blood leading to increased SNR in the perfusion images. A train of short and discrete RF pulses to invert the arterial blood is applied in a thin slab. This is followed by a fast readout covering the entire brain.

**Advantages of pCASL**
When comparing STAR and pCASL side by side, the higher SNR and the ability of pCASL to better visualize gray matter perfusion are evident.

Furthermore, pCASL’s high SNR allows to use isotropic resolution, which enables multiplanar reformatting. Color-based relative quantification of pCASL is available on the console and on IntelliSpace Portal.
Tim Leiner, MD, PhD, is cardiovascular radiologist and Associate Professor of Radiology at the University Medical Center Utrecht since 2010. Previously he was Assistant Professor of Radiology at Maastricht University Medical Center. He is the current President of the International Working Group on MR Angiography.

"We wanted to produce images that sufficiently support the clinical decision process but without adding more sequences than necessary."

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

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

The UMCU team recently developed fast Ingenia 1.5T ExamCards for the five most common exams, each of which require less than 8 minutes scan time. This is a scan time reduction of more than 50% compared to their standard protocols, and still satisfies the image quality criteria defined by the ACR Clinical Image Quality Guide1.

Faster imaging that still supports diagnosis

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

“Our starting point was the ACR minimum requirements for sequence types, image contrast, anatomic coverage, imaging planes and spatial resolution, which we incorporated into the scan protocols,” says Dr. Leiner. “We wanted to produce images that sufficiently support the clinical decision process but without adding more sequences than necessary. This resulted in the five exams taking less than 8 minutes.”
To assess the image quality of the newly optimized fast ExamCards, 40 patients were scanned with both the new and existing protocols for brain, cervical spine, knee or foot/ankle. Results of a blind test showed that the image quality, SNR and artifact presence were not significantly different (p>0.05) although the mean perceived image quality was slightly lower for the fast ExamCards. The UMCU team is now assessing the diagnostic quality of the new optimized ExamCard images. “Before we share these new protocols with others, we want to be sure that their diagnostic values are as good as those of the longer exams.”

**How Ingenia contributes to reducing scan time**

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

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

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

**Comparing fast and normal brain images**

Ingenia 1.5T fast and standard MR brain images show nearly identical appearance of image contrast and lesion conspicuity in right cerebral hemisphere.
More than short scan times: faster workflow

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

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

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

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

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

<table>
<thead>
<tr>
<th>Brain</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 SE sag SENSE</td>
<td>1:38 min</td>
</tr>
<tr>
<td>T2W TSE tra SENSE</td>
<td>1:24 min</td>
</tr>
<tr>
<td>DWI SENSE</td>
<td>0:32 min</td>
</tr>
<tr>
<td>T2 FLAIR SENSE</td>
<td>1:24 min</td>
</tr>
<tr>
<td>T2W FFE SENSE</td>
<td>1:48 min</td>
</tr>
<tr>
<td>T1 IR cor SENSE</td>
<td>1:04 min</td>
</tr>
<tr>
<td>Cervical spine</td>
<td>7:50 min</td>
</tr>
<tr>
<td>T2W sag SENSE</td>
<td>1:32 min</td>
</tr>
<tr>
<td>T1W sag SENSE</td>
<td>1:39 min</td>
</tr>
<tr>
<td>T2DRIVE 3D SENSE</td>
<td>2:09 min</td>
</tr>
<tr>
<td>T1W tra CLEAR</td>
<td>2:18 min</td>
</tr>
<tr>
<td>Foot/Ankle</td>
<td>7:38 min</td>
</tr>
<tr>
<td>T1 cor CLEAR</td>
<td>1:10 min</td>
</tr>
<tr>
<td>PD cor SENSE</td>
<td>0:47 min</td>
</tr>
<tr>
<td>T2 SPAIR sag CLEAR</td>
<td>1:55 min</td>
</tr>
<tr>
<td>PD sag CLEAR</td>
<td>1:16 min</td>
</tr>
<tr>
<td>T2W TRA CLEAR</td>
<td>1:20 min</td>
</tr>
<tr>
<td>PD tra SENSE</td>
<td>0:54 min</td>
</tr>
<tr>
<td>Knee</td>
<td>7:22 min</td>
</tr>
<tr>
<td>PDW SPAIR CLEAR</td>
<td>1:26 min</td>
</tr>
<tr>
<td>T2W TSE sag CLEAR</td>
<td>2:01 min</td>
</tr>
<tr>
<td>T2W SPIR SENSE</td>
<td>1:10 min</td>
</tr>
<tr>
<td>T1W TSE cor SENSE</td>
<td>0:38 min</td>
</tr>
<tr>
<td>T2W tra SENSE</td>
<td>1:42 min</td>
</tr>
<tr>
<td>Liver</td>
<td>6:57 min</td>
</tr>
<tr>
<td>T2 cor</td>
<td></td>
</tr>
<tr>
<td>3D mDIXON (IP, OP, water, fat)</td>
<td></td>
</tr>
<tr>
<td>DWI</td>
<td></td>
</tr>
<tr>
<td>T2 tra</td>
<td></td>
</tr>
<tr>
<td>T2 tra fat sup</td>
<td></td>
</tr>
<tr>
<td>3D arterial, portal, venous</td>
<td></td>
</tr>
<tr>
<td>Total scan time</td>
<td>7:40 min</td>
</tr>
</tbody>
</table>

Comparing fast and normal imaging in cervical spine

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

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

**A true paradigm shift for users and patients**

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

**Comparing fast and normal imaging in the knee**

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

**Comparing fast and normal imaging in foot/ankle**

In the fast exam, total scan time is reduced by 70%. In the example images shown scan times have significantly dropped, while voxel sizes have only slightly increased.
I think mDIXON is really a game changer as it is compatible with very fast imaging.

**Complete Ingenia 1.5T liver exam in 7.5 minutes**

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

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

**Comparing image quality of fast and normal exams**

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

**References**


2. T Leiner, E Alberts, N Blanken, M Stoesz, M Hartjes, J Hendrikse
   *MR Examination Times of Less than 8 Minutes for 4 Common Indications* ISMRM 2013
Elkerliek Hospital achieves major improvements in patient throughput

Installing *Ingenia 1.5T* and taking a fresh look at departmental procedures helps increase patient throughput and reduce waiting time.
The recent installation of an Ingenia 1.5T with its potential for fast, easy workflow and enhanced scanning possibilities stimulated the MRI unit at Elkerliek Hospital (Helmond, The Netherlands), to re-evaluate its clinical strategies and scanning procedures and make plans to improve efficiency. The unit is now already seeing increased patient throughput and a reduction in patient waiting time, with further improvements expected in the future.

Elkerliek Hospital has two MRI scanners: an Ingenia 1.5T system at its center in Helmond and an Achieva 1.5T in Deurne. The Ingenia is a recent acquisition, replacing an aging Intera 1.0T system. The installation of this state-of-the-art scanner at Helmond prompted the unit to perform a thorough reappraisal of its procedures. “The aim here was not only to realize the full potential of Ingenia’s advanced capabilities, but also to look at general improvements we could make in our current mode of working,” says Jan op ’t Hoog, Section Manager responsible for, among other things, the radiology department at Elkerliek.

Identifying areas for improvement
With the support of Philips Healthcare Consulting, the unit organized a Kaizen event, a one-week workshop involving radiologists, technologists, administrative support staff and management, aimed at analyzing processes and brainstorming to identify potential areas for improvement.

As a precursor to this, the MRI unit also subscribed to the Philips Utilization Services, which provides automated collection of usage data and a clear display of statistics on a secure page on NetForum.

“Some shortcomings were still identified, however”, she says. “For instance, our patient waiting list had been growing steadily in recent years. During the workshop it quickly became clear that this was largely due to our planning system being far from optimal. The system had evolved over time, with minor adjustments on the fly to correct for small problems without ever looking at the whole picture. As a result, the planning no longer reflected the real situation. Some exams overran the allotted time and others were completed earlier than planned, which often left us with unproductive time between exams. Time was also reserved for urgent cases, which by their nature are difficult to predict. These were often planned during breaks, when only one technologist was available, putting further strain on the planning schedule.”

“Ingenia 1.5T is less dependent on coil changes, so exam grouping is now based on scan time required, which makes the whole planning much easier and more flexible.”
“Now the process is more strictly organized, and we know exactly what information we can expect from the exams.”

### Average values

<table>
<thead>
<tr>
<th></th>
<th>Elkerleik Starting situation</th>
<th>6th month after start</th>
<th>Benchmark Netherlands*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients per week</td>
<td>Ingenia 120</td>
<td>Achieva 85</td>
<td></td>
</tr>
<tr>
<td>Waiting time</td>
<td>Ingenia 5-35 d</td>
<td>Achieva 5-35 d</td>
<td>5-21 d</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5-23 d</td>
</tr>
<tr>
<td>Exams per day</td>
<td>Ingenia 16</td>
<td>Achieva 17</td>
<td>21</td>
</tr>
<tr>
<td>Procedure time</td>
<td>Ingenia 33 min.</td>
<td>Achieva 29 min.</td>
<td>25 min.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>36 min.</td>
</tr>
<tr>
<td>Exam time</td>
<td>Ingenia 21 min.</td>
<td>Achieva 18 min.</td>
<td>15 min.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20 min.</td>
</tr>
<tr>
<td>Scan time</td>
<td>Ingenia 19</td>
<td>Achieva 13</td>
<td></td>
</tr>
<tr>
<td>Patient change time</td>
<td>Ingenia 12</td>
<td>Achieva 11</td>
<td></td>
</tr>
</tbody>
</table>

*Average benchmark Philips 1.5T MRI systems in the Netherlands

### Knee – old

- **Knee – new**

The new ExamCard for knee shows a scan time reduction of 39%.

### Brain – old

- **Brain – new**

The new brain ExamCard shows a scan time reduction of 30%.

### User experiences

Ingenia 1.5T performance improvement. Utilization graphs help to monitor the improvements achieved.
What helped improve efficiency at Elkerliek:

• Use of Philips Utilization Services for monitoring performance
• Involvement of all stakeholders in defining improvement
• Smarter exam planning:
  - Shorter blocks to reduce time loss within blocks
  - Combine exams in blocks: similar length for Ingenia, similar anatomy for Achieva
  - Reduce number of slots reserved for (relatively) urgent patients
• Better informed patients help reduce preparation time
• Better information exchange between radiologist, technologist and referring physician
• Radiologists specify standardized exam protocols, making work easier for techs and planning more predictable
• Standardized room layout and patient preparation (e.g. IV contrast) enhance efficiency
• Organizing continuous education/information sharing

The lack of predictability in exam times was aggravated further by the fact that the radiologists in the unit all had their preferred sets of protocols for specific clinical questions, that they expected the technologists to follow. “It became clear during the Kaizen event that the exam scheduling and the work of the technologists could be much easier if the radiologists all agreed on the same protocols to follow,” observes radiologist J.P. (Hans) Westerhof, MD, PhD, Medical Manager of the radiology department at Elkerliek.

Smarter exam planning
The first phase of the improvement plan was aimed at improving the efficiency of the planning system. Drawing on the experience of the Philips consultants, a new planning system was designed to improve usage over the working day. Elkerliek’s MRI schedule is divided into blocks of exams with similar characteristics. The old planning system used relatively large blocks over the day, increasing the risk of losing time between the exams within a block. So, one of the changes implemented was to decrease the duration of the blocks and to increase planning flexibility.

“For the Achieva 1.5T in Deurne, the patients are grouped according to exam type to save on coil changes, for example, brain exams or orthopedic exams,” says Helma Hertenberg. “But the Ingenia 1.5T is less dependent on coil changes, so here the planning is based only on the scan time required, which makes the whole planning much easier and more flexible.”

The second phase aims at reducing the number of slots kept in reserve for urgent patients. Since waiting times were long, slots had to be reserved for patients who need to be scanned within 10 days. However, reducing the time lost between exams, reducing the exam duration and working some extra days have decreased waiting time and thus reduced the necessity to reserve slots for urgent patients during normal working time.

Standardized and faster ExamCards
For Ingenia 1.5T, the team is looking at the possibilities to reduce scan times of ExamCards and to reduce the total number of ExamCards. This third phase is currently still in progress. The brain ExamCard was meticulously reviewed in relation to the clinical question and which sequences are really used by the radiologist, and to potential improvements offered by the Ingenia 1.5T system. The new brain ExamCard takes 10:42 minutes scan time, 30% faster than previously. For the knee, scan time is reduced by as much as 39% to 13:45 minutes.* In addition, some of the sequences in both knee and brain now also provide better image quality.

With the standardized exam protocols and ExamCard names, the radiologists can now specify well in advance which ExamCard they require for each referral, again making the time for the exam more predictable.

Significant reductions in waiting time
“For us, a major criterion of success was clear: reduced patient waiting time. In the past waiting time was not only too long, but also inconsistent, varying in some instances from say 10 days to 35 days, depending on the exam,” points out Jan op ’t Hoog. “Now, waiting time is already significantly shorter. At this moment no exam has a waiting time of more than 23 days and we are working on further improvements in the future. We are also achieving more consistent waiting times for different exams.”

The unit’s radiologists also see important improvements. “For the radiologists, it was a useful opportunity to optimize all individual protocols in the ExamCards, to develop and discuss shortcuts, and to really evaluate what we need for our diagnoses and what would be superfluous to our needs,” says Dr. Westerhof. “Now the process is more strictly organized, and we know exactly what we can expect from the exams.”

*These results are obtained by specific choices made by this facility and may not be typical for all facilities.
Intraoperative MR team focuses on patient care and productivity

Henry Ford Health System uses Achieva 1.5T in the midst of neurosurgery to help resect tumor and preserve normal brain

Henry Ford Health System (Detroit, Michigan, USA) is a quaternary care 1000-bed hospital. In February 2011, the hospital opened an MR operating room (MR-OR) including the Achieva 1.5T system, and it has quickly become a well run, highly productive practice.

The MR-OR system is used mainly for brain tumor surgeries, where it helps neurosurgeons to remove as much tumor as possible during surgery. In addition, the hospital’s movement disorder neurosurgery team uses it for Deep Brain Stimulation placement for patients with Parkinson’s disease and essential tremor. This procedure is done entirely within the MRI room, operating in the back of the magnet.

When not needed for intraoperative imaging, the MR system is used as a diagnostic scanner, so it is essentially used around the clock, thanks to the dual-room setup. Approximately 4700 diagnostic scans have been performed on the system since installation, 140 of which have been intraoperative.

Team effort and planning come to fruition
Steven Kalkanis, MD, says the implementation of the MR-OR solution was a multi-disciplinary team effort that took about a year in planning. “An essential initiative we undertook to ensure success was the concept of our team. We assembled an important team of neurosurgeons, anesthesiologists, radiologists, radiation physicists, nurses and scrub technicians, because this is not only a diagnostic scanner but an OR scanner.”

Major advantages for patient, neurosurgeon, hospital
“Monitoring the extent of resection is the biggest advantage of the MR-OR,” says Dr. Kalkanis. “With the immediate feedback of intraoperative MRI, we can make real-time adjustments when necessary. That is very comforting, and it allows us to be more aggressive when it’s appropriate.”

Steven N. Kalkanis, MD is Vice Chair, Department of Neurosurgery and Medical Director at Henry Ford Center for Cancer Surgery. In addition, he serves as President of the Michigan Association of Neurological Surgeons. He performed his Residency and fellowship training at Harvard-Massachusetts General Hospital (Boston, Massachusetts, USA). He has a special interest in brain tumors and diseases of the spine.

Lisa Scarpace is Clinical Coordinator iMRI, Henry Ford Hospital, Hermelin Brain Tumor Center. Her research interests include MRI Diffusion, Perfusion, and Spectroscopy use determining response to treatment and functional MRI use in surgical planning.

“Monitoring the extent of resection is the biggest advantage to the MR-OR. With the immediate feedback of intraoperative MRI, we can make real-time adjustments when necessary.”
A 64-year-old man presents with gustatory hallucinations and paresthesias for more than a year. Preoperative MR on the day of surgery shows a new focus of contrast enhancement in the medial left temporal lobe. Our surgeon used navigation to target this enhancement area and remove the abnormal tissue.

The intraoperative study showed the surgical tract extending from the left lateral temporal region up to the medial temporal tip. Post-contrast T1 images showed that the enhancing nodular tumor was just above and slightly posterior to the medial tip of the surgical track. Postoperative imaging shows a complete resection of the left medial temporal lobe neoplasm. Pathological diagnosis was Dysembryoplastic Neuroepithelial Tumor (DNET). Intraoperative MRI showed the remaining tumor tissue which was essential to the success of this surgery.

Achieva 1.5T was used with Noras coil and integrated head holder frame. Standard imaging was done, T2, FLAIR, DWI, T1 and T1 post-contrast at contiguous thin cuts to load onto the Brainlab sky navigation system.
“We basically use the MR-OR every day and we are currently figuring out how we can do more than one case in a day, because our demand has become so much greater.”

The hospital benefits as well, by having a differentiator in a very competitive environment. Lisa Scarpone, Clinical Coordinator MRI, says, “We’re doing leading-edge medical procedures very efficiently here. Patients are coming to us because we have the intraoperative MRI, and our results are really excellent because of it.”

**Start-to-finish simplicity**
A typical MR-OR procedure is quite efficient. Less than 24 hours before the surgery, patients have a preoperative scan. “If the tumor enhances, we’ll do T1 non-contrast and T1 gadolinium scans to map it out,” explains Dr. Kalkanis. “If it’s a non-contrast enhancing tumor we’ll typically use a FLAIR or a T2 sequence.”

The patient comes to the OR with fiducial markers placed on the scalp. A preoperative scan is done to register the markers. Then an anesthetic is administered, and the patient is positioned in the head holder. “We then plan out our incision, make an incision in the scalp, remove a portion of the bone, and begin the resection. Soon, the tumor begins to look more normal along the margins. This is the critical step. Without the intraoperative MRI, most surgeons would stop at this point so as not to harm the patient and rely on radiation and chemotherapy afterward.”

“Instead, the patient is smoothly transferred into the MR scanner, and FLAIR, T2, DWI, T1 non-contrast and T1 post-contrast scans are performed. This takes about 20 or 25 minutes, and within minutes those images are being beamed back into the OR. And if there is tumor remaining, we can actually mark out on the image where our new target is, and link the stereotactic wand to the new intraoperative MR scan that is pinpointing where the residual tumor is. We then remove any residual tumor, and close up.”

“In about 75% of cases we do one intraoperative scan; in the others we need more than one. We get a formal post-operative MRI scan the following day, and those generally show complete resection.”

“Possibly most remarkable is the short time needed for intraoperative MR scanning,” Dr. Kalkanis says. “In an internal study* we found that our overall operative time was increased by only 38 minutes without any added complications, which includes about 22 minutes of scan time. The extent of resection was increased by over 40% in more than half the cases.”

**Workflow**
The Henry Ford team was worried that using the MR-OR system would add complexity and time to their cases, but Dr. Kalkanis says, “It became easier over time. Having people designated within each group as experts who are always there for every case makes all the difference in the world. Everyone knows his or her role in the overall structure, and it truly is routine. Every moment is accounted for, and it works out very well.”

“The way the MR-OR is configured adds to workflow efficiency,” he says. “It looks like a regular OR, but as soon as the sliding doors open, it’s immediately linked to the Achieva system. The beauty of this setup is that we haven’t changed our instruments in the OR, we haven’t changed our approach, we don’t stand in a different way.”
“Possibly most remarkable is the short time needed for intraoperative MR scanning.”

**Teamwork is the key to success**

Dr. Kalkanis points out the most important aspect of the project. “The biggest initiative we undertook to ensure success was the concept of our team. For every single patient, we include someone from each department.”

Lisa Scarpace emphasizes, “We had great training at the beginning. We had full OR staff (nurses, anesthesia and housekeeping), full radiology staff and all the surgeons there for three days. At first, everyone fought it, but in the end, that’s what made our team so cohesive.”

**The economic picture**

“We basically use the MR-OR every day,” says Lisa Scarpace. “And we are currently figuring out how to move things around so we can do more than one case in a day, because our demand has become so much greater.”

“For us, it’s a consideration of patient care,” she says. “When after surgery it turns out that a little bit of tumor is left, patients may need extensive radiation or chemotherapy, or sometimes a patient needs to be taken back to surgery a second time within the same week. MR-OR helps us monitor the extent of resection, that is a big advantage. Our surgeons are used to the system now, and they are confident that their patients will not need extensive radiation or chemotherapy.”

“Looking at the benefits of intraoperative MR and knowing that it only adds about a half hour of additional time, makes it an easy choice,” adds Dr. Kalkanis.

**Reference**

CR Wirtz, M Knauth, A Staubert, MM Bonsanto, K Sartor, S Kunze, VM Tronnier
Clinical evaluation and follow-up results for intraoperative magnetic resonance imaging in neurosurgery
Neurosurgery 2000 May;46(5):1112-20; discussion 1120-2
Tips for robust motion correction in liver imaging using MultiVane

Single shot breath hold techniques for liver imaging often have relatively low resolution and SNR. Multishot techniques allow use of higher spatial resolution, but multishot TSE with respiratory triggering may suffer from ghosting artifacts due to motion. MultiVane can be added to reduce the ghosting, thus making multishot liver imaging more robust.

In MultiVane, data acquisition is performed in “blades” in k-space. In-plane motion will affect the low frequencies in the center of k-space and can thus be detected and corrected for each blade, resulting in reduced motion effects in the images.

**Setting the MultiVane percentage**

The MultiVane percentage (MV%) controls the number of MultiVane rotating blades in k-space. This parameter is similar to NSA in its effect on scan time and SNR. Applying a MV% of 100 will result in the same scan time as a Cartesian scan.

When the MV% is set too low, streaking artifacts will be seen in the image. Select a higher value to decrease streaking artifacts.

**TIP 1**

- **MV% = 100%** provides scan time similar to a Cartesian scan.
- **MV% ≈ 157%** provides full k-space coverage.
- If MV% is too low, SNR is low and streaking artifacts are visible.
- Good SNR and reduced artifacts.
- SNR is good, but image more blurred, scan time long.

Visit the online Philips NetForum community for more application tips.

Visit the online Philips NetForum community for more application tips.
**TIP 2**

**Shots per blade and TSE factor**

These parameters control the number of turbo shots that together form one blade. For liver imaging, setting the number of shots per blade to 1 is a good choice, because with more shots per blade, motion effects may appear within a blade.

The TSE factor should be high enough to allow adequate motion correction. A rule of thumb is to choose a TSE factor that is about 8% of matrix size, e.g. matrix 400 with TSE factor 32.

![Images showing 1 shot per blade provides good image quality and 3 shots per blade motion artifacts and some RL shading are visible.]

**TIP 3**

**MultiVane gross motion correction**

When a complete anatomy changes position, e.g. head movement in brain imaging, this is called gross motion. MultiVane can detect this gross, rigid motion by registering position differences between blades. Gross motion correction compensates for this gross motion. For small, non-rigid or pulsatile motion, the intrinsic characteristics of MultiVane reduce motion sensitivity to a minimum.

- **MultiVane gross motion correction = NO**
  - This is recommended when only the shape of the anatomy changes, for instance by pulsatile motion. Also use this when motion in the slice direction (through-plane motion) is expected, as in axial liver scanning. As MultiVane is a 2D technique, this type of motion cannot be corrected.

- **MultiVane gross motion correction = YES**
  - This is recommended when severe motion can be expected, for instance in pediatric brain imaging.

![Images showing gross motion correction NO provides best results in axial liver and gross motion correction YES.]

FieldStrength 35
Setting WFS when using MultiVane

When MultiVane is used, the Water Fat Shift (WFS) direction will rotate within k-space. Minimize the WFS to minimize streaking artifacts. The larger the WFS, the larger this effect will be visible in the image.

Images look less sharp with just a minimal increase of WFS.

Comparing MultiVane on Ingenia 1.5T

Breath hold, single shot

Respiratory triggered, multishot

MultiVane

Respiratory triggered, multishot

T2W

T2 SPAIR

T2W

T2 SPAIR

T2W

T2 SPAIR

With single shot the resolution is low and images are not sharp.

The multishot images look blurred and motion artifacts are visible.

MultiVane with multishot produces sharp images without motion artifacts.

The Ingenia 1.5T release 4.1.3 preset protocols include these MultiVane protocols for robust motion correction in high resolution respiratory triggered multishot scans.

Note that MultiVane can also be used without external motion compensation.
Comparing MultiVane on Ingenia 3.0T

The higher 3.0T field strength influences the use of MultiVane in several ways. Scan times tend to be longer as SAR is higher at 3.0T, and the method is more sensitive to B0 variations within the blades. Therefore, the MultiVane percentage at 3.0T is usually set higher than at 1.5T, the TSE factor is also set higher for good motion correction and scan time reduction. Because of the sensitivity for B0 variation, B0 shimming is recommended.

In general, motion correction is robust at 3.0T, even when long TRs are used. This is illustrated in this example below. Although the TSE shot is during the breathing cycle, the resulting images show no motion artifacts.

T2W MultiVane, respiratory triggered, multishot, long TR 3500 ms

Most popular MRI NetForum content in first quarter of 2013

1. ApplicationTip    Metal artifact reduction for MRI of metal prostheses and implants
2. ExamCard          1.5T hip with prosthesis using MARS protocol
3. ApplicationTip    Tips for body diffusion weighted imaging (DWI)
4. ExamCard          Ingenia 1.5T hip with prosthesis using MARS
5. ApplicationTip    Tips for cardiac triggering in MRI
Transform to digital for expanded clinical capabilities and speed

SmartPath to dStream converts Achieva or Intera into a state-of-the-art digital broadband system

SmartPath to dStream offers all the benefits of a digital broadband architecture, without the cost and hassle of installing a completely new system. It transforms an existing Philips MR system into a digital broadband MR scanner. This not only saves money on the magnet itself, but also saves the reconstruction work and cost that would be necessary for magnet replacement.

Achieva

- T2W TSE, Torso XL coil, 0:30 min.
- VISTA FLAIR, 8:16 min
- Cine B-TFE conventional 3.0T

SmartPath to dStream

- T2W TSE, d5 Torso, 0:14 min.
- BrainView FLAIR MPR, 4:53 min.
- Cine B-TFE with MultiTransmit 4D

Enhanced SNR, uniformity and speed
Enhanced volumetric imaging
Enhanced uniformity and contrast
dStream digital technology

dStream is a digital broadband architecture that Philips first introduced with Ingenia. This technological breakthrough brings outstanding clinical capabilities, excellent patient experience and exceptional workflow. By reusing the existing magnet, SmartPath to dStream now offers users of Achieva or Intera access to all these benefits without the need to install a completely new system. The digital platform provided by SmartPath to dStream provides higher SNR than the original system. The integrated posterior coil, the easy coil handling and many automated steps in exam planning streamline workflow and can bring up to 30% improvement in throughput.

Channel independence

As the digitization of signal occurs in the coil, the number of channels available is determined by the coil, rather than the system. This enables plug-and-play expansion of clinical capabilities without major hardware upgrades, resulting in lower lifecycle costs and improved economic value.

Advanced techniques for excellent imaging

dStream captures a high purity MR signal directly in the coil on the patient. Fiber-optic cable is used for broadband data transmission without signal loss. The result is a high SNR, similar to Ingenia. SmartPath to dStream also provides dS SENSE parallel imaging for outstanding image quality and speed. For 3.0T systems, dStream with MultiTransmit 4D enhances image uniformity, reduces dielectric shading and helps manage local SAR, even during real-time applications.

Enhanced workflow

The FlexCoverage posterior coil is integrated underneath the tabletop, which provides increased patient space in routine applications like spine and body. FlexStream is designed to streamline workflow by shortening exam setup times, and reducing the number of repetitive tasks. Faster scanning and improved workflow can bring up to 30% improvement in throughput in a variety of routine exams.

For more information, see www.philips.com/SmartPath_to_dStream
Philips and Elekta establish research consortium on MRI-guided radiation therapy

MD Anderson Cancer Center is the second member of the research consortium, which will comprise leading radiation oncology centers and clinicians

Prior to setting up the research consortium, Elekta, Philips and the University Medical Center Utrecht built and tested a prototype system that integrates a linear accelerator and a 1.5T MRI system. The success of these efforts has enabled the project to move to the next phase of development and testing by the select group of consortium partners.

The MRI-guided radiation therapy system* – uniting state-of-the-art MRI with a cutting edge radiation therapy system – will provide physicians with exceptional images of a patient’s soft tissues and tumor during radiation therapy. This breakthrough innovation also aims to enable clinicians to adapt treatment delivery in real time.

Elekta, Philips and UMC Utrecht recently welcomed MD Anderson Cancer Center (Houston, Texas, USA) as a collaborator in the research consortium dedicated to advancing the development of MRI-guided radiation therapy.

“The development of a meaningful, yet complex innovation like the MRI-guided radiation therapy system* can only be done in partnership with leading healthcare innovators, both from an industrial, as well as a clinical perspective,” says Gene Saragnese, CEO Imaging Systems at Philips Healthcare.

The integrated MRI-guided radiation therapy system is in development and not available for sale.

*The integrated MRI-guided radiation therapy system is in development and not available for sale.
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FieldStrength is a professional magazine for users of Philips MRI systems. Three times per year it provides results of MR studies performed by Philips users. Don’t miss any issue. Register now for your personal email subscription at: www.philips.com/fieldstrength

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Printed in Belgium.
4522 962 81901

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

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Education calendar 2013

**Neuro MR**

*Diseases of the Brain, Head and Neck, Spine*

*Athens, Greece*

**Date:** September 19-22, 2013

The International Diagnostic Course Davos (IDKD) offers interactive teaching workshops, presented by an international faculty.

*Info:* [www.idkd.org](http://www.idkd.org)

**Breast MR**

*European Workshop on MRI-guided vacuum Breast biopsies*

*Bruges, Belgium*

**Dates:** May 16-17; November 21-22

European Workshop for radiologists with experience in breast imaging. Organized by Dr. Casselman, AZ St. Jan.

*Info:* ibenecke@mammotome.com

*Phone:* +49 40 593559116

**Breast MRI - Case-Based Review**

*Las Vegas, NV, USA*

**Date:** September 28-29

*Info:* [www.sbi-online.org](http://www.sbi-online.org)

**Erasmus course: Breast and female imaging**

*Brussels, Belgium*

**Date:** May 27-31

This four-day program provides different workshops and lectures on breast and female imaging. Organized by Dr. B. Brkljacic


**Breast MR with guided biopsy**

*Reston, VA, USA*

**Dates:** August 5-6; November 4-5

This 100-case course is designed to provide practicing radiologists with an intensive, hands-on experience in reading breast MRI. Participants will develop their interpretive skills through extensive case reviews at individual work stations.

*Info:* [www.acr.org](http://www.acr.org)

*Email:* EDCTR-WebReg@acr-arrs.org

*Phone:* +1 800-373-2204

**Musculoskeletal MR**

*Current issues of MRI in orthopaedics and sports medicine*

*San Francisco, CA, USA*

**Date:** August 25-28

*Info:* [www.stollerscourse.com](http://www.stollerscourse.com)

**Cardiac MR**

*Cardiac MR courses at CMR Academy*

*German Heart Institute, Berlin*

All courses are for cardiologists and radiologists. Some parts will be offered in separate groups.

*Info:* [www.cmr-academy.com](http://www.cmr-academy.com)

*Email:* info@cmr-academy.com

*Phone:* +49-30-4502 6280

**Complete course**

**Dates:** Part 1: Feb. 11 - Mar 22; Nov. 4 - Dec. 13

Part 2: home study:

- Mar 23 - May 3

Intensive course including hands-on training at the German Heart Institute, and reading and partially quantifying over 250 cases.

**Compact course**

**Dates:** June 17-21; Nov. 4-8

CMR diagnostics in theory and practice, including performing examinations and case interpretation.

**CVMRI Practicum: New Techniques and Better Outcomes**

*St. Luke’s Episcopal Hospital, Houston, TX, USA*

**Date:** October 10-13

On principles and practical applications of Cardiac MRI.

*Info:* jdees@bleleh.com and villareal@bleleh.com

**Clinical Workshop on Cardiac MR stress imaging**

*London, United Kingdom*

**Date:** October 2-4

Dedicated, intense, individualized and hands-on CMR stress imaging training to a small number of participants (max 10). Aimed at cardiologists and radiologists. Theoretical and practical aspects will be addressed.

*Info:* [www.cvfit.org.uk](http://www.cvfit.org.uk)

*Email:* admin@cvfit.org.uk and enquiries@cvfit.org.uk

*Phone:* +44 20 8983 2216

**Hands-on technologist CMR training**

*St. Louis, MO, USA*

**Date:** Offered monthly, by appointment

Two-day course is designed for technologists, nurses and sonographers interested in cardiac MRI. Maximum of 3 participants per class.

*Info:* [ctrain.wustl.edu/ClinicalResearch/techTraining2.aspx](http://ctrain.wustl.edu/ClinicalResearch/techTraining2.aspx)

*Phone:* +1-314-454-7459

*Fax:* +1-314-454-7490

**MR Spectroscopy**

**MR Spectroscopy course**

*Zurich, Switzerland*

**Date:** t.b.a.

Theory sessions and daily practical scanning and post-processing sessions in small groups.


*Email:* hennig@biomed.ee.ethz.ch

**General MR**

**Essential Guide to Philips in MRI**

*Cheltenham, UK*

**Dates:** May 14-17; November 5-8

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.

*Info:* [education@cobalthealth.co.uk](mailto:education@cobalthealth.co.uk)

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**Register on NetForum to have free access to online training modules** on use of Philips MR scanners and packages, use of coils, use of EWS, MR safety.
Philips North America off-site training courses

Dates: upon request
Info: kara.grey@philips.com
Phone: +1-440-483-5355
Fax: +1-440-483-7946

MR Registry Review
Cleveland, OH, USA or at a customer facility
This didactic course covers MR physics and cross-sectional anatomy. It is designed as an overview course to assist MR technologists in taking the ARRT Registry Exam.

MRI Basics
Cleveland, OH, USA
Designed for novice technologists with little or no previous MR experience. Lectures cover the basic concepts and theory of MRI. This course is entirely didactic and theory based.

MRI Essentials
Cleveland, OH, USA
This comprehensive course for technologists covers Philips MR system hardware, software and basic scanning techniques. It consists of lectures, workstation exercises and hands-on scanning.

MR Advanced
Cleveland, OH, USA
Designed to increase the technologist's knowledge of parameters, post processing features, and scan techniques. It consists of lectures, workstation exercises and hands-on scanning.

Other courses:
MR Advanced Neuro
for technologists

MR Basic Cardiac
for experienced radiologic technologists and professionals

MR Advanced Cardiac
for experienced MR cardiac technologists and professionals

MR Basic Breast
for radiologic technologists and professionals

MR Conversion Course
for technologists and professionals who would like an understanding of the differences between other vendors and Philips MRI systems.

Events calendar 2013

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<th>Event</th>
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<th>More information</th>
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<td>May 18-23</td>
<td>American Society of Neuroradiology – ASNR</td>
<td>San Diego, CA, USA</td>
<td><a href="http://www.asnr.org">www.asnr.org</a></td>
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<td>May 27 – Jun 1</td>
<td>American Association of Neurological Surgeons – AANS</td>
<td>Miami, FL, USA</td>
<td><a href="http://www.aans.org">www.aans.org</a></td>
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<td>June 4-7</td>
<td>European Society of Gastrointestinal and Abdominal Radiology – ESGAR</td>
<td>Barcelona, Spain</td>
<td><a href="http://www.esgar.org">www.esgar.org</a></td>
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<td>June 16-20</td>
<td>Organization for Human Brain Mapping – OHBM</td>
<td>Seattle, WA, USA</td>
<td><a href="http://www.humanbrainmapping.org">www.humanbrainmapping.org</a></td>
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<tr>
<td>Aug 4-8</td>
<td>American Association of Physicists in Medicine – AAPM</td>
<td>Indianapolis, IN, USA</td>
<td><a href="http://www.aapm.org">www.aapm.org</a></td>
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<td>Aug 20-23</td>
<td>MRA Club</td>
<td>Manhattan, NY, USA</td>
<td><a href="http://www.mradclub.com">www.mradclub.com</a></td>
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<tr>
<td>Aug 31 – Sep 4</td>
<td>European Society of Cardiology – ESC</td>
<td>Amsterdam, Netherlands</td>
<td><a href="http://www.escardio.org">www.escardio.org</a></td>
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<tr>
<td>Sep 14-18</td>
<td>Cardiovascular and Interventional Radiological Society of Europe – CIRSE</td>
<td>Barcelona, Spain</td>
<td><a href="http://www.cirse.org">www.cirse.org</a></td>
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<tr>
<td>Sep 22-25</td>
<td>American Society for Therapeutic Radiology and Oncology – ASTRO</td>
<td>Atlanta, GA, USA</td>
<td><a href="http://www.astro.org">www.astro.org</a></td>
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<tr>
<td>Sep 25-29</td>
<td>American Society of Head Neck Radiology – ASHNR</td>
<td>Milwaukee, WI, USA</td>
<td><a href="http://www.ashnr.org">www.ashnr.org</a></td>
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<tr>
<td>Oct</td>
<td>High field MR in Clinical Applications</td>
<td>Bonn, Germany</td>
<td><a href="http://www.highfieldmr-bonn.de">www.highfieldmr-bonn.de</a></td>
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<tr>
<td>Oct 3-5</td>
<td>European Society of Head Neck Radiology – ESHNR</td>
<td>Izmir, Turkey</td>
<td><a href="http://www.eshnr.eu">www.eshnr.eu</a></td>
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<tr>
<td>Oct 3-5</td>
<td>European Society for MR in Medicine and Biology – ESMRMB</td>
<td>Toulouse, France</td>
<td><a href="http://www.esmrmb.org">www.esmrmb.org</a></td>
</tr>
<tr>
<td>Oct 19-23</td>
<td>Congress of Neurological Surgeons – CNS</td>
<td>San Francisco, CA, USA</td>
<td><a href="http://www.cns.org">www.cns.org</a></td>
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<tr>
<td>Nov 11-14</td>
<td>European Association of Neurosurgical Societies – EANS</td>
<td>Tel Aviv, Israel</td>
<td><a href="http://www.eans.org">www.eans.org</a></td>
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<tr>
<td>Nov 16-20</td>
<td>American Heart Association – AHA</td>
<td>Dallas TX, USA</td>
<td><a href="http://my.americanheart.org/professional">my.americanheart.org/professional</a></td>
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<tr>
<td>Dec 1-6</td>
<td>Radiological Society of North America – RSNA</td>
<td>Chicago, IL, USA</td>
<td><a href="http://www.rsna.org">www.rsna.org</a></td>
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SmartPath to dStream is a Philips program that delivers dStream, the digital broadband architecture introduced with Ingenia, on your existing Philips system. It brings you a virtually new system, offering improved workflow and throughput, outstanding clinical capabilities and an excellent patient experience: all without the cost and hassle of installing a new system. Discover how SmartPath to dStream can benefit your hospital at www.philips.com/smartpathtodstream