GE Healthcare

SIGNA pulse

THE MAGAZINE OF MR • SPRING 2010

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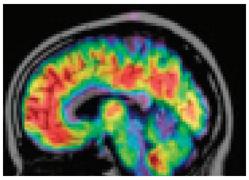
Non-contrast enhanced perfusion assessment brings neuro imaging one step closer to the future



imagination at work

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GE Healthcare News

Clinical Value

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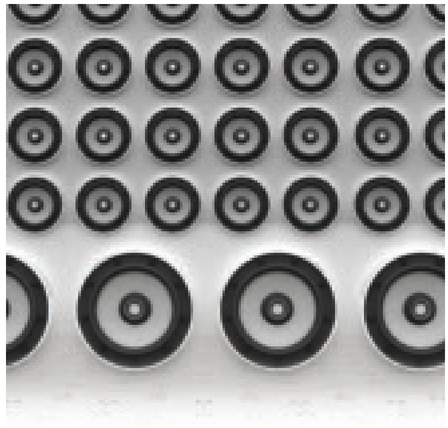

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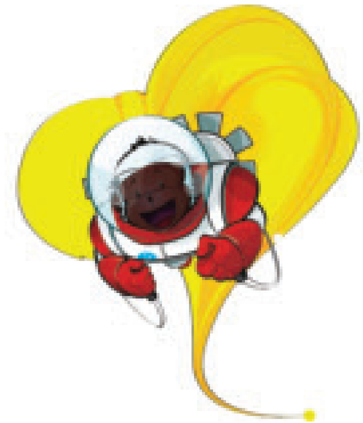

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Technical Innovation

Beyond the Scan

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The article, "*Discovery MR750 3.0T elevates clinical utility of high-resolution imaging of cranial nerves*" published in the Fall 2009 issue of *SignaPULSE* incorrectly listed the spelling of author Dr. Mitesh Gandhi and information about co-author Peter Lavery. Peter Lavery has been involved in several research projects at the University of Queensland while completing his Master's Degree. The editors thank Dr. Gandhi and Mr. Lavery for their valuable contributions and regret any inconvenience caused.

Welcome

Good ideas are everywhere. *Everywhere*. Walking through the MR building at GE Healthcare, it is hard not to be struck by the great ideas that are developed every day.

MR is dependent on innovations. After all, improving the quality of healthcare for people everywhere is no small task! The notion of recognizing good ideas regardless of where they originate and focusing on innovation has been our focus at GE Healthcare. As we entered the new decade, a new line of innovative products came with it that resulted from collaborations. Collaborations that are in line with our mission surrounding healthymagination - to reduce cost while increasing access and quality to healthcare across the globe. And we'd like to tell you more about them in the pages of this issue of Signa*PULSE*.

- **Discovery™ MR750** – a 3.0T system many consider to be a leading research platform in the industry (page 25, 45).
- **Optima™ MR450w** – a 70 cm bore system without compromise.
- **Discovery MR450** – bringing the innovation of the Discovery MR750 to 1.5T (page 30).
- **Optima MR360*** – combining versatility and value without compromise (page 48).
- **Brivo™ MR355*** – uses the same proven magnet as the Discovery MR450, but seeks to bring high-field MR within reach to a vast array of hospitals (page 59).
- And we continue to invest in our **HDxt** platform to provide new applications (pages 7, 55, 57).

In addition, we've added the **MSK Extreme 1.5T** system to our product lineup – a completely dedicated MSK scanner (page 39). We also continue to partner with InSightec to bring you **MR-guided focused ultrasound**, which provides women with an alternative, non-invasive treatment to uterine fibroids (page 21).

I still believe, however, the best MR innovations may be waiting to be discovered … it's what keeps me up at night. That's where you come in. As we look back over our heritage of innovation, we recognize the contribution that our external collaborators have made. These contributions make all of us stronger – and to say we value these relationships is an understatement (see page 43).

Some examples of our collaborations include:

- **3D ASL** (Arterial Spin Labeling), shown for the first time at this year's ISMRM in Stockholm. Invented by David Alsop of Beth Israel Deaconess Medical Center, 3D ASL was further enhanced and validated by a team of GE scientists. This technique will allow physicians to assess and understand changes in cerebral blood flow, which has a number of clinical applications (pages 8, 51).
- **MR-Touch**, the first commercial product for MR Elastography. Developed by Dr. Richard Ehman at the Mayo Clinic, researchers and engineers at GE helped facilitate getting the technology into a commercial application. This technology gives referring physicians a powerful non-invasive option for assessing liver tissue stiffness (page 63).
- **PROPELLER™** utilizes radial k-space and advanced motion correction algorithms, to generate virtually motion artifact-free images. Jim Pipe from the Barrow Institute developed PROPELLER with the support of GE scientists.
- **IDEAL**, the first technique that allows robust water-fat separation, particularly in difficult-to-image anatomies was a joint collaboration of Stanford University, UW-Madison, and GE researchers.

The list goes on and that's where you come in. As I mentioned, good ideas are everywhere. We want to hear from you to help transform your good ideas into products that can help people in years to come and realize the vision of healthymagination.

I hope you join the conversation – I am eager to see where we can go, together.

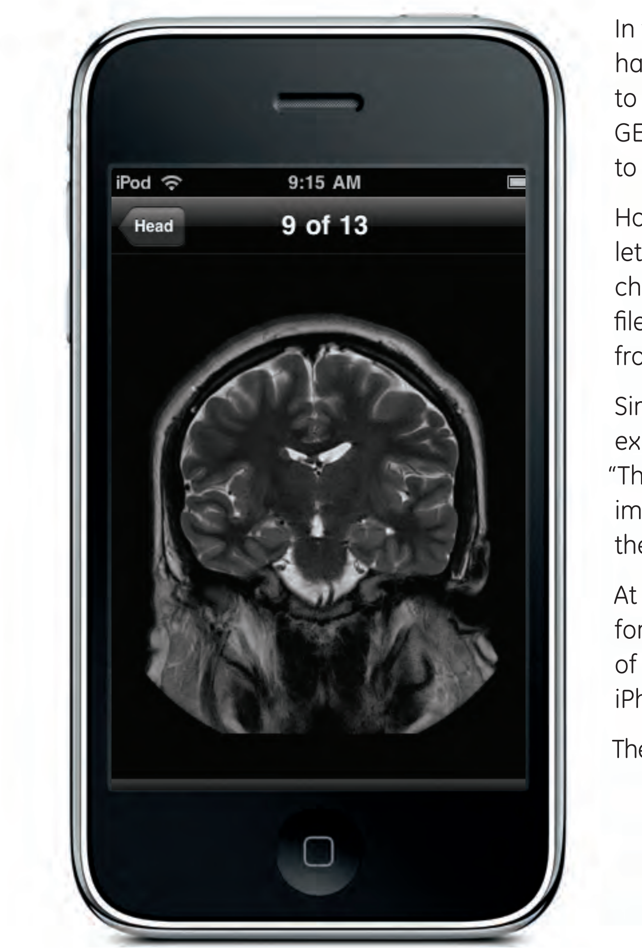
James E. Davis
Vice President and General Manager,
Global MR Business, GE Healthcare

*510(k) pending at FDA. Not available for sale in the United States.

GE looks forward to seeing you at the following events in 2010.

Date	Conference	Site	City/State	Country	Web Link
May 1 – 7	Joint Annual Meeting ISMRM-ESMRMB	Stockholm International Fairs	Stockholm	Sweden	www.ismrm.org
May 12 – 15	91th Röntgenkongress	Messe Berlin	Berlin	Germany	www.roentgenkongress.de
May 15 – 20	American Society of Neuroradiology (ASNR) 48th Annual Meeting & NER Foundation Symposium	Hynes Convention Center	Boston, MA	USA	www.asnr.org
May 25 – 27	4th Russian National Congress of Radiologists "Radiology 2010"	Crocus Expo International Exhibition Centre	Moscow	Russia	www.radiology-congress.ru/eng_version.php
May 28 – 31	30º Congreso Nacional de la Sociedad Española de Radiología Médica	Palacio de Congresos	A Coruña	Spain	www.seram2010.com
June 2 – 5	European Society of Gastrointestinal & Abdominal Radiology (ESGAR) 2010	International Congress Centre Dresden	Dresden	Germany	www.esgar.org
June 6 – 10	16th Annual Organization for Human Brain Mapping	Catalonia Palace of Congresses	Barcelona	Spain	www.humanbrainmapping.org
June 7 – 9	UK Radiological Congress	NIA & ICC	Birmingham	England	www.ukrc.org.uk
June 11 – 15	44° Congresso Nazionale della Società Italiana di Radiologia	Verona Fiere	Verona	Italy	www.congresso.sirm.org
July 23 – 25	RADaim 2010	Conrad Jupiters, Broadbeach	Gold Coast, QLD	Australia	www.phoenixconf.com
Aug. 6 – 8	The Royal Australian and New Zealand College of Radiologists – New Zealand Branch Annual Scientific Meeting	Millennium Hotel	Queenstown	New Zealand	www.ranzcr2010.co.nz
Aug. 28 – Sept. 1	European Society of Cardiology (ESC) Congress 2010	Stockholmsmassan	Stockholm	Sweden	www.escardio.org
Sept. 30 – Oct. 2	Japanese Society for Magnetic Resonance in Medicine (JSMRM) 2010	Tsukuba Int'l Congress Center	Tokyo	Japan	www.jsmrm.jp/modules/en/index.php
Oct. 3 – 5	38th Annual Meeting North American Society for Cardiovascular Imaging (NASCI)	Westin Hotel	Seattle, WA	USA	www.nasci.org
Oct. 4 – 9	European Society of Neuroradiology XIX Symposium Neuroradiologicum 2010	Ospedale Bellaria	Bologna	Italy	www.esnr.org
Oct. 14 – 17	The Royal Australian and New Zealand College of Radiologists Annual Scientific Meeting	Perth Convention Exhibition Centre	Perth, WA	Australia	www.ranzcr2010.com
Oct. 16 – 21	Congress of Neurological Surgeons 2010 Annual Meeting	Moscone West Convention Center	San Francisco, CA	USA	www.cns.org
Oct. 22 – 26	Journée Française de la Radiologie	Palais des Congrès de Paris Porte Maillot	Paris	France	www.sfrnet.org
Nov. 13 – 17	American Heart Association (AHA) Annual Scientific Sessions	McCormick Place	Chicago, IL	USA	www.americanheart.org
Nov. 28 – Dec. 3	Radiological Society of North America (RSNA) 96th Scientific and Annual Assembly	McCormick Place	Chicago, IL	USA	rsna2010.rsna.org

"Clinical Images" Becomes First iPhone app for GE Healthcare



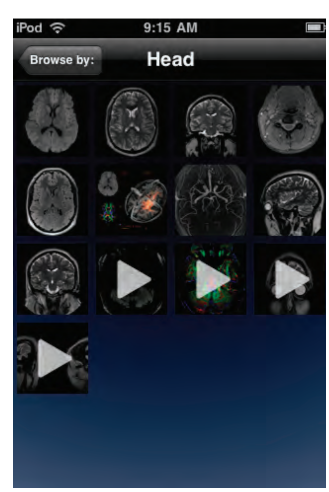
In the climate where "going mobile" is necessary for survival, GE Healthcare has developed its first iPhone app. Called "Clinical Images," the app seeks to enable radiologists quick and easy access to sample clinical images from GE equipment. The images were obtained and posted without retouching to provide industry professionals a realistic output of the imaging technology.

How does it work? Available on iTunes, the app is organized first by modality, letting the user select MR, PET/CT, Xray, or ultrasound. From there, they can choose the clinical area or application to view the clinical images or movie files. Images can be zoomed, saved to wallpaper, and e-mailed directly from the iPhone or iTouch.

Simple? Yes. But that's the point. "Images are everything to our customers," explains Tom Verghese, chief marketing officer for GE's global MR business. "They are the proof points to any system. If someone wants to see sample images on one of our systems, they can go to this app and see them at their leisure."

At time of print, GE's 70-cm 1.5T system, the Optima MR450w, is featured for MR. Clinical images from additional MR systems are in the process of being loaded. In the future, GE may expand the capabilities of the iPhone app.

The app is free and available for download at www.gehealthcare.com/iphone. ■



Two New MR Systems Unveiled

In a move to showcase its on-going investment in technology that meets the specific needs of physicians around the world, GE Healthcare announces two new MR systems.

Optima MR360* 1.5T – versatility and value

Designed for customers needing strong performance, versatility, and outstanding value, the Optima MR360 delivers a broad range of advanced software applications, new RF technology enhancements, workflow automation features, and low overall cost of ownership.

For streamlining exams, the Optima MR360 incorporates the Express Exam approach to workflow, with many automated functions as well as hardware features that help reduce exam time.

The Optima MR360 boasts value: in addition to its competitive price, the system is part of the GE ecomagination family, using about 34% less energy than our previous generation systems. It also employs the highly reliable CXK4 magnet, and is part of the Continuum upgrade path to help ensure your system's capabilities keep up with the evolving technological innovation.

Brivo MR355* 1.5T – MR within reach

For the institution that is considering MR for the first time and wants a high-field system that's comprehensive, affordable, and intuitive, the Brivo MR355 is here. Capable of outstanding brain, neck, spine, abdominal, MSK, and vascular exams, the system aims to make advanced technology accessible worldwide.

New workflow automation features significantly reduce the number of inputs operators need to adjust before scanning – helping to improve consistency and reduce operator training time. The Brivo MR355 is high-field MR within reach – without compromising anatomical capabilities or image quality. ■

ContinuumPak 22.0 is Coming

Since the early 1980s, MR imaging has changed at a rapid pace – with new technology enabling a higher level of clinical utility. And change can be good. A more expansive set of clinical applications has helped you deliver excellent patient care. And new technology and productivity features has helped you image faster, with more consistent outcomes. At GE, we are proud of our Continuum, which is a philosophy of bringing many of these MR advances to our installed base.

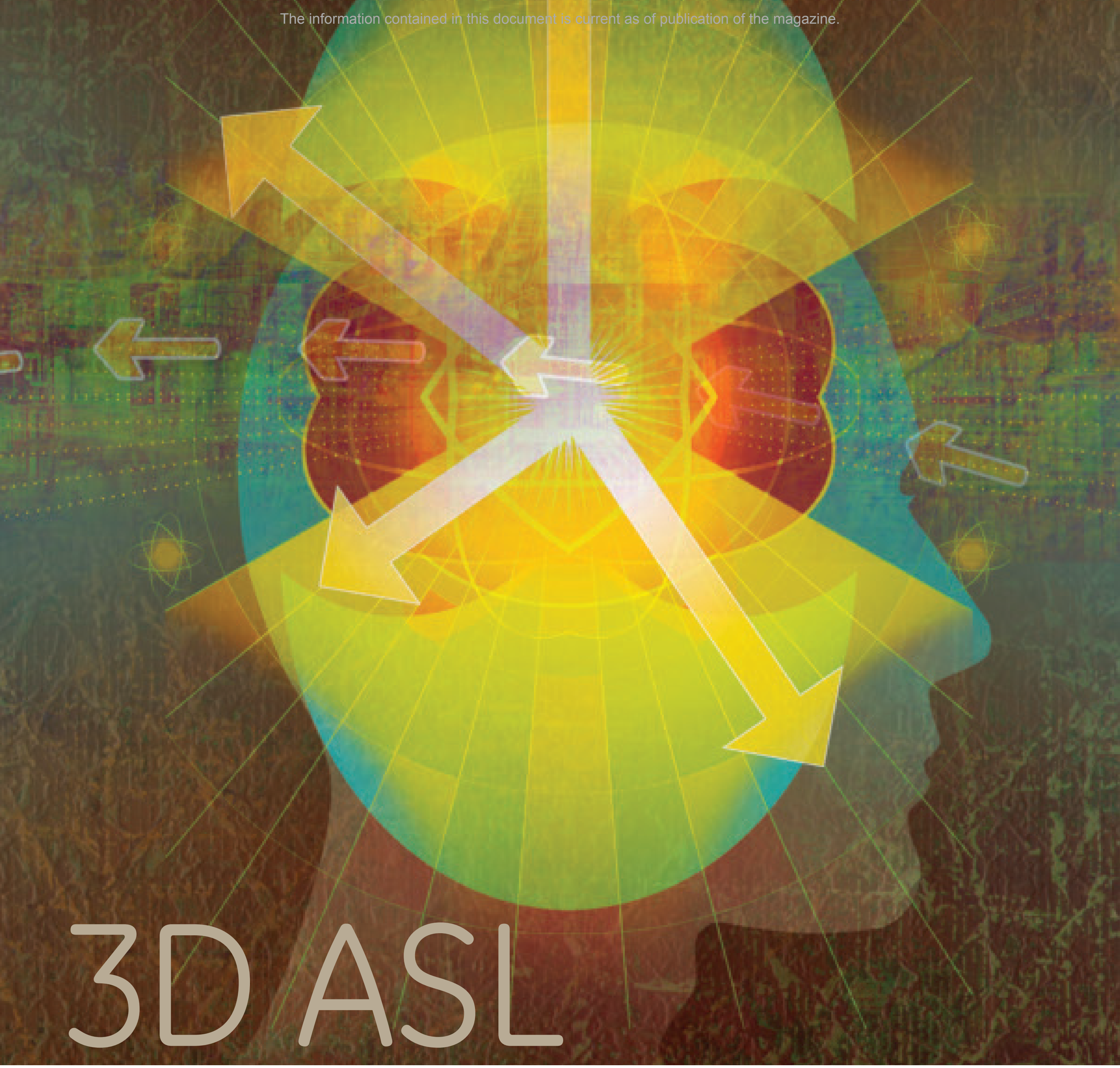
GE has been offering system upgrades since the early 1990s, and in today's challenging environment our ContinuumPak program is more important than ever.

Our commitment to helping you stay current continued in 2009, when we released ContinuumPak 15.0 to all of our Signa HDx customers globally. It included a number of platform and user interface improvements as well as some breakthrough clinical applications such as 3D Dual Echo, which generates registered out-of-phase and in-phase abdominal images in a single breath-hold. Associated with this release was also a rich portfolio of optional clinical applications such as the Inhance suite of NCE MRA techniques, IDEAL, Cube, and SWAN.

We will be releasing ContinuumPak 22.0 in 2010 and we are very excited about the value it will deliver to our Signa HDxt customers and our Discovery MR750, Discovery MR450 and Optima MR450w customers. The release will include productivity enhancements as well as optional advanced clinical applications such as the first ASL (arterial spin labeling) NCE perfusion assessment in 3D, with more robust, consistent performance compared to conventional ASL techniques. Look for more information on MR-Touch, our new MR elastography package. In addition, PROPELLER 3.0 will deliver excellent motion correction in diverse anatomies.

So stay tuned for this and other exciting announcements in 2010. ■

*510(k) pending at FDA. Not available for sale in the United States.



3D ASL Ready for Clinical use

By Hirohiko Kimura, MD, PhD, Professor, Department of Radiology, University of Fukui

Arterial spin labeling (ASL) is a means of non-invasive MR perfusion assessment, which can provide a quantitative value of cerebral blood flow (CBF). It is undisputed that the most advantageous merit of ASL is noninvasiveness as compared to methods that require the tracer injection to patients. It has been argued, however, that ASL perfusion images are not clinically reliable due to the inherent low signal-to-noise ratio (SNR) of current techniques. The latest ASL sequence, developed by GE Healthcare, 3D ASL, is a for both 1.5T and 3.0T and uses an SNR-efficient labeling technique, namely, pulsed continuous arterial spin labeling (pCASL), which allows it to be compatible with body coil excitation. In addition, it uses background suppression and a 3D FSE acquisition to provide robustness to motion and susceptibility artifacts. The result is whole-brain perfusion coverage with improved SNR (Figure 1).

Pulsed versus continuous ASL

There are two types of ASL: continuous ASL (CASL) and pulsed ASL (PASL). In CASL, the blood spins, pass through the labeling plane are repeatedly inverted to augment the brain perfusion signal. In PASL, a single pulse is used for the labeling, which usually attains less perfusion contrast than CASL. Although it is more difficult to implement CASL due to hardware demands, the perfusion signal is much stronger in CASL than PASL, making it easier to detect. Since the time between label and imaging is long in CASL, the perfusion signal is more homogenously distributed, resulting in the perfusion signal becoming less sensitive to arterial transit time.[2]

Since both PASL and CASL techniques have room for improvement, GE Healthcare has developed a pulsed-continous 3D ASL technique that provides the excellent image quality of continuous labeling approaches without requiring specialized hardware. In addition, since it is 3D, it is capable of imaging the entire brain in one scan.

Figure 2 demonstrates the comparison of a PASL and pCASL perfusion imaging technique from the same subject. The images show an over-estimation of CBF in the occipital cortex and thalamic regions on PASL maps, likely due to the delayed arterial transit time resulting in a larger vascular signal component.

CBF quantification

Quantitative measurement of CBF with 3D ASL signal depends on the model and its assumption with a number of parameters including labeling efficiency, cerebral blood volume (CBV), permeability of blood vessels, blood/brain partition coefficient, T1 of tissue or arterial blood, and arterial transit time (ATT). Patients with chronic occlusive cerebrovascular disease have longer ATT in the affected cortex. This could cause the underestimation of CBF values without ATT correction.[3]

CBF and ATT measurements using ASL in a patient with carotid artery stenosis

The 3D ASL sequence with background suppression was used for perfusion imaging on a Signa HD 3.0T.[1] The acquisitions with different post-label wait (PW) were also performed for the evaluation of ATT (PW=1.0, 1.5, 2.0, 2.5, 3.0 sec). PD (TR=2000 ms) and FLAIR (TR/IR=4300/1650 ms) sequences were also utilized for T1 and fully relaxed proton density images. Both CBF and ATT were calculated in a pixel-by-pixel basis using a two-compartment model.[3]

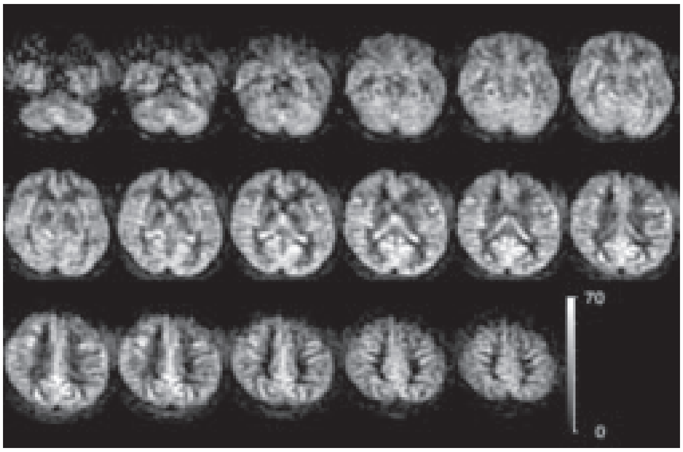


Figure 1. 3D ASL perfusion images of normal brain. 3D ASL prepped 3D FSE acquired with the total acquisition time of 6 minutes and the section thickness of 4.5 mm. Total of 35 sections cover the whole brain region from cerebellum to parietal brain region.

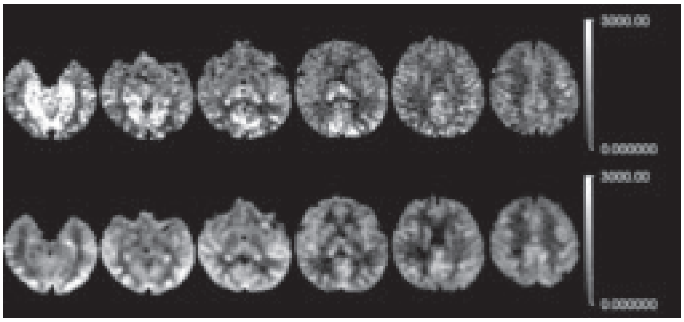


Figure 2. Top row: MR PASL and flow-sensitive alternating inversion recovery technique (FAIR). Bottom row: pCASL perfusion images from normal brain. Both FAIR and pCASL were acquired with the total acquisition time of 4 min and the section thickness of 7 mm. Other parameters of FAIR: TR/TE/TI/NEX=3000/16/1200/80; pCASL: TR/TE/ PW/NEX=5300/16/1200/46.

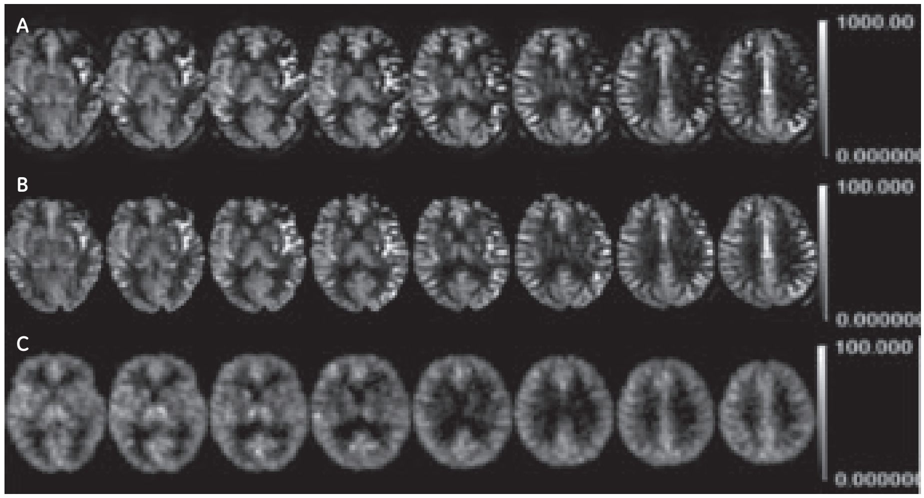


Figure 3. CBF maps from a patient with left ICA stenosis. A) ASL without delay compensation, B) 3D ASL with delay compensation, C) PET-CBF.

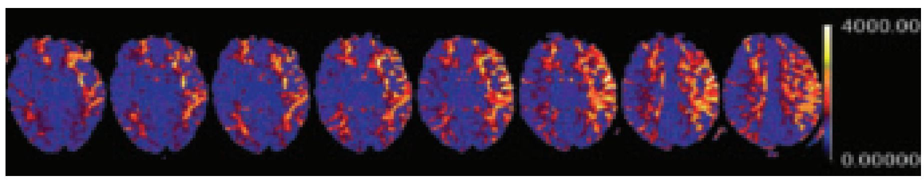


Figure 4. Arterial transit map. Same subject as Figure 1. Left cerebral cortical region is clearly imaged as longer arterial transit time.

Figure 3 shows 3D ASL-CBF maps with and without delay compensation in a patient with left carotid artery stenosis. The territory of left MCA is imaged as prominent perfusion defect with bright vascular signal. However, the slight hypo-perfusion of the left cortical region is observed in delay compensated 3D ASL-CBF maps. The left cerebral cortical lesion is clearly imaged as longer transit time on ATT maps (Figure 4).

Comparison of 3D ASL with PET

The 3D ASL perfusion values were validated by performing a pixel-by-pixel comparison with PET perfusion (Figure 5).

When compared with PET, the correlation of the CBF values between 3D ASL and PET were significant even with an altered hemodynamic state. The elongation of arterial transit time in the affected side was very consistent with the expected hemodynamics in occlusive cerebrovascular disease. The results of this study show 3D ASL is clinically applicable to patients with chronic occlusive cerebrovascular disease and the large range of hemodynamic conditions present.

Clinical application of 3D ASL perfusion imaging

When evaluating central nervous system tumors in a clinical setting using dynamic susceptibility contrast (DSC) perfusion imaging, high-tumor blood flow (TBF) or tumor blood volume (TBV) are the most commonly used criteria for high-grade gliomas. Early reports have shown that both ASL and DSC perfusion images enabled the distinction of high-grade from low-grade gliomas with hyper-perfused brain lesions.[4] Moreover, in some cases, ASL produces better contrast than DSC in the visual demonstration of tumor recurrence via hyperperfusion. Figure 6 shows both DSC and 3D ASL perfusion images in a patient with glioma in the left temporal lobe. The 3D ASL image reveals the hyper-intense perfusion signal, which is often a characteristic feature of malignant brain lesions. It is important to note that the focused lesion is located in the skull base region, where DSC-EPI is less reliable due to susceptibility-induced signal loss.

Summary

GE's 3D ASL sequence has successfully demonstrated the feasibility of continuous ASL-perfusion imaging with ATT compensation in chronic cerebrovascular disease. The correlation between the values of 3D ASL CBF and PET-CBF was significant on the pixel-by-pixel basis comparison. In a patient with a brain tumor, the 3D ASL signal produces a better contrast than DSC, even when the focused area is located near the skull base region, where DSC is unreliable due to the susceptibility-induced signal loss inherent with EPI. ■

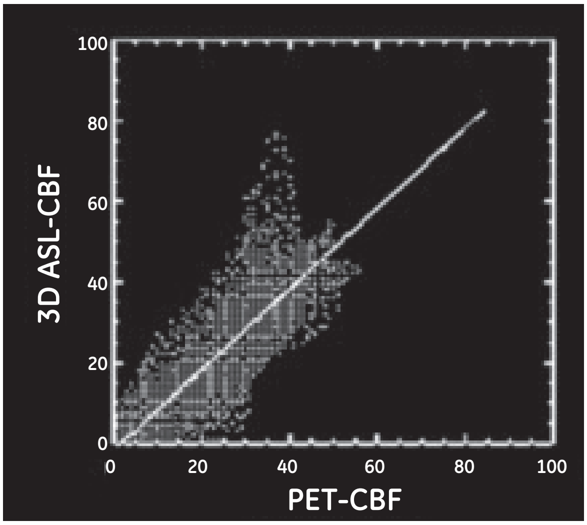


Figure 5. Plot of 3D ASL-CBF and PET-CBF values from a section through basal ganglia level. The linear regression line is drawn on the graph.

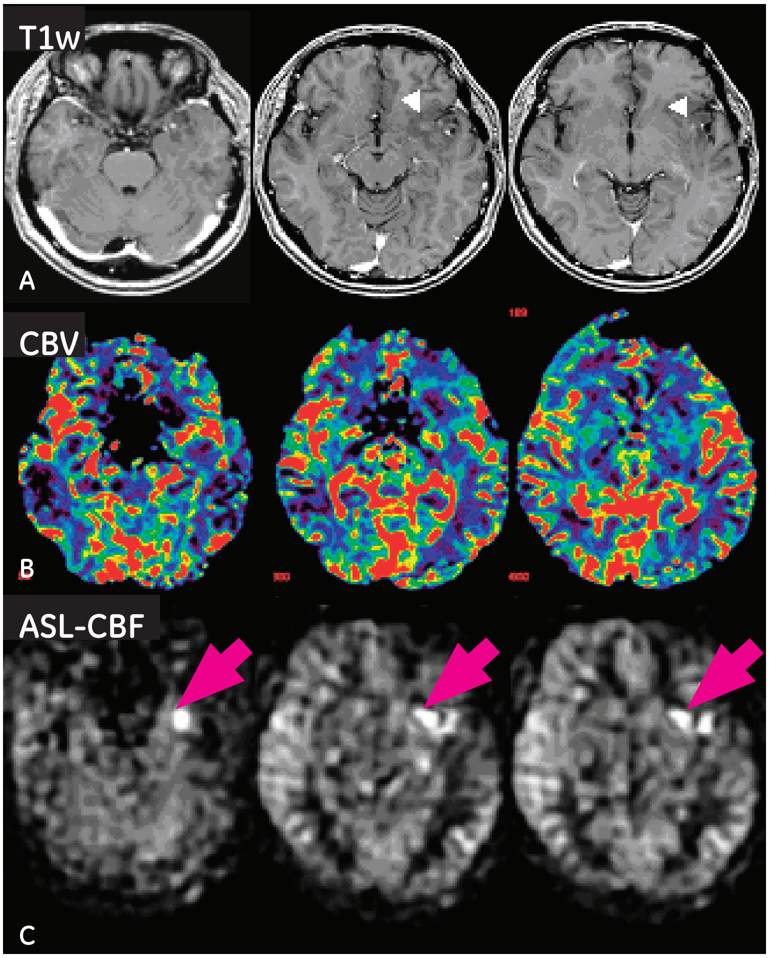


Figure 6. The comparison of DSC and 3D ASL perfusion images in a patient with brain tumor. A) Post Gd-T1 weighted images, B) T2 DSC perfusion images, C) ASL-CBF maps. Post Gd-T1w reveals the subtle contrast enhancement in the left insular region (arrow heads). It may be difficult to point out the increase of perfusion signal on T2 DSC CBV maps. The hyper intensity in the tumor lesion is clearly shown on ASL-CBF images (arrows).

Dr. Hirohiko Kimura

Hirohiko Kimura, MD, PhD, is a professor at the Department of Radiology, University of Fukui in Japan. Dr. Kimura has been extensively published for his ground-breaking work in MR and is recognized as an MR Thought Leader, 2010.

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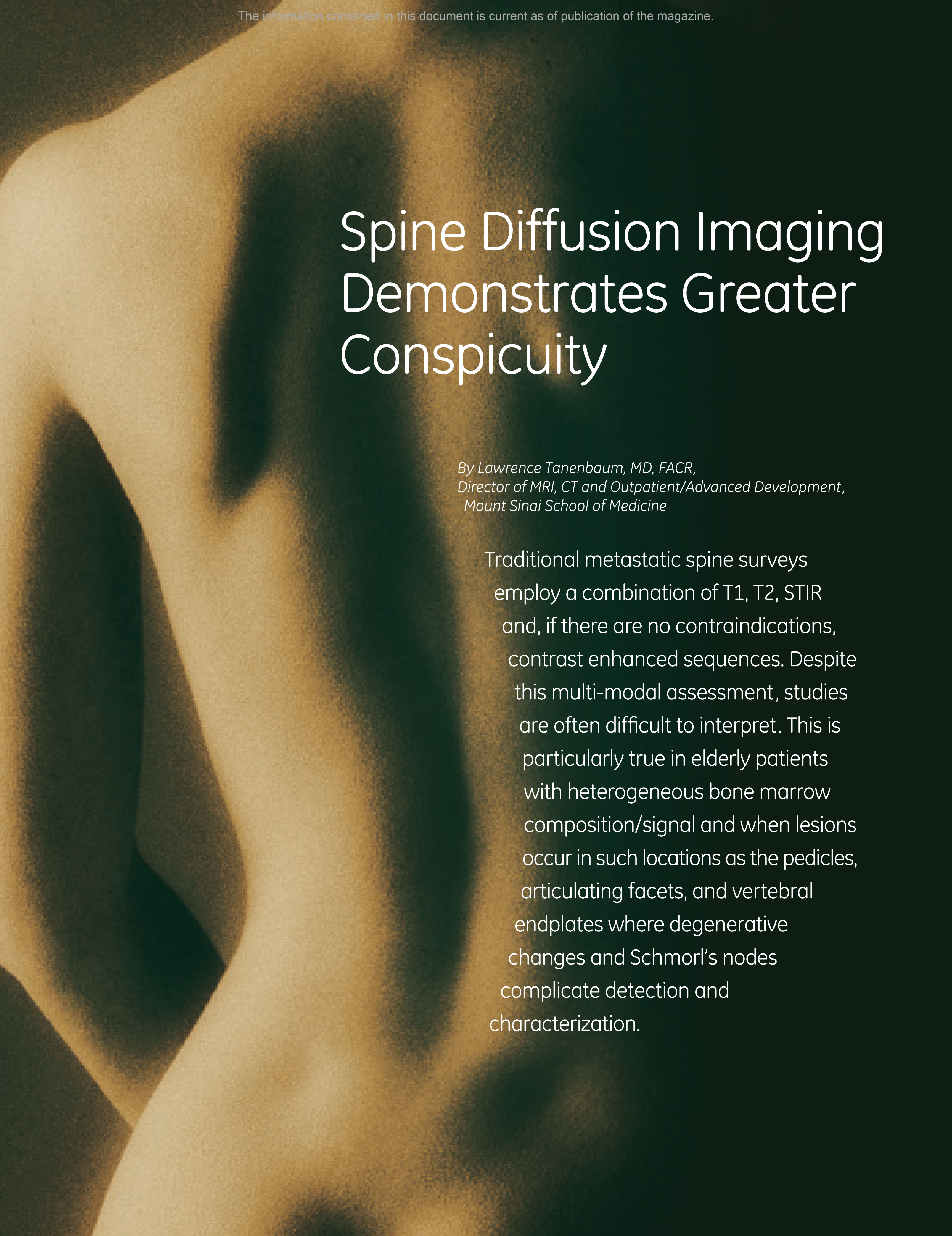


Spine Diffusion Imaging Demonstrates Greater Conspicuity

By Lawrence Tanenbaum, MD, FACR,
Director of MRI, CT and Outpatient/Advanced Development,
Mount Sinai School of Medicine

Traditional metastatic spine surveys employ a combination of T1, T2, STIR and, if there are no contraindications, contrast enhanced sequences. Despite this multi-modal assessment, studies are often difficult to interpret. This is particularly true in elderly patients with heterogeneous bone marrow composition/signal and when lesions occur in such locations as the pedicles, articulating facets, and vertebral endplates where degenerative changes and Schmorl's nodes complicate detection and characterization.

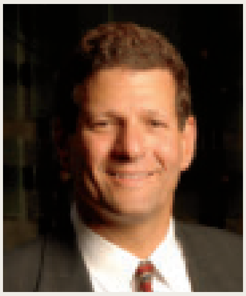
From a microscopic perspective, metastases are composed of densely packed cells that impede water diffusivity in surrounding bone matrix. Based on this observation, diffusion weighted imaging (DWI) may be a useful sequence to highlight the presence of spinal metastases. Several prior studies have shown limited success using DWI to differentiate metastases from benign compression fractures. This may be due to the complex heterogeneous composition of bone that is fractured with hemorrhage and edema confounding detection of tumor.

Recent advancements in high-field MR systems such as gradient enhancements, optical RF technology, parallel imaging, and phased array coils boost SNR and reduce distortion for echo-planar (EPI) based DWI techniques. These developments spurred our group to revisit the role of DWI in spine assessment of patients with known and suspected metastatic disease.

We retrospectively reviewed spinal surveys performed at our institution from June to November 2009 on nine patients with prior pathologic confirmation of spinal metastases at the time of imaging. All spinal surveys employed sagittal T1, STIR, and T2-weighted sequences. A contrast enhanced sequence was obtained if there were no contraindications to gadolinium-based agents. In addition, an EPI DWI sequence was obtained (3 to 6 directions, b value 500 to 800) in the sagittal plane.

Studies were consensus reviewed twice by two experienced radiologists and each lesion was graded separately. In the first review, only the T1, STIR, and (if available) contrast enhanced sequences were reviewed, and each lesion was graded on a scale of 1 to 4 (1 = missed lesion that was visible only in retrospect on second review; 2 = equivocal lesion; 3 = probable lesion; 4 = definite lesion). Subsequently the DWI sequence was reviewed in conjunction with conventional sequences. Lesions were again graded on a scale of 1 to 4 based on additional information garnered from their diffusion characteristics. In addition, conspicuity on diffusion was compared to conventional sequences.

	2D DW EPI # shots 1, B 500	2D FSE T1 FLAIR	2D FSE T1 FLAIR Fat Suppression	2D FSE – STIR
TE	MIN	36	36	42
TR	3700	1700	2100	2350
TI	160	660	660	150
ETL		8	8	12
Bandwidth		42	42	62
FOV	28	31	31	31
Thickness	4	4	4	3
Spacing	1	1	1	1
Freq Matrix	128	448	448	448
Phase Matrix	128	192	192	224
NEX	8	4	4	2
	1.0 PHASE FOV			
Frequency Direction	S/I	A/P	A/P	A/P
	AUTOSHIM			
Options	Spin Echo	No Phase Wrap	No Phase Wrap	No Phase Wrap
	IR Prep	Sequential	Sequential	Tailored RF
	EPI	Tailored RF	Tailored RF	
	Diffusion	Fast	Fast	



Dr. Lawrence N. Tanenbaum, FACR

Lawrence N. Tanenbaum, MD, FACR, is Director of MRI, CT and Outpatient/Advanced Development, Mount Sinai School of Medicine (MSSM). The school opened its doors in the fall of 1968 and has since become one of the world's foremost centers for medical and scientific training. Located in Manhattan, MSSM works in tandem with The Mount Sinai Hospital to facilitate the rapid transfer of research developments to patient care and clinical insights back to the laboratory for further investigation.

About the facility

Mount Sinai Medical Center, named to U.S. News & World Reports 2009-2010 Best Hospitals Honor Roll and ranked 19th nationally, treats nearly 47,000 inpatients and 427,000 outpatients each year. Renowned for its spinal cord and brain injury rehabilitation, Mount Sinai was the first medical school to establish a Department of Geriatrics, as well as departments of environmental and occupational medicine. With more than 3,000 full-time and voluntary physicians on staff, the hospital is a regional leader in numerous specialties and the world's only center for the diagnosis and care of Jewish genetic diseases.

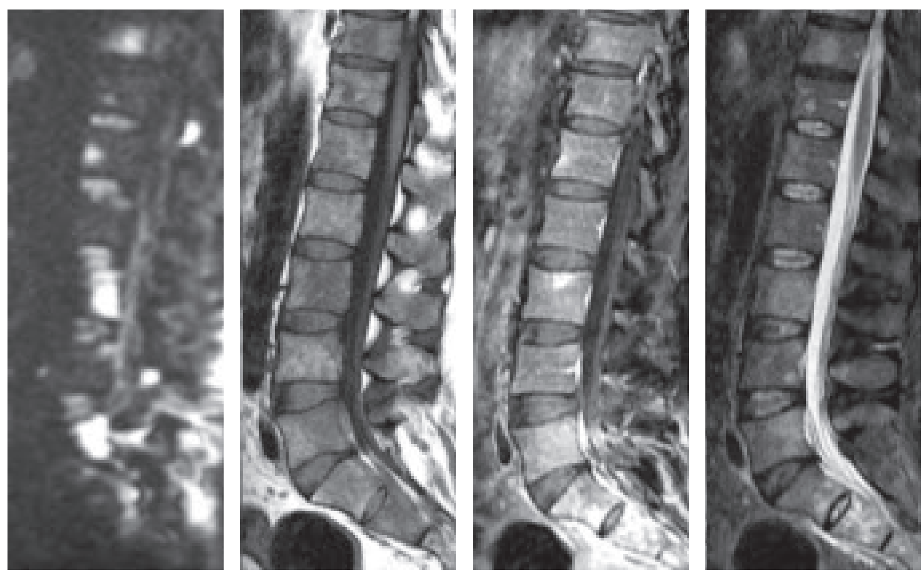
Results

A total of 90 spinal lesions on the nine patients were evaluated. One patient had colon cancer; two patients had hepatocellular carcinoma; two patients had non small cell lung cancer; two patients had breast cancer; one had bladder cancer; and one had poorly differentiated adenocarcinoma.

In terms of conspicuity on DWI compared to conventional imaging:

- 26 of 90 (29%) were deemed similar or unchanged;
- 41 of 90 (46%) were more conspicuous on the diffusion sequence;
- 17 of 90 (19%) were more conspicuous on conventional sequences; and
- Six lesions identified on the DWI sequence were initially missed on conventional sequence evaluation.

Overall, confidence of diagnosis was modified on 44% of the lesions after evaluation of the DWI sequence.



SSEPI DWI B 500 | T1 FLAIR | T1 FLAIR post contrast with fat suppression | FSE STIR

Figure 1. Metastatic disease: Note the striking boost metastatic lesion conspicuity, particularly with respect to the smaller lesions, on the DWI study (left) compared to the unenhanced T1 (left middle), enhanced T1 (right middle), and STIR (right).

Conclusion

DWI is a rapid pulse sequence that may practically be added to the routine MR imaging regimen in patients with suspected spinal metastases. It can improve sensitivity of lesion detection and assist in lesion characterization, especially in problematic locations. While previous studies showed mixed results with diffusion-based imaging of the spine, new MRI systems with stronger and faster gradients as well as new coils can improve the signal to noise of acquired images while using intermediate b values of 500 to 800.

Our study has shown that DWI can improve the conspicuity of spinal metastases and assist in diagnosing smaller lesions that would have otherwise been missed. In addition, added information from diffusion can assist in the diagnosis of metastatic lesions in problematic areas such as the vertebral endplates, where Schmorl's nodes can be confused with metastases. ■

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Big Time Savings for Little Patients

Head-neck-spine coil provides convenience, flexibility, and efficiency

By Russell Low, MD, Medical Director, Sharp and Children's MRI Center

One of the challenges in MRI commonly involves imaging large anatomic areas in very small patients. For example, a combined MR study including the brain and entire spine (e-spine) is ordered 2- to 3-times per day at our center. Common indications for this combined study might include cancer staging in oncology patients, evaluation of a syrinx, assessment of neurofibromatosis, or as a screening exam in trauma patients.

Image acquisition of the brain and e-spine is comprised of four separate studies including the brain, and the cervical, thoracic, and lumbar spine. Traditionally, this required several different scans and at least two separate coils, requiring the technologist to stop the scan, lift the patient to remove and replace the head coil with the spine coil, followed by repositioning and re-landmarking prior to starting the next scan. The result is a lengthy imaging procedure, which can be further complicated if pre- and post-contrast imaging is required for each anatomic area. There is the added risk that the patient will awaken from anesthesia during repositioning, further lengthening the exam time. And since many patients are in pain, movement should be kept to a minimum.

While the technologists at our facility became very adept at this cumbersome imaging process, we preferred to implement a coil that would allow us to scan the entire head and spine without moving the patient. Time savings in the MR scanner would improve efficiency and patient safety by decreasing the time of anesthesia. However, prior commercial attempts to combine a head, neck, and spine coil suffered from poor image quality and lack of flexibility in patient positioning and image acquisition.

Mike Frederick, Lead MRI Technologist at SCMRI, demonstrates positioning of the HD HNS array on a pediatric patient.

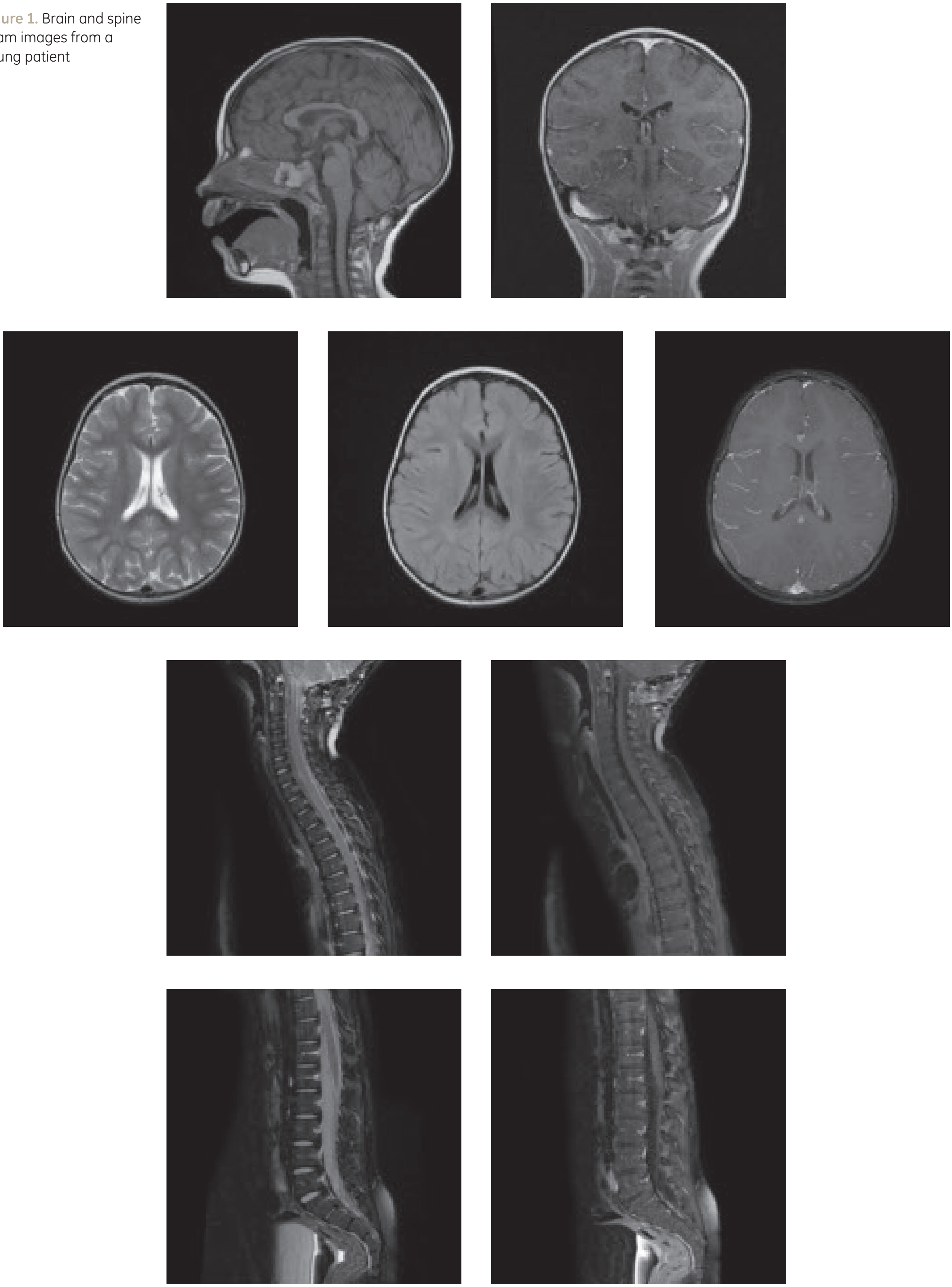


Figure 1. Brain and spine exam images from a young patient

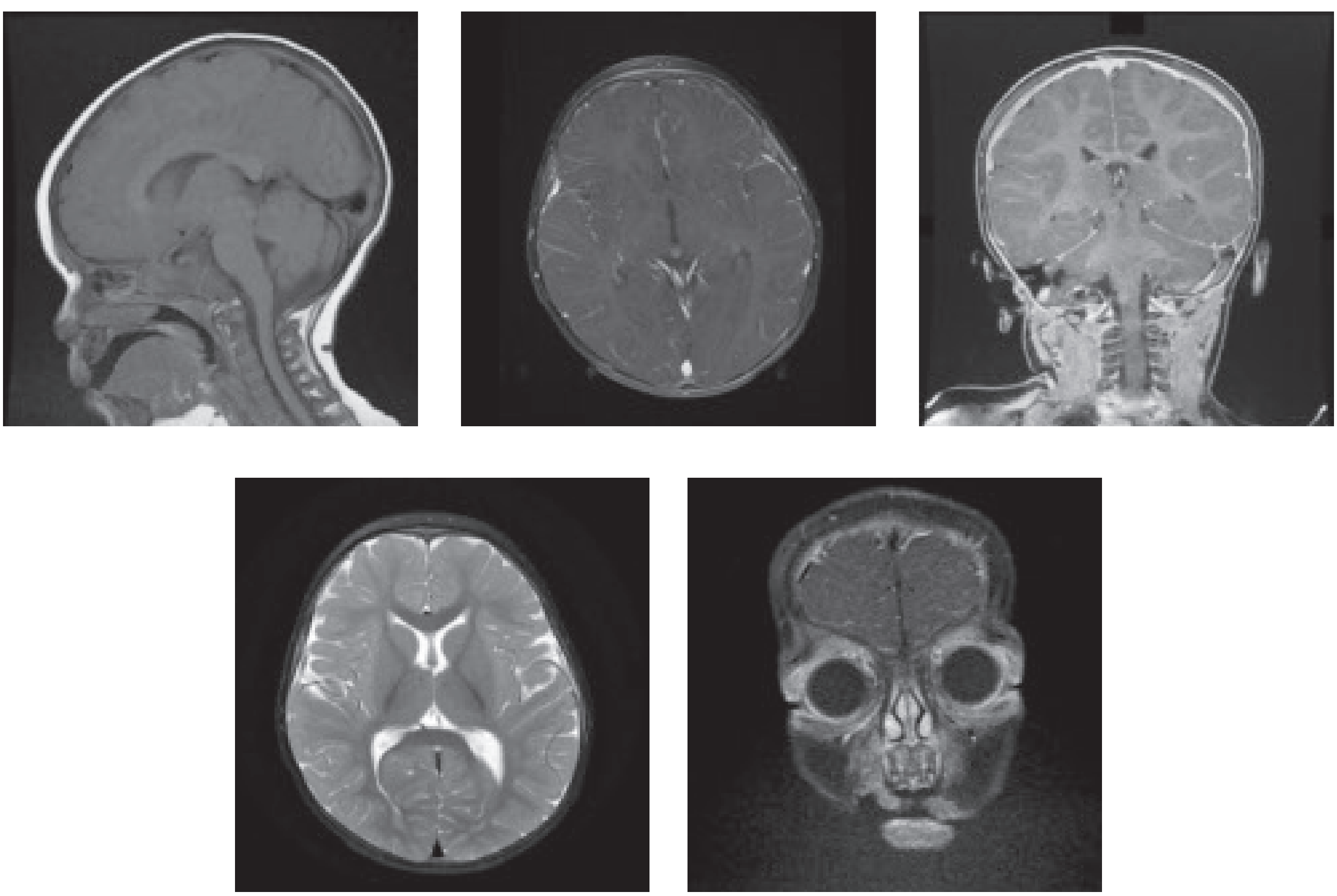
We are saving between 15 and 20 minutes per patient, enabling us to scan at least one additional patient per day...

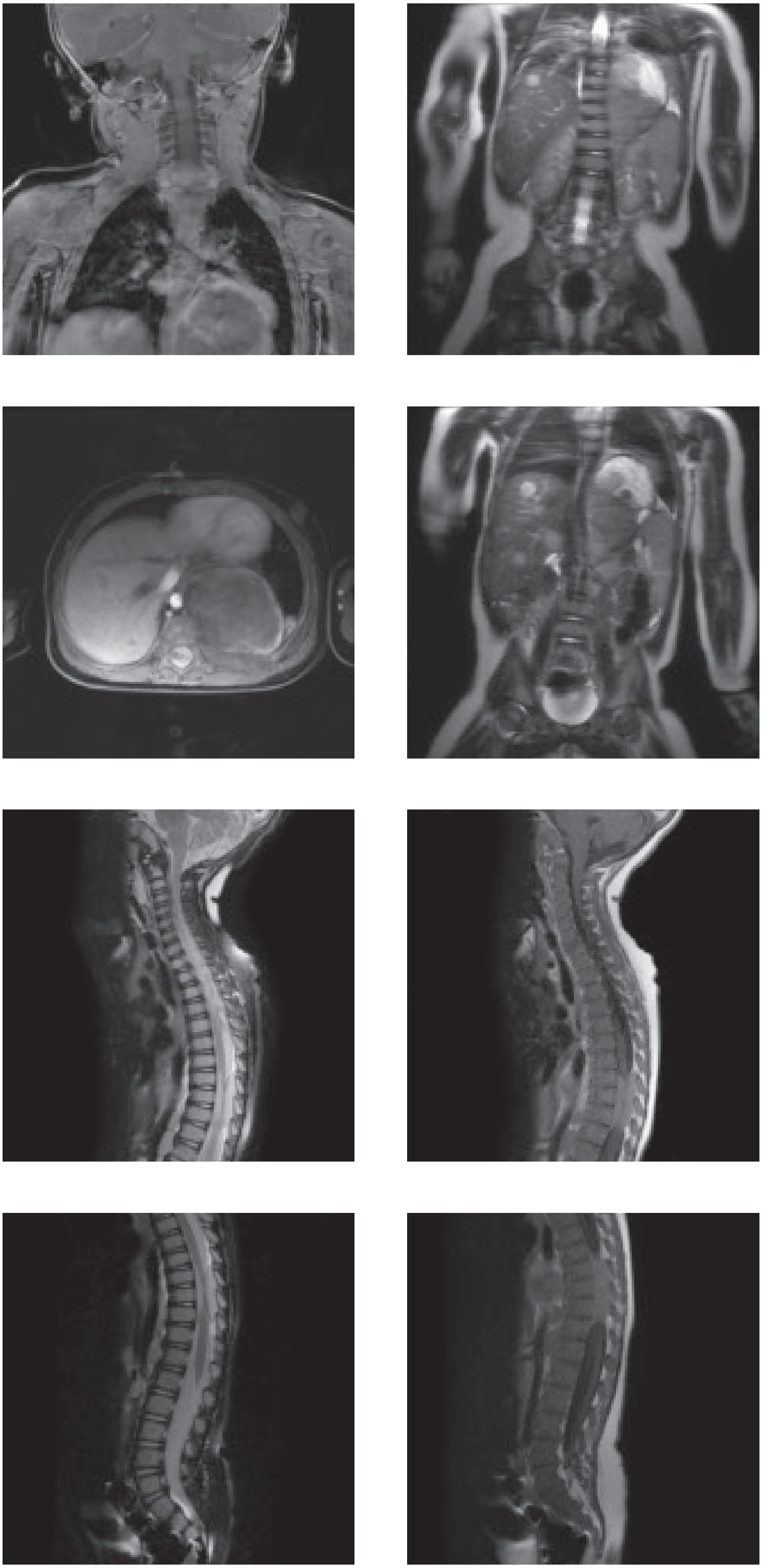
The introduction of the HD head-neck-spine (HNS) array offered a possible solution for resolving these issues. GE Healthcare's HNS coil is a 16-channel, high-definition array with 29 anatomy-specific, high-density coil elements to improve image quality. The HNS array features separate posterior coils for the head and entire spine with two additional anterior components that cover the front of the head and neck.

In November 2009, we received the HNS array and immediately saw its potential for imaging small patients. The results were extraordinary. Our technologists found the HNS array to be very flexible for performing brain, neck, and spine studies in just one scan without having to move the patient. They can activate different elements in the head, neck, or spine components of the coil providing greater flexibility that works well for scanning different-sized patients. Most important for the technologists, they no longer have to stop the scan, switch coils, and reposition the patient.

"The HNS array helps to minimize scan time by allowing you to completely eliminate making coil changes during multiple exams. It also eliminates moving the patient, which is essential with anesthesia and trauma patients," says Mike Frederick, Lead MRI Technologist at SCMRI. "The image quality is excellent with reduced scan time and element selection allows for a large variety of coil configurations that provide us with greater flexibility for imaging our pediatric patients."

Figure 2. Patient with metastatic tumor. All nine exams were performed without moving the patient or changing coils in 30 minutes less than similar prior exams.





Dr. Russell N. Low

Russell N. Low, MD, is Medical Director at Sharp and Children's MRI Center in San Diego and since 1991 has practiced with San Diego Imaging Medical Group. He received his medical degree from the University of California, San Diego, with honors and participated in the NIH Research Training Program. Dr. Low interned at St. Mary's Hospital and Medical Center in San Francisco and completed his residency in diagnostic radiology at the University of California, San Francisco and his fellowship in MRI/CT/Ultrasound at Stanford University Medical Center. He has authored numerous articles, several book chapters and is a frequent speaker at symposiums and conferences, including RSNA and ISMRM.

About the facility

Sharp and Children's MRI Center, LLC was founded in 1986 by Sharp HealthCare, Rady Children's Hospital and San Diego Imaging Medical Group to provide comprehensive diagnostic imaging for children and adults. The MRI Center is dedicated to providing the highest levels of service to our patients in a relaxed, caring, and supportive environment. We are one of the few diagnostic imaging centers in the San Diego area to offer the comfort of anesthesia for both infants and children.

Sharp HealthCare is a not-for-profit integrated regional health care delivery system based in San Diego, California. Sharp includes four acute care hospitals, three specialty hospitals and three medical groups, plus a full spectrum of other facilities and services. Rady Children's Hospital-San Diego is a 261-bed integrated pediatric healthcare system that treated more than 136,300 inpatients and 220,791 outpatients in 2009. The hospital and its physicians are nationally recognized for excellence by U.S. *News & World Report*, *Parents* magazine, Best Doctors, Inc., and *San Diego Magazine*.

With each brain and e-spine study we are saving between 15 and 20 minutes per patient, enabling us to scan at least one additional patient each day, depending upon indications.

Radiologists also find that the image quality is excellent, and at least as good as we obtained when using separate coils for each body region.

Our very creative technologists have found a multitude of uses for this very flexible HNS array coil. For instance, we can image the carotid arteries, neck, and brain in one exam.

In some smaller patients, we can use the anterior neck element to scan the chest without using an additional coil. Currently, the record is nine exams using the HNS array coil in a single small patient without repositioning or changing the coil! That type of flexibility has made the GE HNS array an indispensable part of our MR imaging program. ■

Putting Patients First

Offering non-invasive fibroid treatment is only part of the story – this center offers patients something they can't always find: time

In 2008, Klinikum Dachau, a hospital of Amper Kliniken AG, Germany, founded the Myomzentrum, a center for the treatment of uterine myoma, a benign tumor also known as a fibroid. As part of its extensive range of treatments, the center introduced MR-guided Focused Ultrasound (MRgFUS), a non-invasive outpatient treatment for uterine myoma that employs focused ultrasound waves to destroy fibroid tissue using MR images to guide treatment.

Initially, Myomzentrum utilized the hospital's MR system to capture images of the uterus. Patient volume hovered around 12 cases per month. Continued interest in the procedure, however, as well as high patient satisfaction, led the company to purchase a ExAblate 2000 and dedicate it to MRgFUS. Treatments commenced on the new MRgFUS in the beginning of March, 2010.

Patient service key to success

According to Dr. Matthias Matzko, Chief Physician of Interventional and Diagnostic Radiology at the center, patient service is at the heart of the unit's success. "Our staff is accessible to patients at all times, listening carefully to their needs and concerns, and spending sufficient time explaining all the available treatment options," he explains. "We're with our patients from the initial phone contact through follow-up."

Women can contact the center via a 24-hour MRgFUS hotline, where fully trained nurses provide detailed information on MRgFUS as well as other treatment options. "Nurses have spent up to two hours talking to a single caller to answer all their questions," adds Dr. Matzko. Potential patients can receive additional information upon request or access the center's website for detailed information on treatment options and FAQs.

All women undergo a thorough patient selection process that begins with an initial MRI, which can be conducted near their home or at the center, explains Dr. Matzko. Patient's can then discuss the results with a member of Myomzentrum's radiology team or immediately schedule the procedures.

The center's location in the hospital is a key patient benefit, explains Dr. Matzko. "While MRgFUS can be performed in an ambulatory environment, patients are reassured knowing they can stay overnight if needed. MRgFUS is a relatively new treatment and patients don't really know what to expect. Being in a multidisciplinary environment helps further allay their concerns," he says.

Each week, the team holds inter-disciplinary conferences to discuss the different cases and therapy options – especially when it comes to complex cases – before deciding on the best treatment for each patient. "Working under one roof enhances the MRgFUS process and quality of treatments. It's important for our patients' care that we work together and share information to ensure the best possible treatment."

Dr. Matzko points out that if a patient is not a candidate for MRgFUS, the hospital offers additional available myoma treatments, including embolization, myomectomy and hysterectomy. Once the patient is in contact with the center, they tend to have their minimally invasive or surgical treatment at the hospital, he says.

"Patients come from all over Germany and other parts of the world because they feel comfortable, well-informed and know our facility can provide them the best possible care," he adds. "In fact, the wife of a former German politician was treated with MRgFUS at the unit. The couple were so delighted by the results of the treatment that they wrote a letter to hospital management. It seems that patients are developing a passion for non-invasive treatments such as MRgFUS."

Web site drives patient recruitment

Between 90 and 95% of patient recruitment comes from the Myomzentrum's Web site, currently ranked third in Internet search results. The use of Google Adwords has played an important role in increasing traffic to the site, which is becoming known as a powerful informational tool and source of inquiries.

Unfortunately, only a small number of gynecologists are aware of this option, according to Dr. Matzko, so few are informing patients about MRgFUS and referring them to the clinic. "When we do get referrals, we try to build relationships with the gynecologists and share information to build a common therapy strategy," he says. However, in more than half the cases, patients arrive without a gynecological referral.

Treatment success spurs reimbursement

The clinic recently signed an agreement with Debeka, a private health insurance company, after representatives paid an onsite visit and saw the treatment statistics. "The success of the procedure was very important, as the company did not want to cover a procedure that might fail," he explains. Dr. Matzko believes the excellent treatment results are largely due to the patient selection process. In his experience, about 33% of women with uterine fibroids are approved to receive MRgFUS treatment. Plus high patient satisfaction has helped establish MRgFUS as an accepted therapy option, an important step in launching a new procedure.

According to Fibroid Relief, a patient-support organization launched by the FUS Foundation (www.fibroidrelief.org), a woman must be negative for each of the following factors in order to be considered for MR-guided Focused Ultrasound. Additional medical criteria should be determined by a physician:

- Any reason to avoid MRI;
- Has surgical scarring, clips, or IUD that could interfere in the path of ultrasound waves;
- Has received abnormal PAP smear results within one year, or has acute pelvic infection, uterine cancer, or is post-menopausal;
- Is pregnant or desiring to become pregnant; and
- Has a uterus larger than the equivalent of a six month pregnancy or severe anemia.

Dr. Matthias Matzko

Matthias Matzko, MD, is the chief physician of interventional and diagnostic radiology at AmperKlinikum hospital in Dachau, Germany. Dr. Matzko received his medical degree in Radiology from LMU München and currently is the lead physician and CEO of the FUS-Center in Dachau.

About the facility

The FUS-Center, a center that is specifically focuses on providing painless uterine fibroids therapy MR-guided focused ultrasound (MRgFUS). The FUS-Center is one of the first providers in Germany to offer MRgFUS treatment to women.

Treatment success has also led the center to discuss reimbursement with one of Germany's leading public health insurers. An estimated 80% of Germans are insured under public health schemes, and Dr. Matzo expects an agreement could significantly increase the number of patients opting for MRgFUS treatment.

The future is non-invasive

With demand for the procedure expected to grow, the center anticipates providing 300 to 500 MRgFUS treatments each year. Dr. Matzko hopes to offer MRgFUS for other clinical areas that are currently being researched by InSightec, developers of the ExAblate®2000 MRgFUS system. "MRgFUS could do for men what it has done for women – offer a non-invasive, outpatient treatment undertaken in a short time," he says. ■

About ExAblate

Currently, the only FDA-cleared system for MRgFUS is the ExAblate2000 from InSightec, Ltd. To identify the treatment volume, the ExAblate uses conventional diagnostic MR images taken at the beginning of treatment. The physician delineates the tumor and defines treatment pass-zones that will avoid energy passage through sensitive tissue. The physician selects an application-specific treatment protocol that determines the main attributes of the planned treatment. The system then computes a treatment plan, composed of 20 to 100 sonication points that cover the specified target. During treatment, the system's robotic system positions the transducer below the target point and delivers the planned energy.

A key feature of ExAblate is its ability to provide real-time monitoring of energy deposition. During energy deliver, ExAblate directs the MR to continuously acquire thermal images that include the point being treated and the surrounding anatomy. These images, once processed, provide the essential feedback of where the energy is delivered and the temperature reached. This quantitative feedback allows the physician to monitor and adjust treatment parameters.

The workstation displays thermal images and compute and displays the treated regions. Spots are treated in sequence. The process of adjusting parameters and sonicating under real-time MR imaging continues until the planned volume of treatment is fully treated. Viewing images of the region immediately following treatment enables the physician to evaluate the treatment outcome.

According to sources at InSightec, over 5,500 women have been treated with ExAblate with close to 92% experiencing symptom relief.

Elevating the Quality of Abdominal and Pelvic Imaging with 3.0T

By Laxmi Narayana Lanka, MD, Bina Lanka, MD and Stephen Butler, RT Midland MRI

For abdominal imaging, most industry professionals agree that using a 1.5T MR system can provide optimum results. The improved signal-to-noise ratios (SNR) and new sequences on the Discovery™ MR750 3.0T, however, prompted us to investigate if 1.5T was still considered to the preferred imaging solution for abdomen and pelvis. Having scanned at both 1.5T and 3.0T, we found the extra signal to noise at 3.0T allows us to decrease our FOV and increase our resolution.

Sequences

Increased separation of fat and water signal allows uniform fat suppression that is clinically useful. IDEAL obtains fat suppressed and non-fat suppressed data in one acquisition, thus decreasing the duration of the scan.

Longer tissue T1 and higher net SNR at 3.0T assist in increasing conspicuity of gadolinium enhancement, even though the relaxive properties of gadolinium are not significant between 1.5 and 3.0T. The LAVA-Flex sequence illustrates this.

ARC is a self-calibrating, data-driven parallel imaging technique that synthesizes missing data from neighboring source data in all three imaging dimensions. It is less sensitive to motion artifacts that would occur between the calibrations and accelerated scan. ARC, available on a wide range of sequences and coils, projects aliased anatomy to the edges of the image allowing FOVs smaller than the anatomy being scanned.

Although increased signal can increase movement artifacts, increasing RF receive bandwidths to obtain a shorter data sampling time reduces these effects.

Abdominal imaging

The respiratory-triggered T2 FRFSE sequence provides excellent lesion-to-liver contrast, which can improve lesion detection particularly in liver imaging (Figure 3). Improved contrast resolution in the post gadolinium sequences enables better characterization of liver lesions.

With the IDEAL based LAVA-Flex sequence, we can obtain 3D Gradient T1w fat saturated sequences in 14 to 18 seconds in a single breath hold for most patients. This robust sequence, used extensively in our practice, is illustrated in a renal cell carcinoma with vena caval invasion (Figure 4).

Improved SNR and better fat saturation also translates into effective MRCP sequences. This technique is particularly useful in visualizing the segmental biliary ducts and the pancreatic duct (Figure 5).

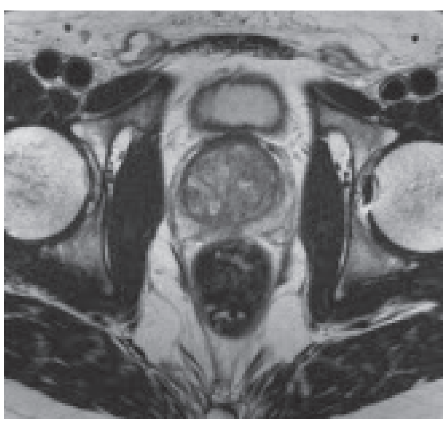


Figure 1a. Axial T2w FSE images of a patient with fluctuating PSA and negative biopsy. 1.5T image was obtained 15 months prior to 3.0T image.

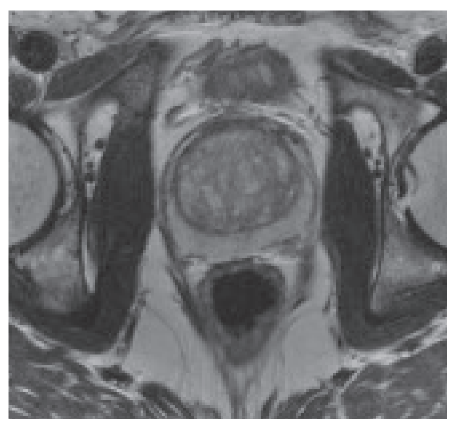


Figure 1b. Higher SNR and small FOV show no suspicious areas on the 3.0T images.

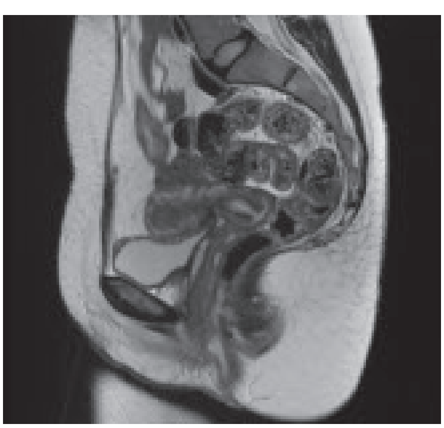


Figure 2a. 1.5T sagittal FSE images in a patient with a fistula-in-ano.

Figure 2b. 3.0T image demonstrates improved image quality and better delineation of the tract than 1.5T (see figure 2a).

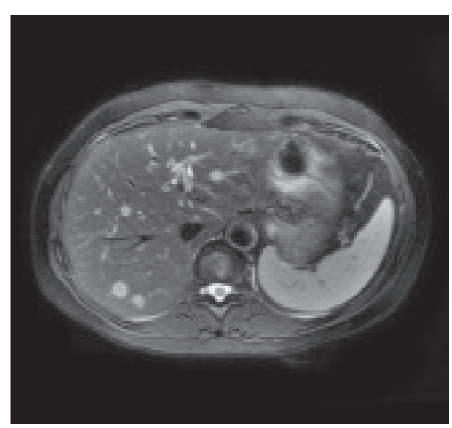


Figure 3. Axial T2 respiratory triggered FRFSE images indicate multiple liver metastases. The high lesion to liver contrast is also apparent.

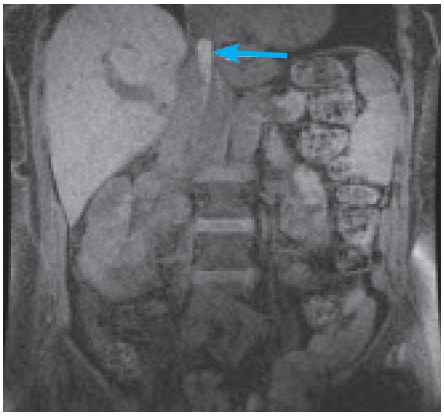


Figure 4a. Coronal pre gadolinium LAVA-Flex image in a patient with a right renal carcinoma. High signal bland thrombus (arrow) is seen in the IVC on the non-contrast image.

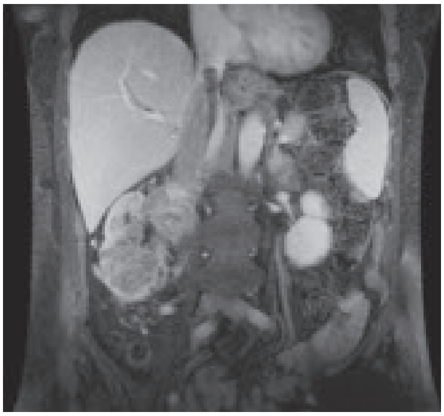


Figure 4b. Post gadolinium coronal LAVA-Flex image shows the enhancing renal cell carcinoma with enhancing tumor thrombus in the lumen of the IVC with the bland thrombus seen of low signal adjacent to it.

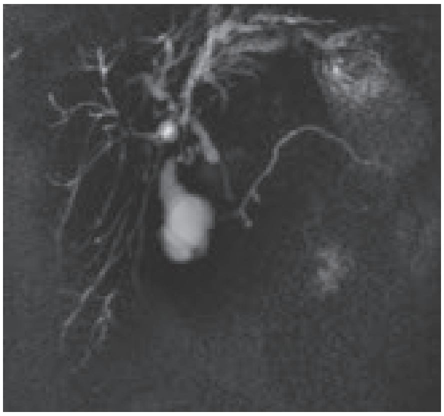


Figure 5. Thick slab MRCP image in a patient with Primary Sclerosing Cholangitis (PSC) showing multiple peripheral intrahepatic strictures and a mid-CBD stricture.

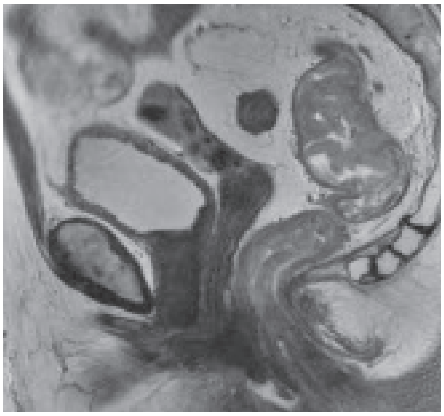


Figure 6a. Carcinoma in the middle third of the rectum is apparent in the sagittal T2w FSE image.

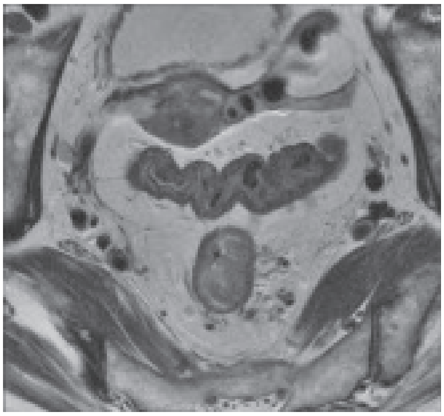


Figure 6b. Oblique axial high resolution T2w FSE image shows the component of the tumor in the rectum. The layers of the bowel wall are also clearly depicted in the normal sigmoid colon.

Pelvic imaging

Improved SNR and higher resolution, enables acquisition of 3 to 3.5 mm thick slices for all pelvic scanning with an in-plane resolution of 0.4 mm^2. Improved visualization of layers of the bowel wall allows more accurate staging of rectal carcinomas (Figure 6).

Reliable fat suppression along with improved spatial resolution helps characterize indeterminate masses and assess their relationship to adjacent structures and the peritoneum (Figure 7).

In patients diagnosed with endometriosis, the high spatial resolution enables detection of endometriotic implants and bowel involvement with an accuracy not previously seen (Figure 8).

Confident assessment of the female pelvic organs for congenital anomalies is now possible with improved SNR allowing visualization of anatomical detail, in particular the septum (Figure 9).

Bowel and peritoneum

A combination of SSFSE, FIESTA and LAVA-Flex dynamic water only sequences help assess the small bowel for strictures, skip lesions and internal fistulae in patients with Crohn's disease (Figure 10).

A combination of high resolution T2W sequences and post gadolinium dynamic LAVA-Flex series are useful for detecting diffuse or localized peritoneal disease in abdominal and pelvic malignancies. Large FOV coronal LAVA-Flex sequence particularly can improve diagnostic accuracy in determining the extent of peritoneal disease (Figure 11).

Dr. Laxmi Narayana Lanka

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Dr. Bina Lanka

Bina Lanka, MD, FRCR, is a consultant radiologist at Waikato Hospital and Midland MRI. She specializes in oncology and pelvic imaging.

Stephen Butler, RT

Stephen Butler MHSc (MRI) is operations manager and charge MRI technologist at Midland MRI.

About the facility

Midland MRI is a radiology group practice providing dedicated MRI services to the greater Waikato region of New Zealand. Their advanced imaging equipment includes the first Discovery MR750 3.0T system installed in New Zealand and a Signa HDxt 1.5T MR scanner. The radiology group offers neurology, MSK, body, vascular, breast, and cardiac MR imaging services.

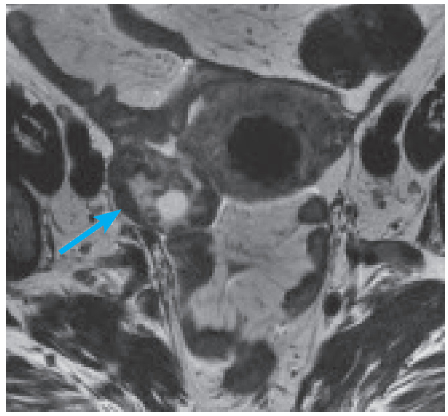


Figure 7a. Axial high resolution T2w FSE image demonstrates invasion of the pelvic side wall fat by the right ovarian mass (long arrow).

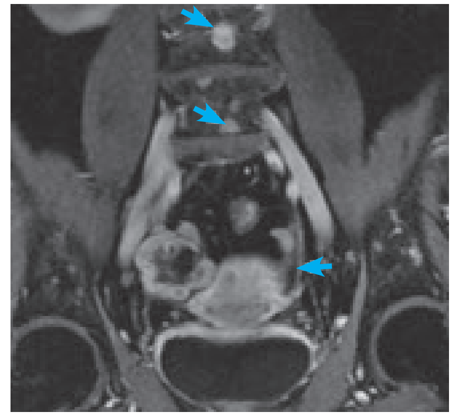
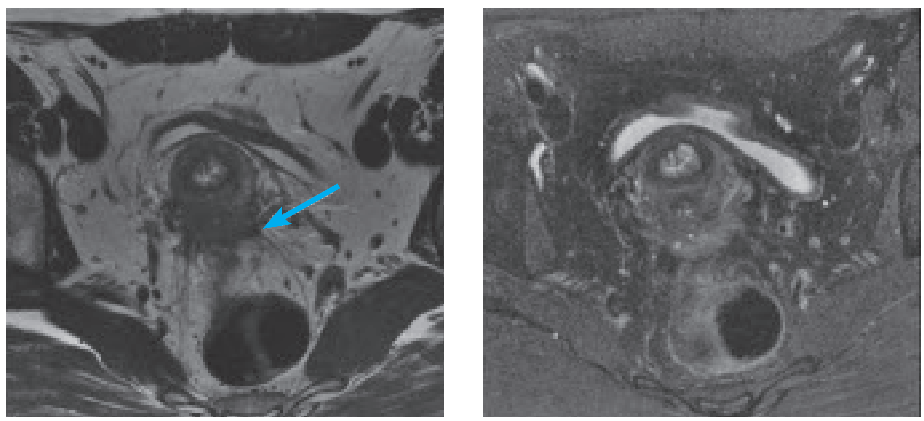


Figure 7b. A coronal post gadolinium LAVA-Flex image shows the enhancing mass, pelvic peritoneal disease and metastases in the lumbar vertebrae (short arrows). The patient was later diagnosed with metastatic lobular carcinoma of the breast.



Figures 8a and 8b. High resolution T2w FSE (8a) and fat suppressed T2w FSE (8b) images in a patient with known endometriosis. An endometriotic implant in the pouch of Douglas is seen with fibrotic adhesions extending to the mesorectal fascia (arrow). The T2 fat-suppressed image shows the multiple tiny cystic spaces in the endometriotic implant.

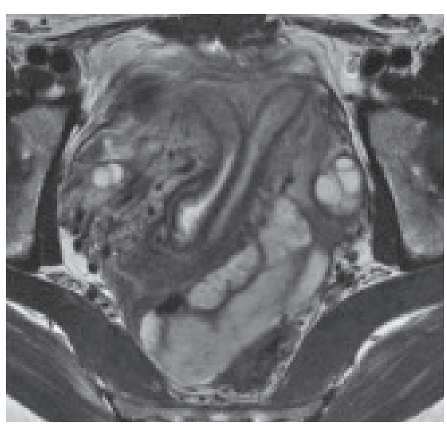


Figure 9a. Patient presented with chronic vaginal discharge. An oblique axial high resolution T2w FSE image shows a septate configuration of the uterus.

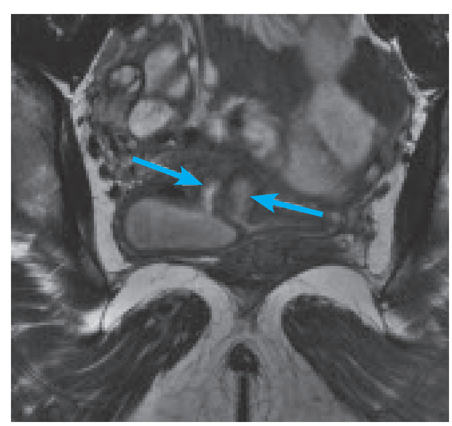


Figure 9b. A coronal high resolution T2w FSE image shows two cervices (arrows) communicating with two vaginal cavities. Hematocolpos is noted on the right with a normal lumen on the left.

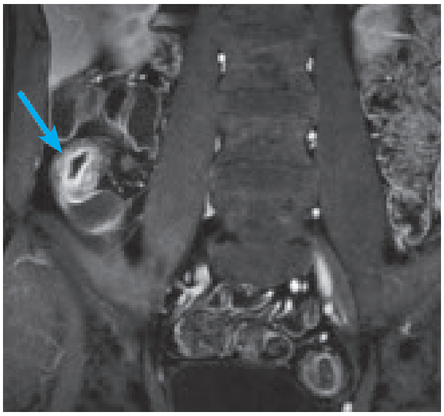


Figure 10. Post-contrast LAVA-Flex coronal image from an MR enterography study in a patient with Crohn's disease. Note thickened bowel wall with enhancement (arrow) in the right lower quadrant indicating active disease.

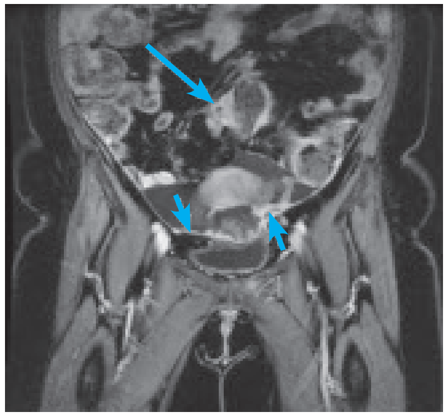


Figure 11a. Coronal post-contrast LAVA-Flex image demonstrates pelvic peritoneal nodular enhancement (short arrow) and a stricturing lesion/ carcinoma in the sigmoid colon (long arrow).

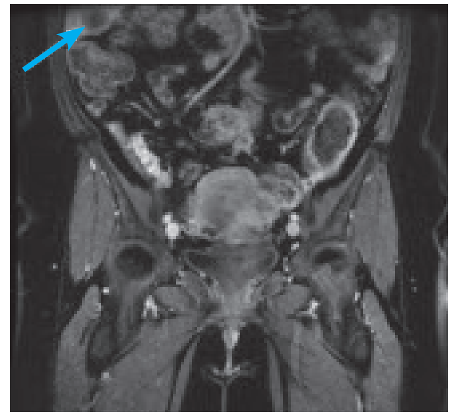


Figure 11b. Another image from the same series also demonstrates a metastasis in segment 6 of the liver (arrow). The patient was diagnosed with metastatic colorectal carcinoma.

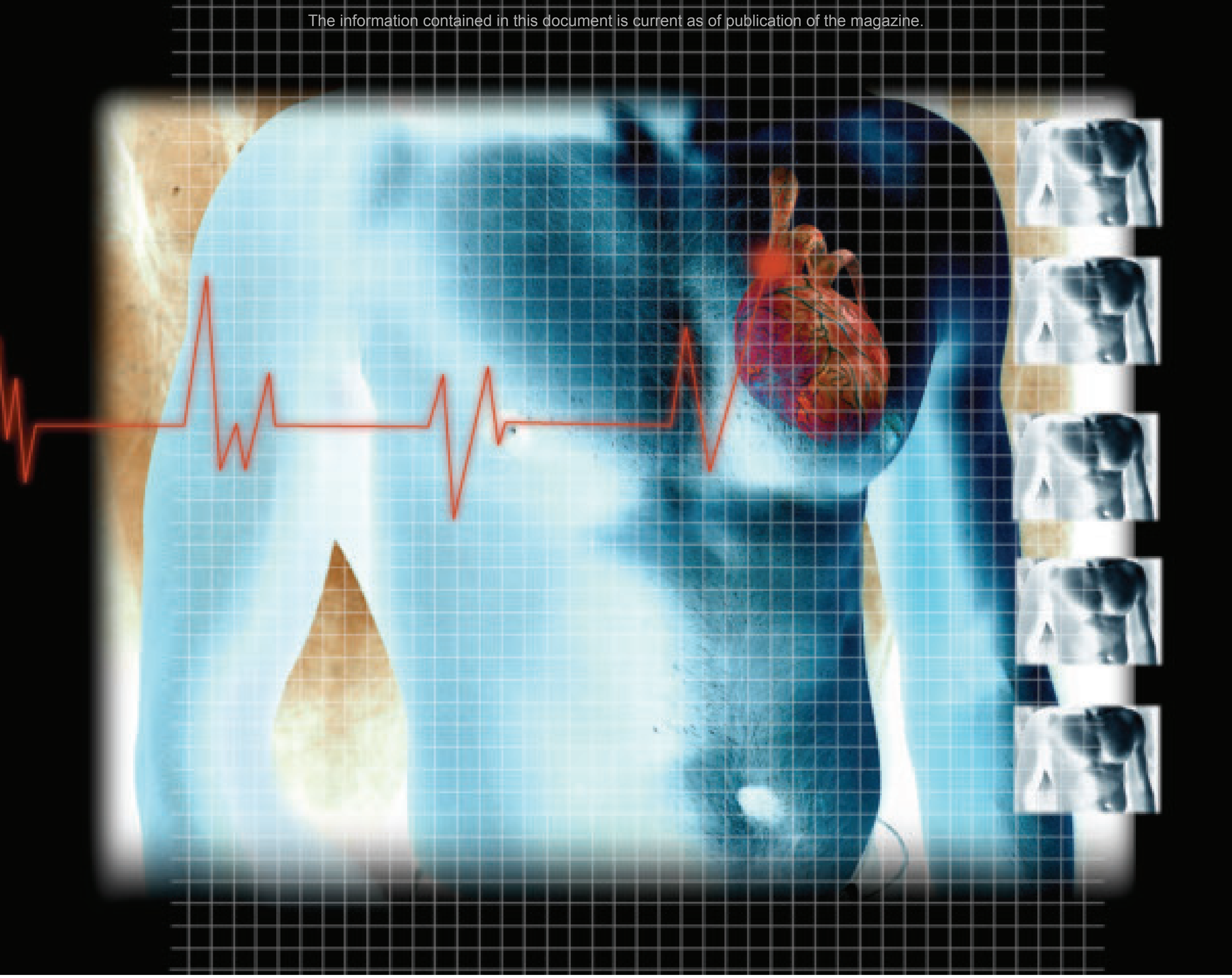
Pelvis – Axial T2 High Resolution			
PATIENT POSITION		IMAGING PARAMETERS	
Patient Entry	Feet first	Imaging Mode	2D
Patient Position	Supine	Pulse Sequence	FRFSE-XL
Coil configuration	Cardiac	Imaging Options	NPW, EDR, TRF, ZIP512
Scan Plane	Axial		
SCAN TIMING		SCANNING RANGE	
Flip Angle	90	FOV	16 cm
Receiver Bandwidth	35.71 kHz	Slice thickness	3 mm
TR	3400	Gap	0.3 mm
TE	102	Slices	20+
ETL	16		
ACQUISITION TIMING			
Frequency	320		
Phase	256		
Frequency Direction	AP		
Phase FOV	1		
NEX	4		

MR Enterography LAVA – Flex Dynamic +C			
PATIENT POSITION		IMAGING PARAMETERS	
Patient Entry	Feet first	Imaging Mode	3D
Patient Position	Supine	Pulse Sequence	LAVA-Flex
Coil configuration	Cardiac	Imaging Options	EDR, ZIP512, ZIP2, ARC, MPh
Scan Plane	Coronal		
SCAN TIMING		SCANNING RANGE	
Flip Angle	12	FOV	34
Receiver Bandwidth	166.67	Slice thickness	3.2
TR	4.1		
TE	1.2	Locs/slab	44
ACQUISITION TIMING			
Frequency	288		
Phase	288		
Frequency Direction	SI		
Phase FOV	0.9		

Conclusion

In our experience, the Discovery MR750 3.0T has enhanced abdominal and pelvic imaging with increased accuracy and diagnostic yield.

Due to the improved image quality and diagnostic accuracy on the Discovery MR750, referrals for body MR imaging have increased in the first nine months of operation. ■



System Enhancements for Cardiac MR at 1.5T

By Jean-Louis Sablayrolles, MD, Chief of CT & MR Radiology, Centre Cardiologique du Nord

In our institution, cardiac MRI is used routinely in the diagnosis of cardiovascular disease. Until recently all of our cardiac exams were performed on a Signa HDxt 3.0T due to the inherent signal-to-noise ratio (SNR) advantage at higher field strength. In October 2009, a Discovery MR450 1.5T was installed at our facility and we began examining cardiac patients on this system. After scanning more then 300 patients, I have found the Discovery MR450 produces outstanding image quality thanks to its gradient performance, OpTix RF, and field homogeneity.

The fast gradient echo time course (FGRE-TC) in multi-plane (short axis and long axis) acquisition has an excellent contrast-to-noise ratio (CNR). As a result, we are more confident in the diagnosis of the myocardium and specifically the apex. And not less importantly, the new user interface and workflow are very intuitive.

Case 1: Myocardial viability assessment

Patient history

A 71-year-old presented with angina post effort for nearly four weeks; subsequent loss of consciousness was due to acute pulmonary edema. An emergency coronary angiography showed a sub-occlusion of the common trunk of the left coronary with an ostial stenosis of the LAD bisector and moderate stenosis of the ostial circumflex, treated by stents. Echocardiography demonstrated an akinesia extended on the anterior and lateral wall with an ejection fraction (EF) estimated at 33%. Thallium scintigraphy at rest showed a complete deficiency of the apex, anterior, and lateral wall, possibly indicating non viable areas.

CMR technique

FGRE-TC in multi-plane (SA and 4ch) FIESTA Cine in 4ch view, long and contiguous short axes. Late enhancement (FGRE-IR) in 4ch view, long, and contiguous short axes.

MR findings

Circumferential pericardial effusion.

Dynamic perfusion shows sub-endocardial defects as hyposignal of the antero-septal and lateral walls, and no defect of the inferior and infero-lateral walls (Figure 1b). FIESTA Cine demonstrates complete akinesia at the apical segment, the antero-lateral and septal walls, and to a lesser degree at the basal segment (Figure 1a).

EF is estimated at 28%.

An important heterogeneous signal of the myocardium was seen on FIESTA Cine and late enhancement as transmural hypersignal with centered zones of hyposignal reflecting impaired microcirculation. A delayed transmural enhancement extended on the entire anterior, lateral, and septal walls (Figure 1c). There is strong suspicion of non-viability of the affected segments, is to be confirmed with follow up at a non-acute phase of the infarct.

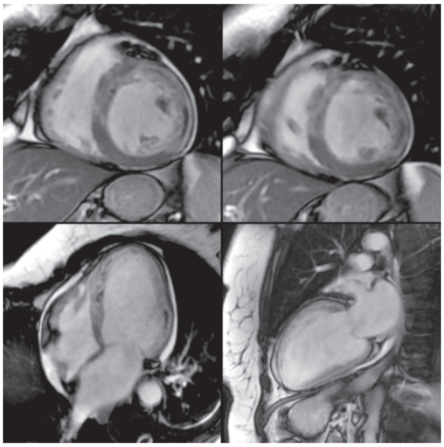


Figure 1a. Multi-plane FIESTA Cine

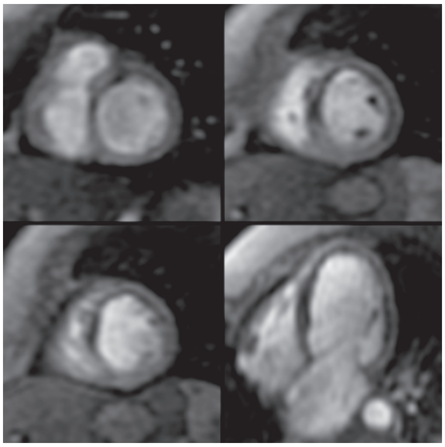


Figure 1b. Multi-plane FGRE-TC

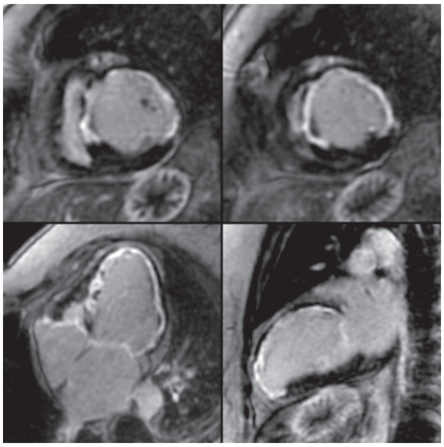


Figure 1c. Multi-plane 2D MDE

Case 2: Myocarditis

Patient history

A 64-year-old has a history of chest pain with troponin elevation dating to 2007. Previously, patient had a normal coronary angiography, although there was suspicion of a myocarditis or coronary spasm.

In 2010, the patient was hospitalized for ventricular tachycardia associated with infection syndrome and impairment of the liver and pancreas. Echocardiography demonstrated an EF of 48% related to a pericardial effusion. CMR was requested to rule out a recurrence of myocarditis.

CMR technique

FGRE-TC in multi-plane (short axis and 4ch view). FIESTA Cine in 2/4ch view and contiguous short axis. Late enhancement (FGRE-IR) in 2/4ch view and contiguous short axis.

MR findings

Pericardial effusion measuring 13 mm next to the LV lateral wall. Aspect of myocarditis and pericarditis with impairment of LV systolic function (EF 48%). Thinning of the LV lateral wall (4 mm). Hypokinesia at the mid-segment of the lateral wall and akinesia of the apex (Figure 2a). Mitral valve insufficiency grade I.

Dynamic perfusion at rest: A hypo-perfusion of the middle segment of the lateral wall of left ventricle and the apex (Figure 2b). A diffused myocarditis with a recent component associated with a sequelae of an old myocarditis of the lateral wall. An almost transmural late enhancement of the left ventricular apex (Figure 2c), suggestive to a fibrous evolution by microangiopathy related to a severe myocarditis.

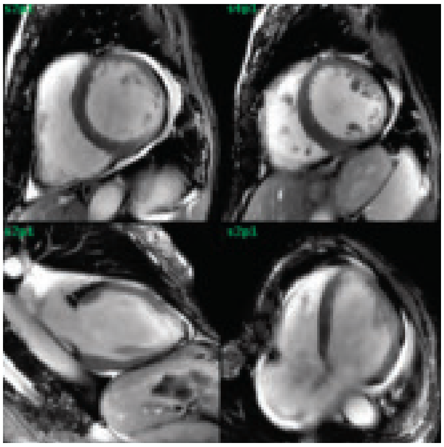


Figure 2a. Multi-plane FIESTA Cine

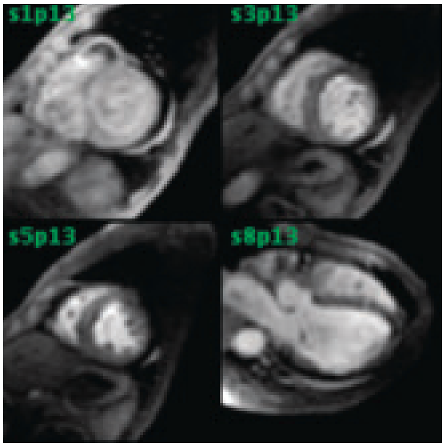


Figure 2b. Multi-plane FGRE-TC

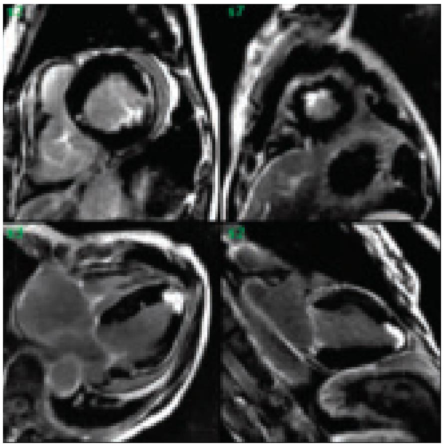
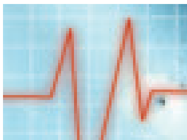
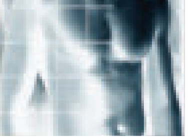


Figure 2c. Multi-plane 2D MDE





Case 3: Myocardial viability assessment

Patient history

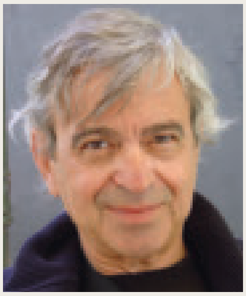
A 79-year-old hospitalized for an acute coronary syndrome underwent a coronarography that depicted a sub-occlusive stenosis of the right coronary, treated by angioplasty and placement of a drug-eluting stent. The patient has arterial hypertension and recurrent insulin diabetes.

CMR technique

FGRE-TC in multi-plane (SA and 4ch) FIESTA Cine in 4ch view, long, and contiguous short axes. Late enhancement (FGRE-IR) in 4ch view, long, and contiguous short axes.

MR findings

Dynamic perfusion at rest shows subendocardial hypo-perfusion of the basal and middle segments of the inferior wall. Myocardial delayed enhancement (MDE) shows a heterogeneous enhancement of the myocardium at the basal and middle segments of the inferior wall of the LV, extended to 75 to 100% of the myocardium wall thickness, with a zone of intramyocardial hyposignal that is highly suspicious of no reflow (Figure 3c). FIESTA Cine demonstrates akinesia of the inferior wall of the basal and middle segment (Figure 3a). Left ventricular systolic function was measured at the lower normal limit with EF 54%. Normal dimensions of the cardiac chambers were noted. A control within three months can be considered.



Dr. Jean-Louis Sablayrolles

Jean-Louis Sablayrolles, MD, is a radiologist at Centre Cardiologique du Nord (CCN) in Saint-Denis, France, where he has been chief of the CT and MRI Department since 1988.

About the facility

The Centre Cardiologique du Nord (CCN) is a private practice created by a group of cardiologists in 1973 in Saint-Denis, France. CCN is considered a center of excellence in the diagnosis and treatment of cardio-vascular diseases. We perform cardiac MRI since 1998. In 2003, a GE Signa HD 1.5T MR scanner was installed and a Signa HDx 3.0T was added in December 2007. Since then more than 2,000 patients with cardiovascular indications have been scanned on the 3.0T system. In October 2009, a Discovery MR450 1.5T was installed replacing the Signa HD 1.5T. CCN also operates two GE Healthcare's CT scanners, a LightSpeed™ VCT XT and a Discovery CT750 HD, both dedicated to cardiovascular imaging.

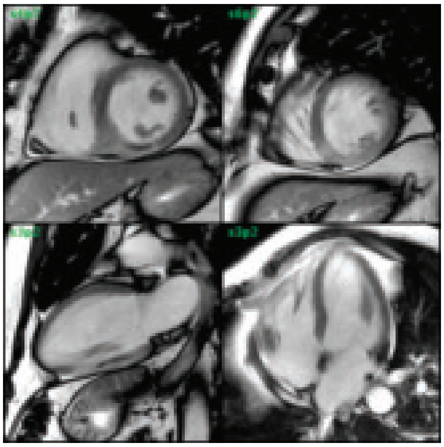


Figure 3a. Multi-plane FIESTA Cine

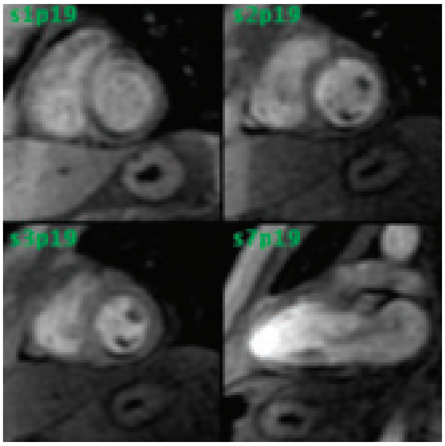


Figure 3b. Multi-plane FGRE-TC

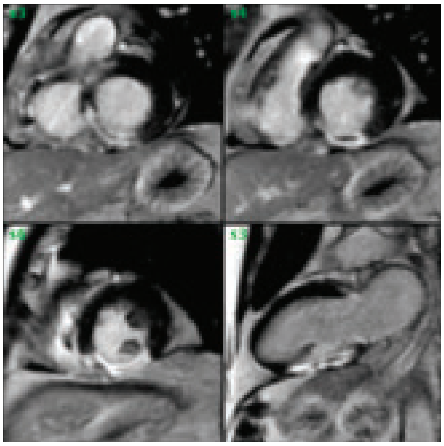


Figure 3c. Multi-plane 2D MDE

Conclusion

After five months of scanning on the Discovery MR450, I have found the system provides excellent image quality and a fast scan time thanks to its gradient performance and OpTix RF, which also delivers a high SNR compared to standard 1.5T. ■

GE Healthcare

Introducing the Discovery™ MR750 3.0T.

Complex exams without the complex.

Why do some MR exams have such a complex? Does the abdomen really need to pose such a challenge? Wouldn't fMRI be more functional if it were faster and more reliable? We think MR should not only deliver clear, consistent images, it should do so quickly and easily – even at 3.0T. Our new Discovery MR750 3.0T is designed to help you achieve success with the most challenging exams. It can conduct complete liver exams in as little as 15 minutes, and actually makes fMRI routine. Combined with a significant decrease in in-room set-up compared with previous systems, the Discovery MR750 can give you a real advantage – by giving tough exams less of a complex.

To learn more, please call 866 281 7545 and reference MR08015 or visit www.gehealthcare.com/mr

imagination at work

Sports Med of Olympic Proportions

No games about it: while prescribing, reading, and diagnosing images from the world's top athletes, this radiologist gets new meaning of performance under pressure – and learns things along the way

No one would ever accuse the field of radiology of being stress free. In the back of every radiologist's mind is the undeniable truth that his or her diagnosis not only affects the patient's treatment plan – but their lifestyle and future. The confident diagnosis continues to be the holy grail for radiologists worldwide.

Consider for a second the added pressure and expectations that come with the honor of being the manager of diagnostic imaging at the Vancouver 2010 Olympic and Paralympic Winter Games. Meet Bruce Forster, MD.

Dr. Forster was asked to lead and manage a team of 20 radiologists as the imaging supervisor for the Games. With two polyclinics each outfitted with a GE Signa HDi 1.5T MR and 16-slice CT scanner, as well as GE's portable ultrasound equipment, Dr. Forster and his team performed and analyzed approximately 950 imaging exams when the world was watching. In an interview with SignaPULSE, Dr. Forster takes a break between the 2010 Games to share the experience, inspiration, and learnings he and his team picked up during their once-in-a-lifetime opportunity.

vancouver 2010

WORLDWIDE PARTNER

SignaPULSE: What was your typical day at the 2010 Games?

Dr. Forster: We started at 7 a.m. and finished at 11 p.m., with [radiologists and technologists] on-call overnight, as well. The clinic would start to get pretty busy around 9 a.m. and stay busy until we closed. One thing that is different from a regular practice is we had varying levels of responses. Level 1 means you need to be ready in 5 minutes; level 2 means be ready in 10 minutes; and level 3 means you have 40 minutes, which generally correspond to an overnight call.

We would look at the day's events and decide which level is applicable. Some events had higher alerts than others. If there was a downhill skiing event, it would be a level 1 response until it was finished. We had flat screens where we'd watch the events. It was an unusual opportunity to see the accidents … it's something we as radiologists aren't exposed to – the cause of an injury first hand. I remember seeing an accident, and a few minutes later hearing the helicopter dropping off the athletes at the polyclinic. Within minutes, we were assessing and speaking to the athlete, trainer, and physician – making sure there was a very complete assessment from every perspective, including imaging.

SignaPULSE: You mentioned the days were busy – can you talk a bit more about the number of patients and the mix?

Dr. Forster: The days varied and the numbers gradually increased. At the Games, a medical visit is called an encounter. There were about 7,500 encounters and 34% of them were athletes – the other patients were from the work force or people "inside the fence." We also had more athletes from more countries than any previous Winter Games – 86 countries in total. Some countries had small teams with limited contingents and physicians, so they relied on us to be their physicians and imaging department. With more athletes than ever before, we needed to be prepared for on-site imaging and higher volumes of patients.

SignaPULSE: Compared to previous years, how important was the field of radiology at the Games?

Dr. Forster: We performed around 950 imaging exams – compared to 567 at the 2006 Olympic Winter Games in Torino, which is almost a 70% increase! It goes to show you how extremely critical and relevant the role of radiology plays in athletes. We don't want injuries, but they're going to happen and the fact that we're being called upon to assist in this critical moment is very gratifying.

SignaPULSE: One would think the majority of scans would be MSK. Is that true?

Dr. Forster: Yes and no. The knee was the most common anatomy injured, followed by pelvis/low back. By sport, the most common injuries occurred with alpine skiing, then snowboard, followed by cross-country skiing and bobsled. Cross-country is a different type of injury – we're looking for tendons, muscle tears, and acute and chronic over-use types of injuries. Given the nature of sliding sports, head, c-spine, or lumbar injuries were pretty common.

One of the challenges we found is while we are fortunate to have great MSK technologists and radiologists, they have to also be skilled in trauma, which includes the head, spine, abdomen, and pelvis. This trend is only going to increase and we need to make sure the skill sets of our radiologists and technologists reflect this. But remember, most of the patients weren't athletes, so we saw a bit of everything.

SignaPULSE: As you know, it wasn't long ago when MR wasn't considered to be a necessity by all physicians. What was the role in MR at the 2010 Games?

Dr. Forster: By modality, digital radiography (DR) was most commonly used, but very close behind it was MRI, followed by ultrasound and then CT. We had two polyclinics, one at Vancouver and one at Whistler. For the first time, CT and MR were in both venues dedicated to athletes, and we did almost twice the number of CTs as was done in the 2008 Olympic Games in Beijing. It's incredible when you consider that the 2008 Games had three times the number of athletes. MR was a real star – at the Vancouver clinic, MRI was actually used more than DR for first time ever.

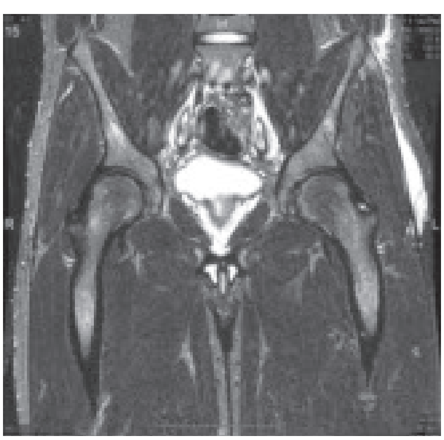
Imaging is playing a more central role in management of athletic injuries. Whether Olympic athletes or weekend warriors, MRI is leading the way. People can forget how important imaging is in the diagnosis and management planning for MSK injuries. The Olympic Games helps us bring focus to that.

SignaPULSE: Did anything surprise you, even after three years of planning?

Dr. Forster: One controversy that did come up was whether or not we should perform MR arthography, and tendon injections to help symptomatic athletes. Three years ago, we decided we would not do these procedures at the Polyclinics, but at a neighboring hospital. I think it was the right decision, but we did have some requests. Even though we did our best to disseminate widely what our program entailed and what it didn't, there's always room for improvement. The role of MSK intervention at the Olympic Games needs to be examined. It's an area for growth.

SignaPULSE: Is there anything you learned that you will take back to your practice?

Dr. Forster: The 2010 Games was a tremendous demonstration of the team approach. It's very much the technologists, radiologists, sports med, and orthopedic team all working together – and it's absolutely critical. We would have physical therapists, trainers, you name it, involved in these meetings and they were inspired by the athletes. We can really learn from each other. Our Imaging team consisted of 51 technologists and 19 radiologists, all world class in MSK imaging, and was led by our dedicated Assistant Imaging Supervisors Karen Smith, Sue Murray, and Drs. Luck Louis and Mark Cresswell.



Fat-saturated T2-weighted coronal image showing a Morel-Lavallee lesion (traumatic dehiscence of superficial soft tissues from underlying fascia) adjacent to the tensor fascia lata.

Axial T2*-weighted gradient recalled echo image of a primary full thickness subscapularis tear.

Coronal CT demonstrating avulsion fracture at the calcaneal insertion of the calcaneo-fibular ligament. The anterior talo-fibular ligament (not shown) was also torn.

Dr. Bruce Forster

Bruce Forster, MD, is professor and vice-chair (research), in the Department of Radiology, University of B.C. in Vancouver, Canada; Regional Director of MRI for Vancouver Coastal Health; and Medical Director, Canada Diagnostic Centres (B.C.). He serves as an Associate Editor for the journal *Radiology*, and the *British Journal of Sports Medicine*, is a member of the International Skeletal Society, and serves as Chair of the Educational Committee for the Canadian Association of Radiology. As an associate member of the renowned Allan MacGavin Sports Medicine Clinic, he participates in clinical, research, and educational activities for radiology, sports medicine, and orthopedic surgery residents. Although he serves as imaging manager for 2010 Games, Dr. Forster admits his own record in sporting events is decidedly checkered.

SignaPULSE: Some think radiologists sit in a dark room and read images without interacting with others. Is it time for a new perception?

Dr. Forster: Unfortunately, there does exist the perception that radiologists don't see patients. But at the same time, there is an increasing trend for them to be more visible in the patient care chain and with specialists. So we may not talk to patients, but we do talk to specialists a lot. In the ideal world, the radiologist would go over studies with patients – but it can be pragmatically difficult to do. The Olympic Games can provide an opportunity to do just that – so it's good to see the benefits and drawbacks. So much is riding on the clinical images, as they help us assess if they can return to play, if they are out for a day or a week, or more. It was a great opportunity to participate that way. But it does raise questions about if it would be workable in a day-to-day practice.

SignaPULSE: It goes without say the Olympic Games are inspiring. Was there anything that you found to be especially inspiring?

Dr. Forster: There were so many things ... the athletes, their dedication – they are members of a team and they inspired us to work as a team. We kept a blog – www.camrt.ca – that is, the Canadian Association of Medical Radiation Technologists where we shared "inside the fence" descriptions of life to the radiologists and technologists. One of our technologists, Sue Murray, wrote how she was assisting with an athlete who crashed and was being assessed. It was clear from the assessment that for him, the Olympic Games were over. People were upset, but he said, "Do you have a TV?" She wheeled one over to him and he instantly forgot his pain and personal tragedy as he watched his teammates compete. His Games weren't over until his team's Games were over. It inspires us to do the same thing – deliver the best patient care you can. The target is always excellence in imaging care and if you keep your focus on that target, you'll be successful and inspired.

These athletes are the best in the world. We need to make sure we are the best in the world at what we do – with skill and equipment – to be there for them when they need us. ■

When Efficiency Meets Specificity, Everyone Wins

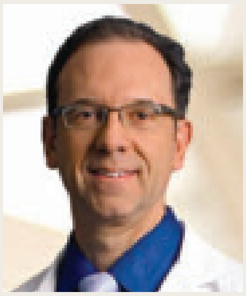
Big bore. Small joints. What in hindsight could be viewed as an obvious solution, forward-thinking radiologists are taking MSK imaging to the extreme

William Morrison, MD said it best: "Scanning with whole-body MRI for just a wrist can be a bad experience for everyone. It shouldn't be bad for anyone."

Easier said than done, right? Not necessarily. Dr. Morrison, director of the division of musculoskeletal radiology at Thomas Jefferson University in Philadelphia, made a decision that he says enables good experiences and prevents bad ones. He became the third U.S. person to install an MRI system that is dedicated to the extremities – the ONI Extreme 1.5T.

"Our goal was to guide our patients to the right MRI scanner for their needs. For those who need extremities scanned, we think ONI is the best," comments Dr. Morrison. "A wrist, for example, only takes 15 easy minutes from start to finish, and the image quality is uncompromised."

Like many academic sites, Thomas Jefferson University requires its radiologists (in this case, Dr. Morrison), to work closely with the country's top orthopedic surgeons. And getting the best MSK image quality isn't without unique challenges.



Dr. William B. Morrison

William Morrison, MD, has served as director of the division of musculoskeletal radiology at Thomas Jefferson University in Philadelphia. He holds the academic rank of professor. He received his medical degree from Jefferson Medical College after attending Rutgers University for undergraduate studies. He then completed a diagnostic radiology residency at Jefferson, and served in the U.S. Air Force as chief of musculoskeletal imaging at Wilford Hall Medical Center, achieving the rank of Major before returning to Jefferson in 1999. Dr. Morrison has authored more than 120 scientific papers or book chapters and three books. He lectures worldwide and has provided over 300 invited presentations. He holds leadership positions in numerous radiological societies, serves as associate editor of Musculoskeletal Imaging for the journal *Radiology*, and is also on the editorial board of the journal *Skeletal Radiology*. Dr. Morrison also serves as the secretary to the Society of Skeletal Radiology. He is the program director for the Jefferson Musculoskeletal Imaging CME program and has been awarded numerous teaching and mentorship awards. Dr. Morrison's areas of special interest include functional MR imaging of the musculoskeletal system, imaging of sports injuries, and musculoskeletal infection.

"Most MR systems are not geared toward MSK imaging because it can be difficult to accurately scan a specific extremity," maintains Dr. Morrison. "But the ONI system is made just for extremities. It's great for scanning wrists, hands, fingers and elbows … it's so much easier for us and for the patient."

Not to mention efficient. Because the scans are short and the magnet is smaller, Dr. Morrison's team can benefit from fast scans, less energy used, and less time needed to prep the patient.

"The first goal is comfort, the second is to keep them still so we can get the best image consistency. The quicker the patient is in and out, the better it is for everyone. We rest assured that we get excellent quality images – every time," says Dr. Morrison.

With a scanning chair that is comfortable and adjustable, Dr. Morrison's staff has noted that the relaxed sitting position helps calm the patient during the scan. In fact, Dr. Morrison notes that even anxious patients are more comfortable in this environment.

Professional athletes, such as Philadelphia Eagles football players, and dancers are among those routinely scanned at Thomas Jefferson University. Abigail Mentzer, a dancer with the Pennsylvania Ballet company, recently received a scan on her problematic ankle. Because of the exquisite image quality, Dr. Morrison was able to diagnose a large fluid-filled cyst called a ganglion, which pinched when she counter flexed. Mentzer underwent a procedure to fix it in a timely manner.

"From start to finish, the [ONI] scan was a piece of cake," comments Mentzer. "I popped into the clinic, sat in the comfy chair, stuck my foot in, and read a book. Unlike the full-body scanners, it wasn't scary at all. It was easy, simple, fast, and it's nothing like the 'Star Trek-y head in the tube' thing."

Dr. Morrison is currently conducting an ongoing three-pronged "project." The first involved Mentzer's ankle, providing information on what injuries are most common for dancers so they can possibly be avoided, or caught earlier, for younger dancers. The second and third phases involve other common challenges for dancers – imaging the midfoot and injuries that affect the ligament in the gantry, planter plate and forefoot.

"I continue to be very impressed with the uncompromised image quality and ease of use of the ONI," maintains Dr. Morrison, adding that he feels the system enables him to more easily provide arthography to his patients. "Switching from a whole-body scanner to this extremity-focused system has been like night and day for us, and for our patients." ■

About the scanner

In 2009, MSK-specific imaging systems joined the GE MR portfolio – the ONI MSK Extreme 1.5T and the ONI MSK Extreme 1.0T.

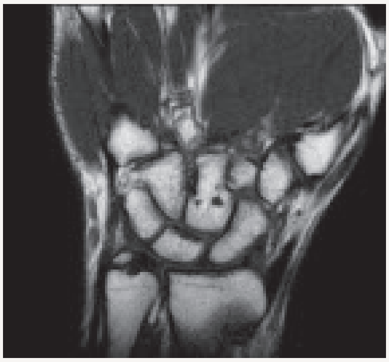
Both systems tout a smaller footprint and quieter operation (relative to whole-body designs), premium image quality, and an improved patient experience. Given they are designed to be specifically dedicated to MSK imaging, some radiologists have expressed their opinion that they believe they have advanced clinical capabilities that rival whole-body MR systems.

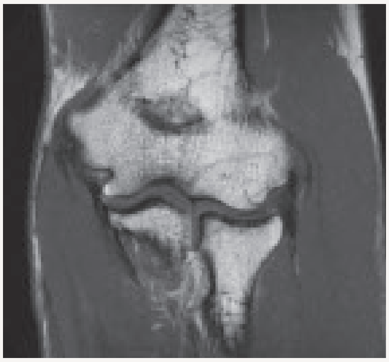



MSK Imaging: A Focused Approach

It's not just a trend – MSK-dedicated systems are being received with enthusiasm.

Let's face it: The field of radiology is competitive. Many radiologists are choosing to focus their attention and excel in a specific clinical area, be it neuro, breast, or abdominal imaging. But could it go as far as anatomy-specific imaging systems? The short answer – yes. Just ask Mario Padron, MD. This head of the radiology department at Clinica CEMTRO in Madrid, Spain says his recent decision to purchase the ONI MSK Extreme 1.5T MR system has allowed his practice to excel in the area of MSK imaging, and enabled his patients to have a more positive scanning experience.



Dr. Padron's practice is in one of the largest hospitals in Madrid, and normally starts scanning patients at 9 a.m., finishing up at 9:30 p.m., averaging 23 to 24 patients per day. Will a system with a small bore for extremities perform in this demanding scenario? While skeptical, Dr. Padron concedes that the images speak for themselves.

"At first, I couldn't believe you could get the images we were seeing," Dr. Padron says. "We are very happy with the image quality. We have been performing small joint MRIs – and not only is the quality of the images very good, the signal-to-noise ratio is very powerful. It's impressive."

True to his nature as a researcher, Dr. Padron began comparing the image quality of the ONI MSK Extreme system with his whole-body Signa HDxt 1.5T system and found the results to be surprisingly similar. The one difference, however, was the patient experience on the ONI MSK Extreme.

Patient experience matters

"Our patients are generally agreeable to whatever scans we prescribe to them," Dr. Padron explains. "When they finish an examination on the MSK system, they tell us they are comfortable. Young people are excited – they can't believe it's really an MRI system."

Elderly patients see an advantage, too. While the whole-body scanner can be uncomfortable and cause anxiety for older patients, simply sitting down and having an MRI scan in comfort is viewed as a pleasant experience. "When they sit and are comfortable, they are quiet," he continues. "When they are quiet, they don't move as much, so we see a reduction in motion artifacts, too."

Dr. Mario Padron

Mario Padron, MD, currently serves as the head of the radiology department at Clinical CEMTRO in Madrid, Spain. After obtaining his MD degree from Universidad Complutense de Madrid, Dr. Padron completed his residency in internal medicine and radiology at Fundacion Jimenez Diaz Universidad Autonoma de Madrid and held a fellowship in MRI at the University of San Francisco, California and Hospital of the University of Philadelphia. Dr. Padron's passion for sports imaging and sport traumatology have led him to be heavily engaged in the field, earning him an expert diploma of the Spanish Olympic Committee. Dr. Padron frequently conducts lectures and is the chairman for the European Society of Musculoskeletal Radiology (ESSR) Sports Subcommittee.

Selective scanning

While Dr. Padron's facility conducts many cutting edge studies, they also get a lot of what he calls "normal" studies. The dedicated MSK scanner enables them to choose which system is best suited for each patient.

"It is a good complement to our other 1.5T whole-body systems," he maintains. "But you can also use every pulse sequence – high-resolution studies, small joints, wrists, elbows, fingers, foot ... the capabilities are really broad. It's not only a system for clinical practice, but for research too. You get a good view of small structures, such as ligaments, capsules, etc. If you are familiar with the anatomy, you can go far with it."

Dr. Padron also filters patients according to suspicion. If he is scanning a young athlete and is suspecting another pathology, like a lesion in the ligament, he can rule out or order a second scan, depending on the results. In the beginning, Dr. Padron admits to scanning some patients on both the ONI and whole-body system out of fear the MSK scanner would "miss" something. Today, if he sees what he is suspecting on the ONI, he feels confident he has the information needed and no further examination is necessary. "It saves us a lot of money and time," he says.

The wave of the future

"I believe this is where the industry is going," Dr. Padron says. "There is a lot of interest from other radiologists and we get the same enthusiasm from our American radiologist visitors as we do with the European ones. Everyone loves it."

While the ONI MSK Extreme may be interesting for radiologists of all fields, Dr. Padron says it's the MSK radiologist who will be especially thrilled. "MSK experts will quickly be able to fully utilize this system," he explains. "If you aren't an MSK expert, it can seem strange in the beginning. MSK specialists won't have any trouble."

Fields for growth

Other than the obvious field of sports medicine, which is growing, Dr. Padron feels the system is a perfect candidate for patients suffering from rheumatoid arthritis. "You can scan at high resolution for small anatomy like fingers, but you can also use enhancements to do sharp, dynamic studies. It produces very good 3D images, so the potential for rheumatoid arthritis is strong. Very strong."

While Clinica CEMTRO has only had the ONI MSK Extreme system for a short period of time, Dr. Padron expects to see additional referrals for sports injuries.

"I strongly recommend this system," he maintains. "I've been impressed with it. I've been talking to my friends and colleagues about it. The future of MRI is anatomy-specific, dedicated imaging. And the future is bright for MSK." ■

How Can We Work Together?

A European Perspective

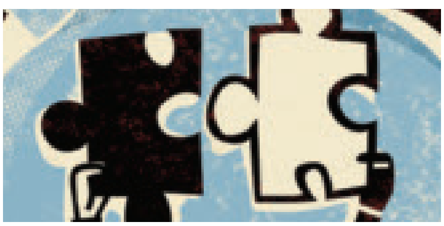
By Guillaume Calmon, Research Manager for Clinical Collaborations

The art of developing new clinical applications in medicine is very elusive. Medical device manufacturers can easily respond to certain demands like scanning patients faster, improving the patient experience, or increasing image resolution. However, when it comes to developing solutions that enhance patient care, manufacturers often are in the dark. This is an area where industry and academia can work together.

Because we aim to provide better care for patients, humans are often used in our research efforts. This practice is covered by multiple laws and regulations, the cornerstone being the Declaration of Helsinki regarding human experimentation.[1] When it comes to developing new clinical applications using MRI, we must keep it in mind as we choose one of the three following paths.

Guillaume Calmon

Guillaume Calmon joined GE in 1999 as a Leader Software Developer in areas of signal and image processing, spectroscopy and functional imaging (fMRI, Diffusion, Perfusion). After joining the MR modality in 2003, he was appointed MR Research Manager, head of Clinical Collaborations in 2009. Mr. Calmon is a Graduate of the French Ecole Polythechnique with a complementary degree in Robotics and Computer vision from the Ecole des Mines of Paris.



References

1. Available at: http://en.wikipedia.org/wiki/Declaration_of_Helsinki

Industry-sponsored trials

With industry-sponsored trials, the manufacturer designs, controls, and monitors the study and owns the data. When manufacturers require such control and rigorous data accountability for regulatory submissions, this is the route to take. However, much of the time, this is not necessary. The most logical method when developing a new device aimed at a particular application is to test the claims before releasing it to the market. This is called pre-market research. The constraints of conducting pre-market research are very high. To prove the claims, trained physicians examine patients with the new device and repeat the standard procedure with a validated device. Volunteers are often used in MRI technology development. In many countries, ethical approval is not sufficient and medical device manufacturers must declare to and obtain approval from a local competent authority such as the Ministry of Health or a national health agency for example, (AFFSAPS in France or MHRA in the UK). In addition, an insurance policy is usually required. This research method is often called the "hard way" because of its financial cost and volume of paperwork.

Investigator-initiated research

With investigator-initiated research, the site researcher is responsible for study design, control, and data ownership. Research software is provided as a set of tools at the disposal of the independent investigator, enabling the customer to creatively explore the clinical utility of new technologies and define the goals of the research.

Our clinical development group has a history of providing new pulse sequences to select customers to utilize in their investigator-initiated research and provide evaluation and feedback. Why? Because the clinical knowledge of our customers far exceeds our own! As a medical device manufacturer, we rely on our customers, users, researchers, radiologists, and technologists to help identify research projects that demonstrate clinical value and answer unmet clinical needs with a particular application or new technology. Working together with our customers most often produces research that is fruitful, applicable, and affordable – not to mention leading to the development of new clinical applications.

Which method is best?

While industry-sponsored trials are sometimes necessary, collaborating with academic investigators to provide tehnology for investigator-initiated research is often preferred. By working together, we can learn from our customers' successes and gather valuable information about the utility of new technology, while helping to enable our customers to retain optimal flexibility and control of their research. Together, our collaboration contributes to improving the quality of patient care.

We look forward to many more examples of industry and academia collaboration, thanks to the clinical evaluations performed by our research partners on new technologies from GE Healthcare. ■

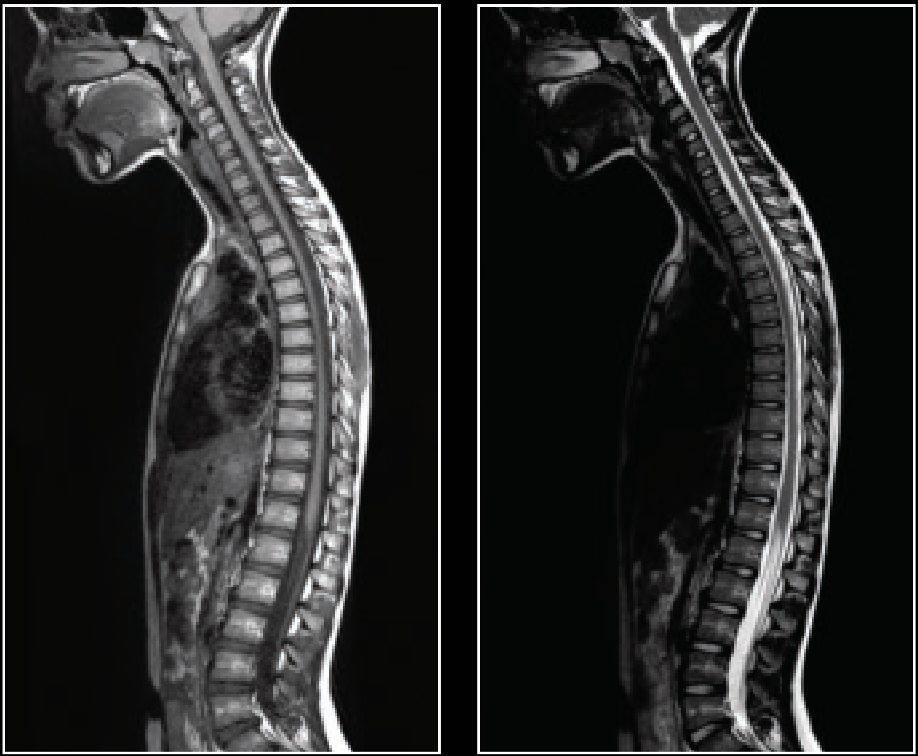
Pushing the Boundaries on 3.0T

The truth behind the hype

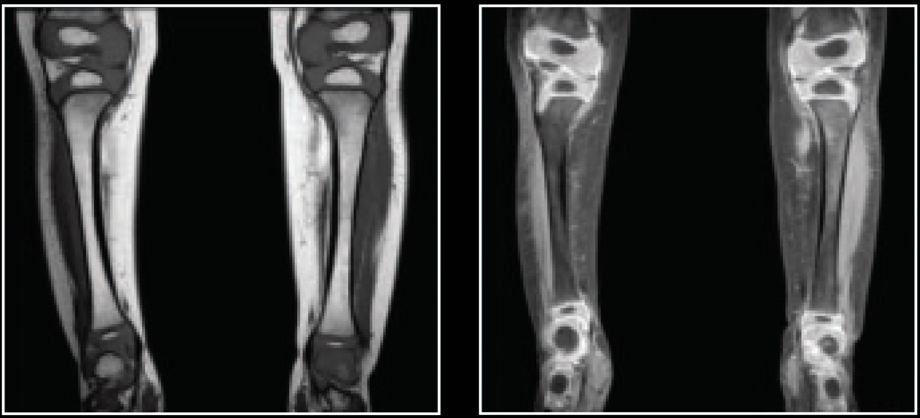
Since its launch in 2008, the Discovery MR750 has demonstrated its capabilities for advanced clinical scanning and researchers around the world are using it to deliver their cutting-edge findings. But does it really deliver?

The images speak for themselves.

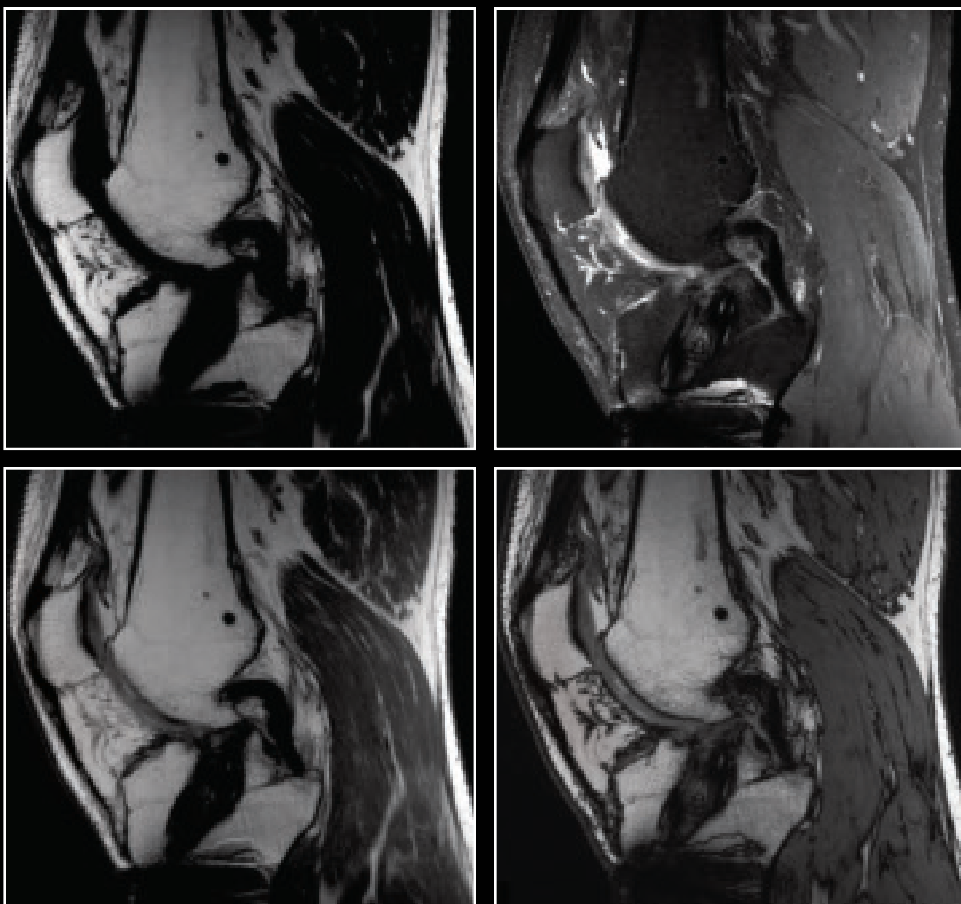
QuickSTEP 3-station CE-MRA performed on patient with aortic dissection in a total of 10-minute table time.



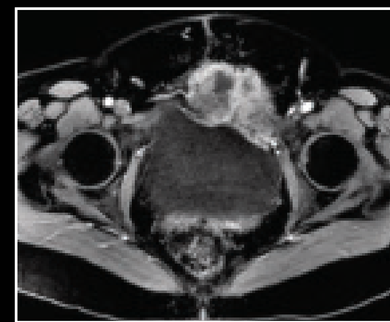
T1 and T2 FSE 2-station sagittals pasted together in a young patient



IDEAL FSE lower limbs on a young patient

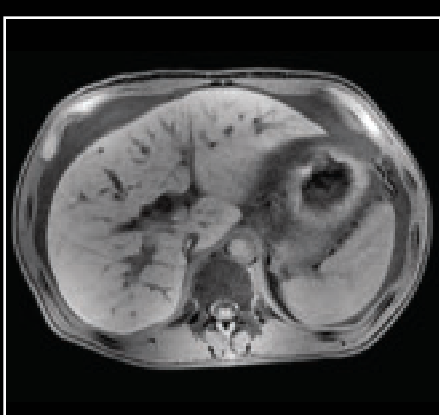


Sagittal FSE IDEAL in knee ACL repair; excellent correction of B0 Inhomogeneities caused by surgical implant

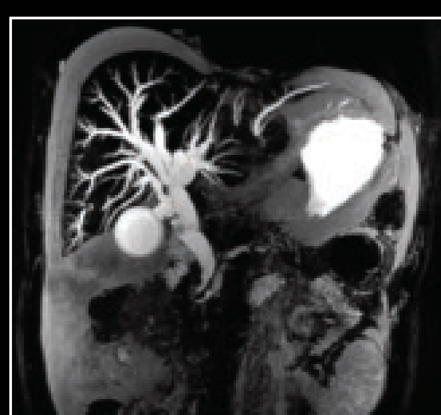


19-second LAVA-Flex in female pelvis, 320x256 matrix

High resolution 1024 matrix PD sagittal of posterior cruciate ligament

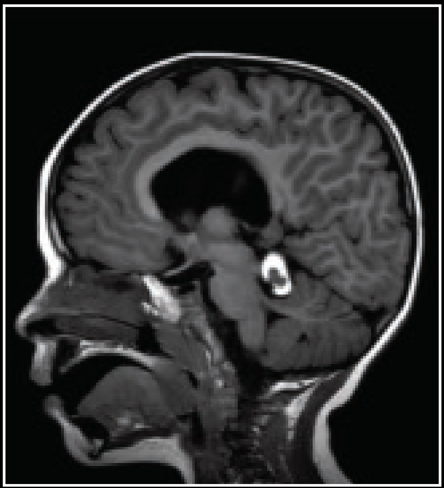


T1 weighted breath-held LAVA in ascites case demonstrating excellent B1 uniformity

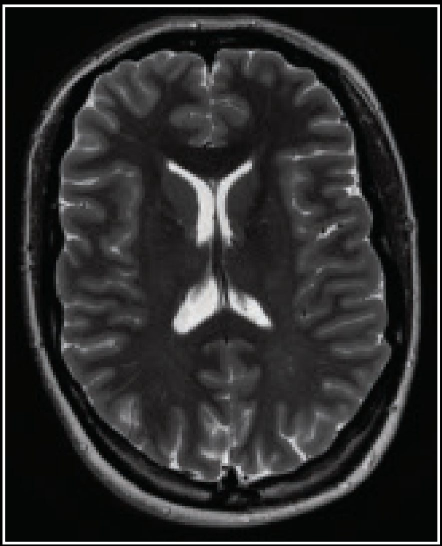


3D MRCP respiratory triggering

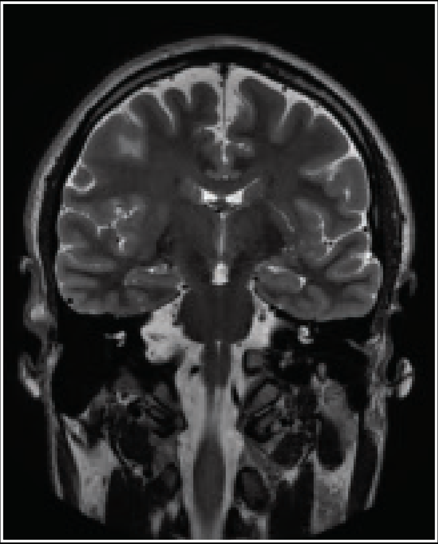
3.0T FSE T2 prostate without endorectal coil



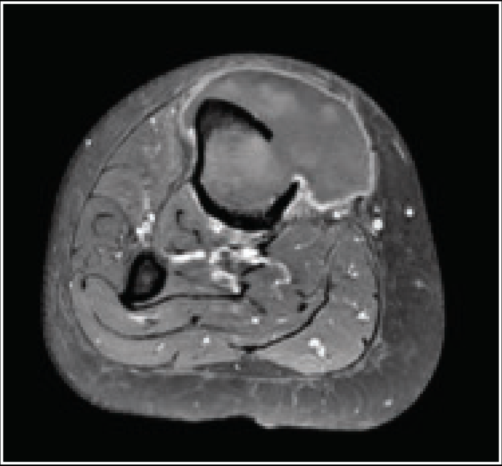
T1 mid-sagittal 3 mm slice



2 mm FSE PROPELLER 512x512 matrix



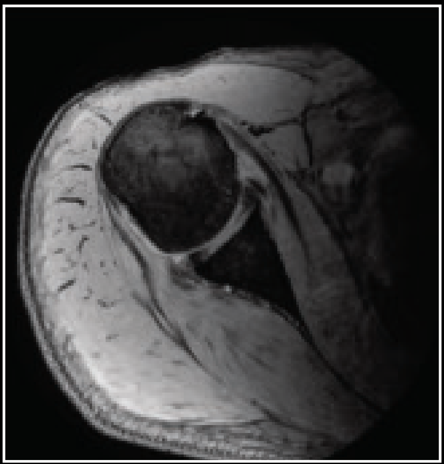
FSE coronal PROPELLER through temporal lobes, 512x512 matrix



32-channel torso coil used to image osteomyelitis

Axial 3D MERGE with 32-channel torso coil

3D coronal wrist, 1 mm slice thickness, 256x256 matrix, 8 cm FOV



3D axial shoulder. 72 2 mm slices 320x320 matrix in 4 minutes

Advances in Non-Contrast Enhanced Perfusion Assessment

By David Alsop, PhD, Director of MRI Research, Beth Israel Deaconess Medical Center and Associate Professor of Radiology, Harvard Medical School, and Ajit Shankaranarayanan, PhD, Senior Scientist, Applied Science Laboratory

Brain tissue perfusion, often referred to as Cerebral Blood Flow (CBF), is a key measure of tissue function and the state of its vascular supply. In normal states of vascular regulation, perfusion is correlated with tissue metabolic activity. In cases of vascular injury or occlusion, perfusion may be more reflective of vascular disease.

Perfusion imaging typically requires administration of a contrast agent, or tracer, but a special technique of magnetic resonance imaging (MRI) permits the imaging of perfusion without any contrast. This technique uses spatially selective radio frequency (RF) pulses to invert the water spins of inflowing arterial blood. Since this inversion "labels" the inflowing blood spins, the technique has become known as Arterial Spin Labeling (ASL). Relative to contrast CT and MR perfusion techniques, ASL can achieve reduced vascular contamination and may provide more accurate quantification when flow is elevated or in lesions with a compromised blood-brain barrier.

ASL perfusion imaging acquires two images. The labeled image is acquired a short wait after the inflowing arterial spins are inverted. This wait gives time for the labeled blood to pass through the arteries and arterioles and enter the tissue. A control image is acquired with the identical imaging sequence, but without inverting the arterial spins. Subtracting the labeled image from the control image produces an ASL perfusion weighted image, which can then be converted to a quantitative image which reflects cerebral blood flow.

In early implementations, clinical ASL often suffered from low sensitivity, motion artifact, image distortions, underestimation of slow flow, and vascular contamination. Recognizing the potential of ASL, GE Healthcare scientists collaborated with investigators at Beth Israel Deaconess Medical Center (Boston, Mass.) to evaluate potential solutions to some of ASL's limitations and to develop a more robust 3D technique.

Description

The collaboration targeted three major improvements over early ASL implementations:

- Pulsed continuous labeling;
- Background suppression; and
- 3D fast spin echo (FSE) acquisition.

Pulsed continuous labeling: Early in the development of ASL, it was appreciated that continuously inverting blood just before it entered the imaged volume would provide a major signal increase compared to labeling the inflowing blood with a single inversion at a single time point. Practical approaches, however, to achieving continuous labeling with more standard clinical hardware were not available until pulsed continuous labeling (pCASL)[1] was invented. pCASL uses many short RF pulses to continuously invert spins just before they enter the volume of interest to decrease signal loss from decay of labeled blood. This labeling approach excellently approximates the continuous inversion of spins but uses a lower RF duty cycle that is more compatible with clinical hardware. The approach also causes less magnetization transfer saturation for improved quantification and higher sensitivity.

Background suppression: Arterial spin labeling has a very small effect on a typical MR image. The perfusion effect can only be seen after subtracting the label and control images that are roughly 100 times larger. Any motion or other changes in these bright images can overwhelm the perfusion sensitive difference with artifacts and noise. Fortunately, a technique first reported by GE scientist Tom Dixon and later evaluated in ASL perfusion by researchers at the National Institutes of Health can greatly improve ASL image robustness.[2] This technique employs additional inversion pulses in the labeling sequence that can suppress the static tissue signal intensity in the label and control images while leaving the perfusion sensitive component almost unaffected.

3D FSE imaging: Early work with ASL relied on echo-planar imaging to minimize noise and artifacts from motion and other image fluctuations. With the use of background suppression, alternative sequences with reduced signal loss and distortion in the presence of magnetic field non-uniformity can be used. Volumetric 3D fast spin echo imaging offers high sensitivity and excellent image quality. To speed image acquisition, a short spiral gradient pattern was used to read out each echo in the FSE train. This yields an acquisition of the center of k-space with every shot, which helps improve image robustness while providing whole brain perfusion images in approximately five minutes. This acquisition is called 3D ASL.

Advantages of the 3D ASL approach include:

- No need for IV access or contrast administration;
- Isotropic 3D whole-brain acquisition;
- More coverage and/or higher resolution in a shorter scan time versus other ASL techniques;
- Exquisite image quality, demonstrating robustness to motion and susceptibility; and
- Inlined and automatic reconstruction for the analysis of perfusion sensitive images.

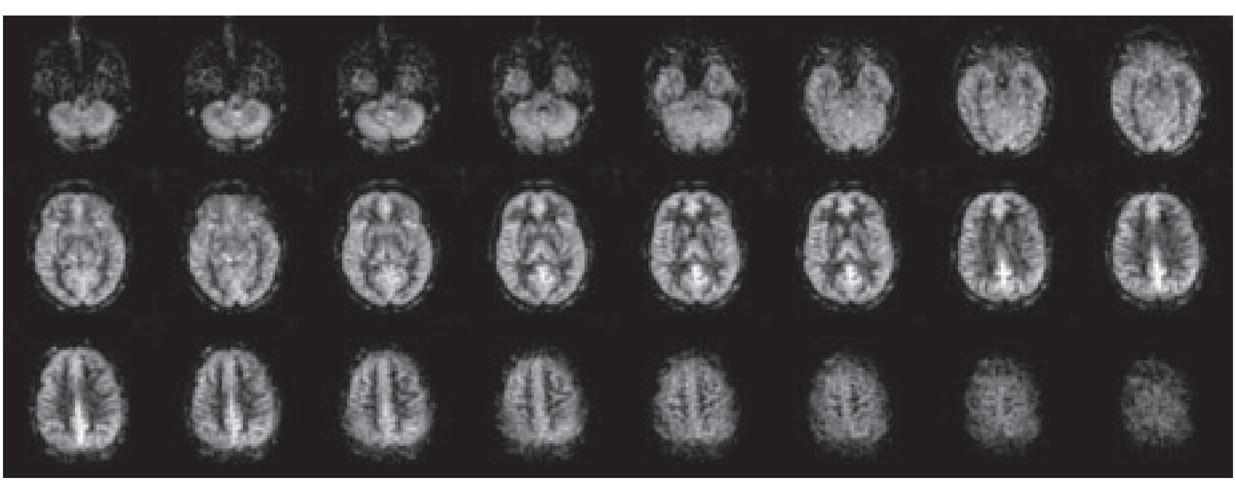


Figure 1. 3D ASL whole brain perfusion images acquired on the Discovery MR750 3.0T system: scan time 5:30 min, isotropic 4 mm voxels

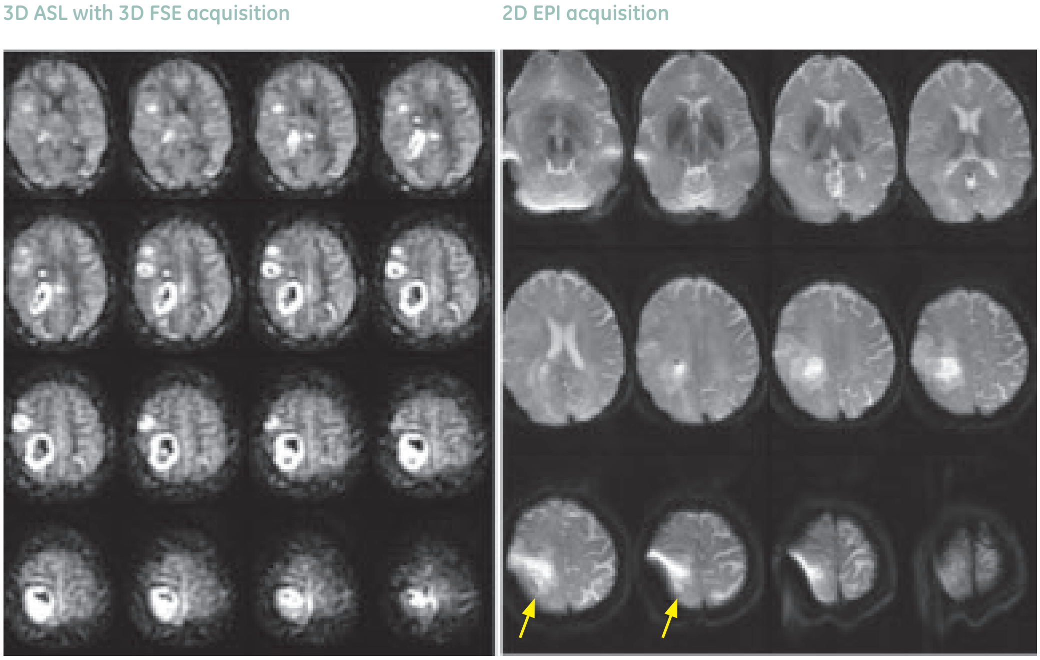


Figure 2. Comparison of 3D ASL scans with 2D EPI images in a patient with a surgical clip; note the significant reduction in susceptibility artifacts in FSE scans allowing for more robust image quality

The 3D ASL sequence has since been tested by several global research sites on over 1,000 clinical cases in a realistic clinical environment. The results are very encouraging: the sequence – including the ability to consistently generate excellent diagnostic quality images in clinically acceptable scan times. Applications to stroke and cerebrovascular disease, brain tumors, and dementia are currently the subject of several pending or scheduled articles.

Based upon the initial experience with this 3D ASL technique, the authors see several potential clinical applications:

- Situations where contrast administration is a concern (e.g. pediatrics, patients with compromised kidney function);
- Assessment of brain tumor vascularity and recurrence;
- Rule out ischemic injury or detect reperfusion;
- Differential diagnosis of dementias; and
- Assessment of inflammation and infection.

With 3D ASL, GE Healthcare aims to introduce a new ASL technique that is robust, fast, patient-friendly, and provides tangible clinical value. ■

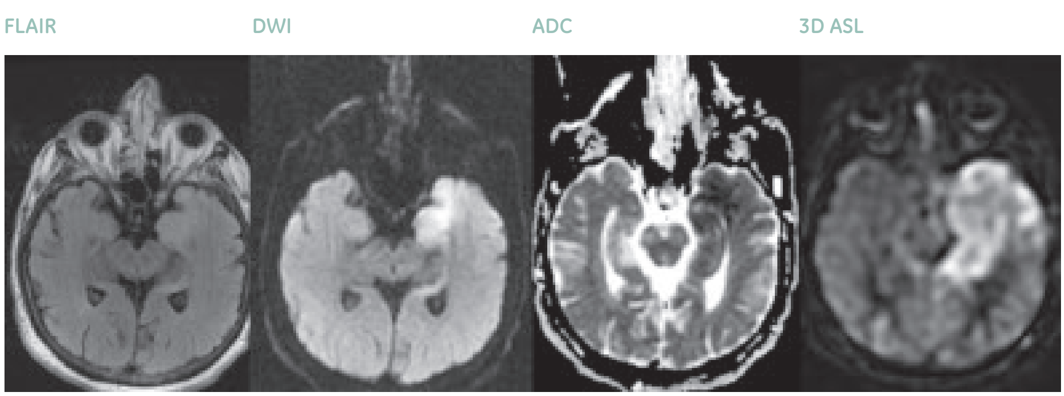
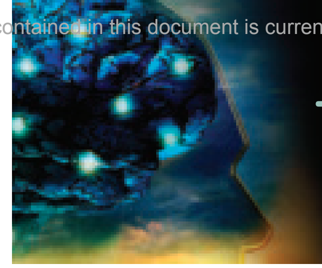


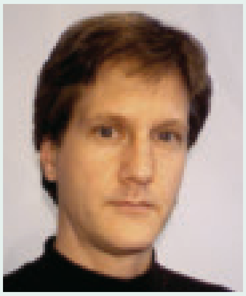
Figure 3. Images acquired on a Signa HDxt 1.5T system of a 59-year-old patient with HSV-1 encephalitis affecting the medial temporal lobe

References:

1. Garcia et al ISMRM 2005, Dai et al 2008
2. (Dixon et al 1991, Mani et al 1997, Ye et al 1998)

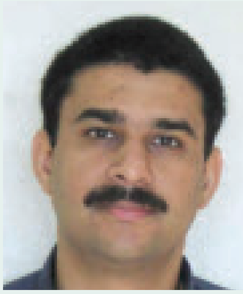


The Researchers' Perspective



David Alsop

David Alsop, PhD, is currently director of MRI Research within the Center for Advanced Imaging at Beth Israel Deaconess Medical Center and associate professor of Radiology at Harvard Medical School. Dr. Alsop received his PhD in Physics from the University of California (Berkeley, CA). His research interests include techniques for rapid Magnetic Resonance Imaging (MRI), high field MRI, perfusion imaging, neuro-imaging, aging and dementia, cancer, and stroke. Dr. Alsop serves as Associate Editor and member of the Editorial Board of *Magnetic Resonance in Medicine*.



Ajit Shankaranarayanan

Ajit Shankaranarayanan, PhD and senior scientist joined GE in 2001 following completion of his PhD from Case Western Reserve University, Cleveland, OH. Some of his research interests include non-contrast perfusion imaging, real-time imaging, motion insensitive imaging and he has worked on a number of novel projects spanning several clinical specialties including neurology and cardiology. In his current role as a senior scientist, he leads multi-disciplinary collaborations with several luminary academic institutions including Beth Israel Deaconess Hospital (Dr. David Alsop), UCSD (Dr. Anders Dale), and Stanford (Dr. Dwight Nishimura). These collaborations have resulted in the development and evaluation of promising new techniques to perform true 3D motion insensitive imaging, robust whole brain non-contrast perfusion imaging, and high-resolution diffusion imaging. The projects have helped cement GE's role as an innovator in MRI technology for the diagnosis of various neuro and cardiac diseases while expanding GE's already impressive application portfolio.

Ever wonder what happens before a new product is launched? Here's what the inventor of the technique we now know as 3D ASL and his GE scientist collaborator have to say about the teamwork, the process, and the satisfaction of ushering a good concept to the clinical setting.

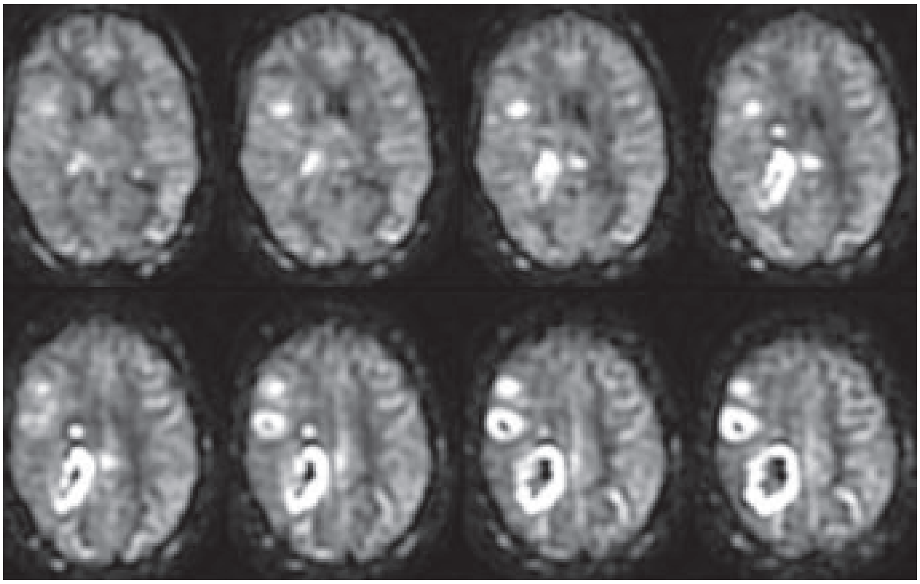
After putting together his own pilot sequence, Dr. Alsop admits his prototype wasn't as sophisticated or as flexible as he envisioned the sequence could potentially be. The prototype still got the attention of former GE ASL Scientist, Ehud Schmidt, who'd developed a reputation for his work in ASL. "GE realized this wasn't just a researcher's toy and had the potential for wide-spread use," Dr. Alsop says. Schmidt connected Dr. Alsop to Ajit Shankaranarayanan, PhD and senior scientist at GE's Global Applied Science Lab (Menlo Park, CA), "We found his idea impressive, but we needed to work together to get it into an environment where people could easily use it," he says.

Dr. Alsop began collaborating with Dr. Shankaranarayanan and his team to incorporate GE's developments in spiral acquisitions. "We worked together – testing and proving different aspects – and created a new prototype that was flexible to use and, as important, easier to use for the technologists."

A key benefit GE Healthcare provided was the large network of clinical sites that could evaluate the new prototype. "Dr. Alsop had the initial prototype in one or two sites, but by the end of 2007, our new prototype was sent to 15 different institutions in the US, Europe, Japan, and APAC," says Dr. Shankaranarayan. While GE helped coordinate the clinical evaluations, Dr. Alsop and Dr. Shankaranarayanan worked together to implement technical changes based on clinical feedback.

"We anticipate this will be a long-term collaboration with Dr. Alsop," adds Dr. Shankaranarayanan, "with our mutual goal to expand perfusion imaging to other areas of the body."

Dr. Alsop agrees that this type of collaboration is necessary for the betterment of healthcare. "Our institution is, in general, interested in technology transfer. By acts of Congress, NIH researchers are obligated to transfer their technology to commercial ventures."



Test Drive MR Apps

Don't take our word for it ... you can try MR software applications before you buy to see for yourself if it's what your facility needs – without the high-pressure sales pitch

Most would scoff at the idea of buying a car without taking it for a test-drive. Why? You need to experience it for yourself – not just take someone's word for it. The concept of "try before you buy" has spread everywhere – from listening to music on the internet before buying a song or tasting gourmet mustard at the grocery store. So wouldn't it make sense that this is expanded into the field of radiology?

Of course, radiology purchases are rarely made on a whim. While we hope for the economy to improve, the current environment forces us all to make selective decisions that are smart, deliver what we need, and can impact the stability of the business. Put simply, no one can afford buyer's remorse.

It's for this reason GE Healthcare has brought the concept of "try before you buy" to the world of MR, by offering a service that enables you to test drive application software before making a purchase decision. Not sure it's the right thing for you? No sweat – just don't buy it. Curious to see if it might be a fit? Give it a go. It's our way of putting the tools in your hands so you can make the decision for yourself. The program is called "eFlexTrial" – and those who've tried it swear they won't go back to the conventional method of purchasing. In fact, in a recent survey, 100% of participants who tried eFlexTrial indicated they would try it again.

Take, for example, Paul Williams. The MRI supervisor at The Gettysburg Hospital in Gettysburg, Penn. has used the program to evaluate MR applications such as CUBE, TRICKS, and 3D FRFSE.

"I've been using eFlex for three years and we all love it, including the radiologists. On a scale of 1-10, I give it a hearty 10," says an emphatic Williams. "It's really helped us make key decisions on our own terms. The program makes it so simple. I can evaluate it on my own without any pressure… there's no one breathing down my neck, and it takes all the guess work out."

Sit back and relax

The program was created to provide customers with an easy, relaxed way to try applications before purchasing. Stephen Bryar, MRI technologist with the VA Medical Center in Salt Lake City, feels it does exactly that.

"Based on the brochure, we thought we knew which applications we should buy. But once we experienced each application hands on, we were able to make a more informed choice," maintains Bryar. "It downloads easily, too. I would definitely recommend using the eFlexTrial before making a purchase."

Mardina Boykins, MRI manager at George Washington University Hospital, agrees. "The use of software without any pressure to buy is impressive. It is wonderful when your application specialist tells you about great images, but when they add that it can be eFlexTrialed, that's an added bonus," she says. "The ability to trial software and produce high-quality images along with excellent clinical information has been great."

It's also good for trying specific kinds of imaging techniques. "I have to say the non-contrast enhanced software worked very well on a patient with the most extreme diabetic neuropathy – the study was performed using the cardiac gating," says Cindy Ostrowski, MRI technologist at Wheaton Franciscan Healthcare in Franklin, WI. "The software was user friendly and the Runoff exam did not take any longer than a CE Runoff. Overall the non-contrast enhanced was uneventful."

Making informed decisions

For Williams and Bryar, a key benefit is enabling radiologists and administration to see the benefits of a new program – not to mention ensuring the applications are a good fit for their facility.

"We would have bought the wrong product had we not used the eFlexTrial. The applications we tried were Cube, IDEAL, and SWAN. For our facility, SWAN is a must have," Bryar comments. "We initially thought that CUBE would be better for us than IDEAL, but after using the eFlexTrial, we decided that IDEAL was a better choice."

According to Boykins, as a manager, the ease of use along with great clinical information has given her additional opportunities to present new software choices to her management and the radiologist. "Seeing is believing," she maintains. "Once these excellent applications and images are seen along with the valuable diagnosis they help enable, the benefits are immediately understood. We've purchased a number of software applications with this program."

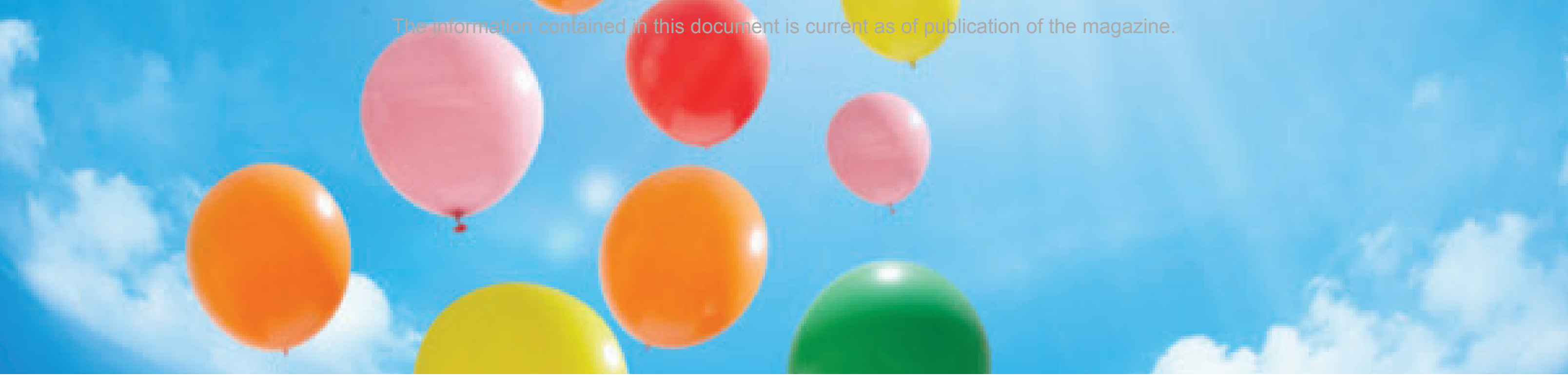
Help – just a call away

As part of the program, GE Healthcare provides trained, knowledgeable representatives to answer any questions customers have while trying applications.

"This trial program is one of the nicest things GE Healthcare has done," says Williams. "In-person demos are great, but what happens when the demonstrator leaves and we have more questions? This way we can try it out at our own pace, in our own environment, and call if we need guidance. I think this 'try before you buy' idea is going to be even more important to MR in the future."

Williams and his staff just finished evaluating Inhance Inflow Inversion Recovery MR angiography, and added it to the capital budget. "The radiologists love Inhance … the renal and brain images were beautiful."

For information on how to utilize the eFlexTrial program, and try applications such as Inhance, visit **www.gehealthcare.com/mr_eflextrial.** ■



Renal MRA is Back and on the Rise

It may have had problems in the past, but renal MRA just got a whole lot better

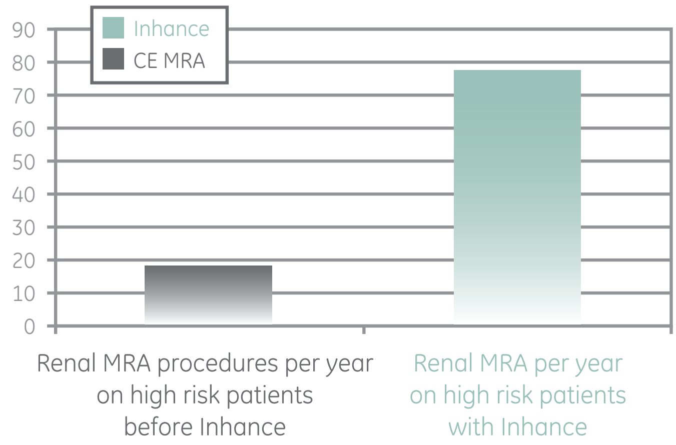
If you've been hesitating to prescribe renal MRA due to risk, patient experience, or image quality concerns, you're not alone. Referring a patient with impaired renal function for a contrast-enhanced MRA was not a good option. On the other hand, conventional non-contrast enhanced MRA sequences have not produced consistent results. So what's a radiologist to do? For many, it's time to stop or dramatically limit renal MRA.

That's not a problem anymore for radiologists like Dr. Robert Lookstein. The director of cardiovascular imaging and associate professor of radiology and vascular surgery at Mount Sinai Medical Center in New York chose to utilize Inhance Inflow IR, a new non-contrast application specifically designed for imaging renal arties. And he hasn't been disappointed.

"At Mount Sinai, we perform close to 3,500 cardiovascular imaging cases per year, and we are pleased to have Inhance MRA suite to help with imaging renal artery cases," says Dr. Lookstein.

Better patient access

Once the concerns of administering contrast agents to patients who may have impaired renal function became



Figures in chart courtesy of Mount Sinai Medical Center.

known, Dr. Lookstein says Mount Sinai's once sizeable volume of referrals for renal MRA was reduced to 1 to 2 cases a month. Today, that's changed. Because Inhance offers exquisite image quality without the contrast agent, he is seeing increased patient volume. And he is certain that there is still room for growth.

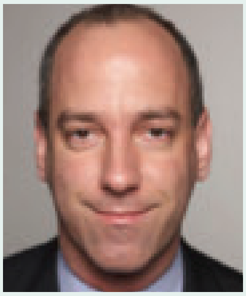
"When we show the images and cases to our referring physicians, they can see the value of this technique," Dr. Lookstein concludes. "Our referrals are definitely growing."

Increasing productivity, visualization

"From a clinical perspective, we can now offer a comprehensive renal exam without contrast in 10 minutes or less. Before, high-risk patients were not eligible for what we considered to be the best non-invasive options. Now, we have a robust diagnostic tool that doesn't require contrast. Patients love the fact that there is no need for an IV line and that they can breath freely during the scan." Dr. Lookstein further notes that the improved workflow, consistent performance and no need for contrast makes Inhance a favorite among technologists.

Dr. Lookstein says the radiologists at Mount Sinai use Inhance Inflow IR to visualize vasculature and Inhance 3D Velocity, a phase contrast-based technique, for physiological assessment. His group has been particularly impressed with the excellent visualization of the distal renal vasculature, which can help identify various pathologies.

"In the past, it was frequently impossible to see small accessory vessels with contrast enhanced sequences," explains Dr. Lookstein. "So the non-contrast nature of Inhance is a better option for patients and their physicians." The Mount Sinai team carefully evaluated the performance of Inhance in daily clinical practice. "For instance, our transplant surgeons specifically ask for Inhance when assessing renal artery grafts," he says. "They find it reliable and robust. Our team at Mount Sinai is happy and we have gone to our partners and referring physicians to say, 'Renal MRA is back'!" ■



Dr. Robert Lookstein

Robert Lookstein, MD, is currently director of cardiovascular imaging, associate director of the Division of Interventional Radiology, and associate professor of radiology in the division of Vascular and Interventional Radiology at The Mount Sinai Medical Center, New York. Dr. Lookstein received his medical degree at the State University of New York (SUNY) and continued on to complete his residency and fellowship in Vascular and Interventional Radiology at The Mount Sinai Medical School, New York. In addition to authoring dozens of scientific abstracts and manuscripts related to cardiovascular imaging and intervention, Dr. Lookstein serves as a peer reviewer for numerous scientific journals, including the *Journal of Vascular Interventional Radiology*, *Journal of Endovascular Therapy*, *Vascular Medicine*, and *Journal of Vascular Surgery*. He also is the president of the New York City Interventional Radiology Society and lectures around the world on various subjects in the field of vascular and interventional radiology.

What's New? Inhance Suite

What is it?

A suite of non-contrast enhanced MR angiography (NCE MRA) sequences that utilize a multitude of advanced techniques to enhance the inherent ability of MR to visualize flowing blood.

Why you need it:

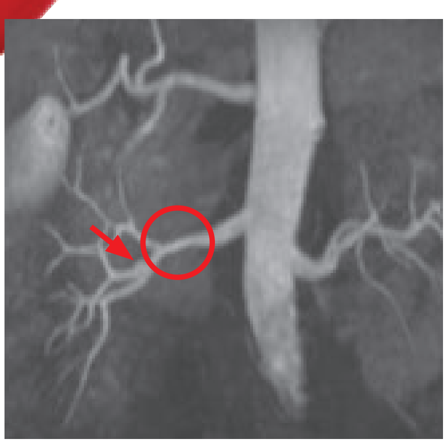
It's robust and fast. Inhance sequences deliver exquisite images in short scan times and eliminates the need for contrast injections or patient breath holding.

Why you'll love it:

See vascular structures without contrast. Image patients with impaired renal function and provide a fast, non-invasive experience for your patients.

What's included in it:

- **Inhance Inflow IR** – delivers high-quality images of the renal arteries with excellent ability to suppress fat, static background tissue, and venous flow.
  - **Why it's fast:** utilizes ASSET parallel imaging to speed up the acquisition that typically takes less than four minutes.
- **Inhance 3D Velocity** – phase-contrast-based sequence optimized to acquire 3D MRA images in the brain and abdomen and can visualize complex vascular systems and structures in intricate detail with excellent background suppression.
  - **Why it's fast:** ASSET-accelerated technique, an image of the entire brain with 0.5 mm x 0.5 mm in-plane resolution takes five minutes, a fraction of the scan time needed for a conventional phase-contrast scan.
- **Inhance 2D Inflow** – captures images of nearly straight-path arteries with robust fat, background suppression and minimized pulsatile artifacts.
  - **Why it's fast:** accelerated with ASSET parallel imaging, it delivers 50% reduction in scan time compared to conventional TOF exam.

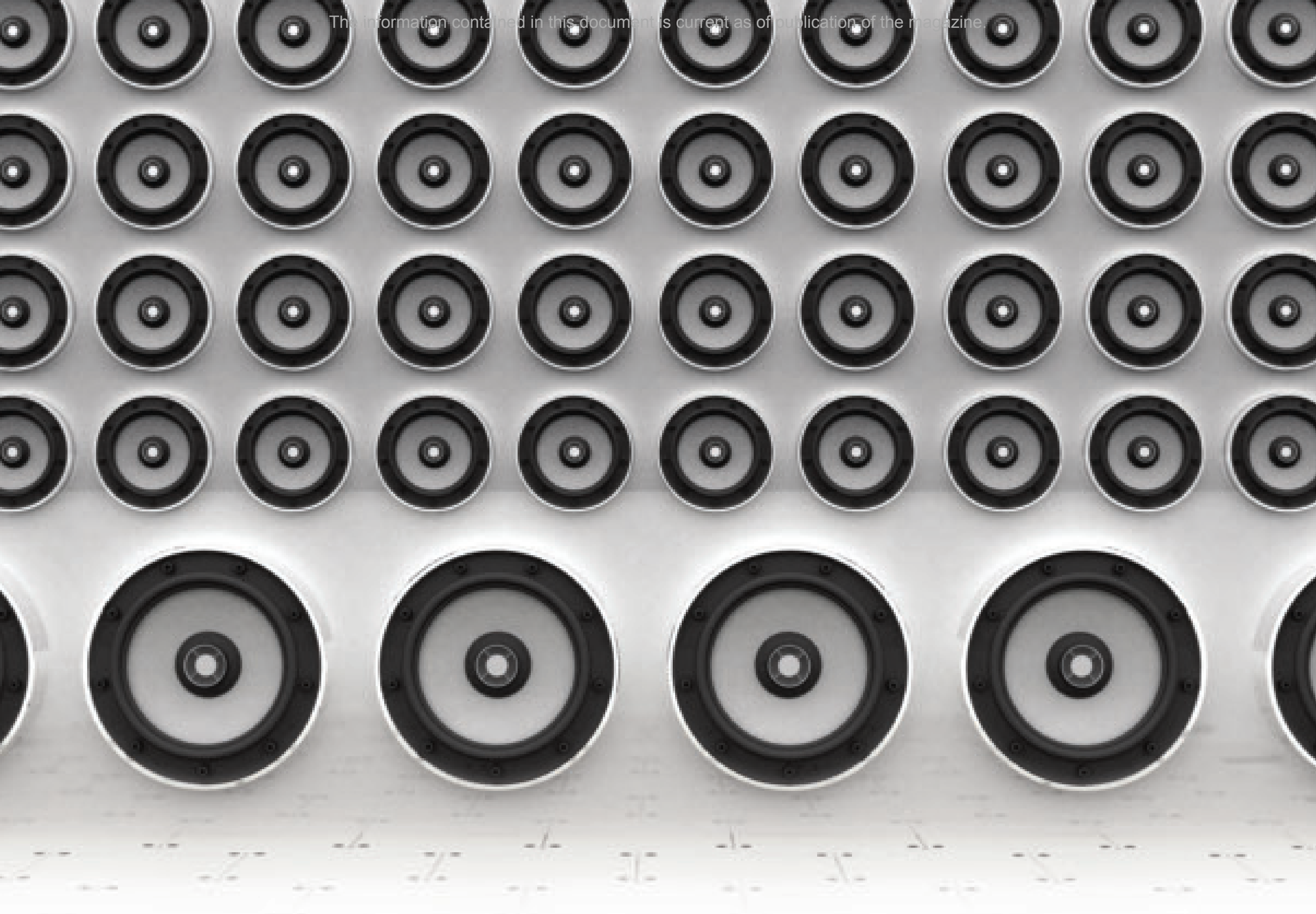


Inhance Inflow IR at 3.0T shows narrowing of RI renal artery in 40-year-old patient with fibromuscular dysplasia. See exquisitely visualized narrowing of the RI renal artery (circle), a typical beading (arrow).

Inhance Inflow IR of the same patient, arrow points to a typical beading. Note well-depicted distal vessels.

Inhance 3D Velocity of the same patient

Images courtesy of Mount Sinai Medical Center, New York.



The Sound Diagnosis

No matter how you look at it, MR Elastography can provide new information and options – and it's here today

By Vinod S. Palathinkara, PhD, Lloyd Estkowski, and David W. Lee, PhD

While MR Elastography (MRE) is an innovative technology, an investment in MRE can bring immediate clinical value to patients. MRE gives referring physicians a powerful new option for liver assessment. It is a new tool that provides diagnostic informatioin without the discomfort and risk of complications due to invasive procedures, enabling more frequent evaluation when closer monitoring is needed. By creating a vivid visual representation of liver tissue stiffness, MRE lets radiologists deliver a more confident diagnosis. MRE enables diagnostic procedures at a lower cost than previous techniques. Both comprehensive and non-invasive, the technique can appeal to patients and referring physicians, and can help expand the role of radiology into new areas. More than anything else, MRE holds the promise of better outcomes at lower costs to the overall healthcare system.

Chronic liver disease and cirrhosis are major public health problems worldwide. In 2004, these conditions were associated with nearly 40,000 deaths and a cost of at least $1.4 billion for medical services in the U.S. alone.[1,2] These figures are expected to increase due to aging, obesity, and end-stage liver disease caused by chronic hepatitis C infection. The major biological process responsible for clinical liver disease is progressive hepatic fibrosis.

Liver biopsy is the current gold standard for detecting hepatic fibrosis. There are, however, limitations with the technique that include poor acceptance by patients, measurement errors, and cost.[3,4] Current non-invasive alternatives to liver biopsy are serum-based testing,[5] which is not reliable for detecting early disease, and transient ultrasound elastography,[6] which has technical limitations in patients with obesity and conditions such as ascites. [21]

MRE, a technique developed by Richard Ehman, MD, and colleagues at Mayo Clinic (Rochester, MN), uses low-frequency mechanical waves to probe the elastic properties of tissue. These mechanical waves are generated in the body through an external acoustic driver, which are then imaged using a special phase-contrast MR sequence. Using a sophisticated mathematical algorithm, the mechanical wave data collected by the MR is then used to generate an "elastogram," – a diagnostic image that depicts tissue stiffness.

In its spirit of bringing the latest technology to clinicians, in July 2009, GE Healthcare commercially launched MR-Touch, an MR-Elastography (MRE) application, available on the Optima MR450w and Signa HDxt systems. GE Healthcare is currently working to expand its availability to other 1.5T systems.

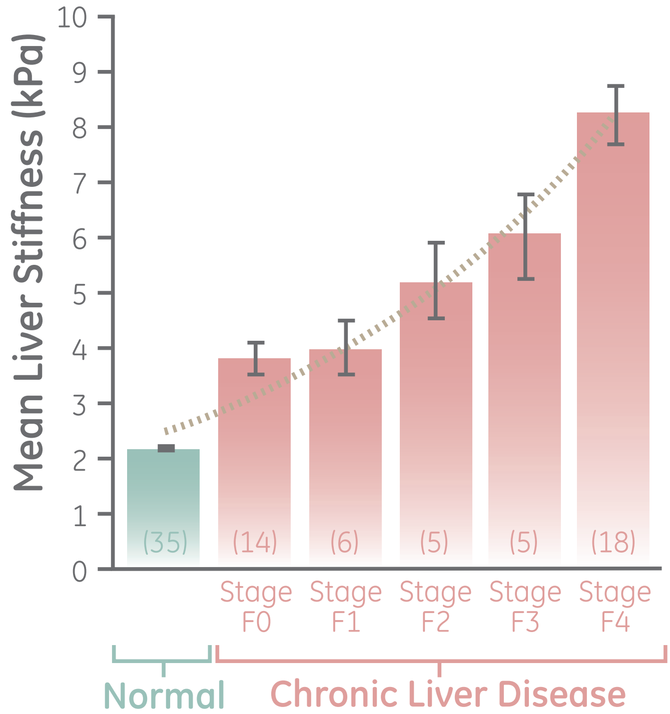


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Figure 1. Mean shear stiffness measurements of the liver for normal volunteers and patients at different fibrosis stage

Clinical value of MRE

Yin et al. evaluated the diagnostic performance of an optimized MR elastography protocol for assessing hepatic fibrosis among patients with diverse causes of chronic liver disease and in normal individuals.[8] The summary of mean values and variance of liver stiffness from the 35 normal volunteers and 48 patients with chronic liver disease are shown in Figure 1.

When assessed by stage of fibrosis, the mean liver stiffness value increased systematically with excellent correlation between histologic fibrosis and shear stiffness obtained with MR elastography ($R^2 = 0.94$, $P < 0.001$) (Figure 1). The study results supported the hypothesis that MR elastography is effective for distinguishing normal, soft-liver tissue from stiff fibrotic liver tissue with a very high negative predictive value. The severity of increased stiffness was shown to allow moderate to severe fibrosis to be distinguished non-invasively from mild fibrosis.

It is important to assess the accuracy of MRE in relation to the accuracy of liver biopsy. A review of the available data on the accuracy of needle liver biopsy to define the stage of fibrosis reveals that significant sampling and interpretive error affects the assessment of liver biopsy. Needle liver biopsy assesses only about 1/50,000 of the volume of the liver and so it may be affected by substantial sampling error.[9] Autopsy and laparoscopy studies that have evaluated the accuracy of liver biopsy for staging fibrosis and diagnosing cirrhosis have clearly shown that cirrhosis is missed on a single blind liver biopsy in 10% to 30% of cases.[10,11,12,13,14] The majority of this error is due to the

MRE has the potential to significantly reduce cost as a triage for liver biopsy.

In liver biopsies, the absence of key findings does not rule out a suspected diagnosis.

under-staging of disease. Both the size of the biopsy and number of biopsies taken have a major effect on accuracy. Abdi et al. report that the correct diagnosis of cirrhosis with a single biopsy increased from 80% to 100% when three specimens were analyzed.[15] Similarly, in a study that evaluated the agreement between three biopsies taken at a single setting, Maharaj reported that cirrhosis was identified in all three biopsies in only 50% of the cases.[16]

Rockey et al. suggest that sampling variability appears to be one of the major limitations of liver biopsy.[17] In a study of 124 patients with chronic HCV infection who underwent laparoscopy-guided left and right lobe liver biopsies, 33% of cases had discordant results by at least one histological stage. A smaller but substantial proportion of biopsies were discordant by at least two stages. Similarly, a single liver biopsy specimen may fail to distinguish steatohepatitis from simple steatosis and may mis-stage the disease by one (or less frequently), two stages if the specimen is much smaller than 2 cm. The authors caution that although even small biopsy specimens may be sufficient for diagnostic purposes in certain situations, the possibility that sampling variability exists must be recognized, so that the absence of key findings does not rule out a suspected diagnosis. By showing information about liver stiffness over one or more cross sections of the entire liver, MR elastography provides a more comprehensive view than before available.

Patient comfort of MRE

According to Rockey et al., pain is the most common complication of liver biopsy, occurring in up to 84% of patients.[3] The most important complication of liver biopsy is bleeding. Severe bleeding requires hospitalization, has an increased likelihood of transfusion or radiological intervention, or surgery. Less severe bleeding is defined as that sufficient to cause pain or reduced blood pressure, but not requiring transfusion or intervention. Mortality after liver biopsy is usually related to hemorrhage and is very uncommon.

MRE does not use contrast or ionizing radiation and provides a completely non-invasive test of liver tissue elasticity, thus resulting in high patient comfort. According to Ehman at al.,

Complications	Risk
Death	1:10,000 – 1:12,000
Bleeding	1:100
Bile leak	1:1,000
Any pain	1:4
Significant pain	1:10 – 1:20

Figure 2. Major complications of liver biopsy[3,18,19]

the vibration has amplitude in abdominal tissue that is very small (typically less than 0.1 mm), and does not cause discomfort.[18]

Health care system costs

Given the novelty of the MRE technology, peer-reviewed academic or medical literature evaluating the potential cost-effectiveness of this non-invasive testing strategy in the diagnosis and management of liver fibrosis is currently limited. There is, however, evidence to suggest that MRE has the potential to lower the overall costs in the management of liver diseases.

Carlson et al. used data originally reported by Wong et al. and adjusts for inflation using Consumer Price Index to arrive at an estimated cost of liver biopsy of $1,255*, but this estimate understates the true costs of a liver biopsy because it excludes procedure-related morbidities.[7,19] Myers et al. used administrative databases from a large Canadian Health Region to identify percutaneous liver biopsies performed between 1994 and 2002.[20] The study found that between 1994 and 2002, 3,627 patients had 4,275 liver biopsies. Thirty-two patients (0.75%) had significant biopsy related complications. The median direct cost of a hospitalization for complications was $4,579 Canadian (range $1,164-$29,641).

As a new technology, MRE is currently not reimbursed with its own CPT code*. Because the acquisition time is very short, the addition of MRE for liver evaluation into a conventional MRI examination protocol adds very little to the typical examination time of 30 to 45 minutes. If MRE is not reimbursed any more than a typical abdominal MRI

*Figures associated with US rates of reimbursement. Not globally applicable.

MRE is effective for distinguishing stiffness … with very high negative-predictive value.

scan, the reimbursement for a valid MRE scan would be similar to the 2010 national Medicare average payment rate for an abdominal MRI, i.e. $628 (CPT code 74183). At this stage, there is no way to predict the willingness of payers to cover the procedure and the level of reimbursement.

MRE has the potential to significantly reduce cost as a triage for liver biopsy. The information MRE provides could be used to assess if and when a patient should undergo liver biopsy. If one assumes that the cost of a liver biopsy is $1,255 and the cost of an MRE would be $628, then MRE would lower costs by at least 15% if it successfully avoids approximately two-thirds of unnecessary biopsies (Figure 3). Yin et al. showed that MRE has high predictive value in distinguishing stiffness associated with normal liver tissue.[8] Even though liver biopsy is accurate in identifying fibrosis, due to its basis as a sampling technique, absence of evidence of fibrosis from biopsy does not rule out fibrosis. MRE may also be a useful tool that helps guide clinicians in localizing the area of biopsy. If MRE achieves a 65% success rate in triaging, it would reduce the total costs by approximately 15%. With a negative-predictive value[8] of 97% (95% CI, 83.8%-99.8%), the threshold of 65% for MRE is far less than the combined true positive, false positive, and false negative rates for MRE.

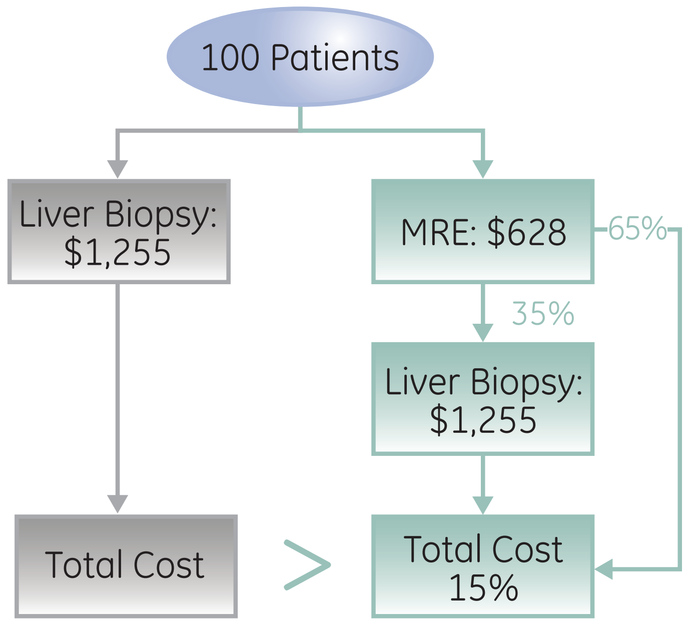

Figure 3. Comparison of direct costs when MRE is used in triaging for biopsy

Conclusion

MRE is non-invasive and provides tissue stiffness information for the entire liver and avoids the discomfort and risk of complications associated with other invasive procedures. In addition, elastograms avoid sampling errors and provide richer information that could assist in diagnosis. Studies show that the technique has excellent sensitivity in differentiating stiffness associated with normal liver tissue and fibrotic tissue. Stiffness of normal liver tissue is comparable to that of subcutaneous fat; studies have also not reported any influence of steatosis on tissue stiffness. In summary, the evidence supports the use of MRE as a triaging option for liver biopsy. The accuracy, lower costs, and the noninvasive nature of the technology offer the promise that MRE could improve outcomes at lower costs. ■

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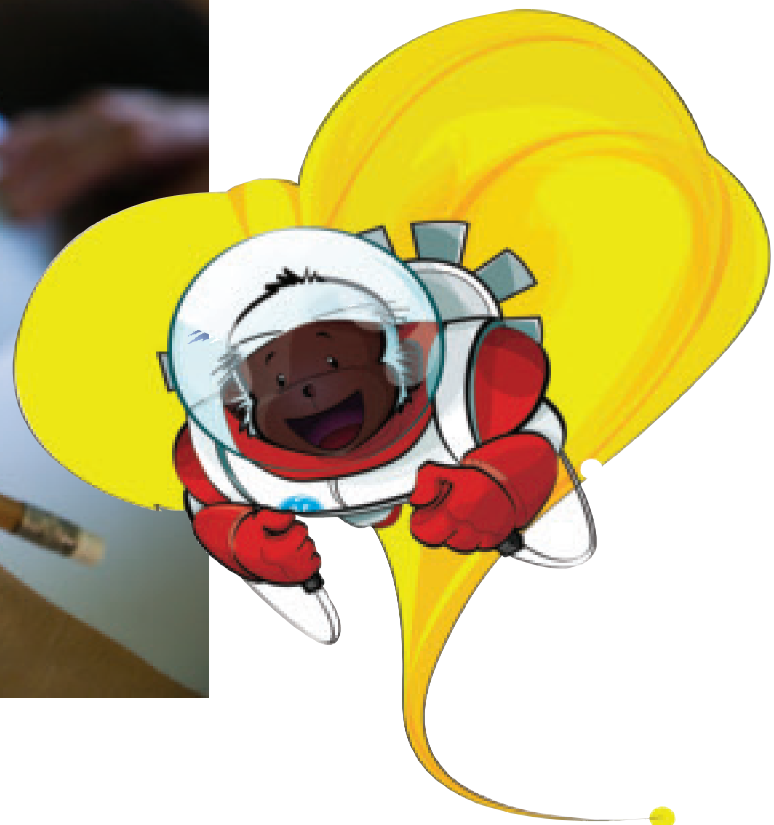
Transforming Anxiety Into Adventure

Captivating characters, lush visuals, and hands-on activities transform the MR experience for kids

Put yourself in the shoes of a child who is about to get a scan. Admit it: imaging equipment can be scary. Entering the imaging suite and being confronted with a huge piece of equipment in a room that is filled of mysterious and foreign medical equipment can be unsettling. Anxiety sets in. Kids get restless. Parents grow concerned.

But it doesn't have to be that way. Imagine if there was never a reason for anxiety – and the whole imaging experience was a fun adventure! It might sound outlandish, but that's exactly what Children's Hospital of Pittsburgh of UPMC is doing. How? With a little creativity and new ways of thinking, the GE Healthcare Adventure Series™ is a bold and innovative concept that makes diagnostic imaging a better experience for kids – and one that's more comfortable and easier for parents and technologists alike.



Scheduled to launch in the United States in mid-2010, the Adventure Series uses sensory tools to create an imaging experience that children find more welcoming. It also employs educational tools to help soothe and reduce a child's anxiety along the way.

Children's Hospital of Pittsburgh of UPMC is the first hospital in the country to incorporate the Adventure Series into its diagnostic imaging suite, and the early results are nothing short of inspirational.

"The Adventure Series has markedly enhanced our ability to provide family-centric care in the MR setting," says Dr. Ashok Panigrahy, radiologist-in-chief and associate professor of radiology, UPMC. "The MR environment is very harsh and cold for both children and their parents. The Space Adventure motif in our MR suite has allowed children to feel more relaxed and engaged with the MR technologists so that the scan can be performed efficiently."

Starting from scratch

The concept is rooted in the notion that the process of imaging children doesn't have to be stressful – but positive and even fun. With that in mind, GE Healthcare teamed up with Children's Hospital of Pittsburgh of UPMC to design a new kind of imaging experience specifically to address the anxieties kids face – and is unlike any other. And they built the program from scratch.

The first step was to gain invaluable insight that children's hospitals face every day: kids have specific challenges and a unique sets of needs, especially when it comes to imaging. Next, observational research was conducted – visiting leading children's hospitals to analyze and dissect imaging processes and best practices. Finally, targeted focus groups – that included kids – were conducted, at which point the children expressed themselves with pictures and personal stories.

The findings were enlightening. While most children view big imaging equipment as scary, it is especially scary for those between the ages of four to nine, as they lack the cognitive reasoning skills to understand what's happening and why. And let's not forget the parents – it's nerve-wracking for them, too. All of this contributes to even more pressure to the technologists.

The good news is that children's hospitals already do a good job at helping kids through the imaging process. The opportunity, therefore, is that the actual look and feel of the imaging equipment itself could be addressed to facilitate a better experience, not to mention the environment in which it sits.

Learning how kids learn

Armed with a wealth of learnings obtained through the research, the concept behind the Adventure Series began to materialize. And who better to help than the experts at the Betty Brinn Children's Museum.

"Children feel more relaxed and engaged with the MR technologists – so the scan can be performed efficiently."

Dr. Ashok Panigrahy,
Radiologist-in-Chief at UPMC

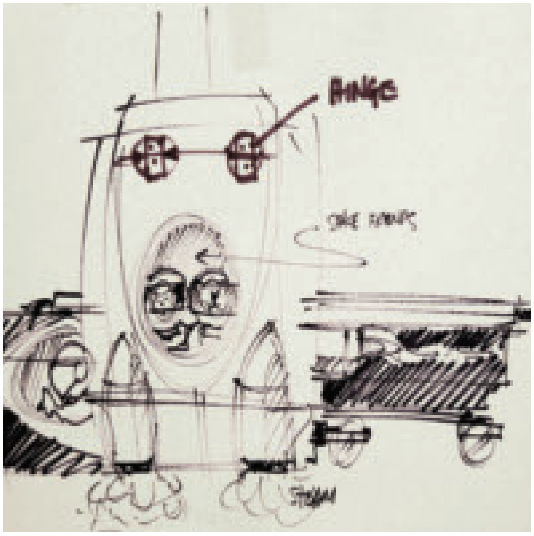
Long-known as a major attraction for children and their parents across the Midwest, the Betty Brinn Children's Museum provided valuable guidance, pointing to their interactive exhibits and educational resources that promote the healthy development of children in their formative years from birth through age 10.

The bottom line? Kids rely on their senses to understand the world. Colors, lights, sounds, materials, temperature, and smells are all key components of the learning process. Story telling is also highly effective. So if an imaging experience were to be truly fun instead of scary, these elements needed to somehow be incorporated.

Lift off!

With all of these elements combined, the Adventure Series was born, which seeks to fill the gap in the pediatric imaging experience – and effectively reach children through their hearts as well as their minds. Aimed at children between the ages of four to nine, the Adventure Series is offered to hospitals that purchase GE Healthcare imaging technology.

While the concept of the Adventure Series is thorough, the process, however, is turn-key with a virtually seamless implementation. A dedicated team designs all aspects of the imaging rooms around any combination of five themes: Jungle Adventure, Space Adventure, Pirate Island, Coral City, and Cozy Camp. The themes include four animated characters to help technologists and child life specialists tell the



imaging story and effectively communicate key messages, such as the power of courage. The characters are Marcellus the Monkey™, Haley the Hippo™, Tillie the Tiger™, and Tara the Toucan™.

Creating smiles

At Children's Hospital, a million-square foot facility which opened in May 2009, the Adventure Series is prominent in its CT, MR, PET-CT, and nuclear medicine imaging suites. Now, children no longer visit MR rooms. Instead, they experience a space adventure. Think about it: the strange sounds of an MR system are now easily explained and exciting – it's not an MR scan, it's a trip to outer space.

The consensus? The experience is better for everyone, including the team at Children's.

"The combination of a great scanner and the ability to entertain a child as part of the scanning process just made my job 100 percent better," says Cindy Corradene, Emergency Department lead technician, UPMC. "I even have adults who come in and want to be scanned here. People are overwhelmed by the friendliness of the room."

Children's Hospital has consistently ranked among the top by U.S. News & World Report and the Leapfrog Group, a national patient safety organization. More importantly, hospitals like Children's are giving kids and their parents yet another reason to smile. The Adventure Series is just one way to help in the bigger effort of improving healthcare – including the experience – for the littlest patients with the biggest hearts. ■

Learn from

the Masters

With hands-on, in-person training, GE Healthcare offers on-going learning opportunities for technologists and radiologists – so you can maximize your potential.

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cold

How to make sure your super cool doesn't become wicked hot

It goes without saying that keeping patients and personnel safe during magnetic resonance (MR) scans is a top priority for all of us. But like it or not, quenching is a possibility that can lead to serious injury. In fact, it's one of two MR-related hazards that have contributed to critical injuries (the other involves magnetic forces or torques). To help ensure your facility is up to speed on magnet safety specific to quenching, let's brush up on the definition of a quench, review procedures to follow in case of a sudden cryogenic release into the magnet room, and explore precautions that can be taken to avoid quenching.

Avoiding the Quench

hot

What's the scoop?

With MR systems, a superconductive magnet uses cryogens to super cool the electrical conductor that creates the magnetic field. Temperatures as low as -269° C/-452° F are achieved to create the proper environment within the magnet.

Occasionally, an abnormal termination of magnet operation can occur when part of the superconducting coil enters the normal or resistive state. This is called a quench – a sudden boil – off of the entire volume of cryogenic liquid, which causes a rapid loss of the static magnetic field.

When quenching occurs, the magnet conductors experience rapid Joule heating, that raises the temperature of the magnet rapidly. This is typically accompanied by a loud bang (as the energy in the magnetic field is converted to heat) and rapid boil-off of the cryogenic fluid.

Though rare today, a magnet can quench for no apparent reason, sometimes even after years of uneventful service. It can also happen intentionally; for example, if an object gets pinned to the magnet and the operator presses the Magnet Rundown Unit (MRU) button.

Vent failure hazards

The good news is that not all quenches are dangerous. A quench is a hazard only if the vent fails, at which time white clouds of cryogen vapor are released into the magnet room.

"While quenches are rare, they also could be serious," says Joe Schaefer, principal safety engineer for MR at GE Healthcare and member of the American College of Radiology's Blue Ribbon Panel on MR Safety. "If a large magnet undergoes a quench, the inert vapor formed by the evaporating cryogenic fluid can present an asphyxiation hazard to operators by displacing breathable air."

Failure to follow precautions can result in additional serious injury – frostbite, injuries due to panic, and even death. This underscores the importance of understanding magnet safety, as well as learning the warning signs that a potentially hazardous situation could be imminent.

Safety review – what to do?

It is critical to have a well-planned response in place to quickly remove the patient and all personnel from the magnet room if a quench should occur. The following procedure, as described in the GE Healthcare Safety Guide, should be used in case of a sudden cryogenic release into the magnet room:

1. **Do not panic.** Staying calm helps you remain focused so you are able to safely remember and follow your planned method of action.
2. **Using the intercom, tell the patient to stay calm and remain on the table.** Assure him or her that someone will be in shortly to offer assistance.
3. **Turn on the magnet room exhaust fan.** Note that some systems vent automatically and there is no fan to turn on.
4. **Prop open the door between the operator room and hallway** or if in a mobile unit, open the door to the outside to promote circulation.
5. **Prop open the door to the magnet room.** If helium venting is in the room, the magnet room door may not open. If the door cannot be opened, slide open the window between the console and magnet rooms. Or, if needed, break the window to the magnet room to relieve pressure.
6. **Enter the magnet room and remove the patient.** If a gurney or wheelchair is needed, make sure it is non-ferrous. When exiting, stay near the floor below any helium gas (where oxygen will be at a greater concentration) and immediately exit the magnet room.
7. **Evacuate all personnel from the area** until the air is restored to normal.

Protect against quenching

While everyone who operates the MR system should know what to do in case of a quench, the good news is there are several things you can do to help prevent quenching.

- **Keep your exhaust fan system clean.** The magnet (RF-shielded) room exhaust fan, vent, and duct system are intended to evacuate the magnet room of cryogenic gas at the MR product specified rate. Over time, the exhaust fan system may become blocked with lint, hair, and other airborne particles. It is important for personal safety reasons that the

Quenches are frequently due to improper liquid helium filling procedures, or failure to fill with helium at the required interval (i.e., a "dry" quench). Here are recommendations for doing it correctly – please refer to the GE Healthcare Safety Guide for more information.

Cryogens come in large vacuum containers called dewars. Liquid helium is generally used for cooling purposes, although some service procedures also require liquid nitrogen. The helium gas fills the magnet to proper cryogen levels. Special considerations should be observed when handling cryogens.

- Dewars and cylinders should not be tipped or heated, nor should the valves be tampered with.
- The cryogens boil off as they cool the magnet wires and must be replenished periodically by qualified personnel. The rate of boil off should be monitored by checking the cryogen level meter found on the system cabinet.
- Contact with the cryogenic liquids or gas could result in severe frostbite; care should be taken when in proximity to these substances. The wearing of protective clothing, such as safety gloves, work gloves, a face shield, a laboratory coat or overalls (cotton or linen), and non-magnetic safety shoes, is essential during all work in conjunction with liquefied cryogens.
- Dewars should be stored in a well-ventilated area, as cryogens could be accidentally released in gaseous form resulting in an asphyxiation hazard.
- All dewars and gas cylinders must be non-magnetic.
- Gas cylinders should be stored upright and secured to the wall by a chain with the metal protective cap in place. (If a cylinder falls over or the valve is knocked off, the container may act like a rocket; a full cylinder has enough power to penetrate walls.)
- Because the cylinder's metal cap may be magnetic, the cap should always be removed before bringing the cylinder into the magnet room.
- If possible, all personnel should stay out of the magnet room when a qualified service engineer is filling cryogens in the magnet. If personnel must be present, they must wear proper gloves, a face shield, and ear protectors.
- A qualified service engineer should be present any time cryogens are transported within the hospital or added to the magnet.
- It is crucial that ventilation and cryogenic systems be kept in good repair and checked regularly to help ensure proper functionality.
- Flammable materials must not be brought near the cryogen containers.
- You are responsible for establishing and following a procedure, in accordance with your local and federal requirements, that includes possible evacuation of the MRI area, if flammable materials are identified near cryogenic gases. If grease, oil or other combustible material is present in the vicinity of the containers, the escape of cryogenic gasses can lead to the formation of a potentially combustible liquid due to liquefaction of air and concentration of oxygen.

exhaust fan system (vent, exhaust fan, ducts, etc.) be kept clean to help ensure the exhaust fan system operates properly and exhausts cryogenic gas to an outside area.

In the unlikely event of a magnet quench or a cryogen gas leak, it is important that the exhaust fan system performs at or above the specified airflow to remove the cryogen gas from the magnet room. The magnet room exhaust fan and air inlet must be sized for a minimum of 1200 CFM and minimum of room 12 air exchanges per hour. The minimum air flow and air exchange rate for mobile, transportable, and relocatable systems are different from those for fixed sites and varies depending on the type of site. Any blockage or obstruction could prevent the exhaust fan system from providing the required airflow. If the exhaust fan system fails to operate at or above specification, accumulation of dangerous levels of helium or nitrogen within the RF screen room could occur.

Additionally, ensure that your vent is not blocked on the outside or inside. Something as simple as a bird's nest can cause big problems. Plus, as your vent glass ages, make sure it has not deteriorated.

- **Stay current with maintenance services.** The planned maintenance (PM) services prescribed in the PM schedules represent the current manufacturer's recommendations. Specific customer requirements and/or your site environment may necessitate more or less frequent intervals for PM service. An agreement to perform PMs less frequently than these recommendations can be made with the understanding that a reduction of system performance may result. Note that the Cryogen Vent is part of the facility and must be maintained / inspected as part of facility maintenance.

  Reminder: The PM service schedules in the Maintenance Service Schedules of Appendix C of the Safety Manual (2381696-100 Rev. 10) list all the PM procedures and the frequency they should be completed by qualified service personnel. There are different schedules for each system type.

- **Exclude magnetic items from the magnet area.** A common cause of "intentional" quenching is the attraction of a large, ferromagnetic object, such as a chair, ladder, or mop bucket, against the side of the magnet. A magnet rundown can be performed, but it results in several days of downtime and could jeopardize the magnet. Your facility needs to define the specific circumstances that would require a magnet rundown so that no one makes an expensive mistake. You should plan and rehearse for a magnet rundown including what to do if cryogen vapor is released into the magnet room.

- **Fill and monitor the helium level** regularly before the magnet runs out of helium. In addition, use proper equipment when filling the magnet, including a pressure regulator and gage for the helium gas used to pressurize the liquid helium storage vessel. See the sidebar for more information about handling cryogens.

- **Follow your scanner's pre-inspection instructions** and inspect your system on a regular basis.

"With quenching, there's a low probability of getting hurt, but there still can be a catastrophic severity," comments David Goldhaber, systems architect in MR at GE Healthcare. "Incorporate these tips and make them an ongoing part of your MR Safety Program training to help keep prevention and safety in mind."

The goal of an MR Safety Program is to minimize risks and harm to patients and healthcare professionals. Integrate this information into safety training for your facility.

Look for articles about additional safety risks and how to avoid them in upcoming issues of SignaPULSE. For more information visit www.gehealthcare.com/usen/mr/mrsafety/index.html, see your field service engineer for the latest revision of the Safety Manual and visit URL of rev 10 Safety Manual Appendices D and F. ■

Quick Steps: Respond to emergencies – quench with vent failure

1. Do not panic.
2. Using the intercom, tell the patient to stay calm and remain on the table.
3. Turn on the magnet room exhaust fan.
4. Prop open the door between the operator room and hallway, or if in a mobile unit, open the door to the outside.
5. Prop open the door to the magnet room.
6. Enter the magnet room and help the patient exit.
7. Evacuate all personnel from the area until the air is restored to normal.

hot

cold

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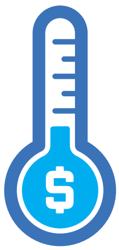

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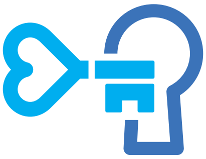

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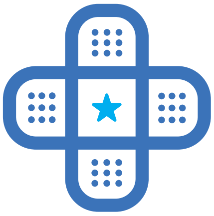

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