

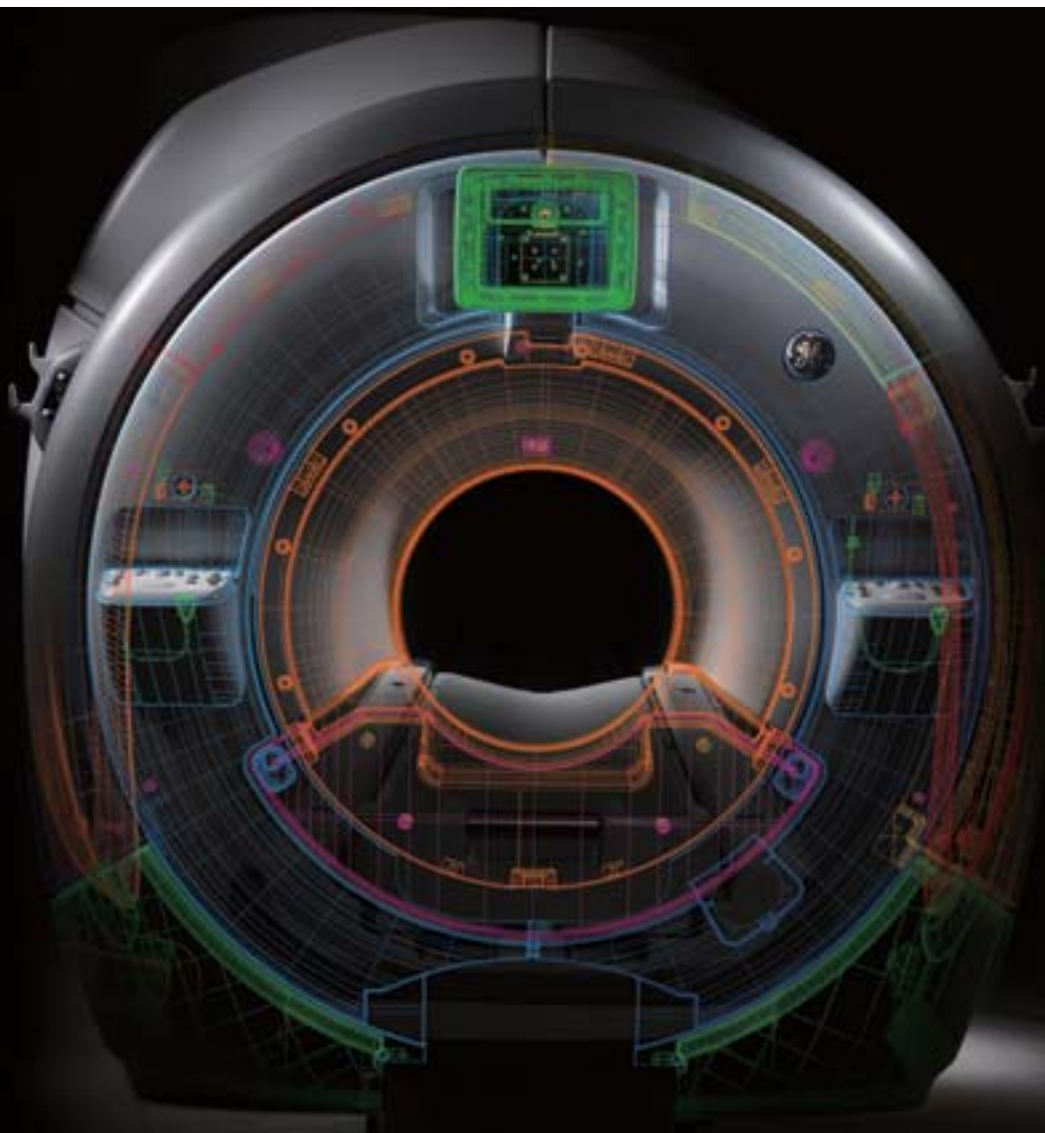
GE Healthcare

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THE MAGAZINE OF MR • SPRING 2008



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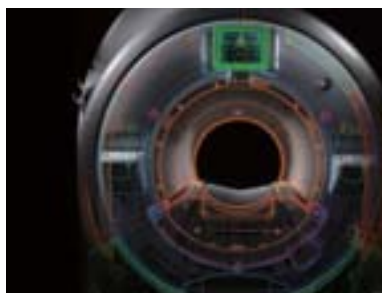


imagination at work

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Welcome

Legend has it, that in 1899, the head of the U.S. Patent Office sent his resignation to President McKinley urging the closing of the office. Why? It wasn't because of inefficiencies or disgruntled employees. Instead, the resignation was spurred for a completely different reason.

"Everything that could be invented had been invented."

Imagine that! Before Ford's Model T, before the Wright Brothers took their first flight, before the X-ray was used for a medical purpose. And that was before the turn of the century.

Fast forward to 2008. Clearly, the U.S. Patent Office hasn't closed. And many more inventions have been brought forward that have changed the way we go about our daily lives. At GE, we have a rich legacy of bringing forward the breakthrough innovations. After all, our company started with the invention of the light bulb from our founding father, Thomas Edison.

That's why this is an especially exciting time for us here at GE Healthcare, MR. We're continuing the tradition of providing cutting-edge technology to help you in your daily lives. Today, we're unveiling a truly innovative solution – an MR system that combines speed and accuracy with the most powerful gradients in the industry.

This system, the Signa® MR750 3.0T, was designed to breakthrough the barriers of traditional MR – from scanning to workflow. Your potential is yours to discover – and now you have the power and precision to achieve your goals – whatever they may be.

This issue, like other issues, is packed with timely, relevant, powerful information you can put to use immediately. But this time, we've taken a slightly different approach. Given that this new system can help MR researchers breakthrough traditional MR boundaries, we've taken great lengths to include shortened white papers so you don't have to take our word for it on the benefits of this new technology. That's not to say this is only for researchers. Key articles detailing workflow efficiencies and exam speed are also included.



James E. Davis

See for yourself the details and proof points behind this remarkable technology. At the same time, make no mistake; this system is ready for clinical prime time. Imagine you could:

- Get up to 60 percent greater coverage;
- See 60 percent higher resolution and significant improvement in uniformity and accelerated acquisition and reconstruction speed;
- Focus on your patient during the scan, not the scanner with our revolutionary in-room display; and
- Reduce set-up time by 71 percent with our re-imagined user interface and one-touch patient positioning.

In addition, we're seeing remarkable achievements, such as a complete liver exam that can be conducted in a 15-minute slot, routine fMRI with shorter paradigms and greater activation and a complete breast exam done in only two sequences. And this is not just imagination. This is reality and it's just the beginning. We're at the tip of the iceberg for the innovative, cutting-edge and smart solutions you need to do your job. And when your customers are in the business of saving lives, that's not a task to be taken lightly.

Thank you for your continued partnership. Your thoughts, collaborations and input are the backbone of our business. We're excited about the promise that the Signa® MR750 3.0T delivers. But we're even more excited when we hear from professionals like you with your next big idea. Because you never know when the next "what if?" will turn into the realities of tomorrow. And if I had to guess, the realities of tomorrow are vast and waiting for us to discover. Together, our imagination at work.

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



Calendar of Events

GE looks forward to seeing you at the following events.

Date	Conference	Site	City/State	Country	Web Link
May 3-9	ISMRM Sixteenth Scientific Meeting and Exhibition / SMRT Seventeenth Annual Meeting	Metro Toronto Convention Centre	Toronto, Ontario	Canada	www.ismrm.org
May 8-10	Society of Breast Imaging	Grande Lakes Resort	Orlando, FL	USA	www.sbi-online.org
May 31-June 5	American Society of Neuroradiology (ASNR), 46th Annual Meeting & NER Foundation Symposium	Morial Convention Center	New Orleans, LA	USA	www.asnr.org
June 5-8	International Congress of Radiology	Marrakesh Congress Center	Marrakesh	Morocco	www.sfrnet.org/icr2008/Pages/Assemblage-FR.htm
June 10-13	European Society of Gastrointestinal & Abdominal Radiology (ESGAR) 2008	Istanbul Conference & Exhibition Center	Istanbul	Turkey	www.esgar.org
June 15-19	Organization for Human Brain Mapping	Melbourne Convention Center	Melbourne	Australia	www.hbm2008.com
Aug. 30-Sept. 3	European Society of Cardiology	Messe München GmbH	Munich	Germany	www.escardio.org
Sept. 11-13	Japanese Society for Magnetic Resonance in Medicine	Asahikawa Citizen and Cultural Hall	Asahikawa, Hokkaido	Japan	www.jsmrm.jp
Sept. 18-21	European Society of Neuroradiology	Auditorium Maximum Jagiellonian University	Krakow	Poland	www.esnr.org
Sept. 20-25	Congress of Neurological Surgeons	Orange County Convention Center	Orlando, FL	USA	www.neurosurgeon.org
Oct. 2-4	European Society of Magnetic Resonance & Radiology	Valencia Conference Centre	Valencia	Spain	www.esmrm.org
Oct. 10-12	HOSPEQ	Beijing Exhibition Center	Beijing	China	www.china3w.com
Oct. 11-14	North American Society for Cardiovascular Imaging	Camelback Inn	Scottsdale, AZ	USA	www.nasci.org
Oct. 15-18	MR Angio Club	Grazer Congress Centre	Graz	Austria	www.mr-angio.org
Oct. 24-28	Asian Oceanian Congress of Radiology	COEX Convention & Exhibition Center	Seoul	Korea	www.aocr2008.org
Oct. 24-28	Journée Française de la Radiologie	Paris Congress Center	Paris	France	www.sfr-radiologie.asso.fr
Nov. 8-12	American Heart Association	Morial Convention Center	New Orleans, LA	USA	www.aha.org
Nov. 30-Dec. 5	Radiological Society of North America	McCormick Place	Chicago, IL	USA	www.rsna.org



Signa Koshien Meeting Accepted Wider Range of Field Strength

Record Users From Every Region in Japan Attended



More than 200 Signa® users from every region in Japan attended the third Signa Koshien meeting, held at the Tokyo Midtown Hall on December 8, 2007. The event was open to a wider range of field strength, between 0.2T and 3.0T, than the previous year.

A record number of GE MR users enjoyed the excitement. The meeting featured 13 presentations from six geographic regions – four more than last year.

The presentations focused on topics such as:

- Scan protocol optimization for better MRA/3D image quality;
- Scan technique for challenging anatomical areas while maintaining patient comfort;
- Scan know-how, available to all Signa users; and
- Users' enthusiasm to maximize the performance of Signa.

Users competed for image quality, creativeness and clinical utility. Three awards were given:

1. Gold: Masaki Kobayashi, RT, Nagano Municipal Hospital, "Biliary Tract Imaging using Gate Free 3D FatSat Fiesta."
2. Silver: Akihisa Iitsuka, RT, Izumi-sano Hospital, "MR Angiography Imaging Technique."
3. Bronze: Kenichi Hirano, RT, Yokohama Sakae Kyosai Hospital, "Acute Stroke Imaging Technique by Three Contrast Long TE SPGR."

Additionally, Masato Kobahashi, RT, Nagano Municipal Hospital, presented "Body Diffusion Imaging Techniques" – which has applications in both 1.5T and 3.0T. He offered tips and technical explanations to achieve outstanding 3.0T whole-body diffusion images.

The presentations are available on the Signa Users Meeting Web site, http://gecommunity.on.arena.ne.jp/signa-l_entrance/. ■



First Signa® HDxt Clinical Results Unveiled at European Congress of Radiology



During the European Congress of Radiology in Vienna, Dr. Mathieu Rodallec from St. Joseph Hospital in Paris presented new approaches in Neuro and Orthopaedic MR imaging, promoting the superb image quality provided by cutting edge techniques such as Cube for volumetric 3D imaging and IDEAL for multiple contrasts acquisitions.

Opinion Leaders Applaud Cube™, IDEAL

On March 9, 2008 in Vienna, GE Healthcare unveiled its latest developments and advances in MRI at the European Congress of Radiology – one of the largest radiology congresses in Europe. Of note were the first Signa HDxt clinical results, released during ECR and also at a special MR symposium hosted by GE Healthcare.

Signa HDxt, the next generation MRI platform, allows radiologists to see more, do more, and expect more from their MRI system.

Support for Cube and IDEAL

Cutting-edge technology and innovative applications from GE Healthcare such as Cube, IDEAL and 3D Dual Echo keep pushing the frontiers of High Definition Volumetric MRI.

The MR symposium, led by GE Healthcare Diagnostic Imaging and Medical Diagnostics, focused on Signa HDxt and the new applications. Professor Carlo Bartolozzi from

the University of Pisa, Italy, chaired the event. Additionally, distinguished opinion leaders demonstrated the unique advantages of GE technology:

- Dr. Marc Zins from St. Joseph Hospital in Paris discussed abdominal MRI at 1.5, highlighting how crucial it is to work with 3D. Thanks to new applications like Cube and IDEAL, the imaging paradigm can be changed to spot smaller lesions that would not have been noticed without 3D.
- Professor Wady Gedroyc from St. Mary's Hospital in London demonstrated the interest of Cube and IDEAL in the MR exam of the female pelvis through compelling clinical cases.
- Dr. Mathieu Rodallec from St. Joseph Hospital in Paris focused on new approaches in Neuro and Orthopaedic MR imaging, promoting the superb image quality provided by cutting-edge techniques such as Cube for volumetric 3D imaging and IDEAL for multiple contrasts acquisitions.

From predicting and diagnosing to monitoring, treating and informing, GE Healthcare continuously dedicates its resources to keep healthcare providers as many steps ahead of illness as possible. ■



Dedicated Breast MR System

Setting the stage for a new era in women's imaging.

Furthering the company's commitment to breast imaging, GE Healthcare introduced a new, dedicated breast magnetic resonance (MR) scanner. As a result of the American Cancer Society's 2007 recommendation for annual MRI exams – in addition to mammography – for patients deemed high risk for breast cancer, breast MR procedures are expected to continue to grow. According to IMV Limited (Des Plaines, Ill), breast MRI procedures grew 58 percent between 2003 and 2006.

The GE Signa® Vibrant™ is a dedicated 1.5T breast MR scanner utilizing High Definition technology and applications specifically designed for breast MR, including VIBRANT acquisition, BREASE spectroscopy, integrated CADstream manufactured by Confirma, Inc., (Bellevue, Wash) and a specially designed



breast MR patient table (Sentinelle Medical, Inc., Toronto, Ont.) that provides optimal imaging and outstanding access for interventions. Signa Vibrant has a unique, patient-friendly design, ideally suited for the environment of many breast-imaging centers. The solution optimizes all of GE's breast MR capabilities – from imaging to intervention to workflow – in a complete solution.

In addition to improving patient comfort, GE is also focused on increasing public awareness and knowledge of breast cancer. With that in mind, GE will apply a portion of the proceeds from Signa Vibrant sales toward breast cancer education and awareness programs. ■

New High-Resolution HD Carotid Array

Excellent sub-millimeter resolution of the carotids lumen, vessel walls, and atherosclerotic plaques.

The GE Signa 3.0T 6-Channel Carotid Array coil provides excellent sub-millimeter resolution of the carotid lumen, vessel walls, and atherosclerotic plaques. Configured to optimize deep penetration high SNR with 15 cm field of view (FOV) Superior/Inferior and Anterior/Posterior coverage, the new phased-array coil enables bilateral diagnostic imaging of the carotid artery bifurcation. The Antennas rotate 300° and pivot in all directions for greater patient comfort. The coil is compatible with ASSET® parallel imaging techniques. ■







Beijing Olympics

GE Healthcare sole supplier of MR technology at the Beijing 2008 Olympic Games.

Diagnosing potential injuries earlier, or simply monitoring treatment, is essential for the world's most elite athletes. Early diagnosis is critical to their performance as every day in rehab is a day lost in training. At the Beijing 2008 Olympic Games, athletes will have access to some of the most advanced MR scanners available today, with GE Healthcare's Signa HDe 1.5T within close proximity to the sporting competitions.

The Olympic Village General Hospital is gearing up as a Center of Excellence with proven medical imaging technologies and world-class clinicians onsite at the Games. GE is the sole supplier of MR technology, installing two Signa HDe scanners for imaging all international athletes competing at the Games.

As an advanced diagnostic imaging tool, MRI provides detailed images of internal organs (soft tissue) and structures, allowing clinicians in sports medicine and orthopedics to identify specific injuries and design individual treatment plans. The Signa HDe 1.5T systems at the Olympic Village General Hospital will provide clinicians with high-definition images, while also decreasing operation costs (water, electricity, liquid helium) by up to 40 percent.

GE Healthcare's MR technologies have become a valuable tool for diagnosing sports-related injuries, as demonstrated previously at the Torino 2006 Olympic Winter Games. GE works closely with host countries, cities and organizing committees to provide Olympic venues with infrastructure solutions, such as power, lighting, water treatment, transportation and

security, and offer hospitals ultrasound and MRI equipment to help doctors treat athletes. In addition, NBC Universal, a division of GE, is the exclusive U.S. media partner of the Olympic Games, with its sponsorship also extending through 2012.

"At GE Healthcare, we are very pleased to be the sole supplier of MRI equipment for the Beijing 2008 Olympic Games. Using GE Healthcare technology and expertise, clinicians can detect and diagnose injury and disease earlier to help ensure better patient care," says Chih Chen, President of GE Healthcare China. "All athletes run a risk of injury, and our experience in sports medicine – as well as our customer feedback – tells us how important it has become for athletes to have advanced MR technology, such as the Signa HDe 1.5T, onsite at the Olympic Village General Hospital during training and competitions."

MR imaging as a non-invasive technique proves to be an optimal means for acquiring high-contrast images of both bone and soft tissue structures, such as the knee or shoulder. These are high-risk body parts for athletes, as musculoskeletal injuries can occur any time. That is why it's important to have leading-edge imaging technologies such as MRI close to the field of play and available to sports physicians, for more accurate monitoring of an athlete's condition, and so more tailored training and recovery protocols can be devised. ■



It's Here...

The wait is over – realize your true potential with the system that provides the power and precision to break traditional 3.0T MR boundaries: the Signa® MR750.

Go ahead. Pinch yourself. Because if you've ever wondered how you could extend your capabilities and reach the next level in MR, be it faster exams, additional functions or enhanced image quality – this is your day. GE Healthcare has developed a new 3.0T MR system designed to deliver the power and precision you need – so you can make the routine exams faster and the advanced exams routine. So you can do MR. Your way.

Simply powerful technology innovations

"It's invigorating to see 'what if' from a few years ago come to life with the technology this system delivers," says Charlie Giordano, General Manager for MR Engineering, GE Healthcare. "The promise of tomorrow's innovations requires a platform that's built for the future. And that's what this system delivers."



Starting with the industry's most powerful whole-body gradient system, the Signa® MR750 combines the eXtreme Gradient Resonance Module (XRM) and eXtreme Gradient Driver (XGD), which provides 50mT/m amplitude and 200 T/m/s slew-rate on each axis at 48 cm field-of-view to deliver up to 60 percent additional anatomical coverage and resolution unit per time.

With its advanced Thermal Management System, the Signa MR750 delivers up to five times the performance over previous generations, thus increasing the freedom for advanced application development. The newly designed RF Transmit system maximizes performance with a 17 percent gain in scanning efficiency and is uniquely optimized for each patient.

In addition, the system includes the GE-exclusive Optical RF Technology, OpTix, that adds up to 27 percent higher signal-to-noise ratio (SNR) over conventional, non-optical MR receivers by reducing electrical noise and increasing signal detection. The Signa MR750 Optical RF receivers are located on the magnet system inside the shielded scan room, isolated from external noise sources.

And for exceptional acceleration technology, ARC™ (Autocalibrating Reconstruction for Cartesian imaging) parallel imaging technique is combined with new High Definition coils to enable high acceleration factors, keeping advanced applications within clinically acceptable scan times. Plus, reconstruction processing performance gains with the Volume Reconstruction Engine (VRE) 2.0 open the door to emerging data-intensive studies.

It's true. Engineered to unleash the power of MR, the Signa MR750 provides exceptional precision for academic studies and pushes the physics of MR, extending advanced applications performance to enable new capabilities for exploring function and anatomy. What's more, it provides spectacular imaging detail in clinically practical exam times as well as:

- Up to 60 percent greater coverage;
- Up to 60 percent higher resolution;
- Significant improvement in image uniformity; and
- Accelerated acquisition and reconstruction speed.

Powerfully simple

The story began when GE approached MR users inquiring about the inefficiencies of a typical MR clinical workflow. The rest, as they say, is history.

"MR users told us that they want to be able to provide the most advanced clinical applications to serve their communities, such as a complete liver exam in a 15-minute slot, routine fMRI with shorter paradigms and greater activation and a breast images you need in only two sequences, but they need to be able to reproduce these exams very quickly and easily – every time. The Signa MR750 puts the most powerful MR technology at their fingertips to use in a very simple way so they can focus on patients. It's exactly what our customers have asked us to build," explains David Handler, General Manager, Global MR Product Marketing. "The ability to deliver their vision is extremely exciting."

"The Signa MR750 was designed around clinical workflow needs with a strong focus on improving productivity," says Bryan Mock, Global 3.0T Product Manager for GE Healthcare. "Thanks to the collaborations we maintain with our customers, we were able to provide an extremely efficient scanner built on a foundation of industry-leading technology."

Built with input from customers, the system includes operational efficiencies such as the newly designed detachable Express Patient Table patient table and iROC in-room operator console. In addition, the IntelliTouch one-touch patient positioning feature enables technologists to quickly and accurately landmark patients. Together, these features enable complete in room setup time in as little as 30 sec.; additionally, the newly designed user interface reduces the number of steps by as much as 68 percent.

The following pages are packed with information explaining in detail how the Signa MR750 can provide solutions that you can put to immediate use, including:

- Information on extended advanced application performance;
- How routine and advanced exams can become faster;
- Improvements in patient workflow from positioning to reading; and
- GE Healthcare's growth platform for future expansion.

And that's just the beginning, so stop pinching yourself. The future is here. The future is now. ■



Answering the Challenges of 3.0T Body MR Imaging

By Lloyd Estkowski, Body Development Manager, Ersin Bayram, PSD/Applications Engineer and James Akao, MR Reconstruction Engineer, GE Healthcare





The adoption of body imaging at 3.0T has followed behind applications such as neuro imaging. Concerns over specific absorption rate (SAR), increased sensitivity to magnetic susceptibility, increased chemical shift effects and reduced tissue contrast due to altered tissue relaxation parameters have been partially to blame. Yet, 3.0T has the advantage of increased signal-to-noise ratio (SNR) for higher resolution imaging, which in turn has an adverse effect on scan time.

Considering the majority of body imaging involves breath-hold acquisitions, ARC™, (Auto Calibrating Reconstruction for Cartesian imaging) the newly developed parallel imaging technique by GE Healthcare, is an answer to reduce scan times to an acceptable clinical level. ARC also helps by reducing SAR and susceptibility effects for echo train sequences such as single shot fast spin echo (SSFSE).





Additional advantages of ARC™ for body imaging include:

- Auto-calibration that helps avoid collecting external sensitivity map;
- Less sensitive to field-of-view (FOV) positioning with a tight FOV;
- Clinically practical reconstruction times for continuous scanning; and
- Respiratory triggering becomes practical for parallel imaging.

ROBUST parallel imaging and workflow

ARC can play a key role in body MR imaging by reducing the two most common artifacts – smaller FOV and motion. The auto-calibrating nature of ARC provides workflow simplification and can be seamlessly integrated into sequences without the need for separate calibration scans. In fact, Signa® MR750 3.0T accelerates the very first scan. SSFSE 3-plane localizer now supports ARC.

The acceleration provides two distinct advantages with SSFSE 3-plane:

1. Scan time savings can be used to increase resolution, slice coverage or a combination of both.
2. Shorter echo trains provide sharper images by reducing T2 decay blurring.

These two advantages combined with shorter echo spacing allows higher resolution 3-plane localizer images, which can potentially eliminate the need for an additional coronal SSFSE acquisition.

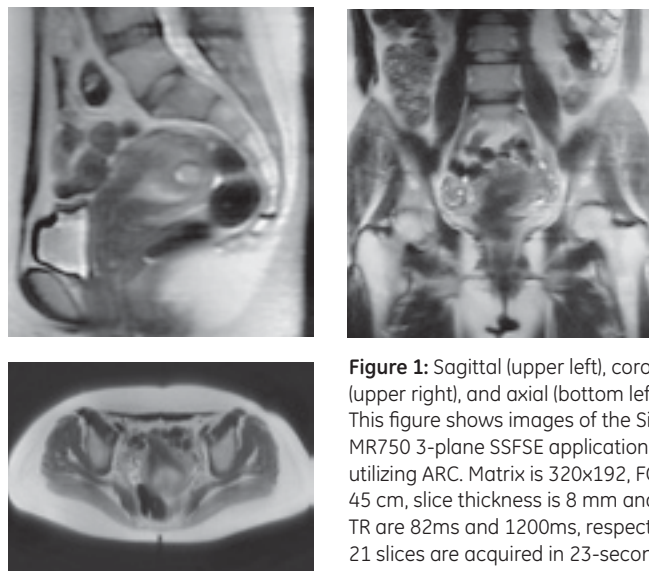


Figure 1: Sagittal (upper left), coronal (upper right), and axial (bottom left). This figure shows images of the Signa MR750 3-plane SSFSE application utilizing ARC. Matrix is 320x192, FOV is 45 cm, slice thickness is 8 mm and TE/TR are 82ms and 1200ms, respectively. 21 slices are acquired in 23-second acquisition using ARC acceleration factor of two.

In-phase and opposed-phase imaging is another critical diagnostic tool for body imaging in assessing fat containing lesions. Signa MR750 introduces the 3D Dual Echo sequence that acquires both in- and opposed-phase in one scan. In fact, 3D Dual Echo is capable of capturing the first opposed-phase TE (~1.2 ms) and first in-phase TE (~2.4 ms). This is critical at 3.0T to eliminate T2* induced signal loss between opposed-phase and in-phase images. Acquiring two echoes within the same scan eliminates potential mis-registration between in-phase and opposed-phase images that can decrease diagnostic confidence. 3D imaging provides sufficient signal to acquire thinner slices and higher in-plane resolution, while ARC provides the scan time savings.

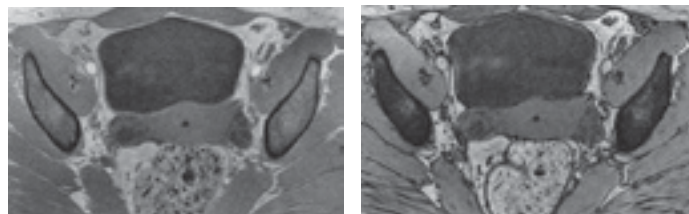


Figure 2: This figure shows images of the Signa MR750 3D Dual Echo application. Matrix 320x320 and 64 slices with 32 cm FOV and 2 mm slice thickness. TE in-phase/opposed-phase (2.6ms/1.3ms) pelvis imaging did not require acceleration.

As a result of these advancements, GE introduces LAVA-Flex on the Signa MR750 3.0T MR system. This sequence is rooted in the 3D Dual Echo imaging technique. It acquires in-phase and opposed-phase images, and utilizes a two-point Dixon technique to reconstruct water contrast and fat contrast images.¹ The user is able to select the output image types: in-phase, opposed-phase, water and fat. LAVA-Flex has the ability to produce four image contrasts with only one scan, allowing the user to reduce the total number of scans per exam. Because water contrast and fat contrast images are synthesized from in-phase and opposed-phase images with shortest possible TEs, effective number of excitations (NEX) for water and fat images is two, providing the maximum possible SNR efficiency.



Aside from the obvious scan time savings, ARC™ offers several unique advantages for LAVA-Flex:

1. **Robust Parallel Imaging:** Although water contrast images have intrinsic SNR advantage and are free from fat signal, ARC works on lower SNR in-phase and opposed-phase source images, which contain hyper-intense fat signal. Higher SNR in water images affords high acceleration factors, pressuring ARC to perform well with lower SNR source images. Bright fat signal creates higher frequency content in k-space, which is more challenging to resolve with parallel imaging. Potential parallel imaging artifacts on unaliased in-phase and opposed-phase images will show up in the water and fat images. The GE specific ARC technology overcomes these challenges to provide exceptional image quality.
2. **Reconstruction Performance:** ARC needs to unalias acquired in-phase and opposed-phase images first. Then, two-point Dixon processing is carried out to reconstruct water contrast and fat contrast images. Despite this added overhead, ARC's efficient implementation along with the high-performance Volume Reconstruction Engine (VRE) 2.0 allows LAVA-Flex reconstruction to keep up with the acquisition for contiguous scanning without delays.

3D T1 weighted fat saturation imaging is an integral part of body imaging. LAVA-Flex provides excellent fat suppressed/water contrast 3D T1 weighted imaging. The fat contrast images may then be used for abdominal fat assessments.

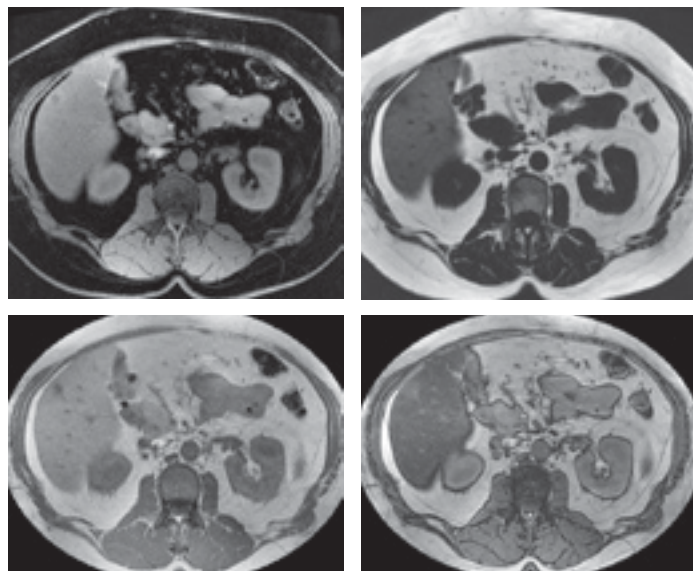


Figure 3: Water (upper left), fat (upper right), in-phase (lower left), opposed-phase (lower right). This figure shows images of the Signa® MR750 LAVA-Flex application. Matrix 320x192 and 52 slices of in-phase (TE=2.6 ms) and opposed-phase (TE=1.3 ms) with 36 cm FOV and 4 mm slice thickness are acquired in 21 seconds using ARC™ acceleration factor of two.

ARC is also compatible with the following three widely used abdomen applications:

1. LAVA is widely known for its superb 3D fat suppressed T1-weighted imaging for body applications. ARC provides extra confidence that image quality and consistent results are maintained.
2. FRFSE-XL T2 weighted sequence is routinely used for abdominal imaging. The user defines either a breath-hold, or a respiratory-triggered acquisition. ARC parallel imaging is a perfect fit for respiratory-triggered imaging due to its auto-calibrating characteristics.
3. SSFSE imaging benefits from the implementation of ARC as well. As in the 3-plane implementation, parallel imaging reduces echo trains, providing sharper images and reducing T2 decay blurring, as well as reducing scan times.

ARC improves imaging at 3.0T by enhancing workflow and at the same time increasing image quality. With new imaging techniques such as 3D Dual Echo and LAVA-Flex, body imaging takes a leap forward on the Signa MR750 3.0T. ■

“LAVA-Flex is a robust sequence that offers ‘fat only’ and ‘water only’ images in addition to excellent in-phase and opposed-phase images in a single breath-hold. This sequence has quickly become a routine part of all our abdominal sequence protocols at 3.0T.”

*Elmar Merkle, MD,
Professor of Radiology, Head of Body Magnetic
Resonance Imaging and Medical Director
of the Center for Advanced Magnetic Resonance
Development at Duke University*

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High Performance Gradients Drive Future MR Applications

The Signa® MR750 Gradient System

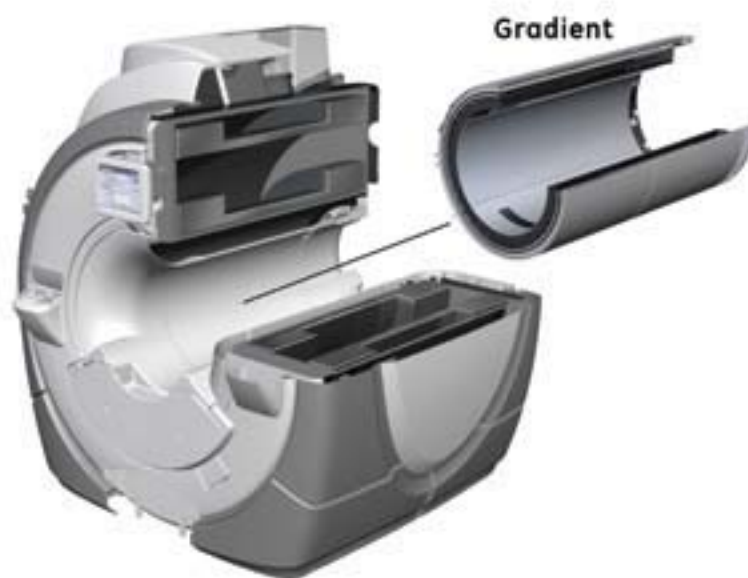
By Bryan J. Mock, PhD, 3.0T MR Product Manager
and Jason A. Polzin, PhD, MR Chief Engineer, GE Healthcare

As MR applications continue to evolve, higher performance levels are required of the MR gradient subsystem. Advanced applications such as fMRI, high-angular resolution diffusion tensor imaging, spiral, in/out of phase breath-held abdominal examinations at 3.0T and spectroscopy rely heavily on the MR gradients to produce consistent and reliable high quality data. Equally important is the ability of the gradient to manage thermal challenges, gradient induced noise and peripheral nerve stimulation limits (dB/dt).

At the heart of the Signa MR750 system is a newly designed whole-body gradient coil – the eXtreme Gradient Resonance Module (XRM) – and high-power amplifier – the eXtreme Gradient Driver (XGD). Together, the XRM/XGD deliver a 50 mT/m gradient field on each axis (X, Y, & Z) simultaneously to maximize gradient amplitude and slew rate at of 200 T/m/s, yielding a zero to full-scale rise time of 250µ sec. This also minimizes coil inductance to provide the proper current density for peak performance level. The result is a gradient subsystem that serves today's demanding clinical applications while providing an uncompromised platform for the development of future applications.

To accommodate for the variation in AC/DC resistance, the Signa MR750's XRM gradient coil utilizes a unique water-cooled thermal-electrical cooling circuit that is five times more efficient for extracting heat from the system. Similarly, the Signa MR750's XGD incorporates digitally controlled feedback, switching-optimized power generation devices and direct-cold plate heat transfer technology to manage the thermal load within the amplifier. As a consequence, the thermal management approach maximizes system performance by 60 percent and improves subsystem reliability by a factor of 10.

Enhanced gradient performance does not translate into increased acoustic noise on the Signa MR750. The system architecture along with GE's Quiet Technology 2.0 minimize



the mechanical interactions within the magnet that generate acoustic noise. The effect is up to 50 percent reduction (six to eight dB) in acoustic noise levels.

Improved gradient subsystem linearity can impact the rate at which the magnetic field is switched (dB/dt) due to peripheral nerve stimulation limits. To address this issue, the Signa MR750 incorporates an automated gradient pulse sequence optimization algorithm that minimizes the number of overlapping gradient ramps. This approach enables a slew-rate that stays within peripheral nerve stimulation limits to achieve shorter TEs and TRs.

Overall, the Signa MR750's gradient efficacy is achieved by a design that takes the gradient coil and driver into account as a single subsystem to deliver the performance researchers desire. ■

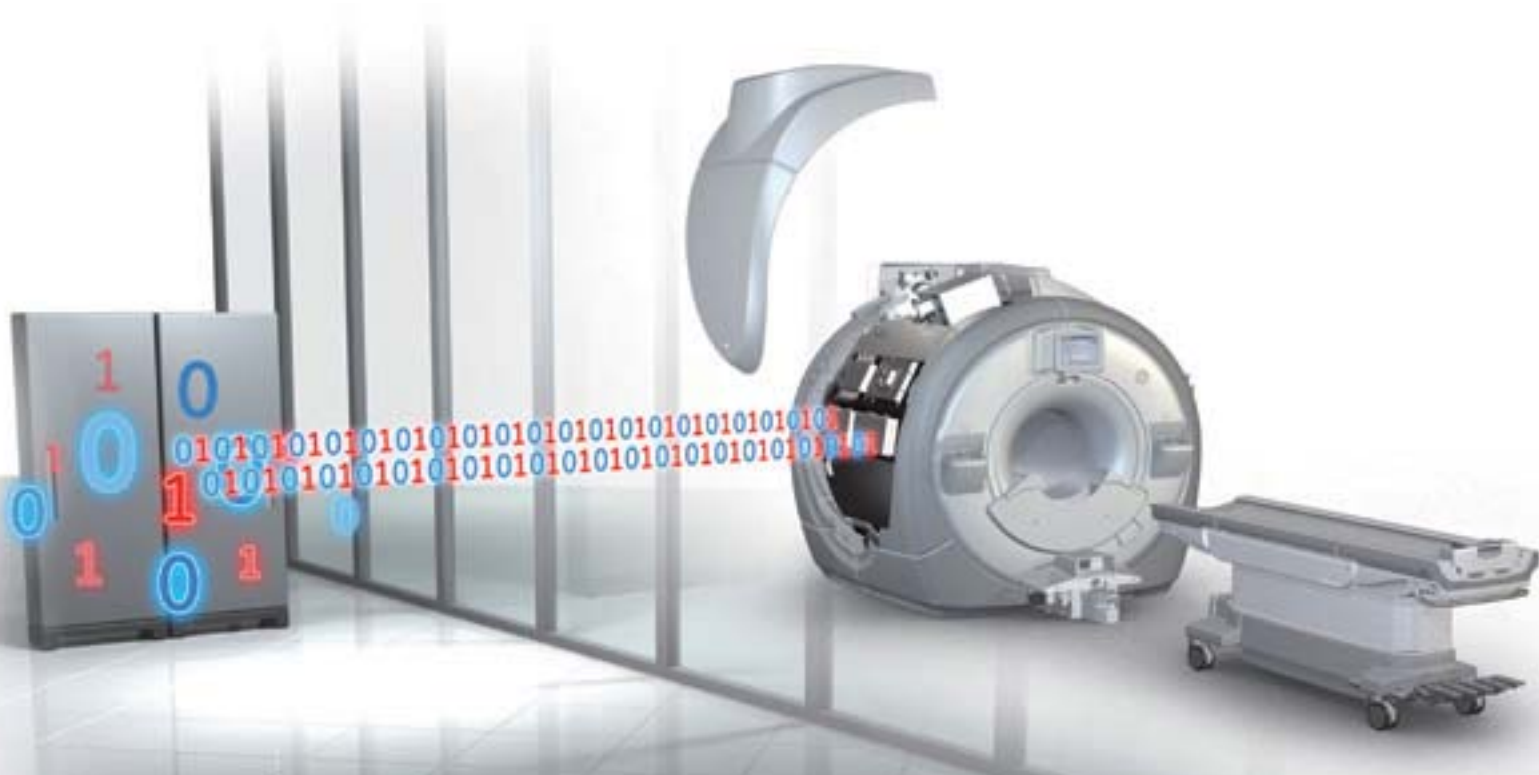
For the complete white paper,
please visit www.gehealthcare.com/signapulse.



Introducing Optics to RF So You Can Sharpen Your Focus on Quality and Performance

By Bill Peterson, Principal Engineer, RF Electronics, GE Healthcare

Applications for whole-body imaging, real-time cardiac, high resolution contrast kinetic imaging and functional MRI increase the necessary rate and quality of data acquisition. Each of these applications can generate large volumes of images in a short period of time and require a high signal-to-noise ratio (SNR) to best monitor physiologic and/or anatomic changes. Combining this increased demand for greater data management with the need for efficient patient and technologist workflow makes the radio frequency (RF) receiver system of an MR scanner a critical component in system design.



The RF Receiver controls the entire chain of events from connection of the surface coils through the digitization and transmission of data to the reconstruction engine for processing and analysis. The Signa® MR750 3.0T OpTix Optical RF system was designed to enhance all of these critical aspects of MR image acquisition – image SNR, acquisition speed and patient and technologist workflow – while also providing a platform for advanced research and development.

SNR and data acquisition speed

OpTix improves SNR by up to 27 percent over conventional, non-optical MR receivers by reducing electrical noise and improving signal detection. Conventional MR scanners have the RF receivers in the electronics room where the MR signal is subject to significant electrical noise prior to being digitized. The Signa MR750 OpTix receivers are located on the magnet system inside the shielded scan room, completely isolated

from external noise sources. The MR signal is digitized within the scan room and then optically transmitted to the reconstruction engine in the electronics room. This design significantly improves image quality. Also, since the intensity of an analog MR signal decreases as it travels along a wire, the close proximity of the receivers to the patient further improves image quality.

The use of optical transmission in the telecommunication industry provides a robust method of data transfer that is immune to external noise. The OpTix system in the Signa MR750 uses a similar method to ensure high speed and high quality imaging. The receive electronics are scaleable in 16-channel increments up to 128 simultaneous acquisition channels. Each receive channel operates an independent 80Mhz digitizer inside the scan room. This high sampling rate provides a very low noise floor, better dynamic range and thus, higher SNR. The volume of data created during this phase of image acquisition is significant; therefore, 2 GB/sec



optical transmission is used to transfer the data to the Volume Reconstruction Engine (VRE) 2.0 for processing and image generation in the electronics room.

Ultra high-density 32-channel coils with parallel imaging enable imaging frame rates that were not previously attainable in the clinical environment. The fast switching capability and high-speed interface technology of the OpTix system facilitates real time image acquisition and display from 32-channel independent receivers. The Signa® MR750 3.0T eXtreme gradient system generates shorter TR/TEs to further increase the rate of data throughput.

The combination of noise immunity and improved signal detection with the Signa MR750 OpTix system results in an SNR improvement relative to conventional RF receivers.



Simplified exam preparation

The Signa MR750 coil interfaces are augmented with four new high-density coil connectors. These new 32-channel connectors in the Signa MR750 system are distributed on the magnet system and end of the Express Detachable Patient Table, the industry's only fully detachable MR table with a coil interface for simplified exam preparation. Each connector provides mechanical assistance for simple insertion and extraction for high-density, multi-station scanning of the entire body. The connectors on the detachable table allow the technologist to fully prepare a patient outside of the exam room to dramatically improve scanner efficiency, enabling in-room patient set up in as little as 30 seconds. The high-density connections also simplify the placement and use of surface coils and accelerates parallel imaging speed to reduce exam duration. For systems with a fixed patient table, patient preparation time may approach the length of the data acquisition time.

Advanced research and development

The OpTix architecture on the Signa MR750 is scalable for both proton and broadband frequencies. The system will support up to 128 independently controlled receivers with independent bias lines for advanced surface coil designs and signal routing. For non-proton imaging, the OpTix system and architecture can simultaneously acquire eight channels of multinuclear (broadband) data. Given the excellent dynamic range and noise immunity of the OpTix system, the Signa MR750 is an ideal platform for advancing clinical applications and research and development.

Conclusion

The Signa MR750 OpTix system offers excellent dynamic range and noise immunity, patient workflow improvements and greater signal detection with faster data transmission. By addressing critical design aspects, the Signa MR750 is the ideal platform for advanced clinical use and research and development. ■



A New Spin on Reducing Motion and Metal Artifacts

By Xiaoli Zhao, MR PSD/Applications Development Engineer
and Joanna Jobson, MSEE, MBA, MR Global Marketing Programs Manager

With the introduction of the new Signa® MR750 3.0T platform, GE Healthcare delivers a new, enhanced version of PROPELLER HD™ that will further revolutionize neuro MR imaging. Introduced in 2003, PROPELLER was the first MR technique designed to alleviate the challenge of scanning restless or uncooperative patients, or those with metal implants. It significantly reduces motion artifacts caused by voluntary patient movement as well as tremor and physiological motion including blood and CSF flow artifacts. As a result, clinicians utilize PROPELLER HD to generate high-quality MR exams on restless children, adults afflicted with Parkinson's Disease and patients with extensive dental work.

The new PROPELLER 2.0 enables equally strong performance in all imaging planes with the implementation of the No Phase Wrap (NPW) technique. NPW allows virtually ghost-artifact-free, motion-immune scans in sagittal, coronal, axial and oblique planes.¹

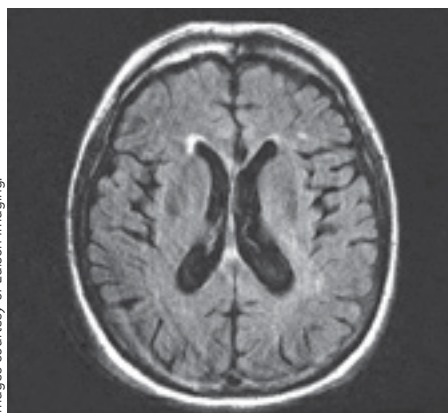
Since this technique effectively deals with the aliasing artifact, PROPELLER 2.0 is now more robust performing small field-of-view (FOV) scans.²

A refined algorithm improves PROPELLER 2.0 imaging capabilities in the presence of extensive motion by implementing certain constraints among ETL, FOV and NPW. The use of a "split blade" technique enhances image quality and reduces the presence of common distortions such as eddy current artifacts while a "center-out" view places early, not decayed, echoes at the center of k-space to diminish shading artifacts.³

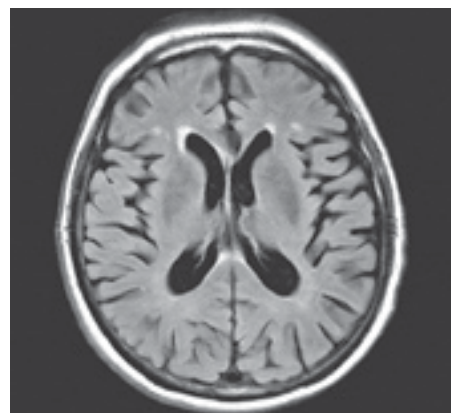
Significantly shortened TE drives SNR increase. Initial investigations suggest that SNR improvements might, in some cases, range from 30 to 100 percent.

For the complete white paper, please visit www.gehealthcare.com/signapulse.

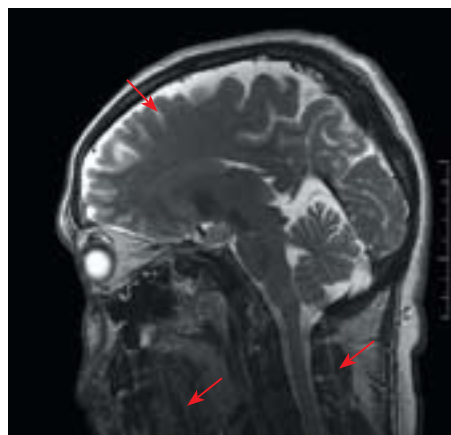
Images courtesy of Edison Imaging.



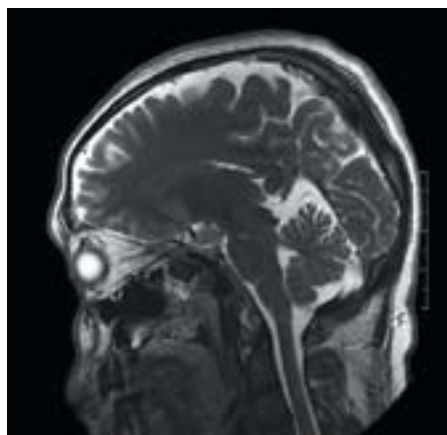
Signa 3.0T T2 FLAIR image quality is severely degraded by motion artifacts.



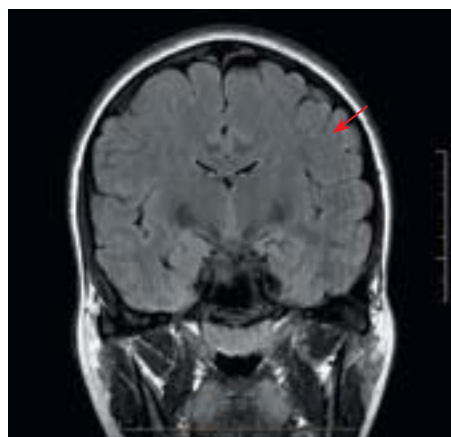
Signa 3.0T T2 FLAIR PROPELLER 2.0 sequence on the same moving patient produced a motion artifact-free image with excellent contrast and detail. Both images were taken using the same matrix, FOV and scan time.



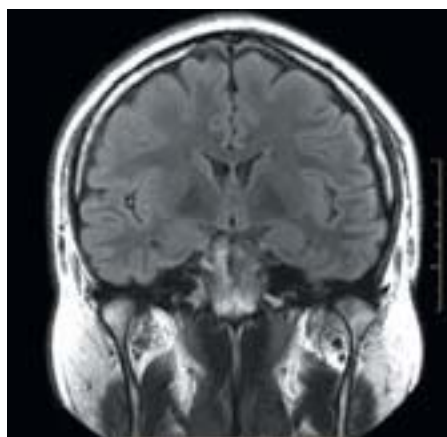
Sagittal T2 FSE showing some ghosting artifacts (see arrows). (Res 512x512)



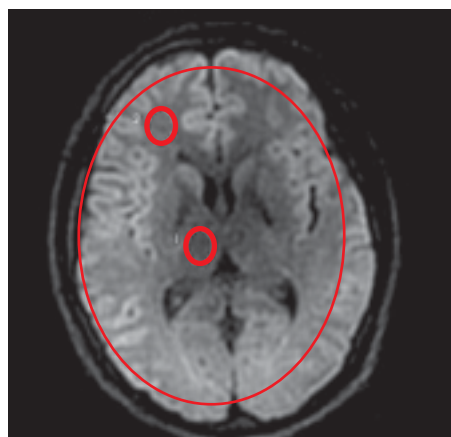
Sagittal T2 PROPELLER 2.0 of the same subject is ghost-free. (Res 512x512)



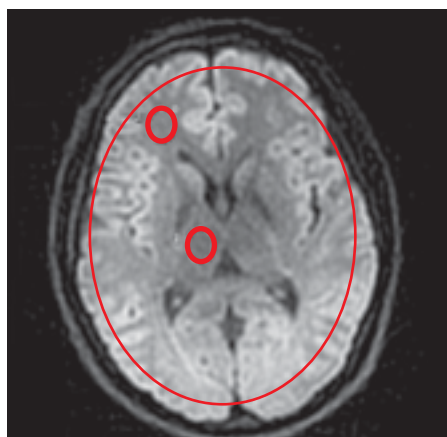
Coronal T2 FLAIR FSE with typical ghosting



Coronal T2 FLAIR PROPELLER 2.0 shows improved tissue contrast and absence of ghost artifacts.



Conventional sequential view order showing a typical shading artifact.



Center-Out view order reduces the shading artifact and boosts the image quality. The improvement is apparent on this PROPELLER 2.0 DWI image and further confirmed by SNR measurements that demonstrate 70 percent inner brain and 30 percent outer brain improvements. Both images were acquired with the same window contrast level.

Benefits

PROPELLER 2.0™ significantly reduces motion artifacts caused by voluntary patient movement, and tremor or physiological motion including blood- and CSF-flow artifacts. PROPELLER 2.0 also optimizes SNR, capitalized as striking tissue contrast. In addition, PROPELLER 2.0 T2 and T2 FLAIR sequences do not compromise image resolution or increase scan time. When used with DWI, PROPELLER 2.0 greatly reduces tissue-air and bone-tissue susceptibility artifacts, such as those caused by metal implants.

References

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2. Shaorong Chang, Xiaoli Zhao, and Ajeetkumar Gaddipati The Investigation of T2 PROPELLER Motion Estimation Efficiency.
3. Xiaoli Zhao, Ajeetkumar Gaddipati, Shaorong Chang, Dawei Gui Shading Reduction and SNR Improvement with Center-Out View Order for Diffusion-Weighted PROPELLER Imaging.



The Real Time Heart Exam



*By Wei Sun, MR PSD/Applications Development Engineer
and Joanna Jobson, MSEE, MBA, MR Global Marketing Programs Manager*

The unique technical and clinical properties of magnetic resonance imaging made it an attractive diagnostic tool for cardiac imaging. Cardiac MR is the only imaging modality that offers the ability to conduct a complete cardiac study (anatomy, structure, pathology, function, flow, myocardial tissue viability) in one minimally invasive, radiation-free exam. Difficult-to-image fine peripheral plaques and silent Myocardial Infarction (MI) cases may be reliably detected with MR, while other imaging modalities occasionally fail to provide conclusive data. Yet, the complexity of a cardiac exam, and a need to simultaneously capture fine anatomical detail and intricacies of the heart's contractivity, as well as to record blood flow dynamics, introduced the need for faster MR platforms, specialized applications and postprocessing tools. These technologies, however, were not available until recently.

While several 1.5T MR systems available today offer full cardiac MR functionality including a real-time cardiac imaging capability pioneered by GE Healthcare in 2003, 3.0T technology has lagged behind.

The technical challenges of 3.0T high-field cardiac MR, including:

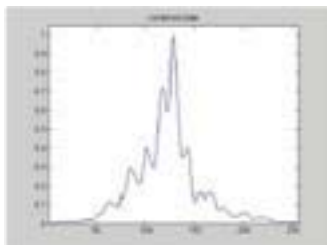
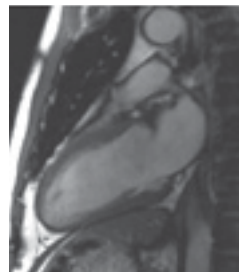
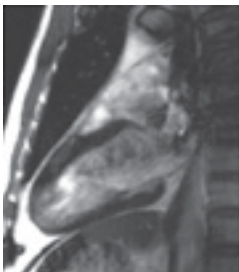
1. Special Absorption Rate (SAR) limitations due to the increase in RF deposition required at 3.0T, theoretically four times greater than 1.5T.
2. Increased sensitivity to susceptibility artifacts, in particular steady state free precession sequences such as FIESTA.
3. Elevated ECG T-waves due to more pronounced magneto-hydrodynamic effects present additional challenges for ECG gating. Vector ECG (VCG) gating waveforms are essential at the higher field strength to ensure good gating waveforms.
4. Off resonance artifacts with steady state free precession sequences may display a muddled blood pool. It is essential that SSFP techniques considered to be leading technology in functional cardiac MR, such as FIESTA, perform well at 3.0T.



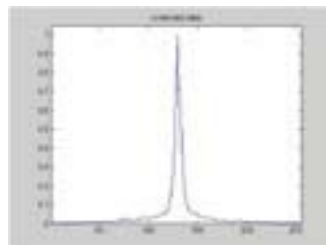
With the new Signa® MR750 3.0T, the power of a high-field system baseline signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) is combined with a full portfolio of robust cardiac applications and tools. This includes MR Echo™, the first real-time cardiac application available for 3.0T MR, which offers:

- Real-time FIESTA with a high frame acquisition mode at a temporal resolution of 65 ms enables localization and qualitative ventricular assessment without cardiac gating or breath holding
- Gated, breath-held FIESTA for high definition imaging
- FGRE or FIESTA blood-flow dynamics compatible with parallel imaging
- 2D Myocardial Delayed Enhancement (MDE)

Another GE innovation is the Center Frequency Adjustment, which combines the small volume gradient shim and slice prescription to exclude frequencies not within the pertinent imaging volume from prescan. This new IR-PRESS pulse helps eliminate FIESTA off resonance artifacts at 3.0T, ensuring a consistent and homogenous signal.

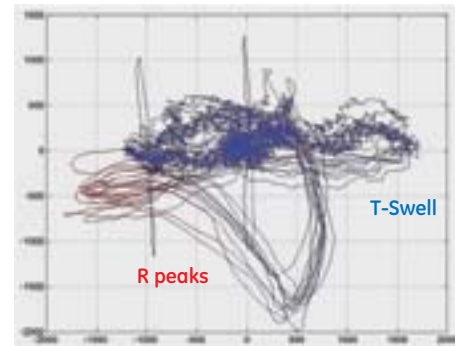


Typical FIESTA image (top image) with inhomogeneities caused by spurious frequencies (graph) originating in the surrounding tissue.

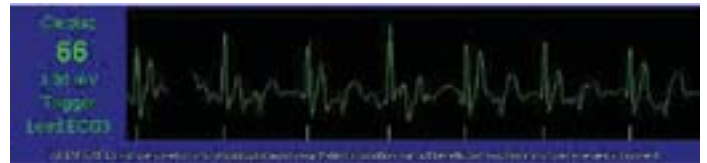


By locating ROI within the slice the frequencies (graph) not related to imaged tissue are eliminated, resulting in a clear image (top).

An easy-to-set VCG gating helps eliminate false image triggers caused by elevated T-wave that result from an increase in the blood magneto-hydrodynamic effect.



2D projection of vector cardiogram.



Gating ECG signal inside magnet with typical elevated T-wave.



Gating signal inside magnet with VCG.

ReportCARD™ 4.0 is significantly enhanced to streamline cardiac MR reporting with useful tools such as automatic left ventricle (LV) segmentation and analysis, T2* iron mapping in the heart and liver, a research database and macro reporting.

As a result of these advancements, the Signa MR750 3.0T GE is the first cardiac MR system to deliver all the versatile capabilities that currently exist on 1.5T MR with the SNR and CNR benefits of a 3.0T system. ■



Making fMRI More Functional and Reliable

The Signa® MR750 3.0T – Stability for fMRI

By Bryan J. Mock, PhD, 3.0T MR Product Manager, GE Healthcare

Overview

Functional MRI (fMRI) is a valuable clinical tool for surgical planning and assessing neurological disease and deficits. The basis for fMRI is an increase in blood-flow to the local vasculature that accompanies neural activity in the brain. When the neural activity increases, the local blood flow increases, creating oxygen-rich hemoglobin. This serves as an endogenous contrast mechanism that a T2 or T2* weighted-sequence can detect.

The MR signal associated with changes in blood flow during fMRI is rather small and can easily be masked by noise. For example, at 3.0T, the signal increase associated with brain activity ranges from one-half to four percent above the baseline. Reliably detecting changes this small requires statistical techniques that reduce the impact of spurious noise. Even with statistical processing, distinguishing between activation-induced signal changes and random changes from noise is challenging.

The Signa MR750 system is optimized to minimize system instability and extraneous noise that can negatively impact fMRI and other noise-sensitive techniques. In fact, improving system stability was a primary design parameter that drove the design of the new gradient subsystem and the optical RF receive chain. The result is a 50 percent improvement in overall stability performance over existing systems and enhanced fMRI reliability and functionality for research and clinical applications.

Measuring stability for fMRI

fMRI relies heavily on the image-to-image stability to detect the subtle changes associated with neuronal activity. Therefore, quality assurance metrics derived from the analysis of multi-phase phantom data provide the most pertinent information for fMRI. Although several analysis techniques exist, a widely known method is the Weisskoff

analysis.¹ A Weisskoff plot trends the temporal standard deviation of a square region of interest (ROI) as a function of the ROI length and size (Figure 1). In the absence of system imperfections, the noise is uncorrelated and hence, the standard deviations decrease linearly with the ROI size (red line). System instabilities often have a spatial dependence and result in a measured standard deviation that does not trend with the theoretical line.

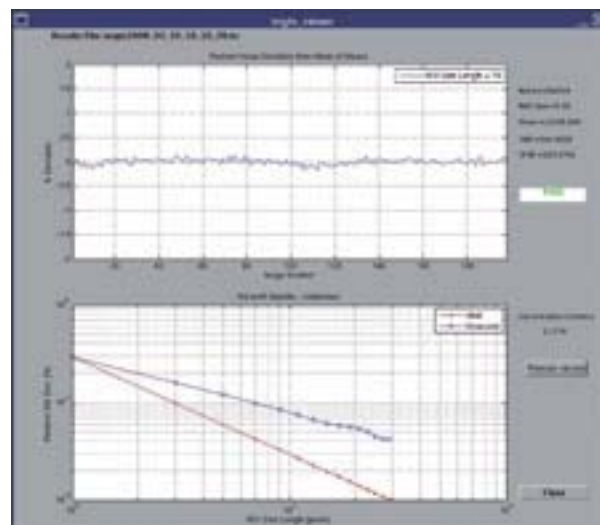


Figure 1. A Weisskoff plot demonstrating the relative standard deviation of the data as a function of the ROI size. System instabilities force the measure stability (blue line) to deviate from the ideal curve (red line).

While Weisskoff plots can be sensitive to system instabilities, this test has limited specificity and is often impacted by the systems signal-to-noise ratio (SNR). For example, the first point (n=1) in plot represents the single point SNR. If the system SNR is low, as represented by a high standard deviation for the first point, system instabilities are masked by too much noise. The result is a plot of measured data that tracks the theoretical line, but in reality provides no useful information about the system stability (Figure 2).

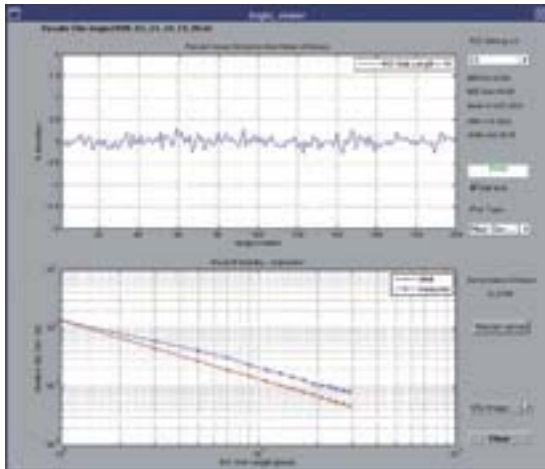


Figure 2. The Weisskoff plot generated by a system exhibiting poor SNR. The measured data follows the theoretical line giving the “false” impression that the system stability is well-behaved.

A less ambiguous approach trends a single metric, such as the relative standard deviation for a particular ROI, over time by performing a daily quality assurance (QA) scan. A routine QA procedure can quickly identify performance changes in system performance, leading to expedited service responses and improved data stability over time.

Signa® MR750 performance levels

Excellent system stability for longitudinal fMRI and quantitative MR examinations is a fundamental design criteria of the Signa MR750 3.0T system. A target level was set at 0.1 percent RMS for the relative deviations across a 19x19 ROI, representing a nearly two-fold improvement over prior MR designs. To demonstrate system stability under extreme conditions, data was acquired and measured from six back-to-back high-duty cycle fMRI scans (protocol: 64x64, 22 cm FOV, 4 mm slice, 1 mm gap, 28 slices, 200 phases, TR=2000, TE=30 ms, quad T/R head coil)* acquired

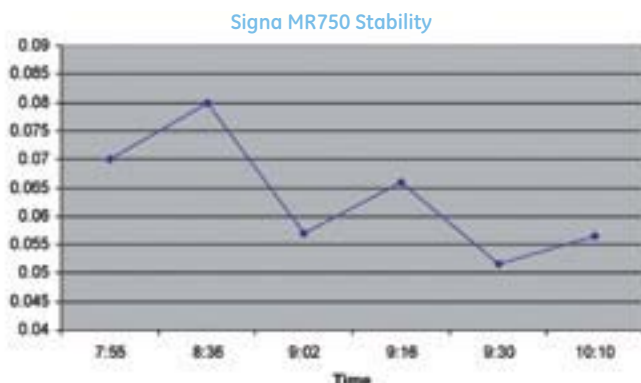


Figure 3. The measured stability over two hours of continuous scanning using the fMRI stability protocol.

continuously over two hours. As demonstrated in Figure 3, the relative fluctuations are consistently less than the specification with no obvious change over the course of the experiment, demonstrating consistent and reliable results on the Signa MR750.

Clinical evaluation

Gary Glover, PhD, Professor of Radiology and Director of the Radiological Sciences Laboratory at Stanford University, has been evaluating the Signa MR750 3.0T MR system for fMRI since its initial installation at his facility in February 2008.

“There are two things that are critical for fMRI performance, and the first is short term stability”, says Dr. Glover. “Short term stability means inter-image fluctuation. When I looked at this metric initially at the GE facility, I was pretty impressed that the stability was even better than that of our current 3.0T system, and it was well within the level that I consider essential for fMRI. For fMRI, one wants the system noise to be substantially below that of the physiological noise produced by the brain. Through our own experience and also that of the fBIRN*, we developed a statistic of 0.1 percent RMS fluctuation as an acceptable level. The factory-based prototype system we evaluated was performing at the 0.06 percent level, and with our recently installed system we were able to duplicate that level of stability within the first week in installation.”

Dr. Glover continues, “The second important aspect is that the system must keep on performing at that level after continuous scanning. I monitored the image and thermal stability of the system over a 40 minute scan. I stressed the system with my spiral fMRI protocol trying hard to break it, and I was unable to! The gradient temperature equilibrated, while the image stability remained excellent. In summary, the system performance is very strong from my initial experience, and overall I’m pretty enthusiastic.”

Conclusion

MR imaging techniques, such as fMRI, that rely on measuring and quantifying subtle physiologic processes place increased demands on the MR system’s ability to produce stable results over time. The Signa MR750 supports exceptional system stability to sustain today’s research and enable tomorrow’s advanced clinical applications. ■

* Note: GE utilizes a protocol promoted by the functional Biomedical Informatics Research Network (fBIRN). For additional information, please see http://www.nbirn.net/index_ie6.shtml.

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1. Weisskoff, R.M., MRM 36:643-645 (1996). Need citation



Hyperpolarization Shows Promise for Realizing the Early Health Model

By Jason A. Polzin, PhD, MR Chief Engineer, GE Healthcare

The early health model is based upon a broader, more efficient model of healthcare that enables clinicians to diagnose and treat disease at the earliest possible point in time. GE Healthcare understands this early health model: early diagnosis to find disease when it is more treatable; delivering information earlier in a form that makes a difference throughout patient treatment and subsequent monitoring; and earlier treatment for more precise therapy and follow up.

Changing the paradigm from 'late disease' to 'early health' means providing critical information whenever and wherever it is needed. This includes identifying patients at risk and enabling accurate diagnosis earlier to facilitate and track targeted treatments.

The need for earlier and better diagnosis is prevalent in many diseases. Take for example prostate cancer. Current screening methods –

such as a digital exam and Prostate Specific Antigen (PSA) blood test lack specificity that may lead to false positive results, which could result in unnecessary biopsies.

Metabolic changes occur during the evolution and progression of prostate cancer resulting in changes in the citric acid cycle, glycolysis and fatty acid synthesis. These actions provide a signature that defines the prostate cancer stage. Metabolic MRI can help measure this biochemical 'fingerprint' of tissue and drive the transformation to early health.





GE's patented approach: Metabolic MRI

GE Healthcare has patented an approach to Metabolic MRI using hyperpolarized agents. SPINlab™ harnesses hyperpolarized ^{13}C to view metabolic processes in real-time, using advanced GE MR technology for functional metabolic imaging. This approach increases the MR signal more than 20,000 times for studying real-time metabolism of disease, opening up new possibilities for MR imaging to move beyond morphology and functionality onto a new platform that may help clinicians visualize information about flow, perfusion, excretory function and organ and cell viability in living creatures.

Metabolic MRI with hyperpolarized agents shows promise by helping support the differentiation of benign and malignant lesions, separating aggressive from slow growth tumors and facilitating non-invasive treatments. The vision of Metabolic MRI with hyperpolarized ^{13}C is to measure the biochemical 'fingerprint' of tissue for earlier diagnosis, improve staging and influence treatment decisions. For example, elevated conversion of Pyruvate into Lactate compared to normal tissue is a strong indicator of prostate cancer.

Why ^{13}C ?

Carbon, the 6th element on the periodic table, is fundamental to biochemistry and abundant in all forms of life. It has two stable isotopes: ^{12}C (six protons and six neutrons) and ^{13}C (six protons and seven neutrons). More than 99 percent of naturally-occurring carbon is ^{12}C with no MR signal. ^{13}C represents approximately one percent of naturally-occurring carbon. As a stable isotope that is magnetically active, ^{13}C can be used in spectroscopy to probe molecular structure. Although changes in molecular structure correspond to metabolic changes, the ^{13}C signal in vivo is too small for use in a clinical setting until the advancement of a hyperpolarization.

Overcoming the challenge of MR imaging ^{13}C

Traditional MR imaging relies on the high concentration proton (^1H) signal associated with water or fat; metabolites occur at a thousand times lower concentration. Additionally, only about one percent of metabolites contain ^{13}C . Finally, ^{13}C generates four times less signal than protons, making in vivo

^{13}C nearly impossible to image. GE's solution is to hyperpolarize the ^{13}C metabolites using Dynamic Nuclear Polarization (DNP), which provides more than a 20,000-fold increase in signal making it possible to detect real-time changes to metabolism.

Hyperpolarization is achieved by placing the ^{13}C sample in a special device – a polarizer – that keeps the sample at a very low temperature (<4 K) in a high magnetic field (>3.0T) where the electrons are nearly 100 percent polarized. The sample is then irradiated with microwave energy at a frequency corresponding to the electron spin resonance transferring the polarization from the electrons to the ^{13}C . This phenomena is DNP.

MR systems must be optimized to image ^{13}C metabolic activity. Since polarization does not recover there is a demand for real-time metabolic imaging, which requires fast imaging sequences. In addition, ^{13}C processes at different frequencies than protons used in standard MR imaging, requiring dedicated RF coils and a broadband system. A low abundance and polarization of naturally-occurring ^{13}C requires a system calibration independent of ^{13}C .

Imaging of metabolism with hyperpolarized ^{13}C requires dedicated local transmit coils tuned to the ^{13}C resonant frequency for signal excitation. For signal reception, dedicated receive array coils tuned to the ^{13}C frequency and capable of acceleration through parallel imaging is also required. These coils must be designed to work in conjunction with existing proton transmit and receive arrays which are used concurrently for anatomical imaging. Dealing with multiple transmit and receive arrays simultaneously can be a challenge to patient set-up. To address this, GE is developing special purpose, dual-tuned coils that work at both proton and ^{13}C frequencies.

Conclusion

Hyperpolarization shows much promise for imaging metabolic synthesis to identify the early footprint of disease. To make this research a reality, GE has integrated its Biosciences and Engineering technology with advances in MR imaging. The Signa® MR750 3.0T MR system provides ultra-fast imaging and multi-channel, multi-nuclear capabilities required to visualize cell metabolism using ^{13}C . ■



Fat-Free Breast Imaging with High Spatio-Temporal Resolution

*By Ersin Bayram, MR PSD/Applications Development Engineer
Jessica Buzek, Advanced Applications for Breast and Pediatric Imaging
Zac Slavens, Signal and Image Processing Engineer
Matt Krauski, Software Engineer, MR Recon Engine
Monika Walser, MR Advanced Program Marketing Manager*

Technological advances in MR breast imaging provide advantages for patients while at the same time creating new challenges for clinicians and technologists. High specificity and sensitivity led to the March 2007 American Cancer Society guidelines recommending MRI screening for women with an approximately 20 to 25 percent or greater lifetime risk. Yet this same capability pushes imaging demands to larger matrix sizes, more signal-to-noise and higher temporal resolution.

Field inhomogeneities and breast implants further test the limit of existing fat suppression techniques. Bilateral breast imaging exacerbates these challenges due to larger field-of-view requirements. Techniques such as VIBRANT™ raise the bar even further with dual shim requirements and higher temporal resolution.

With Signa® MR750 3.0T, GE Healthcare takes MR breast imaging to a new level by harnessing the power of VIBRANT with IDEAL to address these breast imaging challenges in a robust and consistent manner. VIBRANT-Flex collects two echoes with water and fat, spins in- and out-of-phase and utilizes a two-point Dixon technique to synthesize water and fat images. Equipped with the most powerful gradients in the industry (50/200) and novel adaptive dB/dt optimization, the Signa MR750 enables VIBRANT-Flex to catch the shortest in- and out-of phase echoes to keep scan times comparable to single echo acquisitions even though twice the amount of data is collected. VIBRANT-Flex optimizes acquisition with a high signal-to-noise ratio (SNR) for acquiring high quality water and fat images. This capability lets the user prescribe thinner slices for high spatial resolution imaging.

Separate, don't suppress, fat

IDEAL separates fat from water without applying a suppression pulse, leading to a reduction in repeat scans and elimination of a separate non-fat scan. This technique allows visualization of structures within the breast to help diagnose or rule out pathology.

"With the non-fat-suppressed T1-weighted images, if we see bright fat in a nodule, we know it's an intra-mammary lymph node and we don't have to worry about it," says Jeffrey Weinreb, MD, FACR, Professor of Diagnostic Radiology at Yale University School of Medicine and Director of Medical Imaging, Chief of Body Imaging and Chief of MRI at Yale-New Haven Hospital (New Haven, Conn.). "That has prevented us from recommending unnecessary biopsies in a lot of patients."

Workflow is enhanced by eliminating the dependency of accurate shimming and providing higher spatial and temporal resolution acquisitions. The Signa MR750 boosts the thin slice capability of VIBRANT-Flex to 2048 slices, allowing for more robust bilateral axial and sagittal imaging. GE's exclusive ARC™ (Autocalibrating Reconstruction for Cartesian imaging) parallel imaging technique provides an acceleration factor of four for robust imaging that reduces scan time without compromising the diagnostic quality. For instance, a 360x360x160 1 mm³ isotropic voxel VIBRANT-Flex acquisition can be completed in 54 seconds using the GE HD Breast Array (8-channel) with an ARC acceleration factor of four.

Dynamic volume reconstruction

The term "dynamic volume" comes to life with VIBRANT-Flex and Signa MR750. Increased computational complexity and the large dynamic volume needs of VIBRANT-Flex is resolved with a large bulk acquisition memory (BAM) space (14.6 GB for 32-channel) combined with the new Acquisition-to-Disk feature. The latter routes data that overflows BAM directly to Disk for temporary storage until BAM becomes available, enabling multi-phase scans that would otherwise not be possible. This feature also enables the reconstruction speed to keep pace with the acquisition. With two phases of data in BAM, Acquisition-to-Disk keeps pace with 10+ phases of dynamic scanning.

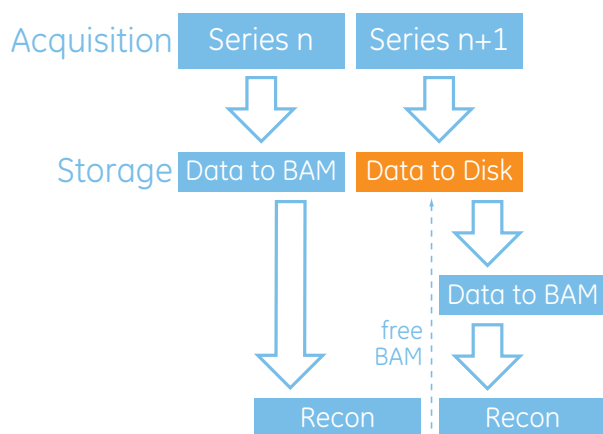


Figure 1: Acquisition-to-Disk – Data overflow in BAM is stored directly to the disk allowing VIBRANT-Flex to utilize multi-phase prescriptions that require space larger than BAM limit.

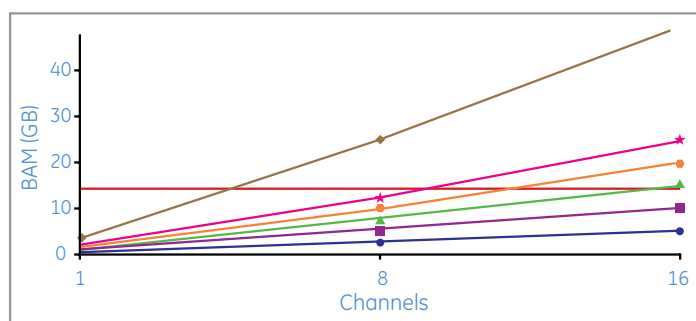


Figure 2: Sample high resolution protocol 360x360x160 and its BAM usage.



The powerful Volume Reconstruction Engine (VRE) 2.0 combined with performance optimization allows ARC™ to unalias both in-phase and out-of-phase images while IDEAL processes two large data volumes to synthesize water and fat images. The result is rapid reconstruction that keeps total exam time in check.

The ability to process large datasets with ease and speed makes dynamic volume imaging a reality with VIBRANT-Flex. From image quality to workflow enhancements, VIBRANT-Flex continues to set higher standards in MR breast imaging. ■

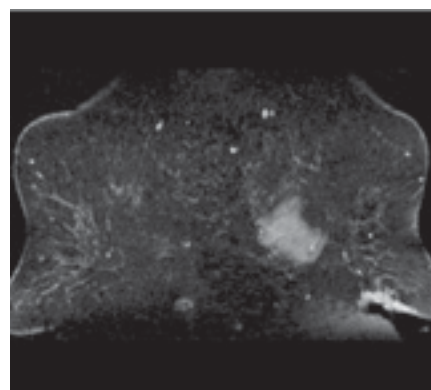
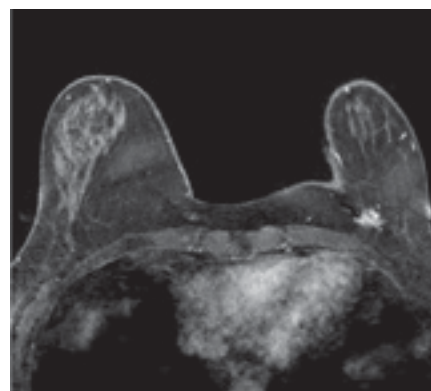
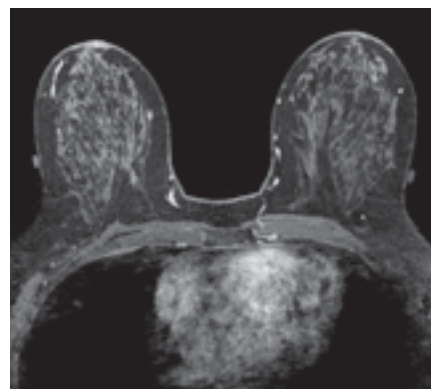
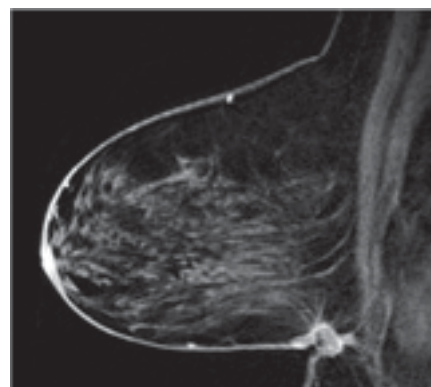


Figure 3: Sagittal VIBRANT-Flex water image with 1x1x1 mm isotropic resolution along with axial and coronal reformats. Signal uniformity and high-resolution allows reformats to be visually indistinguishable from the native acquisition plane.



Reconstruction Opens the Door to Data Intensive Studies

By Sanjay M. Joshi, PhD, Senior Reconstruction Engineer, Fred J. Frigo, PhD, Senior Reconstruction Engineer and Roshy J. Francis, Manager, MR Image Reconstruction

Image reconstruction for MRI has evolved from relatively simple 2D Fourier transforms to highly complex signal processing algorithms. The hardware used for reconstruction has also evolved to high-performance systems capable of implementing advanced algorithms.

GE Healthcare has led the industry in using general-purpose servers for reconstruction with the 2006 introduction of the Volume Reconstruction Engine (VRE) for the Signa® HDx MR. With the introduction of Signa MR750, GE again delivers significant platform enhancements with the VRE 2.0 reconstruction technology, which builds on the VRE foundation to leverage current and future improvements in computer hardware.

Computation challenge and scalability

Signa MR systems have always provided the capability to simultaneously acquire, reconstruct and display images. Continued advances in parallel imaging, namely higher acceleration factors and new algorithms, and acquisition techniques have led to a rapid growth in data size that stretches the limitations of CPU processing power and computational complexity.

Signa MR750 expands the usable memory by executing the reconstruction software on a 64-bit processor in 64-bit mode. Enabling 64-bit computation in reconstruction along with the increase in bulk acquisition memory (BAM) expands computational capabilities and improves reconstruction speed.

By using multiple threads within the VRE 2.0 reconstruction software, Signa MR750 takes advantage of both multiple cores and multiple processors within one computer. With parallel processing, VRE 2.0 reconstruction software can use multiple computers to deliver a ten-fold improvement in network speed between the ICNs with the InfiniBand technology, doubling BAM for high-resolution applications that require more BAM. Signa MR750 leverages the high-reliability and high-speed serial attached SCSI (SAS) technology used in both ICN hard disks.

Acquisition-to-Disk and raw data support

The new Acquisition-to-Disk feature automatically manages the data when the reconstruction is ready for processing, thus intelligently utilizing BAM and extending it beyond conventional limits. Data is loaded into memory only when the reconstruction is ready for processing, thereby enabling

the number of phases for a data intensive acquisition such as VIBRANT-Flex to extend beyond the physical limit imposed by memory and effectively creating a virtual 41 GB BAM (Figure 1).

To further support advanced MR reconstruction development research efforts, the Raw Data Server provides unsorted, un-NEXed views of data and control information in real-time through a simple TCP/IP socket interface. At the client end, a new object-oriented template for raw data client provides an easy-to-use interface for research applications to communicate with incoming raw data.

For research support, Signa MR750 expands existing capabilities for saving raw data to Pfiles beyond previous limits. The size of the disk partition on the host computer has also been increased to 15.7 GB to accommodate the largest possible single-pass Pfile as well as increase the number of available Pfiles.

Conclusion

The amount of data stored and processed continues to increase with the advances in MR system technology. Signa MR750 meets that challenge with reconstruction innovations that take full advantage of computing power by leveraging software and hardware technology for faster acquisition time, higher resolution and a larger number of phases. ■

For the complete white paper, please visit www.gehealthcare.com/signapulse.

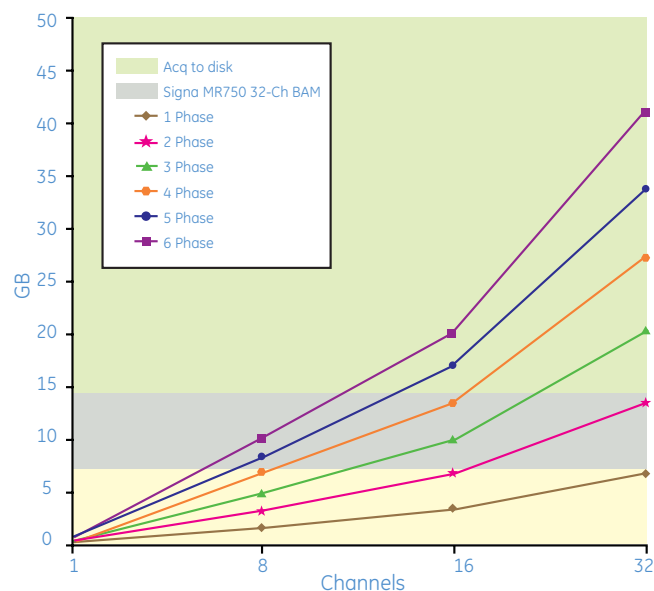


Figure 1. VIBRANT-Flex BAM usage.



*Dr. Lawrence N.
Tanenbaum*

Lawrence N. Tanenbaum, MD, FACR, 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.

A New Trick for Imaging Blood Flow in MRA Studies

By Lawrence N. Tanenbaum, MD, FACR

The limited ability of MR angiography to image physiological information inherent in blood flow has long hampered the clinical acceptance/utility of this technique. Recent improvements in MR scanner gradients enable repetitive data capture and reduce echo times (TE) and repetition times (TR) for higher spatial resolution imaging and wider anatomic coverage.

Yet, converting an MR acquisition from single-phase high resolution (SPHR) to TR involves serial scan repetition as the contrast travels to the organ. For faster image capture, a brute force approach reduces both the spatial resolution of the acquisition phase and frequency matrix and generates fewer and/or thicker slices, limiting use in clinical practice.

TRICKS™ (Time Resolved Imaging of Contrast Kinetics) reduces this effect by sampling the center of k-space more often than the periphery to produce multiple physiologic snapshots during each full pass through. This increases temporal

resolution by a factor of four at a given scan resolution and coverage without reducing signal to noise ratio (SNR). Adding parallel imaging to this protocol doubles temporal resolution and significantly reduces acquisition time.

Multiple snapshots increase accuracy by reducing the possibility of missed timing of an SPHR study. Time resolved MRA also eliminates timing runs or bolus tracking. The result is close-to-perfect reliability in the capture of the ideal arterial phase of contrast passage for dynamic depiction of flow physiology.

TRICKS overcomes the limitations of SPHR that can miss or obscure information such as reduced flow due to stenosis, vascular occlusion and collateral flow. It also delivers clinically useful information on bilateral studies typically hampered by asymmetrical flow due to proximal occlusive disease. ■

Pelvic Congestion Syndrome

By Darren Lum, MD, Radiology Fellow, MRI, University of Wisconsin-Madison
and Patrick Quartermann, Clinical MR Specialist, GE Healthcare

Patient history

A 26-year-old G0P0 patient presented for MRI/MRA with 12 years of left lower quadrant pain. Pelvic ultrasound revealed uterine varicosities. An MR Angiography (MRA) using TRICKS™ was requested for further evaluation.

Protocol

TRICKS (3T HDx)	
Pulse sequence:	TRICKS
TR	Auto (approx. 3.4 ms)
TE	Auto (approx. 1.1 ms)
NEX	1
Flip	30 degrees
FOV	35 cms
Temperature Resolution	4 sec
ZIP	No
Freq	256
Phase	160
Slice Thickness	2.6
Coil	8-ch Torso
Temperature Output Phases	20

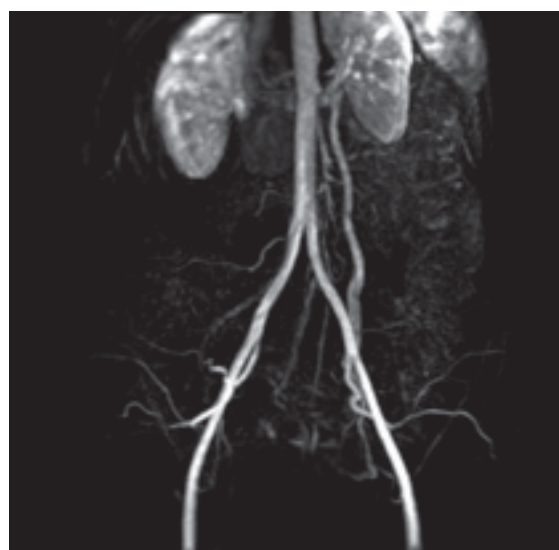
Clinical findings

With the TRICKS MRA exam, the radiologist was able to determine the following clinical diagnostic imaging findings:

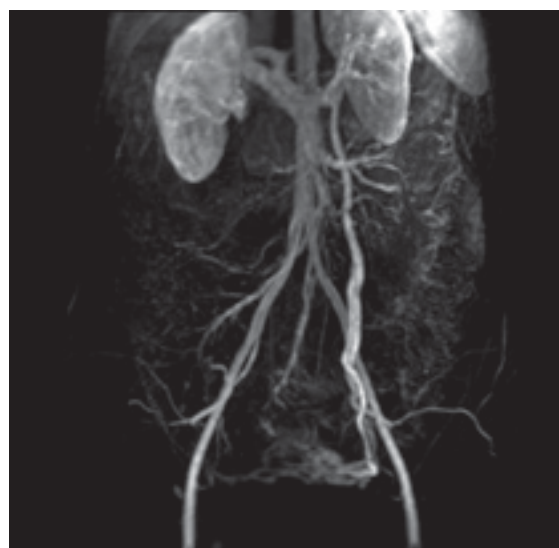
1. Retrograde flow down left gonadal vein to a plexus of varicosities around uterus.
2. Venous phases of TRICKS MRA shows drainage to right external iliac vein.

Discussion

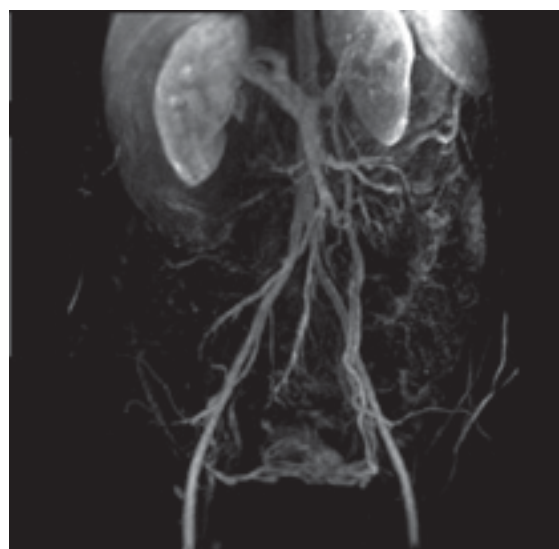
Pelvic congestion syndrome (PCS) is a cause of chronic pelvic pain related to the presence of varicose (abnormally dilated) veins surrounding the uterus and ovaries. All veins contain tiny one-way valves that ensure that blood travels toward



TRICKS phase 7



TRICKS phase 9



TRICKS phase 12

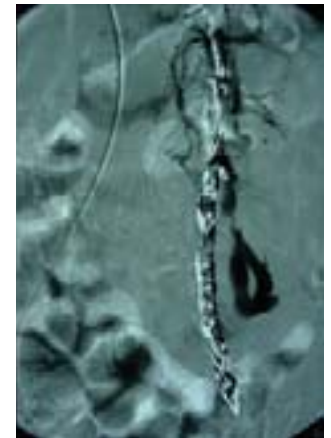
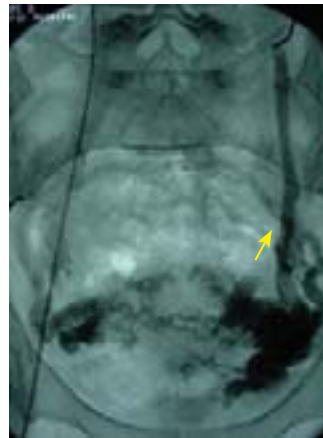
the heart to become oxygenated. When these valves fail, blood can pool and the veins can stretch or bulge. In pelvic congestion syndrome, varicose veins can affect a woman's uterus, ovaries and vulva and may cause dull, aching pelvic pain and occasionally, vaginal discharge or abnormal menstrual bleeding.

PCS can be missed during conventional diagnostic tests such as a gynecologic exam, ultrasound or laparoscopy. A vascular MR study specifically adapted for looking at the pelvic blood vessels offers a non-invasive method for diagnosing PCS.

Treatment

Depending on the severity of a woman's symptoms, treatments for pelvic congestion syndrome may include:

- Analgesics;
- Oral contraceptives;
- Embolization – seals the vein and helps relieve the pressure that is being abnormally transmitted through these veins to the pelvic organs; and
- Surgery – removal of the veins or hysterectomy with removal of ovaries.



X-ray contrast injected prior to embolization shows filling of leaking left ovarian vein (arrow) and numerous engorged veins on the pelvis. The vein was then easily closed with multiple small metal coils.

Summary

From this outline of PCS, it is hoped that clinicians and technologists may quickly identify and therefore hasten treatment of this painful medical condition. Recent advances in MR technology now enable rapid time resolved imaging (as low as one second per phase) that allows for dynamic MRA imaging to visualize arterial and venous blood flow, which is key in diagnosing PCS. ■

GE Healthcare

PLUG IN

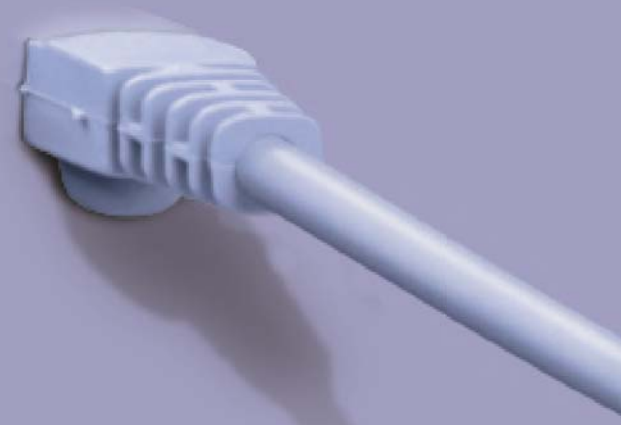
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imagination at work



Cut Out the Fat and Water in Seconds

Raising the bar on contrast-enhanced abdominal imaging

The ability to produce clear, detailed abdominal MR images has made tremendous strides over the last few years. Image quality is vital toward making a correct diagnosis, yet up until now, poor spatial resolution, motion artifacts, inhomogeneous fat suppression and long acquisition times have been clinical obstacles for abdominal imaging.

To help improve image quality, reduce “on-the-table-time” and repeat scans, and ultimately enhance patient care, GE Healthcare introduced LAVA-Flex, a dual-echo acquisition technique that raises the bar on existing sequences to provide consistent, detailed, 3D abdominal images in one breath-hold.

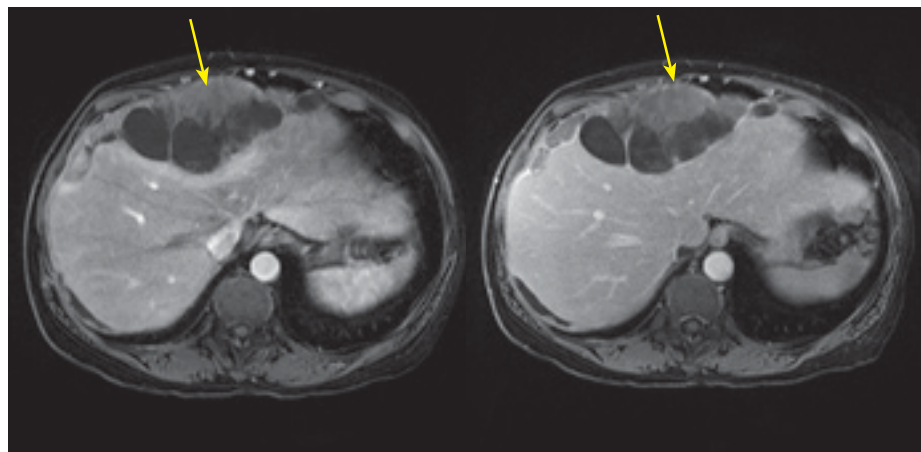
According to Russell N. Low, MD, Medical Director, Sharp and Children’s MRI Center, San Diego, LAVA-Flex with water reconstruction takes current 3D post-contrast imaging one step further, producing superior images quickly and accurately.

“Key aspects of LAVA-Flex are superior fat suppression, greater reduction of artifacts, increased signal-to-noise (SNR) and homogeneity, resulting in overall superior image quality,” he says. “The images it produces are spectacular and the quality is consistently superior to existing techniques.”

Benefits

The abdomen presents one of the most challenging anatomic areas to image. Current contrast-enhanced techniques combine chemical fat suppression with multi-phase 3D gradient-echo imaging. Incomplete or inhomogeneous fat suppression is often evident in large field of view (FOV) abdominal and pelvic imaging. Unsuppressed fat can easily obscure or mimic pathology.

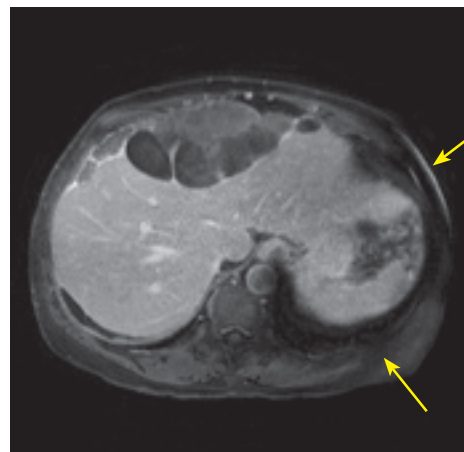
Ovarian Lesions



Arterial phase LAVA-Flex

Portal venous phase LAVA-Flex

Ovarian Lesions



Previous generation technique

“The bottom line is that LAVA-Flex is the new standard for post-contrast abdominal imaging in the industry. Image quality is absolutely paramount.”

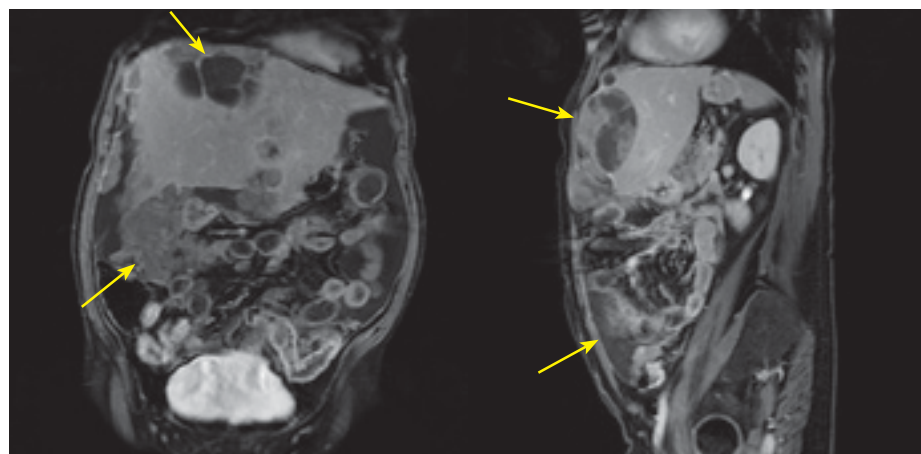
Dr. Russell N. Low

Unlike current methods, LAVA-Flex is a dual-echo acquisition method, producing in-phase and opposed-phase images in one breath hold. LAVA-Flex reconstructs pure fat and water images within seconds by applying a two-point Dixon method to the in-phase and opposed-phase images. In less than one minute, four images (in-phase, opposed-phase, fat and water) are generated. The LAVA-Flex water and fat images show nearly perfect separation of the fat and water signal overcoming the challenges of fat suppression in abdominal imaging.

“LAVA-Flex is superior almost everywhere in the body for post-contrast imaging, including the neck, chest, abdomen and pelvis,” says Dr. Low. “It is particularly beneficial to image anatomy that proves challenging for fat suppression, including large FOV imaging or other problematic anatomic areas such as the neck and brachial plexus. At our center, LAVA-Flex has become our standard fat suppressed 3D sequence for contrast-enhanced imaging.”

Another benefit of LAVA-Flex is its ability to reduce artifacts that interfere with image quality and can make the diagnosis and treatment of disease more difficult. Current 3D post-contrast techniques use physically based parallel imaging methods that require a precise coil sensitivity map. The success of these methods is reliant on accurately calibrating coil sensitivity, which can be difficult to achieve. Image artifacts caused by inaccuracies in coil sensitivity calibration or by motion between the calibration scan and the image acquisition can reduce overall image quality.

Ovarian Lesions



Coronal LAVA-Flex

Sagittal LAVA-Flex



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 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. Sharp was named a recipient of the 2007 Malcolm Baldrige National Quality Award and was the first health care system to be named a gold-level award recipient by the California Council for Excellence (CCE) for the California Awards for Performance Excellence (CAPE) program, the state-level affiliate of the Baldrige Award, in 2006.

Sharp and Children's MRI Center, LLC was founded in 1986 by Sharp Memorial Hospital, 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. And, unlike open or standing MRI devices, our conventional imaging technology provides first-time high quality image results.

LAVA-Flex features ARC™ (Autocalibrating Reconstruction for Cartesian imaging), GE's data-driven parallel imaging reconstruction technique. Unlike physically based parallel imaging methods, ARC uses a full 3D kernel to synthesize missing target data and uses information along all three dimensions for improved reconstruction accuracy with fewer calibration lines. The end result is significantly faster MR data acquisition, superior image quality, and the reduction of calibration and parallel imaging artifacts. It also significantly reduces motion artifacts.

Because ARC is auto-calibrating and requires no coil sensitivity map, it enables smaller field-of-view (FOV) prescriptions and reduces opportunities for error. It also means potentially faster patient throughput, shorter scan times and fewer repeat scans due to error or poor image quality.

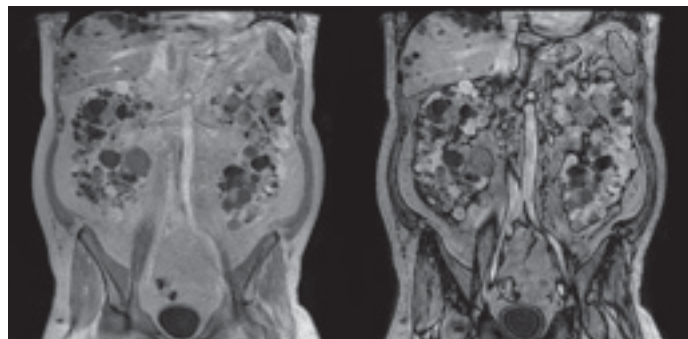
"The images we've seen with LAVA-Flex have been outstanding and are much better than those obtained from standard methods," says Dr. Low. "We've looked at a number of artifacts and compared standard fat suppressed 3D images obtained from previous generation techniques with those from LAVA-Flex. In the vast majority of abdominal cases, LAVA-Flex water images had superior overall quality, with reduced susceptibility and phase artifacts, better anatomical detail and sharper detail."

LAVA-Flex also provides improved (SNR) and produces more homogenous images.

Looking to the future, Dr. Low notes that there is a whole potential for exploration using the in-phase, opposed-phase, fat and water images produced by LAVA-Flex. "For example, we could explore how these images might enable us to look at fat within tumors or organs. This will ultimately add a higher degree of clinical confidence when it comes to diagnosing and treating diseases.

"The bottom line is that LAVA-Flex is the new standard for post-contrast abdominal imaging in the industry" says Dr. Low. "Image quality is absolutely paramount. The better the images the better the chances for correct diagnosis. Otherwise, the potential to miss something is real. Superior images can lead to a higher degree of clinical confidence and have a positive impact on patient care." ■

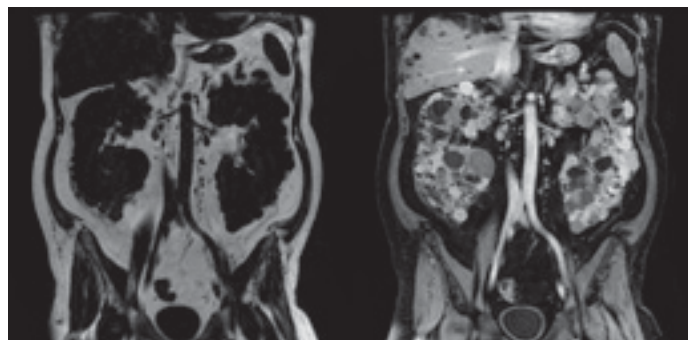
Polycystic Kidney and Liver Disease



In-phase

Opposed-phase

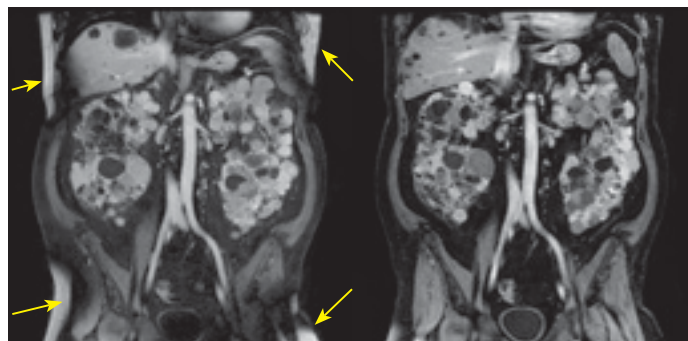
Polycystic Kidney and Liver Disease



LAVA-Flex fat

LAVA-Flex water

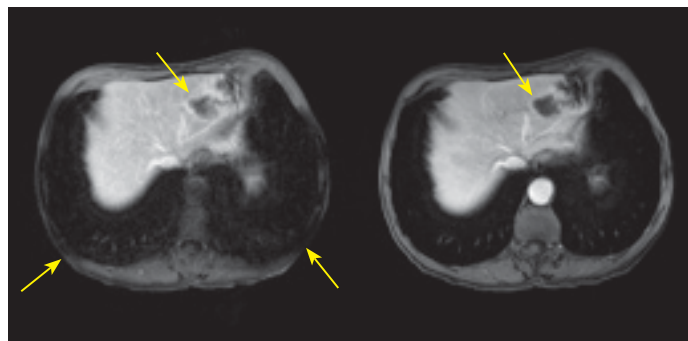
Polycystic Kidney and Liver Disease



Previous generation technique

LAVA-Flex water

Pancreatic Lesions with Liver Disease



Previous generation technique

LAVA-Flex

Complementary 'Fat Only' and 'Water Only' Abdominal MR Images in a Single Breath-Hold

By Elmar Merkle, MD

Reconstructing water and fat images from a 3D gradient dual echo sequence just recently became a true clinical reality with GE Healthcare's new LAVA-Flex. This is accomplished by applying a two-point Dixon method to data from a gradient dual echo acquisition with in-phase and opposed-phase images. Reliable phase error correction prevented this technique from becoming a key component of a routine body MR protocol in the past. Today, LAVA-Flex makes this possible by processing regions with a higher signal-to-noise ratio (SNR) and smaller phase variations. These regions then guide the phase correction in areas with lower SNR and larger phase variations.

A key benefit is the ability to generate (post process) the 'water only' and 'fat only' images using preexisting in-phase and opposed-phase raw data without incurring additional scanner time. These two complimentary datasets offer several advantages:

- The 'water only' image offers superior fat suppression over more common techniques. This two-point Dixon technique is less prone to magnetic field inhomogeneities (Figure 1). In addition, the 'water only' image may serve as a complimentary gradient echo T1W image with fat suppression for comparison purposes in cases where no dedicated pre contrast T1W gradient echo with fat suppression was acquired.
- The 'fat only' image offers several clinical benefits. First, diffuse, focal or geographic steatosis hepatitis is displayed very well and quantified non-invasively (Figure 2). Second, fat containing lesions e.g. hepatic or adrenal adenoma, angiomyolipoma or pelvic dermoids can be visualized with the fatty component demonstrated with a high level of clinical confidence thus improving the characterization of focal lesions (Figure 3). Finally, iron storage diseases such as hemochromatosis or hemosiderosis can be visualized on the 'fat only' image where the T2* effects cause a hyperintense appearance of the liver and/or spleen (Figure 4).



Dr. Elmar Merkle

Elmar Merkle, MD is Professor of Radiology, Head of Body Magnetic Resonance Imaging and Medical Director of the Center for Advanced Magnetic Resonance Development at Duke University. In the mid 1990s, he conducted his MR research fellowship in the laboratory of Professor Jonathan Lewin in Cleveland, where he made significant contributions to the field of interventional MR imaging. Dr. Merkle is a fellow of the Society of Computed Body Tomography and Magnetic Resonance (SCBT), and a member of the Radiologic Society of North America (RSNA), the International Society for Magnetic Resonance in Medicine (ISMRM), the American Roentgen Ray Society (ARRS) and the European Congress of Radiology (ECR) among others.

Dr. Merkle is on the editorial board of the Journal of Endovascular Therapy. He has been invited for numerous lectures, is a visiting professor to universities worldwide, and has published more than 100 peer-reviewed manuscripts and 15 book chapters.

About Duke University

The Duke University School of Medicine is a community of scholars devoted to understanding the causes, prevention and treatment of human disease. Ranked in the top ten with schools twice its age, Duke is committed to socially relevant education, translational research, compassionate patient care and global healthcare solutions.

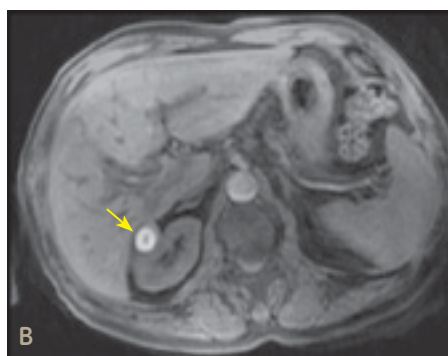
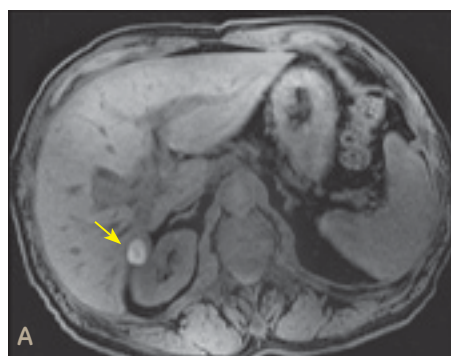


Figure 1: Patient with complicated right renal cyst (arrow). A) 'Water only' T1W 3D gradient echo image demonstrates superior fat suppression in both the retroperitoneum and the subcutaneous tissue when compared to the T1W 3D gradient echo image with chemical shift pre pulse fat suppression (B). Note, that the hyperintense renal cyst on the right side is displayed in a very similar fashion.

The ability to generate 'water only' and 'fat only' images for the detection and characterization of fat and iron within abdominal tissues without increasing data acquisition or scan time is clinically useful and helps maximize scanner efficiency. LAVA-Flex shows promise for becoming a part of routine abdominal and pelvic MR imaging as this new technique makes it possible to generate a set of four corresponding images within one breath-hold – opposed-phase, in-phase, and complementary 'fat only' and 'water only' images. ■

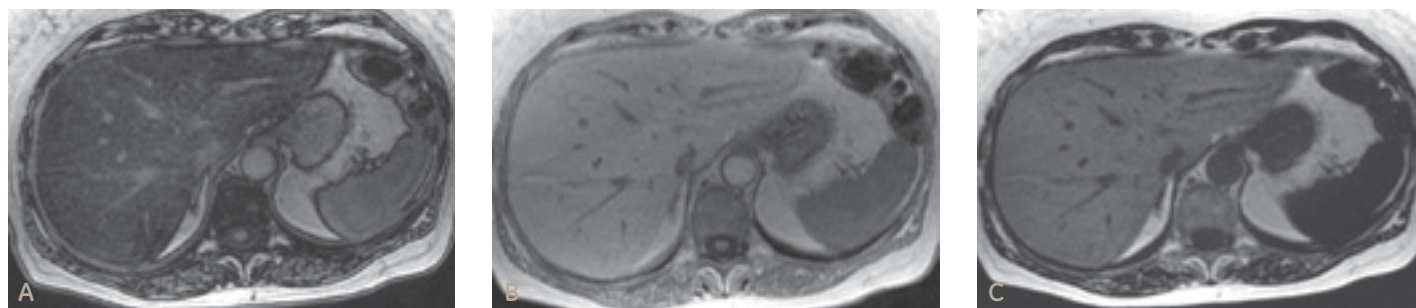


Figure 2: Patient with diffuse fatty infiltration of the liver. A) 'Opposed-phase' T1W 3D gradient echo image demonstrates marked hepatic signal loss when compared to the corresponding 'in-phase' T1W 3D gradient echo image (B). C) Corresponding 'fat only' image shows marked hepatic signal intensity which is substantially higher than the signal intensity of the background noise and spleen. The hepatic signal-to-noise ratio correlates with the degree of fatty infiltration thus offering a fast and non-invasive semi-quantitative approach for evaluation of steatosis hepatis.

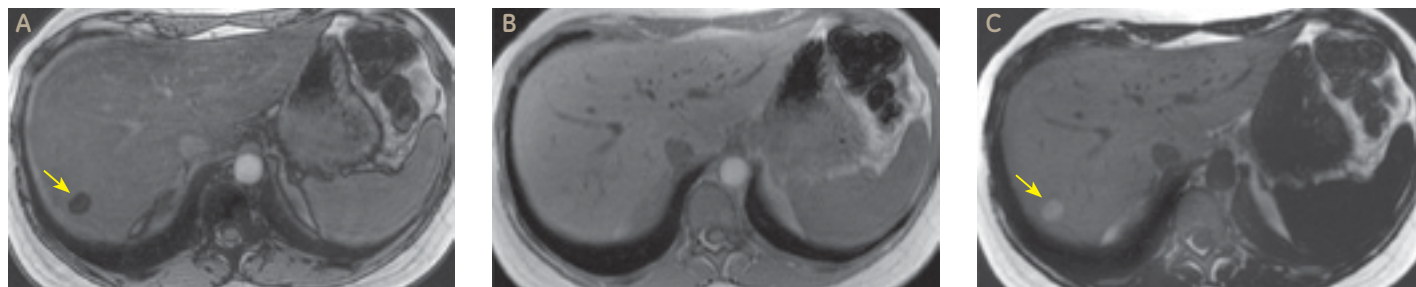


Figure 3: Patient with diffuse fatty infiltration of the liver and fat-containing hepatic adenoma in segment 7. A) 'Opposed-phase' T1W 3D gradient echo image demonstrates marked hepatic signal loss when compared to the corresponding 'in-phase' T1W 3D gradient echo image (B). The focal hepatic lesion in segment 7 (arrow) is not visualized on 'in-phase' imaging, but clearly seen on both, the 'opposed-phase' image (A) and the 'fat only' image (C) where the lesion appears hyperintense compared with the fat containing liver.

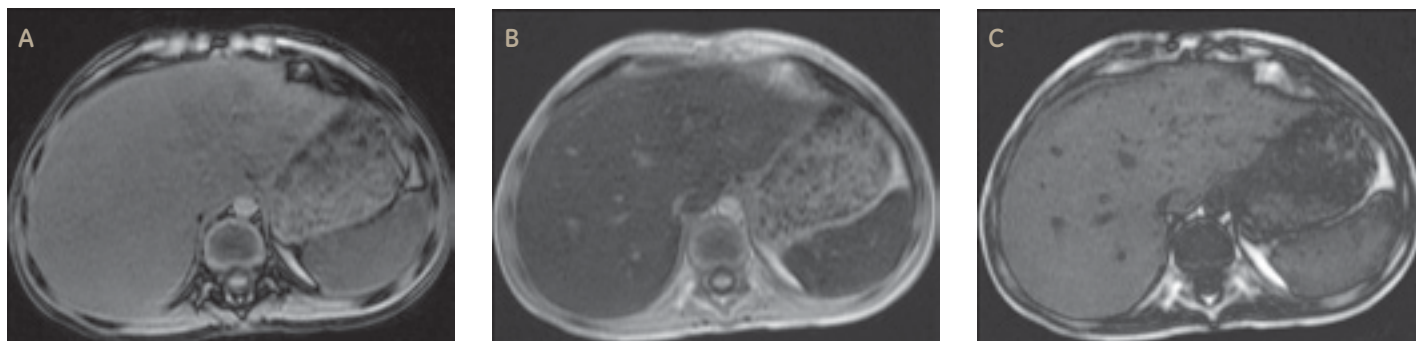


Figure 4: Eight-year old child with hemosiderosis following multiple blood transfusions. A) 'Opposed-phase' T1W 3D gradient echo image demonstrates markedly higher hepatic and splenic signal intensity when compared to the corresponding 'in-phase' T1W 3D gradient echo image (B). This is due to iron deposits in the liver and spleen which cause substantial shortening of the T2* relaxation time and subsequent signal loss on the image with the longer echo time. The 'fat only' image (C) also shows these effects as a hyperintense signal in the liver and spleen when compared with the background noise. This finding may not be misconstrued as steatosis hepatis, but must be correlated with the 'in-phase' and 'opposed-phase' images.

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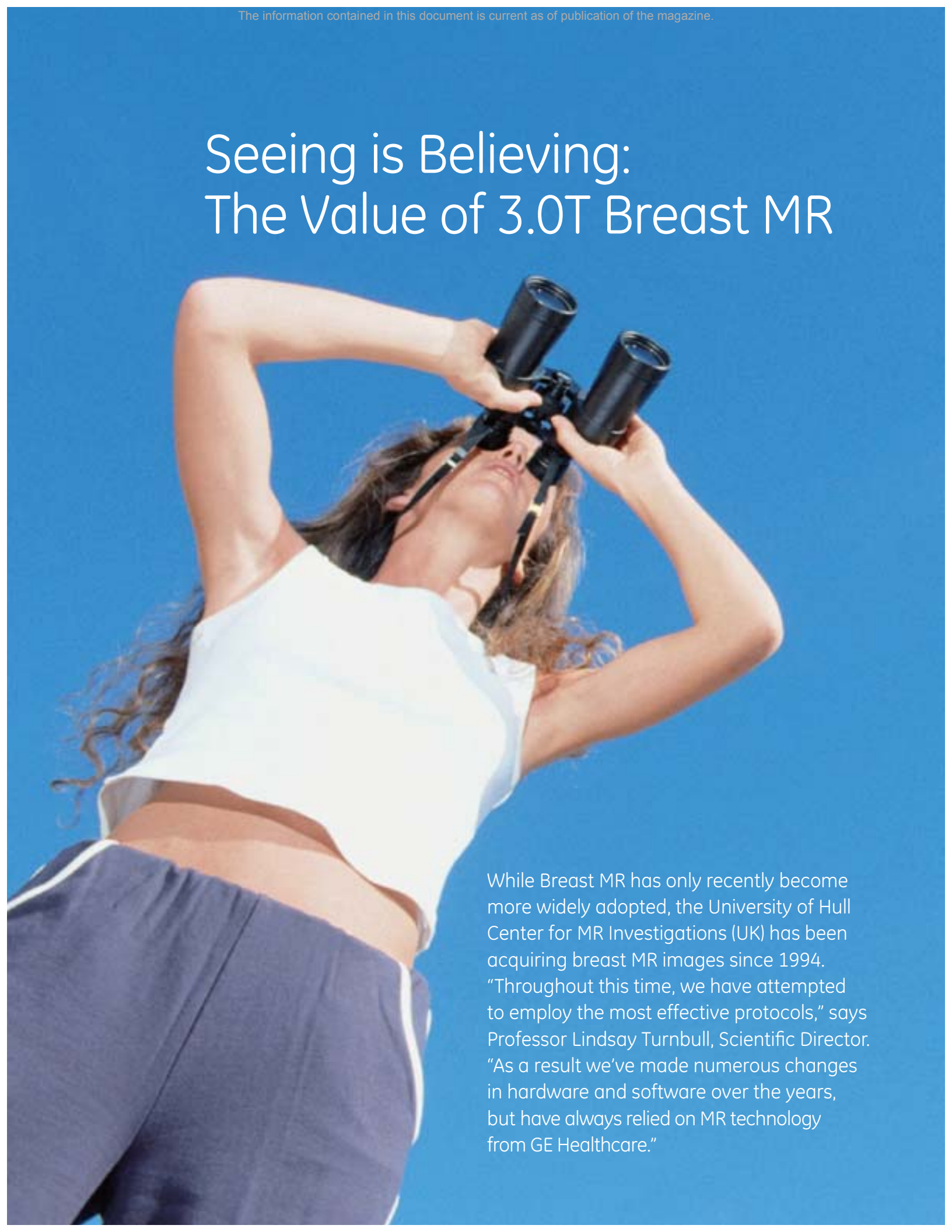
Olympic athletes should be treated with world-class orthopedic scanning technology. That's why two Signa® HDe MR scanners were purchased for the 2008 Olympic Games in Beijing. GE Healthcare is proud to support the best athletes in the world with this exceptional technology.

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imagination at work

Seeing is Believing: The Value of 3.0T Breast MR

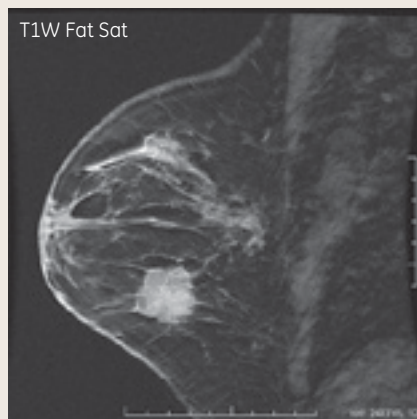


While Breast MR has only recently become more widely adopted, the University of Hull Center for MR Investigations (UK) has been acquiring breast MR images since 1994. "Throughout this time, we have attempted to employ the most effective protocols," says Professor Lindsay Turnbull, Scientific Director. "As a result we've made numerous changes in hardware and software over the years, but have always relied on MR technology from GE Healthcare."

Case 1**Lesion Characterization**

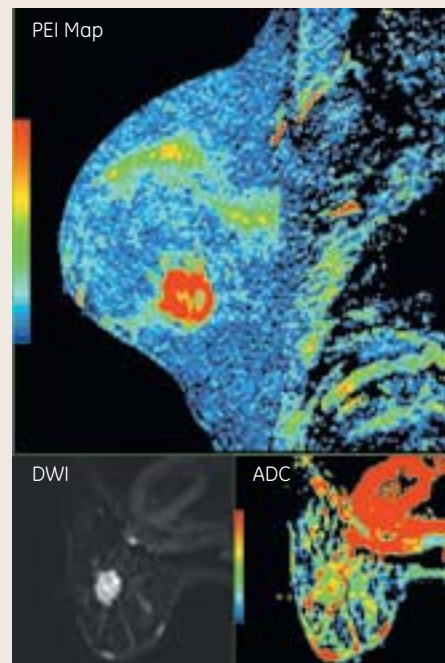
Patient with a self-diagnosed lump. Mammography and ultrasound identified a single lesion. Core biopsy confirmed malignant nature (NST, Grade III, ER and PR positive). MRI requested to stage disease prior to neoadjuvant chemotherapy.

MRI helped identify a relatively well-defined lobulated 3 cm diameter mass lesion demonstrating a Type III uptake curve. A further 9 mm satellite lesion was also noted.

**Protocols:**

Dynamic VIBRANT: VIBRANT, 10° flip, TR4.1 TE1.6/Fr, TI 6.0, 41.7 kHz, 22x22cm FOV, 220x160 matrix, 4/-2 mm, 1NEX, SPECIAL, NPW, ZIP2, ASSET multiphase (2 pre 10 post)

T1W High Resolution: VIBRANT, 10° flip, TR7.5, TE2.9/Fr, TI 5.0, 41.7 kHz, 20x20 cm FOV, 512x512, 3.6/-1.8 mm, 1NEX, SPECIAL, ZIP2



Prof. Turnbull and Martin Pickles, PhD, research radiographer, currently use VIBRANT™ on a Signa® HDx 3.0T system. "The current protocol uses high temporal and spatial resolution sequences, incorporating multiple parameters that are analyzed by various techniques," Prof. Turnbull explains, "for a robust and effective clinical assessment."

In 2008, Hull University expects to examine nearly 650 cases with breast MR. Of those, Dr. Pickles estimates 200 will be screening exams of high-risk patients with family history, while the remaining 450 will be a mix of problem-solving cases. "This includes staging of invasive disease, neoadjuvant chemotherapy treatment follow-up, breast implants and to a small degree, MR-guided biopsy," he adds.

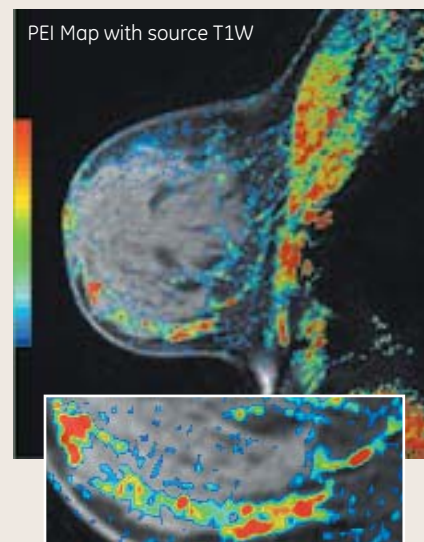
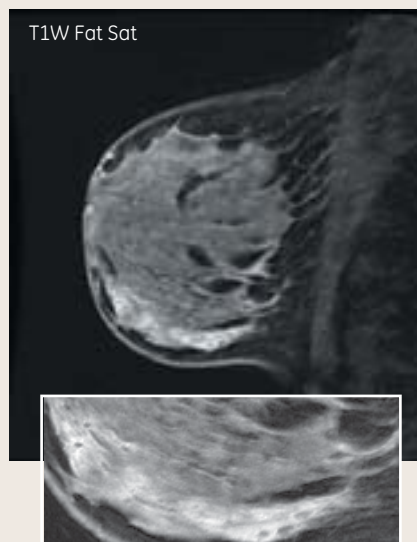
Case 2**Ductal Carcinoma In Situ (DCIS)**

Patient has a high-risk family history. Mammogram was normal but MRI requested due to dense nature of the breast tissue.

The MRI images depict a prominent ductal type enhancement in the inferior aspect of the breast in keeping with the appearance of DCIS.

Protocol:

T1W High Resolution: VIBRANT, 10° flip, TR7.5, TE2.9/Fr, TI 5.0, 41.7 kHz, 20x20 cm FOV, 512x512, 3.6/-1.8 mm, 1NEX, SPECIAL, ZIP2



Case 3**High-Risk Family History**

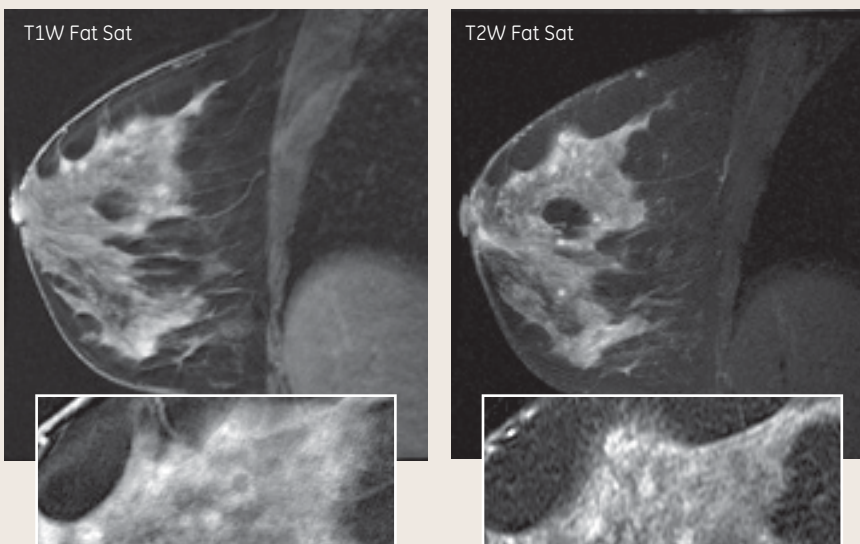
Woman with high-risk family history referred for MRI. The exam uncovered extensive punctuate areas of contrast uptake (Type 1) seen throughout both breasts. Post-contrast T1W images reveal multiple tiny ring enhancing structures corresponding with high signal intensity areas on T2W images. As a result of the MRI, patient was diagnosed with fibrocystic disease.

Protocols:

Dynamic VIBRANT: VIBRANT, 10° flip, TR4.1 TE1.6/ Fr, TI 6.0, 41.7 kHz, 22x22cm FOV, 220x160 matrix, 4/-2 mm, 1NEX, SPECIAL, NPW, ZIP2, ASSET multiphase (2 pre 10 post)

T1W High Resolution: VIBRANT, 10° flip, TR7.5, TE2.9/ Fr, TI 5.0, 41.7 kHz, 20x20 cm FOV, 512x512, 3.6/-1.8 mm, 1NEX, SPECIAL, ZIP2

T2W High Spatial Resolution: FSE-XL, TR5780, TE80.6, 41.7 kHz, 20x20 cm FOV, 512x320, 3.6/0 mm, 2NEX, fat sat, NPW, TRF, ED, ZIP512



According to Dr. Pickles, "VIBRANT™ allows us to acquire functional data with a 35 sec temporal resolution and 1.00x1.37x2 mm spatial resolution. Additionally, we use VIBRANT to acquire post-contrast, high spatial resolution (0.4x 0.4x1.8 mm) images that further improve our specificity."

The value of VIBRANT is quite clear to the clinicians at Hull University. Prof. Turnbull says. "With the elevated signal-to-noise ratio of the Signa® HDx 3.0T, coupled with the ASSET™ parallel imaging method, we obtain a high level of diagnostic accuracy with the superior temporal and spatial resolution of the VIBRANT sequence." ■

Case 4**Breast Augmentation**

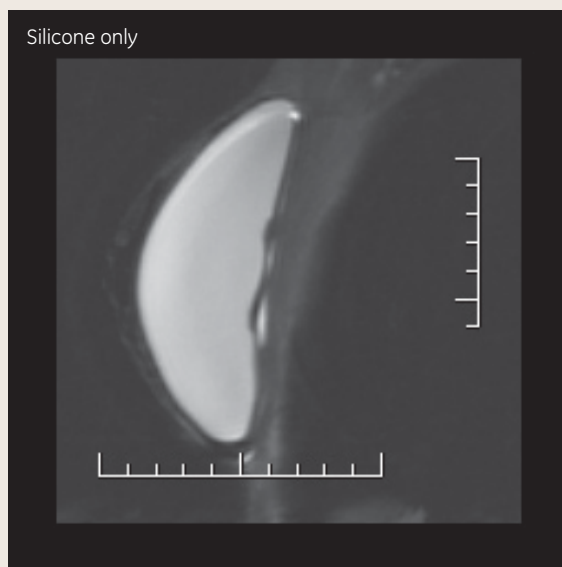
Patient underwent breast augmentation in 2003. Recent RTA breasts are described as lumpy and tender. Due to possible silicone rupture, patient referred for breast MRI. MRI found evidence of extracapsular silicone posteriorly but no evidence of an intracapsular rupture.

Protocols:

Dynamic VIBRANT: VIBRANT, 10° flip, TR4.1 TE1.6/ Fr, TI 6.0, 41.7 kHz, 22x22cm FOV, 220x160 matrix, 4/-2 mm, 1NEX, SPECIAL, NPW, ZIP2, ASSET multiphase (2 pre 10 post)

T1W High Resolution: VIBRANT, 10° flip, TR7.5, TE2.9/ Fr, TI 5.0, 41.7 kHz, 20x20 cm FOV, 512x512, 3.6/-1.8 mm, 1NEX, SPECIAL, ZIP2

Silicone only: FSEIR, TR4920, TE13.0, T1200, 15.6 kHz, 30x30 cm FOV, 256x256, 4/1 mm, 1NEX, water sat



GE Healthcare

A breast MR solution designed for breast MR—without limitations. Imagine that.

In breast MR, diagnostic confidence comes with being able to identify critical lesions. And that kind of clarity comes with the Signa® breast portfolio, the only portfolio designed specifically to be a breast MR solution. And the most comprehensive HD solution available for breast MR. It starts with VIBRANT™, the first ever bilateral, volumetric acquisition technique introduced for breast, and still the industry standard for speed and resolution. And it's supported by BREASE, a breast-specific proton spectroscopy solution, CADstream™ automated analysis and reporting to drive efficient workflow, and the HD Breast Array that enables outstanding image quality and easy access for procedures. Combine all this with the Vanguard Breast Table™ from Sentinelle Medical, and these solutions add up to excellent specialization capabilities and diagnostic confidence. When Breast MR is technology's focus, every detail becomes very clear. **Breast MR Re-imagined.**



imagination at work

MR Helps Turn the Tide Toward Prostate Conserving Therapies



This year in the United States, more than 186,000 men will be diagnosed with prostate cancer. If diagnosed and treated early, 90 percent of them can be cured.¹ Blood prostate-specific antigen (PSA) value and a digital rectal exam are both used to screen the presence of disease. A biopsy is then performed to determine if there are cancerous cells in the prostate.

Standard treatment options, including radical prostatectomy and radiation therapy, depend upon accurate staging. At Yale – New Haven Hospital, Jeffrey Weinreb, MD, FACR, Chief of MRI and Director of Medical Imaging, has been using MRI for prostate imaging. “MR provides additional information to help evaluate the stage of prostate cancer,” Dr. Weinreb looks at extension through the prostate capsule, into the seminal vesicles, and to the regional lymph nodes.

“MR can show extracapsular extension of cancer and adds incremental improvements in the accuracy of staging, especially in patients with intermediate grade tumors and PSA levels that are not markedly elevated,” he says.

“We also use MR for patients with an elevated PSA level who had more than one failed attempt to localize the suspected lesion with ultrasound-guided biopsy,” he adds. According to Weinreb, MR can often provide critical information that can be used to identify the area in the prostate that is likely to yield positive biopsy results.

There are also newer conservative therapies for saving the prostate that depend on localization of the tumor(s) within the prostate gland and MR is assuming an increasing role for these as well, Dr. Weinreb adds. “The bottom line, all therapies are dependent upon imaging to optimize patient treatment.”

Haesun Choi, MD, Director of Body MRI, Diagnostic Radiology at The University of Texas MD Anderson Cancer Center, also uses MR imaging for localizing prostate tumors. “In areas that are questionable and non-specific, spectroscopy further helps to distinguish tissue, locate the dominant tumor and is useful for guiding biopsy.”

Prostate cancer is a multi-focal disease, explains Dr. Choi, and as a result prostate cancer treatments historically either irradiated or removed the entire prostate. “Today, radiation therapy improvements enable the precise targeting of the tumor if we know where it is,” she notes.

She also agrees with Dr. Weinreb that the most important information gained from MR imaging is whether the cancer is confined to the organ or extended beyond it. “A review of the literature shows that the accuracy of local staging with MRI is about 90 percent with experienced hands.” Spectroscopy, she says, has no direct role in this aspect but can increase that specificity indirectly by improving tumor localization within the gland.

Spectroscopy has technical challenges, says Dr. Choi. “We really need good quality spectroscopy data for an accurate interpretation.” For a good quality image, spectroscopy requires a very homogenous field. Air in the rectum behind the prostate must be avoided by placing a prostate spectroscopic volume box in front of the rectum. Also, it is necessary to suppress the fat surrounding the prostate, she explains.

Dr. Weinreb also believes that MR spectroscopy shows promise for potential use and in fact, some facilities are using it routinely to help guide management decisions. At present, he sees this tool as most useful after radiation therapy to determine if it was successful or if there is a recurrence.

According to Dr. Choi, the image quality is dependent upon a good endorectal coil. However, the coil can create artifacts, which can be removed with special software once the images are acquired. When the MR images are fused with CT images, deformation of the prostate can make it difficult to match the different configurations.

Although nothing is 100 percent, Dr. Choi believes spectroscopy does help to sort out specific cases, such as those with a negative biopsy and a high PSA level. “PSA can rise for other reasons, and in these cases spectroscopy is helpful to either guide the biopsy or exclude the cancer.” ■



References

1. Available at www.prostatecancerfoundation.org



High-End MR Technologies Provide Competitive Edge for Imaging Center



Gaining the competitive edge in today's post-Deficit Reduction Act (DRA) market, while producing high-resolution, state-of-the-art MR imaging has been a daunting task for many small, free-standing imaging centers. Procedure reimbursement cuts due to DRA have made it difficult for facilities to invest in the high-end technical equipment necessary to produce state-of-the-art results and stay competitive.

Unlike other facilities that were looking to reduce costs by cutting back on capital equipment purchases, The Imaging Center of Pensacola (Fla) (ICP) invested in new high-end MR scanners from GE Healthcare, including the Signa® HDx 3.0T and the Signa HDe 1.5T. The gamble has paid off, establishing ICP as not only a leader in high-resolution imaging technology, but positioning them as a premier center for breast MR in Northwest Florida.

"Anytime you have a different environment (as with DRA), you have to set yourself apart from the competition," says John Sowers, MD, Medical Director, ICP. "Having a brand or a way to differentiate on quality can increase your chances for success. The advent of DRA meant we had to look for new opportunities in the market and set ourselves apart."

Sherrin Sowers, Administrator, agrees and also believes that the correct niche market for ICP is the high-quality specialty market. "Our center receives a lot of the difficult, tedious cases in the Pensacola area," she says. "We focus on educating referring physicians and patients on the value of high field, and it seems to be paying off."

"We saw a growth opportunity with the addition of the scanners to our arsenal of technologies," explains Dr. Sowers. "From the start, ICP has been at the forefront of technology."

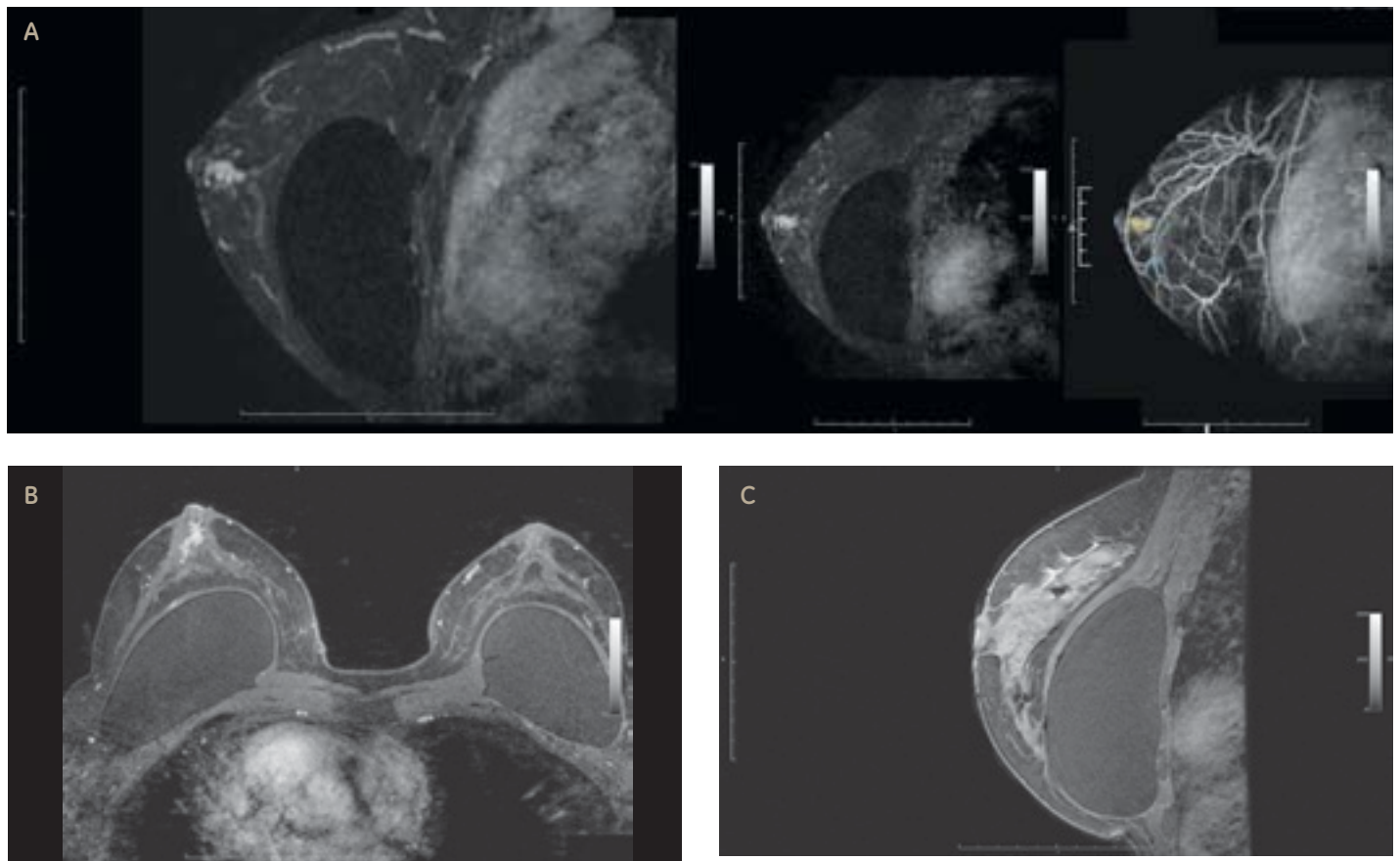


We have consistently upgraded our equipment to stay abreast of technology. The combination of the Signa HDe 1.5T and Signa HDx 3.0T scanners has enabled us to establish ourselves at the higher end of the market and provided us with something unique to offer the community. It's allowed us to grow in an environment where other facilities are struggling."

In its initial business plan 10 years ago, ICP considered buying out the first 1.0T at the end of the lease. Dr. and Mrs. Sowers instead opted to upgrade to a new lease to take advantage of emerging MR technology, such as open MR and GE's 1.5T Excite platform. Five years later, they were able to upgrade the Center's technology again. In 2007, when faced with either re-leasing their current equipment, or investing in new technology, they opted for the latter, providing ICP with a competitive edge in the diminishing market that emerged following DRA.

"At the time, there was a lot of excitement over the greater resolution and faster patient throughput that the 3.0T MR provided," says Dr. Sowers. "For little cost difference, we were able to upgrade to the latest technology. We replaced our open MRI with the HDe, but we noticed that many of our competitors were offering 1.5T MR as well. By adding the 3.0T scanner to our repertoire, we were able to differentiate ourselves from the competition and retain our leadership position in the market," he adds. Plus, the Signa HDe boasts a 30 percent smaller footprint than a typical 1.5T, so ICP was able to site the high-field scanner in the same space as the low-field open MRI with minimal construction expense.

Having two high-field MR scanners enables greater patient throughput and allows ICP to take on a variety of complex cases, such as Magnetic Resonance Angiography (MRA). Faster imaging sequences from the 3.0T mean patients



47-year female with history of invasive ductal carcinoma in the right breast, treated with a lumpectomy and radiation therapy, has a left nipple discharge. High resolution 3.0T images post contrast with isotropic voxels allow reformat in multiple planes (1a). MRI acquired in the axial plane (1b) revealed extensive subareolar ductal pattern abnormal enhancement in the left breast as well as two additional separate suspicious areas of enhancement. The patient's surgeon requested needle localization of the lesions for biopsy (1c). Needle localization was performed on the HDe using Sureloc software.

spend less time in the scanner. The result is more patients can be scheduled – particularly those requiring contrast studies.

“The 3.0T MR can reduce a contrast scan by 15 minutes,” says Dr. Sowers. “This translates to improved patient comfort and more available slots for contrast studies during hours that physicians are present.

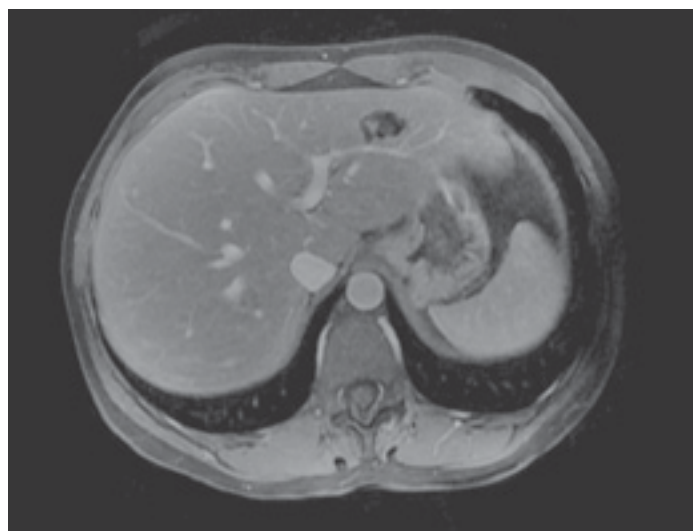
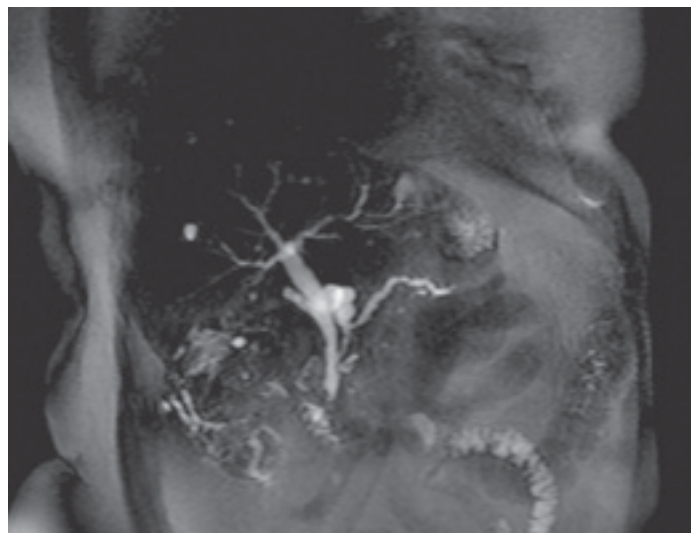
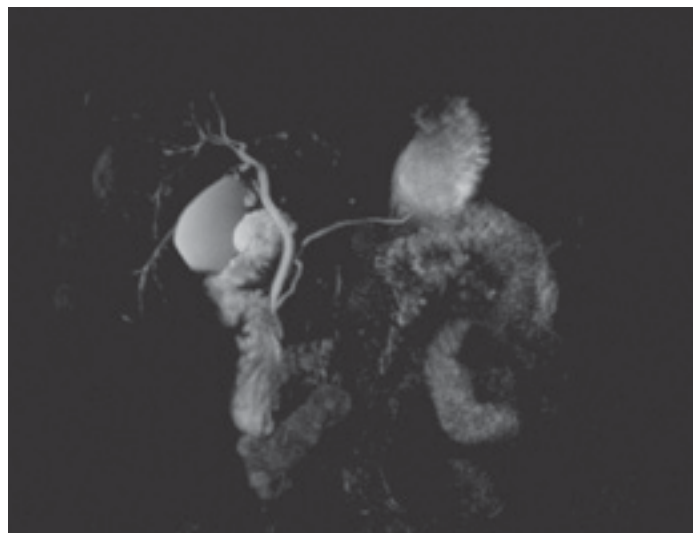
“The 3.0T and HDe scanners work in tandem,” he explains. “Our goal is to maximize utilization of our MRI equipment. Between the HDe and the Signa® HDx 3.0T we can schedule more patients. Depending on patient needs, we can even change which machine we are going to use at the time of the appointment. For example, the HDe can be better for some patients and certain examinations. We can accommodate the patient right away and not have to reschedule later.”

A new niche in breast MR studies

In addition to providing greater resolution and faster patient throughput, the combination of Signa HDx 3.0T and Signa HDe technologies also enables ICP to position itself as a leader in the breast MRI niche.

The American Cancer Society estimates that more than 200,000 women will be diagnosed with breast cancer in the United States this year. To enhance early detection efforts, on March 28, 2007, the American Cancer Society (ACS) released new recommendations for the use of MRI for women at increased risk for breast cancer, including those with a genetic predisposition or strong family history of the disease.

“We’ve embraced the VIBRANT™ breast imaging technology,” notes Sowers, “and since the ACS recommendation last March, payers are more open to reimbursement.”



The two top images are MRCP post-contrast of a pancreatic pseudocyst. The bottom left image is a post-contrast image of a calcified liver mass.

The Signa® HDx 3.0T scanner can provide information that is useful in making a breast cancer diagnosis. It affords higher spatial resolution, enabling radiologists to see finer details, sharper borders, and clearer margins in the images and ultimately provides crucial information not attainable at lower resolutions.

The 3.0T scanner at ICP is equipped with High Definition (HD) technology, such as the HD 8-channel Breast Array and VIBRANT™, a GE application that enables fast, high resolution bilateral breast imaging with uniform fat suppression. Bilateral exams provide several benefits. Physicians can compare the breasts for symmetry to help find suspicious areas in the breast that may otherwise appear disease-free. It eliminates the need to choose between scanning for structural detail and scanning rapidly for uptake information. Clinicians also have the choice of direct sagittal or axial imaging and automatically optimized parameters, making it easy for technologists to deliver consistent image quality.

With the capability to image both breasts simultaneously for a true bilateral exam, patients gain the added convenience of avoiding two separate imaging exams on different days.

"The 3.0T produces 1 mm slices and allows us to reconstruct with isotropic voxels. This provides better localization and the ability to visualize anatomy in another plane," says Dr. Sowers. "We can scan in the axial plane and reconstruct in the sagittal plane with good results. We've found the reconstructed sequences are just as good as scanning in two separate planes.

There are numerous advantages of using 3.0T for breast imaging, including 1 mm slices, improved multi-planar reconstruction capabilities, decreased exam time and clearer margins and borders for improved characterization of lesions. These capabilities combined with careful, intelligent business decisions, have enabled ICP to increase their referral base and expand their market – and to position them as a leader in high-resolution MR imaging. ■

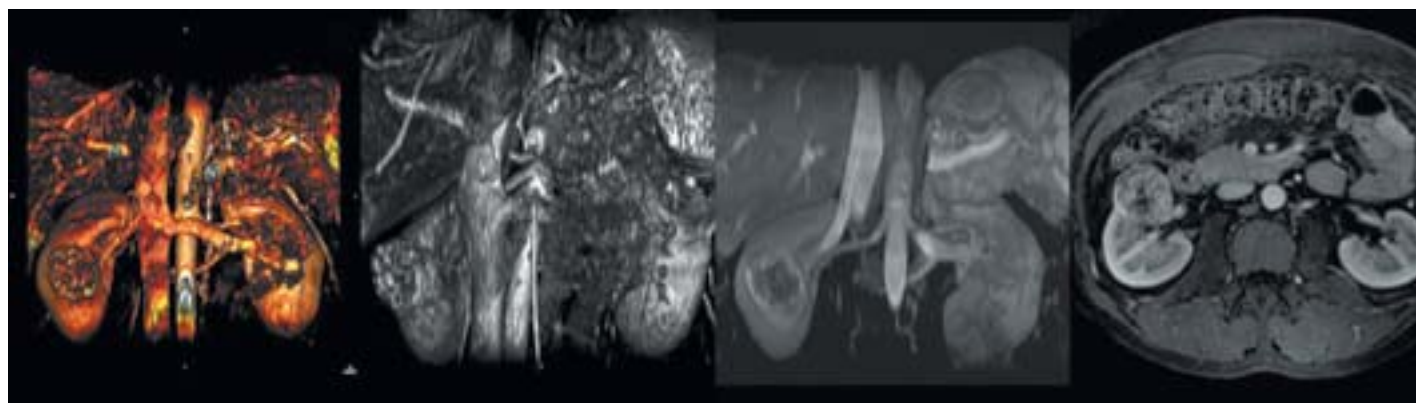


Dr. John Sowers

About the facility

Founded in 1997, the Imaging Center of Pensacola offers advanced diagnostic imaging services with its arsenal of GE technology, including Signa HDx 3.0T and Signa HDe 1.5T MR scanners, a BrightSpeed Select16 CT scanner and Logiq 9 ultrasound. The center specializes in musculo-skeletal MR imaging, neurology, sports medicine and MR arthrography. The center is distinguished as a GE national show site and at RSNA 2007, Dr. Sowers received an award from GE for 10 years of imaging excellence service.

Known for quality imaging, ICP operates with two radiologists on-site at all time, seven technologists, two sonographers and 14 supporting staff. The center provides guidance to local clinicians seeking to select the correct imaging study for patients, and is known for technical expertise, spectacular imaging and quick turn-around of reports.



Right renal mass 3D volume rendered reconstruction from axial LAVA™ sequence.



MR Gets Nod from United Kingdom as a Key Component in New Stroke Strategy

Every 40 seconds someone in the United States suffers an acute stroke – and every three to four minutes a person dies from one. According to the American Stroke Association (ASA), it is the third leading cause of death, after heart disease and cancer, with one in every 16 deaths occurring from stroke. Of 750,000 acute stroke cases diagnosed every year in the US, 87 percent are ischemic, 10 percent are caused by intracerebral hemorrhage and three percent subarachnoid hemorrhage.

Aside from the devastating impact stroke has on individuals and families, it is also the largest cause of severe, long-term disability and has a major impact on the nation's economy. The ASA projects that in 2008, the direct and indirect costs of stroke will be \$65.5 billion.

Studies show that intensive physiological and neurological monitoring of patients in the early phases of stroke is critical for halting an event's progression and preventing more damage. Certain therapies, such as tPA (tissue plasminogen activator, a thrombolytic agent used as a clot-busting drug) treatment for ischemic stroke, must be administered within three hours of the onset of the event. This same treatment, while life-saving for ischemic stroke patients, could be fatal for patients with a hemorrhage. In many cases quick diagnosis

and early therapy for patients presented with TIA (transient ischemia attack, a pre-stroke condition), can prevent the stroke. If untreated, TIA patients are at significant risk of developing full acute stroke event.

Therefore, the need to quickly diagnose TIA and stroke and correctly differentiate between ischemic and hemorrhagic stroke is crucial for successful treatment. A 2005 study by the Stroke Association (London) indicated that TIA is under recognized, diagnosed and treated. Only half the people surveyed could correctly identify what a stroke is, and one-fourth believed that specialized treatment was not necessary. Even more alarming was that one in five general practitioners did not refer one-fifth of their TIA cases for further assessment and treatment. Of the 150,000 people per year suspected of TIA or a minor stroke, only 35 percent are seen and assessed in a neurovascular clinic within seven days. Additionally, only 12 percent of hospitals have protocols in place with ambulance services for the rapid referral of those with suspected stroke and less than 50 percent of hospitals with acute stroke units have access to brain scanning within three hours of admission to hospital.

The significance of such lack of treatment has come to the forefront globally, with the United Kingdom (UK) recently

instituting a 10-year Stroke Strategy designed to improve the outcome of stroke patients. A key component of this strategy is the use of high-field MRI for patients presenting to the emergency room with stroke-like symptoms.

The strategy requires that all patients with minor stroke and all higher-risk patients with TIA must be assessed with MRI by a specialist and treated within 24 hours. Aggressively investigating and treating high-risk patients with TIA within this timeframe could produce an 80 percent reduction in the number of patients who go on to have a full stroke.

High-field imaging of the brain tissue and cerebral blood flow is a critical component of successful stroke treatment. While CT found a broad application in stroke triage by helping clinicians quickly rule out hemorrhagic stroke, a critical question when considering tPA therapy, MR is a gold standard in imaging ischemic stroke as it can provide a complete differential stroke diagnosis in one exam.

MR is better for imaging soft tissue, can detect early ischemic changes and can help distinguish an old from a new acute stroke by helping clinicians assess the size and location of the lesions. The size of the lesion is an important factor in determining prognosis. Although lesion size may not correlate with severity of clinical presentation, larger lesions in the same vascular area are often associated with more severe damage than smaller lesions in similar locations. MR can also be very effective in ruling out hemorrhage, pinpointing the location of the thrombus and determining whether there is a collateral flow to the affected region of the brain. Tissue

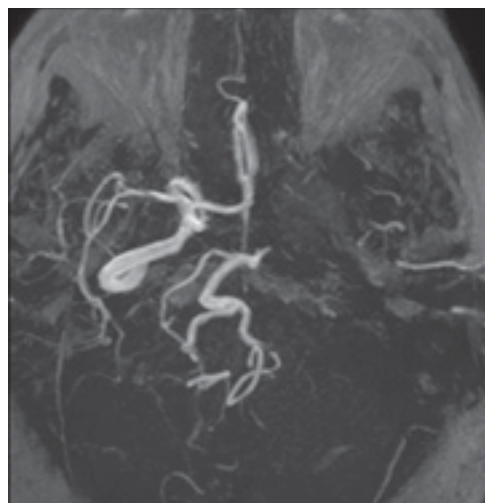
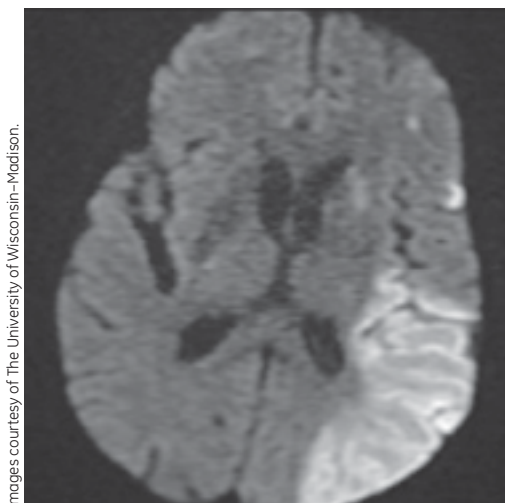
viability assessment provided by MR may be the basis for a decision whether the patient would benefit from an intervention.

MR can also rule out seizures and other conditions that mimic stroke. Of the 200,000 to 500,000 people in the U.S. who are diagnosed with a TIA, 20 percent have a chance of suffering a full-blown stroke within four weeks. Studies show that in 2006, less than one percent of patients who presented with TIA received tPA, primarily due to delayed treatment and/or diagnosis; fifteen percent of full-blown strokes were preceded by TIAs.

According to the UK's Stroke Strategy, if just 10 percent of acute stroke patients receive tPA at the onset of their neurological event, more than 1,000 patients every year would experience full recovery, preventing severe neurological damage and dependence.

Fortunately, medical and technological advances have made it possible to see what happens when someone experiences a stroke and provide treatment options for restoring blood flow and improving brain function.

TIA and stroke must be treated as medical emergencies to promote optimal treatment and maximize a person's chances for survival and independent living following a stroke. Including MRI as an integral part of an interdisciplinary emergency room team can save lives by enabling clinicians to quickly and effectively diagnose, assess and treat stroke and TIA at its onset – when it can make the most difference. ■



Images courtesy of The University of Wisconsin-Madison.

The DWI image (left) of the acute stroke patient shows large infarcted area in the left posterior cortex as well as some lesions in the white matter. 3D Time of Flight image of Circle of Willis shows dramatically reduced blood flow.

Non-Contrast MR Arthrograms Generate Exquisite Images

The advantages of fully-balanced gradient echo techniques (b-SSFP, b-FFE, FIESTA, true-FISP, etc.) have been well established over the past several years. Fully balanced pulse sequences result in all of the gradient moments being integrated to zero over the TR. This provides a high Signal-to-Noise Ratio (SNR) per unit time and an excellent Contrast-to-Noise ratio (CNR). However, due to the lower ratio of T2/T1, the soft tissue contrast provided by b-SSFP techniques is only suitable for several specific clinical applications.

In any balanced acquisition, after the initial RF pulse the MR signal tends to fluctuate or “oscillate” during the transition to a steady-state period. Without special preparatory sequences, the period of signal oscillation is quite long and requires a number of “dummy” RF pulses to occur before imaging can be achieved. These dummy pulses are designed to make the signal “settle”. Recent developments in variable RF flip angle preparation schemes have resulted in much shorter transitions to this steady-state period, ultimately leading to more efficient imaging.

Instead of ignoring this transition or oscillatory period, 3D COSMIC™ (Coherent Oscillatory State acquisition for the Manipulation of Image Contrast) exploits the unique properties of the MR signal evolution in order to generate the desired soft-tissue contrast. During this initial period, soft tissue exhibits an elevated T2/T1 signal component, which can be captured to yield a high CNR of those structures. To minimize ghosting and blurring artifacts, the unique variable-flip angle RF pulse train is used at the beginning of each segment to minimize the signal oscillations that would otherwise occur during the transition period (Figure 1).





Figure 1. Pulse sequence timing for a 3D COSMIC acquisition. The RF prep and RF post segments improve the oscillatory signal state while the recovery period aids SNR by allowing recovery of the longitudinal magnetization.

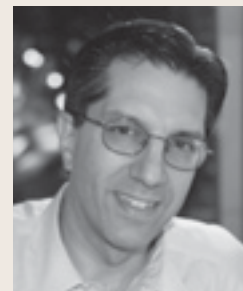
This results in maximized T2/T1 contrast from the soft tissues. Following this short preparation sequence, the image data is acquired. The data acquisition occurs while the signal is transitioning to steady-state. 3D COSMIC™ uses segmented centric ordering to capture the majority of the unique signal properties within the center of k-space. A true elliptical sampling of the k-space data is used where the corners of the k-space volume are zero-filled outside of a given k-space radius. This saves time – approximately 30 percent – and minimizes aliasing artifacts while maximizing image resolution.

To further improve the signal stability, a separate variable-flip angle RF pulse train is used following the acquisition period. Additionally, a recovery period is used to allow the longitudinal magnetization time to recover between segments, thereby improving SNR.

A. Joseph Borelli, Jr., MD, uses 3D COSMIC for arthrography studies. Dr. Borelli notes several benefits of the sequence, including:

- Short scan times of two to three minutes;
- High through-plane resolution, typically 2.0 mm zipped to 1.0 mm;
- High in-plane resolution (500-800 microns);
- Inherent high SI of joint fluid, making the use of gadolinium contrast unnecessary; and
- Insensitivity to vascular pulsation artifacts.

The following images from Dr. Borelli depict the excellent soft tissue visualization capabilities of 3D COSMIC without the use of gadolinium contrast. ■



Dr. A. Joseph Borelli, Jr.

A. Joseph Borelli, Jr., MD, is President and Medical Director of MRI at Belfair, LLC, in Bluffton, SC. He has developed MRI facilities in the northeastern and southeastern US. He also served as Assistant Clinical Professor of Radiology at the Medical University of South Carolina.

Dr. Borelli received a BA in chemistry at the University of Pennsylvania. He attended Hahnemann University School of Medicine in Philadelphia. He completed his residency at the University of Oklahoma Health Sciences Center and his MRI fellowship at the University of Pittsburgh Medical Center. Dr. Borelli is chairman of the American College of Radiology's committee on MRI accreditation.

Images courtesy of Belfair LLC.

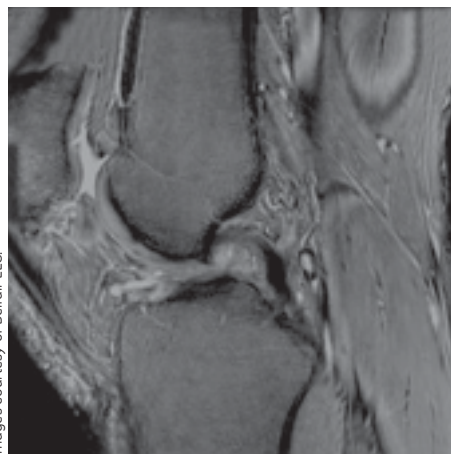


Figure 2. Note the extremely high SI of joint fluid, highlighting Grade 3 patellar chondromalacia.

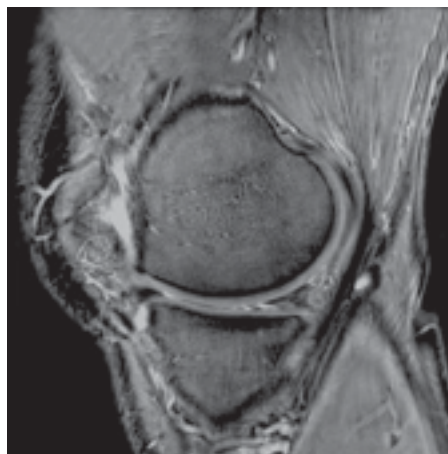


Figure 3. Exquisite demonstration of complex meniscal pathology, which cannot be viewed with a typical three to four mm slice thickness.



Figure 4. Note the beautiful arthrographic effect in the wrist, showing intact scapholunate and lunotriquetral ligaments.




Future Directions for 7.0T Human MR Systems

By Douglas A. C. Kelley, PhD, Applied Science Lab, GE Healthcare

The primary motivation behind higher field MR systems is elevated intrinsic signal to noise ratio (SNR), which increases slightly less than linearly with field strength – nearly doubling from 1.5T to 3.0T, and more than doubling again from 3.0T to 7.0T. (7.0T systems are only available for investigational use.) Higher SNR allows greater sensitivity to magnetic susceptibility.

Nearly all tissues in the body are slightly diamagnetic, although there is some dispersion in the magnetic susceptibility (over a range of roughly 3-4 parts per million). This susceptibility can even change due to changes in iron metabolism, or accumulation of blood products. While the variation is small, it does scale linearly with field strength, and the effects are quite remarkable at 7.0T. Methods to extract the effects of susceptibility variations on the phase of the MR signal provide remarkable tissue definition, may allow differentiation between calcification and hemorrhage, and help identify venous vasculature – all of which suggest strong potential, in among other things, characterizing multiple sclerosis and other neurodegenerative disorders.

Another area where clear benefits have been demonstrated from higher field strengths is parallel imaging. As the RF fields within tissue become more complicated due to the competing effects of conduction currents (resistive losses which shield the tissue) and displacement currents (dielectric effects which enhance the field in the tissue), the fields from individual array elements become more unique, reducing the noise amplification factors when data from these elements are combined to produce the final image. The additional benefits from parallel imaging include faster acquisition, better magnetization preservation and reduced power deposition, all of which can improve existing imaging techniques.

Challenges

Higher field strengths bring both engineering and physical challenges to MR systems. Most obvious is the cost and complexity of the magnet and its siting.

RF uniformity remains another significant challenge for many applications, and represents the single biggest impediment to body applications. The RF field within the tissue is dependent not just upon the design of the coil, but the characteristics of the tissue itself – primarily its conductivity and permittivity. Competition between these effects produces the characteristic center brightening in high field images. Furthermore, as more RF power is generally required to produce a needed flip angle, the SAR limit will be reached faster.

A third class of problems concerns B0 homogeneity. Most tissues are weakly diamagnetic, and as the field strength increases, the static field distortion produced by the tissue itself becomes significant. Further, since the distortions are produced by the tissue, if the tissue moves due to breathing, for example, the distortions will change over time, making compensation very difficult and introducing ghosting and other distortions that must be corrected.

Conclusion

While 7.0T systems have demonstrated their potential quite clearly, bringing this technology to clinical applications requires overcoming technology maturity, regulatory, safety and economic barriers. As research continues to move from technical questions (MR physics and engineering) to biological questions – for example using these tools to understand the aging processes in the brain and musculoskeletal system – clinical applications of this technology will surely follow in areas where the barriers to entry can be cleared. However, broader clinical utilization of the technology must rely on techniques that, while superior at the higher field strength, with engineering improvements can also be pursued at lower field strengths, and also any breakthroughs that may appear from biologically-focused research studies. ■

***For the full white paper on 7.0T, visit www.gehealthcare.com/signapulse.**

Acknowledgements

The author is pleased to acknowledge many helpful discussions with Sarah Nelson, Dan Vigneron, Sharmila Majumdar, Duan Xu, Cornelius von Morze, Partik Mukherjee, Chris Hess and Derk Purcell of UCSF; and John Schenck of the GE Global Research Center.



Cardiac Tamponade – an MR Imaging Challenge?

By Stuart Clarkson, Americas 3.0T Marketing Manager

Cardiac tamponade is the accumulation of fluid in the pericardium, or the membranous sac enclosing the heart. The increase in pericardial pressure places significant pressure on the heart, and causes a decrease in diastolic filling of the ventricles. This leads to a reduction in stroke volume (quantity of blood ejected from the heart with each heartbeat) and results in ineffective pumping of blood, followed by shock and often death.

While MRI is rarely a primary diagnostic test for cardiac tamponade, the continued increase in Cardiac MR (CMR) procedures require that clinicians and technologists be able to diagnose this life-threatening condition if or when it arises.

Causes

Cardiac tamponade is caused by either a large or uncontrolled pericardial effusion, or the buildup of fluid inside the pericardium.¹ Fluid within the pericardium may be caused by myocardial rupture, cancer, uremia, pericarditis or cardiac surgery.² Cardiac tamponade occurs when the pericardial space fills up with fluid faster than the pericardial sac can stretch. If the amount of fluid increases slowly (such as in hypothyroidism), the pericardial sac can expand to contain a liter or more of fluid prior to tamponade occurring. If the fluid collection occurs rapidly (as it may after trauma or myocardial rupture), as little as 100 ml may cause tamponade.³ The fluid is often blood, but pus is also found in some instances.²

Diagnosis

There are a number of differential clinical scenarios that make the initial diagnosis challenging.

Classic cardiac tamponade presents three signs, known as Beck's triad.

1. Rising jugular venous pressure evidenced by distended jugular veins while in a nonsupine position. This is caused by reduced filling of the right ventricle, due to the outside pressure exerted by the expanding pericardial sac.
2. Fall in systolic pressure, which results when the fluid in the pericardial cavity accumulates to a degree that it impairs ventricular filling, thus reducing stroke volume and cardiac output.
3. Suppressed heart sounds that occur due to the muffling effects of sound passing through the fluid surrounding the heart.

Tamponade can be diagnosed radiographically. In 1983, Gillam et al described the collapse of the right atria as a sign of cardiac tamponade.⁴ While MR scanning would rarely be the primary modality for imaging a case of suspected tamponade, this pathology should be excluded when a pericardial effusion is present and the patient is in the scanner.

Until recent improvements in the real-time capabilities of MR scanners, gated imaging was required. Pericardial effusions are easily detectable with gated cardiac images. However, any gated scan requires that the heart be in the same position from one heartbeat to the next. If a transient heart wall



Images courtesy of Advanced Cardiovascular Imaging, New York.

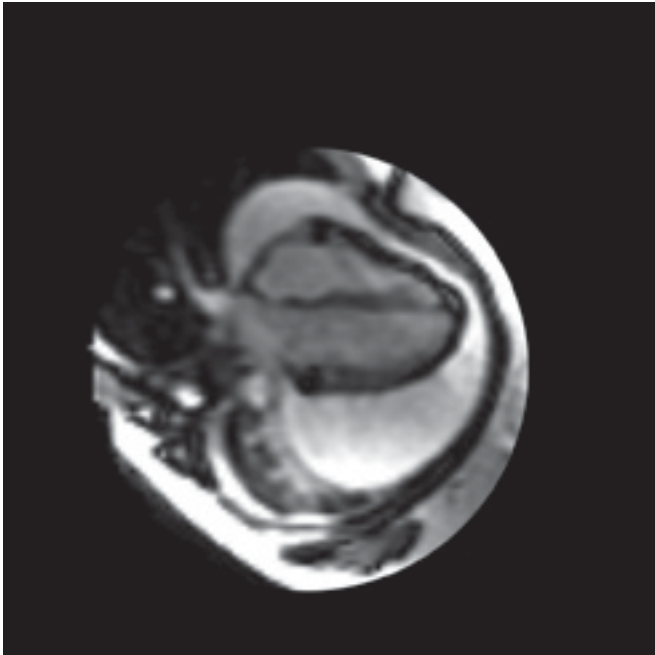


Figure 1. Blood in pericardial sac.

collapse occurs during the scan, it would likely be missed as it would be averaged out over many heartbeats. True real-time imaging with acquisition times of 60 to 80 ms enables capture of the heart walls and any potential transient collapse to confirm diagnosis. The implementation of cardiac real-time imaging on GE Signa® HDxt MR scanners is possible with the real-time MR Echo™ application, which includes the required pulse sequence and an interface designed specifically for cardiac imaging.



Figure 3. Pericardiocentesis on simulator model.

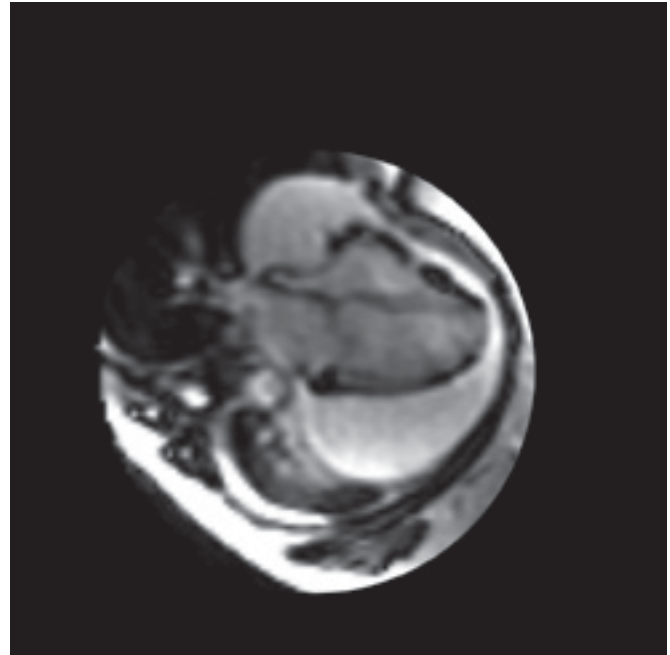


Figure 2. Four-chamber view of heart in expiration and inspiration taken during a nongated, free-breathing scan.

Treatment

Cardiac tamponade is an emergency condition that requires hospitalization. To save the patient's life, improve heart function and relieve symptoms, clinicians may perform pericardiocentesis, the draining of fluid around the heart by cutting or removing part of the pericardium (pericardial window).

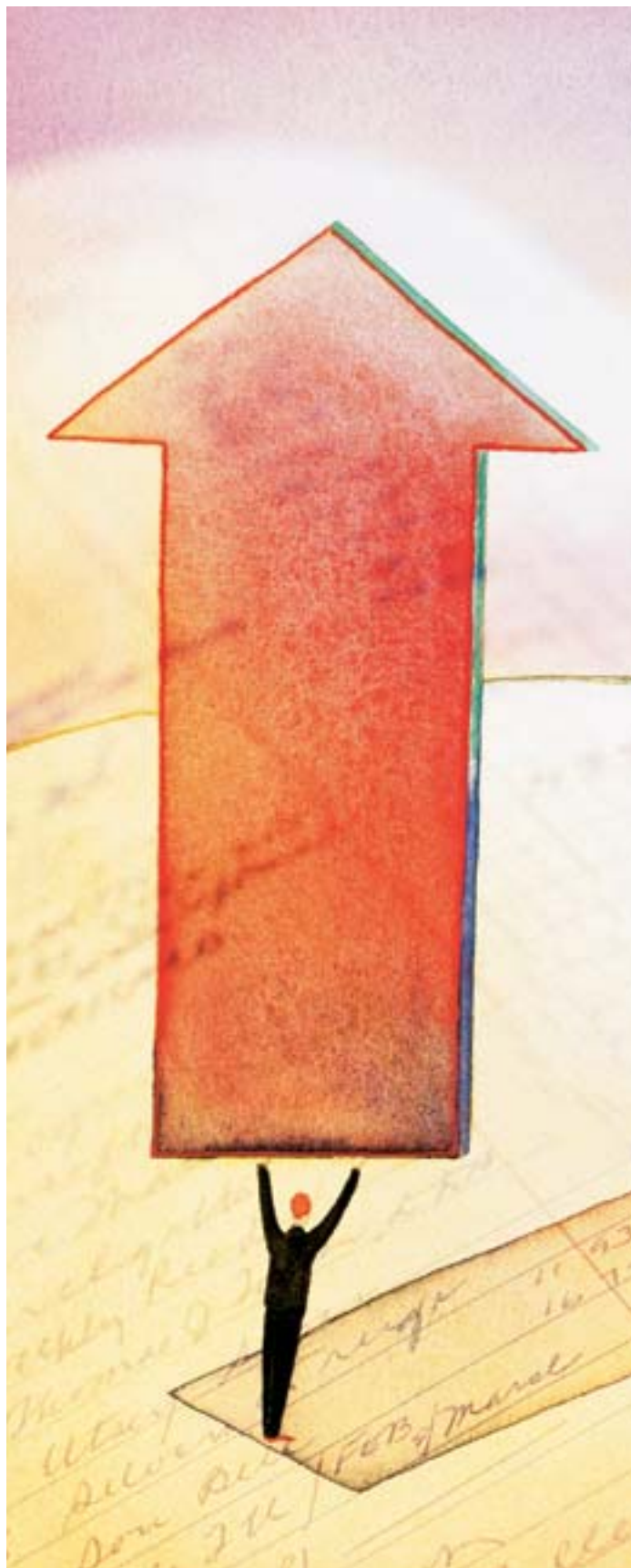
The cause of the tamponade must also be identified and treated with the use of medications, such as antibiotics, and surgical repair of injury.

Summary

Clinicians and technologists can quickly identify cardiac tamponade during an MR examination, and therefore can hasten treatment of this life-threatening medical condition. Recent advances in MR technology enable rapid scan times (60-80 ms) that freeze cardiac motion, enabling visualization of the heart without gating or patient breath hold. ■

References:

- 1) Thibodeau, G.A., Patton, K.T. Anatomy & Physiology. Missouri: Mosby, 2003.
- 2) Mattson Porth, C. (Ed). Pathophysiology: Concepts of Altered Health States, 7th Edition. Philadelphia: Lippincott Williams & Wilkins, 2005.
- 3) Fornauer, Andrew; Dasika, Narasimham L., Gemmete, Joseph J., Theoharis, Constantine. Pericardial tamponade complicating central venous interventions. J Vasc Intervent Radiol, Spring 2003. OR: Fornauer, Andrew, et al. Pericardial tamponade complicating central venous interventions. J Vasc Intervent Radiol, Spring 2003.
- 4) Gillam, Linda D., et al. Hydrodynamic compression of the right atrium: a new echocardiographic sign of cardiac tamponade. Circulation 68, No. 2, 294-301, 1983.



Magnify Your MR Potential

Investigate an evidence-based approach to understanding your MR market

Magnetic resonance imaging continues to expand with changing demographics, technology advances and rising consumer needs. According to The Advisory Board Company, this trend should continue. By 2010, it is estimated that 10.4 million outpatient MR procedures will be performed in the United States, with a 10-year CAGR of five percent. One of the fastest growing MR procedures is expected to be breast MRI, with a projected volume of one million procedures in 2010, up from 130,000 in 2005. This represents a ten-fold increase, or four percent of total MR procedures.

Roughly 38 percent of U.S. hospitals lack their own MRI machines, while only 10 percent do not have CT (computed tomography) equipment. Not having access to an MRI through a local hospital can create accessibility issues for the community and often require patients to travel long distances outside their communities for care.

To help hospitals assess their market readiness for a new MR system, GE Healthcare's Performance Solutions developed a comprehensive and data-driven approach. Using reliable market intelligence sources, Performance Solutions helps clients answer a frequently asked question: Is there a business case for investing in a new MR system based on valid market and feasibility studies?

Finding the right answer begins with a deeper understanding of the hospital's existing market and potential opportunities. The Performance Solutions team works closely with their hospital partners to develop a market assessment for MR that reviews four major areas: market, financial, operational readiness and MR installation and training.



Market assessment case profile

An academic medical center in the Northeast began to evaluate plans to augment their existing infrastructure with additional MRI technology. The hospital's leadership team wanted to better understand their current MR market and potential for growth. Before adding a major imaging system, they also wanted to assess their operational readiness from an access and service standpoint.

Through a focused consulting engagement with GE Healthcare's Performance Solutions, the hospital found their primary market was growing at 39 percent annually, with 58 percent MR market share. Performance Solutions helped analyze the hospital's primary and secondary service areas to assess the current market share and projected MRI growth patterns.

The main deliverables for the project included:

- Market analysis of outpatient MR volumes and trends;
- Analysis of local MR procedure mix and growth;
- Competitive and saturation analysis;
- Interviews with the top referring physicians;
- MR backlog assessment;
- MR "no show" assessment;
- Report turnaround times analysis;
- MR capacity and utilization analysis; and
- Financial model.

The operational analysis looked at current MR systems at both the main hospital and ambulatory locations. Analysis revealed an opportunity to improve current patient flow through radiology, as well as an urgent need to reduce no shows and backlog to acceptable levels, creating more capacity and avoiding lost revenues.

A market analysis of the proposed new MR location revealed that MRI procedures were expected to grow 38 percent over the next five years to approximately 14,400. Breast MRI's were expected to double, growing 98 percent over the next five years. In 2007, the hospital had an estimated 65 percent MR market share in the proposed new location (or almost 10,000 procedures). The capacity to capture 30 percent or more of the 4,000 procedure growth over the next five years, while maintaining the current 65 percent market share, led to the conclusion that the market is robust enough to support a new MRI system in that location.

As a result of the project, the hospital was projected to increase its MR market share by five percent, representing an estimated \$800,000 in additional revenue based on a utilization assumption of 75 percent. As part of the MR assessment, the Performance Solutions team reported that 75 percent of physicians interviewed said they would refer patients to the proposed new MR location.

"With GE's help, I was able to take a detailed look at market trends and our potential return on investment for the new MR technology we planned to purchase," says the physician executive in charge of leading this effort for the hospital. "The assessment process helped us to understand how much of the market we would need to capture in order to make this a profitable venture. We were also able to get some valuable assistance on the operational side. We found we could improve the implementation process by taking an early, proactive approach and focusing on the opportunity to streamline patient flow and reduce backlog for MR procedures." ■

"With GE's help ... we could improve the implementation process by taking an early, proactive approach and focusing on the opportunity to streamline patient flow and reduce backlog for MR procedures."



Online MR Marketing Tools Now Available

Savvy materials can be targeted and customized

When Watertown Memorial Hospital planned an open house for a new hospital wing with an O.R. and MR suite, Mike Hayhoe, Director of Radiology, didn't have to reinvent the wheel for promotional materials.

Thanks to GE Healthcare's new MR marketing tools program, which is now conveniently available online, he was armed with savvy marketing and press materials to create awareness of the facility's new Signa® HDx 1.5T MR scanner.





"GE's marketing tools are fabulous," Hayhoe says. "I have an entire arsenal of materials and resources with targeted messaging for patients and referring physicians." He used posters and press releases from GE to generate awareness of the open house throughout the community. The result: Watertown Memorial had three times the expected turnout.

For Hayhoe, the value extends beyond the materials. "I don't have to worry about developing creative, obtaining licensing rights or generating scans – it's all included," he says. "This is a resource that any hospital, no matter the size, can use to its advantage."

Materials specific to each system

Recognizing that most healthcare facilities engage in marketing and advertising, GE provides a vast assortment of PR and marketing tools for customers to market their MR system to their referring physicians, communities and patients.

Tools are designed to build awareness and drive patient volume – without the time and big-budget investment needed to create marketing tools from scratch. All marketing and PR materials are available in high-resolution, print-ready formats and ready to use as-is. They can also be customized with customer logos and branding.

Marketing and press materials

Target referring physicians and patients with customizable, print-ready marketing materials.

- Patient brochures
- Print ads
- Billboards
- Web banner ads
- Posters
- Referring physician direct mailers, postcards, letters and e-mails
- Event invitations
- Posters

Introduce your new GE technology and services to the community through local media.

- Product fact sheet
- Customizable press release

Images

An extensive library of high-resolution system and clinical images is also included. All materials are available to GE MR customers at no cost via a proprietary Web site for quick and easy access. The site also includes a Knowledge Center with how-to guides, basic marketing tips and more to help customers get the most from their marketing and PR materials.

"Our own community didn't know the high level of advanced technology that we can now offer," Hayhoe adds. For this 95-bed hospital, informing referring physicians that their patients don't have to travel to Milwaukee, Madison or Chicago for the latest MR technology is crucial for maximizing equipment utilization.

Next on his marketing to-do list is promoting the Signa® HDx for breast and cardiac imaging to referring physicians by utilizing direct mail postcards. "We are also going to try the slick scheduling cards for patients." Beyond creating awareness, Hayhoe firmly believes these tools can make an impact on increasing volume and maximizing MR utilization. "There is a lot of great value to these marketing and press materials, and so much more that we can do with them."

To find out more about how you can access marketing and PR materials online to announce and market your new GE MR system, contact your local GE sales representative. ■

"GE's marketing tools are fabulous. I have an entire arsenal of materials and resources with targeted messaging for patients and referring physicians."

Mike Hayhoe, Director of Radiology



If you want new MR technology that means a new scanner, right? Wrong! Leverage your initial investment and save time and money with the MR Continuum from GE Healthcare.

The Dirty Little Secret about Your Scanner





With the speed at which new technology is being developed today, it can make one's head spin when it comes to purchasing decisions. And often, it comes with the sad acknowledgement that the purchase will be repeated all too soon if you want to stay current. But here's something you may not know or may have forgotten: Your GE scanner that was bought years ago is closer to being state-of-the-art than you may think.

Celebrating its 25th year of providing affordable means to update technology to existing MR systems, the Continuum program by GE Healthcare continues to be the only program today that provides the Flexibility to bring your existing MR to the latest technology at nearly any point in the product life. And since GE magnets are built to last, it's more affordable than you may realize – eliminating expense for reconstruction.

Easy. Painless. And sometimes free-of-charge.

While you may think that any upgrade is a tiring affair that means extended downtime and department disruption, think again. With the entire process completed in as little as a few days to two weeks for extensive upgrades, GE customers can achieve state-of-the-art, leadership technology that can grow patient volumes or achieve a competitive advantage.

And don't forget the ContinuumPak, the no-additional-charge program that provides software enhancements to customers. You don't have to send in a thing to take advantage of it. We'll bring it to you.

What's in it for me?

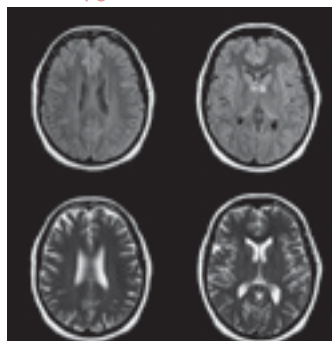
It may be difficult to think how your 17-year-old Signa® LX scanner can be state-of-the-art. But it's true. You can upgrade to the Signa HDxt – and wrap an entirely new system around your current magnet to experience:

- Enhanced image quality on every scan;
- Up to 50 percent faster end-to-end exam times;
- Expanded clinical capabilities with an exceptional portfolio of advanced applications;
- Greater consistency with fewer errors and rescans; and
- Faster exam set-up and execution.

So before you think of replacing your magnet, think twice. Your MR scanner is ready for the next chapter in today's technology – and for a lot less of an investment. ■

Before Upgrade

Ax FLAIR
18 slice
256x224
4:10 min

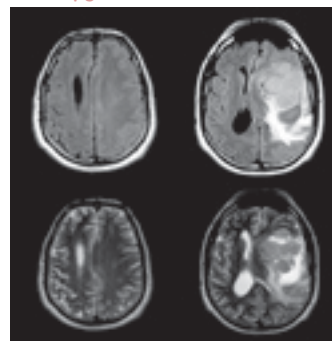


15:01 min

Ax T2
18 slice
320x320
3:51 min

After Upgrade

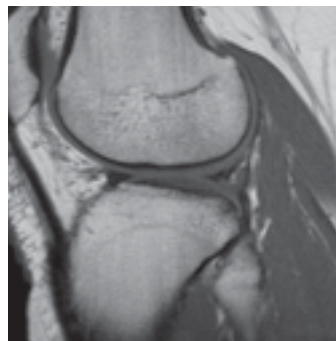
Ax FLAIR
18 slice
256x128
0:56 min



2:15 min

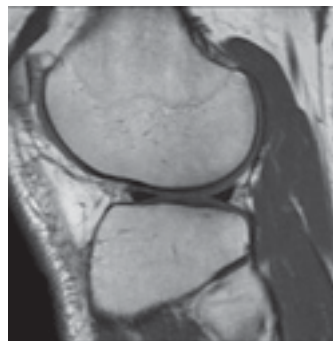
Ax T2
18 slice
384x224
0:38 min

Before Upgrade



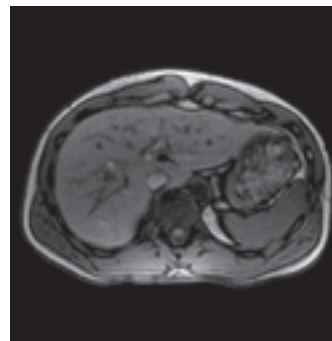
T1, 20 slices, 320x224, 3:41 min

After Upgrade



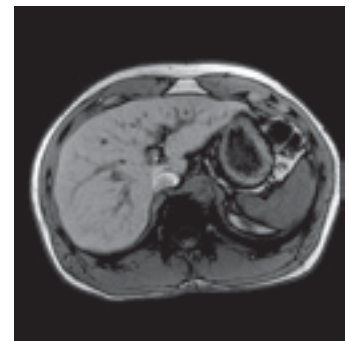
T1, 20 slices, 416x256, 1:02 min

Before Upgrade



Axial SSFSE, 21 slices,
256x224, 0:21 min

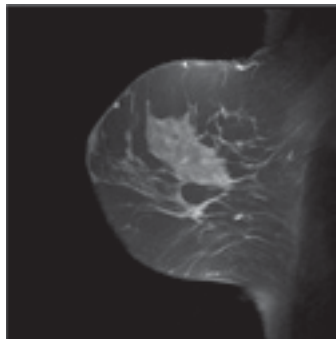
After Upgrade



Axial SSFSE, 23 slices,
384x224, 0:17 min

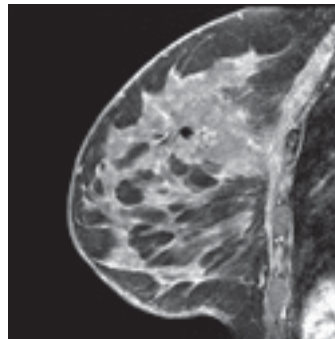
Breast

Before Upgrade



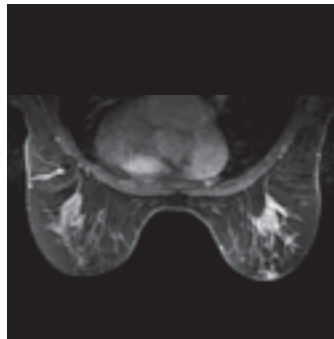
LX 4-channel breast array

After Upgrade



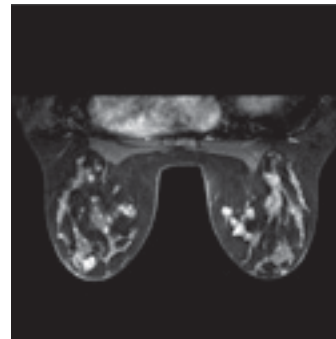
HDxt VIBRANT™ 8-channel coil

Before Upgrade



LX 4-channel breast array

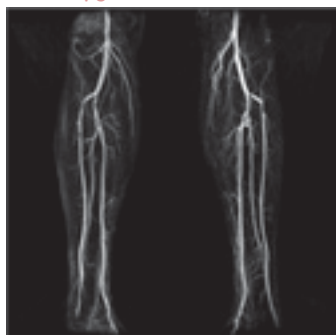
After Upgrade



HDxt VIBRANT 8-channel breast array

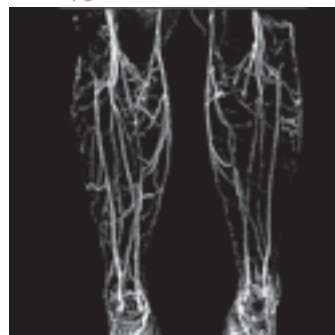
MR Angiography

Before Upgrade



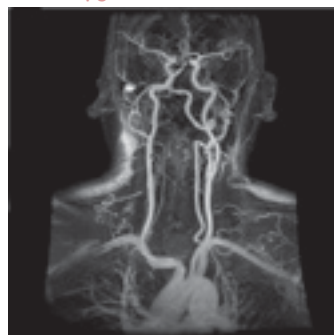
MR Angiography – runoff

After Upgrade



MR Angiography – TRICKS™ runoff

Before Upgrade



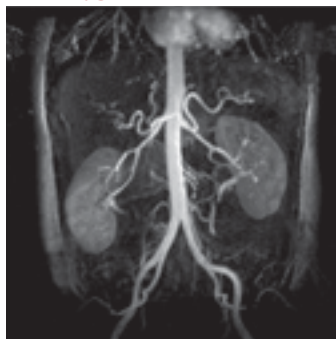
3D ToF

After Upgrade



3D ToF

Before Upgrade



LX

After Upgrade



LAVA



What Our Customers Say

We know the upgrade process
is smooth and a good investment.
But don't take our word for it.

After installing a Signa® LXI in March, 2001 and going through several software upgrades, Diagnostic Health of Weston, Fla., took the leap to the HDxt software in November 2006. "The upgrade went as smoothly as we could have imagined," says Caryn J. Nolen, RT, Clinical Coordinator. "We rented a mobile GE LXI 9.0 MR while upgrading to HDxt, and we maintained our volume and had no down time."

Prior to the HDxt upgrade, Diagnostic Health's maximum patient volume was 12 patients in a 12-hour day. "Our image quality immediately improved, while scan times decreased by approximately 40 percent," adds Nolan. Today, the center scans up to 20 patients each day, exceeding their own projected volume.

Improvements were obvious. According to Nolan, patients comment on how quick their scan is in comparison to scans at other facilities. And, she says, referring physicians prefer the higher image quality resulting from the upgrade to Signa HDxt. "We increased throughput without decreasing image quality to dramatically improve our bottom line."

For Dick Kelly, chief MRI technologist at Exemplar Lutheran Medical Center in Wheat Ridge, Colo., the upgrade of a Signa LX 9.1 to a Signa HDxt translated to improved patient throughput, scanning efficiency

and image quality. "The improved exam throughput is a patient satisfier and allows us to add several extra exams each day without compromising image quality or patient care."

As a result of the upgrade, Exemplar Lutheran could add several new advanced imaging sequences, such as TRICKS™ for vascular and VIBRANT™ for breast imaging. "With its ease of use, we never miss or repeat a contrast-enhanced MRA exam," Kelly adds. "Plus, TRICKS provides our physicians with superb quality images and physiological information that adds diagnostic value to the study."

"TRICKS lets us reduce contrast dose on MRA exams, which is beneficial in lowering costs, but more importantly, reduces a patient's chance of developing Nephrogenic Systemic Fibrosis (NSF)."

According to Kelly, VIBRANT has opened a new service line for the surrounding community. "VIBRANT gives the ability to individually fat sat each breast, plus the added capability to scan bilateral sagittal or bilateral axial breasts, which has significantly improved our breast imaging program."



Your Facility Transformed Into Virtual Classrooms

The Three Rs: Reduce Costs; Retain Staff; Recruit Stars

Picture this: A staff member asks to take a course called Fast Imaging Techniques. In the past, it was an expensive, inefficient use of time to send the employee to a class outside of your facility. You might have made the hard decision to not grant this request, and others like it – possibly affecting your ability to retain solid employees.

Welcome Training in Partnership Television™ (TiP-TV), an opportunity to provide your staff with continuing education inside your facility – making it less expensive, simple and convenient to fulfill their requirements. Your team will have peace of mind knowing their employer cares about the next steps in their education.

Online or on the tube

Launched in 1993 as a satellite network, TiP-TV now provides distance education to imaging technologists, clinicians and administrators via satellite and the Internet. Offerings include clinical, technical service, patient and leadership education.

Satellite broadcasts are aired live each week through a designated TV channel at your facility and can be taped for later viewing. The programs are also available online at GE's Education Web Site: www.gehealthcare.com/us/en/education/index.html.

TiP-TV offers more than 100 courses that are accredited by a variety of organizations and presented by "best in class" clinical educators. Whether your staff views programs via satellite or online, the Healthcare Learning System web portal is the place to:

- Take courses to earn continuing education credit;
- Print a certificate immediately after successful completion; and
- Create a personal training report.

"The RNs, LPNs, techs, physicians – we're all able to view the same [TiP-TV] material at our convenience so that we have the same knowledge base and it helps us move forward as a team."

Harold Duke, MD



“TiP-TV makes us aware of what is going on and keeps us really cutting edge.”

*Debbie Wojnar
CT Coordinator*

The balancing act

It can be difficult to balance day-to-day productivity and patient care with the amount of continuing education requested by your staff. TiP-TV provides these benefits:

- Training costs are reduced, as your TVs and computers are used as “virtual classrooms.” Access to the courses in your facility helps staff members make the most efficient use of their time.
- There is no limit on the number of employees who are eligible or the number of credits that can be earned.
- Not only can TiP-TV help retain staff, it can assist with recruiting new stars, as well. It’s a smart investment that demonstrates your facility’s commitment to ongoing learning.
- A unique variety of cutting-edge content – not available from any other single source – is part of the TiP-TV package. Programs feature best practices based on real-world applications and the latest research.
- The courses are approved for continuing education through organizations such as the ASRT, SDMS and SNM.
- A leadership education series, designed for leaders of diagnostic imaging departments, focuses on the challenging issues confronting today’s imaging department directors, administrators, supervisors and other team leaders.

TiP-TV is available by a subscription purchased either through a GE Service Contract or through a stand-alone subscription. Please contact GE Healthcare at **877 438 4788** or geeducation@med.ge.com for more information. For course listings, samples, customer testimonials and more, visit: www.gehealthcare.com/education.

GE Healthcare is dedicated to helping your staff gain the knowledge and skills to optimize equipment usage, clinical practice and patient care. TiP-TV makes getting that training a whole lot easier. ■

MR TiP-TV

MR: ACR Accreditation Update

MR: Breast Imaging in High-Risk Patients

MR: Cardiac MR Imaging

MR: Fast Imaging Techniques

MR: Newshour 2007

MR: Understanding MR Coil Technology

MR: What Is Diffusion Tensor Imaging?

“TiP-TV is an invaluable resource, not only for studying new technology but for the continuing education.”

*John Dolan
Manager of Medical Imaging*

Quality and safety network

Developed by Joint Commission Resources, the Quality & Safety Network delivers the tools to strengthen the quality of your patient care initiatives. This twelve-program series offers timely solutions through proactive strategies and practical tactics to protect your patients, staff and hospital.

This series is available as a separate subscription offering. To learn more, please visit www.jcrqsn.com or contact TiP-TV customer service at **877 438 4788**.



Think Beyond. Stay Ahead.

With the rapid changes in today's outpatient imaging market, it's never been more important to think outside the box.

Keeping current on the trends affecting the outpatient imaging market is a challenge. You've got a broad spectrum of considerations to run a viable business and fulfill on your commitment of excellence to your patients. Meeting your patients' varying needs, marketing effectively to physician referrers and your community, optimizing scheduling and work flow, maximizing your internal capabilities and managing staffing considerations are only a few of the many key factors that need to be addressed.

But here's the good news: you don't have to do it alone.

In a move to answer the growing needs of outpatient imaging centers, GE Healthcare is pleased to present Beyond™, an innovative, interactive program designed especially for outpatient imaging centers who wish to take their initiatives to the next level. In other words, if you've ever wondered if there was a program that was specifically designed with your success in mind that can provide you with targeted information and tools you need and can put to immediate use to maximize potential and save costs – your day has come.

Providing a vast and evolving array of tools and resources specific to your clinical and business needs, the Beyond program is taking outpatient imaging to a whole new level.





"Beyond™ has been instrumental in helping Advocate Ambulatory Services define and develop our division in these early phases and I'm pleased with your team's involvement," states George Lesmes, PhD, COO, Ambulatory Outpatient Division, Advocate Healthcare, which is recognized as a leading integrated healthcare delivery network in the U.S. and services communities in northern Illinois. "Your insight in developing the infrastructure and the collaborative vision for the division has helped us to develop early collaborative gains."

The Beyond success stories are diverse and powerful. Each one demonstrates the program's unique ability to provide tailored solutions to complex outpatient imaging challenges. Metropolitan Diagnostics of Garden City, New York saved \$500,000 over a three-year telecom contract. Advanced Radiology, the largest imaging provider in Maryland, which provides services to six Baltimore-area hospitals and 21 outpatient centers, saved \$280,000 over a three-year energy agreement. And Hialeah Hospital, a 378-bed acute-care facility, was able to accelerate the installation of a Trane MRI chiller by 33 percent (or two months) with intervention and preferred service prioritization.

How does it work? Working on the notion that it doesn't pay to have to reinvent the wheel, GE Healthcare reached out and opened its vast network of trusted associates to create a one-stop resource that is accessible exclusively to Beyond members. This new network offers valuable solutions and access to over 50 product and service suppliers across a variety of categories, including expert strategic advice, extensive resources critical to any phase of the outpatient imaging center business and allows users to gather information on anything from design and construction to finance, marketing and reimbursement.

The program also was designed with user-friendly, specific features to help members hit the ground running.

- *Ask an Expert.* Whether you need help managing your business, are looking for ideas or simply want your voice to be heard, Beyond has experts on call for you. *Ask an Expert* provides your outpatient imaging center with new, innovative ways to get connected with knowledgeable imaging professionals in the field.
- *Custom Inquiries.* Investigating resources and finding assistance for your business needs can be costly and time consuming. *Custom Inquiries* provides you with an efficient, detailed overview of your resource landscape. The GE team will review your requests for support and offer you a relevant and timely overview of available industry resources.
- *Medcyclopaedia.* To ensure you have direct access to the most accurate information – from the right sources, in the right format – GE has brought together international leaders across several fields of diagnostic and therapeutic medicine to develop *Medcyclopaedia*, a unique combination of a scientific library, virtual classroom, and a handy toolbox.

It doesn't get much easier than this. Or more useful. So before you start thinking you have the world on your shoulders and no one is there to help, think of GE. Think Beyond. ■

For more information, visit www.gehealthcare.com/beyond or contact beyond@ge.com.

Meet the Experts and go BEYOND
at the Third Annual GE Healthcare
Outpatient Imaging Center Conference
in Washington, D.C.
July 23-25th
Visit gehealthcare.com/registration
for more information.



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3.0T and 1.5T Advanced MR Practicum

with Lawrence Tanenbaum, MD, FACR

Location and dates to be announced.

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Basic MR Physics:

Understanding and Applying

with Emanuel Kanal, MD, FACR

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Cardiovascular MR

with Steven Wolff, MD, PhD

New York, NY

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with Constance Lehman, MD, PhD

Seattle Cancer Care Alliance, Seattle, WA

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