GE Healthcare

SIGNA pulse

THE MAGAZINE OF MR • AUTUMN 2008

Contrast. Unplugged.

imagination at work

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Clinical Value

Issue Spotlight

Technical Innovation

Beyond the Scan

Welcome

It's hard to think we're at the close of yet another year. And what a year it has been! 2008 was anything but boring. The United States elected a new president, concern for the health of the global economy reached new levels, energy policies and green movements gained momentum – and that's just what's been in the mainstream media. Specific to our industry, we at GE Healthcare have had our own share of news that's packed with promise.

So before we welcome in 2009, I'd like to reflect on some of these exciting moments.

- **GE Healthcare welcomes John Dineen, CEO and President.** With 22 years of global experience across GE, John brings tremendous strength in technology, operations and global business leadership to the Healthcare team.
- **Breaking 3.0T boundaries with a new approach.** In May, we unveiled the Discovery™ MR750, a 3.0T scanner that enables radiologists to break the traditional boundaries of MR. The scanner was introduced to the world's most discriminating MR research community – ISMRM – with incredible fanfare.
- **Announcing the Discovery MR450.** While the Discovery MR750 generated tremendous excitement and advanced 3.0T imaging beyond our expectations, we strive to continue to meet the differing needs of our customers. That's why we're thrilled to add the most advanced technical and clinical innovations – complete with the world's strongest gradients – to the 1.5T field strength.
- **The first ecomagination product.** GE Healthcare announced the first "green" MR system – the Signa® HDe. This system can save up to $7,000 a year in energy costs. Considering the growing trend towards green hospitals, we're especially excited to offer this much needed technology. It's also fully upgradeable to our HDxt platform, and has a new suite of applications to uphold our Continuum promise for all GE customers.
- **Exclusive system to the 2008 Olympic Games.** The Signa HDe also had a strong presence at the Olympic Games, selected and purchased specifically for use in the Polyclinic on the world's best athletes.
- **Collaborating with brilliance.** In a time when everyone is pushing harder and faster to produce the next best answer for healthcare, together we have maintained the thought leadership in MR research. By collaborating with the brightest minds, we continue to push the envelope. Plus, the fact that GE again submitted the most papers for the 2008 ISMRM Annual Meeting is something of which we're especially proud.

James E. Davis

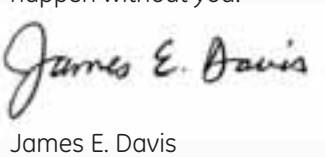
- **More solutions in non-contrast.** You've spoken, and we've responded. We now have more options for non-contrast imaging. We're thrilled to offer the Inhance Applications Suite, non-contrast applications that you can put to immediate use.
- **More advancements in neuro.** We're also pleased to announce SWAN – a fast, easy, mutli-echo acquisition technique that has promise of helping clinicians diagnose patients with ischemic and cerebral disease.

While I'm not a gambling man, I'd bet that these are the days when we will look back and think, "I was part of that." Because none of us can move the needle in magnetic resonance imaging alone – it takes a team bigger than any of us – to come together and make smart decisions and achieve industry leadership.

In addition, you'll start to see new products across the GE Healthcare diagnostic imaging portfolio with the Discovery, Optima, and Brivo brands – indicative of a new way we're committed to doing business.

Whether you're interested in the most advanced applications, trying to achieve maximum workflow and productivity, or looking for a distilled solution, we're here for you.

Yes, 2008 was exciting. And while I'd love to let the cat out of the bag and tell you all of the things we've got in the pipeline for 2009, let's just say that you won't be disappointed. The accomplishments in 2008 are only a taste of what's in store – because healthcare as we know it is evolving. And it couldn't happen without you.

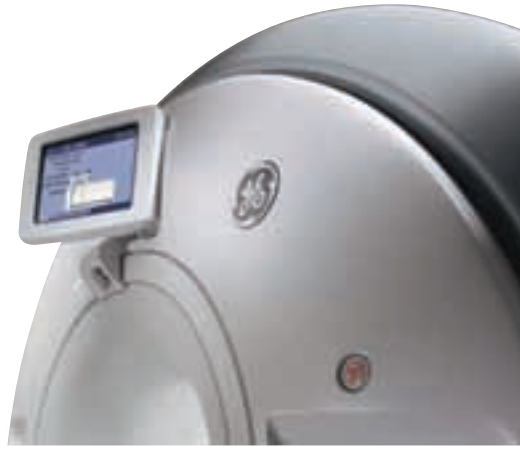


James E. Davis
Vice President and
General Manager,
Global MR Business
GE Healthcare

GE looks forward to seeing you at the following events in 2009.

Date	Conference	Site	City/State	Country	Web Link
Jan. 17 – 18	Society of Breast Imaging	Loews Santa Monica	Santa Monica, CA	USA	www.sbi-online.org
Jan. 29 – Feb. 1	Society for Cardiovascular Magnetic Resonance (SCMR)	Rosen Shingle Creek	Orlando, FL	USA	www.scmr.org
Feb. 15 – 20	Snowmass 2009: MRI in Clinical Practice	Snowmass Conference Center	Snowmass Village, CO	USA	www.educationalsymposia.com
Feb. 16 – 20	Harvard Medical School MRI 2009: Clinical Update and Practical Applications	Gran Melia Cancun	Cancun	Mexico	www.cme.hms.harvard.edu/index.asp
Feb. 25 – 27	American Society of Functional Neuroradiology (ASfNR)	Omni La Mansion Del Rio	San Antonio, TX	USA	www.asfnr.org
Feb. 25 – 28	American Academy of Orthopaedic Surgeons (AAOS)	Sands Expo Center & Venetian Hotel	Las Vegas, NV	USA	www.aaos.org
March 6 – 10	European Congress of Radiology 2009	Austria Center Vienna	Vienna	Austria	www.myesr.org
March 29 – 31	American College of Cardiology (ACC) 58th Annual Scientific Sessions	Orange County Convention Center	Orlando, FL	USA	www.acc.org
March 30 – April 1 March 30 – April 3	26th Annual MRI of the Head & Spine 2009 26th Annual MRI 2009	Encore™ at Wynn	Las Vegas, NV	USA	www.educationalsymposia.com
April 16 – 19	Annual Meeting of Japan Radiological Society & Japanese Society of Radiological Technology	Pacifico Yokohama	Yokohama Kanagawa	Japan	www.jrs68.com
April 18 – 24	ISMRM – 17th Scientific Meeting and Exhibition	Hawaii Convention Center	Honolulu, HI	USA	www.ismrm.org
April 21 – 25	Society of Pediatric Radiology (SPR)	La Costa Resort & Spa	Carlsbad, CA	USA	www.pedrad.org
April 25 – May 2	American Academy of Neurology (AAN)	Washington State Convention and Trade Center	Seattle, WA	USA	www.aan.com
April 26 – 29	The Breast Course	Radisson SAS Hotel	Nice	France	www.thebreastcourse.com
April 30 – May 3	France-Latin America Congress of Radiology 39th São Paulo Radiological Meeting	Transamerica Expo Center	São Paulo, SP	Brazil	www.spr.org.br/jpr2009
May 2 – 7	American Association of Neurological Surgeons (AANS)	San Diego Convention Center	San Diego, CA	USA	www.aans.org
May 16 – 21	American Society of Neuroradiology 47th Annual Meeting & NER Foundation Symposium 2009	Vancouver Convention & Exhibition Centre	Vancouver, BC	Canada	www.asnr.org
May 29 – June 2	American Society of Clinical Oncology (ASCO)	Orange County Convention Center	Orlando, FL	USA	www.asco.org
June 12 – 14	2009 Clinical 3.0T MRI Today: Myths and Reality, Issues and Applications	The Venetian	Las Vegas, NV	USA	www.educationalsymposia.com
June 18 – 22	Organization for Human Brain Mapping	San Francisco Marriott	San Francisco, CA	USA	www.humanbrainmapping.org
June 23 – 26	European Society of Gastrointestinal and Abdominal Radiology 2009	Palacio de Congresos de Valencia	Valencia	Spain	www.esgar.org
Oct. 22 – 25	Royal Australian and New Zealand College of Radiologists (RANZC) 60th Annual Scientific Meeting	Brisbane Convention and Exhibition Centre	Brisbane, Queensland	Australia	www.ranzcr.edu.au
Oct. 24 – 29	Congress of Neurological Surgeons	Ernest N. Morial Convention Center	New Orleans, LA	USA	www.cns.org
Nov. 1 – 5	ASTRO – 51st Annual Meeting	McCormick Place	Chicago, IL	USA	www.astro.org
Nov. 29 – Dec. 4	RSNA – 95th Scientific Assembly	McCormick Place	Chicago, IL	USA	www.rsna.org

GE Healthcare "Breaks Boundaries" at 17th Annual ISMRM 2008



When it comes to research and MR, there's one place to see and be seen: ISMRM. At the 2008 event in Toronto, Canada, rather than simply talking about new advancements, GE Healthcare chose to show attendees exactly what the fuss was all about – starting with the brand-new 3.0T system: the Discovery™ MR750.

"We wanted the best MR researchers in the world to be able to touch the system, ask questions and see for themselves," explains Maria Piazza, global marketing manager for 3.0T systems with GE Healthcare. "In addition, we thought it equally important to secure key individuals who have been using the Discovery MR750 to speak about their experiences and allow people to talk to them first-hand." The system boasts the world's most powerful gradients, in addition to making a 15-minute liver exam, routine fMRI, and two-sequence breast imaging possible.

Providing testament to the simply powerful and powerfully simple functions and technology were Professor Gary Glover, Stanford, as well as Professors Dr. Scott Reeder and Dr. Tom Grist from UW-Madison. The result? Packed houses of attendees who overwhelmingly agreed – this is not just another 3.0T scanner.

"The new Discovery MR750 is a perfect example of why collaboration is so fundamentally important," says Piazza. "It enabled us to think differently about what we can achieve – and focus on what our customers need, breaking through traditional boundaries of MR." ■

Second European Brain eXpert Contest Winner Announced

Study examines importance of B-Matrix reorientation

Alexander Leemans, CUBRIC, School of Psychology, Cardiff, United Kingdom, won the second Brain eXpert Contest, which is held by GE Healthcare to recognize the best neuro-science projects in Europe. Leemans' project, "To Rotate B or not to Rotate B?" examined the importance of B-matrix reorientation during realignment of diffusion tensor MRI data.

Leemans concluded that when correcting DW motion artifacts, reorientation of the B-matrix should not be neglected as it introduces bias in anisotrophy and fiber orientation estimates. The errors are not uniform, but depend on the orientation of the underlying fiber pathways. Not rotating the B-matrix can have potentially disastrous consequences on quantitative and tractography studies, such as surgical planning.

Over 20 projects were submitted from all over Europe. Projects were judged for scientific originality, interest, and content by a jury panel of seven MRI researchers from top-level European institutions and three GE employees. The panel was led by Elna-Marie Larsson, MD, DMSc, professor of radiology and director of neuroradiology at Aalborg University Hospital, Denmark.

"Since the first ISMRM conference in Dallas, Texas, in March 1994, the number of researchers in MRI has increased tremendously," said Dr. Larsson. "This competition has been developed to solidify links between GE Healthcare Europe and its European users, and to promote innovative research." ■

First AGM Signa® 3.0T MR Users Meeting Held in Malaysia

Experts demonstrate how 3.0T MR Improves diagnoses and operational efficiencies

Thirty-seven 3.0T MR customers from all over Asia attended the first Asia Growth Market (AGM) 3.0T MR users meeting, held May 22-23, 2008 at Kota Kinabalu, Malaysia. "This first AGM GE 3.0T users meeting did much to stimulate interest and enthusiasm for 3.0T MRI in this market," said Jeffrey Weinreb, MD, FACR, from the Yale School of Medicine.

A distinguished panel of global and regional luminaries presented a wide range of clinical and research topics on 3.0T MR. GE experts and specialists demonstrated how the technology from GE and advanced applications can make the difference in better medical diagnoses and greater operational efficiencies. ■

100th Signa HDe 1.5T Unit Sold in Japan

Sites of first two installations host celebrations

In 2008, GE Healthcare achieved 100 unit orders for Signa HDe 1.5T in Japan. The HDe was designed to fit the needs of community hospitals and imaging centers concerned about energy efficiency and siting space – needs common in markets like Japan. Since its introduction, the HDe has received strong feedback and customer appreciation.

To mark the milestone, 100th Anniversary Award celebrations were hosted by the sites of the first two installations – Seirei Hamamatsu Hospital and Rissyou Kousei. To date, over 300 Signa HDe systems have been installed worldwide ■

3.0T Symposium in London

GE Healthcare hosted the 1st UK 3.0T MR Symposium on October 8, 2008, at the Kings Place venue in Kings Cross, London.

The Event, which attracted over 160 Radiologists, Radiographer Managers and general imaging community staff, featured a 3.0T Imaging Symposium and the launch of the Discovery™ MR750 3.0T to the UK MR market.

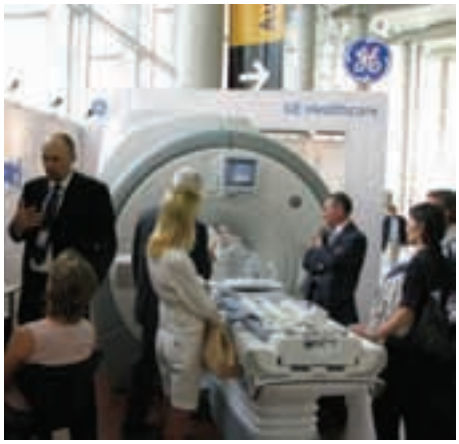
Stephen Gibbs, MR Manager for GE Healthcare UK, summarized the excitement surrounding the introduction of the Discovery MR750. "With Discovery MR750 3.0T, we are affecting a change in MR field imaging through advancements in stability and technology," he says. "The results are advances in volumetric imaging and multi-phase imaging that allow users to push the boundaries of clinical MR to image simply and powerfully in all clinical areas." ■

ESMRMB 2008: New Heights in 3.0T Imaging

At the annual meeting of the European Society of Magnetic Resonance in Medicine & Biology (ESMRMB). GE Healthcare unveiled the Discovery™ MR750 for the first time to 1,200 MR users and researchers from prominent academic sites representing more than 20 European countries.

A key highlight was the presentation from Thomas Grist, MD, University of Wisconsin-Madison (USA) on the Discovery MR750 with spectacular MR images and breakthroughs with the new technology.

In addition, Dr. Martinez de Vega, Hospital Quiron (Spain), unveiled the latest advances in Breast and Body MRI clinical research at 3.0T using the most recent sequences developed by GE Healthcare – IDEAL, Cube and VIBRANT-Flex. ■



Magnetic Resonance: Reality and Perspectives in Puerto Rico

They call Puerto Rico the "Island of Enchantment." Seems fitting, as this past August, GE Healthcare presented the latest innovations – and instead of the island enchanting tourists, it was GE enchanting the audience – as engaged attendees numbered over four times the amount expected. The San Juan event showcased clinical application learning and the latest technologies that have been introduced in MR.

Lizette Quintero, product specialist in Puerto Rico, presented GE Healthcare MR products and software, followed by Dr. Alexandre Borges of Hospital Centro Médico de Campinas – São Paulo/Brazil, who presented intriguing new findings within clinical applications.

Attracting many prominent guests from Puerto Rico, the event focused on delivering the promise from GE Healthcare to provide cutting-edge technology along with continuous education to customers – so we can all benefit from additional clinical knowledge. ■

Annual 3.0T MRI Conference in Las Vegas Explores Issues and Applications

More than 100 attendees were enlightened by some of the world's most experienced 3.0T imagers at the annual 3.0T MRI Conference, "3.0T MRI Today: Myths & Reality, Issues and Applications," hosted by Lawrence Tanenbaum, MD, FACR, at the Mandalay Bay Convention Center in Las Vegas on April 11-13, 2008. ■

Cutting-Edge MR Innovations – Now at 1.5T

In May 2008, GE Healthcare announced the Discovery™ MR750, a 3.0T scanner that claims the world's most powerful gradients, not to mention enables a 15-minute liver exam, routine fMRI, and two-sequence breast imaging. Today, GE Healthcare brings these technologies to the most widely used field strength with the Discovery MR450.

"We recognize that our customers' needs and, therefore, field strength preferences, vary," explains Chris Fitzpatrick, premium 1.5T global marketing manager at GE Healthcare. "The Discovery MR450 brings the same leading technical advancements and unique clinical capabilities as the Discovery MR750 to our 1.5T customers." The Discovery MR450 is the first 1.5T MR product within the Discovery portfolio for GE Healthcare. ■

Signa® HDe 1.5T Recognized as ecomagination Product

First medical imaging product to be recognized saves space and energy

The Signa HDe 1.5T Magnetic Resonance Imaging system is the first medical imaging product from GE Healthcare to be recognized as an ecomagination offering. "We are extremely excited and proud as an MRI business to feature the first ecomagination product for GE Healthcare," said Jim Davis, vice president and general manager of global MRI business.

ecomagination is the commitment from GE to imagine and build innovative technologies that help customers address their environmental and financial needs, such as the need for cleaner, more efficient sources and uses of energy. Signa HDe 1.5T was recognized as an ecomagination product on the basis of energy savings, as well as operating benefits. Compared to the average 1.5T MRI system, the Signa HDe 1.5T uses 20% less space, increasing site flexibility.

Signa HDe 1.5T uses approximately 41% less energy than previous generation MRI systems while still achieving outstanding image quality. This MRI system reduces annual electricity by about 70,000 kWh, roughly equivalent to the annual electricity consumption of 15 households in the UK or about 15 urban households in China. The projected annual savings is $7,000 under normal operating conditions in the US. ■

Dineen Named President and CEO of GE Healthcare

GE Chairman and CEO Jeff Immelt announced the appointment of John Dineen as president and CEO of GE Healthcare. "John Dineen is a talented global leader who has consistently delivered double-digit growth by globalizing our Transportation business and diversifying its high-tech portfolio," Immelt said. "His sharp customer focus combined with the talented team at Healthcare will help the business to continue to grow around the world."

Dineen, 45, is a 22-year GE veteran and since 2005 has been president and CEO of GE Transportation, a $4.5 billion global leader in the rail, mining, marine, drilling, and wind industries. Before leading GE Transportation, Dineen served as vice president and general manager of Plastics at GE Advanced Materials, held various assignments in Corporate Finance, and was president of GE Plastics-Pacific. He was also manager of finance for GE Asia in Hong Kong and served as general manager of GE Power Equipment, the Meter business, and the Microwave and Air-conditioning businesses.

In his new position, Dineen will be located in London, where GE Healthcare is headquartered. Dineen succeeds Joseph Hogan, who has taken a position as CEO of ABB. ■

H. Lee Moffitt Cancer Center First to Install Signa® Vibrant Dedicated Breast MR System in the US

GE Healthcare is pleased to announce the first US-based installation of the Signa Vibrant 1.5T dedicated breast MR system at H. Lee Moffitt Cancer Center, an NCI-designated research facility. The system was installed in July 2008 at Moffitt's Lifetime Cancer Screening & Prevention Center and has since been used to scan five to six patients each day.

According to Lynne Hildreth, Director of Lifetime Cancer Screening, the system was selected based on its high image quality and exclusive detachable breast table. "Signa Vibrant is an elegant solution for breast MR imaging that is very patient and technologist friendly," says Hildreth. "The system is easy to use and our radiologists were very impressed with the image quality.

We've been very impressed with GE service on other modalities in our center, so we knew we could rely on them for excellent uptime."

Hildreth also notes that compared to other dedicated breast MR systems on the market, the Signa Vibrant offers Moffitt more flexibility. "We know we can upgrade the system to perform other studies, or add entirely new applications such as MR-guided focused ultrasound."

Signa Vibrant 1.5T utilizes high definition technology and applications specifically designed for breast MR, including the VIBRANT acquisition, BREASE spectroscopy, integrated CADstream (Confirma, Inc., Bellevue, WA) and the specially designed breast MR table (Sentinelle Medical Inc., Toronto, ON). ■

Marketing Kits Expanded and Enhanced for GE Healthcare Customers

Healthcare professionals who are looking to spread the word about their services and capabilities can now order personalized materials specific to their GE Healthcare products on Get Creative, a customer marketing Web site. Additional new features also include expanded product images, advertising downloads, and additional media kits for public relations. All materials are available to GE Healthcare customers at no charge. www.getcreative.gehealthcare.com. ■

GE Healthcare Unveils Signa® Magnetic Resonance Imaging Oncology Package at ASTRO

Dedicated oncology solution enhances magnetic resonance imaging for radiation therapy planning

In September 2008, GE Healthcare launched its new Signa Magnetic Resonance Imaging (MRI) Oncology Package at the American Society for Therapeutic Radiology and Oncology's 50th annual meeting. The package, a dedicated oncology solution, enhances magnetic resonance imaging for radiation therapy planning and is compatible with the most widely used GE MRI systems.

"MRI is widely considered the modality of choice for imaging brain, spine, and other soft tissue tumors," said Bryan Van Meter, MRI global marketing manager for surgical and radiation oncology at GE Healthcare. "We are committed to providing radiation oncologists and cancer centers with the tools to easily integrate high-definition MRI imaging into their treatment plans."

The Signa Oncology Package improves the ease and consistency of co-registering MRI and computed tomography (CT) images. It allows exquisite soft-tissue contrast of MRI to be more easily and accurately fused with CT images by providing MRI images that are acquired in the same patient positioning as CT. The result is the enhanced accuracy, consistency, and confidence required for the advanced radiation treatment systems of today. ■

New 32-Channel Coil Accelerates Image Quality

While the balance between element radius and depth of penetration are a continual trade-off in coil development, a new 32-channel torso coil from GE Healthcare geometrically overlaps coil elements to achieve significant SNR and parallel imaging improvements over 8 channel technology. At high field MR such as 3.0T, there is an abundance of SNR that may be utilized to trade off scan time; therefore, new coil technologies that maximize parallel imaging capabilities are imperative.

The new 32-channel torso coil is particularly useful with the Discovery MR750 scanner and 3D pulse sequence, LAVA-Flex. This technique produces four images for each slice location. By using the coil in conjunction with the new parallel imaging algorithm, ARC, abdominal studies that were previously unattainable can now be accomplished with a single breath hold. ■

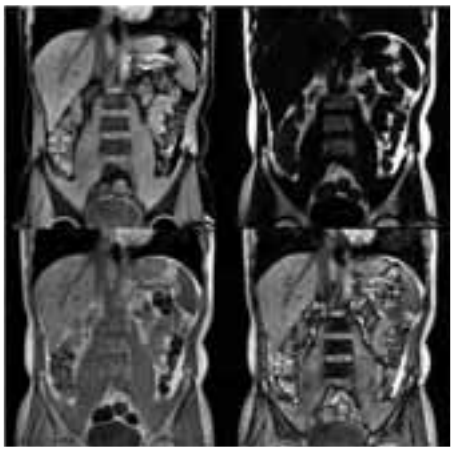


Figure 1. Coronal LAVA-Flex acquisition; 120 slices with 44 cm FOV; 4 mm slice thickness with 320 x 320 matrix; Acceleration = 5.02 X; Scan time = 13 s.

Figure 2. Element orientation of anterior and posterior sections of 32-channel torso coil.

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.**

For more information, please visit www.gehealthcare.com/breastmri

imagination at work

MR Imaging of Iron Overload

By Cynthia Rigsby, MD, Angela Nicholas, DC, Monica Micholotti, BA

β-thalassemia is an autosomal recessive anemia that requires lifelong blood transfusions and medical care to maintain adequate hemoglobin levels. In the US there are over two million people who carry the trait for β-thalassemia. The transfusions that these patients receive are life-sustaining; however chronic transfusions result in iron overload in multiple organs, including the heart and liver, which can lead to failure of these organs. Heart failure due to iron overload is the most common cause of death in β-thalassemia patients.[1] Fortunately, the iron overload can be successfully treated with iron chelation therapy.[2] Recent developments in the treatment of the iron overload with improved chelation therapy have dramatically increased the expected lifespan of patients with β-thalassemia from less than twenty years in the 1960s to greater than forty years today.[3]

Iron load in the body can be evaluated with either blood levels of iron or hepatic iron concentration by biopsy, since much of the body's excess iron is deposited in the liver. Liver biopsies have traditionally been used as a representation of total body iron load. Liver biopsy, however, is invasive and therefore not an ideal method for frequent liver iron monitoring. Also, studies have shown that blood iron levels and liver iron measurements do not directly correlate with cardiac iron levels, as the hepatic and cardiac tissues have different mechanisms and kinetics of iron uptake, storage, and clearance.[4] Therefore, assessing risk of heart failure from blood iron concentration or liver biopsy may not be accurate.[5, 6]

All images courtesy of Children's Memorial Hospital

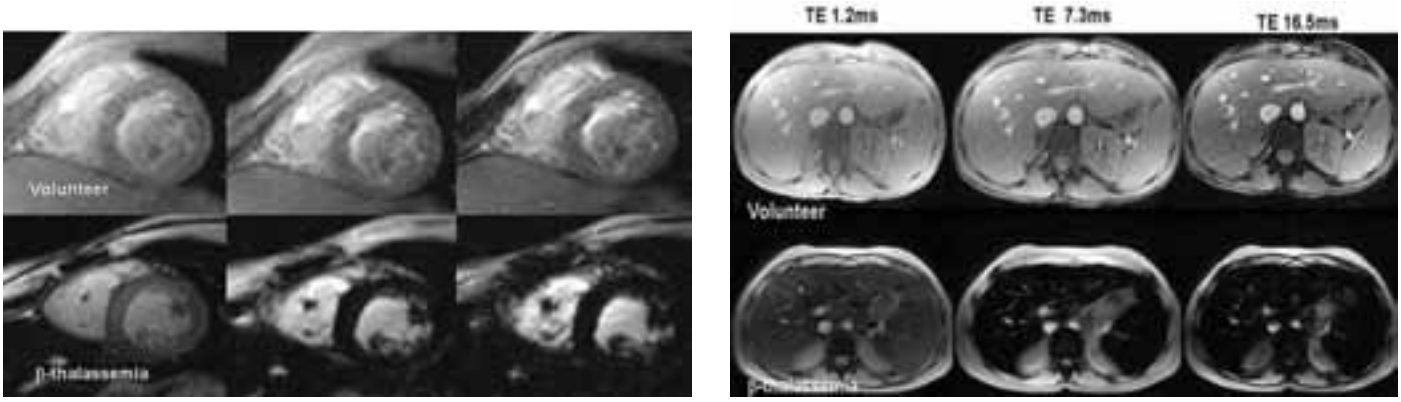


Figure 1. T2* images of the heart and liver in a normal volunteer and in a patient with β–thalassemia. A. Short axis T2* cardiac images with increasing echo times in a normal volunteer (top) and a patient with β–thalassemia (bottom). The images in the normal volunteer do not show significant signal decrease over time, indicating relatively low liver iron content. The images in the patient with β–thalassemia show significant decrease in signal over time, indicating high iron content. B. Axial liver T2* images with increasing echo times in a normal volunteer (top) and in a patient with β–thalassemia (bottom). The images in the normal volunteer do not show significant signal decrease over time indicating relatively low liver iron content. The images in the patient with β–thalassemia show significant decrease in signal over time, indicating high iron content.

MRI offers a noninvasive imaging study for assessment of tissue iron levels, and can be used to monitor iron burden in the heart and liver so that patients at risk for cardiac and liver failure can potentially be identified before lethal symptoms develop. MRI is increasingly being used worldwide to follow organ iron overload in β-thalassemia patients, but can also be used to assess other types of patients with iron overload states including sickle cell disease and hemochromatosis.[7,8] MRI can be used to evaluate heart and liver iron values because hemosiderin molecules in iron produce local disturbances in the magnetic field. The greater the iron content, the greater the magnetic field disturbance causing quicker MRI signal decay rates. T2* signal decay rates are measurable and proportional to the tissue iron concentration allowing for MRI T2* imaging techniques to be used for evaluation of tissue iron load.[9]

T2* imaging is accomplished using a breath-hold multiple echo gradient echo pulse sequence to acquire a series of images with increasing echo times. This sequence can be used in the liver and heart. For the heart, an ECG-gated version of the sequence is used to compensate for cardiac motion. T2* imaging is completed in a single breath-hold for each slice (Figure 1). MRI cardiac functional analysis is also generally performed in addition to T2* imaging.

Once MRI imaging is performed, the actual T2* values are calculated offline using customized software programs. Regions of interest are placed in the left ventricular septum and in the liver for evaluation of iron content in those areas (Figure 2). The mean signal intensity within the region of interest is determined for each image in the series and plotted as a function of the echo times. T2* values are then calculated by fitting the mean signal intensity data to a decay curve. The T2* relaxation rates are inversely proportional to the slopes of the decay curves, so the higher the slope of the decay

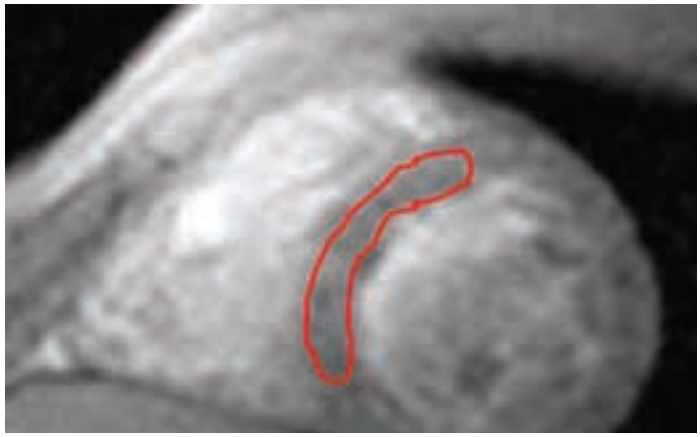


Figure 2. Short axis T2* image of the heart showing one large region of interest placed in the left ventricular septum for T2* evaluation.

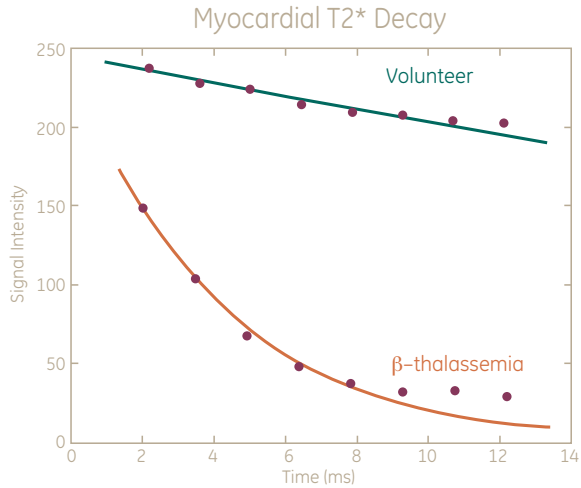


Figure 3. Decay curves from the liver in two patients with β-thalassemia, one patient with high liver iron content (red decay curve) and one with lesser liver iron content (green decay curve). The slope of the red line is greater than that of the green line, which will lead to a lower T2* value for the patient with higher organ iron content.

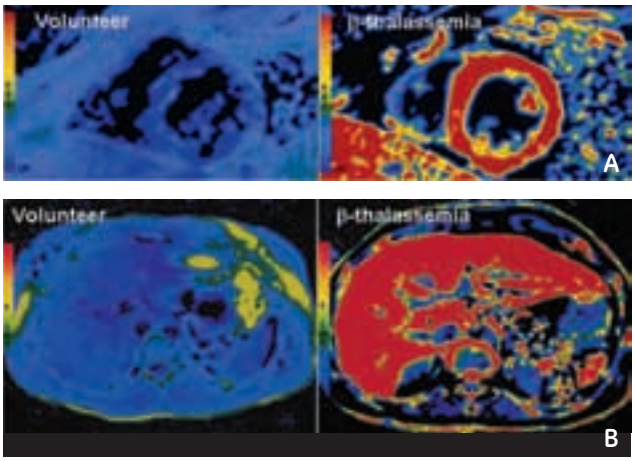


Figure 4. T2* iron content color maps of the liver and heart in a normal volunteer and in a patient with β–thalassemia. Scale of the color images: Blue = low iron content; Red = high iron content. A. Short axis T2* color map of the heart in a normal volunteer shows low iron content (left ventricle shows blue coloring). Short axis T2* color map in a patient with β–thalassemia shows high iron content (left ventricle shows red coloring). B. Axial T2* color map of the liver in a normal volunteer shows low iron content (liver shows blue coloring). Axial T2* color map of the liver in a patient with β–thalassemia shows high iron content (liver shows red coloring).

curve, the lower the T2*, and the lower the slope of the decay curve, the higher the T2* (Figure 3). A cardiac T2* value of greater than 20 msec is considered normal.[10] Liver T2* values can be translated into hepatic iron concentration using calibration curves that have been developed to relate T2* with liver iron concentration (Figure 4).[11, 12]

MRI T2* evaluation is often performed yearly for surveillance of organ iron load, but can be performed more frequently if needed. Indications for MRI surveillance for heart and liver iron load are based upon individual patient transfusion and iron chelation history and laboratory evaluation including serum ferritin values. T2* imaging can be performed even in very young children, but may not be clinically necessary until later in childhood or adolescence with routine imaging surveillance continuing into adulthood.[13] Patients are generally followed by hematologists and/or cardiologists for changes in heart or liver T2* values that may lead to a need for a change in chelation therapy with the goal of reducing organ iron overload and helping prevent complications such as iron overload related heart failure from occurring. ■

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13. Wood JC, Enriquez C, Ghugre N, et al. Physiology and pathophysiology of iron cardiomyopathy in thalassemia. Ann N Y Acad Sci 2005; 1054:386-395.

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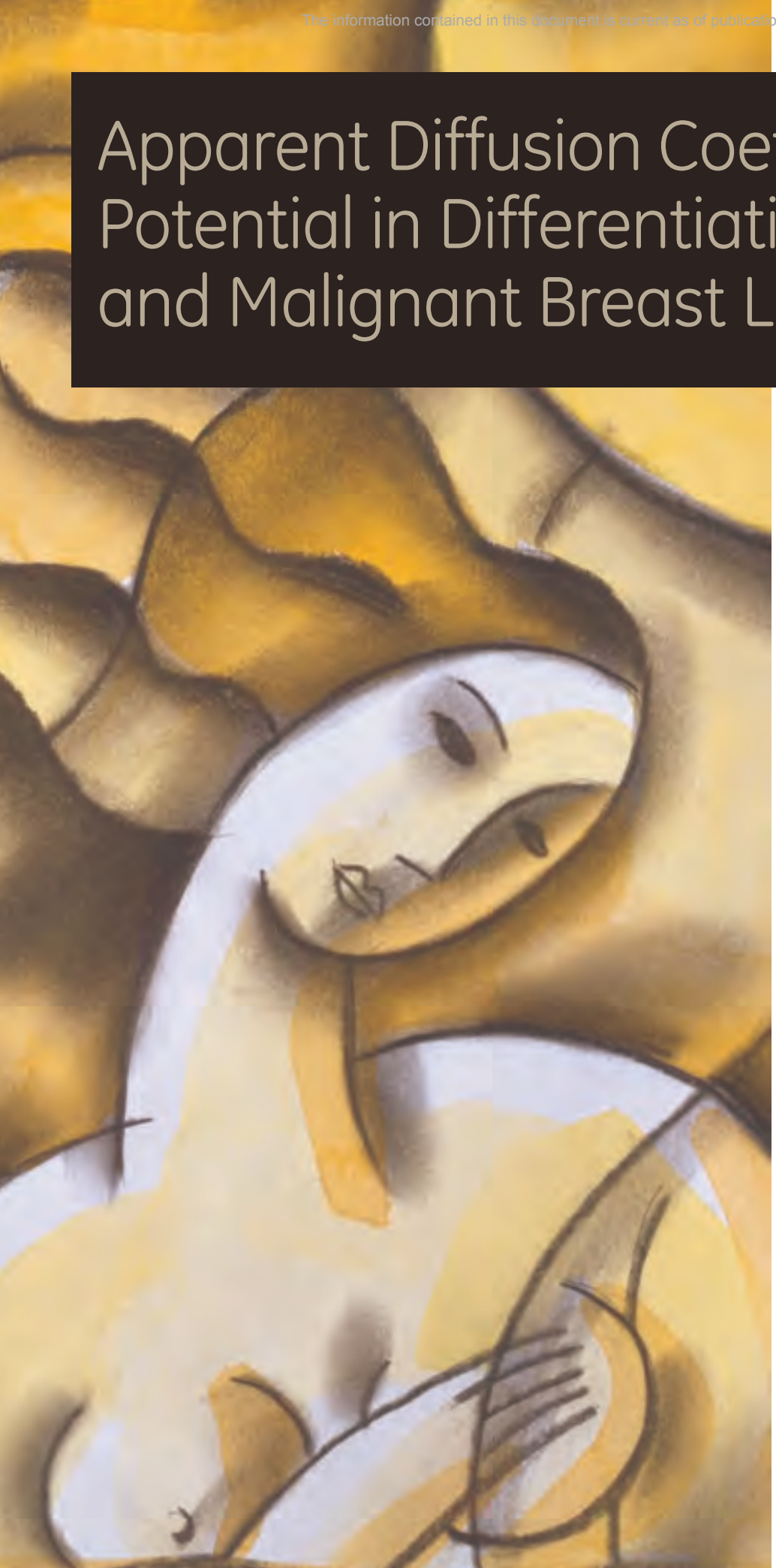
About the facility:

Children's Memorial Hospital is Illinois' only freestanding hospital exclusively for children. Licensed for 270 beds, Children's Memorial has nearly 1,100 pediatric specialists in more than 70 specialties. In 2007, the hospital treated over 113,000 with 9,549 inpatient admissions, had nearly 392,000 outpatient visits, and conducted nearly 42,000 radiology procedures and 16,000 surgical procedures.

Apparent Diffusion Coefficient Potential in Differentiating Benign and Malignant Breast Lesions



Fernanda Philadelpho Arantes Pereira, MD
Gabriela Martins, MD
Marisa Nassar Aidar Domingues, MD
Raquel V. Carvalhaes de Oliveira
Eduardo Figueiredo
Romeu Côrtes Domingues, MD

Introduction

Magnetic Resonance Imaging (MRI) shows good sensitivity in detecting breast tumors, with results ranging from 89% to 100% and superior to 95% for invasive cancer.[1,2] However, its specificity is limited due to the existence of contrast uptake pattern overlapping of benign and malignant lesions.[1,3,4] There is also the influence of the female hormonal cycle and the use of hormonal therapy.

Recently, the emergence of new imaging techniques has allowed for the improvement of breast MRI specificity. For two decades, diffusion-weighted imaging (DWI) has been used to evaluate intracranial diseases, such as stroke. In the 1990s, technological breakthroughs allowed the use of diffusion in extracranial sites,[5,6] including the breast.

Images derive from the difference of movement of water molecules (Brownian motion) across tissues,[4,7] enabling qualitative and quantitative information that reflect changes at the cellular level. The value of water diffusion into tissues is measured by the apparent diffusion coefficient (ADC). ADC reduction reflects the histological pattern of higher cell density, which inhibits the effective movement of water, restricts diffusion, and causes signal fall.[7,8]

Examination and Image Processing

Breast MRI examinations were performed on a GE Healthcare Signa® HD 1.5T system, Echo Speed Plus 33/120 gradient, employing an 8-channel HD Breast coil. Following the standard protocol (T1 and axial STIR, T2 with sagittal fat suppression and axial VIBRANT™) and, preferably, prior to the endovenous administration of contrast, SE-EPI diffusion sequence was performed in the detected lesions.

Protocol:

Ten 5 mm axial sections, 0 spacing,
36 x 36 cm FOV
160 x 192 matrix
NEX 16
rBW 250 kHz
TR 1800 ms
TE 93.8 ms, fixed for all b values of 0, 250, 500, 750, and 1000 s/mm^2
Total time: 3 min, 44 s

In theory, it is known that the more b values sampled, the more accurate the apparent diffusion coefficient (ADC) map measure.[3,5] All images were transferred to a workstation, with the execution of black/white and colored ADC maps; the latter with a Puh-thalium color scheme, ranging from black (diffusion restriction) to red (without diffusion restriction).

Visual inspection of the signal and ADC calculation using Functool for b values 0, 250, 500, 750 and 1000s/mm^2 were performed after the placement of regions of interest (ROIs) on the lesion to obtain the mean and one ROI in the glandular parenchyma. The ADC value found in each lesion was correlated with the imaging findings and histopathological diagnosis.

We evaluated the diffusion sequence capacity of locating breast lesions, calculated the ADC value for lesions and gland parenchyma, and compared malignant and benign lesions' ADC values, highlighting a cutting value. P values < 0.05 were considered statistically significant. The diffusion's sensitivity, specificity, and accuracy were calculated in order to differentiate benign and malignant lesions.

Results

In a preliminary study with 35 female patients (25 to 72 years old; mean, 45.7 years) 37 lesions were observed, of which 16 were benign (fibroadenoma, fibroadenolipoma, phyllode tumor, epidermoid cyst), measuring 0.8 to 9.5 cm (mean, 2.0 cm), and 21 were malignant (CDI, CDIS, tubular carcinoma, adenoid cystic carcinoma, mucinous colloid carcinoma), measuring 1 to 11.2 cm (mean, 2.8 cm). Two benign lesions measuring 0.6 and 0.9 cm were excluded, as they could not be located in the diffusion sequence. Of the 37 lesions, 11 showed movement artifacts, most of which were corrected in image processing. ADC values' mean was significantly lower for malignant lesions (0.89 +/- 0.20 x 10^{-3} mm^2/sec) when compared with benign lesions (1.46 +/- 0.26 x 10^{-3} mm^2/sec) with $p < 0.001$.

There was one false-positive, epidermoid cyst with ADC of 1.39 x 10^{-3} mm^2/sec and one false-negative, mucinous colloid carcinoma with ADC of 0.72 x 10^{-3} mm^2/sec, with the latter easily explained due to the distinct tumor composition.[7] Presuming a cutting value of 1.2 x 10^{-3} mm^2/sec to distinguish benign and malignant breast lesions, we observed sensitivity, specificity, and accuracy superior to 90%. ADC values' mean for gland parenchyma was 1.13 +/- 0.39 x 10^{-3} mm^2/sec.

Conclusion

Diffusion sequence can help with the characterization in differentiating malignant and benign breast lesions, increasing breast magnetic resonance imaging specificity, and reducing the number of false-positives and unnecessary biopsies. It is performed without significantly increasing examination time and can be easily introduced into the standard breast MRI protocol.

Perspectives

Neoadjunctive chemotherapy treatment results in lysis, loss of cell membrane integrity, increase of extracellular space, and therefore, increase of water diffusion. For this reason, there is growing interest in applying diffusion to detect tumor response.[5,8]

There are preliminary works showing that diffusion can detect lymph nodes affected by neoplastic cells, once the change and increase of lymph nodal cellularity results in diffusion restriction.[5] ■

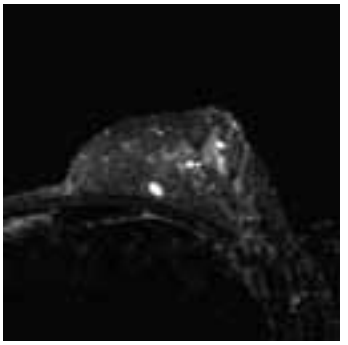
The author presented a breast DWI study as a scientific poster presentation in the category Breast Imaging, MR at the 2008 Annual Scientific Sessions of the Radiological Society of North America.

Dr. Fernanda Philadelpho Arantes Pereira

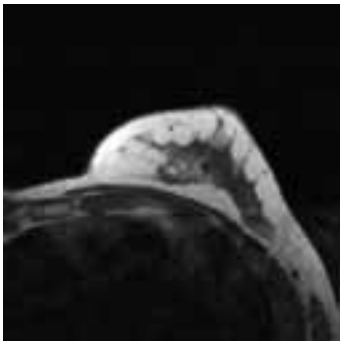
Fernanda Philadelpho Arantes Pereira, MD, graduated in medicine from the University of the State of Rio de Janeiro (UERJ), with medical residency in radiology at the School Hospital Pedro Ernesto (UERJ), Brazil. She specialized in MRI at the Resonance and Multi-imaging Clinic and in breast radiology and invasive procedures at the National Institute of Cancer (INCA), Rio de Janeiro, Brazil. Currently, she works as a breast radiology specialist at the Diagnostic Imaging Clinic (CDPI), Rio de Janeiro, Brazil. She is a member of the Brazilian School of Radiology (CBR), Radiological Society of North America (RSNA), and American Society of Breast Disease (ASBD).

Benign Nodule

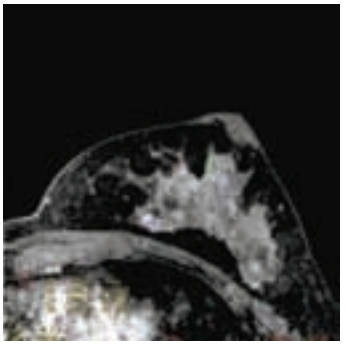
36 year-old patient, right mastectomy, with 0.8 cm stable nodule showing benign characteristics suggesting fibroadenoma in the internal superior quadrant of the left breast.



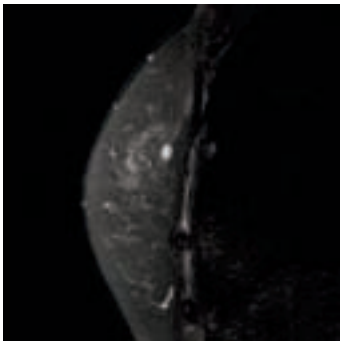
Axial T2 STIR



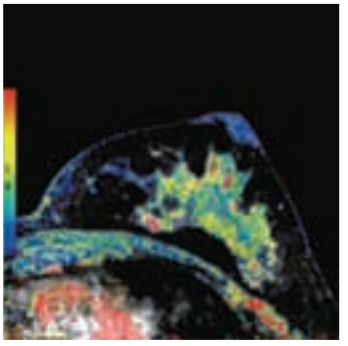
Axial T1 FSE



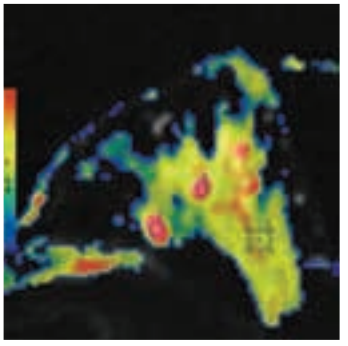
Reference ROI Curve



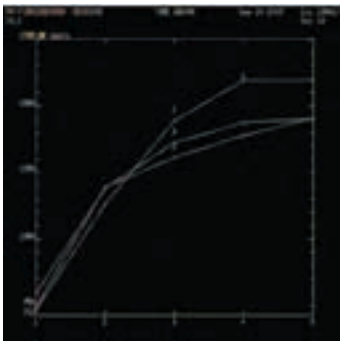
Sagittal T2 Fat Sat



Maximum Slope of Increase



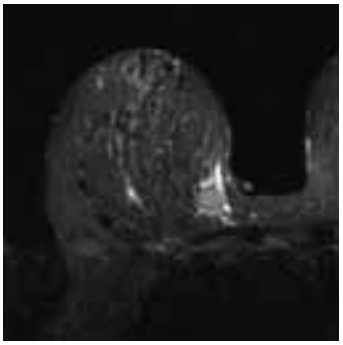
ADC Map



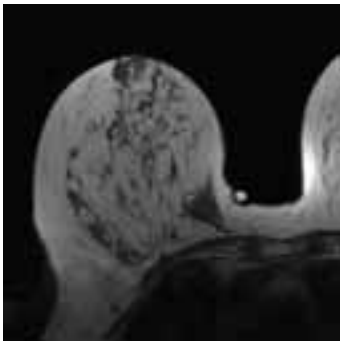
Dynamic Curve

Malignant

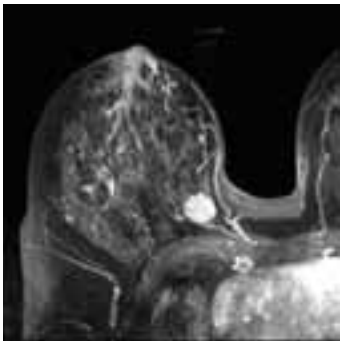
69 year-old patient showing Infiltrating Ductal Carcinoma.



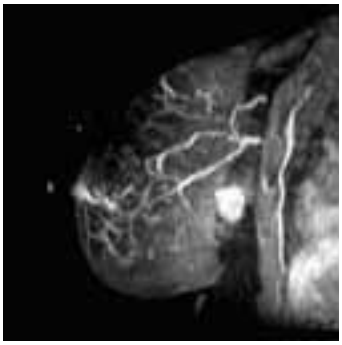
Axial STIR FSE



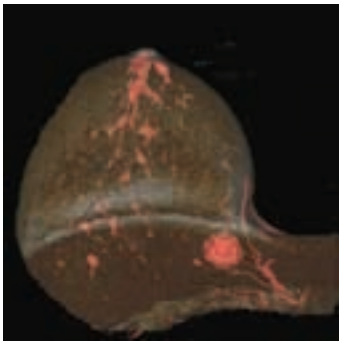
Axial T1 FSE



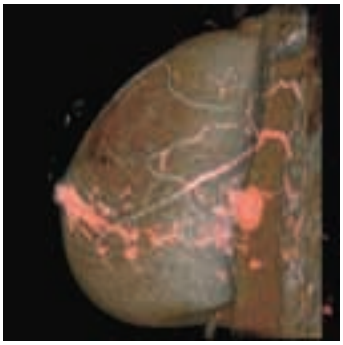
Axial MIP



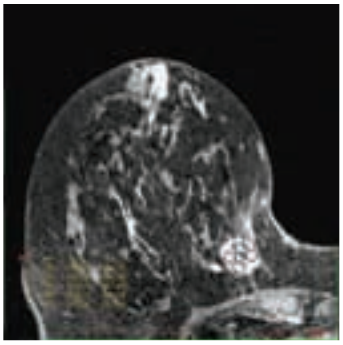
Sagittal MIP



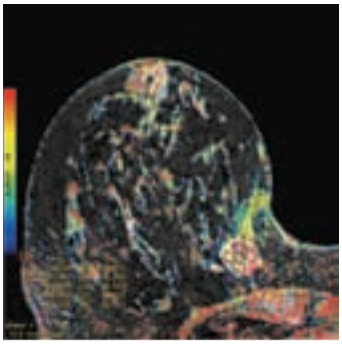
Axial Volume Rendered



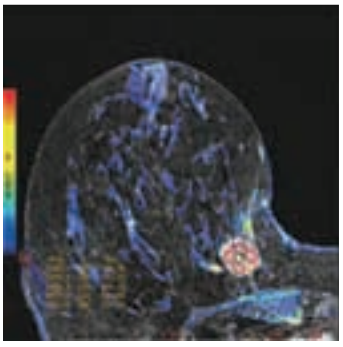
Sagittal Volume Rendered



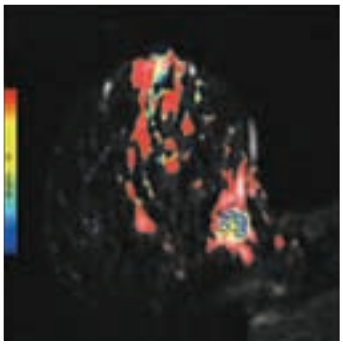
Reference ROI Curve



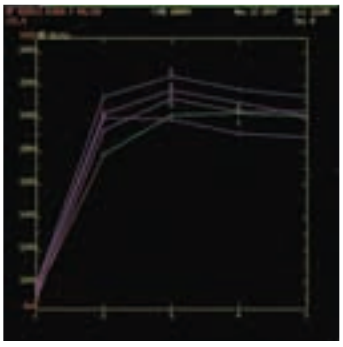
SER



Maximum Slope Increase



ADC Map



Dynamic Curve

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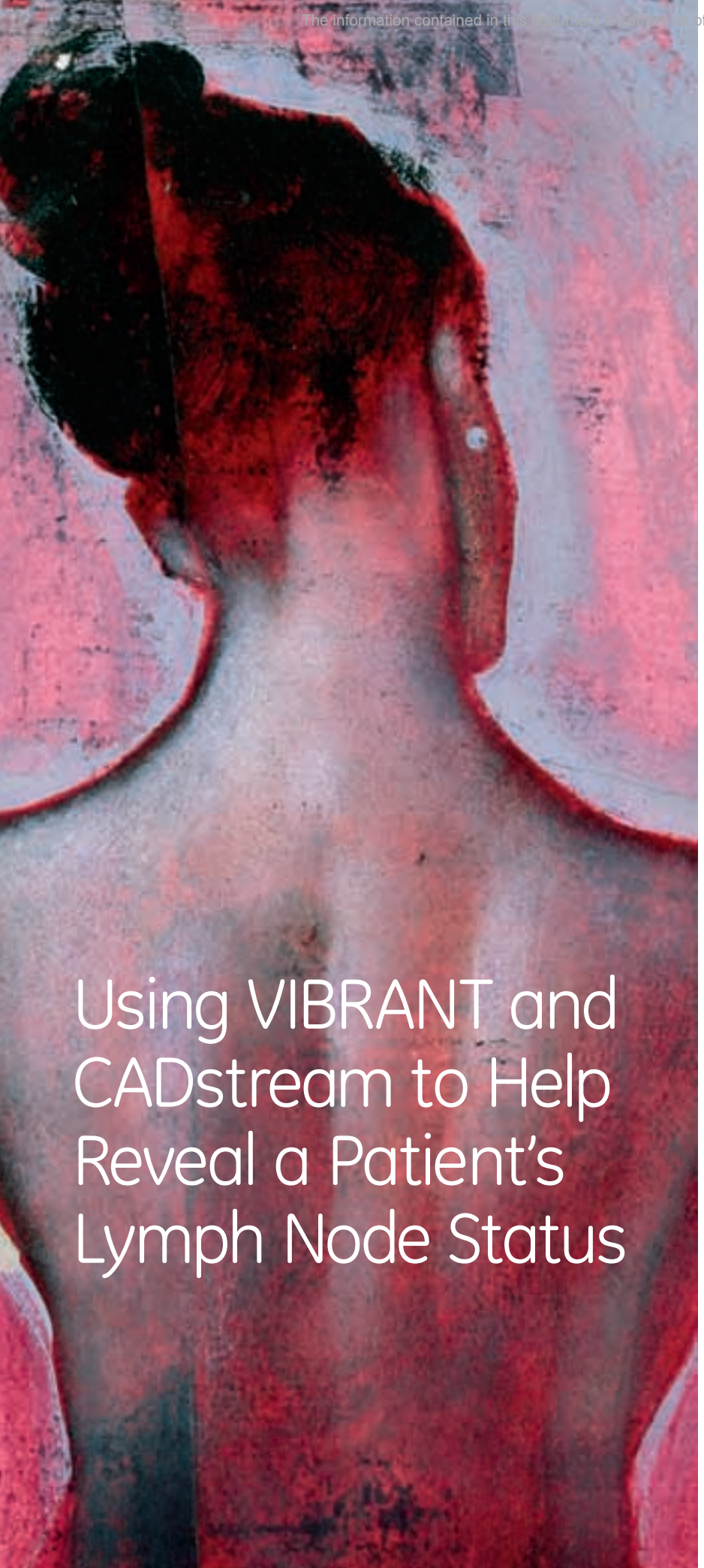


Using VIBRANT and CADstream to Help Reveal a Patient's Lymph Node Status

Breast MRI continues to grow as a clinical imaging modality, particularly for women at high risk. In 2007, the American Cancer Society released new recommendations for the use of MRI for women at increased risk for breast cancer. The new recommendations include annual MRI screenings, in addition to mammography, for women who meet certain criteria.

In 2008, data from a small retrospective study suggest that the MRI-related kinetics of a breast tumor may reveal a patient's lymph node status without surgical sampling.[1]

Christopher Loiselle, MD, of the University of Washington in Seattle, reported the findings at the American Society for Therapeutic Radiology and Oncology's annual meeting in October.

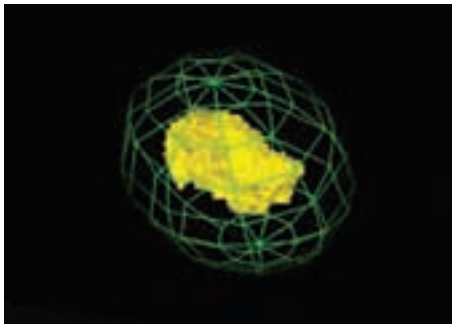
Patients with positive nodes had primary tumors with significantly greater initial peak enhancement and percent rapid enhancement on dynamic contrast-enhanced MRI compared with node-negative patients.

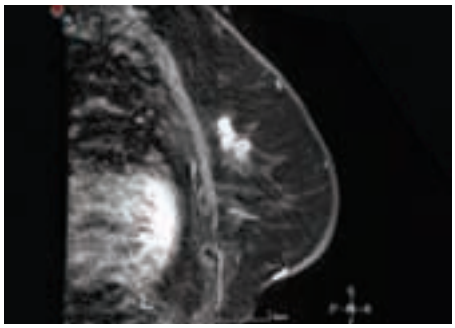
The findings have potentially major implications for patients undergoing neoadjuvant chemotherapy and for planning radiation therapy. The study suggests that tumor characteristics on an MRI scan may be the answer to the question of, is there another way to stage those lymph nodes?

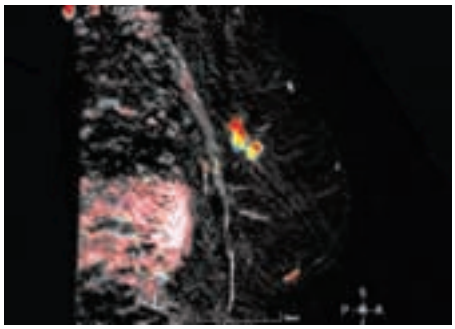
Many oncologists and radiologists consider VIBRANT™ from GE Healthcare as their sequence of choice. VIBRANT produces high resolution bilateral, axial, or sagittal 3D data sets without compromising temporal or spatial resolution. The sequence yields the high resolution detail needed to delineate the lesion and CADstream™ analyzes the data in a comprehensive manner.

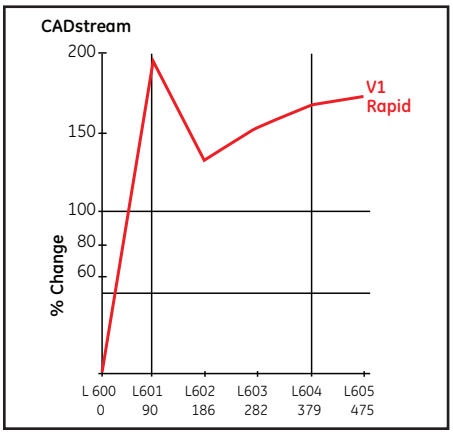
As clinical indications during breast MRI studies continue to expand, so does the amount of data produced for each exam. CADstream – the first CAD application designed exclusively for users of the GE Signa® MR Family – can facilitate more rapid interpretation of the MR study in a standardized and efficient manner. Analysis of data using CADstream allows for a fast, accurate diagnosis, volume calculations of the lesion, color map overlays, and corresponding uptake graphs to aid in characterization of the pathology. ■

All images courtesy of City X-ray









The following clinical case was submitted by Peter Kitchener, MD, and Barnabas Bakos of City X-ray, Sydney Australia.

VIBRANT™ examination and CADstream™ analysis on Signa® HDe 1.5T

Patient History

Patient presented with a palpable mass in the left upper/outer quadrant of the breast with skin thickening. Fullness of the left axilla was also noted. The patient had undergone a mammogram and ultrasound before the MRI examination where a mass was demonstrated. The lesion did have some calcifications as well as edema and there were no lymph nodes. MRI was performed to confirm the nature of the lesion.

MRI Technique

At City X-ray, the breast protocol consists of the following sequences: Axial and sagittal T1 and T2. The patient is positioned prone feet first and scanned using the HD Breast Array and the VIBRANT sequence. VIBRANT enables bilateral sagittal 3D imaging without compromising temporal or spatial resolution. Typically five dynamic phases post contrast are acquired. City X-ray then uses CADstream for the analysis of the post contrast data. CADstream creates Angiomaps, volumes and uptake curves providing a very comprehensive report.

MR Findings

The MRI demonstrated an irregular rounded mass that correlated well with the mass that was seen on the mammogram and ultrasound scan. The uptake curve depicted a rapid uptake and washout, typical of a malignant lesion. The VIBRANT sequence provides the high resolution detail needed to delineate the lesion while CADstream analyses the data in a comprehensive manner.

The lesion was very suspicious of malignancy with the likelihood of lymph node involvement.

Discussion

The Signa HDe 1.5T MR system, coupled with the breast coil and VIBRANT acquisition generates high-quality breast examinations. Analysis of the data using CADstream assists with fast accurate diagnosis with volume calculations of the lesion, color map overlays, and corresponding uptake graphs to aid in characterization of pathology.

References

1. Loiselle CR, et al. Dynamic contrast enhanced MRI kinetics and invasive breast cancer: a potential prognostic marker for radiation therapy. Int J Radiat Oncol Biol Phys 2008; 72 (1 Suppl): S176. Abstract 2018.

(For more information, visit http://www.medpagetoday.com/MeetingCoverage/ASTRO/11060)

Mind Over Matter: Susceptibility Enhanced Imaging of Brain Vasculature with SWAN

By Lawrence Tanenbaum, MD, FACR and Tony Vu, PhD

T2* or susceptibility enhanced contrast arises from local inhomogeneities of the magnetic field among tissues. T2* weighted contrast has been suggested to be a promising imaging technique for the enhanced imaging of brain vasculature. The sequence offers clinical properties for imaging high-resolution venous vascular network that allows the clinician to visualize venous structures and assess iron buildup in the tissue in neurodegenerative diseases. Imaging of major hemorrhages and microbleeding may assist clinicians in diagnosing cerebrovascular disease and broad spectrum of lesions.

The conventional 2D single TE gradient echo with sufficiently long echo time (~30 to 50 ms) is typically employed to achieve T2* weighted contrast. Low SNR, long acquisition time, and low spatial resolution capability of the 2D single TE method limits its clinical potential for susceptibility enhanced imaging. Other approaches involving 3D single TE gradient echo acquisition demonstrate some improvement in image quality but suffer similar SNR constraint, thereby, limiting the overall achievable spatial resolution.

Description

3D T2-**S**tar **W**eighted **AN**giography (SWAN) combines a unique 3D T2*-based multi-echo acquisition with a special reconstruction algorithm. This technique has significant advantages over the conventional T2* sequences.

During each TR, SWAN captures multiple TE readouts at different echo times with varying degrees of T2* contrast. All echoes are then automatically reconstructed and combined as a weighted average by the postprocessing algorithm within SWAN.

Technical advantages

The advantage of this GE-unique multi-echo approach is a significantly enhanced susceptibility effect, which can be translated into improved blood-tissue contrast. Since the SNR is directly proportional to the square root of the number of TE readouts per TR, the SNR in SWAN images is typically two to four times higher compared to a single echo T2* acquisition. 3D data sets can now be acquired with sub-millimeter spatial

resolution, without constraint by low SNR. In addition, chemical shift artifact is further reduced with multi-echo acquisition through the deployment of high receiver bandwidth, minimizing image blurring that is typical of T2* acquisitions.

Another advantage of the multiple TE readout is that the reconstructed SWAN image compiles not just one but the entire range of distinct T2* tissue contrasts. This unique property, combined with enhanced susceptibility sensitivity, high SNR, and ability to image small, sub-millimeter structures, makes SWAN an attractive technique for imaging small vascular structures and microbleeds, as well as large vessels and metal depositions in the tissue, at both the 1.5T and 3.0T field strengths. SWAN is a simple to use, fast, and robust technique that typically acquires a high-resolution 3D image of the entire brain in five minutes.

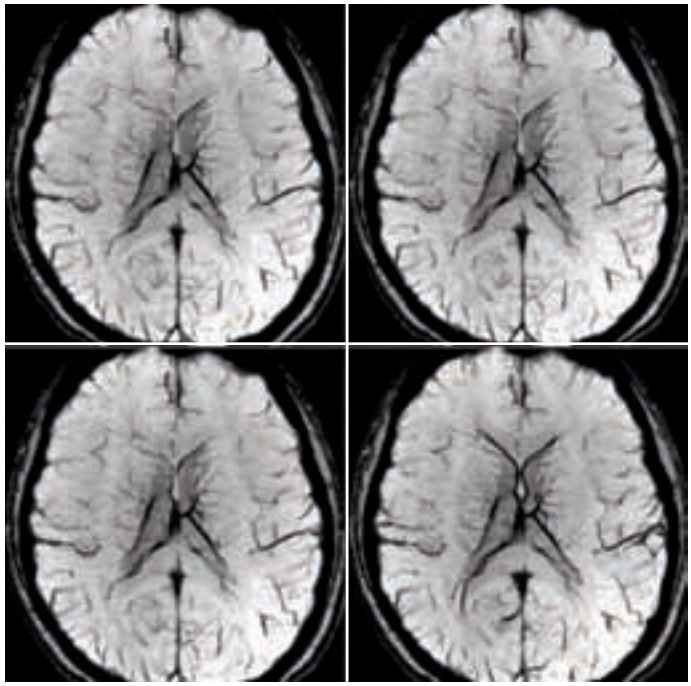


Figure 1. Representative minimum intensity projection images of 3D uni-polar 5-echoes acquisition obtained from a healthy volunteer. SWAN provides the enhanced visualization of venous vasculature.

Protocol:

Matrix size = 448x384
Flip angle = 20
Receiver bandwidth = +/- 62.5 kHz
FOV = 24 cm
TR = 40.7 ms
Effective TE = 25.4 ms
Number of echo = 5
TE_i = 15.1-35.8 ms with 5.1 ms echo spacing
2X acceleration
Total acquisition time = 2:53 minutes

Potential clinical applications

SWAN imaging provides enhanced visualization of susceptibility foci in tissue. This can help improve detection and characterization of:

- Vascular lesions characterized by hemosiderin deposition such as cavernous malformation and angiomatosis (Sturge-Weber Disease);
- Hemorrhage in acute and chronic stroke, useful in anticoagulative and thrombolytic therapeutic decision making;
- Hemorrhage in neoplastic disease assisting in tumor characterization and grading;
- Hemorrhage in chronic traumatic brain injury and suspected non-accidental brain trauma, improving assessment of disease presence and extent;
- Subcortical small vessel damage in vascular dementia;
- Iron deposition in deep brain nuclei, which can be associated with thalassemia, hemochromatosis or neuro degenerative diseases;
- Calcification in neoplastic lesions improving characterization; and,
- Calcification improving sensitivity to suspected chronic brain inflammatory disease.

Furthermore, SWAN imaging provides enhanced visualization of venous vasculature. This may assist with evaluation and characterization of:

- Vascular lesions such as developmental venous anomalies, capillary telangiectasias and arteriovenous malformations;
- Diseases with a perivenular distribution such as multiple sclerosis; and,
- The relationship of venous structures to neoplastic lesions.

Dr. Lawrence N. Tanenbaum, FACR

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.

Dr. Tony Vu

Tony Vu, PhD, Principal Engineer, Global MR Software and Applications Engineering, GE Healthcare.

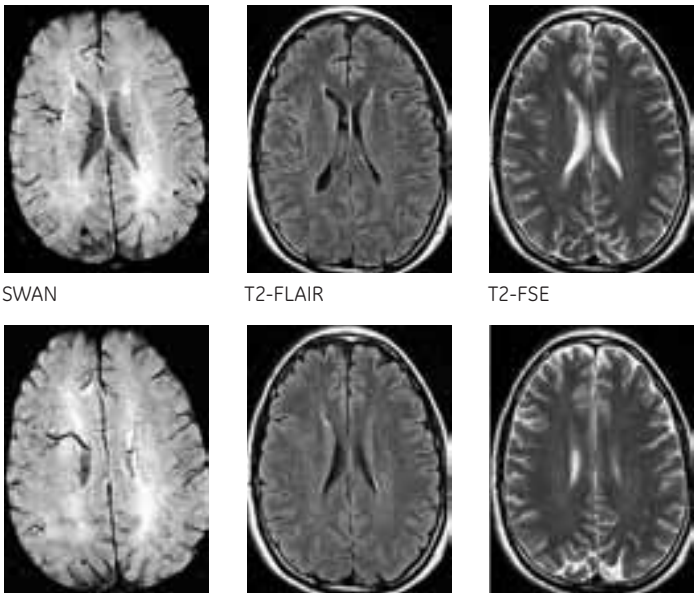


Figure 2. Venous anatomy and anomaly are well visualized with SWAN (left column). Note that the multiple rounded foci of susceptibility are better seen with SWAN than FSE (middle and right column).

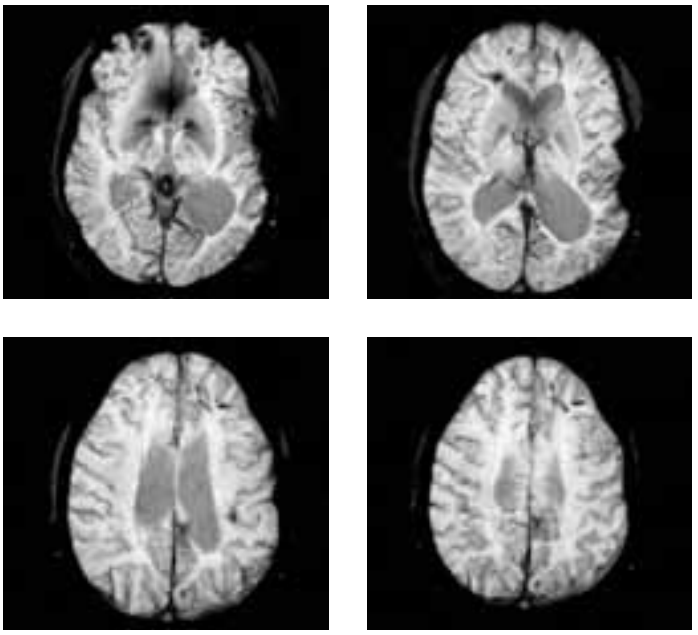


Figure 3. Traumatic brain injury. Note the superb depiction of hemosiderin in foci of traumatic/shear injury in these SWAN images.

Summary

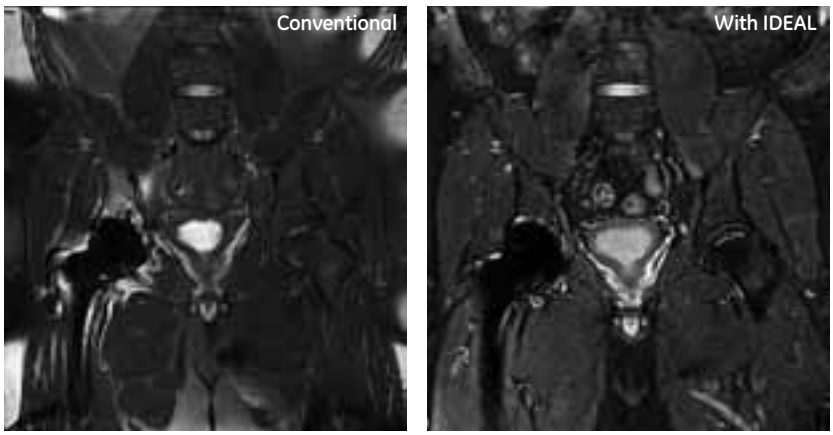
The broad clinical properties, high sensitivity with abundance of SNR, robust, reproducible performance, and relatively short scan times of SWAN make this GE-unique application relevant and attractive for most MR users. ■

An IDEAL Advantage for MSK Imaging

By Anne Cotten, MD

In the clinical practice, techniques to remove or eliminate fat are frequently employed. With spectrally selective techniques, for example fat saturation, inhomogeneity may occur when studying anatomy with a large field of view (FOV), extremities, anatomical regions with magnetic susceptibility differences at air-tissue interfaces (e.g., the lung apices, the cervical spine), and joints with surgical hardware (Figure 1). While another technique, Short Tau Inversion Recovery (STIR) sequence does provide more uniform lipid suppression than frequency-selective fat saturation techniques, it suffers from a lower signal-to-noise ratio (SNR), produces a single type of image contrast (T2W), and is not recommended with post-contrast studies.

A unique and novel technique from GE Healthcare overcomes these issues. IDEAL is a method that acquires three images at slightly different echo times to generate phase shifts between water and fat. The underlying acquisition technique makes IDEAL a particularly SNR-rich sequence that translates into very high spatial resolution potential. Compatible with the latest generations of phased-array coils, IDEAL achieves robust uniform fat suppression, even in the presence of metallic hardware, due to higher SNR and increased spatial resolution (Figures 1). In our facility, we have found IDEAL so useful that we no longer use the fat saturation sequence on these patients. In addition, IDEAL provides unique fat suppression capabilities on the fringes of a large FOV, therefore, we use it for all large FOV studies, particularly of the hips, shoulders, and spine.



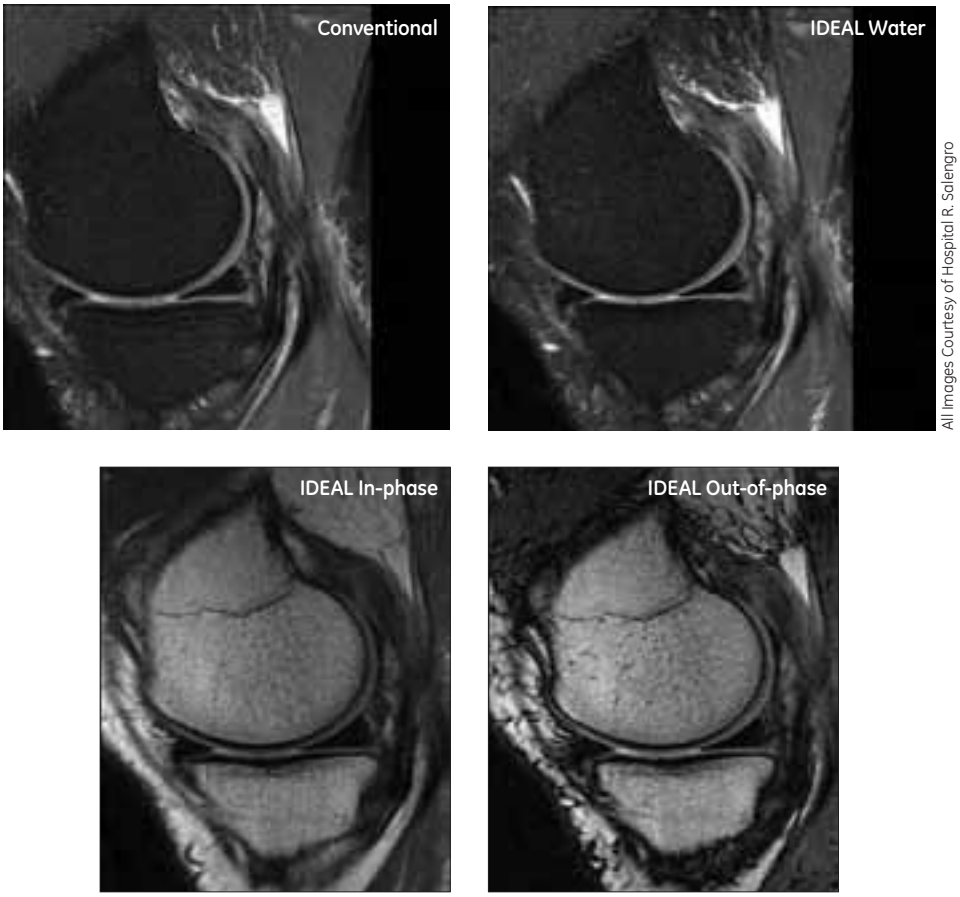
All Images Courtesy of Hospital R. Salengro

Figure 1. Patient with hip prosthesis. Note the artifacts along the neck of the prosthesis and high signal intensity of the acetabular roof indicating local failed fat saturation in the fat sat T2-weighted image on the left. The IDEAL image on the right shows good fat suppression with no artifacts, allowing the assessment of the bone and soft tissues surrounding the hip prosthesis.

Dr. Anne Cotten

Anne Cotten, MD, is Professor of Radiology and Head of the Department of Musculoskeletal Radiology at Hospital R. Salengro, Lille, France. Dr. Cotten is the past secretary and current vice president of the ESSR (European Society of Musculoskeletal Radiology).

The IDEAL technique provides the user four selectable images – water only, fat only, in-phase, and out-of-phase. When applying IDEAL, fat is consistently and reliably separated from water, and can be recombined into "in-phase" and "out-of-phase" images. With other techniques, this would require two separate acquisitions and was clinically impractical due to the length of the exam to generate these four images. Prior to IDEAL, in-phase/out-of-phase imaging was rarely performed for MSK applications in our facility. This ability represents a step forward in MSK imaging that may be useful for the evaluation of intra-articular structures, such as cartilage and the meniscus (Figure 2). Fat images may also have useful indications as shown in Figure 3. ■



All Images Courtesy of Hospital R. Salengro

Figure 2. IDEAL produces two additional informative images – in-phase and out-of-phase – without incurring any additional scan time. Note the nice depiction of the meniscus and cartilage.

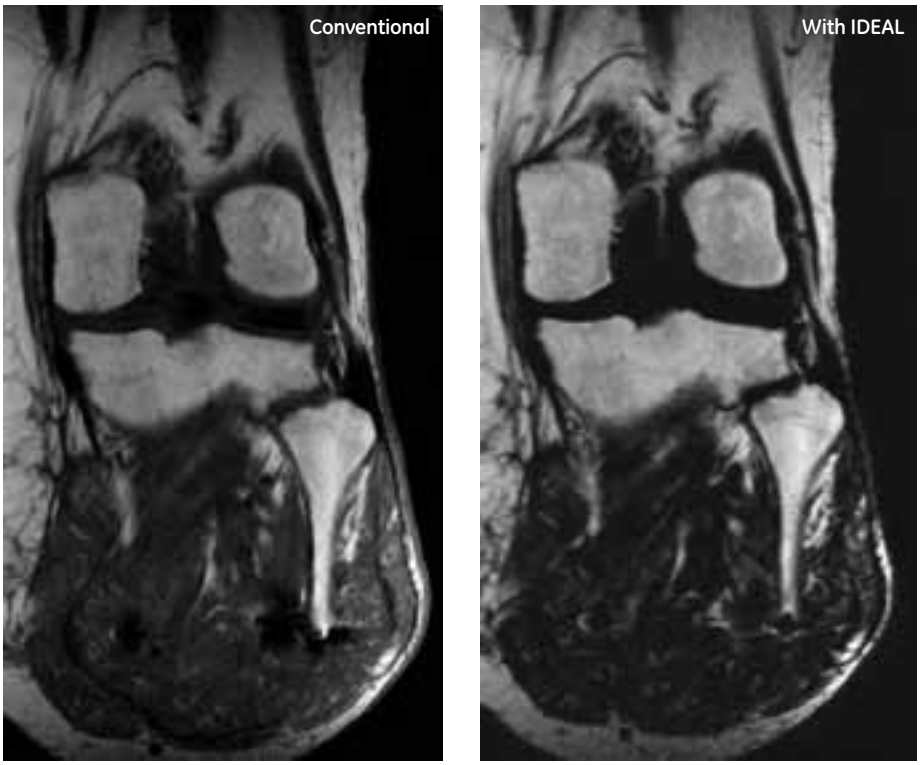


Figure 3. In this amputated leg, the distal end of the fibula is better assessed on the IDEAL fat only image (right) than on the fast spin echo T1-weighted image (left). IDEAL fat-only images may be useful to assess bony structures with fatty bone marrow.

Breaking New Ground in Detecting Early Cartilage Degeneration

MR imaging continues to change sports medicine. High-resolution imaging capabilities coupled with advancements in T2 mapping is opening new doors in musculoskeletal imaging and related orthopedic therapy.

At Mercy Hospital Anderson, William Strub, MD, has seen first-hand the benefit of T2 mapping with the GE Healthcare Signa HDx 1.5T MR and the CartiGram application. "I can see things that I couldn't see before, namely the earliest changes in cartilage degeneration." With CartiGram, Dr. Strub can see the breakdown of cartilage even before there is any change to cartilage thickness.

"Normal cartilage is tightly bound together. When cartilage is damaged, it shows its earliest changes by taking on water," he explains. "T2 mapping with Cartigram picks up the change in signal at this early stage, before the cartilage begins to fragment and breakdown."

The implication of this new capability, in Dr. Strub's opinion, is nothing short of groundbreaking. Identifying cartilage degeneration at an early stage opens new possibilities for extending the applications of current therapies used to treat cartilage damage such as:

- Osteochondral grafting;
- Chondrocyte transplantation; and
- "Microfracture" technique.

Early identification may help the patient benefit from these therapies, notes Dr. Strub. Plus, early detection before cartilage breakdown may potentially prevent irreversible osteoarthritis, although more long-term data and clinical studies are needed to support this. "The CartiGram sequence could also be used to help monitor treatment outcomes," adds Dr. Strub.

Since the application is quick and easy to use, Dr. Strub routinely performs the study on all joint and sports-related injury MR scans. "It takes just a couple of extra minutes to get this invaluable information."

Dr. William M. Strub

William M. Strub, MD, is a staff radiologist at Mercy Hospital Anderson. He graduated Summa Cum Laude with a BA in Chemistry from Saint Louis University and received his doctorate in medicine from the University of Cincinnati College of Medicine. Dr. Strub completed a one-year residency in internal medicine at The Christ Hospital (Cincinnati), where he was voted Intern of the Year from 2001-2002, followed by a residency in diagnostic radiology, including Chief Resident Diagnostic Radiology from 2005-2006, and a body imaging fellowship from The University Hospital (Cincinnati). He has received several honors and awards, including Cum Laude Award for a poster presentation at RSNA 2006 and the RSNA Roentgen Resident Research Award in 2005.

About the facility

Mercy Health Partners (MHP) Southwest Ohio is based in Cincinnati, OH and serves the community through five acute care hospitals and six long-term care campuses that offer a range of services, from skilled nursing to independent living. In 2007, Mercy Health Partners – Southwest Ohio Region was named one of the nation's 100 Most Wired Healthcare Organizations by Hospitals & Health Networks, the journal of the American Hospital Association.

For three consecutive years beginning in 2006, Mercy Hospital Anderson was named to Solucient's annual list of the nation's 100 Top Hospitals and received three-year approval with commendation from the American College of Surgeons' Commission on Cancer, including recipient of its 2005 Commission on Cancer Outstanding Achievement Award.

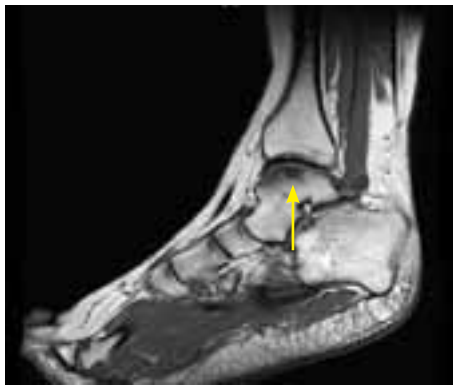
Clinical Case

A 30 year-old athletic female was referred for an MRI scan for persistent, chronic ankle pain that was not responsive to conservative treatment. Prior plain (X-ray) films, taken six months earlier, showed no abnormalities or fractures.

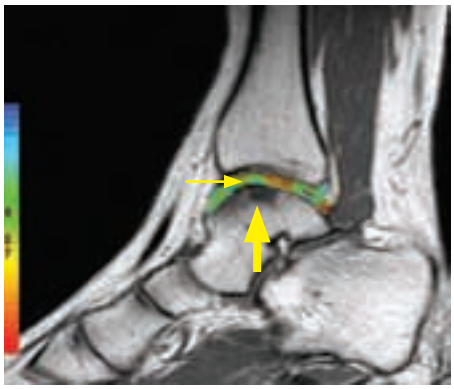
MR Acquisition Protocol

Non-contrast MR was obtained with a Signa HDx 1.5T system using the CartiGram T2 mapping sequence as part of the routine protocol.

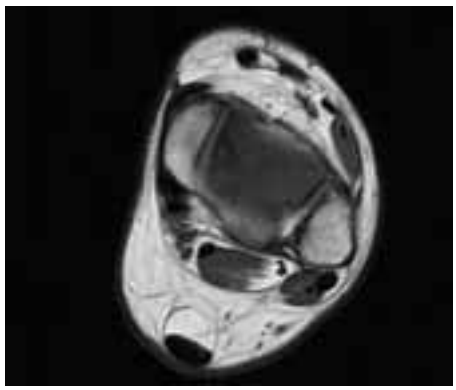
All images courtesy of Mercy Hospital Anderson



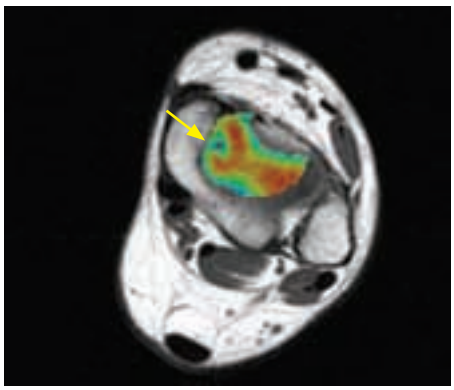
T1 sagittal without CartiGram. Traditional MR sequence showed only a bone bruise (arrow).



Sagittal MR of the ankle obtained using CartiGram. Cartilage damage visible (blue green, small arrow) overlying the bone bruise (large arrow).



T1 axial without CartiGram.



Axial image through the same cartilage injury at the tibial-talar joint. Arrow denotes the focal cartilage injury (blue green) in the normal appearing cartilage (red).

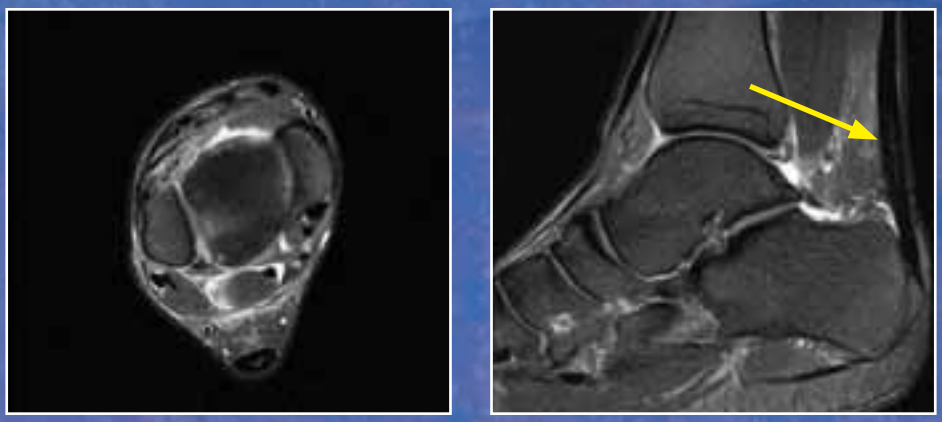
Conclusion

The CartiGram sequence has the ability to provide additional diagnostic information about potential causes of a patient's pain that may not be readily visible on traditional MRI sequences. When implemented in musculoskeletal imaging protocols, CartiGram can help detect changes in their earliest form, helping physicians provide the most comprehensive treatment plan for the patient. ■

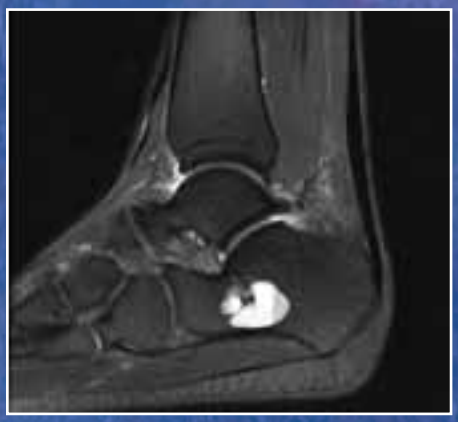
HD Image Quality of Olympic Proportions

Just in from Bejing, these clinical images illustrate the extraordinary athleticism and image quality of the Signa® HDe 1.5T.

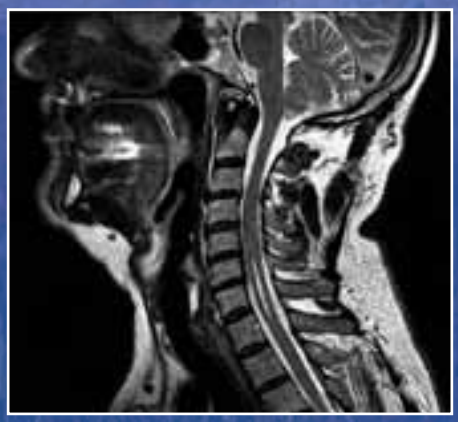
World-class athletes deserve world-class imaging. Chosen for the HD imaging capabilities and energy saving properties, the Signa HDe 1.5T more than proved itself during two weeks of service at the 2008 Olympic Games. That's quite a statement, considering the time pressures and demand for the best care for the best athletes, 688 athletes from 139 countries were scanned on the Signa HDe 1.5T scanner, averaging 20 patients per day on each system. But how'd it perform? See for yourself. ■



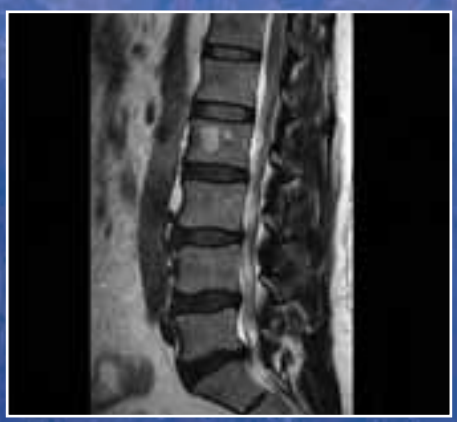
Demonstrates outstanding sensitivity in detecting injury in Achilles tendon
Axial Proton Density Fat Sat and Sag T2 Fat Sat



High resolution ankle image, showing cyst containing fluid
Sag Proton Density with uniform Fat Saturation



HDe detects syrinx in patient's cervical spine
Sag T2 FRFSE



Posterior disc "bulge" at L5-S1
Signal Intensity increase at L2
Sag T2 FRFSE

"The system performed extremely well! The HDe was very stable, and produced excellent high quality images of the athletes who needed treatment. GE also provided outstanding support to us before, during, and after the Olympics, and we couldn't be happier with the results."

Chen Min, MD, Director of Radiology, Beijing Hospital

Non-contrast MRA in the Abdomen: Ready for Clinical Use

By Takayuki Masui, MD, PhD

Due to concerns over adverse reactions to contrast agents such as nephrogenic systemic fibrosis, further advancement of non contrast-enhanced MR Angiography (NCE-MRA) is attracting particular attention. Several methods of NCE-MRA have been suggested, and stable results have been produced. Very promising results have been reported with the Inhance Inflow IR technique, especially for the visualization of the renal arteries.

The Inhance Inflow IR method utilizes the in-flow effect to image arterial flow. Inversion pulse is selectively applied to the acquisition volume to help suppress stationary tissue and venous flow signal, while respiratory triggering help minimize breathing artifacts. Targeted blood vessels can be depicted by utilizing the in-flow effect of unsaturated blood, which enters the acquisition volume at higher velocity and, therefore, is not affected by the inversion pulse (Figure 1). After the saturation of venous blood is achieved, the arterial network is then imaged using 3D FIESTA with spectrally selected inversion recovery pulse for fat in the transverse plane.

Dynamic contrast MRA has been one of the most often utilized radiation-free methods for the detection of stenosis or peripheral aneurysmal dilatation of the renal artery. To selectively visualize the renal arteries against the renal veins and parenchyma, optimal acquisition timing is critical. Even with the use of fluoro-triggering or “SmartPrep” techniques, optimal timing for capturing dynamic arterial phase of renal

arteries is occasionally missed. This may result in overlapped visualization of the renal arteries, veins, and parenchyma when using a maximum intensity projection algorithm for MRA. Therefore, applications such as TRICKS that require an injection of the gadolinium chelate contrast media to capture flow dynamics of the entire arterial and venous filling have been used to visualize the renal arteries without overlaps.

NCE-MRA may provide two major benefits. One is the capability to easily repeat image acquisition with different imaging parameters settings for sufficient image quality to make a confident diagnosis. Second is the excellent contrast between the renal vasculature and the parenchyma (since the latter is never enhanced without contrast media), resulting in good suppression of the background tissue. High-quality images are pivotal for the accuracy of the diagnosis when assessing stenosis (Figure 2) or the aneurysm of the renal artery (Figures 3, 4).

Inhance Inflow IR can become the sequence of choice for the evaluation of the renal artery in patients with stable respiration, eliminating the need for contrast media. This technique enables the potential for further development to visualize vascular structures in the entire body. ■

Dr. Takayuki Masui

Takayuki Masui, MD, PhD, is Chief of the Department of Radiology, Seirei Hamamatsu General Hospital, (Hamamatsu, Shizuoka, Japan). He received his medical and doctor of philosophy degrees from Hamamatsu University School of Medicine, and completed an MRI research fellowship at the University of California, San Francisco. Since 2006, Dr. Masui has served on the editorial board for the Journal of Computer Assisted Tomography. His research is focused on the abdomen, pelvis, cardiovascular MR and CT.

About the facility

Seirei Hamamatsu General Hospital is a core hospital of Seirei Social Welfare Community. As the largest community in Japan, it was established in 1930 and offers more than 100 facilities and 200 services, including five major hospitals, two medical check-up facilities and seven clinics.

Located between Tokyo and Kyoto, Seirei Hamamatsu General Hospital has 744 beds and employs more than 1,500 active medical staff who serve 1,800 outpatients and 700 inpatients each day. Seirei Hamamatsu General Hospital is certified by the Japan Council for Quality Healthcare and Japan Accreditation Council for Healthcare Information Certification, and received the Healthcare Quality Encouragement award.

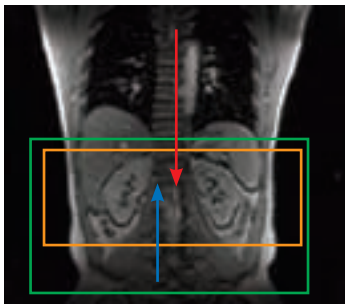


Figure 1. Inhance Inflow IR method utilizes the in-flow effect to image arterial flow.

Orange frame: Acquisition volume
Green frame: Inversion Pulse prep volume
Red arrow: Artery
Blue arrow: Vein

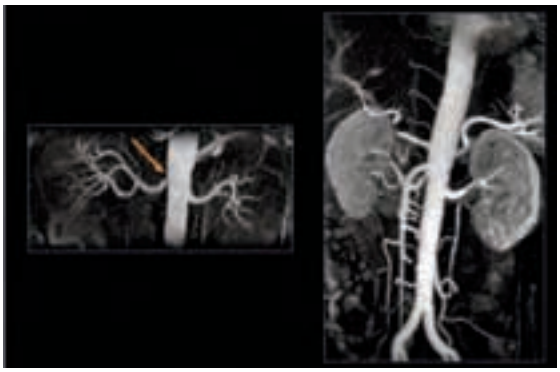


Figure 2. Stenosis of the right proximal section of renal artery, which caused by the surrounding soft tissue tumor is apparent in the Inhance Inflow IR image (left) and confirmed by the CE-MRA image (right).

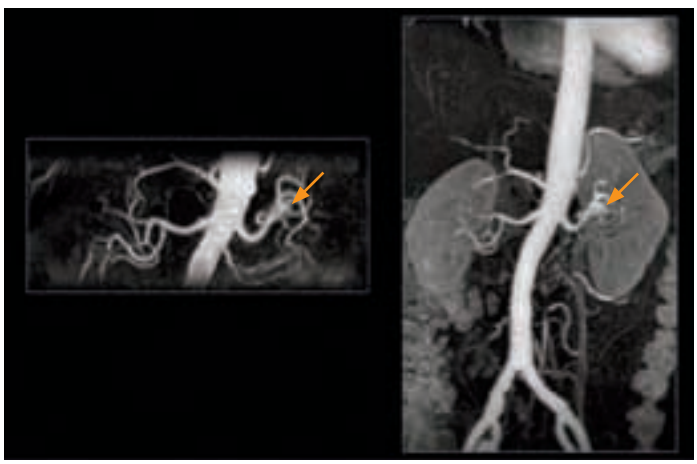


Figure 3. Aneurysm in the periphery of the left renal artery is apparent on the Inhance Inflow IR image (left) and confirmed by the CE-MRA (right).

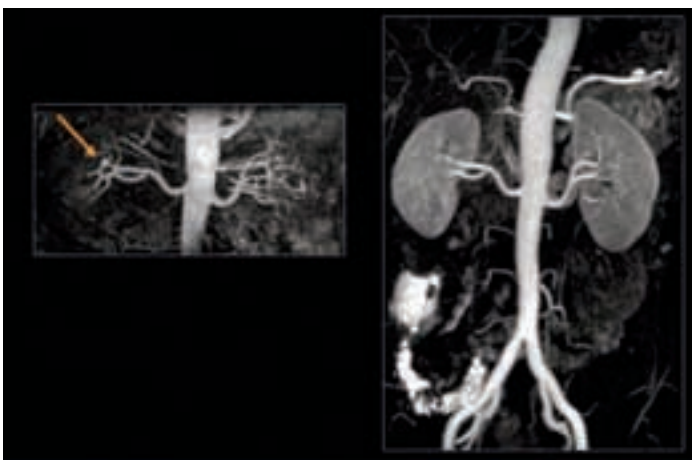


Figure 4. Saccular aneurismal dilatation of the periphery of the right renal artery is well visualized on NCE-MRA (left). Aneurysmal lesions are obscured on CE-MRA (right), due to overlaps with the enhanced renal parenchyma.

MR Angiography using TRICKS with ASSET

By Alexandre Peroni Borges[1]; Paulo R. de Lima Hatschbach[1]; Eduardo M. de Oliveira Jr.[1]; Andre Munhoz[2]; Angelo Turrer[2]; Beatriz C. B. Kaniak[2] ; Luiz Frederico Paiva Prado[2]; Eduardo Figueiredo[3]; Adilson Prando[4]

Introduction

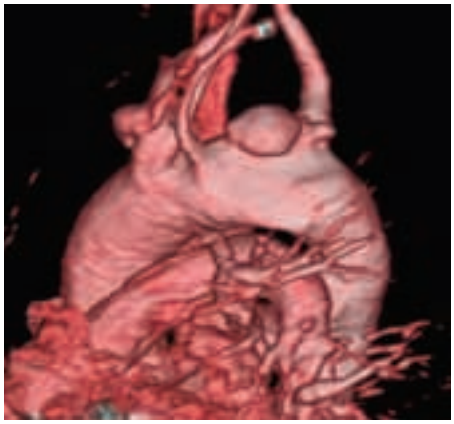
Magnetic Resonance Angiography (MRA) studies have been very challenging because they depend on several subtle techniques, that have direct influence on the failure or success of the exam. Basic requirements of hardware configurations such as high field strength, powerful gradients, and phased array coils are not enough to guarantee a high quality MRA exam. Suboptimal and low quality exams are often the result of inappropriate timing (ideally, image acquisition is performed when the contrast is at its maximum arterial peak concentration in the anatomy of interest) or patient inability to hold breath.

Objective

To examine whether the use of the Array Spatial Sensitivity Encoding Technique (ASSET), and Time Resolved Imaging of Contrast KineticS (TRICKS) techniques improve the quality of thoracoabdominal aorta MRA.

Material and method

A prospective study was performed during December 2005 to May 2006 in 17 patients aged 52 to 82 years (average 67 years; seven were female and 10 male). All studies were performed on a Signa® HD 1.5T MR (GE Healthcare, Milwaukee, WI), 33 mT gradient, and 120 T/m/s slew rate, using the 8 channel body coil. Medrad Spectris® Solaris (Pittsburg, PA) injector was used. The dose of Gadolinium (Magnevistan, Bayer-Schering) was 0.2 ml/kg injected at a rate of 1.5 ml/s, followed by a 20 ml flush of normal saline. The sequence used was a 3D TRICKS with ASSET, with a slice thickness of 3.0 mm to 4.0 mm, a 288x160 matrix, 40 to 48 cm FOV, 62.4 kHz variable bandwidth, and 1 NEX. Image assessment was accomplished by consensus of two radiologists experienced in MRA.



All Images Courtesy of Hospital Centro Medico Campinas

Figure 1. Reconstruction in "Volume Rendering" VR (Anterior view) of the aorta arch demonstrating aneurysm at the emergence of the aberrant right subclavian artery.

Footnote

1. Medical Radiologists at the Hospital Vera Cruz;
2. Resident Doctors of Radiology at the Hospital Vera Cruz at the time of the study.
3. Advanced Application Engineer of GE Healthcare in Brazil
4. Chief of the Department of Radiology of the Hospital Vera Cruz.

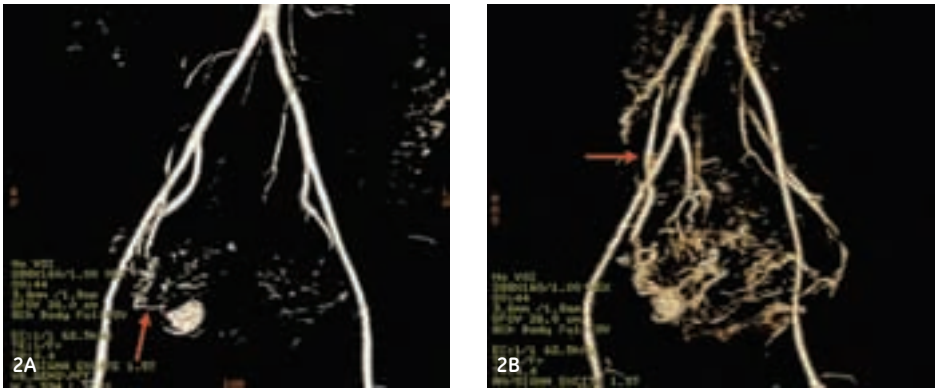


Figure 2. TRICKS MRA with ASSET. Reconstruction in VR (anterior view) in a patient with uterine arteriovenous fistula. Note the dominant nutritive artery in the arterial phase (2A-arrow). In the venous phase, drainage is done by the right ovarian vein (2B-arrow).

Results

Optimal image quality was obtained in 100% of the studies (17 patients). The following changes were detected in these 17 tests: two tests were normal; one showed an aneurysm at the emergence of the aberrant right subclavian artery; two stenoses at the emergence of the renal artery; four thoracoabdominal aneurysms; and, eight thoracoabdominal dissections (two Stanford type A and six type B). The most demonstrative cases are shown in Figures 1 to 6.

Discussion

New techniques, such as parallel imaging with ASSET, provides a 50% scan time reduction (with a trade off of 40% signal loss), and TRICKS MRA, which achieves a high temporal resolution through k space segment sharing, have led to a considerable quality improvement of these exams.

The main advantage of this new technique is the ability to acquire exams with high temporal resolution in two seconds for each 3D volume to accurately demonstrate the dynamics of blood flow. Thus, a good characterization of the real lumen and the false lumen are achieved in an aortic dissection study. The re-entry orifice and the relation of the thoracoabdominal aorta main branches with the true and false lumens are also accurately detected. This capability has significant implications in therapy planning.

The study of aortic aneurysms without a dissection also benefits from this technique. The turbulence and generally reduced flow speed within the aneurysm can lead to weak contrast signal during the arterial phase in tests with low temporal resolution. TRICKS MRA with ASSET allows clinicians to perform studies in patients unable to maintain apnea. Due to its high temporal resolution, respiratory movements do not interfere with image quality.

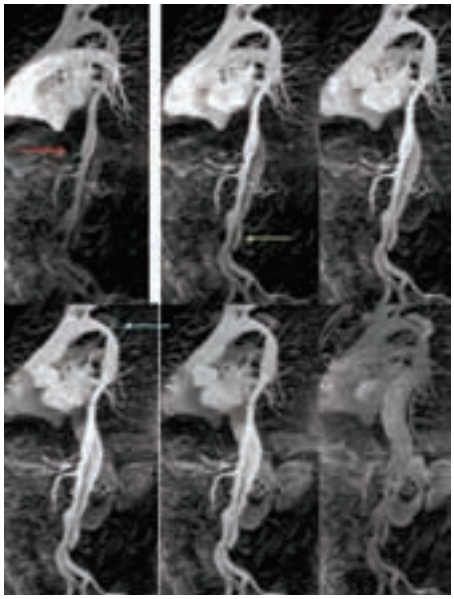


Figure 3. TRICKS MRA with ASSET with multiple phases of 2 s each in a patient with Stanford type B aortic dissection of the thoracoabdominal aorta. Note the premature filling of the real lumen (red arrow). The false lumen shows retrograde filling from the distal aorta (green arrow). There is also delayed anterograde filling of the initial portion of the dissection (blue arrow).

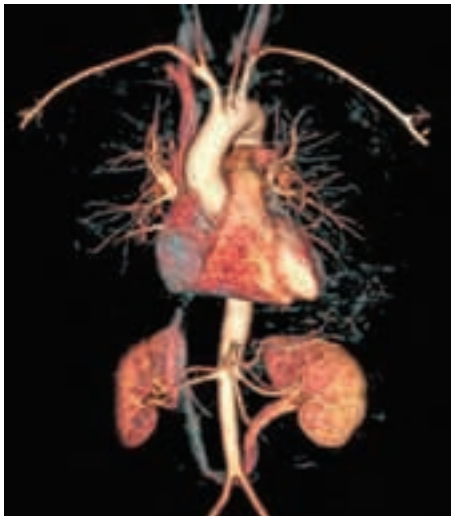


Figure 4. TRICKS MRA with ASSET with 15 phases of 2 s each. Reconstruction in VR (anterior view) demonstrating the retroaortic left renal vein.

Dr. Adilson Prando

Adilson Prando, MD, is Chairman of the Department of Diagnostic Radiology of Hospital Vera Cruz. He completed his fellowship in Diagnostic Radiology at M.D. Anderson Cancer Center, Houston, Texas and is currently the Scientific Director of the Brazilian College of Radiology (CBR). His area of expertise is abdominal imaging with a particular emphasis in uroradiology.

Dr. Alexandre Peroni Borges

Alexandre Peroni Borges, MD, is Chief of the Magnetic Resonance Department at Hospital Centro Médico of Campinas, São Paulo, Brazil. Dr. Borges specializes in Body and Cardiovascular Magnetic Resonance and works in Body MRI research. He completed international fellowships at Advanced Cardiovascular Imaging with Steven Wolff, MD, PhD, in New York and a Body MR fellowship at the University of California San Francisco.

About the facility

Hospital Vera Cruz was founded by a group of physicians in 1943 and is considered one of the best private hospitals in the region of Campinas, São Paulo, Brazil. The hospital continues to grow rapidly by performing procedures in all medical specialties. The hospital's department of radiology, Centro Radiológico Campinas, performs around 10,000 radiological studies per month, including interventional radiological techniques.

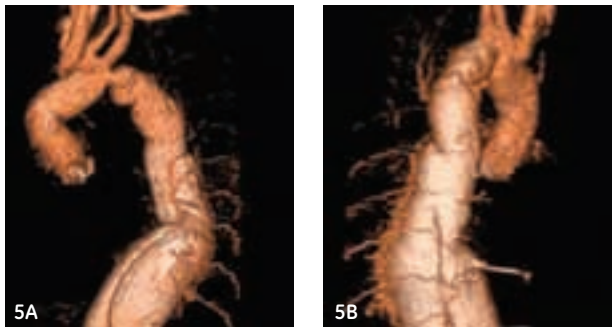


Figure 5. Reconstruction in VR (anterior view) demonstrates stenosis of the distal anastomosis of the prosthesis on the aortic arch, dissection of the descending thoracic aorta. A focal dissection can also be noted affecting the celiac trunk and the left renal artery, which has a pseudo-aneurysm at the emergence (5A). Posterior view demonstrates the emergence of the intercostal arteries from the real lumen (5B).

The disadvantages are associated with lower spatial resolution, compared to the 3D spoiled gradient echo (3DSPGR) MRA technique with ASSET. We should point out, however, that the latter technique has an acquisition time of approximately 20 s per phase, which characterizes low temporal resolution and makes it susceptible to breathing artifacts.

Conclusion

3D contrast MRA TRICKS and ASSET technique allows high temporal resolution image acquisition. This factor provides a good alternative for imaging pathologies such as aneurysms and dissections of the aorta and is indicated for patients who are unable to maintain apnea.

With the arrival of new body coils offering a greater number of channels and more powerful image reconstruction engines, this MRA method promises to revolutionize vascular studies, allowing high temporal and spatial resolution studies. ■

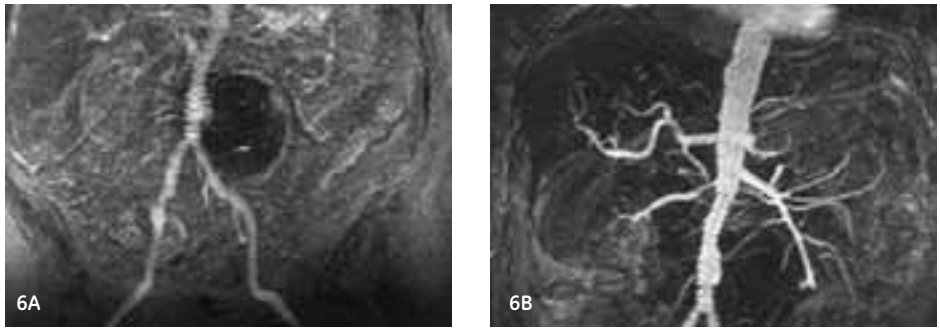


Figure 6. 3D SPGR MRA with ASSET: 1 phase of 20 s smudging of the walls of the major vessels and fading of the smaller caliber vessels are due to the breathing artifact (6A). This same patient had a TRICKS MRA with ASSET at 15 phases of 2 s each, contrast peak in the arterial phase, showing optimal characterization of the abdominal aorta and its branches (6B).

MRI of Congenital Heart Disease

Evaluation of Shunts and Quantification of Qp/Qs

By S. Gay Luebchow, RT (R) (MR)

Background

The amount of blood that is pumped to the systemic circulation (Qs) via the left heart is typically the same as that pumped to the lungs (Qp) for re-oxygenation. If one measures the flow in the main pulmonary artery and compares it with the flow in the ascending aorta, the Qp/Qs ratio may be determined.[1] When this ratio deviates from the normal 1:1 value it is often a result of blood being shunted via a variety of conduits that are typically grouped under the term Congenital Heart Disease.[2] Qp/Qs flow results are often used to determine subsequent intervention and therapy.

Shunting is the term used to describe the flow of blood in the heart that doesn't follow the normal flow path and often allows blood to traverse from one side of the heart to the other, resulting in a mixture of arterial and venous blood.

Congenital heart diseases are most often diagnosed during childhood, although some are detected in adulthood. Common congenital heart defects associated with shunting are Atrial Septal Defect (ASD, Figure 1),[3] Ventricular Septal Defect (VSD, Figure 1),[3] Patent Ductus Arteriosus (PDA, Figure 2)[3] and Partial Arterial Pulmonary Venous Return (PAPVR, Figure 3).[3]

Figure 1. ASD/VSD

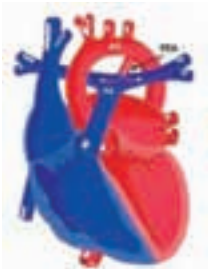


Figure 2. PDA

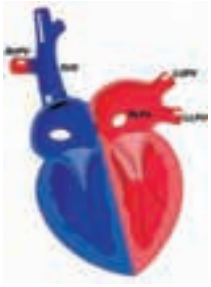


Figure 3. PAPVR

Graphics and Images Courtesy of: Cove Point Foundation, Congenital Heart Disease, Helen B. Taussig Children's Heart Center John Hopkins University. Advanced Cardiovascular Imaging, New York, NY

Methodology

MRI is a safe and non-invasive method to determine blood flow within the cardiovascular system using gated phase contrast pulse sequences.[3] Phase contrast relies on velocity induced phase shifts to distinguish flowing blood from stationary tissue. An RF excitation pulse is applied to the volume of interest, which incorporates two bipolar gradients. As blood moves across the applied gradients, phase shifts are acquired to calculate velocities. By summing the total velocities within a vessel, MRI can accurately quantify blood flow in ml/s.

Phase contrast slices are positioned perpendicular to the ascending aorta (Figure 4) and main pulmonary artery (Figure 5). Each sequence is scanned and data sets are analyzed with ReportCARD. Regions of interest (ROIs) are placed around each vessel (Figures 6 and 7). Flow curves and flow volumes are automatically generated (Figure 8). Flow measurements from the aorta determine blood volume in the left side or systemic heart. Flow measurements from main pulmonary artery (MPA) represent blood volumes in the right side or pulmonic heart. These values are then compared for each vessel to determine Qp/Qs ratio.

Sequence

Protocol: Fast 2D phase contrast
TR: Min Full
Flip Angle: 20
Bandwidth: 31 kHz
FOV: 40 cm
Thickness: 8 mm
Gap: 0 mm
Matrix: 256 x 128
NEX: 1
Pfov: 1
Imaging Options: Gating, Sequential, Fast

Gating Screen:

- Arrhythmia Rejection Window = 20
- Trigger Delay = min
- Number of Cardiac Phases = 30
- VPS = 4-8

Vascular Screen:

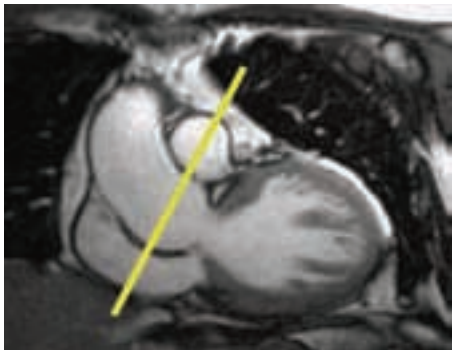
- Collapse = Off
- Flow Analysis = On
- Flow Recon = Phase Diff
- Flow Direction = Slice
- VENC = Aorta 250 cm/s, MPA 150 cm/s

User CVs : CV0 =1, CV2 = 0
Scan Time: ~ 15 s/slice

Discussion

There are many degrees of shunts associated with congenital heart defects (CHD). These defects may be asymptomatic or may produce symptoms that range from mild to severe, depending on the size, location, and number of shunts present. Larger shunts may cause the pulmonary vessels to become congested resulting in more severe symptoms such as congestive heart failure. In addition, shunting defects are often present in combination with other defects.[3] Typically, blood flows from higher resistance to lower. Shunts are classified as right-to-left, left-to-right, or bi-directional. Over time, shunting defects often affect left and right heart pressures, which may be beneficial or detrimental to the patient's condition.[3]

Cardiac shunts are often initially diagnosed with a combination of contrast-enhanced angiography, cardiophysiology techniques, and Doppler echocardiography.[4] Although very effective, angiography is invasive and requires follow-up imaging, exposing patients multiple times to radiation and iodinated contrast injections. MRI offers assessment of cardiac morphology, function, and flow without radiation exposure, which is most important to the pediatric and young adult population. For adults, the absence of radiation exposure is important. Because most surgical procedures performed on adults with CHD are re-operations – modifications or revisions of procedures that were performed in childhood – additional operations are often necessary because the original repair has lost some of its effectiveness as the pediatric patient grows into adulthood, or because new anomalies have developed.[3]



Images courtesy of: Advanced Cardiovascular Imaging, New York, NY

Figure 4

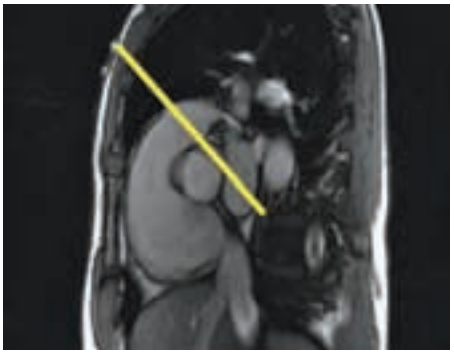


Figure 5

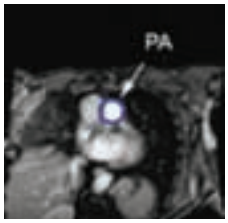


Figure 6

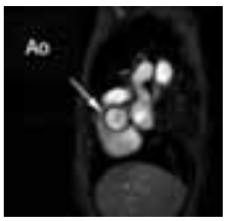


Figure 7

S. Gay Luebchow

S. Gay Luebchow, RT (R) (MR), is an Advanced MR Cardiovascular Applications Specialist for Neosoft, dedicated to training 1.5T and 3.0T users on cardiovascular MRI. Previously Luebchow was a GE MR Field Applications specialist for 4 years based in the SE sector of the USA. She has extensive cardiac MR experience with years of clinical experience as an MRI technologist at Wake Forest University Baptist Medical Center, North Carolina. Luebchow has assisted in the development of cardiovascular training programs, and has globally trained physicians, applications specialist and technologists in the area of cardiovascular MRI.

Treatment

Location, size, and severity of shunt defects are essential data points for patient management. Qp/Qs is important because the possibility of surgery depends partly upon pulmonic flow results. Location of shunts are typically an abnormal interrelation at the atrial, ventricular, or aortic levels. Shunt size depends on the pulmonary vascular resistance and size of the communication defect. The normal systemic vascular resistance is always greater than the pulmonic vascular resistance and the pressures in the left heart and aorta are always greater than the right heart and pulmonary artery. Therefore, a non-complicated defect will have left-to-right shunting and the Qp/Qs > 1.[2] Generally, Qp/Qs < 1.5 is considered a small shunt, Qp/Qs ≥ 1.5 to 2.0 is considered a moderate shunt, and Qp/Qs > 2.0 is considered a large shunt.[2] Asymptomatic patients with a Qp/Qs ratio of < 1.5 are usually managed conservatively, and patients with a Qp/Qs ratio of > 1.5 are commonly referred for surgical intervention or correction.[1]

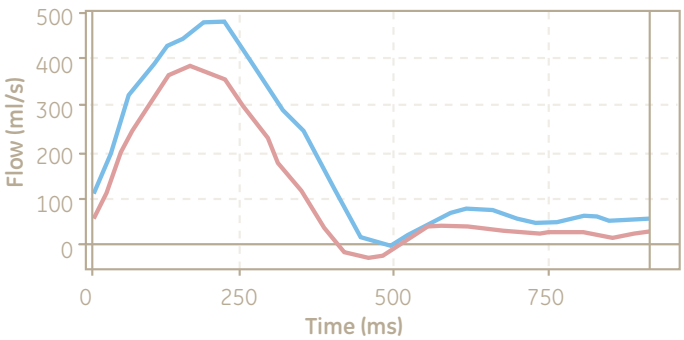


Figure 8. ReportCARD Flow Curve Analysis

Summary

Cardiovascular shunts associated with congenital heart disease are often suspected on echocardiography and confirmed by cardiac catheterization and oximetry. MRI is emerging as a powerful non-invasive diagnostic tool that provides a comprehensive evaluation of systemic and pulmonic blood volumes, cardiovascular morphology and cardiac function.[1] Due to the nature of CHD, patients are repeatedly imaged over their lifetime and so reduction of the radiation burden on such patients is paramount, particularly in the pediatric population.

MRI is considered a powerful, non-invasive diagnostic tool for planning therapeutic management and surgical strategies for patients with congenital heart disease.[4] ■

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Non-Contrast Enhanced Renal MRA

By Thorsten Alexander Bley, MD

Multiple non-contrast-material enhanced MR Angiography (NCE-MRA) techniques have been available for several years, including Time-of-Flight (TOF) MRA, phase-contrast (PC) MRA, and balanced steady-state free precession (FIESTA). Because of recent concerns over the association between gadolinium-based contrast material and nephrogenic systemic fibrosis (NSF), there has been a renewed interest in the use of NCE-MRA. Also, significant improvements in MR scanner technology and sequence design, including parallel imaging techniques, have facilitated tremendous improvements of these methods.

Due to multidirectional flow pattern and respiratory motion, the renal arteries can be problematic for flow-dependent NCE-MRA techniques. In TOF MRA, bright intraluminal signal results from inflowing, unsaturated protons. Stationary protons surrounding the vessel are saturated by repeated RF pulses resulting in signal loss. This technique works well with through-plane flow. In-plane flow, however, becomes saturated, and for this reason, TOF MRA methods are limited for evaluation of renal arteries. For the renal arteries, balanced SSFP (FIESTA) sequences have been shown to be an excellent alternative.

The latest NCE-MRA sequence from GE Healthcare for assessment of the renal arteries, Inhance Inflow IR, combines the benefits of the inflow effects of TOF MRA and the bright luminal signal of the FIESTA sequence. These are combined with an inversion recovery pulse to suppress venous signal.

Inhance Inflow IR is a new angiographic sequence specifically developed to deliver consistent, reproducible images of the renal arteries with excellent ability to suppress static background tissue and venous blood. This 3D FIESTA-based application produces high-quality 3D bright blood images with significantly increased signal-to-noise ratio (SNR). A selective inversion pulse is applied over the region of interest (ROI), which inverts the magnetization of arterial and venous blood, as well as static tissue. Subsequently, during magnetization recovery, another pulse is applied at the time of the null point of venous blood to sample the arterial signal. The net result is an angiographic image with robust background suppression that is virtually free of venous contamination. Spectrally selective inversion recovery fat suppression using an adiabatic RF pulse is implemented to provide uniform fat suppression, while respiratory gating minimizes respiratory motion artifacts in free-breathing renal artery MRA.

In our experience at the University of Wisconsin-Madison, the Inhance Inflow IR technique has reliably produced excellent image quality in both animal studies and clinical MRI examinations in patients. This push-button sequence is very easy to use; simply upload it and choose the correct field of view to include both kidneys and renal arteries. Respiratory motion is eliminated by using the respiratory bellows. The technique is also appreciated by patients as it does not require any breath-holding. This is particularly beneficial with sick or sedated patients who are unable to hold their breath. The image acquisition time is typically four to five minutes followed by data reconstruction for immediate availability of the images for viewing.

Convinced by the excellent image quality and robustness of this technique, our facility has started applying the Inhance Inflow IR sequence in patients for evaluation of the renal arteries. As a result, we have experienced excellent renal artery delineation, which includes the first and second degree branch vessels (Figure 1). This technique can be used to evaluate renal artery stenosis in the workup of renovascular hypertension. Accessory renal arteries can be reliably depicted, which is important for surgical planning (Figure 2). This sequence has also been shown to be feasible in the diagnosis of fibromuscular dysplasia, an entity that requires high quality, high spatial resolution MRA.

It is known that contrast-enhanced MRA (CE-MRA), and to a greater extent, flow-dependent MRA techniques, may produce false positive results by overestimating the severity of stenoses. As vascular radiologists, we are aware of this potential pitfall in MRA. To better understand the performance of the Inhance Inflow IR technique, we conducted in our lab an animal study with surgically produced renal artery stenoses of various degrees (Figure 3). For precise quantification of the true degree of renal artery stenosis, a 3D rotational catheter angiography was obtained. The 3D data set was reformatted to display orthogonal cross sectional images of the stenosis in the renal artery proximal and distal to the stenosis (Figure 4). This study demonstrated that the Inhance Inflow IR sequence produces consistent results. In cases of ambiguous results the Inhance Inflow IR sequence and the CE-MRA were found to overestimate the degree of the stenosis (Figures 5). Just as with CE-MRA, it is important to recognize the properties of the Inhance Inflow IR method, as it does increase our level of confidence when interpreting a normal NCE-MRA of the renal arteries. ■

Figure 1. A 27 year-old female patient with severe hypertension was referred for MRA to rule out renal artery stenosis. The two free breathing, non-contrast enhanced sequences Inhance Inflow IR and Inhance 3D Velocity were acquired with a Signa® HDxt 3.0T scanner. Renal artery stenosis was confidently excluded. The renal artery anatomy with three arteries on the left and one single artery on the right are viewed without image degrading artefacts. CE-MRA confirms the findings.

Dr. Thorsten Alexander Bley

Thorsten Alexander Bley, MD, is a visiting Assistant Professor of Radiology at the University of Wisconsin-Madison, Department of Radiology. Prior to this, he held the position of Assistant Professor of Diagnostic Radiology at the University of Freiburg, Department of Radiology and Medical Physics. Dr. Bley completed his residency at the University of Freiburg after receiving his medical degree in July 1999 at Westfalian-Wilhelms, University of Muenster. He is a member of the RSNA, ECR, the German Roentgen Society and the Society of Cardiovascular Computed Tomography (SCCT).

About the University of Wisconsin-Madison

University of Wisconsin Hospital and Clinics is a 471-bed facility that ranks among the finest academic medical centers in the United States. Frequently cited in publications listing the nation's best healthcare providers, University of Wisconsin Hospital and Clinics is recognized as a national leader in fields such as cancer treatment, pediatrics, ophthalmology, surgical specialties, and organ transplantation.

The University of Wisconsin Hospital and Clinics offers more than 800 active medical staff and more than 80 outpatient clinics. The hospital has six intensive care units (trauma and life support, pediatric, cardiac, cardio-thoracic, burn, neurosurgery) with 74 total beds, and is one of only two organizations in Wisconsin with designated Level One adult and pediatric trauma centers.

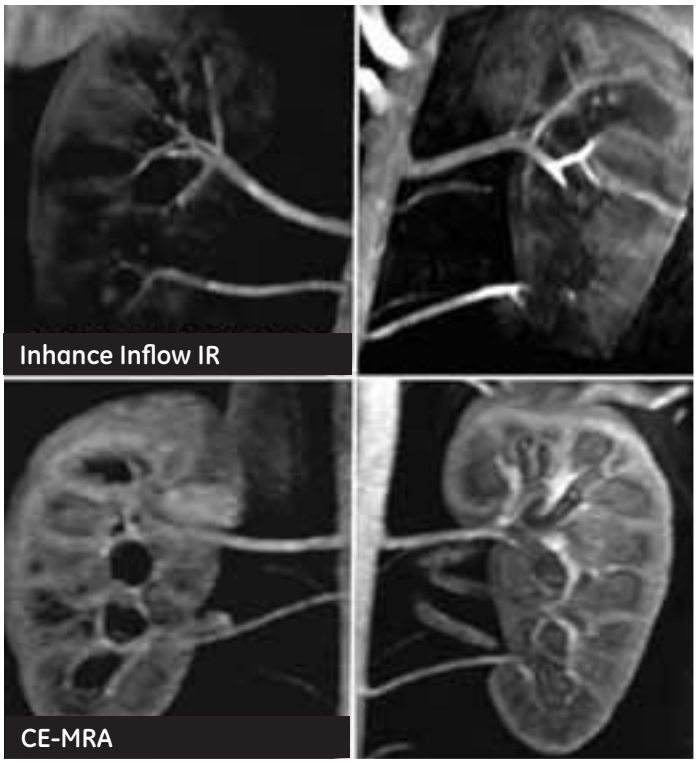

Figure 2. A 52 year-old patient with two renal arteries imaged bilaterally. The two MRA techniques, Inhance Inflow IR (top row) and CE-MRA (bottom row), can hardly be discerned. Both techniques reveal the anatomy in excellent image quality. The faint venous signal seen in the suprarenal inferior vena cava and the renal veins can be used to differentiate CE-MRA from the NCE-MRA Inhance Inflow IR sequence.

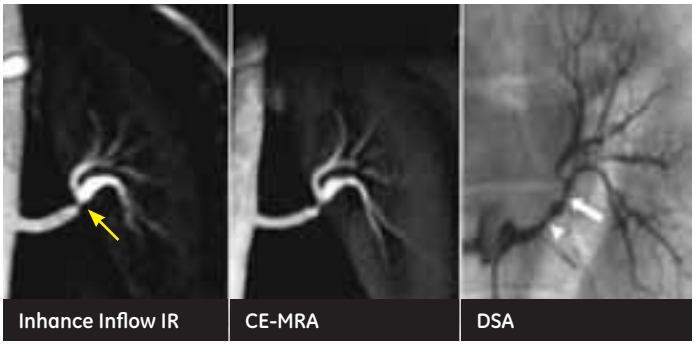

Figure 3. Surgically created stenosis of the left renal artery in a porcine model. Non-contrast Inhance Inflow IR sequence readily reveals the location and severity of stenosis (arrow). Morphology and severity of the stenosis has similar appearance on CE-MRA. Digital Subtraction Angiography (DSA) confirms the finding of an approximately 58% stenosis (arrow). Please note that the vasospasm (arrowhead) proximal to the surgically created stenosis has resolved at the time of MRA.

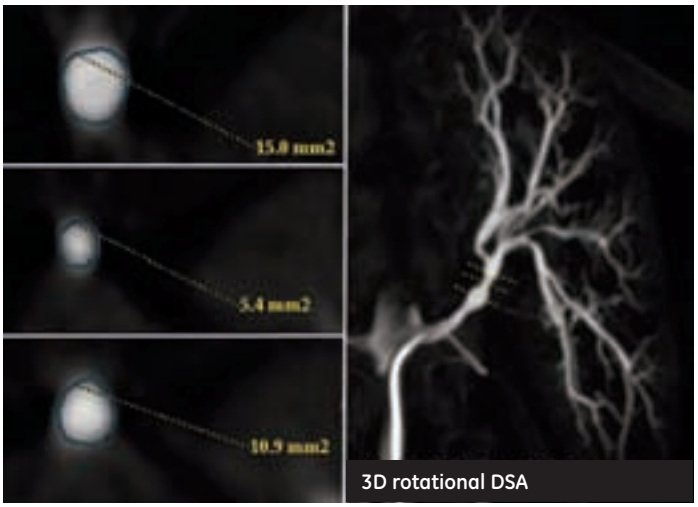

Figure 4. 3D rotational DSA of the same left porcine renal artery was used to precisely quantify the degree of stenosis. Planimetry of orthogonal sections of the renal artery was performed proximal, within the stenosis and distal to the stenosis (as marked on the right by the yellow dotted lines), and revealed a significant stenosis with 58% luminal narrowing.

Figure 5. Surgically created stenosis of the right renal artery in a porcine model. NCE-MRA Inhance Inflow IR sequence readily reveals a significant stenosis. A faint residual lumen can be appreciated on the Inhance Inflow IR and on the CE-MRA. DSA confirms the findings of a 70% stenosis.

Dedicated Breast MR System Helps Moffitt Increase High-Risk Patients' Access to Expert Care

While many cancer centers strive to prevent and cure cancer, only a few have the resources to translate scientific discovery into real-world patient benefits. H. Lee Moffitt Cancer Center & Research Institute in Tampa, FL is one of them.

Focused on a broad-based cancer care delivery system, the Moffitt Total Cancer Care is dedicated to providing far-reaching access to the latest discoveries in lifesaving research and delivering the highest standard of patient care.

According to Moffitt's CEO and Center Director William S. Dalton, PhD, MD, "The goal is to increase access to expert cancer care for as many people as possible." That includes availability to the latest technology, as well as addressing the cancer care needs of the population in both prevention and treatment. An example of one new technology is breast MRI.

When the American Cancer Society recommended new guidelines for breast MRI in high risk women, Lynne Hildreth, Director of the Lifetime Cancer Screening & Prevention Center, and Christy Smallwood, Radiology Supervisor, saw an opportunity to increase patient access. "Even though we had access to an MR system a couple days each week, the demand became so high that we weren't able to accommodate the 30 or more women needing studies each week," explains Hildreth. "That is when we realized our center needed its own dedicated breast MR system."

After a thorough review of available MR systems, Moffitt selected the Signa® Vibrant 1.5T dedicated breast MR system from GE Healthcare. According to Hildreth and Smallwood, the decision was based on image quality, ease of use and the Sentinelle Vanguard™ table.

Vanguard is a trademark of Sentinelle Medical Inc.

Dr. Christine Laronga, FACS

Christina Laronga, MD, FACS, is a surgical oncologist and Chief of the Comprehensive Breast Program at H. Lee Moffitt Cancer Center & Research Institute. Breast cancer has been Dr. Laronga's passion for many years. Her interests are broad and range from bench basic science research to translational research and patient care. Dr. Laronga's current research involves creating blood protein profiles to diagnose breast cancer or differentiate between different aspects of breast cancer such as race or genetics. Her clinical research focuses on lymphedema and nipple sparing mastectomy. Her clinical expertise spans from diagnosing and treating breast cancer, and she is known for her compassionate and cutting edge care.

Dr. Margaret M. Szabunio

Margaret M. Szabuino, MD, is a diagnostic radiologist and Chief of Breast Imaging at H. Lee Moffitt Cancer Center & Research Institute. Dr. Szabunio has focused on breast imaging for over 15 years. Dr. Szabunio has a strong interest in cancer research and clinical trials and is currently the principal investigator for a study on sonoelastography in the characterization of breast nodules. She is extensively involved in education and teaching activities on the international, national, and local levels and is the director of the breast imaging fellowship program at Moffitt.

Lynne Hildreth

Lynne Hildreth is Director of the Lifetime Cancer Screening Prevention Center.

Hildreth feels the new breast MR system took very little time to ramp up and was a great decision. "A typical facility will do three to four studies per day when they first get started doing breast MRI" she says. "Within one month of installing the equipment, we are consistently performing five to six breast MR studies each day, and expect to increase to eight or more within six months." The center works hard to fulfill urgent exam requests by filling last minute cancellations or adding on patients as needed.

The importance of breast MRI

At Moffitt, the Signa® Vibrant is more than a tool for evaluating high-risk patients. "An MRI provides crucial information on the extent of breast cancer – information that often helps a patient decide which course of treatment to follow," says Smallwood. One of the first decisions a women diagnosed with breast cancer must make is whether or not to undergo breast conservation surgery. "The high sensitivity of breast MRI can often confirm a women's choice to keep her breast or provide information on other suspicious lesions that may lead her to convert to a mastectomy," says Christine Laronga, MD, FACS, Chief of the Comprehensive Breast Program.

According to Margaret M. Szabunio, MD, Chief of Breast Imaging at Moffitt, MRI does increase detection in certain select populations. "We run a high risk clinic, and we know that MRI increases detection of breast lesions in this select population."

Breast MRI can be used to:

- Evaluate abnormalities found through mammography or other imaging modalities;
- Detect early breast cancer in women at high risk for the disease, particularly those women with dense breast tissue for whom mammography is less effective;
- Screen women who have implants and/or scar tissue that limit the effectiveness of mammography;
- Determine the integrity of breast implants;
- Assess for multifocal or contralateral disease prior to breast conservation surgery;
- Determine whether the cancer is more extensive than the mammogram reflects or invades into the chest wall;
- Review the margins at the surgical site after a breast biopsy or lumpectomy to assess the extent of residual disease if positive margins are encountered; and,
- Measure the patient's response to neoadjuvant chemotherapy.

In one recent case, Dr. Laronga shares, "a patient had a needle localization lumpectomy revealing DCIS. At three of six margins, pathology showed remaining cancer. An MRI was performed to estimate the amount of residual disease with regards to continued breast preservation. While the MR confirmed that the other margins were clear, I was surprised to find that there was additional DCIS in an unsuspected adjacent area. If not for the MR, I would have only known to address the disease at the margins based on the pathology report – and in time, this woman would have had a recurrence."

Enhancing the continuum of care

As important as breast MR is to the diagnostic armament at Moffitt, Dr. Szabunio is cautious. "None of these diagnostic imaging techniques stand alone. Ultrasound, mammography, and MRI all complement each other. We don't view the patient condition in a tunnel, rather we put the whole picture together and correlate the studies."

Running multiple breast clinics specializing in high-risk, undiagnosed and diagnosed cancer patients, Moffitt needs all the proper tools for Total Cancer Care. Dr. Szabunio believes that any center conducting breast MR should also have the capability to biopsy. "It is simply good patient care; there is nothing worse for these women than the uncertainty of whether or not they have the breast cancer," Dr. Szabunio says. In fact, she finds the Vanguard™ table on the Signa® Vibrant enables more access to tissue for biopsy.

Similarly, having radiologists who specialize in breast imaging is also important. Out of the 20 radiologists practicing at Moffitt, five specialize in breast imaging. "Using dedicated breast imagers is the trend in radiology," adds Dr. Szabunio. "They perfect the technique and can then teach others."

At Moffitt, patients receive much more than screening or diagnostic studies, biopsies, and breast surgery. The entire center is dedicated to preventing and curing cancer, from genetic testing to radiation and medical oncology treatment delivery.

"As a multi-disciplinary cancer prevention center, our specialists work together to collectively determine treatment," says Dr. Laronga. "One hundred percent of our breast cancer cases are peer reviewed with the images. We find these discussions are not only very effective for recommending the best course of treatment, but it truly allows us, as a team, to personalize patient care."

In addition to greater clinical collaboration, Dr. Laronga notes that another advantage of bringing cancer diagnosis and treatment under one roof is the proximity of the imaging tools. Mammography is next to the breast ultrasound system, which is next to the breast MRI unit. The surgical clinics surround this area as well. "For the surgeon, we can walk right over for consultation with the breast imager to formulate a plan for patient care."

The approach further enhances patient care, notes Dr. Szabunio. "In addition to having all the right diagnostic tools, communication is important in patient care," she says.

Looking ahead

Despite the proven value of breast MR, both Dr. Szabunio and Dr. Laronga caution against inappropriate utilization. "MRI is a complementary tool that is very important, and referring physicians should understand the benefits of this exam in select populations," explains Dr. Laronga. "Breast specialists also need to educate other clinicians on when the test should be ordered."

Dr. Szabunio also calls for the development of industry standards as they pertain to conducting the MR imaging study, radiology reading, and reporting and performing the biopsy - similar to the Mammography Quality Standards Act.

"MRI won't replace mammography," Smallwood adds, "although it does close the imaging loop." ■

About the facility

H. Lee Moffitt Cancer Center & Research Institute has made a lasting commitment to the prevention and cure of cancer, working tirelessly in the areas of patient care, research and education to advance one step further in fighting this disease. As part of an elite group of National Cancer Institute (NCI) Comprehensive Cancer Centers, Moffitt focuses on the development of early stage translational research focused on quickly adapting scientific discoveries to benefit patient care. Since the first patient admission in October 1986, Moffitt physicians, scientists and staff members have worked together to establish a tradition of excellence offered in an atmosphere characterized by kindness, caring and hope. The Cancer Center's future growth in clinical care and research, and fulfillment of its mission to contribute to the prevention and cure of cancer, rests firmly on this tradition and makes possible the changes ahead.

GE Healthcare

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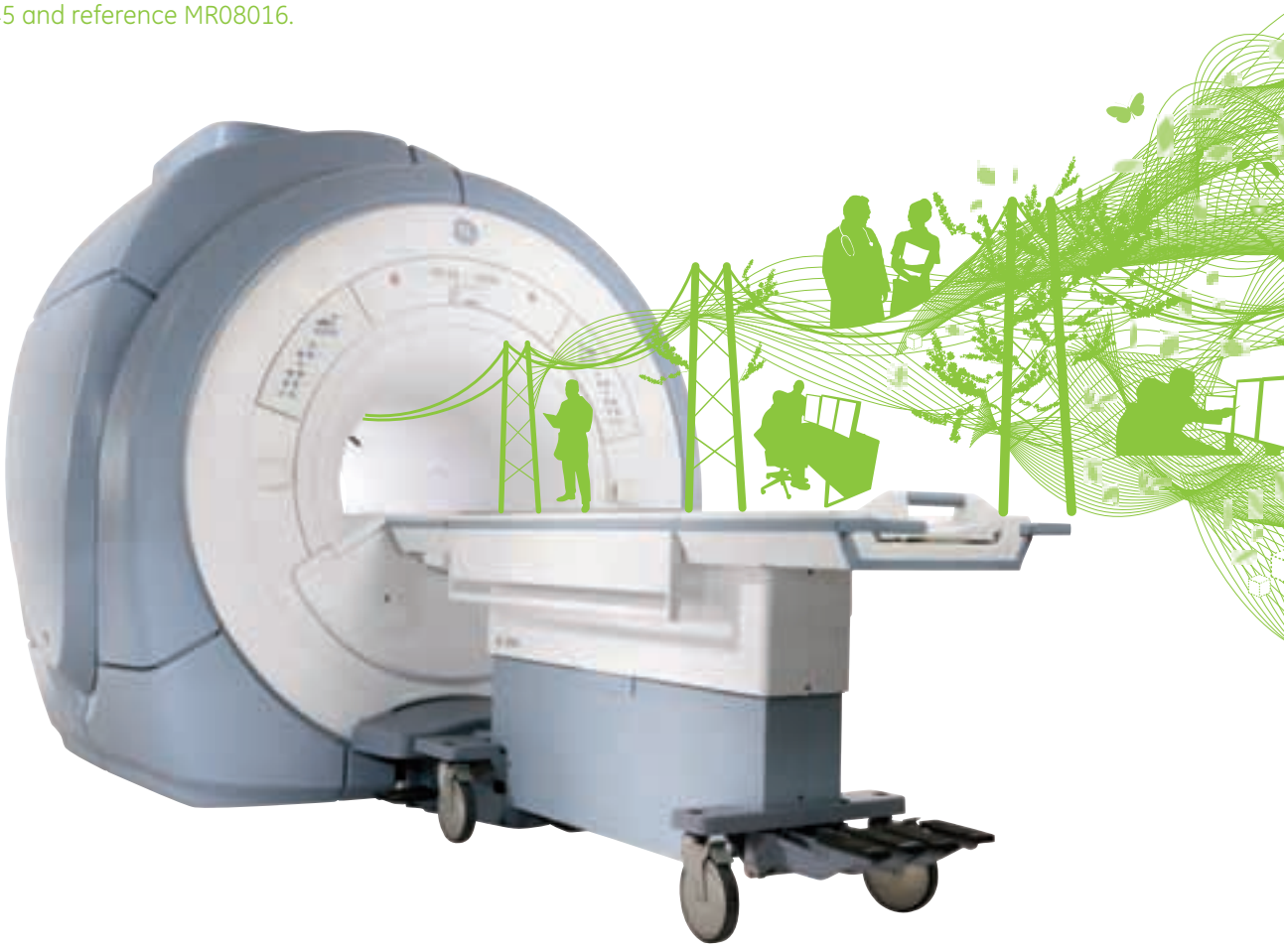

imagination at work

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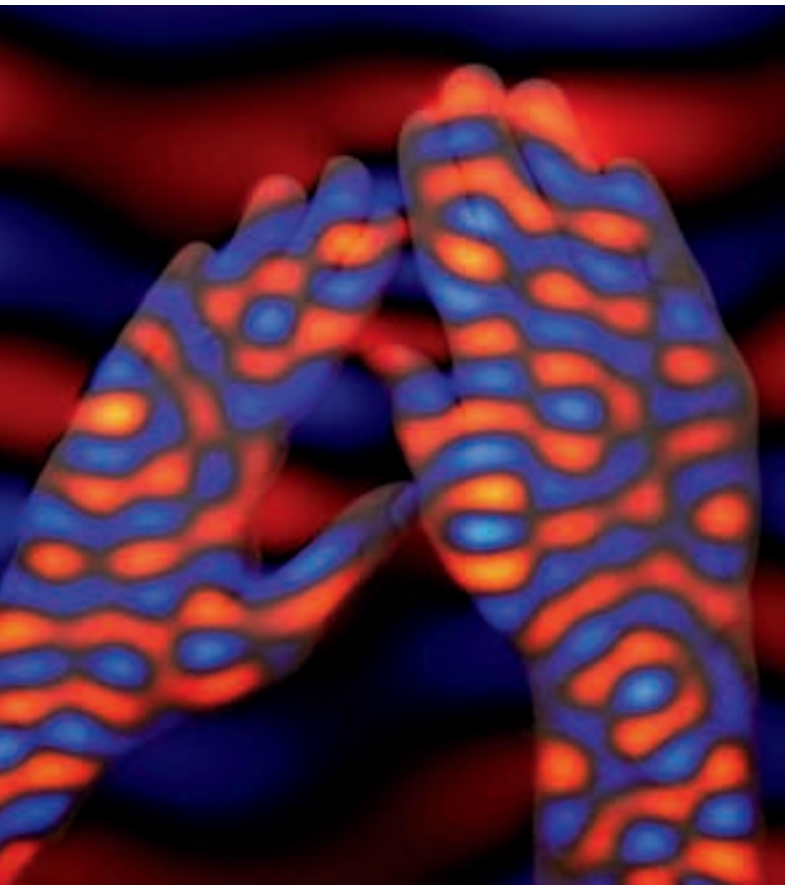


A New Touch for MR Imaging*

Advances in medicine come about in a variety of ways: new technologies that allow clinicians to visualize body structures and functions they've never seen before, novel therapies that bring new hope to patients, and basic advances in the understanding of the molecular basis of disease that offer physicians new capabilities in prediction and prevention of illness.

On few occasions, medical advancements bring together the new with the old. This is the case with MR-Touch. More than just an a new pulse sequence, MR-Touch, is an MR elastography (MRE) technique that brings together advanced MR imaging with the age-old clinical skill of touch palpation.

MR-Touch provides an imaging counterpart to the physical examination technique called palpation. For centuries, clinicians have used simple touch to assess the mechanical properties of tissue, and this has served as an incredibly powerful diagnostic tool to detect diseases. MR-Touch allows physicians to assess these same tissue properties at a much higher sensitivity than can be achieved by palpation and in regions of the body that are inaccessible to palpation.

MR elastography – what is it?

Invented at Mayo Clinic (Rochester, MN), MRE is a technology that employs low frequency mechanical sound waves in combination with MRI to probe the mechanical properties of tissue. The technique is implemented as a software and hardware upgrade to a conventional MR scanner and can be easily included in standard MRI protocols.

During MRE acquisition, mechanical waves in the range of 40 Hz to 200 Hz are generated in the tissues of interest using a compact, nonmetallic MR compatible acoustic driver device that is placed in contact with the body. The vibration causes no discomfort and has an amplitude that is typically less than 0.1 mm, falling well within established safety limits for vibration exposure.[1] A special phase-contrast MRI sequence is used to image the pattern of propagating mechanical waves within the body. This sequence is capable of depicting waves with amplitudes as small as the wavelength of light.[2] Advanced software algorithms are then used to automatically process the wave information to create "elastograms," which represent tissue stiffness on a color scale.

The special cyclic motion sensitizing gradients that are used for wave imaging can be potentially incorporated into virtually any MR pulse sequence, including spin echo, gradient echo, and echo-planar methods. The MRE sequence is also compatible with parallel-imaging and motion artifact reduction techniques such as gradient moment nulling and spatial pre-saturation.

*510(K) pending at time of print.

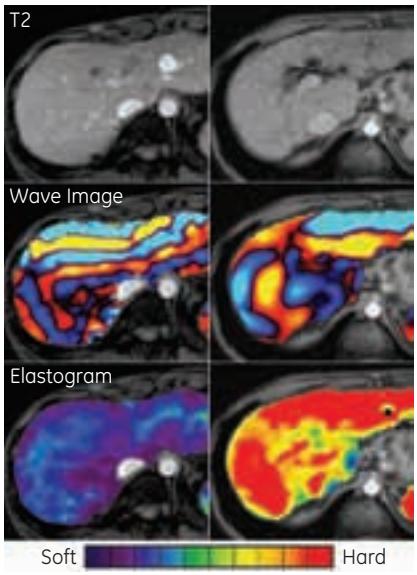
Discussion

With the advent of MRI, radiologists learned to understand the basic T1, T2, and proton density contrast provided by this modality and how it could be used to depict anatomy and characterize tissues. Yet that was just the beginning. Over the years, researchers have introduced techniques for imaging many new properties including, chemical shift, flow, diffusion, perfusion, and BOLD contrast, yielding powerful new diagnostic applications.

MRE provides a different type of contrast – tissue stiffness. Initial exploration of this new capability has focused on diseases that are already known to cause local changes in tissue stiffness. MRE is a non-invasive, pain free procedure. As such, one of the most promising applications of MRE to date has been its use as a supplement to conventional MRI in evaluating chronic liver disease.[3] The addition of MRE to a standard MRI protocol enhances the comprehensive nature of the diagnostic exam. Countless other applications remain to be explored.[3]

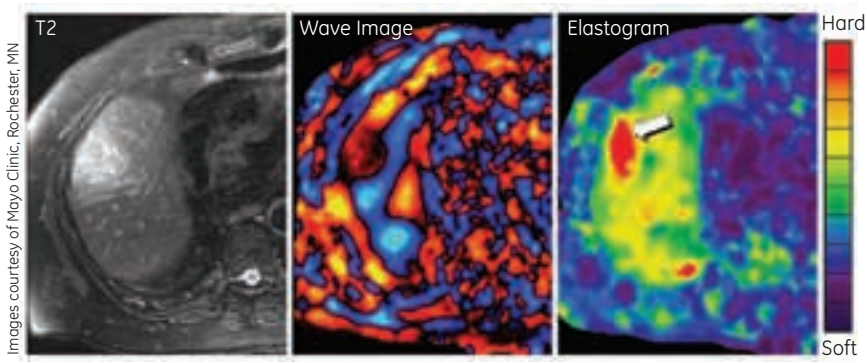
At Mayo Clinic, Richard Ehman, MD, and colleagues have been evaluating MRE to non-invasively measure tissue stiffness (Figure 1). Dr. Ehman and his group are also exploring many other applications of MRE (Figure 2).

In recent years, researchers have become more aware of the profound way in which the mechanical environment of tissue affects the behavior of cells. Abnormal tissue stiffness is now thought to contribute to the development of many diseases. MRE provides access to a new, largely unexplored, set of quantitative imaging biomarkers that await investigation. ■



Images courtesy of Mayo Clinic, Rochester, MN.

Figure 1: MR elastography is used here to characterize the relative stiffness in soft tissue. **Top row:** Conventional MR images of two different individuals are not capable of showing the presence or absence of liver fibrosis. **Center row:** Mechanical waves are generated in the upper abdomen with an acoustic driver device and imaged with a special MRI technique. **Bottom row:** The wave information is processed to generate "elastograms," showing the stiffness of tissue. The patient on the right has marked elevated tissue, consistent with moderately advanced liver fibrosis. The patient on the left has a normal liver stiffness appearance.



Images courtesy of Mayo Clinic, Rochester, MN

Figure 2: Left: Conventional MR image shows a mass in the liver. **Center:** Mechanical waves are imaged in the liver, using an MRE sequence. **Right:** The wave information is processed to generate an elastogram, which indicates that the mass (arrow) is very hard, consistent with a malignant tumor (hepatocellular carcinoma).

Lloyd Estkowski, MR manager for Body Applications at GE Healthcare, contributed to this article.

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2. Muthupillai, R., D.J. Lomas, P.J. Rossman, et al. Magnetic resonance elastography by direct visualization of propagating acoustic strain waves. Science, 1995. 269(5232): p. 1854-1857.
3. Talwalker JA, Yin M. MR Elastography inspires new wave of hepatic imaging. Diagnostic Imaging 2008; 30(8):20-27.
4. Venkatesh SK, Yin M, Glockner JF, et al. MR elastography of liver tumors: preliminary results. American Journal of Roentgenology. 2008;190:1534–40.

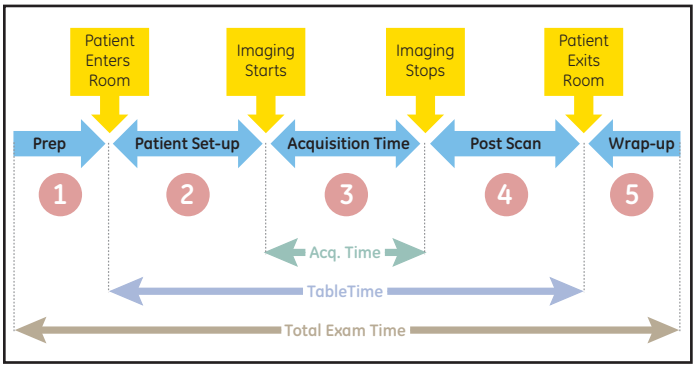
Streamlined Workflow

Do More in Less Time

Improving department workflow is a primary goal for the majority of healthcare leaders. Consider given that three major challenges facing radiology today include reduced reimbursement; and technologist shortages, significant patient wait time due to low MRI to population ratios In fact, the technologist shortage issue is only getting worse, with some studies indicating as high as 18% of tech positions are unfilled.

As a result of these challenges, radiology departments and imaging centers are expected to do more with less; more patients, less staff; more images, less time. Although current-generation CT and MR systems generate thousands of slices per exam that can improve diagnostic confidence, radiologists or the healthcare facility don't always have additional time – or reimbursement – to evaluate and diagnose more complex studies.

So the question remains: How do radiology departments or imaging centers counteract lower reimbursement, technologist shortages, and waiting patients? The answer? Increase patient throughput in the same hours of operation. The caveat is that this increase in patient throughput cannot impact quality of the study or patient comfort.



Source: Performance Solutions

To overcome the challenges previously mentioned, facilities must generate higher productivity levels that can lead to the ability to increase patient throughput, leveraging the MR scanner as an asset that needs to be kept as highly efficient as possible. The first step in addressing this is to break down the exam into measurable steps and look for ways to improve the efficiency.

1. Patient Preparation Time
2. Patient Set Up Time
3. Scanning Acquisition Time
4. Post Scanning Time
5. Wrap Up Time

While each facility can and should review and evaluate their operational processes to improve workflow, one area that is often overlooked but is pivotal to workflow is the system itself. The two new systems introducted by GE Healthcare, the Discovery MR750 3.0T and Discovery MR450 1.5T were designed with workflow and efficiency in mind – without compromising scanning capabilities.

Patient prep: Outside the scan room

"Radiology professionals need to keep the scanner at its highest efficiency, so we needed to think about what steps could be performed outside the scanner room. Our answer was the Express Patient Table, which provides 32-channel table coil connections enabling full patient preparation outside the scanner room" Baldev Ahluwalia, MR Product Development Manager, GE Healthcare. In addition, features such as a single hand motion for side rail operation, integrated IV pole, table handles, and a single action table wheel lock add to time savings.

Faster set up: In as little as 30 seconds

The next step to consider is the set up time within the scan room. Many systems feature a fixed table that require the technologist to walk in and out of the room several times to complete patient set up. Not GE. In fact, set up can be done in as little as 30 seconds. Called IntelliTouch, the innovative feature of the table includes simple patient positioning, eliminating back-and-forth toggling and laser landmarking. In addition, a backlit "Advance to Scan" button guides the technologist to a quick and easy set up.

Another way to add to set up efficiencies include ensuring the patient information is accurate. The solution provided by GE Healthcare is the in-room operator console (iROC), enabling the technologist to check information and helping to improve accuracy while in the scanner room. The efficiencies afforded include a quick visual check on patient information, scan parameters, coil connection, and any required cardiac gating or respiratory triggering without leaving the scan room. The point? Save time. Focus on the patient.

Acquisition with focus on the patient

"We designed the user interface to shorten exam time by creating efficient and automated protocols that require fewer steps, so the technologist to focus on the patient," says Sheila Washburn, Advanced Technology Program Leader for GE Healthcare. In addition, the new design only requires the user to set the anatomical coverage once, and press scan. Repetitive tasks that do not rely on the patient or circumstance are often the culprit for inefficient productivity, so by simply automating them has reduced the number of steps by up to 68%.

Available both on the Discovery MR750 and Discovery MR450 are a number of applications that minimize scan time while delivering exquisite images. LAVA-Flex: dual-echo acquisition technique that provides three-dimensional abdominal images in one breath-hold. In addition, LAVA-Flex produces four image contrasts with a single scan: in-phase, out-of-phase, water only, and fat only. This application enables clinicians to complete a complete liver exam in 15 minutes.

VIBRANT-Flex produces fat-suppressed imaging with high spatio-temporal resolution and catches 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.

Post Scanning: An exam step of the past?

Being able to quickly toggle between tasks is key in ensuring optimized efficiency. For this reason, multiple sessions can open at once to speed time expedite patient on/off table time and hasten exam completion. In other words, while a patient is being scanned, the technologist can review images from other studies, build protocols for the next exam or complete the prior patient exam. Post scanning time is no longer a serial activity, and the total exam time can be reduced even further.

Another thing to think about is protocol-defined post processing. This lets the user launch or automate a host of post-processing applications right from the workstation, without accessing a web-browser or changing desktops. For example, the user can select Multi Planar Reconstruction to launch automatically from a task list. Plus, the technologist has the ability to view images straight from the scanning desktop without launching the browser and can get an instant review of the middle slice from every series by simply switching to the Image Management desktop. These capabilities make the post-scanning workflow step easy and efficient.

Wrap up

While it may seem simple, transport in and out of the room has enormous impact on efficiency and workflow. A detachable patient table provides the ability to undock and move the patient back into the preparation room allows for the next prepared patient to proceed to the scanner to immediately begin the exam. In an emergency, the patient can be removed from the scanner room in as little as 30 seconds. In addition, while the exam is concluding, the patient can to be moved to a separate room for comfortable and discreet movement off of the table.

Summary

The need to streamline workflow and reduce patient exam times is apparent across the MR industry as a result of reduced reimbursement, a foreseen shortage of technologists and the patient wait times. When comparing MR scanners take into account how these challenges might affect your department or center today and into the future. The Discovery MR750 and Discovery MR450 were designed with these challenges in mind and provide an MR workflow that is easy to use yet enables the technologist to obtain high-resolution images and greater coverage, even with the most complex exams. ■

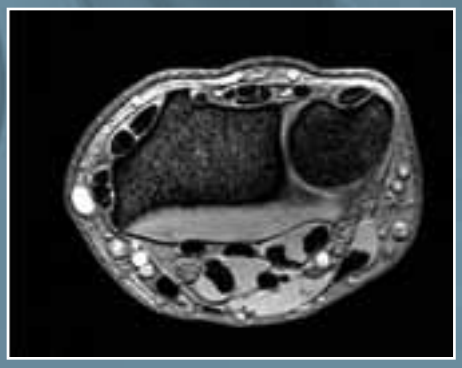
Image is Everything

Hold on to your hats – these clinical images demonstrate how the Discovery™ MR750 is re-shaping the definition of image quality.

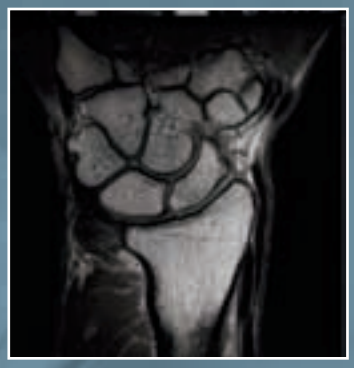
In the last issue of *SignaPULSE* we introduced to you the Discovery MR750 – the system that was designed to break traditional boundaries of 3.0T scanning. We provided white papers, system specs, and technical articles so you wouldn't have to take our word for it. And the response has been tremendous. However, as they say, "the proof is in the pudding" so, to demonstrate what your everyday imaging could be like, we've included a taste of the image quality.

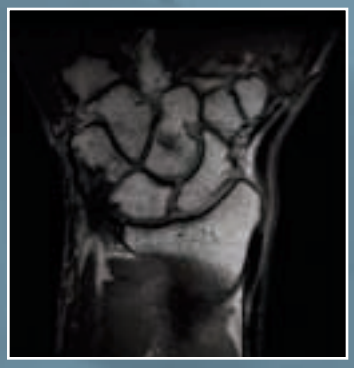
We'll let you see for yourself. ■

Musculoskeletal

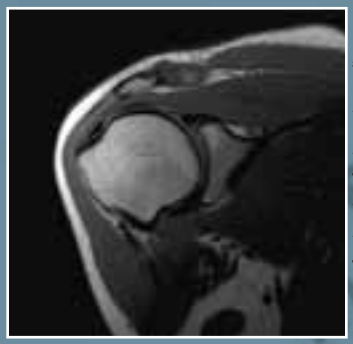


3D MERGE acquisition with 60 slices 2 mm thick scanned through the wrist. Excellent depiction of all tendons with 288 x 288 matrix and 12 cm FOV. Scan time 2:34 min.

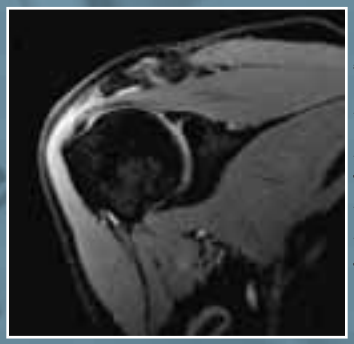




Small FOV, high resolution imaging of the wrist trabeculae and carpometacarpal joints. 1 mm acquired slices thickness, 1024 x 1024 matrix.

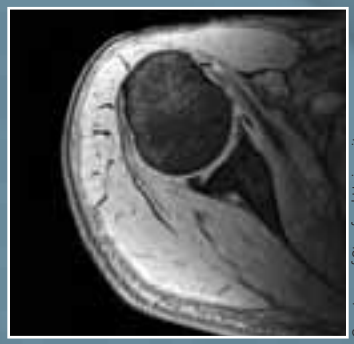


Courtesy of University of Wisconsin, Madison



High-resolution imaging of the glenoid, articular cartilage, and rotator cuff structures.

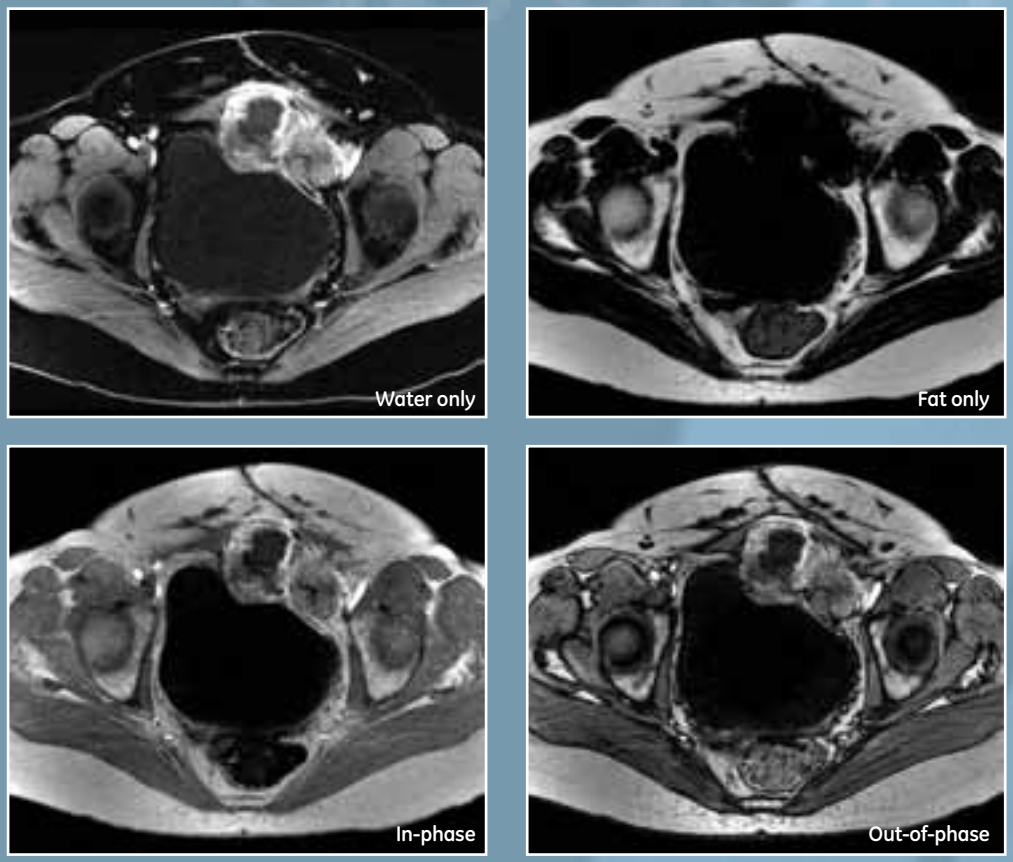
Courtesy of University of Wisconsin, Madison



Courtesy of Stanford University

3D MERGE acquisition with 72 slices 2 mm thick scanned through the shoulder. The glenoid labra are exquisitely seen due to high SN R provided bythe sequence and 8ch concentric designed shoulder coil. 320 x 320 matrix with 16 cm FOV. Scan time 4:14 min.

Abdominal

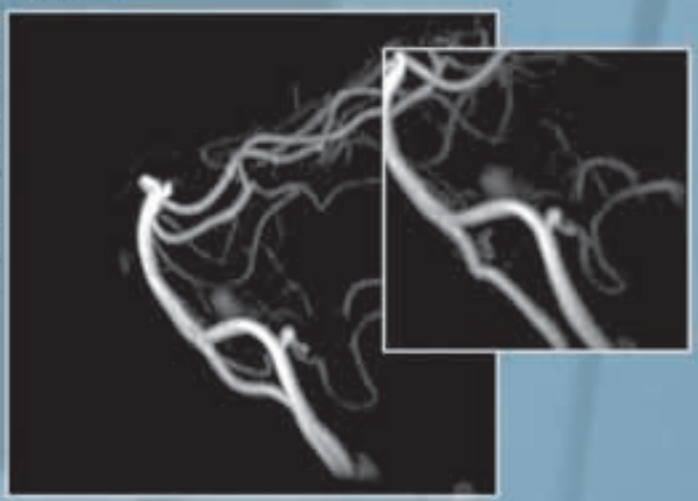


All images courtesy of Stanford University

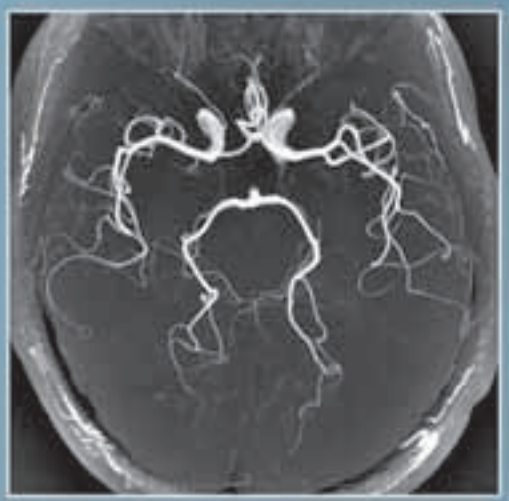
LAVA-Flex study in pelvis displaying 4 unique images acquired at each slice location. A total of 84 images scanned in a 19 s breath hold with a 320 x 256 imaging matrix.

A TR of 4.8 ms allows acquisition of two echoes at 1.1 and 2.2 ms which correspond to the out and in phase images (at 3.0T). The water and fat only images are subsequently reconstructed from the acquired 1.1 and 2.2 ms TE images with perfect separation of the 1H in fat and water. The result is exquisite suppression of fat (or water) which enables excellent visualization of pathology.

Vascular

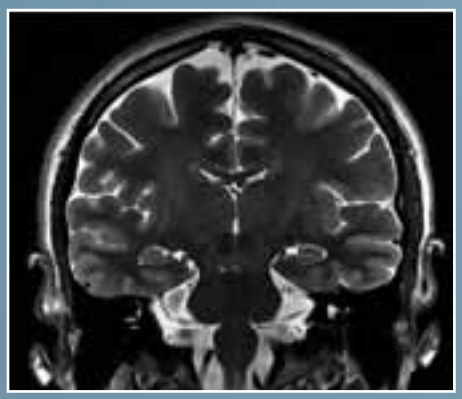


3D TOF images of the posterior cerebral circulation display a 1.1 mm neck on an aneurysm of the posterior inferior cerebellar artery (PICA). Short TEs and excellent background suppression result in visualization of very small pathologies. 1 mm overlapping slices are employed to ensure excellent reformatted images of the Circle of Willis.



3D TOF using large single slab (113 slices 1 mm thick) with an 864 x 416 matrix displays both excellent blood signal deep into the imaging volume with 230 micron x 480 micron pixel resolution.

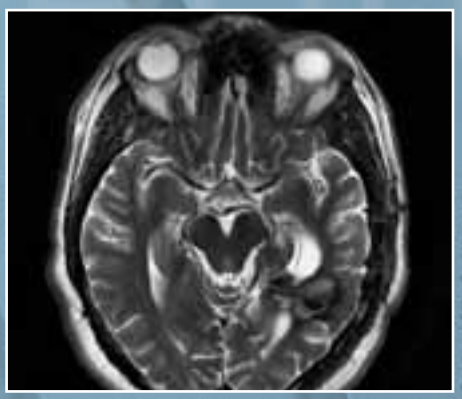
Neuro



T2 weighted Fast Spin Echo PROPELLER 2.0 in the coronal plane is very useful to visualize the temporal lobes and hippocampus. 3 mm slices imaged with a 22 cm FOV and 512 x 512 matrix results in a pixel size of 430 x 430 microns, 15 slices in Scan Time 2:45 min using 32 ch brain coil.

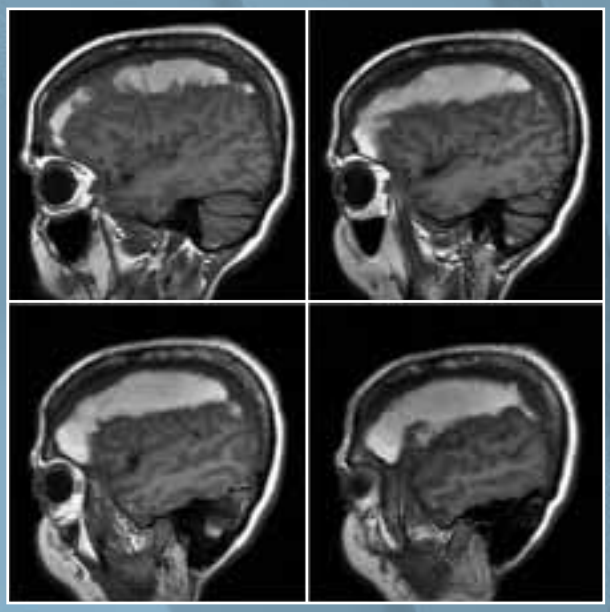
Courtesy of University of Wisconsin, Madison

Sagittal FLAIR PROPELLER 2.0. 3 mm slices with 320 x 320 matrix with an ETL of 40 allows 32 slices in a scan time of 3:11 min.



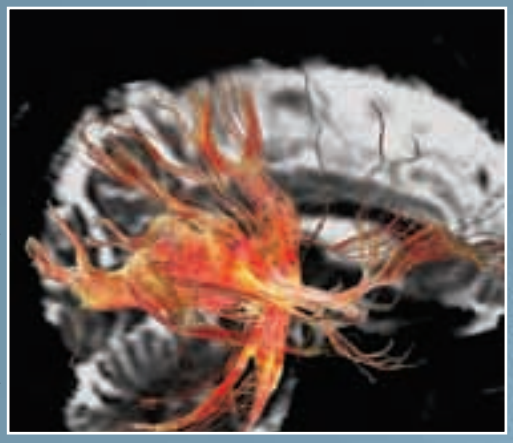
Courtesy of Stanford University

Axial FSE PROPELLER 2.0 with 512 x 512 matrix displays excellent motion resistance with fast scan time of 2:39 min. Uncooperative patient with hemorrhage in left hemisphere.



Courtesy of Stanford University

Sub arachnoid hemorrhage imaged with T1 weighted FLAIR. 28 slices in 2:08 min with 320 x 224 matrix.

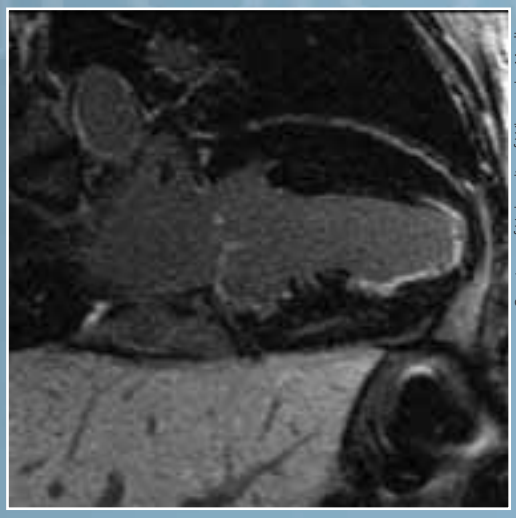


Courtesy of Stanford University

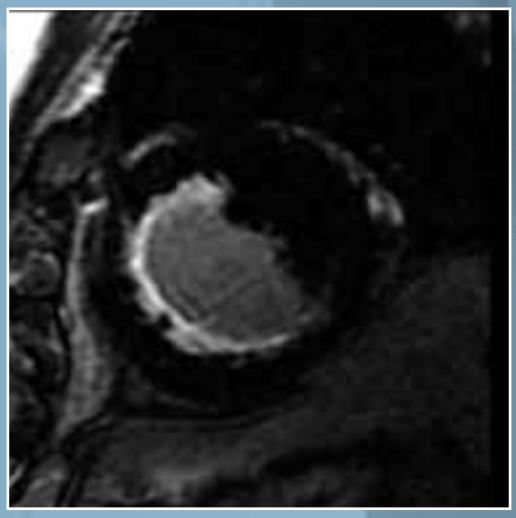
Thin slice diffusion tensor imaging in practical scan times is enabled by the Discovery MR750. This image displays 60 slices scanned with 20 tensor directions with 2 NEX in 5:44 min.

The resulting Tractography image displays excellent white matter fiber delineation.

Cardiac



Courtesy of University of Wisconsin, Madison

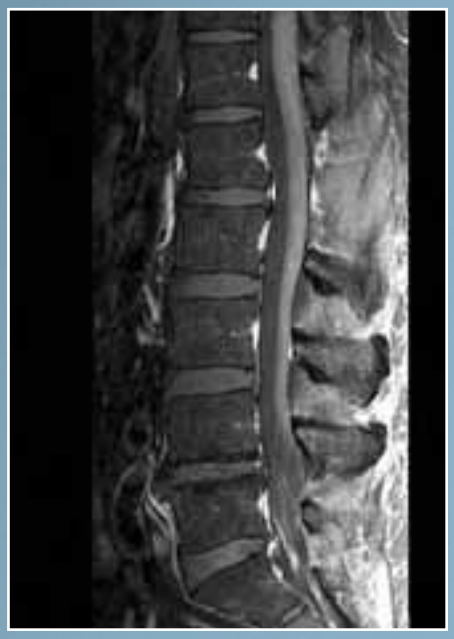


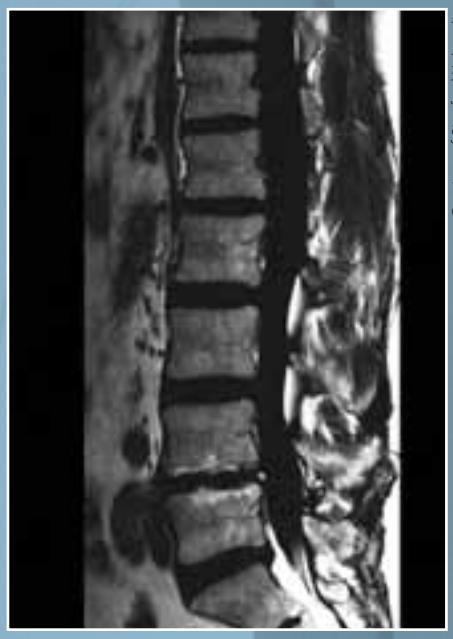
Courtesy of University of Wisconsin, Madison

2D myocardial delayed enhancement images in long axis and short axis orientations of the left ventricle.

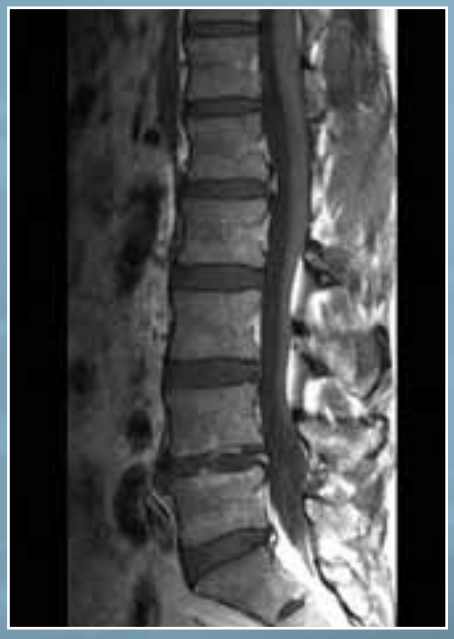
3.0T increases in SNR allow thinner slices versus 1.5T and adiabatic IR pulses ensure excellent suppression of normal myocardial tissue. Myocardial infarction seen on 6 mm thick slices acquired at 256 x 160 and zipped to 512 x 512.

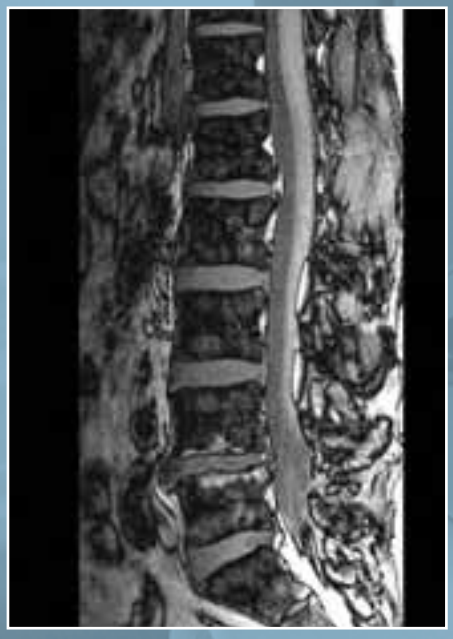
Spine



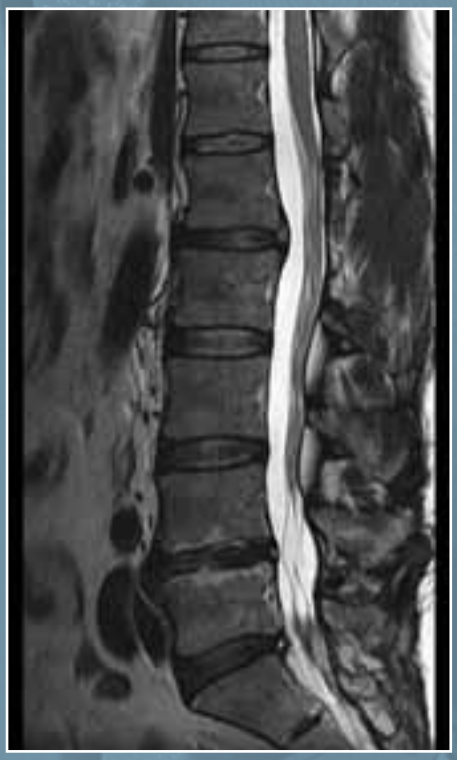


Courtesy of Stanford University





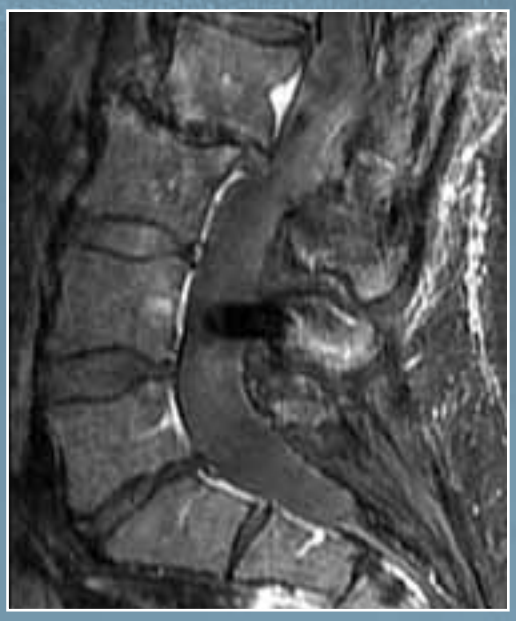
Sagittal T1 weighted IDEAL lumbar spine images post contrast demonstrating the superb separation of the water and fat images, plus the bonus images of in- and out-of-phase.



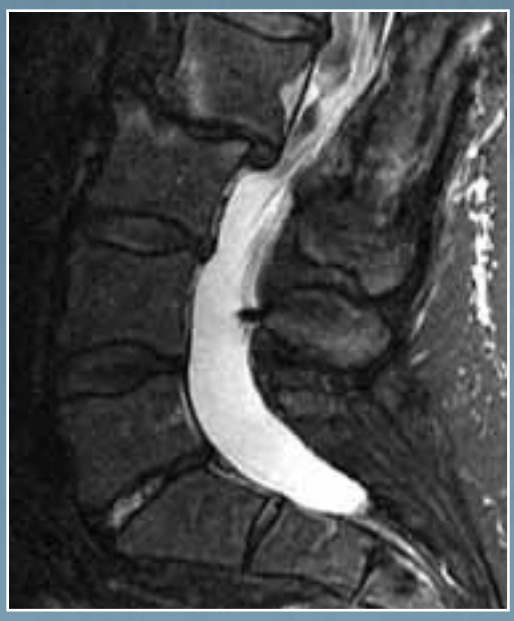
Courtesy of Stanford University

T2 weighted FRFSE sagittal lumbar spine image in 48 year-old patient with degenerative disc changes at L4/5 and a posterior bulge at L1/2.

15 slices acquired 3 mm thick in 3:05 min with a matrix of 384 x 224.



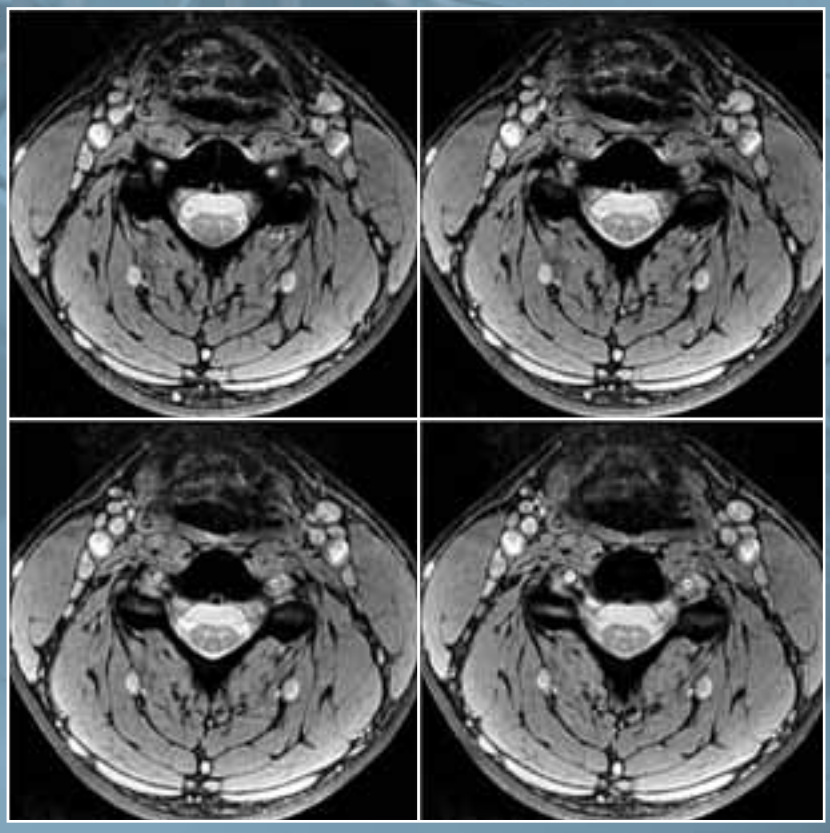
62 year-old male with previous surgical intervention at mid L4 level. FSE T1 fat suppressed image shows classic metal blooming artifact at L4 level.



Courtesy of Stanford University

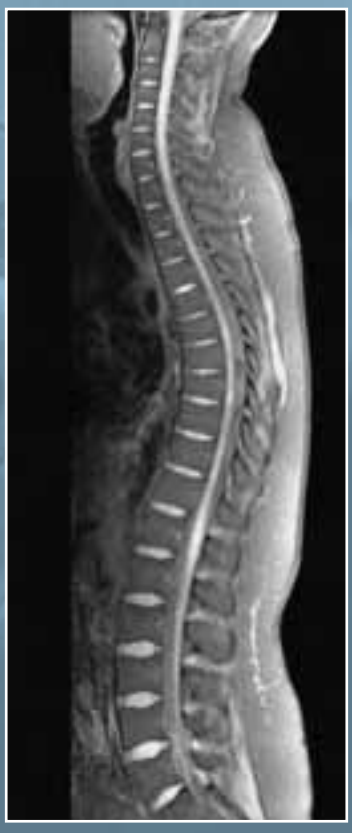
Same slice location imaged with IDEAL "fat suppression" and T2 weighting, which displays the remarkable reduction in metal artifact distortion compared to FSE T1.

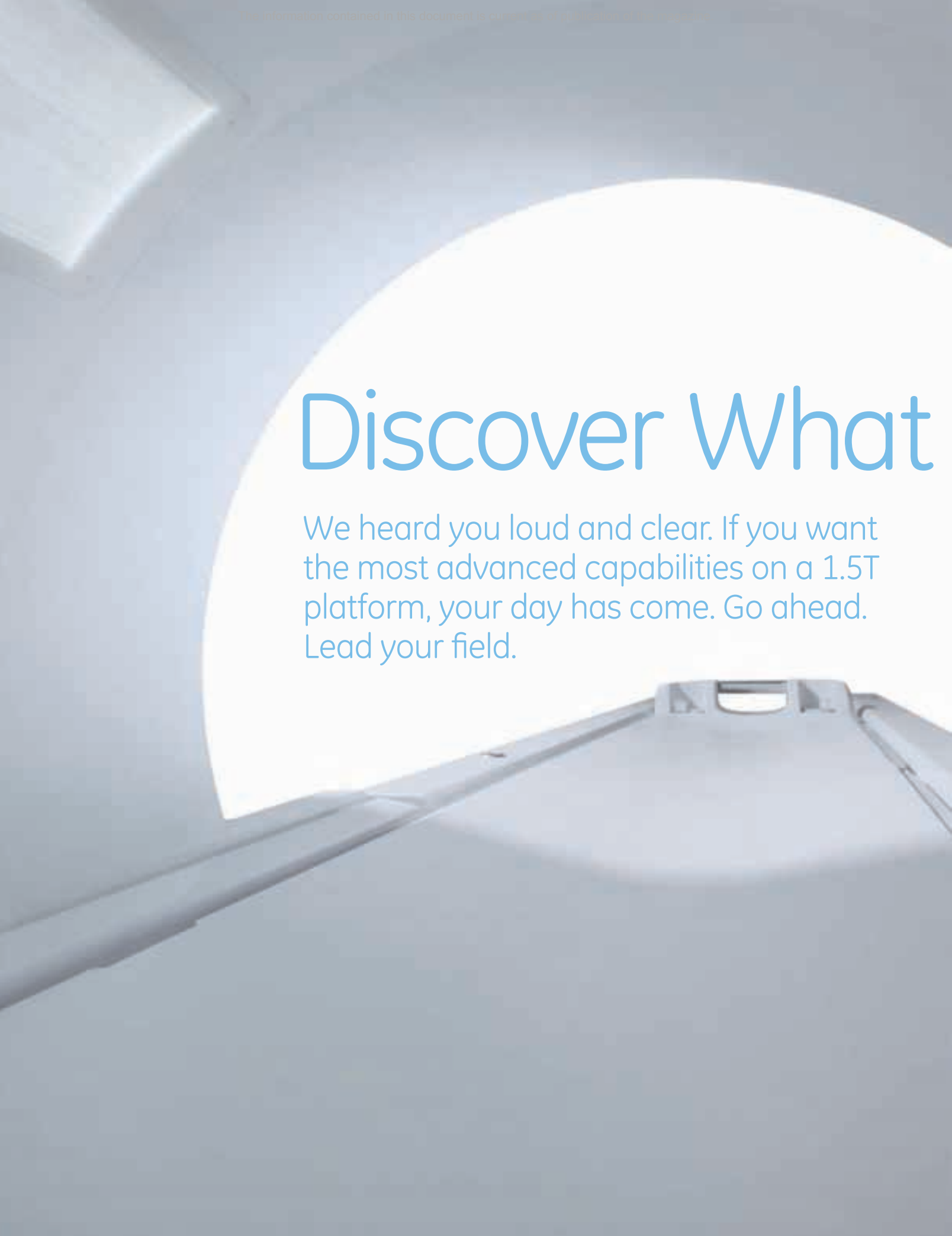
Courtesy of Stanford University



3D MERGE in the axial cervical spine. 60 slices covering 3 disc spaces in 2:50 min with a 288 x 256 matrix. Excellent depiction of the grey and white matter of the spinal cord.

Multi-station spine scan with IDEAL exhibiting excellent fat exclusion along the entire length of the spine.





Discover What

We heard you loud and clear. If you want the most advanced capabilities on a 1.5T platform, your day has come. Go ahead. Lead your field.

1.5T Can Do For You

We get it. Everyone has a different view of what they need to advance MR imaging. In May 2008, GE Healthcare announced the arrival of the Discovery™ MR750 – the 3.0T system that was designed to give you the power and precision you need to break traditional 3.0T boundaries.

But what about those who prefer scanning at a 1.5T field strength? The leadership technical innovations and unique clinical advancements of the Discovery MR750 are now available on the industry's most widely used field strength – creating even more opportunities to push the limits of MR imaging beyond our imaginations.

Leading the way

"We realize that our customer's needs vary and many healthcare professionals are challenged to find ways to become a recognized leader in their market," explains Chris Fitzpatrick, global marketing manager for premium 1.5T MR at GE Healthcare. "These clinical leaders need leading-edge technology to deliver higher quality and performance. The Discovery MR450 brings the industry's most compelling advancements to the 1.5T field strength, so they can remain the strongest in their field."

With the high-resolution iROC (In-Room Operator Console), the technologist can complete patient setup right in the scan room for streamlined exam.

Located to the left and the right of the scanner bore, dual-sided controls enable the scanner to be operated from either side of the patient table.

Two 32-channel surface coil connections integrated at the end of the table simplify patient preparation outside the scanning room.

Simply powerful innovations

The Discovery™ MR450 starts with the industry's most powerful whole-body gradient system, which provides 50 mT/m amplitude and 200 T/m/s slew rate on each axis at 48 cm field-of-view. This impressive gradient system delivers up to 60% additional anatomical coverage and resolution per unit of time. In addition, the Discovery MR450 delivers up to five times the performance over previous generations with technology that is uniquely optimized for each patient.

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

Kid friendly. Radiologist approved.

Some of the most rewarding – and difficult – patients to scan are children. The combination of technology and field strength makes the Discovery MR450 a good choice for pediatric patients. "The system is extremely fast," explains Joanna Jobson, global marketing manager for pediatric MR, GE Healthcare. "This combined with additional developments in non-contrast imaging and quieter scanning is extremely important for these patients." Jobson explains that a big issue with pediatric scanning is when children awake during the transfer from a transport bed to the MR patient table. The detachable Discovery MR450 Express patient table allows patient preparation in another room, where parents can be present to calm fears. It also helps physicians avoid waking up the child before the scan. In addition, the Discovery MR450 features an in-room operator's console, so technologists can spend more time beside the table and focus on the patient – not the system.

Immediate benefits

The Discovery MR450 offers exciting benefits that are a far cry from previous capabilities. These include:

- Scanner room set up time reduced by 70%; and,
- 68% reduction in number of steps to scan.

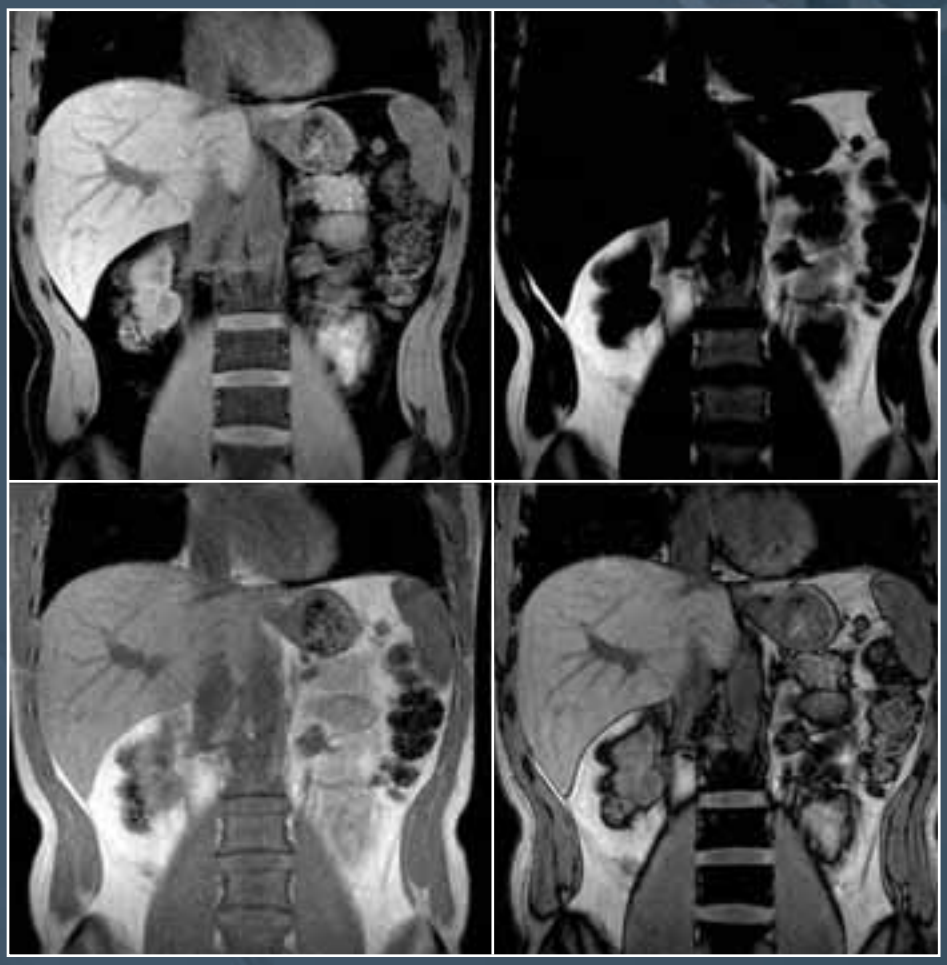
"This is not a small step forward," explains Fitzpatrick. "This is an entirely new platform for customers who want the most advanced technology at 1.5T."

It's not a coincidence this product is called "Discovery." The challenge is yours to discover what your organization – or the industry – can do. ■

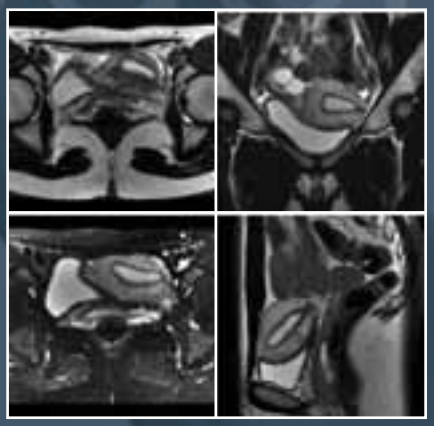
> "This is not a small step forward. This is an entirely new platform for customers who want the most advanced technology at 1.5T."
>
> *Chris Fitzpatrick, global marketing manager for premium 1.5T MR for GE Healthcare*

Discover the Potential of 1.5T

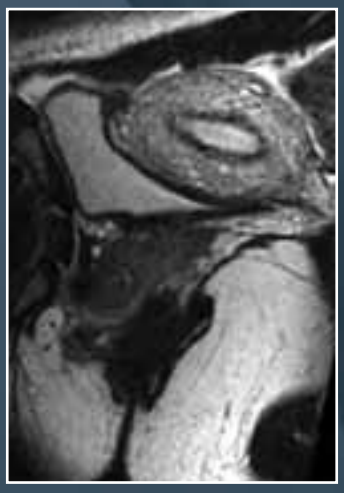
Abdominal



LAVA-Flex

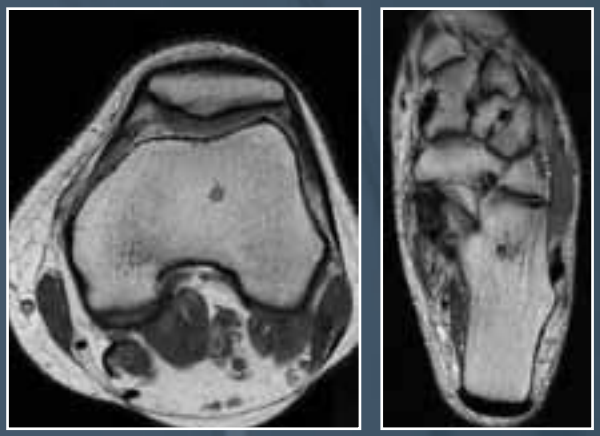


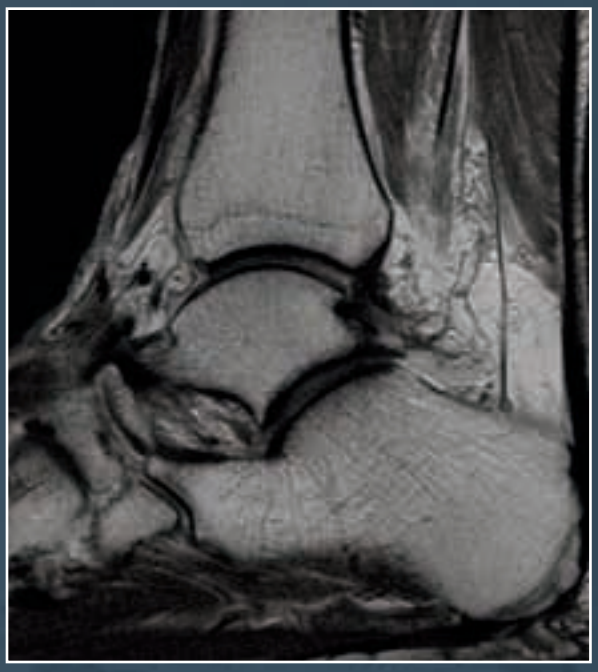
Cube



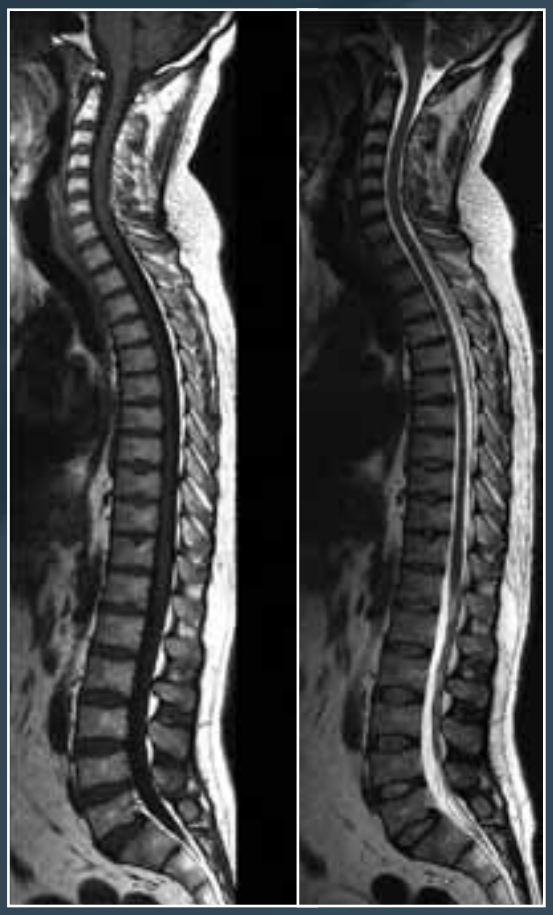
Cube Reformat

High-resolution Musculoskeletal



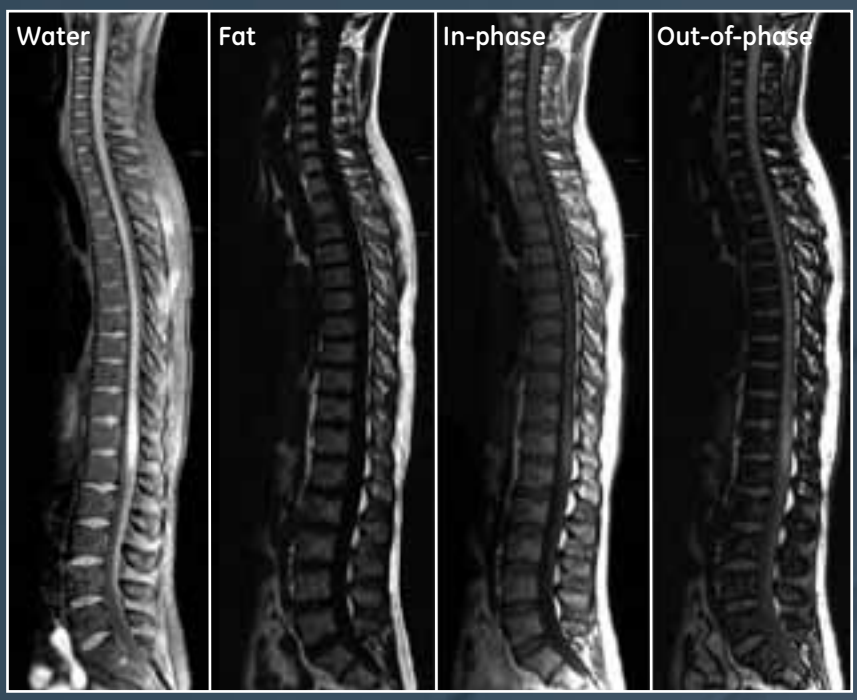


Spine

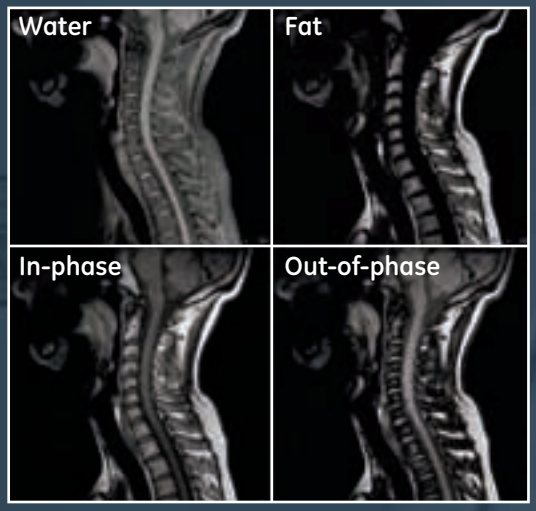


Whole Spine T1 FSE

Whole Spine T2 FSE



IDEAL



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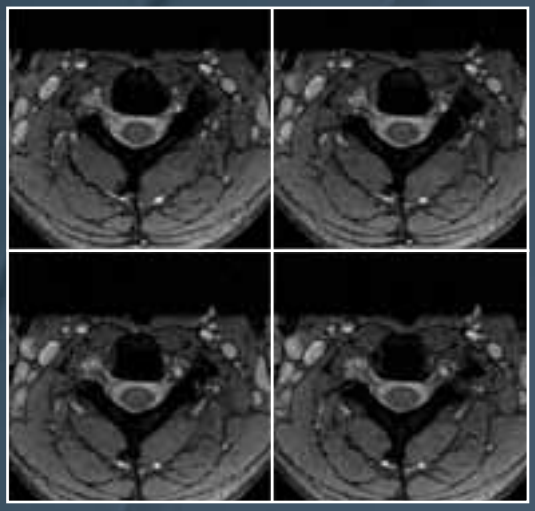
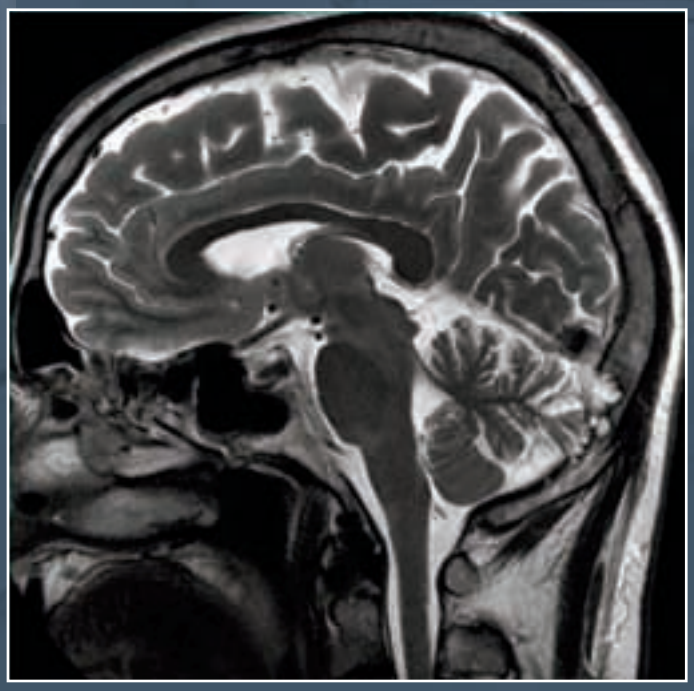
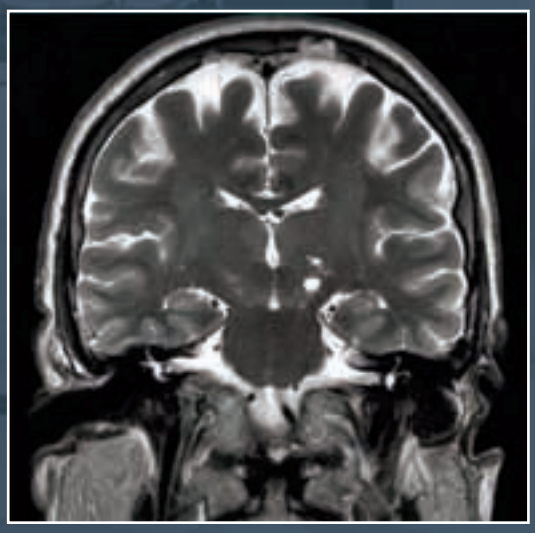


3D MERGE

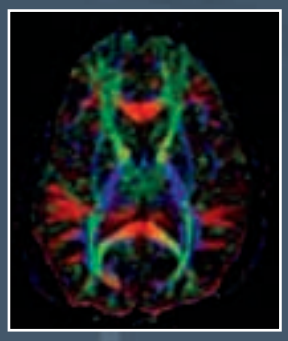
Brain



PROPELLER 2.0

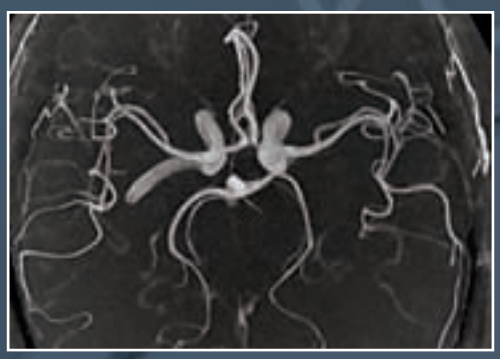


PROPELLER 2.0

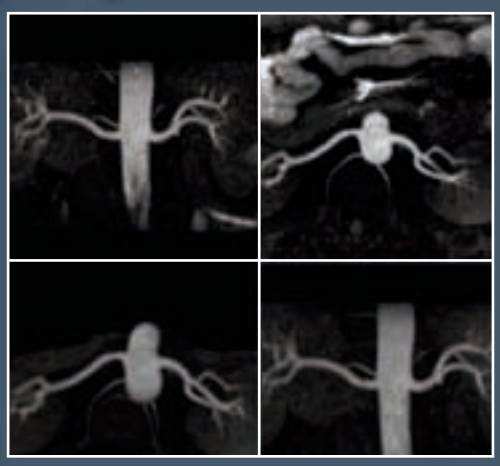


Diffusion Tensor Imaging (DTI)/FiberTrak

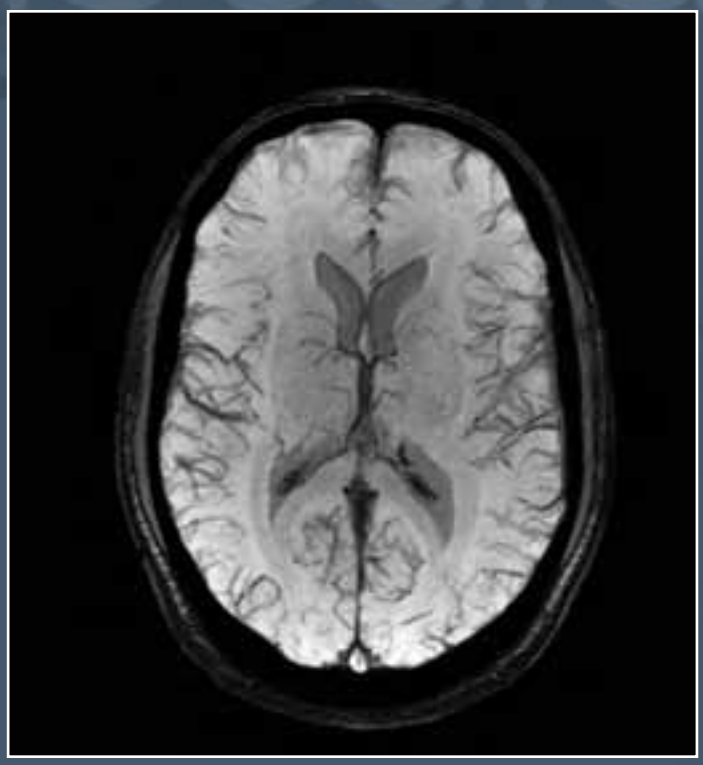
Vascular



3D TOF



Inhance Inflow IR (non-contrast MRA)



SWAN

Hospitals, GE Healthcare

Signa® HDe 1.5T is First to Receive ecomagination Status

Go Green

Skyrocketing fuel and energy costs, global warming, organic food, reducing the energy footprint…the "green machine" continues to gain momentum throughout our daily life. But did you know that "going green" is also a trend for hospitals?

The green trend is catching on as hospitals strive to reduce toxins and waste, lower energy bills, and achieve a healthy, healing environment. In fact, according to an article on *The Green Guide*, reducing energy consumption is one of 12 criteria used to assess the top green hospitals in the United States.[1]

From August 2007 to August 2008:
natural gas futures rose 154%; oil increased 43.93%; heating oil, 112.4%; and electric utilities across the U.S. are raising prices up to 29%.[2,3]

In November 2007, the US Green Building Council announced the release of a draft Leadership in Energy & Environmental Design (LEED) Program for hospital certification with an expected final release in the first quarter of 2009. That hasn't stopped several facilities from pursuing LEED certification under the commercial building program. With 28 North American cities driving LEED through tax breaks, mandates, and accelerated permits, the financial perks of "going green" may soon keep pace with environmental and energy benefits.

Pursuing LEED certification and building a green hospital can increase construction costs. One way for hospitals seeking LEED certification is to recoup the higher upfront expense with lower power consumption and reduced energy expense.

ecomagination comes to healthcare

Established in 2006, ecomagination is a GE corporate-wide business initiative to help meet customer demand for more energy-efficient products while simultaneously investing in innovative solutions to environmental challenges by delivering valuable products and services to customers. For GE, ecomagination also means doubling the investment in research and development for cleaner technologies – from $700 million in 2005 to $1.5 billion in 2010 – reducing greenhouse gas emission and increasing energy efficiency of the operations within GE, improving water use and reuse, and informing the public.

In July 2008, the first GE Healthcare product to receive ecomagination status is the Signa® HDe 1.5T MR. Not any product can receive this distinguished designation.

"Throughout the Signa® HDe product lifecycle, we can reduce our overhead costs by tens of thousands of dollars – potentially more. And that is our goal."

Eric Haberichter

The criteria states that the product "must substantially improve customers' operating performance or value proposition, and significantly and measurably improve customers' environmental performance." The grueling process includes a detailed analysis of industry power consumption relative to the ecomagination nominee, an independent audit of data and calculations by an external consulting firm, and certification of marketing claims by the board of review.

The Signa HDe is a product that helps healthcare facilities fulfill two opposite ends of the "going green" spectrum. By employing efficient gradient and electronics design as well as innovative water-cooling technology, the Signa HDe is among the most energy efficient 1.5T MR systems, using about 41% less energy than previous generation systems.

Also, compared to the average 1.5T MR system, the Signa HDe 1.5T is designed to use more than 20% less space with a small siting footprint requirement, further increasing installation flexibility. This also translates to lower construction costs.

As a result, the Signa HDe was the only 1.5T MR installed at the Olympic Village General Hospital in Beijing for the 2008 Summer Olympics. "The Signa HDe is a reflection of our commitment to produce quality, energy-efficient technologies for our customers worldwide," said Jim Davis, vice president and general manager of the global MRI business.

Customers are seeing green

Smart Choice MRI. For any outpatient MRI center, including Smart Choice MRI of Milwaukee, WI, keeping operating expenses in check is very important in today's healthcare environment – particularly with rising costs and lowering reimbursement. It becomes more of an issue when all MRIs are billed at $600 per exam.

Eric Haberichter, RTP(R), co-founder of Smart Choice MRI, and his two partners believed they could deliver high-quality images and excellent service while combating rising healthcare costs. "We knew that controlling overhead and siting a scanner at a reasonable cost were imperative to our success," commented Haberichter.

In early 2006, they created a trendline of energy costs and projected it would double within five years. An MR scanner that consumed less energy with a small footprint and small equipment room that did not compromise high-quality imaging would be central to their vision.

Their search ended at nearby GE Healthcare with the Signa HDe 1.5T MR. "We chose the magnet around our concept, then built the space around the magnet," explained Haberichter. "The siting and energy cost savings are substantial." The Signa HDe was installed in September 2006, making Smart Choice the first outpatient facility in Wisconsin to install this system.

"Throughout the Signa HDe product lifecycle, we can reduce our overhead costs by tens of thousands of dollars – potentially more," said Haberichter. "And that is our goal."

Providence Medical Center. Located in Wayne, NE, Providence Medical Center is a 25-bed critical access hospital. As a licensed electrician, Chief Operations Officer Ed Simpson was confident the GE Signa HDe 1.5T was the logical choice for his facility.

"Along with the savings associated with the Signa HDe, the system will operate with a degree of efficiency that compliments our bottom line," said Simpson. "For every dollar Providence Medical Center can save today on efficient equipment investments, we will reap savings of two and three dollars in the not-too-distant future."

Along with the energy savings, Providence Medical Center is also able to utilize existing services and transformers.

"I trust GE products. I believe that the savings they advertise will truly be there year after year," added Simpson. "The slogan which appears at the end of each of my e-mails reads, 'Reduce, Reuse, Recycle, Repurpose, Respect.' I am convinced that GE has all of this in mind, and more!"

Rissyou and Azabu Neurosurgical Hospitals.

For many existing hospitals, space is a commodity. This is particularly true on the island nation of Japan. When Rissyou Hospital began a search to upgrade its only MR scanner, a GE 0.5T Vectra, they believed that any increase in Tesla strength would require an extension of the MR room. They soon learned about the Signa® HDe 1.5T MR, which easily fit into the existing 0.5T MR room without any major reconstruction, saving valuable budget yen.

Plus, with only one MRI, the hospital couldn't afford to have the system down for three to four weeks during installation in October 2005. "GE completed the Signa HDe installation – up to the system check – within one week after installing the magnet," said Hiroshi Tomizawa, RT, HP radiology engineer. "This fast installation is a great benefit for a hospital such as ours by minimizing downtime and reducing negative revenue impact."

A similar situation ensued at Azabu Neurosurgical Hospital. "Because of the high expectation of 1.5T MR imaging, we decided to replace our 0.35T Ovation with the Signa HDe," explained Syuichi Kodera, RT. In January 2008, the hospital installed the Signa HDe in the same room as the Ovation. Just like Rissyou Hospital, no major reconstruction of the MRI room was required, saving both time and money.

"It was impressive to see this smooth replacement," added Kodera. Nearly 4,000 scans later, the quality of the HDe scans remains a competitve edge to this leading neurosurgical hospital. ■

References:

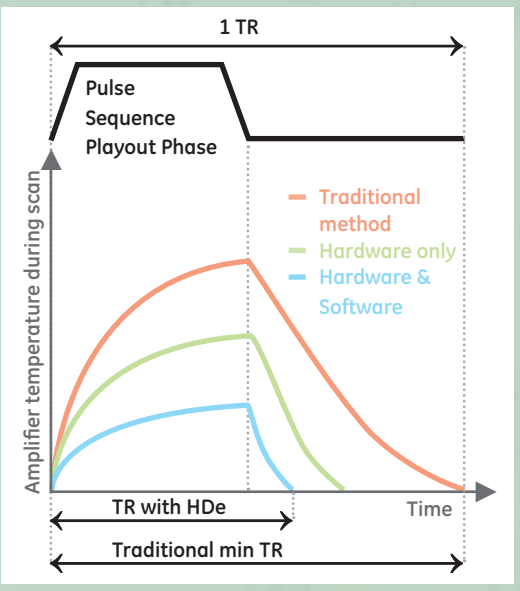
1. Weller, Kim, AIA. The Top 10 Green Hospitals in the U.S.: 2006. Available at: http://www.thegreenguide.com/doc/113/top10hospitals
2. Available at http://www.hfmmagazine.com/hfmmagazine_app/hospitalconnect/search/article.jsp?dcrpath=HFMMAGAZINE/PubsNewsArticleGen/data/2006October/0610HFM_DEPT_EnvirSer&domain=HFMMAGAZINE
3. Available at http://tonto.eia.doe.gov/oog/info/twip/twip.asp

Unique technology delivers impressive Image quality, reduced energy consumption

The unique, highly efficient gradient technology, used by the Signa HDe 1.5T, delivers high quality images and reduced energy consumption.

The Signa HDe was designed with both outstanding image quality and energy efficiency in mind.

Despite a relatively low power draw during image acquisition, the system achieves impressively short repetition time (TR) through a very efficient gradient waveform control system. As shown, both software and hardware combine to manage the amplifier temperature, allowing the system to initiate echo repetition more quickly. The result is outstanding image quality even during today's demanding imaging techniques such as volume (3D) and dynamic studies.



Combined with other features to reduce consumption when the system is not scanning, this technology enables the Signa HDe to reduce overall consumption substantially. Among the most energy efficient 1.5T MR systems, the HDe consumes about 41% less energy than previous generation systems. It reduces annual electricity use by about 70,000 kWh, equivalent to:

- Saving more than $7,000 per year, based on typical electricity rates in the United States (or 6,000 euros or 1.2MM yen);
- The annual electricity use of six US households or 15 households in the UK or China; and
- 42 tons of carbon dioxide in the generation process (i.e., the annual CO^2 emissions of more than 8 cars on US roads).

GE Healthcare Thought Leadership Class

For the second year, GE Healthcare has recognized individuals both within GE and outside based on their contribution in the field of magnetic resonance. "We believe the best work is done in a collaborative setting," explains Jim Davis, Vice President and General Manager, GE Healthcare. "Some of the best ideas started with a simple 'what if?' – and it's those ideas that push us all to advance the industry."

This year's class was packed with talented individuals who inspire and demonstrate perseverance and commitment to pushing the boundaries within MR.

These topics, while for research use only and not commercially available, could be reality in years to come. ■

Graham Wright, PhD – Professor, Department of Medical Biophysics, University of Toronto and Research Director, Schulich Heart Program, Sunnybrook Health Services Centre, Toronto, Canada. Dr. Wright has pursued cardiovascular MR research for two decades, developing a wide range of tools for imaging vascular and myocardinal pathophysiology. His recent work involves new methods to distinguish and characterize the "grey zone," the border between endocardial infarcts and the blood pool, as well as the creation of novel catheter-based imaging devices for use in the management of occlusive vascular disease. Dr. Wright works closely with GE scientists and clinicians to define the role of MR in directing a number of cardiovascular therapeutics.

Jim Pipe, PhD – Director for Neuroimaging Research, Barrow Neurological Institute, Phoenix, AZ. Dr. Pipe invented Propeller, the first commercial MR method to eliminate blurring in a scan during patient movement – a method developed in collaboration with GE and now available on most commercial scanners. Along with furthering this technology, he works with GE to develop techniques that better capture images of brain structure, function, and connectivity. In establishing the mathematical underpinnings for many next-generation MR methods, Dr. Pipe aims to greatly reduce exam times while increasing the information available to physicians.

Eddy Boskamp, PhD – Chief Scientist, RF Coils, GE Healthcare, Waukesha, WI. Dr. Boskamp has designed RF coils for more than a quarter century. His groundbreaking research has resulted in numerous publications, as well as more than 45 patents. Dr. Boskamp is currently developing integrated high channel count receive coil arrays for increased performance and reliability, adjustable whole body transmit coils for improved efficiency, and whole body transmit arrays for optimal uniformity.

Makoto Sasaki, MD – Associate Professor, Advanced Medical Research Center, Iwate Medical University, School of Medicine, Morioka, Japan. Dr. Sakasi is leading the invention of imaging techniques to detect neuromelanin, a black pigment exclusively located in the catecholamine neurons. The MR methods developed by his team are furthering the ability to visualize neuronal loss or pigmentation. The results may yield new ways of assessing alterations in patients with degenerative or psychiatric disorders, including Parkinson's disease, Alzheimer's disease, depression, and schizophrenia.

Tony Vu, PhD – Principal Engineer, Global MR PSD/Applications Engineering, GE Healthcare, Waukesha, WI. Dr. Vu is an industry leader in the research and development of MR clinical applications. He is the principal architect behind such groundbreaking applications as LAVA, COSMIC, MENSA, SWAN, FIESTA, FTMRA, MEDAL, MERGE, and QuickSTEP. Dr. Vu has developed novel patient safety centric optimization techniques to fully exploit system capabilities, and his unique insights into complex clinical problems have inspired many robust yet elegant solutions.

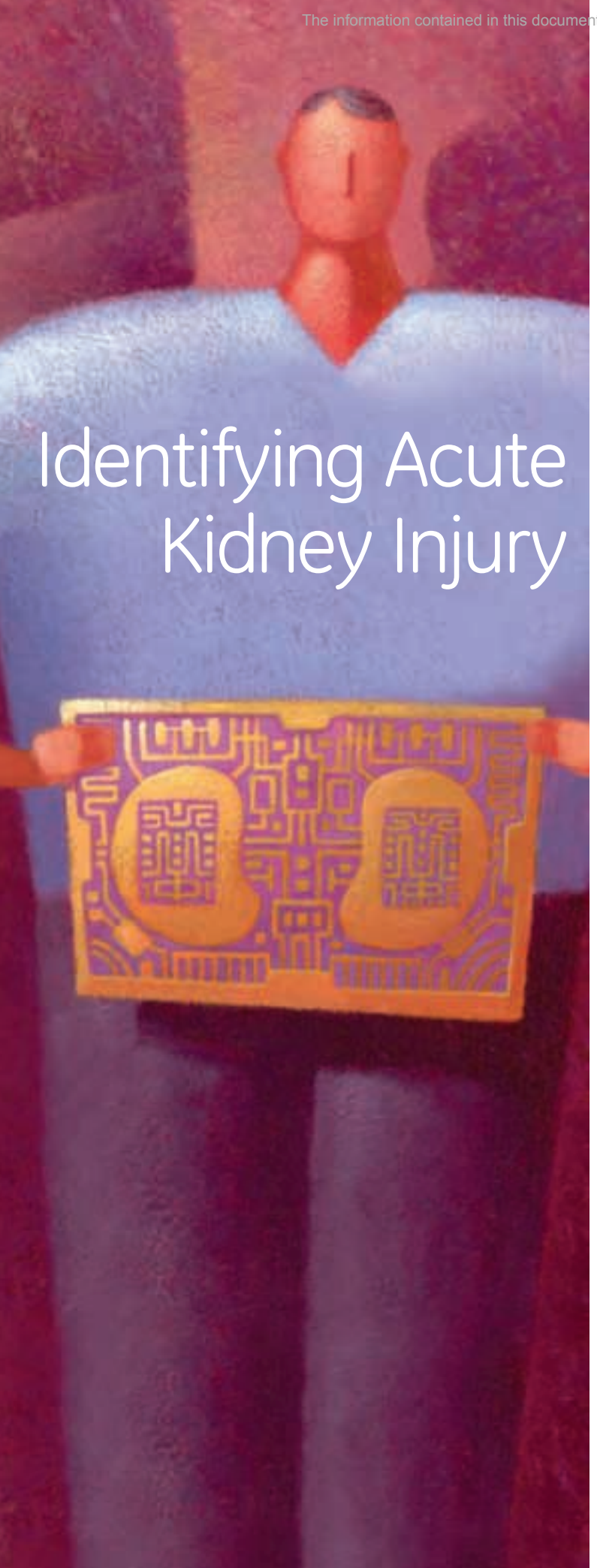
Mitsuharu Miyoshi – Scientist, GE Healthcare, Japan Applied Science Laboratory, Hino, Japan. Mr. Miyoshi is a leading designer of pulse sequences for the non-contrast MR angiography technique. He recently conceived of a sequence known as Flow-Preparation Pulse, which allows for the imaging of blood vessels without use of a contrast agent. The technique detects arterial and veinous signals separately using a unique combination of velocity encoding and spin labeling.

David Alsop, PhD – Director of MRI Research, Beth Israel Deaconess Medical Center, Boston, MA. Dr. Alsop develops and implements state-of-the-art techniques for imaging blood flow with arterial spin labeling. His methods, including pulsed continuous arterial spin labeling and rapid 3D stack of spirals acquisition, are being evaluated in tumors, dementia, stroke, and normal brain function. He is also pursuing their application to body imaging, particularly toward renal disease and renal cancer when contrast is contraindicated.

Dwight Nishimura, PhD – Co-director, Magnetic Resonance Systems Research Lab, Stanford University, Stanford, CA. Dr. Nishimura harnesses the advanced capabilities of GE's instrumentation to invent new pulse sequences and data processing methods. These innovations not only achieve better imaging performance and enhance image contrast – they also bring MR technology into new applications. Among these advances, developed with PhD candidate Tolga Cukur, are fast-imaging pulse sequences targeting non-contrast MR angiography. With PhD candidate Emine Saritas he has also developed sequences allowing for more robust diffusion-weighted imaging outside the head.

John Pauly, PhD – Co-director, Magnetic Resonance Systems Research Lab, Stanford University, Stanford, CA. Dr. Pauly is best known for his work in designing RF pulses, specifically 1D slice-selective pulses and multidimensional pulses that allow the excitation of arbitrary shapes. His team has also developed real-time color flow and MR Doppler imaging, useful applications in assessing valvular disease. With Research Associate Jin Hyung Lee, PhD, he is working on a new method of sensitizing the MR signal to the oxygen frequency shift using steady-state free precession – an advance offering potential for both higher spatial resolution and greater spatial specificity.

Sean Fain, PhD – Associate Professor of Medical Physics, University of Wisconsin, Madison, WI. Dr. Fain uses hyperpolarized contrast agents to develop and apply fast MR techniques for functional imaging. His team pioneered a combined study of ventilation and airway remodeling to better understand the mechanisms of asthma. Using diffusion-weighted hyperpolarized gas MR imaging, Dr. Fain is also advancing the evaluation of lung structure, detecting microscopic changes that can be used to evaluate early onset emphysema and structural changes due to the aging process.



Identifying Acute Kidney Injury in High-risk Patients

By Eric Scott Cantor, MD

Radiologists across the globe began routinely screening patients for kidney disease after Nephrogenic Systemic Fibrosis (NSF) was initially associated with the use of Gadolinium Based Contrast Media (GBCM) in patients with acute or chronic severe renal insufficiency. The American College of Radiology (ACR) has since published screening guidelines to identify patients at high risk of developing NSF. These guidelines can be found at www.acr.org/Secondary-MainMenuCategories/quality_safety/contrast_manual.aspx.

One of the tools for screening patients is Glomerular Filtration Rate (GFR). GFR has historically been considered one of the primary methods used to measure renal function. Estimated GFR is a fairly rapid tool for identifying and classifying patients with Chronic Renal Failure (CRF) as defined by the National Kidney Foundation (NKF).

But what about those with Acute Renal Failure (ARF), which has also been identified as an at-risk group for those receiving gadolinium-based contrast agents? ARF can broadly be defined as an abrupt decline in renal function resulting in an inability to excrete metabolic waste and maintain proper fluid and electrolyte balance. The majority of ARF cases are secondary to acute tubular necrosis (ATN) from sepsis or nephrotoxin exposure. Most patients fully recover in a week to ten days but CRF or death is possible. Hospital length-of-stay and one-year mortality rates are significantly higher after a bout of ARF.

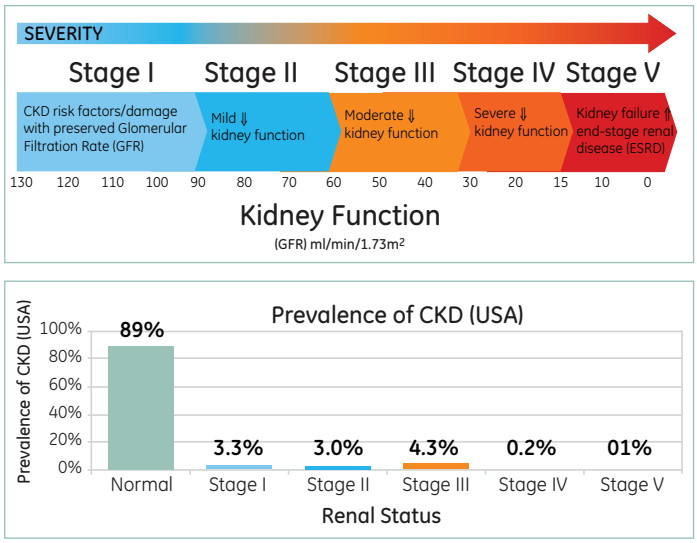


Figure 1

The incidence of ARF was reported by Ali to be 1811 cases per million in a retrospective hospital study in Scotland;[1] Liano reported 209 cases per million in 13 tertiary-care hospitals prospectively in Spain;[2] and Xue reported 23.8 cases per 1000 discharges of hospitalized US Medicare beneficiaries.[3] ARF, known to occur more frequently in older people, is rising in frequency in relationship to the changing demographics of the population, with an estimated incidence rate between 2% to 5% of hospitalized patients.

A review of the literature clearly indicates that epidemiologic studies of ARF are few in number, are all based upon sick hospitalized patients, and fraught with differences in patient populations and characteristics, and there exist differing definitions of ARF. We can, however, discern that the incidence of ARF in the outpatient setting is rare.

A practical challenge arise, since ARF has traditionally been diagnosed after the acute insult and damage occurs, because of the delay in elevation of the serum creatinine biomarker. Renal failure can be asymptomatic but is often associated with non-specific symptoms of fatigue, hematuria, flank pain, dyspnea, edema, hypertension, nausea, confusion, a decrease in urine output, or abnormal urinalysis , especially when associated with surgical or medical co-morbidities. A urinalysis examined immediately after voiding may demonstrate granular casts, renal tubular epithelial cells, proteinuria, or red blood cells. Nephrologists will likely evaluate the urine sample under the microscope; check urine specific gravity, urine electrolytes and other tests to determine the cause of the ARF or acute kidney injury (AKI).

Patients who present with AKI in the outpatient setting most commonly have AKI secondary to drug toxicity, volume depletion, or sepsis. On an in-patient basis AKI is often a result of multiple risk factors and co-morbidities.

There are three broad categories of AKI: pre-renal, renal and post-renal. Radiologists commonly administer hydration with or without bicarbonate or N-acetylcysteine to minimize renal under perfusion and risk of contrast-induced nephropathy. The most common post-renal causes of AKI are kidney stones, most commonly evaluated with renal ultrasonography. Once the clinician rules out pre-renal and post-renal cause, intrinsic renal disease is most often ascribed to ATN. ATN is most often caused by renal hypoperfusion and renal ischemia but intrinsic and extrinsic nephrotoxins should also be considered.

Diagnostic criteria for acute kidney injury

The formation of the Acute Kidney Injury Network (AKIN) has resulted in a new consensus definition of AKI. Likewise, nomenclature has changed to clarify the range of renal dysfunction associated with renal injury, not all of which results in kidney failure. Therefore, the preferred terminology is now Acute Kidney Injury (AKI) with ARF indicative of severe renal dysfunction that may lead to renal replacement therapy or result in end stage renal disease.

The new diagnostic criteria for AKI based upon AKIN is characterized by an abrupt (within 48 hours) reduction in kidney function defined as an absolute increase in serum creatinine of more than or equal to 0.3 mg/dl (≥ 26.4 µmol/l),

a percentage increase in serum creatinine of more than or equal to 50% (1.5-fold from baseline), or a reduction in urine output (documented oliguria of less than 0.5 ml/kg per hour for more than six hours).[4] A new grading system based upon the acronym RIFLE (Risk, Injury, Failure, Loss, and End stage) has been defined by changes in serum creatinine and urine output, which divides AKI into three levels of severity. Staging can be assessed over one week as any abnormalities are typically sustained for more than 24 hours.

Challenges to rapid diagnosis remain as serum creatinine is a biomarker of renal function not injury. Estimation of CRF assumes a steady or equilibrium state, which is inconsistent with the rapid changes in renal function that occur in AKI. Creatinine increases slowly relative to the change in renal function. It may take 48 to 72 hours to observe an elevation in serum creatinine after an acute insult to the kidney. Serum creatinine level is based upon production, which varies with muscle mass, volume of distribution, and tubular secretion, which can in turn vary based upon age, sex, race, weight, diet, drugs, and muscle metabolism.

Looking ahead

A number of new biomarkers under investigation show promise in their ability to increase sensitivity, specificity, and clarification of etiology, prognosis, and time sensitivity for detection of AKI as compared to the historical use of serum creatinine. Many of these new biomarkers are released in response to tubular injury, a measure of anatomic pathology rather than function. These include urinary gamma gutamyl transpeptidase (GGT); N-acetyl glucosamindase (NAG); alpha and omega glutathione S-transferase; netrophil gelatinase associated lipcalin (NGAL); kidney injury molecule 1 (KIM-1); and cystatin C. In some circumstances, these urinary enzymes can detect AKI from 12 hours to four days earlier than a rise in serum creatinine. Although these markers are currently being used on an experimental basis, they are expected to impact the practice of clinical medicine in the not too distant future.

Until these new biomarkers are clinically available, radiologists can be reassured by the knowledge that the incidence of AKI on an outpatient basis is rare. AKI is commonly but not always associated with symptoms or change in urine output, an abnormal urinalysis and serum creatinine. Conversely, in-patients should be considered at higher risk for AKI and concomitantly NSF. They should routinely have their blood tested for serum creatinine, with a comparison made to their baseline, before administration of any GBCM. For those on chronic hemodialysis, it is recommended that they receive hemodialysis as soon as possible after administration of a GBCM and certainly within 24 hours. Gadolinium is dialysable but has not been proven to decrease the incidence or severity of NSF.

Prince et al in the September 2008 edition of Radiology study found no cases of NSF after 74,124 patient exposures to GBCM, when receiving standard dose, even without pre-screening of patients.[5] Reasonable screening and identification of patients at highest risk for NSF, based upon FDA class labeling and ACR recommendations, should minimize the risk of NSF moving forward. ■

Dr. Eric Scott Cantor

Eric Scott Cantor, MD, is head of medical & professional services at GE Healthcare, Medical Diagnostics.

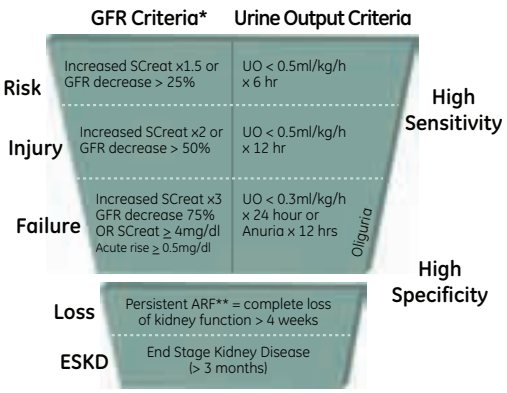


Figure 2

*GFR = Glomerular Filtration Rate

**ARF = Acute Renal Failure

Source: Bellomo R, Ronco C, Kellum JA, Mehta RL, Palevsky P, ADQI workgroup. Acute renal failure – definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. Critical Care 2004, 8:R-04-R212. Available at http://ccforum.com/content/8/4/R204

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Breast Imaging: The Engine Driving

By David R. Gruen, MD

Breast imaging faces a market paradox. Low reimbursement, high equipment costs, and a stressful work environment has led to fewer clinical resources – radiologists interpreting mammograms and techs performing mammography exams – and diminished capacity. From 2001 to 2004, more mammography centers closed than opened while applications for breast imaging fellowships decreased 75%.[1] Yet the demand for breast imaging services continues to increase, by 2010, 74 million American women over the age of 40 will seek mammography service; by 2015, that number increases to 78 million.

Mammography Statistics 10/2001 – 10/2004*	**2001**	**2004**	**Percent change** increase/(decrease)
Facilities	9,306	8,768	(6%)
Machines	13,995	13,400	(4%)
Radiology technologists who perform mammography	31,402	30,503	(3%)
Physicians who interpret mammograms	19,675	18,690	(5%)

*Source: GAO Report to Congress, July 2006

Figure 1. Nationwide, capacity for women's imaging is decreasing.

Certified facilities, as of October 1, 2007	8,837
Certification statistics, as of October 1, 2008	
Total certified facilities / Total accredited units	8,814 / 13,404
Certified facilities with FFDM[1] units / Accredited FFDM units	3,774 / 5,729
FY 2008 inspection statistics, as of October 1, 2008	
Facilities inspected	8,432
Total units at inspected facilities	12,294
Total annual mammography procedures reported, as of October 1, 2008[2]	**36,287,070**

Figure 2. MQSA National Statistics

1 FFDM – Full Field Digital Mammography unit.

2 This number is an aggregate of the total number of procedures performed annually as reported by facilities to their accreditation bodies. Facilities are asked to disclose this information at their initial accreditation, and then at the time of their re-accreditation, which takes place once every three years. FDA began collecting these data in 1998. The aggregate does not reflect the current number of procedures performed at these facilities, but only the numbers reported by them during the three-year period prior to the current date. The FDA has aggregated only the numbers reported by certified, non-Veterans Administration facilities.

Source: MQSA Facility Scorecard, available at http://www.fda.gov/cdrh/mammography/scorecard-statistics.html

During this same time, advancements in breast imaging technology took center stage. Interestingly, a February 2002 Time magazine cover story, "The New Thinking on Breast Cancer," did not mention digital mammography, CAD, breast ultrasound or breast MR imaging. Yet today in our practice at Norwalk Radiology & Mammography Center, these technologies form the cornerstone of our breast imaging services. In fact, breast imaging is the engine driving the success of our practice.

Consider that many female-specific health issues typically require an imaging exam – from screening mammograms to bone density studies. Further, in many US households women remain the primary caretakers and, therefore, often initiate the delivery of care process. By gaining their loyalty, a breast imaging/women's care clinic can develop a patient-physician relationship.

Therefore, determining the return-on-investment (ROI) of a breast imaging practice must take into account all technologies, not just screening mammography. In fact, while the mammogram itself may not be highly profitable (a practice must perform a high volume of studies to achieve a reasonable ROI when considering only mammography), the potential spin-off is significant.

a Successful Practice

Recognize that women often require additional imaging services such as breast MR imaging, breast ultrasound, breast biopsies, bone density scans, and vein therapy procedures. Women, who account for half of the population, may also need an MRI of the knee or CT scan of their abdomen. The idea here is to follow basic marketing: If you treat women well on their annual mammogram visit, then they will remember you when they or their family members need an imaging study. There is no better marketing, or better patient loyalty, than that. And it works; we discovered that with the right mix of modalities, service, and patient-centric focus, these patients and their families are likely to come back to our practice for their diagnostic imaging needs.

Dr. David Gruen

David Gruen, MD, is the Assistant Chief of the Medical Staff at Norwalk Hospital and the Medical Director of the Connecticut Breast Center at Norwalk Radiology. He holds a seat on the Norwalk Hospital Board of Trustees, and serves on the hospital's Strategic Planning, Neoplastic Disease, and Quality Committees. He is also on the board of Norwalk Hospital's Smilow Family Breast Health Center.

Dr. Gruen received his degree in medicine from Weill-Cornell University Medical College. He completed his radiology residency at New York Hospital-Weill Cornell Medical Center and then completed postgraduate fellowship training at Memorial Sloan-Kettering Cancer Center. He was certified by the American Board of Radiology in 1997. Dr. Gruen has become a nationally recognized expert on breast MR, having given numerous lectures, both live and web-based. He has also lectured nationally on the business of radiology, including 'best practices in women's imaging.'

The opinions expressed in this article are those of the author and do not represent the opinions of GE Healthcare or its employees.

ACS Recommendations for Breast MRI Screening as an Adjunct to Mammography

Recommend Annual MRI Screening (Based on Evidence*)

- BRCA mutation;
- First-degree relative of BRCA carrier, but untested; and
- Lifetime risk 20% to 25% or greater, as defined by BRCAPRO or other models that are largely dependent on family history.

Recommend Annual MRI Screening (Based on Expert Consensus Opinion)**

- Radiation to chest between age 10 and 30 years;
- Li-Fraumeni syndrome and first-degree relatives; and
- Cowden and Bannayan-Riley-Ruvalcaba syndromes and first-degree relatives.

Insufficient Evidence to Recommend for or Against MRI Screening***

- Lifetime risk 15% to 20%, as defined by BRCAPRO or other models that are largely dependent on family history;
- Lobular carcinoma in situ (LCIS) or atypical lobular hyperplasia (ALH);
- Atypical ductal hyperplasia (ADH);
- Heterogeneously or extremely dense breast on mammography; and
- Women with a personal history of breast cancer, including ductal carcinoma in situ (DCIS).

Recommend Against MRI Screening (Based on Expert Consensus Opinion)

- Women at <15% lifetime risk.

* Evidence from nonrandomized screening trials and observational studies.

**Based on evidence of lifetime risk for breast cancer.

***Payment should not be a barrier. Screening decisions should be made on a case-by-case basis, as there may be particular factors to support MRI. More data on these groups is expected to be published soon.

Source: Saslow D, Boetes C, Burke W, Harms S, Leach MO, Lehman CD, et al. American Cancer Society Guidelines for Breast Screening with MRI as an Adjunct to Mammography. CA Cancer J Clin 2007, 57:75-89

For more information: ACR published guidelines for the performance of magnetic resonance imaging (MRI) of the breast can be found at www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/breast/mri_breast.aspx

Patient-focused practice

A breast imaging center creates success by changing the paradigm of how it conducts business. At our practice, the central focus is the patient. This focus goes beyond clinical performance to encompass the psychological impact of breast cancer.

Consider that convenience – location and access to services – is most important to patients. Breast imaging centers fulfill this need by taking a different approach to service. At our practice, we've made an important commitment to women: detection to diagnosis in 48 hours.

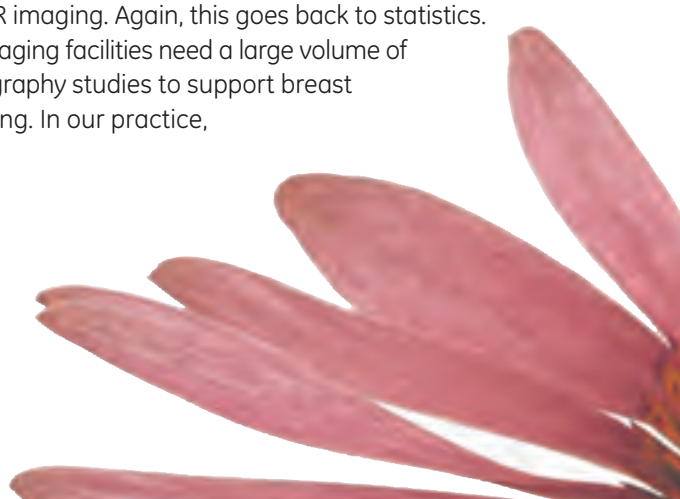
To accomplish this, we trained our staff to say "yes." Yes, that we can open early or stay late to accommodate a patient. Yes, that we can squeeze a patient in on an already full schedule. Yes, that we will treat all patients as we would want our mother, daughter, or sister treated. Yes, that their radiologist is available to that patient when needed. Saying yes is at the heart of our breast imaging growth.

Growing the practice with breast MR imaging

Breast imaging starts with mammography but doesn't stop there. By increasing our mammography business we can also increase our breast MR imaging business. Statistics demonstrate that with mammography we will find a certain number of new breast cancer cases. Just as the American Cancer Society (ACS) recommends that women at high risk receive a yearly breast MR in addition to mammography, the tumor board at our medical center now requires that all new cases of breast cancer receive a breast MR prior to their definitive surgery.

Why do we perform breast MR? Because we can find more disease. The very first step is to recognize patients who will benefit from breast MR. Following the recommendations of the ACS, we identify women as high risk with family or personal history of the disease and those with a lifetime risk greater than 20% to 25%.

Second, determine if the patient base is sufficient to support breast MR imaging. Again, this goes back to statistics. Breast imaging facilities need a large volume of mammography studies to support breast MR imaging. In our practice,



more than 5% of the patients who get screening mammography also receive breast MR imaging examinations. That number will vary depending on whether the screened population is high or low risk. It will also depend on whether the referring physicians – typically breast surgeons, radiation oncologists, and medical oncologists – find value from the studies. That's where the next recommendation comes in.

Find a breast MR "champion" in your practice – someone who will talk to patients, tumor boards, referring physicians, medical directors, and surgeons on the value of breast MR imaging and patient benefits. This champion must be committed to making breast MR work. If you can demonstrate that breast MR adds to the quality of patient care, you've gone a long way towards a successful program.

Fourth, proper equipment is crucial to a successful breast MR imaging program. It starts with a 1.5T magnet, minimally, along with the capability to image both breasts dynamically. CAD for MRI should be considered a necessity, not an option. Then, if you find a lesion, you must have the capability to intervene and biopsy. The availability of MR-guided interventions should be considered a mandatory prerequisite for offering breast MR imaging.

Last, breast MR should be read with the same expertise as corresponding mammogram and ultrasound studies. There is a learning curve to breast MR similar to mammography. Radiologists should track results just like mammography; review biopsies to ensure concordance with pathology and learn from any missed diagnoses; discuss difficult cases with colleagues; and compare the radiologists' diagnostic accuracy by comparing statistics against radiologists in the practice who have been reading breast MRs for a longer period of time. The bottom line: to ensure the highest excellence in care, conduct enough MR studies so you become proficient in identifying the realm of normal and abnormal breast MR imaging studies.

Overcoming challenges

Third-party payers have become a substantial challenge to a breast MR imaging program. In our experience, breast MR is a red flag on the insurance carrier's radar screen. Often, they disapprove this study because the radiologist "hedges" on the necessity of the exam in the report.

Another challenge is the physician-to-physician relationship. Even if a radiologist strongly recommends a breast MR study and it is not performed, do not challenge the relationship of the patient with that referring physician. Recommend breast MR, breast ultrasound, and biopsy appropriately and ethically, always keeping the

About the facility

Norwalk Hospital is a private, not-for-profit, voluntary acute care community hospital located in Fairfield County, Connecticut. The Hospital, founded in 1893, has maintained a tradition of outstanding service to the residents of Norwalk and neighboring communities. At Norwalk Hospital, the Smilow Family Breast Health Center offers education and support for women as they cope with abnormal breast screening findings.

This program addresses breast care in a seamless manner, beginning with community education and screening. Focusing on rapid diagnosis, the program provides on-going support through-out the process of referral and scheduling to all needed services and physicians.

Since 1985, Norwalk Radiology & Mammography Center has grown into the largest imaging center in Fairfield County. The practice has also formed the Connecticut Breast Center at Norwalk Radiology, which is fully accredited by the American College of Radiology in mammography, MRI, and ultrasound, and certified by the FDA in mammography. The Connecticut Breast Center is designated as an ACR Breast Imaging Center of Excellence (BICOE), offering a full array of imaging technologies – FFDM, MR, ultrasound, CAD – and stereotactic, MR, and ultrasound biopsy capabilities. Plus, the center is the only site in Fairfield County with the GE Senographe Essential Digital Mammography System, featuring a 24 x 31 cm detector. The clinicians and staff are committed to providing patients with professional, concerned radiologists, highly trained technicians, helpful support staff, and – most of all – individualized care. Their promise to patients is detection to diagnosis in 48 hours.

Measuring ROI of women's imaging is like measuring "ROI" of marketing	
Breast MR Imaging	60 per 1000 mammograms
Breast Ultrasound	165 per 1000
DEXA (Bone Density	187 per 1000
Breast Biopsies	44 per 1000
Vein Therapy Procedures	65 per 1000 mammograms

Figure 3. Recognize that women's imaging is one of the few opportunities radiologists have to be the primary care physicians. Develop patient-physician relationships to understand what your patients need and want and then deliver the services that meet their clinical needs.

patient's health as your top priority, followed by the interests of the community. Work closely with referrers to demonstrate this; yet at the same time, if a breast MR referral is denied recognize that the carrier is challenging the physician-to-physician relationship and act accordingly. Fight for the patient's right to healthcare with the insurers when necessary.

Magnet utilization is a tremendous challenge for most breast imaging centers. There is a delicate balance to fulfill the request for a timely breast MR without putting off other referrers. The key is juggling your schedule without alienating other referrers. This goes back to saying yes, and making yourself available to patients in the same manner that you would want to be treated.

Results point to success

By performing a high standard of care for all patients, with a particular emphasis on patient convenience and clinical availability, our practice has continually increased patient volume since 2001. During this same time, we have achieved double-digit growth for mammography, breast ultrasound, and breast MR imaging procedures.

We accomplished this by viewing our women's imaging business as an annuity. Each screening mammogram performed at our facility opens new opportunities to provide additional imaging services. Therefore, it is important to remember that the ROI of women's imaging is measured by the total sum of modalities and services, not just mammograms.

Building a successful women's imaging center requires the right mix of technology along with a patient-centric approach. Work closely with referring physicians to appropriately identify patients who will benefit from additional breast imaging studies such as ultrasound and MR. As with any new technology, having a champion within your practice who is committed to working with specialists, tumor boards, and referring physicians helps build loyalty at the clinical level. By addressing the psychological as well as physical issues associated with breast cancer, you can win the loyalty of not just physicians, but also patients, their families, and all those they talk to. Remember that breast imaging presents a unique opportunity for a radiologist to become a trusted confidant who can help women manage their health for life. ■

References:

1. GAO report to Congress, July 2006.

Facts and Stats

Incidence rates continue to drop:

Between 2001-2004, invasive breast cancer incidence rates decreased by 3.5%. This is the first time rates dropped since 1980.

Eighty percent of in situ breast cancer cases are ductal carcinomas (DCIS); Since 2000, incidence rates for in situ breast cancer have leveled off among women aged 50 and older. While rates continue to increase for younger women, the result is largely attributed to mammography's ability to detect cancers that cannot be felt.

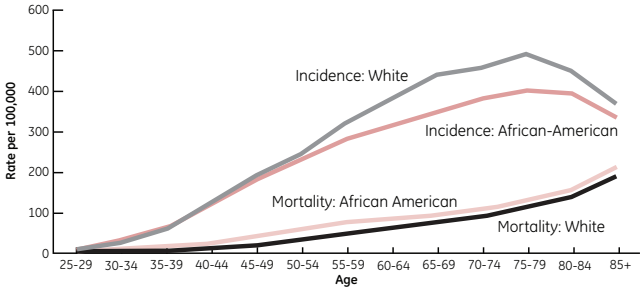
Mortality:

1975-1990; death rates increased by 0.4% annually.

1990-2004: death rates decreased by 2.2% annually.

The decline, largest among younger age groups (3.3% per year for women younger than 50, 2.0% per year for women 50 and older), isattributed to both improvements in breast cancer treatment and to early detection.

Figure 1. Female Breast Cancer – Incidence and Mortality Rates by Age and Race, US, 2000-2004



Data sources: Incidence – Surveillance, Epidemiology, and End Results (SEER) Program, SEER 17 Registries, 2000-2004, Division of Cancer Control and Population Science, National Cancer Institute, 2007. Mortality – National Center for Health Statistics, Centers for Disease Control and Prevention, 2007 American Cancer Society, Surveillance Research, 2007.

Survival rates:

At five years after diagnosis: 89%; 98% for localized; 84% for regional disease; 27% for distant-stage disease.

At 10 years after diagnosis, 81%.

At 15 years after diagnosis, 73%.

Size, regional disease:

The five-year relative survival for tumors less than or equal to 2.0 cm is 94%; for tumors 2.1 to 5.0 cm, 30%; for tumors greater than 5 cm, 66%.

Age at diagnosis:

The five-year survival rate: for women diagnosed before age 40 is 82%; for women diagnosed at age 40 or older, 89%; Tumors diagnosed in younger women may be more aggressive and less responsive to treatment.

Genetics:

It is estimated that five to 10% of breast cancer cases result from BRCA1 and BRCA2 inherited mutations or alterations.

Women with BRCA1 mutations have a 65% risk for developing breast cancer by age 70; for women with BRCA2, the risk is 45%.

Women with a family history of breast cancer and either hyperplasia (ADH) or atypical hyperplasia (ALH) lesions have a higher risk of developing breast cancer.

High breast tissue density:

Several studies indicate women with the highest levels of breast density were found to have a four- to six-fold increased risk of breast cancer.

Source: ACS Breast Cancer Facts & Figures 2007-2008. Available at http://www.cancer.org/docroot/STT/content/STT_1x_Breast_Cancer_Facts_Figures_2007-2008_08.asp

MR Safety Proofing Your Facility

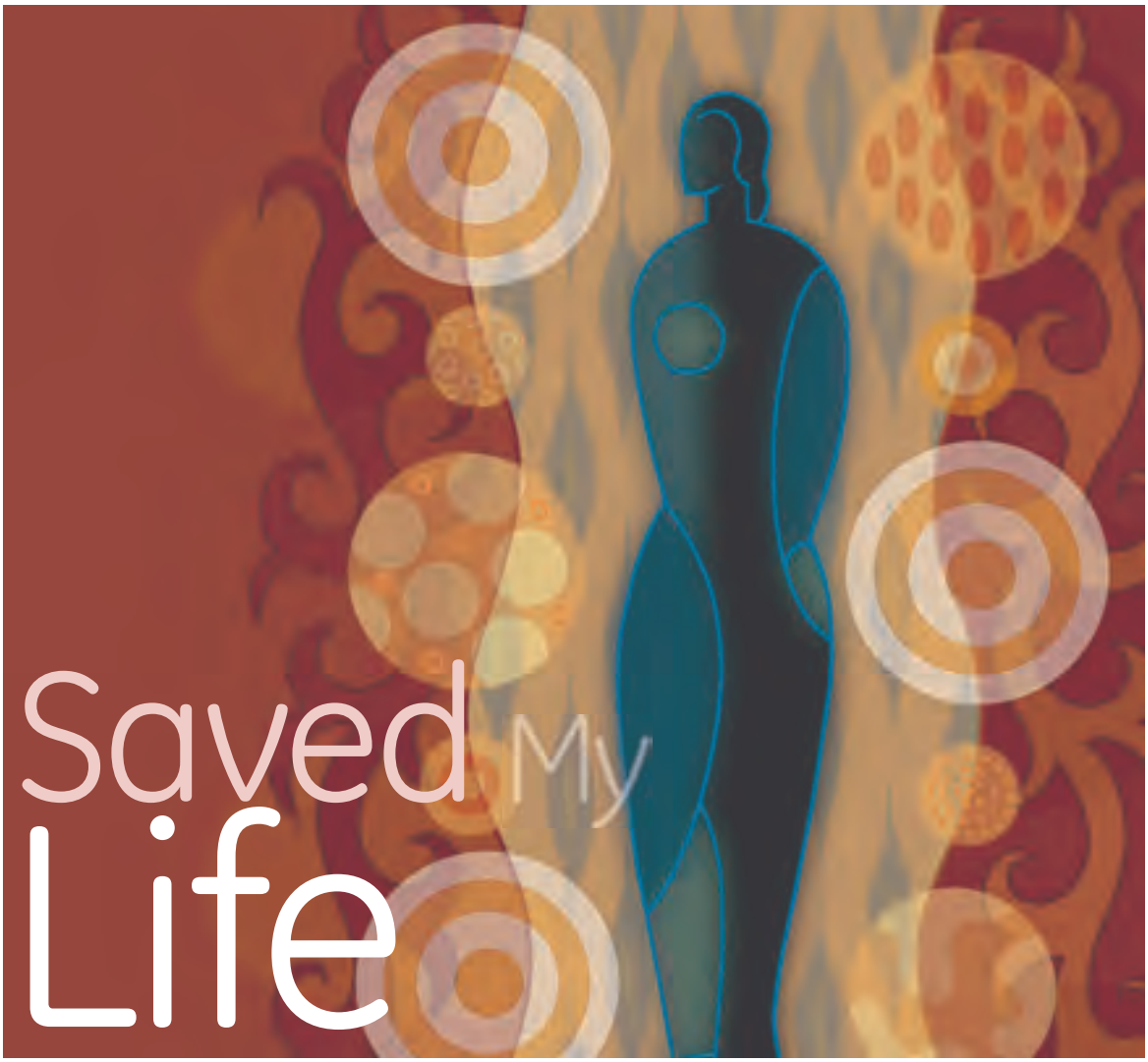
What kind of MR safety program is in place at your facility? Is it as safe as possible? Taking a systemic approach to MR safety and establishing a culture of awareness and responsibility at all levels of your organization can help minimize the likelihood of MR accidents and injuries to patients, operators, and others.

"It's crucial that sites train anyone who might have access to the magnet room, including those who are only occasionally or rarely in the magnetic fields of MR scanners, such as security, housekeeping personnel, firefighters, or police," suggests Joe Schaefer, principal safety engineer for GE Healthcare and member of the American College of Radiology's Blue Ribbon Panel on MR Safety.

Here are additional recommendations to help ensure that your site is as safe as possible.

- **Designate a leader for your MR safety program**
  The leader of your MR safety program should have the experience, training and authority to effectively champion all MR safety activities throughout the organization.
- **Establish policies and procedures to address MR safety**
  Clearly documenting the MR safety policies and procedures at your facility can facilitate training, minimize confusion and help to establish common terminology and work practices. These policies and procedures should address:
  - Emergency procedures (actions to take in the event of fire, natural disaster or similar emergency situation);
  - Adverse event investigation and reporting;
  - Facility and MR suite access restrictions and control mechanisms; and
  - Processes and documentation associated with patient screening.
- **Establish a personnel qualification process**
- **Build a strong training program to include new employee education and recurring training**
  According to Schaefer, it's crucial that the training be frequent, at least annually.
- **Conduct regular walkthroughs and self audits**
  Don't get overly comfortable with your MR safety program; evaluate it on a regular basis and find ways to improve.

This is part one of a series on MR safety. Look for articles about success stories, plus potential adverse risks and how to avoid them, in upcoming issues. For more information, visit **www.acr.org/SecondaryMainMenuCategories/quality_safety/MRSafety.aspx** or **www.gehealthcare.com/usen/mr/mrsafety/index.html** ■



MRI Saved My Life

Hearing you have breast cancer is something no woman ever wants to experience. But today women have many more choices for screening and treatment than ever before. For Jill and Amy, advanced imaging technologies are literally their life-savers. Here are their stories.

For Jill Bald, the term "early health" means everything to her – it is her greatest chance to survive. Jill, a breast cancer survivor and GE Healthcare employee, knows all too well the devastation caused by breast cancer. Her mother lost her battle with breast cancer as Jill was beginning her second round with the disease.

Starting at age 35, Jill received annual mammograms because of her family history. By 2004, at age 39 she was in the best physical shape of her life thanks to a consistent exercise regime. Yet, she couldn't ignore the small lump in her breast that mammography didn't detect. Jill knew better than to ignore it. Working in the healthcare industry gave her the knowledge, and watching her mom go through chemotherapy provided the gut feeling that something was wrong.

Fortunately, she trusted her instinct and questioned why the level of screening did not identify what she physically and psychologically felt.

Jill's story

"I pushed the issue and my doctor sent me for an ultrasound, which confirmed my worst nightmare," Jill recalls. "I had a 2 centimeter cancerous tumor that had been growing inside me now for years."

She proceeded with a lumpectomy and radiation therapy at the site, followed by six months of chemotherapy.

"There were so many specialists, I couldn't name them all," she says. Radiologists, oncologists, radiation oncologists, surgeons, pathologists; each a different stakeholder in Jill's health, working together to achieve a successful result.

Her six month mammogram follow-up was normal; however, at the following six month check-up due to her family history and dense breasts, her doctor recommended that she alternate between mammograms and breast MRIs.

Although Jill knew what to expect with an MRI – the loud noises, pings and rattles – the hardest part was not letting her mind run away and cause additional anxiety. "I had to lie face down, and it was not comfortable," she says. But it was the breast MRI results that shattered her resolve.

"Just when I thought it couldn't get worse, it did," Jill recalls. The MRI revealed an area of suspicion adjacent to the lumpectomy scar. When a subsequent mammogram did not reveal the lesion, she pushed for another ultrasound followed by a biopsy that confirmed a second, smaller site of breast cancer. Since a patient can not undergo radiation a second time, she knew that she had to face her worst fear and that a mastectomy was now her only option.

"If that wasn't enough, the very day I got my news, I learned my mother was no longer responding to her chemo treatments. She lived only another two weeks."

Jill underwent a double mastectomy with reconstruction and today she is breast cancer free. "I alternate between ultrasound and MR screenings every six months." But she knows that many women are more passive than she was in pushing for additional screening tests that undoubtedly saved her life.

"Trust yourself. You know if a test result isn't quite right," she adds. "You are always better off knowing the truth early because then you have the opportunity to fight. My mom didn't have that chance."

Her advice to other women is always ask questions to understand all of your choices and push for additional testing if something suspicious is seen or felt. And, she knows first hand the value of breast MRI. "If something is seen with a mammogram or ultrasound, then I would suggest asking your doctor if you would benefit from an MRI before lumpectomy or mastectomy. Your doctors will have a 3D image of the breast that will provide a complete picture that can help them identify the entire area of suspicion. I went through radiation and chemo only to find out there was more cancer left behind the first time."

> "Trust yourself. You know if a test result isn't quite right."
>
> *Jill Bald*
> *breast cancer survivor*

Amy's story

Breast cancer doesn't discriminate by age or family history. Just ask Amy Atchison, who was only 32 when her primary care doctor referred her for a mammogram in September 2000. "I was shocked to receive a mammogram at such an early age," she says. The mammogram showed calcifications in her left breast, yet the stereotactic breast biopsy results were negative.

Five years later, Amy's gynecologist recommended she receive a baseline mammogram due to the dense nature of her breasts. Again, she had calcifications, this time in her right breast. Another biopsy deemed the calcifications were not pre-cancerous.

Fast forward to September 2007 and Amy's next mammogram. "Because of my history, I waited for the on-call radiologist to review my results." Again, she had calcifications in both breasts. "By this time, I was very upset since I never experienced a normal mammogram. So I decided to consult a breast specialist." Another biopsy of her left breast came back normal.

Within two months, however, a hematoma formed at the site of her last biopsy. Twice, her breast specialist tried to aspirate it unsuccessfully. Her doctor recommended she keep a close eye on it. But the lesion seemed to double in size over the next two months and Amy knew something was not quite right. The hematoma was removed, and Amy re-focused on her mother who was fighting uterine cancer. Her focus turned inward when the pathology results showed cancerous cells in and around the hematoma. An MRI was scheduled.

"I was a bit anxious, and the technologists asked me if I was claustrophobic, which I'm not, or so I thought." Laying face down in the MRI scanner, she began to panic. "The tech said I had to be in there for 30 minutes but I couldn't last 30 seconds. I guess I learned that day I am claustrophobic." The exam was rescheduled, and Amy would have to be sedated.

The breast MRI results showed another area of concern in her left breast. Although her doctor initially recommended lumpectomy, the hospital surgical review board recommended mastectomy.

"I was very upset and confused over all the information and mixed messages," Amy recalls. She got a second opinion and met with a plastic and general surgeon, oncologist, gynecologist, and nurse practitioner trying to weigh her treatment options and next steps. She saw a geneticist and decided to test for BRAC1 and BRAC2. "I have an identical twin sister, so I wanted to do the genetic testing for her." Fortunately, that came back negative.

Amy was about to make the most important decision she had ever faced. "It was actually my oncologist who helped me make the decision to have a mastectomy," she says. "He simply reminded me that it is my life and ultimately, I have to make the best decision for me."

Her decision was further spurred by the fact her cancer was HER2-positive, a more aggressive form of breast cancer. This also impacted her post-mastectomy treatment plan. In addition to six rounds of chemotherapy, Amy receives weekly Herceptin injections that will continue for a full year.

In September 2008, Amy had her first normal mammogram on her right breast and completed chemotherapy. While she waits to complete reconstructive surgery on her left breast, she looks back at the past year and realizes that had she not been proactive in her own care, her breast cancer battle likely would have a different ending. "Ask questions, get a second opinion and speak up!" Today, she takes one day at a time, and brings her positive attitude into everything she does. "I count my blessings at the end of each day, and yes, a sense of humor is critical." ■

"Ask questions, get a second opinion and speak up!"

Amy Atchison
breast cancer survivor

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